ENVIRONMENTAL SCIENCE THEORY

Concepts and Methods in a One-World, Problem-Oriented Paradigm

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Leiden University
1992

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Preface to the Ph.D thesis version

The present Ph.D. thesis is the abbreviated version of a book with the same title, published by Elsevier Science Publishers in October, 1992. The Elsevier publication, besides the five chapters of the Ph.D thesis, contains a three-chapter sequel:

- 6: Participation in Environmental Management
- 7: Interpretative Directions for Environmental Science
- 8: Partnership with Nature: A Philosophy for Practice.

Where useful, the book will in this thesis be refered to as De Groot (1992b), with the appropriate Chapter added.

Because of the restrictions with respect to acknowledgements in Leiden University Ph.D theses, the acknowledgements are taken up in the Elsevier publication only.

The aim of this study as a whole is to foster the growth of environmental science into a fully-fledged problem-oriented discipline. In this introductory chapter, this aim is related first to environmental science in the Netherlands, a country as rich in landscapes as it is in environmental problems. Then, the aim is approached at a more fundamental level: can, for instance, a discipline be problem-oriented and a real, theory-rich science at the same time? This exploration leads to a formulation of what a 'fully-fledged problem-oriented environmental science' is, and it is indicated that the aim of the study may be operationalised into three objectives, coinciding with its three core chapters: (1) to develop a (one-world, fully interdisciplinary) framework for research and teaching, (2) to clarify environmental science's normative foundations and (3) to develop a methodology for research into the social causes of environmental problems.

Chapter 1

INTRODUCTION

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Q. Mr. Arbuthnot, I understand that you have undertaken a career as a social scientist.

A. That statement conforms in a high degree to its truth value in terms of reality testing.

Q. What's that again?

A. Yes.[1]

1.1 Environmental Science In The Netherlands And The Position Of This Study

In the 1970s, largely as a response to the rapidly growing public awareness of environmental problems, the majority of Dutch universities established Centres for environmental science, most of them with a multidisciplinary staff and an interfacultary position. Besides these centres, most universities have spawned 'environmental specialisms', such as environmental law and environmental chemistry, within the traditional disciplinary walls.

Taken as a whole, the environmental science centres have been growing at a steady rate of 10 % per year (ICM, 1987), at present comprising a total payroll of 200 'full-time equivalents' of academic staff (RAWB, 1989). Most of these people are still funded by government research contracts, but from the late eighties onwards the universities have been catching up on funding the centres themselves, an evolution connected to a rapid growth in environmental science education.

Fitting nicely into the general descriptions of the process of professionalization (Johnson, 1977), a bi-monthly scientific journal was started in 1986, and an Association of Environmental Scientists in the same year. A one-year post-academic professional training course was established in 1987.

The early nineties have been characterized by rapid developments in environmental science education. Up to that time, only minor subjects and field research had been supplied to the surrounding, monodisciplinary departments. By shrewd planning,

[1] Taken from Bereldsen, "The Cliché Expert Testifies on the Social Sciences", manuscript privately circulated circa 1950s, found in Dubin (1969).

some students could study environmental science for up to two years but even then they still remained students in biology, sociology or whatever. At present, six Centres offer environmental science curricula of three to four years.

The present study, as its title indicates, is about environmental science theory. The coming sections of this chapter will discuss what such theory should contain and delineate the aims of this study more specifically. At this point we may gain an initial impression by simply taking an empirical look at what Dutch environmental scientists are actually doing in their research and education work. Annex 1.I gives an overview of the characteristic subject matter of research at the environmental science centres; Box 1.1 does the same for a typical introductory course. I have left the listing fairly long in order to preserve its empirical, uninterpreted character.

The research subject list of Annex 1.I is structured along two dimensions, taken from ICM (1987), a report written by the coordinating body of Dutch environmental science. The first one is the *level ofgeneralness* of the knowledge that is sought. 'Theory', as will be discussed further in the next section, is roughly equivalent to 'general knowledge', for any kind of science. As a first conclusion, then, Annex 1.I shows that *in a loose sense* (because many Dutch environmental scientists will doubt whether all the general knowledge they develop really deserves the honourable label of 'theory'), *environmental science theory is not something strange to environmental science;* it is not a discipline that can be conceptualized simply as only an area of case-by-case applications of theories from elsewhere. As we can see further in the Annex, the 'general research' level was more substantially filled in 1990 than it was in 1986; theory-building is a trend.

The second structurizing dimension in Annex 1.I is a classic in Dutch environmental science, namely a subdivision of the discipline not by the type of ecosystem or social system that is researched, but by the *type ofenvironmental problem*[2] that is adressed; categories here are "environmental hygiene", "nature and landscape", "environment and development", "energy and physical resources", or others of the same order. Also, Annex 1.I shows that the discipline is virtually saturated by normative terms such as pollution, risk, management, impact, evaluation, standards, policies, depletion, over-exploitation, design and so on. As a second conclusion, the Annex shows that, again *in a loose sense* (because many environmental scientists will doubt whether the orientation is as all-pervading as I suggest) *Dutch environmental*

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[2] Environmental problems, as Chapter 3 will explain more fully, may be defined as discrepancies between (actual or expected) facts and norms, at the level of impact (e.g. environment-related health), at the level of environmental parameters (e.g., toxic substances in the air) and at the level of environmentally relevant activities (e.g., a proposed highway).

science is problem-oriented[3], paradigmatically permeated by a normative sense of right and wrong.

Annex 1.1 also shows that Third World problems and global problems are studied by the same institutions that study the local and the national, 'Western' ones. Hence, a third conclusion is that the discipline is *conducive to a one-world approach* (Sanyal, 1990), i.e. research and education that treats the world not as a small number of homogeneous political-economic blocks, but as a manifoldedness of differences, united on a single globe.

The present study is, or at least aims to be, one hundred percent theory, problem-oriented and 'one-world'. In that sense, it is nothing but an enhanced version of what Dutch environmental science is already. At the same time, however, this study is not at all a review of what Dutch environmental science (or, for that matter, environmental science anywhere) is predominatingly doing at present. It does not build on present strong points, but instead tries to strengthen the weak ones. The identification of what these weak points are depends, of course, on one's vision of what environmental science should be; this will be the subject of the next sections. Here, Annex 1.1 may again serve to provide a first impression.

It can be seen that, as a whole, the discipline is dominated by the natural sciences (roughly: studying the environment, and environmental impacts, in a normative, problem-oriented perspective).

Secondly, it can be seen that the theory level is still relatively poorly developed. The discipline has a tradition of 'problem hopping' (De Groot, 1992), adressing one environmental problem after another, without much reflection on their general causes, on general methodologies or on the normative principles that are applied to define what is a problem or a good solution at all.

This character of the discipline coincides with what is usually denoted as "environmental management", encountered in textbooks such as Ortolano (1984), Baldwin (1985), Jørgensen and Johnsen (1989), Dorney (1989)[4] and many others[5]. Exag-

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[3] The problem orientation of Dutch environmental science is also visible in its self-declarations. Bouwer and Gersie (1983) say that environmental problems are the object of environmental science, and warn against the "traditional overburden of non-problem-oriented notions" of other disciplines. In the same vein, Tellegen (1983) warns against the vagueness of ecological concepts, and proceeds by saying that "the environmental scientist should search for the causes and solutions of environmental problems with a maximum of openmindedness". For opinions from outside the discipline, unanimous about the problem-oriented character of environmental science, see Zonneveld (1983) Zandvoort (1986), Mertens (1989) and Van Hengel (1991).

[4] Dorney (1989), for instance, lists 51 types of tasks for environmental management,

- 20 under the heading of 'Principles Applicable to General Planning', among which: 'identify objectives', 'evaluate new technology', 'assess designed land use flexibility', 'undertake risk assessment';
- 23 under the heading of 'Natural Science-Based Principles', among which: 'inventory resources', 'determine carrying and assimilative capacity', 'identify areas opportunity', 'map land sustainability', 'identify indicator and rare species';

gerating slightly, the aim of this environmental management is to analyse the natural science aspects of an environmental problem, and then try to solve it directly by means of technical measures.[6,7] It is much to be applauded that from the late 1980s onwards, this focus of environmental science has begun to shift in the Netherlands; a growing amount of attention is being given to the fundamental aspects of global environmental problems and sustainability, the social causes of environmental problems and the linkages between environmental science and ethics. This movement is not just a nice enrichment of an interesting discipline; it is a crucial step if environmental science really wants to contribute to the prevention of suffering on an unprecedented scale, inherent in the present rates and causes of environmental destruction.

Environmental science education is less dependent than research on external funding by traditional (monodisciplinary and government) agencies. Therefore, it may be regarded as a more direct expression of what environmental scientists themselves want their discipline to be. Box 1.1 has been included for this reason, summarizing an introductory course[8] (2 months' study-time) for third-year students following an environmental science minor. Visible in the Box are the 'environmental specialisms' such as environmental chemistry and environmental law, included in the course and yet different from environmental science proper. In the Dutch tradition (e.g., De

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- 8 under the heading of 'Social Science-Based Principles', among which: 'identify perception where acceptance or rejection resides', 'develop strategies to alter values', 'map recreational capability', and 'specify public participation approach'.

All these tasks (and the others not listed) pertain to the environmental problem and the design and implementation of its solutions, not to the problem's social causes.

[5] The collective product of UNCRD/ILEC/UNEP (1987), for instance, formulates the objectives of environmental planning and management as "(1) assess environmental consequences of alternatives [= problem analysis and evaluation], (2) resolve conflicts and allocate the use of resources [= design], and (3) direct, control and manage development activities [= design and implementation]". Consequently, four "stages" are identified: "Diagnosis and prevention; Plan formulation; Plan implementation; Monitoring and evaluation", without problem explanation.

[6] Strangely enough, the environmental management handbooks also neglect the design of technical measures or policies; Section 3.11 gives some more details on this.

[7] Also, the environmental management textbooks are dominated by matters of pollution and waste. In this respect too, the present study shows the opposite emphasis, i.e. an emphasis on problems with respect to nature, natural resources and basic sustainability. Bluntly put, this study is everything that the four quoted books are not; they represent the traditional and still quite strong backbone of the discipline, while this study represents the new outgrowths. Together, one could say, they make the discipline.

[8] Much more than the short courses, the three-to-four year curricula are dependent on endorsement by surrounding departments. In the Netherlands, these curricula show a strong bias towards either the social or the natural science departments; it is either environmental science plus social science, or environmental science plus natural science. It is hard to say whether this expresses what environmental scientists think is justified or simply represents a compromise with the academic power centres. See also the Annex of Chapter 2.

Groot and Udo de Haes, 1983; Boersema et al., 1984), these disciplines are conceptualized as branches of their respective 'mother disciplines', feeding into, but not part of, interdisciplinary environmental science.[9] More important for the purpose of this study, the basic characteristics of this course, compared to those of the research subjects, are as follows.

- All students follow a common, general introductory part, before branching out to the two sequels, focusing on Western and Third World problems, or following them both. Thus, a theory level and a one-world tendency are more visible than they are in the research list.
- Environmental problems hold a place of primacy as they do in the research, but problems are not visualized as only in need of analysis and solution, but also of *explanation,* i.e. the study of the social and normative context from' which they arise. As a result, philosophy and social science are much more visible inputs.

Although the level of what is taught in the course is not comparable to what is studied in the research, the course is more advanced in the sense described in the previous paragraph. It depicts a more fully-fledged problem-oriented discipline, gaining in scope and depth with respect to its environmental management origins.

The aim of the present study, therefore, has not been that of a lone hunter, although at certain points the author could not escape that feeling. Besides drawing much from surrounding disciplines such as philosophy and the social sciences, it builds on many inspirations from within the discipline itself.

The aim and structure of the study will be more fully enunciated in the Sections 1.3 and 1.4. First, however, it serves to cross over for a while to the complete opposite of taking a simple empirical look at the discipline. The next section thus touches upon the one of the more fundamental struggles out of which this study has grown.[10] The basic question considered there is: can a problem-oriented discipline be more than merely an area of application of other disciplines? In other words, can it really have a theory level of its own? Or, in yet other words, can it be a discipline at all? This question, obviously, has much to do with the basic image of what science, *real* science, is.

[9] The Dutch term 'environmental sciences' (plural) thus denotes the environmental specialisms plus environmental science. This differs from the Anglo-Saxon tradition, in which 'environmental sciences' usually is the umbrella term for geology oceanography, physical geography and so on." In that conceptualization, environmental science' (singular), as visible in Kupchella and Hyland (1986) and Chiras (1988), comes * denote the conglomerate of the applied branches of these environmental sciences hence without the non-physical disciplines such as environmental law, sociology or ecological anthropology. Weis (1990) provides an overview of U.S. undergraduate environmental science programs. On the whole, the picture is the same as in the textbooks: a strong domination of the natural sciences a problem-orientation tot ,s understood as the application of these sciences, and some brief glances into social sciece and ethics.

[10] Another one is described in Section 3.1.

Box 1.1

SUBJECT MATTER OF THE COURSE 'INTRODUCTION TO ENVIRONMENTAL SCIENCE' AT LEIDEN UNIVERSITY, 1991

COMMON CORE
- First exercise: aluminium, energy and North-South linkages
- Environmental Science I: history, mission, basic concepts, interdisciplinarity
- Environmental Science II: environmental problems overview
- Environmental Science III: the concept of sustainable development
- Environmental Science IV: analysis and explanation of environmental problems
- Environmental Science V: design and evaluation of solutions
- Environmental philosophy
- Environmental movement
- Environmental policy (national, international)
- Exercise: chemical waste

'WESTERN' SEQUEL

Environmental specialisms
- Environmental chemistry and toxicology
- Environmental biology
- Environmental economy and sociology
- Environmental psychology
- Environmental law

Cases

The manure excess problem:
- background views, analysis, expianation
- policy options and policy design

Landscape fragmentation:
- landscape excursion
- problem analysis

Climate change:
- problem analysis, policy options
- exercise: policy design

'ENVIRONMENT AND DEVELOPMENT' SEQUEL

Problem analysis and explanation
- Normative foundations
- Natural science analysis and explanation
- Carrying capacity in the field
- Cultural explanations
- Socio-economic explanations
- Gender in analysis and explanation
- Exercise: North Luzon region

Design and action
- Environmental planning
- Environmental projects
- Participation and action research
- Environment and development cooperation
- Excercise: participatory design of environmental project, North Cameroon

1.2 Theory And The Aims Of Science

Theory is the core of any discipline. Internally, theory guides a discipline into efficiently framing and solving questions and inspired exploration of new areas. Externally, theory is what a discipline is judged by, and rightfully so, in Academia. It is useful, therefore, to briefly review what this concept stands for.

(1) In the Oxford dictionary, we read: *theory is a supposition explaining something, based on principles independent of the phenomena etc. to be explained.*

(2) From social science comes the definition of Hess et al. (1982): *theory is a set of logically related statements*[11] *that attempt to explain an entire class of events.*

(3) And from the humanities, e.g. the historian Ankersmit (1984): *theory [of history] is the level of generality between the level of philosophy [of history] and the level of [historical] studies.*

(4) In natural science, no-one bothers much about a definition of theory. In Einstein (1976), for instance, we find some characterically off-hand statements: "..... *theory (equations)....*" and "*A theory is the construction of a theoretical model .....*" in which the model "serves to represent the complex of our experiences".

One notion, obviously, is common to all definitions. Theory statements are *general* statements, relating to 'an entire complex' at a level that may not be as high as philosophy, but is more general than separate cases. We already encountered this notion in the previous section; terms like Merton's (1967) 'middle range theories', as opposed to the 'grand theories' of society as a whole, work with the same definition.

The four definitions, curiously, do not demarcate between general trivialities and general statements of a higher quality. In everyday language, however, nobody refers to general trivialities as theories. They are true, but they are too *obviously* true, too much in the realm of common sense. Everyday language follows Popper (1972), demanding that scientists should search for what is *unlikely,* and yet true.

As shown by the ethno-methodologist Garfinkel (1967), the cognitive processes of daily life (ethnomethodologies and ethnotheories, we could say) are not qualitatively different from those of science, but only by degree, e.g. their degree of precision and accountability. These criteria, in my view, hold throughout the scientific landscape.[12] At the same time, practice shows that large differences exist with respect to the degree and type of sophistication necessary for a general statement to pass the 'theory test'. This is not a contradiction, since much depends on the nature of the phenomenon the statement is about, especially its accessibility and complexity. At the extremes, scientific competence is shown either by stating quantitatively sophisticated things

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[11] In this chapter it is not discussed whether a theory should be 'related statements' or single ones. I ignore whether $E = mc^2$, for instance, is a single statement or a set (or a 'model', or a 'law'); the term theory is used throughout.

[12] See also the discussion in Section 7.6.

about very simple phenomena (say, molecules), or by stating qualitatively sophisticated things about very complex phenomena (say people, or cultures). The demarcation between everyday knowledge and scientific knowledge, therefore, is not a horizontal plane dividing the two levels of sophistication, but 'hilly', differentiated discipline by discipline.

This image holds some relevance with respect to the inferiority complex of social scientists. It also holds some relevance as to why this study is called 'Environmental science theory' in spite of the fact that its greatest achievement in the quantitative field is the proper numbering of the footnotes. The prescription of how to explain an environmental problem (Chapter 5) should be judged by the same criteria, and yet very differently from, say, a prescription to perform the t-test.

I have stressed the point, however, in order to prepare for a more essential matter. In the image of the hilly demarcation between scientific and everyday knowledge, the demarcation pertains to *all* realms of human reasoning. The deeper consequences of this may be assessed by taking stock of what these realms of human reasoning are. I shall start with the everyday level.

(1) If somebody is always irritable on Mondays, we may explain this, say, as the after-effects of the weekend stresses of a bad marriage. Or if we see dark clouds gathering, we may expect rain. With such everyday-level explanations and predictions, we 'test' their empirical truth by means of counter-'hypotheses' and everyday statistics, for instance.

(2) As parents we may have to choose which type of school would be best for our 10-year-old child. Then, we will probably do some everyday statistics with simple facts, e.g. school tests, as we did above with the bad temper and the dark clouds. Typically for a situation like this, however, we also try to come to a different, deeper understanding, i.e. a 'Verstehen' to what the situation means - not to us or the child as an object of everyday statistics, but to the child as a subject whose hidden potentials we may somehow grasp, as a structure not yet unfolded.

(3) During a discussion, we may say, for instance: "First you say one thing, then another, but they can't *both* be true, can they? Be logical!" In such a case, we do not refer to empirical truth, but to the formal correctness (the tautologicalness) of statement structures.

(4) In many other everyday discussions and reflections, facts (1), understanding (2) and correctness (3) have a status as tools, but the objective of the discussion is to formulate what is the *right* thing to do. Sometimes, the focus is on a more or less fundamental, ethical question. Sometimes, it is simply a question of evaluating different types of car in order to decide which one to buy. In yet other cases, the key is the *design* of something, e.g. a holiday plan. In all cases, the focus may be either substantive (i.e. focusing on real-world actions), or methodological (i.e. focusing on the proper procedures for decision-making, design or, for that matter, doing empirical science).

In the image of the 'hilly demarcation', these four realms of everyday reasoning all have their corresponding level of scientific theory. They are enumerated below, with (1) and (2) collapsed into one because, following Berger (1978), they are more like two extremes in a single dimension than the others. It should be borne in mind that the three aims do not exactly coincide with disciplines, as will be shown more extensively later on. Thus, the aims of science are:

(1) The construction of formal *correctness.* Concrete proposals and more general theories that claim to meet this aim are tested for their tautological compliance with axioms. This test is 'internal', that is, without reference to real-world facts or values.
(2) The *empirical* aim, i.e. the construction *of truth.* Proposals and theories claiming to meet this aim are tested for their compliance to facts, on the continuum from quantitative-statistical to 'deeper', more qualitative and interpretative procedures (Chapter 7 of De Groot, 1992b). The facts concern both the physical world and the social world, as well as their interactions, e.g. 'people-environment systems'.
(3) The *normative* aim, i.e. the construction of*value,* to be understood here as simply meaning 'the good', or the appropriate action. Proposals and theories claiming to meet this aim are tested for their compliance to norms (criteria etc.).

The discussion of the present chapter concerns the normative aim and its status with respect to the empirical aim. Here, it serves to note that, implicitly, we have arrived at an image of science that runs counter to the dominant one. We see this, for instance, in the definitions of the theory concept at the beginning of this section; 'theory' there denotes only empirical theory, and especially explanatory empirical theory. In the philosophy of science expressed by its mainstream authors (Popper, Kuhn, Lakatos), 'science' is only empirical science, and in fact only a priviliged part of that (physical science), and again in fact only a privileged part of that (physical science studied in the statistical-quantitative tradition), and in fact again a privileged part of that, namely, the study of nature's lowest system levels (elementary particles; the universe; molecules). If you have the misfortune of being a biologist, for instance, and you want to study the interaction between antilopes and lions, never try to convey some real understanding of the fear of the antilope when it spots the lion in its deadly spurt; just measure the speeds and the energy budgets and correlate these with the population age structure, no matter how trivial (Passmore, 1974; Chapter 8 of De Groot, 1992b).

In the totalizing discourse of modernity, as the postmodern philosophers call it in the footsteps of the older critics of Cartesian science (Habermas, 1981; Chapter 4), one type of rationality is erected above all others. Everything falling outside this scope is "metaphysics", "ethics", "not value-free", "technology", "applied science", "narrative", "humanities", "preparadigmatic", "management", "social engineering", "qualitative explorations", "area studies" or whatever, but not science, certainly not *real* science. Its unfortunate practitioners must either accept that they are of some inferior breed and pass under the yoke each time they apply for funds, or create a hide-out under as big a heap as possible of logico-mathematical and laboratory brambles, or gather their own strength and go separate ways, as the technologies have done.

Environmental science, if it wants to live in the Cartesian palace, cannot escape failing one way or another. It either has to 'go for status' and confine itself to the 'value-free' study of the environment or people-environment interactions, or it has to accept being only an area of application, applying theories of the true sciences, without a theory level of its own (Verkroost, 1987).

In the first option, environmental science would end up in the quiet harbour of trying to duplicate physical and social geography, ecological anthropology and the other empirical disciplines already studying people-environment interactions. In the second option, environmental science would end up where so many attempts to create society-oriented areas of interdisciplinary studies have (rightfully) ended: a re-integration into the old monodisciplines (Chapter 2). In practice Dutch environmental science has long been trying to follow an intermediate course between Scylla and Charybdis, focusing on physical-scientific modelling and 'problem-hopping' in the "environmental management" style, close to the government agencies doling out the funds for applied research. This strategy has been successful in the sense that it has bought time and has laid a quantitative basis for the environmental science centres. This is exactly how far the intermediate strategy goes, however.

On the basis of the strength gathered in the 1980s, environmental science has begun to slowly establish linkages with (dangerous, low-status) disciplines like social science and ethics, and has begun to assemble its own theory level. Thus, it is moving out of the Cartesian trap, proving to itself little by little that a discipline can be problem-oriented *and* theory-rich.

This, basically, is also the strategy followed in this study. There will be no foundational discussion with the dominant image of science. Instead, I have used the everyday discussions and the 'hilly image' of science to simply *define* that normative, problem-oriented science is possible, thus side-stepping the Cartesian trap; the 'proof that life is nice out there will essentially be given if you, as a reader, have found that out for yourself. Theoretical support for this journey will be given little by little. In Annex 1.II, Edward (an astronomer standing for empirical science) and Norman (a mechanical engineer standing for normative science), will settle the issue once and for all (at least, to *them),* focusing especially on the distinction between normative science and applied studies. In Chapter 2, the Cartesian trap will surface with respect to the issue of interdisciplinarity. In Chapter 3, it will be shown that, elegantly like an amoeba, normative science engulfs the empirical disciplines. Chapter 4 provides a brief postmodern flash. Chapter 5 provides an actor model that transcends the Cartesian *homo economicus.* De Groot (1992b) provides further discussions with respect to environmental science stepping beyond a claim to privileged rationality, non-quantifying directions for environmental science and a philosophy beyond the Cartesian alienation of Man from nature.

Theory may now be defined as: *sophisticated general knowledge for the construction of formal correctness, truth, or value.* Here, 'sophisticated' refers to the demarcation with respect to everyday knowledge. The three types of theory are logico-mathematical, empirical and normative, respectively. The phrase '*for* the construction of ....'

denotes that, in the last resort, a theory's adequacy is established at a level of generality lower than the theory itself, viz. the level of specific studies, where empirical hypotheses are tested for their conformity to facts, and normative hypotheses (e.g. proposals to solve conflicts, designs of environmental projects, evaluations of policy plans) are tested for their conformity to values, e.g. a general theory of justice (Rawls, 1971), or the somewhat less general criteria of environmental science (Chapter 4), or the specific criteria of target groups.

In encyclopedias of science, normative science or theory is defined in the following ways.

- "Normative theory may be used as an attempt to provide a systematic course of action for the solution of a social problem" (Theodorson and Theodorson, 1969).
- "Normative sciences are those that do not explain what is, but ground what should be" (Grooten and Steenbergen, 1958).
- "Normative sciences are those for which guidelines for behaviour are the object" (Kuypers, 1979).

In a general sense, these definitions are in agreement with mine. However, in these définitions normative science tends to be perceived as being more aloof from real-world action and design. In my definition, the family of normative disciplines runs from ethics all the way through to, say, mechanical engineering.[13,14]

Finally, it serves to note that normative theory may be conceptual, substantive or methodological.

- *Conceptual* normative theories are those claiming to describe basic structures in the world of values (as do conceptual empirical theories in the world of facts). Most of Chapter 4 is an example.

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[13] Other terms often used to denote essentially the same as 'normative' are 'practical' and 'prescriptive' theory and science (e.g. Strike, 1979; Koningsveld, 1987; Voogd, 1985). That Strike's 'practical theory' denotes the same as my 'normative theory' is shown, for instance, by his insistence, much as in Annex 1.II, that 'applied' means something different from 'practical': "The term 'applied science' is misleading (....). We need to distinguish between explanatory and practical theories." I have preferred the term 'normative' because it has fewer connotations with 'applied' and rigid recipes than do 'practical' and 'prescriptive'. Another term often associated with normative science is 'critical science' (e.g. Verhoog 1988). This should be avoided on deeper than terminological grounds. Although environmental science is often critical with respect to existing policies, this is not intrinsically so. As an example, we may take Van den Berg and De Groot (1987). In this study, my collègue and I used current objectives of soil and water policies as the 'value input' to design a monitoring strategy for aquatic sediments. This is an (applied) normative study, but nothing critical.

[14] It may be noted that these definitions, as does my own, run counter to a well-known perception of normative science, found, for instance, in Van Hengel (1991): "The normative sciences do not reason out what is good, but which [externally decided] objectives are implementable". This definition comes remarkably close to Weber's idea of value-free *empirical* science: "An empirical science can teach nobody what he should do, but only what he can do" (Laeyendekker, 1981, p. 314). Normative science in this sense, cut off from connections with ethics, is not normative science at all; it is the science of the 'value-free' builders of implementation machines, social or technical, for anyone powerful enough to dominate the formulation of objectives, i.e. government and the big corporations. (Ironically, this is the very image of science Van Hengel seeks to critize in his article.)

- *Substantive* normative theories are those claiming to describe contents in the world of values; again, they have their empirical counterpart. Ethics (not meta-ethics) are an example, as is Chapter 8 of De Groot (1992b).
- *Methodological* (normative) theories are those claiming to describe appropriate ways for the construction of value (as defined before), e.g., to design a regional plan, to do an economic evaluation or to approach moral matters in a contextual procedure (Chapter 4). Methodological theories have no empirical counterpart; the methodologies in empirical science are normative elements serving the overall empirical aim. From the basics of the 'empirical cycle' down to the level of laboratory prescriptions to measure dissolved phosphate, they are designs made to meet the criteria of validity, cost-effectiveness, replicability and so on. They are not tested for their truth content; as any design, a bad method is as true as a good one. Thus, also the action-in-context framework discussed in Chapter 5, claiming to be a flexible, rich and cost-effective way to explain environmental problems, is also an example of methodological, and with it normative, theory. The core of the next chapter ("How To Make An Interdiscipline") is another.

As the subtitle of the present study states, its emphasis will be on conceptual and methodological matters. Throughout the study, the term 'theory', when standing on its own, will denote all three types.

1.3 Problem-Oriented Environmental Science

Combining Section 1.1 and the previous section, by now it will roughly be clear what 'problem-oriented environmental science' is. This section aims to sharpen the general notion, so that we arrive at a (simple) definition with sufficient footing underneath.

'Problem-oriented environmental science' obviously denotes a discipline. The previous section has focused on the *aims* of science, however. The first issue of this section therefore is to settle the relationship between these two concepts.

As we noted already, empirical disciplines contain normative elements. They also use many products of normative disciplines, e.g. as in Annex 1.II the astronomer uses the telescope designed by the mechanical engineer. Analogously, normative disciplines contain many empirical facts (e.g. environmental models) and use many products of empirical disciplines, especially 'middle-range' theories. As discussed in Annex l.II, this mutual exchange (or overlap, as drawn in the Annex) typically concerns ready-for-use, that is, *applied* products (or 'finalized' products, as the Starnberger philosophers of science put it). All this does not change these disciplines' character as empirical or normative disciplines, however; this character is defined by the disciplines' final aim, which expresses itself in their basic structure, the objects they study (e.g. social problems, not social systems) and especially the questions they ask, as we will see below.[15]

In this conceptualization, most disciplines belong unequivocally to one of the two realms. Some large and vaguely defined disciplines, however, encompass both aims in one structure. In psychology, for instance, the empirical and the therapeutical are also closely intertwined (Van Strien, 1986)[16]. Economy, on the one hand, is an empirical science, studying individual (micro) and collective (macro) behaviour; on the other hand, economy is the normative discipline[17] that rules the world, proclaiming to hold the key for rational decisions (cost-benefit analysis), designing policies for further economic growth and environmental destruction (Jacobs, 1984) and, fortunately, also sprouting a small but lively subdiscipline of quite a different character (Chapter 4).

The problem-oriented disciplines are a subgroup of the normative family. Although the boundaries are vague, the family as a whole may be said to consist of three types of disciplines.

(1) *Ethics* occupies itself with the (grounds for) general values and normative procedures. Rawl's theory of justice is a typical example. Focusing on more specific decision areas, ethics has several more applied branches; environmental ethics is one of them. The theory of cost-benefit analysis (Chapter 4) may also be seen in the applied ethics realm; good or bad, it is a (methodological) theory of fairness.

(2) *Problem-oriented disciplines* focus on areas of societal problems, e.g. law on problems of social order, medicine on problems of health, environmental science on problems of sustainability and our dealings with nature. Compared to ethics, they are much more concrete and 'filled with facts'. To a large extent, they remain operationalized ethics, however (Zweers and De Groot, 1987), giving concrete shape to the (proposed, supposed) good in countless (medical, juridical, environmental etc.) problem situations.

(3) *Design-oriented* disciplines differ from the problem-oriented ones in that they are grounded more in generalized societal demands than in concrete problems: civil engineering in the generalized demand for efficient infrastructure, agricultural science in the generalized demand for secure food production, landscape architecture in the generalized demand for harmonious surroundings, and so on. In general, the technologies are the typical example.

There is much more to say about the character and relationships of these disciplines.

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[15] An example is the concept of environmental capacity, cf. Chapter 3. An environmental capacity is a norm, denoting the acceptable number of cattle in a certain area, say. This norm is derived from 'higher' norms, e.g. the sustainability of the range or the protection of species. In the subsequent derivation, many facts are drawn in; probably even, the majority of the scientific work is on the application of empirical models. Still, environmental capacity remains a norm, part of normative environmental science.

[16] See Wardekker (1977) about pedagogy, Van Steenbergen (1983) about "designing sociology", Dietvorst et al. (1984) about social geography.

[17] Keynes refered to these two branches as 'positive' and 'regulatory', respectively.

Here, however, I will concentrate briefly only on the position of design and explanation.

Design is an inherent element in the problem-oriented disciplines, but these designs arise as answers (proposed solutions) to concrete questions (problems). In the design-oriented disciplines, the designs predominate. They wait, as it were, for problems to come by.[18] Another difference is that in the design-oriented disciplines, not all designs are responses to problems. Many, as explained in Chapter 3, are "opportunity-driven", not problem-driven.

This is why explanations are poorly represented in the design-oriented disciplines. Opportunities can be explained, of course, but the explanation of an opportunity does not contribute to the design of a proper response to the opportunity (Chapter 3). The contrary is true with respect to problems; understanding the causes of a problem often generates the most cost-effective solutions. In the list of policy options in Chapter 5, for instance, the majority of options are connected to their social causes. In a more general sense, understanding why a problem has arisen is crucial to avoid unnecessarily shallow, symptoms-abatement solutions.

Common to all sciences is a notion of methodological circularity. In the positive branch of empirical science, for instance, there is the 'empirical cycle', i.e. the image that hypotheses are deduced from the general theories, that these hypotheses are tested in real-world cases, and that the results are fed back into the theory level. In the interpretative-hermeneutic branch, there is the 'hermeneutic circle' (Chapter 7 of De Groot, 1992b). And in every textbook on physical planning, policy analysis, environmental management, farming system analysis, industrial design etc. we find the normative-science counterpart, often called the 'policy cycle' or 'design cycle'. Usually, three steps are distinguished. The first is characterized by terms such as problem identification, problem description, problem diagnosis, problem analysis, modeling and so on; in this study, I use problem *analysis* as the umbrella term. The second step is characterized by terms such as design, policy formulation, plan evaluation and so on; I use *design* as the umbrella term. The third step is usually called implementation. Although it will be given some attention in Chapter 3, it is in itself not a type of research; I therefore leave it out in my 'normative science triad'.

Sadly missing in almost all textbooks and research practice is the *explanation* of the problem analyzed and attempted to be solved by way of some design. Why this is sad has been touched upon already, as well as the fact that environmental science (in the Netherlands, at least) is growing out of the 'environmental management' neglect of the causes of the problems it tries to solve.

Although normative-science research, especially of the applied type, is often strongly cyclical (Chapter 3), the basic sequence is to first analyse a problem, then try

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[18] If problems are in short supply, the technologies will try to raise them. The case of remote sensing ("an answer in search of a question") is a well-known example. Less innocent are the health-and-happiness technologies of medicine and psychotherapy (Achterhuis, 1979). The true success story is that of the military complex, on which the poorest continent of the world now spends more than on health, agriculture and education.

to find out why it has arisen, and then try to solve it. Thus, the *methodological triad* of problem-oriented science: analysis, explanation, design.

All concepts in the definition of problem-oriented environmental science now have sufficient clarity, depth and profile. *Problem-oriented environmental science is the science of analysis, explanation and solution of environmental problems.*

1.4 Aim, Structure And Overview Of This Study

In Section 1.1 it has been indicated that Dutch environmental science has three basic characteristics: problem-orientedness, a conduciveness to a one-world approach and a tendency to evolve its own theory level. Furthermore, the discipline has been seen to be dominated by the 'environmental management' emphasis on physical-scientific modelling and impact studies. At the same time, developments have been shown to exist towards studying the social and normative context out of which environmental problems arise. The preliminary formulation of the goals of the study was then stated as being to strengthen the basic characteristics and the new developments.

The subsequent sections explored the more fundamental layer of the endeavour, indicating that the goals are mutually compatible and may be summarized in a single aim: *to support the growth of environmental science into a fully-fledged normative discipline of the problem-oriented type.*

Three core objectives may be derived from the aim, which, on the basis of the preceding sections, I hold to be the most essential in view of the present (physical-science and "management"-oriented) state of the art:

- to supply environmental science with a *paradigmatic framework* that expresses what it is to be 'fully-fledged', sufficiently general to strengthen environmental science as a single (one-world, all-problems) discipline, and sufficiently concrete to guide the corresponding, fully interdisciplinary research;
- to strengthen environmental science's *normative foundations,* in order to sensitize the discipline to its linkages with ethics, and to facilitate more grounded, more critical and more consistent problem analyses, impact assessments and policy designs;
- to develop a general methodology for the *explanation of environmental problems,* especially with respect to their social causes, in a way directly connected to normative work.

These core objectives define this study's three major chapters:

- Chapter 3 ('Problem-in-Context') is an attempt to formulate a conceptual framework encompassing the discipline as a whole (added to which is a brief review of another neglected area, design techniques);

- Chapter 4 ('Values, functions, sustainability') focuses on the normative substance and methods that drive and structurize environmental problem analysis;
- Chapter 5 ('Action-in-Context') is an attempt to show the explanatory way from problematic actions to actors, structure and culture in society.

Chapter 2, about interdisciplinarity, is an illustration of Chapter 1 and a relatively light-hearted stepping stone to arrive at the bulk of 'Problem-in-Context'.

Of the two core concepts of the study's subtitle, "one-world" and "problem-oriented", the latter has been the more 'driving' one. In the background, however, I have tried to keep a constant check, based on the literature and my own experiences, on the applicability of concepts and theories to the full array of problem scales and contexts, ranging from the pesticides in my own garden all the way up to global warming and all the way 'sideways' to Third World situations. Throughout most chapters, therefore, I freely mix examples and insights from the industrialized and developing countries.

Overview

Chapter 1, *Introduction*, focuses on the basic notions of what problem-oriented environmental science is, and what is needed to develop its full potentials.

Chapter 2, *A Discipline for Interdisciplinarity*, indicates that once a discipline is conceptualized as one problem-oriented discipline amongst others, the concept of interdisciplinarity loses its problematic character. Emphasis is put on the conditions (besides this self-perception) for growing from a collection of studies into a consistent discipline with a theory level of its own.

Chapter 3, *Problem-in-Context*, concerns a conceptual-methodological framework for applied and theory-building research of environmental problems, their causes and their solutions, interconnecting ethics, physical science and social science in a single structured whole. The chapter starts out with a discussion and a reflection on the difference between empirically studying people-environment systems and normatively studying environmental problems. The problem-in-context framework is then built up by way of an applied study example. The framework, being reflective and recursive, then appears to contain the study of people-environment systems, but in a specific way. The framework is subsequently formalized and some attention is paid to design methodology.

Chapter 4, *Values, functions, sustainability*, focuses on a specific part of problem-in-context, the 'value input' for problem analysis and design, and the procedures of evaluation. First, attention is given to matters of structure, such as the derivation and aggregation of environmental quality parameters. Then follows an interlude on contextual ethics, needed for the next section, where the criteria of naturalness and diversity are operationalized. Then follows an enumeration of the functions of the environment, because of their important position as a structurizing concept between environmental quality parameters and the 'final variables' of environmental science. The chapter is rounded off by two topics of normative economics: the proper way to include sustainability in the national accounts, and the basic issue of how to account for the value of sustainability in efficiency-oriented project and policy evaluation (e.g. cost-benefit analysis). In the Annex, the value of sustainability triggers off an excursion into normative modelling, resulting in the notion that the square metre is both a practical and the most policy-relevant parameter for foundational sustainability models. The substantive basis of this is that not energy but pollution, biodiversity and productive ecosystems are the key variables of sustainability.

Chapter 5, *Action-in-Context,* focuses on another part of problem-in-context, the social causes of problematic activities. It tries to develop a relatively strict but flexible research methodology, guided by principles of relevance, to lead the way from the environmental problem to structure and culture in society. The core of the approach is to study actions, actors, options and motivations. Tied to these options and motivations, secondary and subsequent actors and factors may be identified. Then, layer by layer, the options and motivations of each actor can be related to wider contexts. The chapter is rounded off by a discussion of what 'model' to adopt to understand actors, and an enumeration of the types of policy options ('instruments') that may be identified through action-in-context research.

The aim of this study is such that it largely ignores the existing achievements of environmental science in its narrower, 'environmental management' conceptualization. This study should therefore not be taken as describing, empirically or normatively, the subject matter of problem-oriented environmental science as a whole. The discipline, in my view, should do its best to become a more consistent (and one-world, all-problem) discipline (Chapters 2 and 3), it should be more actively aware that a normative discipline needs its own normative foundations and linkages to ethics (Chapters 4 and Chapter 8 of De Groot, 1992b), it should explore its connections to the humanities (Chapters 4 and Chapter 7 of De Groot, 1992b) and it should spread its much-needed wings into the social sciences (Chapters 3, 5 and Chapter 6 of De Groot, 1992b), but it should of course also retain its 'traditional' core of physical-scientific modelling and applied policy designs.

ANNEX 1.I

Research Subjects Of Environmental Science At The Leiden University And The Free University Of Amsterdam

Source: Annual reports for 1986 and 1990. The year 1990 has been included to indicate the growth of the general research level and because the Third World problem field in 1986 was too recent to give a representative picture. The problem field of 'energy, waste and physical resources' is lacking because it is covered by other centres.

General research, 1986
- long-term identification of environmental problems
- development of a regional module in the Integrated Environmental Model
- concepts and methods for normative environmental science
- social and financial environmental policy instruments
- counterfactual history for long-term environmental evaluation

General research, 1990
- an integrated environmental quality index
- evaluation methods for EIA
- the sustainability concept in regional environmental modelling
- national sustainability indicators
- instruments for product-oriented policies
- financial instruments for environmental policies
- environment and international trade
- natural resource valuation and accounting
- concepts and methods for normative environmental science
- ecosystem and policy concepts for regional environmental policies
- ecology-based environmental quality assessment
- eco-profiles of products

Nature, natural resources and landscape, 1986

General
- the concept of ecological infrastructure
- ecotope description, prediction and evaluation system
- landscape-ecological information and interpretation system
- ecological risk analysis

Case studies
- cattle in forest management
- criteria of 'wise use' of Dutch delta wetlands
- valuation of natural resources in Eastern and Western Europe
- various nature development plans for agricultural areas
- nature development and agriculture in the European Community
- nationwide exploration of the impacts of groundwater over-extraction
- economic benefits of forest management

- design of wetlands for water purification
- acid emission standards with respect to nature protection
- ecological management of agricultural ditch banks
- determinants of meadow bird densities
- pesticide impacts on terrestrial vertebrates

Third World problem field, 1990

General

- EIA for developing countries
- timber trade and deforestation
- success and failure of environmental projects
- participatory local environmental appraisal
- development and conservation of tropical wetlands

Case studies

- environment and rural development in Botswana
- environmental evaluation of Dutch development cooperation
- environment and tribal groups in Indonesia
- carrying capacities for sea cows, Indonesia
- pioneer shifting cultivation, The Philippines
- wildlife and grazing management, Cameroon
- local resource management, Cameroon
- regional environmental problem assessment, The Philippines
- incentives for reforestation, The Philippines
- nature management in Sahelian wetlands

Pollution and Health, 1986

General

- development of the Sectoral Emissions Model
- financial instruments for pollution abatement
- environmental health prediction and evalution system
- quantitative structure-effect relationships (QSARs) of pollutants
- various methodological studies of bio-monitoring
- a model for the economic effect of pollution control
- 'environmentally conscious' product design.

Case studies

- various pollutant monitoring projects (heavy metals in water and sediments, PCBs etc.)
- bio-accumulation in polluted sediments
- various studies of technological options for emission abatement (including acid emissions) and their economic effects
- various 'pollutant overviews' (PAHs, bromine)
- design and evaluation of various monitoring systems
- environmental impacts of energy systems
- impact of acid rain on materials
- an evaluation method for bulk waste strategies
- ecological rehabilitation of polluted soils
- various analyses of public complaints and attitudes
- potentials of a products-oriented environmental policy
- pesticide risks for young children

ANNEX 1.II

Empirical, Normative, Applied: A General Image

A bar, at midnight. Subdued light. Metaphysical atmosphere, enhanced by the incessant playing of Brown's (1977) hit "Shiß Your Symbol System". Enter Norman, a normative scientist (or, to be more precise, a mechanical engineer) with philosophical inclinations. Greets Edward, already vaguely musing over a beer, an empirical scientist, in fact, an astronomer. Both work at the United University, in the Mechanical Engineering and the Physics departments, respectively.)

Norman: Hi, Edward. Been working late?

Edward: Yes. You know, I couldn't get away from this Dark Matter problem of mine. It eludes me . . . . I know it must be there, somewhere in this bloody universe, that dark matter. But how to find it? I thought I had found a proper detection principle, but the images I analyzed didn't yield the goods .... Now, I'm thinking of revising the detection criteria .... But how? It's fascinating, this problem! It grabs hold of you, it sucks you in! And you, how did you arrive here?

Norman: Oh well, I was also working late. I got sort of sucked in too. I am doing this bicycle study, you know. It's fascinating, this bicycle problem!

Edward: Do you have a problem with your bicycle? Can't you repair it, being a mechanical engineer?

Norman: I don't study *my* bicycle, Edward, I'm fascinated by *the* bicycle.

Edward: Are you fascinated by bicycles? Funny. In a way, I always pity you mechanical engineers. You are so terribly *applied!* Do you know Popper, the philosopher of science? He said that a long time ago. I must agree with him .... We at the Physics department supply your department with applied physics, like the applied mechanics of static structures, or shock wave knowledge for the stresses in bicycles. And we do acoustics for the architectural department, and so on. But what's in it, really? It doesn't mean anything for the progress of physics! It's all Newtonian level stuff, as Popper would say. *Pure* research, that's what we live by! The Dark Matter conjectures!

Norman: This conjectural Popper, I really like his books.

Edward: You did? Popper himself said that his theories were not applicable to technology.

Norman: Well, I've read him and I did like him. He opened my eyes to the conjectural element in design problems. And speaking of Popper's applicability, Kuhn and other critics have said that his theory isn't applicable to science either, actually. Science simply doesn't work the way that Popper says it does. Yet, his theory inspires me, as a technologist.

Edward: And it does inspire me also, in fact, in spite of Kuhn. His theory may not be very true empirically, but it is a kind of, how shall I put it, a kind of *normative* theory, warning you away from dull inductivism and the verification of trivialities. That is *valuable,* isn't it, independently of its actually being true or not?

Norman: Who put these words into your head, Edward? 'Normative' and 'value' are the very words that come up when I'm wondering what it is exactly that I'm doing on the bicycle.

Edward: Do you *wonder* about that? Personally, I simply *ride* my bicycle.

Norman: Now come on Edward! How can you be so lucid with Popper and so dumb with technology? I don't care about *my* bicycle, I work with *the* bicycle, the *general* bicycle, the essence of *bicycleness,* the ....

Edward: OK, sorry. If you want, tell me more about it. But let's finish this Popper matter first.

Norman: Didn't we finish that already? We concluded that his theory may be empirically applicable to none of the sciences, but normatively applicable to all of them.

Edward: Did we conclude that? Well, anyway.

Norman: It was you who put the notion into my head that Popper, contrary to his later colleagues in the philosophy of science, didn't bother very much with the factual business of science, but set out to show science a guiding principle for progress. He worked in a normative, prescriptive perspective, we might say. He wanted to *design* something *valuable* for the progress of science, - in fact, he wanted to do for science what I want to do for the bicycle!

Edward: Popper, the philosophical technologist?

Norman: Well, let's say, Popper the normative scientist. In our department, we usually say 'normative science' when we want to stress the affinity of engineering with juridical science, medicine, physical planning and the like. If we say 'normative science', Popper will feel in better company.

Edward: I wonder. He despised the engineer. Do you know what he wrote about people of your kind? I have it with me here. Wait ... Here it is, in Popper's contribution in 'Criticism and the Growth of Knowledge'. He refers to a conversation he had with his friend Philipp Frank, in 1933, and writes: "Frank at that time complained bitterly about the uncritical approach to science of the majority of his engineering students. They merely wanted to 'know the facts'." I must say that Popper's allegation is not outdated. Exactly the same thing happens when I have to teach physics to *your* students! *"Just give us the facts, sir"*, they say, *"we only want to apply them!"*.

Norman: There was no need to look up that passage. I know it by heart. Some time ago, it made me quite angry. Engineers are no such dumbos, I thought, we too have some critical people! But then, I remembered something from my own experiences, and suddenly my whole perspective started to shift. Every year, you know, I have to read the course 'Astronomical Instruments' to *your* astronomy students. In the beginning, I tried not to focus merely on the actual instruments, but also to make the students understand something about the methodological design background of the instruments, the rejected design alternatives, the criteria used to arrive at the specific type of telescope they use, the reason why so many different types of hinges are applied in their telescope, the maintenance philosophy that has been applied, the way that had worked out in the physical design, etcetera. As you know, the mechanical department did most of the design work on the non-optical part of your telescope and the auxiliary instruments... But how did they respond, those pure science students of yours? *"Just give us the things, sir,"* they say, *"we only want to apply them!"*

Edward: Of course, what did you expect?

Norman: Yes, I was naive indeed, then. I expected that your empirical science students would be interested in the theoretical background of normative science results. They only need, and want, to apply them. In fact, I realized later, I was naive in exactly the same way as Popper's friend, who expected normative science students to be interested in the theoretical background of empirical science results. Suddenly, I saw two mirror worlds.

Edward: I still don't quite grasp what you mean. You seem to imply some terrible things. Mirror worlds, you say. Mirror applications. We call mechanical engineering an applied science. You seem to imply that physics too is an applied science. Is physics applied mechanical engineering? I can hardly accept that. It doesn't fit.

Norman: I agree with that. Physics does apply a lot of mechanical engineering products. In fact, it also applies architectural products, products of chemical engineering, and several more from the normative science world. In *that* sense, physics is an applied science. In the same sense, mechanical engineering is also an applied science, because, as you said, it uses products of physics. But, physics, as you know, doesn't only apply mechanical engineering and other products; it also adds a lot of its own. It adds its own empirical science data and theory, for instance, about dark matter. But then, if you apply the same criterion, mechanical engineering is no applied science either. Mirrorlike, it applies a lot of physics products, and knowledge of other empirical disciplines. But, mirrorlike, it also adds a lot of its own: normative science knowledge and normative science theory. For instance, general design principles.

Edward: Now you refer to your general bicycle, your essence of bicycleness, your ...

Norman: Among other things, yes. But let that rest for a moment.

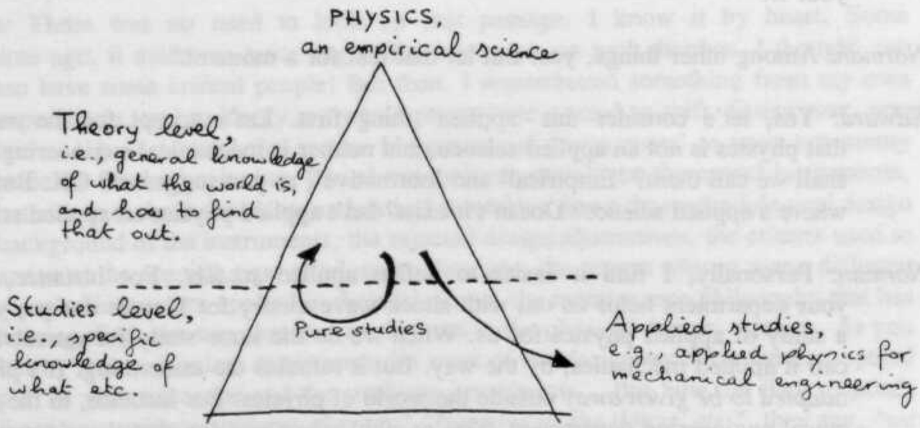
Edward: Yes, let's consider this 'applied' thing first. Let's accept for the moment that physics is not an applied science, and neither is mechanical engineering. How shall we call them? 'Empirical' and 'normative', as you suggested? OK. But then, where's applied science? Doesn't it exist? Isn't applied physics an applied science?

Norman: Personally, I find it easier to define applied *studies*. For instance, when your department helps us out with shock wave theory for bicycle design, you do a study of applied physics for us. When we do the same study for ourselves, we call it applied mechanics, by the way. But it remains the same thing. It's physics, *adapted to be given away* outside the world of physics. For instance, to the mechanical engineering department. You're right when you say that there's not much in it for physics theory. But, mirrorlike, we do the same thing. For instance, when we were asked to help out with the design of the new telescope for the physics department, I remember I was opposed to this assignment. I said: "It's so terribly *applied!* There's nothing in it, really, for mechanical engineering theory! Let some commercial engineering firm do the job!" You may remember that this ended up with the mechanical engineering department being slightly reluctant to do the design job, and your department paying us a a lot of money for it, most of which we used for extending our general bicycle study! I remember your department's chairman being quite amazed and cross about our attitude. He considered it an honour for us to work for Empirical Science. But as to *his* department, he considers it boring to help us out with shock wave theory. He suffers from a broken mirror, so to speak. Read too much philosophy of science.

Edward: I'm starting to like this mirror game! Should we try to make a real picture of it? See if we come out with a completely symmetrical structure?

Norman: Let's try. Make a drawing of physics.

Edward: Let us say we have two levels of generality: on top is theory, and below are the multitude of 'studies' or 'research' projects. Since there are more studies than theories, I'll give physics a triangular shape. Now, we put in the relations between the studies and the theory levels. First, we go round. That's the empirical reseach cycle. It starts at the theory level, from which we deduce some idea about reality, then we test it with real data, and then we adapt our theory, going back to that level. Sometimes, we do it more inductively, forgetting about the first step. But the principle is the **same**: you go from the studies level up to the theory **level.** That is: *pure research.* Then, we have the applied studies. With them, you go only downwards. You only use **theory,** and don't refer back to theory. These studies end up outside the triangle, for instance, in your engineering department. There we are:



Norman: This should be acceptable to everyone, shouldn't it? Now, for the **mech anical** engineering picture to become **mirrorlike,** you should ask me one thing in particular: do the normative sciences also have pure research? Then I can finally tell you about my bicycle **study**.

Edward: Do the normative sciences also have pure research?

Norman: Sure they have! Take the bicycle study, for instance! We started out with a functional analysis of the **bicycle,** in order to find the essence of bicycleness in the most abstract and general terms possible. In that way, we laid a basis for defining the ultimate First Order Bicycle Elements, with special reference to their Multiple Compatibility and whether they require high-tech **manufacturing.** Do you know what we wanted to do with this analysis?

Edward: Of course not, Norm. You are so Pure now. Do tell me.

Norman: First of all, it should be clear that we do not finally aim at truth. Any bicycle, good or bad, is as true as any other. ***Valuability***is what it is all about. A bicycle should be cheap, reliable, efficient, beautiful, multifunctional etcetera. If you give these criteria a relative weight, you define your overall **valuability,** and hence, your optimal bicycle. For different types of consumer, different sets of weights apply. Now, what we want to do is not to design a new type of bicycle for each type of consumer, but to arrive at the *general* set of the Ultimate Multiple Compatible Lowest Order Bicycle Elements In Need Of A High-tech Solution. You follow me?

Edward: Not quite.

Norman: Let me be more specific then. At the current stage of the study we have defined, and already made some prototypes, of four Ultimate Elements: a gear unit, a wheel-cum-fork unit, a chain unit and a pedals unit. These need a high-tech solution, hence, they are best manufactured at some central, capital-intensive plant. Out of these, you can make Your Own Bicycle, by combining the units in Your Own Way and interconnect them with structures that are much more arbitrary in form and technology. Let us say, for instance, that you want the Most Efficient Bicycle. Then, you combine a wheel unit, a gear unit and a pedal unit, without a chain, into *the front* wheel of your bicycle. To another wheel unit you add a steering device and then you have a local industry weld it all together, adding the brakes, the saddle etcetera along the way. If you do this properly, you end up with a queer contraption on which you sit in a very slanted position, driving the wheel with your feet in front of you, easily making 40 miles an hour. On the other hand, if you were an Asian farmer, you might want to have the Unbreakable Multi-purpose Workbike. Then, you use the *same* units, but assemble them completely differently. You may leave out the gear box, but use the chain unit for a normal rear wheel drive; possibly, you make a tricycle with a load space in between the rear wheels, and so on. Using other combinations and welding-togethers, you can make the Collapsable Bicycle, the Add-On Bicycle, and even the Normal Bicycle. As you see, in our bicycle study we hope to lay the general basis for a *single* Bike System that can generate *all* relevant types of bicycle in an optimal mix of centralized production of a few high-tech elements, combined with local construction to make the bike that people need locally, in the industrialized as well as the developing world!

Edward: Now I understand why you work as late as I do, Norman. This may be even more fascinating than my Dark Matter! But I don't quite yet see how this could be labelled as a *pure* research project. It looks so practical!

Norman: Yes, it does. But looking practical or not does not seem a proper criterion to me. Everything normative scientists do is intended to be practical, you could say, even the very general normative theories. For instance, philosophers say that ethics is theory for action. It is practical theory.

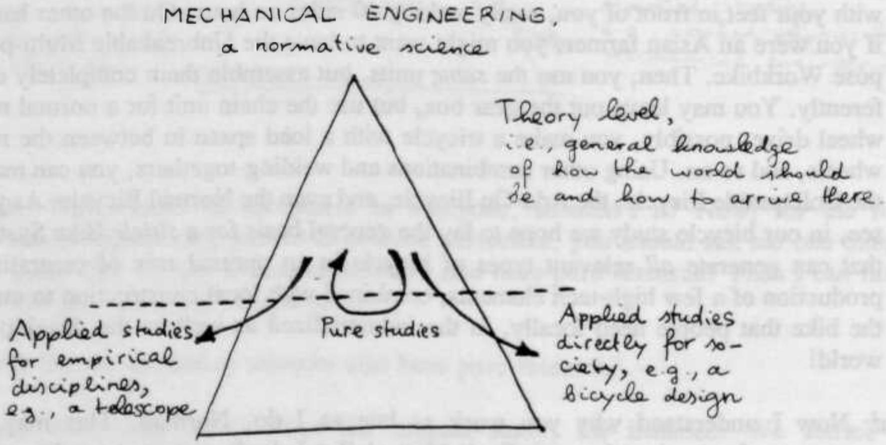
Edward: Then, what is pure normative science research?

Norman: The mirror of your pure empirical science research. Research designed to make a contribution to theory, that is, general knowledge, not direct application in specific cases.

Edward: Then, how does your bicycle study fit into this definition?

Norman: We have two aims. The most important one I've already told you: to find the general Bike System. That's a design theory for a relatively specific area of mechanical **engineering**. It mirrors the relatively specific Dark Matter theory you want to arrive at. Our second aim is to make explicit use of formal, general design methods, so that we can find out how well they **structurize** the design process, and adapt them if necessary. You see, it's a pure study for these two reasons. Of course, we very much hope that our final result will one day cross the border Une from 'pure' to **'applied'**. We have some contacts with a bicycle factory in China. Maybe we'll start a joint project with them. Our theory should become good enough, 'finalized' you could say, for **factory-employed** engineers to become the final applicators.

Edward: I think we can draw our mirror triangle now. Let me try:



Edward: As you see, it occurred to me that I should draw two arrows for applied studies. One from your science to society, and one to the empirical disciplines. That one comprises, for **instance,** my telescope.

Norman: That looks OK.

Edward: But it spoils our mirror image. Physics doesn't have two arrows. We've drawn only one arrow of application, in the direction of the normative disciplines.

Norman: Is that right? Is there a flaw in our game of symmetry?

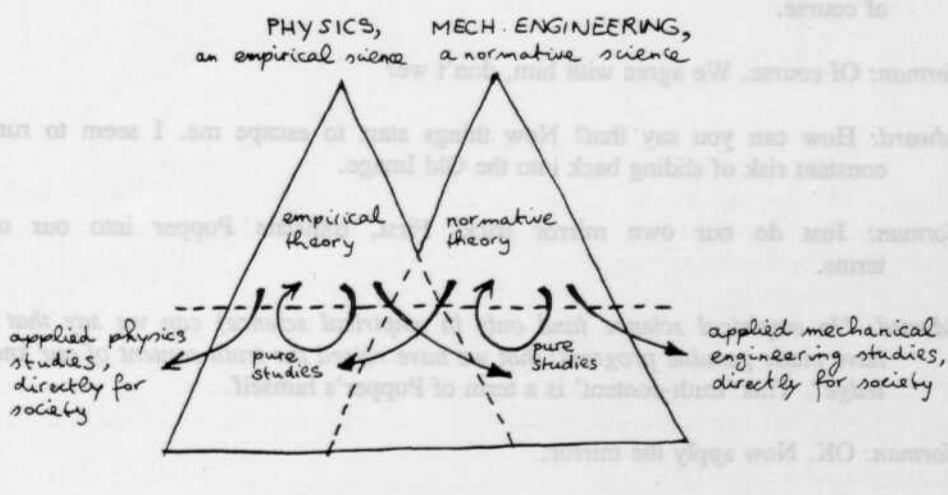
Edward: **In astronomy, we often find a new type of stellar object if a theory predicts it should be there. Good empirical theories 'make' new facts, so to say. So we might as well play on now. What fact does our theory of symmetry predict that should be there?**

Norman: It predicts the existence of applied physics, directly for society. Not for mechanical engineering, not for medical diagnosis, not for computer **electronics**.... Physics, generating empirical knowledge that is 'consumed' *as such,* without a normative science **intermediary**.... I have it! I am a great consumer of that knowledge myself ! In fact, when I consider buying a *Scientific American,* first of all I check whether **there's** anything on your supernovas, white dwarfs, up and down quarks, dark matter, super-inflating big bangs and what have you. Your department has millions of consumers when it applies physics theory for writing 'popular physics' articles and books!

Edward: OK. Although I don't quite know how to explain it to the chairman of the physics department, let's draw that second arrow **of** application on the left-hand side of the empirical science triangle. The two are now beautifully congruent.

Norman: There's only one thing to be settled now. How do the two realms of science relate to one other? Are they separate worlds, or do they overlap?

Edward: They overlap, I would say. A few minutes ago, you said about my applied-physics shock wave study: "When *we* do it, we call it applied **mechanics"**. There are studies, and even some theories, it seems, held in common. So, let's shift the two triangles like this ... draw in the arrows of pure and applied studies ... *Voilà* the Image of Science!



Norman: It's a beautiful picture indeed ... It only looks a bit too specific, it seems, with only our two disciplines drawn in. Do all the other ones fit too?

Edward: Yes, I'd say so. Just specify that empirical science also includes chem istry, ecology, social psychology and so on, and specify that the normative disciplines also include forestry, architecture, medicine, physical planning, regulatory economics, ethics, law and so on.

Norman: That's right, but it's not the only thing. How about mathematics, for instance? That doesn't seem to have a prescriptive or an empirical aim. And how about the humanities? These often say they don't aim at a 'superficial', empirical truth, but at something 'higher', or 'deeper', or more 'meaningful'. And how about the social sciences? They seem to embrace all aims imaginable .... Maybe it's a bit dangerous to use disciplines as the defining categories. Perhaps we should strictly use the aims instead, if we want to arrive at a really consistent picture. Tomorrow, we should make a neat and somewhat more generalized version of the New Image on a PC. Hang it on your door, then, in case that chairman of yours happens to drop by.

Edward: This man still bothers me a little bit. How shall I explain our Image to him?

Norman: Just explain to him what we explained to ourselves.

Edward: He won't believe it. Do you know what he'll do? He'll quote Popper, from the very same article that we took our quotations from. Look, here it is. *"In science (and only in science) can we say that we have made genuine progress: that we know more than we did before. "* By 'science', Popper means empirical science, of course.

Norman: Of course. We agree with him, don't we?

Edward: How can you say that? Now things start to escape me. I seem to run a constant risk of sliding back into the Old Image.

Norman: Just do our own mirror trick! First, translate Popper into our own terms.

Edward: *"In empirical science (and only in empirical science) can we say that we have made genuine progress: that we have raised the truth-content of our knowledge"*. This 'truth-content' is a term of Popper's himself.

Norman: OK. Now apply the mirror.

Edward: *"In normative science (and only in normative science) can we say that* *we have made genuine progress: that we have raised the valuability of our designs."*

Norman: Could you conjecture the variant for mathematics and logic?

Edward: "In formal science (and only in formal science) can we say that we have made genuine progress: that we have raised our number of interesting tautologies."

Norman: And how about the humanities?

Edward: "In hermeneutic science (and only in hermeneutic science) can we say that we have made genuine progress: that we have raised the meaningfulness of our understanding."

Norman: How about your chairman now?

Edward: He may feel a bit bruised, I guess. But he will have an argument of last resort. He'll refer to Popper again and say: "This Image is not falsifiable, and not even verifiable. Hence, it's metaphysics."

Norman: He's right. It's meta-mechanical meta-physics.

Edward: But then he'll quote Wittgenstein and say that we should be silent about metaphysics!

Norman: It's late enough now to follow this advice, for once. Let's go metaphysically home on our metamechanical bicycle.

Happily clutching the drawing of their Image, Norman and Edward leave the bar.

For a discipline in the making, applied interdisciplinary studies are an opportunity to get off the ground. This involves the risk, however, that scientific development gets stuck at the level of *ad hoc* work. Counterbalancing this risk first of all requires a clear notion of what may be 'beyond interdisciplinarity', and this clarification is the first aim of the present chapter. Based on a brief survey of the current terms, literature and practicalities of (applied) interdisciplinary studies, it shows that if we are able to conceptualize environmental science as a problem-oriented discipline alongside the other problem-oriented disciplines, interdisciplinarity sheds its cloak of being something epistemologically special or problematic. On that basis, building an interdiscipline and an interdisciplinary curriculum becomes a fairly straightforward matter, in which the existence of a problem-oriented theory level is of pivotal importance.

Chapter 2

A DISCIPLINE FOR INTERDISCIPLINARITY

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Q. It must be difficult to keep all these matters correlated.

A. Correlated! Why, I didn't know you were a social scientist too.

Q. I guess I meant to keep them all together in your mind.

A. Oh, it's not so hard ifyou have a systematic theory ofcomponent hypotheses.

Q. I should think not. Do you?

A. No. But then, no one does[19].

2.1 Introduction

As discussed in the preceding chapter, environmental science is defined throughout this study as the discipline focussing on the analysis, explanation and solution of environmental problems. This implies that environmental science does not encompass the disciplines that study problem elements (such as environmental chemistry) or study problem aspects (such as resource economics) or study phenomena that are of wider relevance than being part of environmental problem situations only (such as geography, anthropology or ecology). Environmental science theories, one could say, are preliminary *whole-problem* theories, and the bulk of the factual knowledge that has to be integrated (through these theories) in environmental science studies will always be found *outside* the integrating discipline. Environmental science is obviously something interdisciplinary.

The 'discovery' of interdisciplinarity in the 1960s (Roy, 1979) has triggered off a host of aspirations, theoretical discussions, practical problems, successes and failures. Much of the resultant literature treats interdisciplinarity as something elusively philosophical (Van Doorne and Ruys, 1988), something very problematic (Van Koppen and Blom, 1986; Zandvoort, 1986; Spaargaren, 1987; Broido, 1979), something that takes many steps (Jungen, 1986) and so on. On the other hand, successful interdisciplinarity research has long been a common phenomenon in environmental science. In fact, organizing interdisciplinary student teams was the first thing the Leiden Environmental Science Centre did when it was launched in 1977 and it has organized them ever since, taking up students from the physical, social, juridical and

[19] From Bereldsen, "The Cliché Expert Testifies on the Social Sciences", a manuscript privately circulated circa 1950s, reprinted in Dubin (1969).

technical science fields. Experiences like these have had their counterparts all over the world and have given rise to another, more practice-based type of literature on interdisciplinarity (e.g. Kendall and Mackintosh, 1978; Levin and Lind, 1985; Garcia, 1989).

Even this type of literature, however, leaves much to be said. There is, for instance, the persistent unclarity about the 'fragmentation of science', a phenomenon seen as a disease for which interdisciplinarity is a cure. Yet, the fission of disciplines is obviously functional in many respects (Adriaansens, 1988)[20] and it is also hard to see why an interdisciplinary study of a small shallow lake should be less of a fragment than a monodisciplinary study of, say, a supernova or a social security system. Moreover, the majority of the data and discussions in the literature deal with such things as the managerial and psychological aspects of group work, the reasons for interdisciplinarity or institutional arrangements, without adressing the crucial issue of whether all those interdisciplinary studies might in the end amount to something scientifically *real,* i.e., something more than a series of applied studies. It is no wonder, then, that in spite of case-to-case successes of interdisciplinary teams and in spite of the fact that many departments or even whole universities 'went interdisciplinary' in the nineteen-seventies, the structural results have not been breathtaking (Klein, 1985).

The contributors in Levin and Lind (1985) show that several interdisciplinary centres and departments have found an uneasy *modus vivendi* with surrounding Academia, and almost all contributors stress the institutional aspects of having own funds and an own reputational structure for interdisciplinarity. In my opinion, own funds in the end, will have to find a justification in scientific progress, and reputational structures can only be built if there is something scientifically real to build upon, that is, a *growing structure ofcoherent interdisciplinary theory.* Therefore, the pivotal question, both for day-to-day practice and long-term survival, is epistemological: how to build a coherent theory for interdisciplinary fields. Consequently, the subject of this chapter concerns the *theory* of science, not the sociology or the management of science; matters like institutional structures, team leadership, incentives, peer review and so on will receive only minor attention[21].

I will argue that many problems with environmental science interdisciplinarity, as is the case with environmental science as a whole, have arisen out of a failure to see environmental science as a normal member (actually or potentially) of the normative sciences family. In order to arrive at this point with sufficient ground underfoot, and in order to shed some light on a number of more minor issues, I will first explore some basic concepts (Section 2.2) and then focus on the role of theory at the level of

[20] Fission becomes counterproductive if it goes to the extreme of creating isolated and marginal groups, as depicted by Hagstrom (1965). Hagstrom's warning does not really concern the issue at hand here, however, since his 'model of segmentation', may as well apply to the rise of higher-level, integrative disciplines such as human ecology, which might counterbalance rather than strengthen reductionistic tendencies.

[21] See for instance Mar et al., 1976 and the overview of Epton et al. 1983.

more or less applied, ad hoc interdisciplinary studies (Section 2.3). This lays the basis to discuss the making of environmental science as an interdiscipline (Section 2.4), the exchange of theory with surrounding disciplines (Section 2.5) and interdisciplinary curriculum design (Section 2.6).

2.2 Exploring The Terminology[22]

A number of terms have to be defined in order to make a good start with this chapter. The chapter will hinge on the same three terms that dominate the present literature: monodisciplinarity, multidisciplinarity and interdisciplinarity. These will be presented in a picture in the style but not the full content of Jantsch (1971)[23]. A number of supportive concepts will then be defined more informally. The three core concepts are defined as follows, using the well-known principle that a whole is more than the sum of its parts.

- Monodisciplinarity: *a single discipline* working on an empirical or normative science problem, at a case study or a more general theoretical level.
- Multidisciplinarity: *more than one discipline* working side by side on an empirical or normative science problem, at a case study or a more theoretical level, *without-coming to a result that is significantly more than the sum of the disciplinary contributions.*
- Interdisciplinarity: *more than one discipline* working on an empirical or normative science problem, at a case study or a more theoretical level, *coming to a result that is significantly more than the sum of the disciplinary contributions.*

In their italicized core terms, these definitions follow current interpretations[24]. In the words of Pétrie (1976), for instance:

> "I distinguish between interdisciplinary and multidisciplinary efforts. The line is not hard and fast, but roughly it is that multidisciplinary projects simply require everyone to do his or her own thing (...). Perhaps a project coordinator or manager is needed to glue the final product together, but the pieces are fairly clearly of disciplinary size and shape. Interdisciplinary efforts, on the other hand, require more or less integration (...) of the disciplinary subcontributions."

Pétrie draws the dividing line between 'glueing the final product' and 'more or less integration'. In practice, something more than glueing is almost always attempted, without a study being called interdisciplinary. This is reflected by Anderson (1985):

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[22] The literature study by A.W.M. Verkroost and H.F. Stolwijk is gratefully acknowledged.

[23] Later also used by Di Castri (1978) and Wilpert (1979).

[24] See, for instance, Udo de Haes (1984) and RAWB (1985) for the Dutch field. The international review of Klein (1985) follows the same line, as well as, in different wordings, Rossini et al. (1979), Scott (1979) and many others.

"The outcome of an interdisciplinary study, if all goes well, is likely to be an account with a coherent vocabulary and sustained by an integrated theory (...)• Reports from multidisciplinary projects are likely to comprise chapters written from disciplinary perspectives, followed by chapters which summarize and attempt to synthesize."

The dividing line between multi- and interdisciplinarity may be put anywhere between Petrie's or Anderson's; therefore, I leave it open what is 'significant' in my definitions. Greater precision will be seldom needed.

The non-italicized terms in my definitions are intended to keep the scope of the mono/multi/inter-disciplinarity discussion sufficiently broad; they do not differentiate between the concepts but emphasize three issues that have been extensively treated in Chapter 1.

(1) Mono/multi/interdisciplinarity may take place within the empirical science family and within the normative science group as well as between them. Increasing the responsiviness of the empirical sciences to societal problems may have been a prime motivation for interdisciplinarity[25], but it is by no means the only one. The only more or less fixed relation between participating disciplines is that they usually work together to produce insight *at a higher system level,* relative to the system level of the usual object of the participating disciplines. This system level may be a supernova, the bio-chemical system of a cell, a human-ecological system, a landscape or a societal problem (De Groot, 1984b). Quoting Jantsch (1971):

"Interdisciplinarity is that a common axiomatics for a group of disciplines is defined at a higher level; this concept is used to co-ordinate the disciplines".

For this reason, interdisciplinary theories and methods are called 'integrative' throughout this chapter, and the tiered representation in Figure 2A indicates real higher and lower systems levels of the discipline's objects[26].

(2) Mono/multi/interdisciplinarity may, as repeated in the definitions, aim at contributions concerning one or several concrete cases, but may also aim to build or test insights at the more general level of theory and methods.

(3) More importantly, it should be noted that a case study having a normative-science nature, that is, focussing on the analysis, explanation and solution of societal problems, can be freely combined with an aim of contributing to theory, namely, theory also focussing on the analysis, explanation and solution of societal problems. This point, trivial as it may seem, is overlooked in all literature found. This is just another way of stating what in the introductory section has been called 'the failure to visualize environmental science as a normal member of the normative sciences family' and that, in its turn, is just another way of describing the 'Cartesian trap' of Chapter

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[25] As may be found throughout Levin and Lind (1985), Kockelmans (1979) and Chubin et al. (1986).

[26] It is not perfectly true, of course, that all disciplines that contribute to interdisciplinary studies or theories are lower system level disciplines. Mathematics and geography are cases in point. This does not impede our argument, however.

1.

Figure 2A illustrates the three core terms. The dotted and the solid lines indicate the relative strengths of each discipline and the relations between them, as they occur in the particular types of research. In every picture, there is a lowest-level type of discipline. The fact that all of these have been dotted denotes that these disciplines act as more or less passive suppliers of knowledge, applied as a matter of course by the higher-level disciplinarian. This happens daily in all research, 'pure' or applied, empirical or normative, with respect to astronomy and mechanical engineering in Annex 1.II.

In the multidisciplinary case, the 'top-level' concepts, theories and results are weak, or 'insignificant' as the definition puts it, relative to those of the lower-level disciplines, and consequently exert weak integrative power. Interdisciplinarity arises when these forces become significant.

Drawing from a wide array of U.S. experiences and literature, Klein (1985) and Lynton (1985) distinguish between two types of interdisciplinarity, "synoptic / conceptual" and "instrumental". It is of importance to go into this distinction somewhat more deeply here, because it is relevant in itself and also because it tempts us to follow a conceptually mistaken road. As we will see, this mistake is again a consequence of the inability to see problem-oriented sciences *as sciences,* possessing their own level of problem-oriented theory.

"Synoptic" or "conceptual" interdisciplinarity, following Klein and Lynton, has a long history, driven by the desire to preserve a unity of thought against the ever-increasing fragmentation of science and the disconnection of science from responsible human life. Synoptic interdisciplinarity is therefore associated with the ideal *and praxis* of the 'liberal university', holistic enterprises, grand theories, the hermeneutic approach, cultural studies, integrated 'area studies'[27], and the Bildung of students as opposed to teaching them disparate theories and data grinding methods. Much of the material found in Kockelmans (1979) stands in the synoptic perspective.

"Instrumental" interdisciplinarity, again following Klein and Lynton, has more recently arisen from the pragmatic need to integrate disciplines for studying higher system levels (e.g. bio-chemical systems, the ocean) or for analyzing and finding solutions to complex societal problems (e.g. health and environment).

As Klein indicates, both categories of interdisciplinarity are deeply entrenched in U.S. education, research and professional organisations, and the future course of institutionalized interdisciplinarity may be substantially influenced by the ongoing discussion between the two. This makes it all the more interesting to take a look at

[27] Although Klein does not mention it as an example in her review, much of human ecology as it is taught, for instance, at the College of the Atlantic (Borden, 1989), is built on the same aspirations.

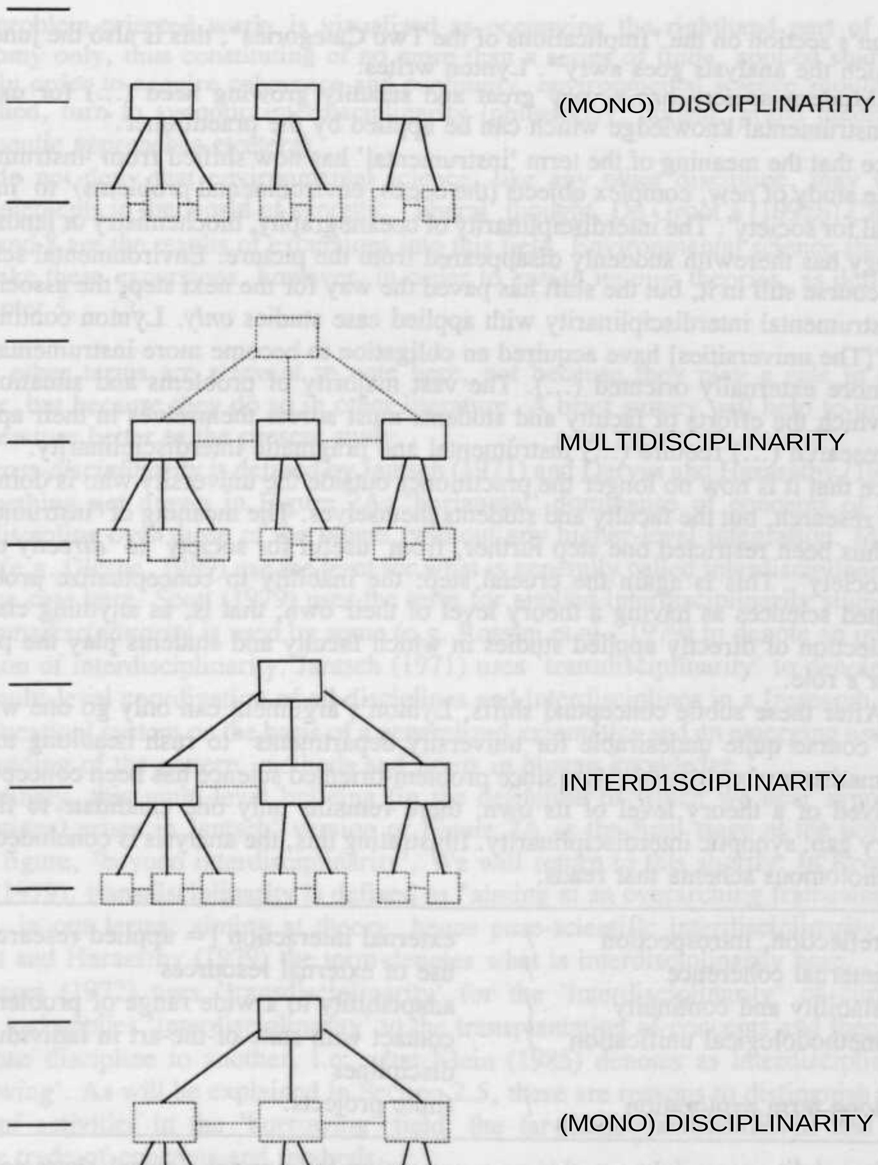

Figure 2A

The pattern of **monodisciplinarity, multidisciplinarity** and **interdisciplinarity.** The squares denote disciplines. If drawn in a solid line, the discipline contributes its paradigm, theories and data. If drawn in a dotted line, the discipline's **contribution** consists of 'finalized', non-paradigmatic products only (e.g. data and models).

Lynton's section on the "Implications of the Two Categories"; this is also the juncture at which the analysis goes awry[28]. Lynton writes:

> "**Modern society has a very great and steadily growing need (...) for usable,** instrumental knowledge which can be applied by the practitioner."

Notice that the meaning of the term 'instrumental' has now shifted from 'instrumental for the study of new, complex objects (the ocean, environmental problems)' to 'instrumental for society'. The interdisciplinarity of oceanography, biochemistry or landscape ecology has therewith suddenly disappeared from the picture. Environmental science is of course still in it, but the shift has paved the way for the next step, the association of instrumental interdisciplinarity with applied case studies *only*. Lynton continues:

> "[The universities] have acquired an obligation to become more instrumental and more externally oriented (...). The vast majority of problems and situations to which the efforts of faculty and students must adress themselves in their applied research (...) require (...) instrumental and pragmatic interdisciplinarity."

Notice that it is now no longer the practitioner outside the university who is doing applied research, but the faculty and students themselves. The meaning of 'instrumental' has thus been restricted one step further, from 'useful for society' to '*directly* useful for society'. This is again the crucial step: the inability to conceptualize problem-oriented sciences as having a theory level of their own, that is, as anything else but a collection of directly applied studies in which faculty and students play the practitioner's role.

After these subtle conceptual shifts, Lynton's argument can only go one way. It is of course quite undesirable for university departments "to rush headlong toward pragmatism and outreach". And since problem-oriented science has been conceptually deprived of a theory level of its own, there remains only one candidate to fill the theory gap: synoptic interdisciplinarity. Illustrating this, the analysis is concluded with a dichotomous schema that reads:

reflection, introspection	/	external interaction [= applied research]
internal coherence	/	use of external resources
stability and continuity	/	adaptability to a wide range of problems
methodological unification	/	contact with state-of-the-art in individual disciplines
long term exploration	/	finite projects.

At first sight, one might see this as representing the normal, logical characteristics distinguishing the theory level from the studies level, within any discipline or programme (ecological, engineering, oceanographical or environmental science). In Lynton's analysis, however, it represents the difference between synoptic and instrumental interdisciplinarity. In other words, environmental science, together with all

[28] Close-reading will reveal that the authors are in fact more nuanced than my quotations suggest; I have concentrated on what most readers will pick up as the main message. Verkroost (1987), is an example.

other problem-oriented work, is vizualized as occupying the righthand part of the dichotomy only, thus constituting of no more than a series of finite, applied studies. Thus, in order to acquire coherence and continuity, environmental science should, it is implied, turn to synoptic interdisciplinarity (philosophy, holism, grand theories, hermeneutic approaches etcetera).

I do not deny that environmental science, like any other discipline, may find useful elements in the world of synoptic, 'liberal' thought. De Groot's (1992b) Chapters 7 and 8 are the results of excursions into this field. Environmental science should undertake these excursions, however, in order to *enrich* its *own* theories, as defined in Chapter 1.

A few other terms are relevant to note here, not because they play a role in this chapter, but because they do so in other literature. A brief survey will help to tie up this literature better to the present study.

Cross-disciplinarity is defined by Jantsch (1971) and Darvas and Haraszthy (1979) as something not drawn in Figure 2A: 'horizontal' dominance of concepts of one monodiscipline over those of the others, without any higher-level integration. Many others (e.g. Glesne, 1989) use the term for what is generally called interdisciplinarity, as is the case here. Scott (1979) uses the term for applied interdisciplinarity studies.

Transdisciplinarity is used by some (e.g. Rossini et al., 1979) to denote an intensification of interdisciplinarity. Jantsch (1971) uses 'transdisciplinarity' to denote a

> "multi-level coordination of all disciplines and interdisciplines in a [research and education] system on the basis of a generalized axiomatics and an emerging understanding of the pattern, methods and limits in human knowledge."

Interestingly, this multi-level building (in the definition of which we hear synoptic inspirations) arises in Jantsch' version of Figure 2A as the final stage at the bottom of the figure, 'beyond interdisciplinarity'. We will return to this shortly. In Kockelmans (1979), transdisciplinarity is defined as "aiming at an overarching framework", that is, in our terms, aiming at theory, hence pure-scientific interdisciplinarity. In Darvas and Haraszthy (1979) the term denotes what is interdisciplinarity here.

Piaget (1972) uses 'transdisciplinarity' for the 'interdisciplinarity' of current usage, and applies 'interdisciplinarity' to the transplantation of concepts and theories from one discipline to another, i.e. what Klein (1985) denotes as interdisciplinary 'borrowing'. As will be explained in Section 2.5, there are reasons to distinguish two types of activities in the 'borrowing' field: the far-flung transplantations and the regular trade of concepts and methods.

I have avoided the term transdisciplinarity for several reasons. A practical reason is that the term is not in common usage with a common understanding of its basic meaning, as is the case with the prefixes mono-, multi- and inter-. Other reasons go deeper. The term seems to be most often triggered by a (justified) idea that there must be something 'beyond interdisciplinarity'. Jantsch, working with the image that interdisciplinarity works to establish (pure or applied) knowledge at a higher system level than the monodisciplines, imagines the world beyond interdisciplinarity as a multi-level, multi-relations pyramid of disciplines. For other authors, transdisciplinarity is more simply an intensification of interdisciplinarity, without a 'levels' connotation. Both ideas are partly right and partly wrong. As drawn in Figure 2A, going beyond interdisciplinarity does not result in something that should have a special name, nor in ever-increasing complexity, but in the *return of simplicity,* namely monodisciplinarity, albeit at a higher level. As we will see later, this occurs because the lower-level disciplines 'fade out' under the strength of the higher-level theory.

Polydisciplinarity is a term used by Kendall and Makintosh (1978) to denote all work that involves more than one discipline, hence constituting an umbrella concept for multidisciplinarity, interdisciplinarity and any other variants one might wish to define. Using such a term is conceptually consistent, and is in fact more consistent than current practice, which usually lumps multi-, inter- and all other disciplinarities together under the heading of interdisciplinarity (Scott, 1979).

2.3 Mono-, Multi- And Interdisciplinarity At The Studies Level

In this section, we will explore the interplay of two variables, size-of-problem and strength-of-integrative-theory, in the establishment of successful interdisciplinarity at the level of case studies. This clarifies some issues pertaining to the interdisciplinarity discussions, and acts as a primer for the next section, in which we will define what 'interdiscipline' in fact is and answer the questions of relevance and strategy for making an interdiscipline. As said, we will focus on the epistemological, not the institutional side of the matter. The argument is built up by way of four studies examples. As a starter, we take a study at the sub-scientific (daily-life knowledge) level, very applied and of the 'designing' type[29]. The latter ensures that it automatically has a whole-problem objective, since no designs can be made on the basis of studying single elements or aspects.

Imagine that a local pressure group has managed to put the problem of the use of pesticides in the public parks on the political agenda of the municipality. A civil servant with an environmental science background is assigned to look into the problem and to investigate the possibilities of an alternative, low-pesticide park maintenance system. What types of information will the civil servant look around for?

(1) He will want to know what pesticides are applied and how much of each, how toxic these are in humans and ecosystems, how persistent they are and so on, so that he may gain an idea of the risks associated with them. Time and enthusiasm permit-

[29] The terms have been defined in Chapter 1.

ting, he may even try to carry out a more integrated risk quantification; he then applies a particle of interdisciplinary theory[30].
(2) He will want to know if alternative chemicals are available and how feasible they seem in terms of risks, range of applicability and cost.
(3) He will want to know what can be achieved with mechanical weed control, in terms of costs, working conditions etc.
(4) And he will want to know what options exist for decreasing the need for pesticides by planting alternative species. Or perhaps, more weeds and pests could simply be tolerated, as the pressure group suggests.
(5) This point also triggers off a need to know more about the values that are at play. For instance, if he were to propose reshaping the parks into simple grass lawns (cheap and free of poisons), people might protest for aesthetic and recreational reasons. It may also transpire that people do not like dense, natural thickets because these look disorderly and may attract crime. These value patterns will vary according to the groups the civil servant comes into contact with in the course of his analysis (the environmental group, the older inhabitants of the neighbourhood, the public parks service and so on).

What has the civil servant been doing here, in scientific terms? Firstly, he has been loosely analyzing an environmental problem situation, intermingled with the first steps of the design of a solution. Secondly and more importantly in the context of this section, he has been succesfully interdisciplinary, using chemical, toxicological, biological, economic, technical, landscape-architectural, administrative and social data, blending them all into the integrated thing he is making: a design and evalution of one or two alternative park maintenance systems.

Thirdly, we may note that the integrative proceedings have been guided by common sense. The sub-scientific, daily-life schema for the integration of data has primarily been that of the civil servant, but kept in check by those of the surrounding colleagues and citizens. Some of the component data he has used have been scientific (e.g. the ADI-values of the pesticides) and a semi-scientific assessment formula may have served as a sub-integration, but the overall process of analysis and design has been something that any sensible person could have carried out.

Here, we discover what may be called the *scientific problem size* as the first variable determining whether an interdisciplinary approach may be successful. This variable is composed of two subvariables: (1) scientific problem size in its pure sense, i.e., the *quantity and availability of the data needed,* and (2) the *demands on precision, replicability, certainty and so on.* The example shows that if these two subvariables have a sufficiently low value, interdisciplinarity can be achieved by a single person, even when using only common-sense-level 'theory' for integraion[31]. Perhaps

[30] For instance using the little formula of De Groot and Murk (1986) combining all the factors into a single assessment.

[31] It may be noted that the 'size of problem' variable has a much wider range than the 'quality of theory' variable which will be explained below. Theory may vary between common sense and sophisticated models, but size-of-problem may vary between almost zero (much less even than in the park

because it calls for modesty when assessing why interdisciplinary teams have been successful, this fact is overlooked in the interdiscipinarity literature[32].

Strength of integrative theory is the second variable which determines the success of interdisciplinary approaches. It comes into focus by taking a look at a group of seven students, of engineering, physical science and social science backgrounds, working to design a new, more environmentally friendly domestic waste strategy for the municipality of Leiden (De Groot and Mulder, 1983). The study was of the same directly applied and 'designing' nature as the first example. Much more data had to be integrated with much greater precision, however. Some social science data were also not available, requiring a quantitative survey and a qualitative interview series to be carried out. Sufficient finalized theory was available to do this on a routine basis, but time consumption was of course unavoidable. The scientific problem thus being too large to be tackled by a single person, the group was established. It was also obvious that, by themselves, common sense and intuition were too weak to guide the data gathering and integration process. As it turned out, the group worked smoothly and steadily towards an integrated result that led to municipality action, guided by a semi-scientific mix of 'enhanced common sense' (scheduling, group discussion, reflectiviness etc.) and some easy bits and pieces of theories for systematic analysis, design and evaluation (e.g. Section 3.11).

Larger problems, it appears, require a group approach and a more intense involvement of integrative theory.

In order to illustrate the latter, we may turn to a third example (also of the applied and 'designing' type). It concerns a group of ten students, drawn from landscape ecology, economics, biology, anthropology and physical geography, aiming at the design of a National Conservation Strategy for Zambia (De Groot and Van Tilburg, 1985). This group was successful in the end, but the path taken was neither smooth nor steady. In fact, it was several times on the verge of disintegrating to the level of multi-disciplinarity, everybody doing his own disciplinary thing only.

Size-of-problem was the major factor behind this. The amount of data that have to be gone through before one understands the functioning of a country to the degree necessary to draw up a conservation-cum-land-use plan is enormous. And how to integrate that mass into a plan? Some stepwise procedure was obviously indicated, but what? Region-by-region, sector-by-sector, and then integrate these at the national system level? And what are, in fact, the goal variables for such a plan? National income? Equity? Liberty? Sustainability? Self-reliance? And how to operationalize

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pesticides case) and incomprehensible complexity. A high-precision, high-certainty, fine-detail whole-world no-pesticide alternative is impossible to design, whatever the group size and the sophistication of models, concepts and other theory.

[32] It is also overlooked in practice, for instance, by myself and collègues. We have always been fairly proud of our capacity to organize interdisciplinary student team research; we nor anybody else checked this critically against the size-of-problem they tackled.

these into practical guiding principles for design? And what should be mapped: soils, tribes, land-use systems or environmental problems? And what happens, in fact, when you 'zoom in' from a national to a regional level? A shift in scale and detail only, or also a drop in social system level? If the latter is the case, should higher-level rationalities be parentesized, to be integrated later when moving back to the national level? And how to define regions at all? What is in fact a system boundary? These are only a few of the issues the group encountered in its headlong crash with the need for integrating theory, a crash in which "analytical distinctions flew in all directions and reproduced promiscuously"[33]. Finally, however, the group put together a common basis for integration and lived up to Sjölander's (1985) rule that "a project having come this far (....) will often prove to produce results at an astounding rate". Contrary to the domestic waste recycling study, the study not only resulted in a (mapped) plan, but also in a contribution to design theory.

What we have seen here is an interdisciplinary study that was almost pulled down to the multidisciplinary level by the sheer weight of data to be integrated, relative to the counterweight of integrative theory.

The next example adds some other elements to the picture now emerging. The type of study is different from the others in three respects: it was not applied but 'pure' (ref. Chapter 1), not designing but analytical and not whole-problem but of reduced interdisciplinarity.

Biesiot and Pulles (1989) describe the struggle of this study to reach the interdisciplinarity level, working in a situation that, if simply accepted, would enable only multi-disciplinary conclusions. The study concerned an attempt to build a policy-relevant model which interrelates individual social and health background variables, psychological coping strategies and stress, noise and noise-related health impact. Methodologically, the study consisted of three components: a survey (N = 2000), medical-*cum*-psychological measurements in the field (N = 860) and clinical experiments (N = 24).

Two major obstacles transpired to stand in the way of achieving the interdisciplinary objective of a unified result. Firstly, no integrative concepts or model proved to be available; such a model had to be formulated during the study itself. This would be no different from the previous example, were it not that some kind of better-than-common-sense integrative framework had to be formulated to design and start the study at all. Thus, a preliminary framework had to be assumed, on the basis of which monodisciplinary substudies could be designed and executed, on the basis of which the framework could be adapted, and then tested through a second round of substudies. Epistemologically, this is normal and sound practice. The budget, however, did not permit a second round, so that the substudies had to be given their definite shape prematurely, and could only be loosely interconnected.

The second obstacle turned out to be that the disciplinary substudies could not apply finalized disciplinary methods, but had to use 'advanced', unfinalized

[33] Gouldner, 1970.

approaches. These 'monodisciplinary insecurities' reinforced the ever-present tendency (Luszki, 1958; Schütze, 1985) to seek recognition in one's own monodiscipline rather than working towards the interdisciplinary objective.

The resulting struggle was, as Biesiot and Pulles put it, characterized by "tensions that could not always be put to creative use". The study finally resulted partly in a few rough categorisations that enabled some integrated conclusions. For another part, separate substudies seemed to indicate "converging evidence", thus enabling a kind of multidisciplinary conclusion, illustrating the study's intermediate position between multi- and interdisciplinarity.

It may be noted that the study did not get stuck in its intermediary position because of the weight of data to be integrated, but for lack of integrative theory. The contours of the conclusion that is emerging may have become clear by now, but in order to give the conclusion its sharpest possible form, we will return briefly to the park pesticides study, forgetting for the moment that the study is at the sub-scientific level. What the civil servant has done has been called "succesfully interdisciplinary". But being executed by one person, wasn't this in fact simply a *mono*-disciplinary study? After all, do not *all* monodisciplinary studies, applied, strategic or fundamental, apply bits and pieces of results of other disciplines?

As for the terminology, the answer to this question is largely an arbitrary matter, based on personal psychology and the status of a given discipline. An architect working on his own on the design of a relatively simple house will not conceptualize what he is doing as an interdisciplinary study but simply as a piece of (applied) architecture. Geography, to mention another example, is typically a very broad discipline incorporating data and theory from a wide variety of other disciplines, without defining itself as an interdiscipline. All this has much to do, of course, with the degree to which disciplines have succeeded in suppressing labels and paradigms of contributing disciplines in the course of the academic education of the people concerned.

The issue of labels carries no epistemological weight, but it does indicate something real, namely, the existence of factual *mono*disciplinarity 'beyond interdisciplinarity'. What the label of the park pesticide study should be is unimportant here, as long as the principle is clear: there exists a type of study in which the integrative theory becomes so strong compared to the component data and theories that the study is *de facto* monodisciplinary, at a higher level. Figure 2A visualizes this. Higher-level (mono)disciplinarity, as a higher-level but congruent repetition of the (mono)disciplinarities at the top of the figure, sits at the bottom, beyond interdisciplinarity.

It is justified and tempting to read Figure 2A as a process: interdisciplinarity and then higher-level monodisciplinarity arising out of multidisciplinarity, because of the growing strength of integrative theory. It should be kept in mind, however, that the position of a study on the ladder also depends on the size-of-problem variable, so that the figure may also be read as: given a certain strength of integrative theory, it depends on the size-of-problem variable whether the problem can be tackled in a multi-, inter- or (higher-level) monodisciplinary way. The next section will proceed from this result.

Rounding off the present section, we conclude that:

- at the studies level, there exists a ladder composed of (mono)disciplinarity, multidisciplinarity, interdisciplinarity and higher-level (mono)disciplinarity
- the position a study may attain on this ladder depends on the balance between the weight of available integrative theory and what may roughly be called the size of the scientific problem the study tackles
- this size-of-problem variable is in turn composed of (1) the required quantity, complexity and precision of data to be integrated and (2) the unavailability of these data or, making matters worse, unavailability of finalized specialist theories to collect and interpret them.

In this formulation, 'theory' may, as always when unspecified, be read as concepts, conceptual frameworks, models, laws, methods etc. It is easy to see that the whole picture hinges on the strength of integrative theory. The whole picture thus hinges on the ability to conceptualize that problem-oriented interdisciplinarity, aiming at being there for society, can be there *with theory*. The inability to do so has been at the root of the disappointment the next section begins with.

2.4 A Discipline For Interdisciplinarity: What It Is And How To Make One

In her 1985 review, Klein writes:

> "While interdisciplinarity still stands in opposition to academic fragmention and in support of greater social and political relevance, program survival has become a major preoccupation and the 1970-72 rallying cry - today's interdiscipline is tomorrow's discipline - is now regarded as (...) nonsense"

Regarding this quotation, the concepts of fragmentation and relevance have been dealt with in previous sections, and I may add that programme survival is not at all a preoccupation for environmental science in the Netherlands, but this section will deal especially with the 'nonsense' of the rallying cry. Something seems wrong here; can it really be nonsense, what seemed so simple and so logical in the previous section? And there is also something that is nonchalantly noted in interdisciplinary literature, but never really grasped in its full implications, namely the rise of biophysics, biochemics, sociolinguistics and other disciplines that quietly made it, without rallying (e.g. Chubin et al. 1984; Klein, 1985; Kockelmans, 1979). What did they do that made them more successful? What are the secret ingredients needed to rise above the level of a vague cluster of studies? Does environmental science in fact rise above that level?

The big step

As we have seen in the previous section, an architect, an ecologist or any other 'disciplinarian' works in the mono-disciplinary mode when on an assignment that his own, disciplinary, theory can cope with. All disciplinarians, however, 'retreat' from the monodisciplinary to the interdisciplinary mode if their subject becomes too complex (relative to the strength of their integrative theory). The ecologist may call to help soil scientists, hydrologists, taxonomists, ethologists and suchlike if, for instance, he has to make a high-precision prediction of, say, a tropical-forest predator-prey-system. Likewise, the architect will call in a construction engineer, an acoustician, a financial expert, a logistics mathematician and a social scientist if confronted with a very complex case, such as the design of, say, an opera-house-cum-multi-service building.

Epistemologically, there is nothing problematic in this retreat. The called-in specialists will simply do in their sophisticated ways what the ecologist/architect would have done himself in an easier case, and they will work under the guidance of the integrative ecological/architectural theories and methods, - all provided that these theories and methods are strong enough, of course. Both the ecologist and the architect will probably try to keep their teams as small as possible. They do so in order to save on the budget and to avoid management risks but not - and this is the crucial point - because single-person monodisciplinarity or teamwork interdisciplinarity would make a difference in reaching a prediction or a design as such. The difference between interdisciplinarity and (high-level) monodisciplinarity, therefore, is only practical. If, however, the integrative power of the ecological/architectural theory had succumbed under the weight of the specialist data and theories, in other words, if the studies had fallen from an interdisciplinary to a multidisciplinary level, no prediction or design would have been possible. At the studies level, therefore, the step from multidisciplinarity to interdisciplinarity is the crucial step forward. The step from interdisciplinarity to higher-level monodisciplinarity is also important, but only for practical reasons.

We now see why it is important for environmental science to become an (inter)discipline. In order to predict something scientifically about system X or design something scientifically for problem Y, one needs whole-X and whole-Y theories, in order to rise above the multidisciplinary level at which in fact no scientific predictions or solutions (or explanations, or whatever) about X and Y are possible. If we define an 'interdiscipline' as a body of theory strong enough to permit interdisciplinarity at the studies level, becoming an interdiscipline is the crucial thing for the scientific-level analysis and solution of environmental problems, and becoming a (mono)discipline later a relatively minor, practical aim.

This basic conclusion has to be sharpened somewhat before we can proceed to the question of How To Make An Interdiscipline. First, it should be kept in mind that whether or not interdisciplinarity can be established at the studies level depends not only on the strength of the integrative theory, but also on the 'scientific size' of the problem tackled, as defined in the previous section. The concept of interdiscipline should take care of that. My proposal for a definition is as follows:

An *interdiscipline* is an open structure of theory[34] powerful enough to permit interdisciplinarity in studies tackling problems of normal scientific size.

And analogously,

A *(mono)discipline* is an open structure of theory powerful enough to permit (mono)disciplinarity in studies tackling problems of normal scientific size.

A few terms in this definitions require some further specification.

1) 'Theory' again denotes (ref. Chapter 1) non-trivial general knowledge in the widest sense (concepts, conceptual frameworks, models, methods, laws etc., empirical and normative)

2) I have added the word 'open' with an eye to the next section. It denotes nothing extraordinary; all disciplines should be open structures.

3) The 'scientific size' of a problem is a very multifacetted concept. It will, however, easily be grasped intuitively by any scientist. The previous section has given a more explicit definition.

Rounding off this definitional intermezzo, two issues remain to be settled. One concerns the terms 'interdiscipline', 'monodiscipline' and plain 'discipline'. The other is the question of what in fact should be regarded as *normal* scientific size.

Both inter- and monodisciplines are defined as 'structures of theory', hence as disciplines, only of a certain type. Therefore, refraining from using too many exotic terms, I usually call environmental science simply a *discipline,* whether real, would-be, should-be or in-the-making. If one wants to be more specific concerning its relation to interdisciplinarity, the term interdiscipline may be used. Usually, I then specify this one step further, calling environmental science a discipline-for-interdisciplinarity or, to be more precise, *a discipline (at the theory level) for interdisciplinarity (at the studies level).* This does not preclude, as we saw, that studies of smaller scientific size may be tackled in the one-person, monodisciplinary mode.

As we have seen in the previous section, it is no great achievement to be successfully interdisciplinary, or even monodisciplinary, when tackling small and simple problems. On the other hand, no discipline is judged on its capacity to solve problems of all-embracing complexity. In order to judge whether a discipline has arrived somewhere, it is therefore crucial to have some feel for what problems of *normal* size and complexity are. This cannot be ascertained with any precision here, of course, but a few observations may be of help.

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[34] I have preferred the term 'structure of theory' over the more common term 'body of knowledge' for several reasons. Firstly, 'knowledge' is associated too easily with specific knowledge, that is, simply *facts,* data about a lot of disparate little things. This is exactly what science is not. Secondly, the term 'body' associates too easily with something unstructured, a heap (of data). Thirdly, the term 'body' associates poorly with the term 'open'. I think that disciplines should be open to a degree that bodies, in their daily language connotation, are not.

A first observation is that, as Garfinkel (1967) has studied and stated so beautifully[35], the term normal has two basic meanings, (1) that which is the norm and (2) that which is usually the case. In daily life, and in the judgment of disciplines, these two meanings blur. A second observation comes from Chapter 1: the norm of what is considered as a contribution to theory, and hence science, is either (1) to say very sophisticated things about simple objects, for instance molecules or ballistic curves, or (2) to say relatively simple things about very complex objects, for instance underdevelopment or culture.

Combining these observations, it becomes apparent that if you need to justify that you are only able to say simple things about your object of study (or can say more sophisticated things only when retreating to the interdisciplinary mode) and yet classify as a science, you have to convince others that the problems you study are very complex. This is precisely a standard rhetoric of environmental science, and it still works well. One cannot keep this up undefinitely, however. In the longer run, it will be found out what is really usually the case. In my opinion, environmental problems come in a wide range, from the very simple to the very complex, and environmental science should therefore be quite aware and self-critical about what degree of sophistication of results and which position on the 'ladder of disciplinarity' are warranted to classify as (applied or 'pure') *scientific* environmental science studies[36].

Finding sources and permanence

We may now turn to the question of what it takes to become an interdiscipline. Many factors in such a process are tactical and institutional, of course. The rhetoric mentioned above is an example. Here we will concentrate on the serious, long-term epistemological business.

In our analysis so far, the 1970-1972 slogan that "today's interdisciplines are tomorrow's disciplines" turns out to have pointed at something real, but also trivial and unimportant. Probably, any interdiscipline, backed up by a small measure of rhetorical and institutional tactics, will grow towards monodisciplinarity; as we have seen, this is not of key importance, for society nor science. The point is, to become etablished as an *inter*discipline first of all. If the 1970-1972 interdisciplinarians had

[35] "People know and encounter the moral order as the perceivedly normal courses of action."

[36] Norms in a more absolute sense can only be established in a critical debate. Here, I can only mention briefly what I would venture as a personal 'proof of the pudding', in terms of the applied study examples of the preceding sections:

- a study such as that of the domestic waste recycling plan should have been possible in half the time, making time available to either broaden the problem or contribute to methodology
- a study such as the NCS should go smoothly and steadily, not at the let's-keep-our-fingers-crossed level that it did
- in the somewhat longer run, it should become possible for studies like these, if sufficient specialist data are available, to be carried out by one, two or at most three environmental scientists.

looked around critically, they would have found a mass of inter-studies, inter-themes,[37] inter-actions, inter-groups, inter-faculties, inter-symposia, inter-colleges, inter-courses and inter-what-have-you's - but inter*disciplines*? That is, coherent structures of integrative theories, or at least, groups consistently working towards them? They would have found biochemistry, of course, and several similar bondings of nearby neighbours, diligently putting together a new theory level . . . . No wonder, then, that most of the inter-things were later thrown back to the level of mere survival, putting too much of the blame on institutional arrangements or the fragmentation of science.

In a way, losing this struggle is just as well. If you do not do what science (including problem-oriented science) is there for, that is, to build problem-oriented or empirical theories, then why should a scientific community support you on a structural basis? In the end, academic standards cannot be diluted, as Papadopoulos (1985) rightfully puts it, and the funds and institutional protection that new interdisciplinary initiatives may receive constitute only borrowed time, as it indeed should be[38].

Hence, an *inter*discipline, how to become one rapidly enough? We will close in on the answer by way of OECD/CERI (1976), where it has been stated that:

> "Environment spreads horizontally across the conventional academic divisions of knowledge in the natural sciences, the life sciences, the social sciences and the humanities."

This is of course very true. But it is not the relevant truth when it comes to structural interdisciplinarity. The quotation is a specified version of the well-known slogan:

> "Communities have problems, universities have departments",

which is also very true. To fully see this truth, let us take a look at what problems and departments there are. We have a problem of order; there is a department of law. We have a problem of health; there is a department of medicine. We have a need for infrastructure; there is a department of civil engineering. We have a need for communication; there are departments of mechanical and electronic engineering. We need food; there is a department of agricultural sciences. Indeed, a beautiful, hand-in-glove

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[37] For instance, "Technology and Social Change", or "Water in Environment and Society" (Nordenfelt, 1985).

[38] Considering the issue from some distance at this point, it is good to distinguish (within what Klein and Lynton have defined as 'instrumental interdisciplinarity') interdisciplinarity tied to a more or less permanent object, field or theme (the ocean, the environmental problems, 'technology and society' etc.) from interdisciplinarity expressly designed to be temporary. The latter also has a role to play in science and society. All kinds of surprising things may happen on the borderlines between disciplines; 'pure' disciplines may be enriched by being involved in applied studies from time to time; crossdisciplinary borrowing experiments may be in need of encouragement, and so on. These groups should, however, never be burdered with an obligation to build up their own theory level. Conversely, these groups as such should never be institutionalized, because the functions of expressly this type of interdisciplinarity are best served if new groups addressing new problems are allowed to freely assemble and disperse. Indeed, to follow the wording of the quotation that opened this section, it is nonsense to assume that disciplines may grow out of these groups, and even detrimental to try it (Klein, 1985).

arrangement! Yet, the two quotations were meant not to point at a nice arrangement, but at a fundamental problem.

This basic misconception is again the Cartesian trap, from which one cannot conceptualize problem-oriented science as science. This leads to thinking that problem-oriented work, lacking a theory level of its own, can only be the application of the empirical-science theories. And it leads to the idea that something very special and difficult has to take place if society has a new type of problem or need, something like interdisciplinary crossbinding so many empirical-science disciplines. In fact, something very normal and relatively easy may take place primarily, namely the making of another problem-oriented discipline alongside the many already existing - if the problem is worth it.

I may call special attention to the notions of 'horizontally across' and 'alongside', relating as they do to the image of the empirical departments standing vertical, and problem-oriented work going horizontally across. If one draws the normative disciplines in this picture, they also lie horizontally across, arranged according to the societal problems and needs fields, but not as *ad hoc* studies, but as permanent disciplines[39]. 'Going across' may thus be either horizontally or vertically, as is 'going alongside. In the empirical realm, for instance, we have seen biochemistry, psycholinguistics and social psychology arising new empirical (inter)disciplines alongside existing empirical disciplines. You make biochemistry starting with borrowing, adapting, criticizing, integrating etc. data, theory and methods of biology and chemistry. This is much easier than 'going across'. Therefore, making environmental science does not seem particulary difficult if conceptualized as making a new structure of theory alongside the existing structures of other problem-oriented disciplines. There are so many concepts, theories and methods to borrow, criticize, adapt and integrate! Going 'alongside' instead of 'across' enables an interdiscipline-in-the-making to rise rapidly to at least rudimentary academic standards.

Apart from this epistemological choice to go 'alongside' instead of 'across' existing disciplines, there exists one more condition that needs to be fullfilled to gain permanence as an (inter)discipline. An (inter)discipline-in-the-making needs sufficient volume and sufficient time to grow, and it needs to be sufficiently different from the others. Again, in the longer term this is not a matter of funds or arrangements. If a theme like "Water and Society", for instance, turns out not to be sufficiently identifiable as something special that needs a special academic structure, for instance, it will be 're-integrated' into the old monodisciplines (Anderson, 1985), and this may be quite justified. Fully stated, *(inter)disciplines may arise if they work on systems or*

[39] Completing this picture, we may note, with Annex 1.I, that also the empirical disciplines have their direct connections with society and that the use of 'finalized' products of the empirical sciences by the normative sciences also has its reverse counterpart, although these intertrades do not have the same intensity and balance at every crossing point of the empirical and normative disciplines.

processes (as empirical disciplines) or on societal problems or needs (as normative disciplines) which are sufficiently identifiable, important, persistent and different. [40]

It is for this reason that medicine and law, working on the problems of health and social order, are the oldest and most powerful disciplines around; agricultural science, civil engineering, administrative science and many others are obvious other examples in the normative realm. On the empirical-science side, society, soil, mind, molecules and many more are systems that qualify for carrying their own respective disciplines[41]. It is also for this reason that many clusters of research activities do not come to stand as a (sub)discipline on their own, but live within the house of the discipline that surrounds, shelters and feeds them. It is then the discipline as a whole that remains the primary theory structure on which the "academic reference groups" (Papadopoulos, 1985) are built.

Could (problem-oriented) environmental science be or become an (inter)discipline on its own? I think it can, if it builds on the proper self-conceptualization, as discussed before. For once, environmental problems seem persistent enough to enable environmental science to keep on growing. And because environmental problems are the only social problems that 'work through' the environment, they are probably also different enough (although, of course, not so very different that environmental science would not share many theory elements with its neighbours). As for their importance and identifiability, society itself speaks out clearly.[42]

This, it seems, holds for environmental science as a whole. I doubt if water problems, pollution problems, nature problems, Third World or any subtype of problems have sufficient identifyability and differentness to support real subdisciplines. Therefore, environmental science as a whole should probably remain the primary frame of reference for the time being and environmental scientists should dilligently flock

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[40] Roy (1971) states that "permanent interdisciplinarity units" should centre on "the basic human needs" or "permanent human concerns"; environment is one of these.

[41] This image of a near-perfect arrangement of the disciplines holds only for the basic ground pattern, of course. The precise boundaries and approaches are in fact arbitrary (Birnbaum, 1969), full of gaps and overlaps (Campbell, 1969) and in need of re-arrangement when applied to a different culture (Moore, 1974).

[42] As a matter of local importance, it may be asked whether environmental science in the Netherlands is already in the desired state of being an interdiscipline. Such an assessment would require more than simply counting the number of successful interdisciplinary studies, as we have seen, because doing well in easy cases is no achievement. The general atmosphere at the moment is optimistic, however, and marked by a conspicious frequency of the term 'integrated', in congresses and Ph.D. research, with subjects such as integrated wetland management, integration of pollution and nature protection policies, integration in environmental planning, integrated substance flow analysis, integrated product analysis and so on. Other current Ph.D. projects are less obviously 'integrative', but all do what should be typical for a problem-oriented field with its own theory level, namely, achieve a combination of policy relevance and a high level of generality. Illustrative subjects are: ecological environmental standards, policy-relevant ecosystem classification, operationalisation of the environmental quality concept, 'emic' and 'etic' knowledge in local environmental problem analysis and regional environmental planning, both for the developed and less developed countries.

together, in the meantime keeping their eyes open in all relevant directions, as will be shown in the next section.[43]

2.5 Interdisciplinarity At The Theory Level

Environmental science, defined as it is throughout this study, can be visualized as a core of integrative theory on which to hook on specialist data or theories, as required by the problem at hand. The process of hooking on and integration at the studies level has been the subject of Section 5.3. The previous section has had a more 'vertical', whole-discipline character, focussing on the linkages between the studies and the theory levels. The present section will again work on a horizontal plane: interdisciplinary relations at the theory level.

The nature of the relations between environmental science and other disciplines changes when moving from the studies to the theory level. Firstly, if a discipline is 'hooked on' to environmental science at the studies level, it is primarily *data* that travel across the link, and these data are then taken up in a process of integration, e.g. a historical problem analysis or the design of an environmental policy. At the theory level, it is of course theory elements (concepts, conceptual frameworks, methods, models, substantive theories, etc.) that travel across; these elements are then not so much processed as adapted, extended, fused and so on. Therefore, they may also travel *back* in their adapted form, in a process of mutual borrowing, discussion and exchange. Secondly, relations at the studies level are often intense but of a short duration; specific data and models are very necessary for the specific problem under study, but not relevant for others. At the theory level, environmental science is occupied more permanently with general problem types, solution types, explanatory

[43] Besides dilligently flocking together, other institutional matters play a role too, although less fundamentally than the epistemological ones. They are treated in most of the literature found in this chapter. Here, I may add some prescriptions of my own. (1) *Be aware of the time perspective.* If the borrowed time is short, publish everything you happen to know and give a course to every student you may fetch. If the time perspective is longer, invest in the really future-rich matters, e.g., a conceptually sound organisation, a paradigmatic research programme and people with brains instead of knowledge. (2) *Make yourself uncleavable.* The monodisciplinary departments will always try to 'reintegrate' you. Therefore, make research groups fully multidisciplinary, weave the educational task through the research groups in a warp-and-woof pattern, never allow subgroups to enter negotiations, make a strong level of 'general studies', and always keep the peace, internally. (3) *Do not struggle on irrelevant fronts.* Participate in the general and local rituals of science; wear a tie even in bath. In the meantime, establish a journal and your own peer review structure, get the discipline established in institutional structures and sell your capacity for applied studies for too much money, so that profits can be re-invested in scientific progress.

mechanisms and so on. At that level, therefore, the linkages with other disciplines are of a more structural nature[44]. Thirdly, because interactions at the theory level concern more general concepts, models and methods than the 'studies-type' interactions, the relative importance of disciplines shifts when rising to the theory level. There will be more of environmental ethics, for instance, and less of environmental chemistry.

The image thus arising is that of a set of openings, 'doors', through which theory elements are more or less permanantly exchanged with neighbouring disciplines. Obviously, different parts of the internal structure of environmental science exchange elements with different disciplines, and it will be of use to specify, however roughly, what types of outside theoretical elements are exchanged with the different parts of environmental science. This then will be the 'picture of interdisciplinarity at the theory level' that this section will conclude with. We will arrive there by first rolling aside the boulder of far-fetched transplantations, then circumvening the puddle of vague pluralism and finally using Hermens (1989) as a halfway stepping stone.

Instead of regular exchanges with neighbours, theoretical interdisciplinarity is sometimes understood as hauling in theory elements from far-away places and implanting these, through metaphorical 'analogue reasoning', into the own body of theory. Such far-fetched transdisciplinarity may serve heuristic purposes from time to time, but I would rather give two examples that illustrate Luther's saying that every consequence leads to the devil. One example comes from transplanting systems ecology to the normative realm, the other from transplanting systems ecology to social science.

Gilliland and Risser (1977), impressed by the beauties of the analysis of energy flows in ecosystems following the Odum (1983) school, state that "energy measures work done by nature" and this work is then translated as "the public service functions of nature". This leads to the idea that energy is the superior measure to quantify the value of the environment, having the additional advantage of being objective, "not involving the biases of someone's value system". Hence, "the use of the energy unit permits quantification of the total impact" of projects, for example, in environmental impact assessment. Then, focussing on such a project, Gilliland and Risser construct an energy model with 61 relationships and calculate that the project leads to a decrease of 1 % of the area's energy flow, which turns out to be no more than 1 % of the primary production. Quite apart from the fact that the energy elephant turns out to have given birth to a disappointingly little mouse, one may ask: what does it in fact imply that an effect on primary production equals "total impact"? It implies that removing a small area from a super-productive maize field is worse than destroying an expanse of desert biome. In fact, the whole of the Netherlands, a country choking in manure and full of nature protection agencies struggling for the survival of species-

[44] For that reason, they also have an institutionally different shape. Practice in Leiden shows, for instance, that it is easy to establish a short-duration link with almost any discipline within the framework of a concrete study. Intensive exchanges of theory, on the other hand, require that you have something to offer in the theory game; you therefore need an X-person in your team to establish a link with discipline X.

rich mesotrophic and oligotrophic ecosystems, should be handed over to the potato-growing industry.

As a second example, we have Hawley's (1986) depressing Human Ecology, in which the ever-present tendency in American functionalism to grow into a totalitarian system religion (Gouldner, 1970) is reinforced by transplanting ecosystem theory to social systems theory. Here, we find the human individual roaming around like a deranged predator, "compulsively expansive" and "immensely adaptive" in pursuing his lusts. Fortunately, the individual (you, I and Hawley, that is) is just "a construct"; only the system is real.

Sitting in the Cartesian pit of being able to see only empirical science as science, Zandvoort (1986), poses the question as to which big, empirical-science discipline should "guide" environmental science into becoming something real. When no such empirical discipline, as could be expected, turns out to exist, Zandvoort makes a "plea for pluralism", which should be visualized as "a network of environmental specialisms, of which some will act as a guide more often than the others".

What should such a network be? Should environmental chemistry and environmental sociology form a relationship in a network? To do what? The idea of "acting as a guide more often than the others" is fairly unsuitable at the theory level, where interactions should be stable and simultaneous, not with one discipline during one period and then with another. It applies, if anywhere, at the studies level, where participating disciplines may vary largely from one study to another, as will, to a certain extent, the integrative models applied. That level, however, is irrelevant for what concerns Zandvoort (and us, here), that is 'guidance' of environmental science as a science or, in our terms, the structure of interactions at the theory level.

Mertens (1989) first summarizes some essentials of my previous writings (De Groot, 1984 a, b and 1986) and then proposes a structure that visualizes a permanent bonding between environmental science and two other, basic disciplines. This structure has much in common with De Groot (1988), but since it has been developed from an independent source, we will take a separate look at it. Mertens starts out with a rejection of Zandvoort's *ad hoc-ism,* even at the studies level:

> "The analysis of concrete environmental problem situations and the design of concrete environmental policy plans require an application of general environmental science insights, without this having to imply that environmental science should be amended all the time (...). I should say that environmental science does not have the structure of a piece of chewing gum, but disposes of sufficient theoretical depth to find out what disciplines should function as suppliers of knowledge, dependent on an analysis of the [environmental problem] situation at hand. For this analysis one needs theories and concepts which are *in*dependent of the situation."

Mertens then proceeds to define the permanent relation between environmental science and other disciplines. He does so by pointing at the analogousness of environmental science and other problem-oriented disciplines. Taking agricultural plant engineering as his primary example, he then broadens the picture to the technologies in general, which he sees as an integration of (branches of) physical science and "general theory of goal-oriented action"; he then moves over to the 'soft' problem-oriented sciences, of which environmental science is an example. The picture he arrives at is three-layered. At the bottom are two basic sources, "general ecology" and "general theory of goal-oriented action". From these develop two environment-oriented disciplines, "environmental ecology" and "environmental administration science", respectively. Then, these flow into environmental science.

One question here is what would be the role of, say, ethics, ecological economy, physical planning and other disciplines that obviously also hold many relevant theories. A second question is why "goal-oriented action" is confined to environmental policy making. Do not the goal-oriented actions of other government agencies, corporations, individual citizens and other actors cause, and sometimes also solve, environmental problems? Here again we have the picture of environmental science as 'environmental management' as discussed in Chapter 1, leaving the explanation of environmental problems out of its scope, sometimes, and not completely unjustified, described as the symptoms-abatement machine of shallow, technocratic government (Schroevers, 1983; Van Hengel, 1991).

On the positive side, however, stands that Mertens underpins the notion of a permanent theory level, exchanging theories with other disciplines on a permanent basis. This is the image, then, I will hold on to below.

The theory linkages between environmental science and the surrounding disciplinary fields become clear if we do not see environmental science as an undifferentiated entity, but attach the linkages to different areas in the epistemological structure of environmental science. In its simplest form, this structure is the well-known triad of problem analysis, problem explanation and design of solutions. The problem-in-context framework, to be expounded in the next chapter, is nothing but a 'blown-up' version of this basic structure. Below, the italicized passages summarize the problem-in-context framework; they are followed by an indication of characteristic theory linkages.

Environmental problems are discrepancies between what the world is (i. e. facts) and what the world should be (i. e. values, norms). More specifically, they may be analyzed as a pair of parallel causal chains, one factual and one consisting of norms. At the 'top end' of these two chains lie the discrepancies in terms of 'final variables', that is, effects and norms in terms of human health, economic values and the intrinsic value of nature. Further 'down' lie the discrepancies in terms of intermediate variables, e.g. a measured or predicted erosion rate versus an acceptable erosion rate. At the 'bottom' of these chains lie the discrepancies in terms of people's activities, i. e. between actual activity and norms of activity, which are generally catted environmental capacities; emission standards and carrying capacities are examples.

Theory linkages connected to problem analysis branch off in two directions. One goes to the physical sciences and especially concern *environmental models.* Many of such problem-analytical models are built up inside environmental science, but many others, although conceptually no different or less relevant, are traditional properties of other disciplines. Acidification models are an example of the former group; eutrophication models and erosion models, properties of limnology and soil science respectively, are examples of the latter. The most characteristic intertrade here is the borrowing and adaption of 'finalized' products, preferring, for instance, the Universal Soil Loss Equation over more advanced but less ready-to-use erosion models.

The second linkage between problem analysis and surrounding disciplines concern the *normative core concepts* of environmental science, such as sustainability and environmental quality. Here too, some of them are developed within the discipline itself, while others receive their creative impulses elsewhere and are exchanged with environmental science after that. As Chapter 4 will indicate, the functions-of-the-environment concept is an example of the former, while the discussion in the Netherlands about the relationship between the values of diversity and naturalness shows more characteristics of a direct exchange between environmental scientists and landscape ecologists, and the operationalisation of the sustainability concept has largely been an effort of ecological economics.

Behind human activities and environmental capacities lie, in a causal sense, two types of problem explanation: the reasons why actors act in the detrimental way they do, and the reasons why the environment cannot deliver or process more than it does. The actors' reasons depend on the options and motivations the actors have, which are in their turn tied up with cultural and structural backgrounds. The environmental capacities depend on ecosystem patterns and processes. A third type of problem explanation is not empirical, but concerns the ethical foundations of why researchers or policy agencies hold the environmental values that define the environmental problem.

Because these are three types of problem explanation, there are three avenues of theory exchange. The first one is with the *social sciences;* they concern general theories such as about collective action and the reasons ('rational' and others) that actors have for their choices. Other exchanges with the social sciences concern more specific elements, such as theories about local knowledge systems or research techniques. Chapter 5 gives two examples of selective borrowing; one is the adaption and after that the further development of the methodology of progressive contextualization; the other is the critical adaptation of rational choice theory and its pairing with other theory about human motivation.

The second field of exchange is again with the *physical sciences,* but then with respect to their more fundamental theories. They concern, for instance, biogeographical diversity theories, landscape and soils classification systems and the epistemology of modelling deterministic, stochastic and chaotic phenomena.

The third field of exchange again lies in the normative realm, but concerns the *normative foundations* of environmental science, branching out from the normative core concepts into ethics and normative economy. Examples of this 'normative contextualisation' as it will be called in the next chapter, are the excursions into the efficiency versus equity issue in Chapter 4 and the debates with 'deep ecology' and utilitarian ethics in De Groot's (1992b) Chapters 7 and 8. An other example issue, not

touched upon in this study but of rapidly growing relevance, is the theory and practice of global distributive justice.

During the course of the analysis and explanation, all kinds of options for change are identified. These may be fed into the third type of environmental science research: the design and evaluation of solutions. In this research, the options are selected and combined to form a new system level: a regional environmental policy plan, a design for local rural self-help, a waste recycling scheme or any other type of environmental design. Usually, this research is rounded off by an ex ante evaluation, e.g. an EM or a cost-benefit analysis.

The theory exchanges here, obviously, concern those with other normative disciplines, such as the technologies. An example are the design techniques in the next chapter; those of the industrial design field, for instance, are quite inspiring if you are able to mentally make the jump from the design of vacuum cleaners to the design of environmental projects (e.g. Barendse et al., 1989, about "rapid prototyping"). Other important exchanges are with the normative parts of the social sciences; they concern, for instance, the concept of participation of target groups and the ways to incorporate the values of nature in cost-benefit analysis.

Theory exchange, obviously, is crucial for the discipline; there is simply no other way to attain academic standards in a reasonable time[45]. At the same time, there is not single "guiding discipline". Firstly, because it is not other *disciplines* that count in the theory exchange process, but theories. Administration science, to take an example, of course holds relevant theory elements, but heaven forbid that we should have to study the discipline as a whole, let alone swallow its paradigms and imagery, before turning to the relevant theories; the only discipline of interest to environmental scientists should be environmental science. Secondly, the idea of a *guiding* discipline is wrong because much more should be at stake then guidance; all theories guide in different directions, and theories should be drawn in and digested rather than followed, in order to prevent environmental science falling apart into 'schools' too small to survive. Take, for instance, the theories of participation. These theories happen to have their emphasis on the participation of farmers in developing countries in development projects and for that reason, Third World-oriented environmental scientists come across them first. The worst thing to happen then is that a Third World-oriented branch of environmental sciences 'goes participatory'. What should happen is that first the theories are digested (environmental science is not only there for farmers, after all, but also for future generations and nature), and then are spread over the discipline, so

[45] In this restricted sense, I agree with Tellegen (1989), who warns against the perspective of environmental science as an isolated discipline and against the naivité of environment al science theory builders who re-invent wheels that have been in existence for a long time. Tellegen exaggerates his fears, however, to such an extent that he only sees that perspective of isolation, condemning all efforts to develop a discipline of environmental science as an expression of the materialist interests of environmental scientists, "according to Marx". Quite inconsequentially, Tellegen sees all concepts that environmental science does share with other disciplines or lay people as proof that environmental science does not exist as a discipline, instead of cherishing its openness.

that also other environmental scientists may go participatory, the environmental science way.

Thirdly, there is no *single* guide for environmental science. Relevant theory exchanges spread into the physical science, social science and normative science **realms.** This is simply a consequence of that the internal structure of environmental science itself holds these three types of elements: social facts, physical facts, and values. Values, we may note with some emphasis, are not primarily there in an external position (in a role of ethical ***reflection*** *on* the research, as is the usual position, if any), but *as part of the* research, co-defining the object of study, the environmental problem, itself. This, in its turn, is a consequence of non-Cartesian character of the definition of environmental science as a problem-oriented discipline, as will be further explored in the next chapter.

ANNEX 2.I

Principles Of Curriculum Design

This Annex aims to translate the findings of the chapter to the design of environmental science curricula, mixing the chapter's principles with a number of general educational and job market principles. It has been thought wiser to lay down the general principles of curriculum design in a straightforward and sufficiently explicit manner than to get lost in the host of practical details and types of choices one can make depending on one's particular institutional and paradigmatic context. Consequently, I do not attempt to survey and discuss current educational practices; the examples I will mention are taken up only to illustrate a few points.

Let me state at the outset that, following the rule that people should not be given the fishes but the knowledge to make a net, I am a firm believer that, education-wise, theory (substantive and methodological) should have precedence over facts[46].

A 'theory strategy' in environmental science education will also help us to escape from the well-known criticism that you can only go deep (that is, be scientific) if you confine yourself to a narrow subject, and that you are necessarily shallow if you phough wide. This criticism is quite justified, but with respect to 'facts-teaching' only. To illustrate this, let us look at the teaching of astronomy. This discipline ploughs from one side of the universe to the other, and deals with a breathtaking array of facts. Why is it that teaching astronomy is not considered shallow? Because the students are not taught these facts! Confining ourselves to individual stars, for instance, they do not learn all the stars' positions, the states they are in and the light spectra they emit. Students are taught about star *types,* the *general* processes in the (types of) evolution of stars and the physical and chemical theories behind these. Likewise, environmental science students should be taught about environmental problem *types,* the *general* processes in their 'evolution' and the physical and social-science theories behind these. Like stars, there is a myriad of environmental problems and a myriad squared of facts about them. But there is less than a myriad of environmental problem types, less than a myriad of explanatory theories and design methods, and only one sustainability concept. Therefore, a curriculum that follows the 'theory strategy', focussing on generalized key facts, generalized processes, methods and concepts is never shallow. There is only one condition, of course: *that we have theory to teach.* If we don't, we should confine ourselves modestly to what environmental science in the Netherlands, and probably all over the world, started doing in the seventies: giving short, factual courses to monodisciplinary students to show them how monodisciplinary knowledge connects to environmental problems. This has been useful and still is, but it is not (problem-oriented) environmental *science* and not a basis for a fully-fledged environmental science curriculum.

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[46] It is interesting to note that a survey carried out among former students of the centre for environmental science of the University of Amsterdam (Dubbeldam-De Vries and Van Zonneveld, 1987) indicated that former students in their job situation rarely use the factual knowledge they acquired in the environmental science research teams they had participated in, but frequently use the more general methods they acquired in the teams.

What I mean by 'methods, concepts etc.' has already been treated extensively and will be further illustrated in the coming chapters of this study. What is meant by 'generalized key facts' may need some illustration here. Let me take 'tropical deforestation' as an example problem type. Then, 'facts' are the countless local variations on a theme of 'generalized facts' which, following the triad of analysis/explanation/design, comprises:

- types of actors in types of environments, key environmental impacts (e.g. soil degeneration, erosion, loss of biodiversity and river deterioration) social impact types on types of receptors (benefits to the rich, costs to the poor, to nature and to future generations)
- strategies of types of actors (loggers, local people, governments etc.) and their interactions, backgrounds in world markets and politics, ecological backgrounds (e.g., 'island theory' of species diversity equilibria).
- types of social and technical options for solutions, key dilemmas and key experiences at the local, regional and national levels.

This, one could say, is a problem-ology, comparable to the star-ology of the astronomers. 'Facts' in the sense of specific knowledge come into the picture only for secondary educational purposes, e.g. to illustrate the general knowledge. Dove's (1986) beautiful case study of a small area in Kalimantan (Indonesia), problem-oriented, rich in detail and rich in theory linkages, may for instance be used to add the real-world touch to many general deforestration aspects and trigger off a one-week students exercise on "Is Cogon Grass Really Not A Problem?"

This way, problem-ology will act as the educational bridge between the more general methods, conceptual frameworks, theories of collective action and other theory elements on the one hand, and the myriads of facts on the other.

Taking the analysis of the preceding sections together, it will be fairly clear what the content of an environmental science curriculum could be. Put in formula style, the matter is simple. If we want to teach environmental science and if we think that environmental science is the general knowledge, methods and theory for the analysis, explanation and solution of environmental problems, then that is what we should teach. Figure 2B, which lays down the essential structure of an environmental science curriculum is therefore nothing more than a simplified redrawing of the problem-in-context picture (Figure 3J), putting in the terms 'general facts, methods and theory' because of their educational relevance.

The four blocks in the figure are drawn with open boundaries to the surrounding science fields, following the preceding section. Of these, block C, the environmental problems themselves, is drawn as more closed than the others, symbolizing the fact that this field, more than the others, is environmental science's 'own thing'. The two explanatory background blocks A and B have relatively vague boundaries. It is largely a matter of taste to define where 'environmental physical and social science' ends and environmentally relevant 'normal' physical and social science begins. This also indicates that it is not a matter of principle whether these elements are taught by environmental scientists or by social or physical scientists; problem relevance is what counts. The choice of subjects in the A and B blocks should therefore be determined through a primacy of the 'C-subjects'.

The caption of Figure 2B says it is the 'essential' structure. This emphasizes that it indeed seems essential not to lose sight of it when designing or assessing an environmental science curriculum, but also that countless variations of form may be made without impairing the essential content. Below, some examples will be considered for a better grasp of what exactly may be essential, and what not.

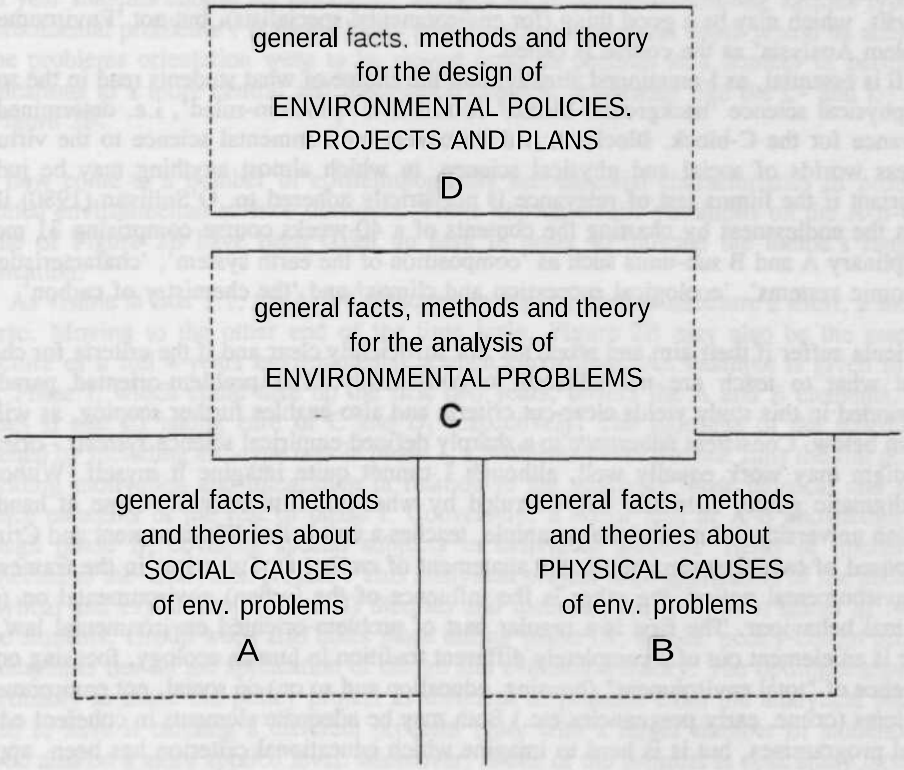

Figure 2B
The essential structure of a problem-oriented environmental science curriculum. The figure is a reduced version of the Problem-in-Context image, Figure 3J.

Repeating a point already touched upon, what is essential is *that* subjects are taught in a coherent manner, not whether this is done by inside or outside teachers. Choices may therefore be made largely on institutional, budgetary or other more secondary grounds. If a university is strong in physical geography or ecology, students may receive the bulk of their B-knowledge there; if a university is strong in physical planning or administration science, it is good to try to join forces (and clash paradigms) over there, and so on[47].

It is essential that *sufficiently equal weights* are given to the A-, B-, C- and D-components. As will be shown later in this paragraph, there is a fair amount of room to move here, but this room is certainly not unlimited. Van Koppen and Blom (1986) describe a course in which the majority of time is spent gathering mono-disciplinary physical science data and analyzing them in the laboratory, after a common-sense level 'analysis' of a problem as simple as the park pesticide study of Section 2.3. Using such an exercise for a more problem-conscious analysis of pesticides in the park soil is contextualized environmental soil analysis, which may be a good thing (for environmental specialists), but not 'Environmental Problem Analysis' as the course is called.

It is essential, as I mentioned already, that the choice of what students read in the social and physical science 'background blocks' A and B is 'problem-ruled', i.e. determined by relevance for the C-block. Blocks A and B connect environmental science to the virtually endless worlds of social and physical science, in which almost anything may be judged important if the litmus test of relevance is not strictly adhered to. O'Sullivan (1980) illustrates the endlessness by charting the contents of a 40-weeks course comprising 31 mono-disciplinary A and B sub-units such as 'composition of the earth system', 'characteristics of economic systems', 'ecological succession and climax' and 'the chemistry of carbon'.

Curricula suffer if their aim and scope are not sufficiently clear and if the criteria for choice about what to teach are not adhered to consistently. The problem-oriented paradigm expounded in this study yields clear-cut criteria and also enables further scoping, as will be shown below. Consistent adherence to a sharply defined empirical science *systems* - oriented paradigm may work equally well, although I cannot quite imagine it myself. Without a paradigmatic guide, curricula will be ruled by what lies institutionally close at hand. A Belgian university, to mention one example, teaches a unit called 'Environment and Crime', composed of two elements; one is the abatement of environmental crime in the framework of environmental policy, the other is the influence of the (urban) environmental on (any) criminal behaviour. The first is a regular part of problem-oriented environmental law, the latter is an element out of a completely different tradition in human ecology, focusing on the influence of "total environment" (housing, education and so on) on social, not environmental problems (crime, early pregnancies etc.) Both may be adequate elements in coherent educational programmes, but is is hard to imagine which educational criterion has been applied to combine them in one.

An interesting case of searching for a theory-rich, paradigm-led curriculum is described by Moffatt (1982), writing about the 4-year environmental science programme at Stirling, Scotland. This programme aiming to be an interdisciplinary curriculum, it is quite justified that Moffatt stresses the need to "integrate concepts" and to find a "general theoretical

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[47] Generally, external teachers may be less efficient in strict terms of programme coherence, but this may offset the risk that students may feel caught in a web of too tight, too paradigmatic coherency.

framework", a "general theory or paradigm which can act as a focus". This theory should encompass "the structure, function and management of social and ecological systems" or "the structure, function and management of all environmental systems and their interaction", that is, in short, everything. It comes as no surprise then, that "at present, there is no such general framework" to be found in the systems approach to environmental science. Yet, it is said that "the programme developed at Stirling has achieved an integrated course in environmental science". How has this been wrought? Partly by dropping most of the social science elements that should be there even in a systems approach[48]. But most of the integrative work is done, in my judgement, by silently shifting to a partial *problems*-approach to environmental science. Pollution problems creep in at the beginning of the second year, with 'land and resource use' in a kind of in-between position. In the third year, mathematics are applied to 'substantive environmental problems' and students are taught about ecosystems management, settlement planning, land evaluation, resource conservation and so on. In the final year students choose six électives, "in-depth short courses examining various types of environmental problems". It seems likely that more coherence and depth would be achieved if the problems orientation were to be moved from its position in a number of peripheral applications to a more central and theory-rich position, somewhat like the C- and D- units in Figure 2B.

We now come to a number of epistemologically non-essential characteristics of problem-oriented environmental science curricula. These unproblematic variations on the A-B-C-D-theme of Figure 2B have been taken up here in order to indicate the theme's range of application.

As visible in Box 1.1, the A-B-C-D schedule may be used to structure a short, 2 months course. Moving to the other end of the time scale, Figure 2B may also be the essential structure of a full 4-years environmental science curriculum. An example is given in Box 2.1. Phase I, which could take up the first two years, covers the A and B elements, with phases II and III taking care of C and D, respectively. The tightness of the schedule is softened by including a C-type unit in phase I, a problems overview that runs the full period, providing motivation and integration in relation to the relatively loose physical and social science elements of the rest of phase I. Conversely, a minor unit of A-B knowledge runs through phase II, covering special subjects in individual students' fields of interests or connected to the 'analytical project'. This analytical project is an application of the problem-analytical and explanatory (phase II) theories and methods, carried out in teams of two or three students. Group work also takes place during phase III; in this 'policy-design project' the emphasis lies on the application of design and evaluation theory. The optimum approach is probably to make the policy project as different as possible from the analytical project, hence to have it tackling a different problem type, with a larger number of students and maybe also on a more applied level. Moreover, if one of the projects is desk study based on secondary data, the other should be a field study in direct contact with the actors involved. A series of seminars covering general and topical issues, presentations of Ph.D. work etc. runs through phases II and III.

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[48] Subjects read in the first two years comprise energy flows and mass balances, geological processes, biology, field geography and so on, with minor attention being given to resource use, economics and geography.

Box 2.1

AN **EXAMPLE OF A FOUR-YEAR** PROBLEM-ORIENTED CURRICULUM

Phase J

- integrating core: the problem-ologies of acidification, desertification, heavy metal pollution, waste, global warming, landscape fragmentation etc.
- core concepts and normative foundations of environmental science
- problem-explanatory and analytical basics in the physical sciences
- problem-explanatory and analytical basics in the social sciences.

Phase II

- theories, methods and research examples of environmental problem analysis and explanation
- problem-analytical and explanatory research project (in small team)
- selected subjects, physical and social science
- seminar series.

Phase III

- theories, methods and research examples of policy and project design and evaluation
- policy-design research project (in larger team)
- short dissertation on theory topic
- seminar series.

Narrowing the scope of a curriculum is a means of arriving at curriculum coherency when one does not yet possess sufficiently strong integrative theories to span the whole. By narrowing the scope, the students absorb more facts relative to theories and the integrative theories need to be less abstract. There exist two basically different directions of curriculum narrowing: by disciplines and by problem type. The first implies that large parts of the A-B-C-D structure are dropped and is therefore epistemologically problematic; it will be treated later in this section. The problem-type scoping is not without problems either, but since these are 'only' practical, it will be treated first.

If we take chemistry as an example, we see that this discipline is in itself a narrowing of general 'nature-ology' to 'molecule-ology'. Within chemistry, one may take a further narrowing step, e.g., to a curriculum in organic chemistry, and even one step more, e.g., to PVC-ology. Nobody does the latter, of course, because it would be a waste to train people to become a PVC-ologist when chemical theories are good enough for students to become organic chemists. Note, however, that the PVC-ologist would still be fully equipped for researching and solving scientific problems in his field; he is not epistemologically invalidated. This is because all the narrowing steps have been narrowing only the *subject* of study. Moving over to (problem-oriented) environmental science, we see that the discipline is in itself a narrowing of general societal problem-ology to environmental problem-ology. We could narrow the subject of a curriculum down to the extreme of, say, toxic-waste-and-local-communities-ology, and still the student could be taught the full epistemological scope of environmental science, that is, the whole A-B-C-D structure.

How and to what degree environmental science curricula should be scoped depends therefore on a number *of practical* considerations. Some of these relate to how one views environmental science itself. An assessment of the strength of environmental science theories, for instance, determines what is regarded as maximum breadth and what is too narrow and therefore a waste. Furthermore, the scoping problem interplays with the degree to which one expects and wants environmental specialisms to develop their own theories and job market claims. Many other considerations concern this job market, e.g. the size and structure of its segments and the degree to which environmental scientists are expected to know a lot of readily applicable facts or to be able to go slower but deeper, led by more general theory. Personally, I would opt for curricula not narrower than, for instance, the fields of 'environment and development', 'waste and toxic pollution problems' and 'nature protection and land use' or, subdividing by problem scale instead of by problem type; 'local and regional problems and policies', 'national problems and policies', and 'European/international problems and policies'. Other delineations are possible, of course, that also have the same broad but not all-problems character.

Perpendicular to the scoping by problem type (or scale) runs the idea of scoping by *disciplinary fields* that contribute to environmental science. In practice, students then either read physical science subjects with a minor in social science, or the reverse. When students take up environmental science after two or more years of monodiscplinary education, this bias becomes even more outspoken. Especially in the latter case, the epistemologically holistic character of environmental science education comes under severe strain. The 'building of environmental science' pictured in Figure 2B stands on two legs, after all, and too asymmetric foundations lead to unbalanced wholes.

There is, for instance, the ever-present risk of implicit biases arising when monodisciplinary paradigms are applied to problems much broader than their original setting. We have already considered the example of ecology in Section 2.5; Geerling et al. (1986) point to the biases arising from the 'mapping paradigms' of soil science, landscape ecology and land evaluation. Other examples are the 'crop bias' implicity inherent in farming systems research, the anthropological *parti pris* towards the interests of local people and traditional cultures (Galjart, 1988), and economy's well-known habit of declaring itself the science of human rationality, working in reality with the paradigm of the insatiable *homo economicus*.

The second aspect of too asymmetric a disciplinary substructure in the A and B elements of Figure 2B does not concern this matter of 'deep' biases, but the quite practical fact that the more monodisciplinarily biased researchers become, the more of them are needed to carry out a whole-problem analysis. As we have seen in Section 2.3, a simple environmental problem often requires knowledge from as many disciplines for its analysis, explanation and solution as a hugely complicated one, but it is obviously inefficient to put a team of ten specialists on every local problem or incremental policy design. On the other hand, when there is a very new or big problem, it is inefficient to put a team of ten researchers to work who all know the same whole-problem facts and theories and the same relatively few specialist facts and theories. Generally speaking, very small problems ask for single-person research by a "complete" researcher, and very big problems ask for large teams of researchers with strongly biased, monodisciplinary knowledge, complementary to one other and supplied with a sufficient dose of integrative, whole-problem theory.

Logically, there is also something in between these two extremes, namely, the small team of two or three only 'weakly biased' environmental scientists working on 'medium-sized' problems. As I will indicate below, this type of teams may be of special relevance for environmental curriculum design.

Before moving on to this issue, however, it may be noted that I have expressly avoided the terms 'generalist' or 'specialist' here. This is because there are, as we have seen, two very different dimensions to becoming a specialist or a generalist: in terms of environmental problem type or in terms of background disciplines. Somebody may, for instance, be completely specialized in a problem type, being educated, for instance, in domestic waste problems only, but completely covering all relevant disciplines in that field: social backgrounds, technologies, physical impacts, law, design methods, research approaches and so on. He is the problem-specialist-cum-disciplinary-generalist. On the other hand, a completely specialized environmental biologist may be trained in biology for any problem type: species protection, soil life, toxification, water-borne diseases, forest acidification and so on. He is the problem-generalist-cum-disciplinary-specialist. The other two clear-cut types are the true generalists (the GP's of environmental science) and the true specialists, that is, both in discipline and problem type, such as the (eco)toxicologist.

Returning to the subject of disciplinary scoping of environmental science curricula, it appears that there exist three 'epistemological perspectives' for this scoping:

- *the single-person perspective,* in which students are trained to tackle on their own (albeit in contact with specialists) relatively simple environmental problems
- *the small-team perspective,* in which students read a 'weakly biased basis' in the social or physical sciences, and are trained for medium-complexity whole-problem analysis and design in teams of two or three (again in contact with specialists)
- *the large-team perspective,* in which students dig deep into a single social or physical science discipline but maintain a sufficient level concerning whole-problem theory and methods to work efficiently in truly interdisciplinary teams, focusing on the problems of the greatest complexity that environmental science can handle.

All types of teams obviously have a role to play in science and society, and so they do in environmental education. To round off this section, this will be further substantiated, emphasizing the second curriculum type. The descriptions will be mixed with considerations concerning the type-of-problems scoping dimension.

Single-person research is especially feasible in contexts where a relatively confined scope of relatively simple problems is combined with low budgets. This type of situation typically occurs at the municipal and the provincial level and in the work of many directly-practical organisations, such as (in the Netherlands) agricultural, water management and recreational boards. In the Netherlands, many 'applied-science schools' (with a 4-year curriculum at sub-university level) successfully operate programmes of this type. This has the happy consequence that environmental science units at the universities can concentrate on more theory-rich, less directly applied education.

The other extreme, the large-team perspective, has long been the overall teaching strategy of the universities, offering short électives of whole-problem theory and interdisciplinary training to monodisciplinary students. Such an interdisciplinary addition to disciplinary specialists is still considered of vital importance to enable students to contribute efficiently to large-team research and open up the road to acquire more stand-alone capacities in their later on-the-job situation. In the Netherlands, a 1-year post-graduatue vocational course (Barendse et al., 1989) specialized in this curriculum type trains even non-environmental specialists, ranging from chemists to historians. It is of importance here that students are not narrowed in the type-of-problem dimension, so that their disciplinary specialist knowledge may keep its full relevance.

Curricula in the *small-team perspective* are, in my judgement, the heart of the matter for the decade to come. Recent developments in the Netherlands show that this opinion is held more generally (e.g. Stolwijk and Klaassen, 1989). In these curricula, students read the relevant elements of either a broad set of social disciplines or a broad set of natural disciplines, and share a strong environmental science core. This choice is at the same time the most 'future-rich' strategy, as the Dutch say, because these curricula challenge environmental science to strengthen its own whole-problem theories and methods.

Chapter 3

PROBLEM-IN-CONTEXT:
A CONCEPTUAL FRAMEWORK FOR ENVIRONMENTAL SCIENCE

Environmental problems being the core object of problem-oriented environmental science, environmental problem *analysis* is its core research activity. Going one step further, *explaining* an environmental problem requires an understanding of the contexts out of which the problem has arisen. Explanatory contexts come in three types: normative, physical and social; they are connected to three different elements of the environmental problem's core structure. The identification of options for solutions follows from analysis and explanation; these options are fed into environmental science's third major research type, the *design* of possible solutions.

In this chapter, we will see how a single conceptual framework can guide these three interdisciplinary research (and education) types, at the level of specific studies as well as the level of more general modelling and theory.

The framework also gives environmental science a footing in (and against) the philosophy of science. For this reason, this chapter's treatment of concrete examples and practical details will be interwoven with more abstract exercises. One of these is showing that the Problem-in-Context framework is reflective, "subjectivity objectified". This insight will show how normative problem-in-context research may incorporate non-normative, 'people-environment systems' research.

A briefer and less fundamental representation of Problem-in-Context, also including much of the action-in-context material of Chapter 5, is in De Groot and Stevers (1992).

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Q. It certainly is complicated.

A. Yes, but then everything is integrated in terms of a reference frame, or a frame of reference, or a conceptual framework, or if you prefer, ongoing theoretical developments.

Q. I suppose everything has to have a frame of reference.

A. At least one[49]*.*

3.1 Sources And Preview Of Problem-In-Context

Contrary to the empirical sciences, Koningsveld (1987) asserts, 'normal science' in the normative disciplines is not primarily related to the success of puzzle-solving in the discipline itself, but to the success of puzzle-solving for society. This obviously poses a risk; a normative science will only go through a paradigmatic shift if the solutions brought to society begin to fail, and it may take a long time before these signals are strong enough. Therefore, Koningsveld proceeds, the normative sciences should have their own internal "reflective capacity", actively studying and discussing the foundations, especially the normative foundations, of their routine activities. To this, Van Hengel (1991) adds that "many irrationalities in our society, science-steered as it is, may be related to the failing of the reflective capacities of the normative sciences".

The present section gives a brief glance at the sources of the Problem-in-Context framework. This is not because I would believe that ideas are better when the history of their inception is long and complex. The history of Problem-in-Context, however, provides an informal example of 'internal reflective capacity' at work; the discussions and explorations took place in the 1980s, a period that environmental science in the Netherlands had no problems in receiving attention and funds for its applied, society-oriented work. Moreover, the descriptions of this section shed some informal light on the basic characteristics of the Problem-in-Context framework.

Problem-in-Context is a conceptual framework in the sense of Rapaport (1985), i.e. a paradigmatic structure that helps to order, in Rapaport's words, "the material".

[49] From Bereldsen, "The Cliché Expert Testifies on the Social Sciences", manuscript privately circulated circa 1950s, found in Dubin (1969).

This ordering may take place as the ordering of thoughts at a theoretical level, as well as the ordering of research steps and questions at the case study level. In this section and the next, the emphasis is on the first level; in Section 3.3, we start from the other end.

During the 1980s, mainstream Dutch environmental science was roughly equal to applied physical-scientific impact models and applied, directly policy-connected work. This was not applauded everywhere. Schroevers (1983), for instance, stressed that this environmental science, not going to any root of the environmental crisis, was in fact *"part of the* very system that destroys the world". In a more mainstream fashion, Opschoor (1987) discussed a more fully-grown environmental science, more connected to ethics and social science and more occupying itself with fundamental sustainability and explanatory research into "society-environment interactions".

These statements are part of a long-drawn reflective discussion of which the core question, in retrospect, may be formulated as: if we want environmental science to become more fundamental and more scientific, does that imply that the problem-orientation should be dropped? In the meantime, as we saw in Section 1.1, environmental science kept up its problem-orientation on the surface of its day-to-day work, as it did in its self-declarations. This was not simply conservatism; it was mainly because the alternative was perceived as fundamentally unattractive. Dropping the normative perspective would imply to become an empirical science of 'society-environment interactions' or 'people-environment systems'. What would such a science be? Should we go and study the zillions of people-environment interactions (people cutting roses in their garden, people breathing air, people driving their cars against trees, people collecting clay to build a hut ...)? If we finally would manage to bring some overall concepts into these studies, wouldn't we end up as something we already have for a long time - geography, human ecology and so on? And if the core concept of the science would be 'people-environment systems', how far would that concept bring us? The biosphere as a whole is obviously a people-environment system, and so are many remote islands and isolated tribal cultures, but for the rest, that is, for the vast majority of cases, people-environment systems simply *do not exist* as bounded, studyable objects! (Bouwer, 1980; Vayda, 1983; Young, 1989[50]; De Groot, 1992).

My own writings at the time (e.g., De Groot and Udo de Haes, 1983; De Groot, 1984) made a sharp distinction between environmental science and explanatory work. Environmental science was "solution-oriented integration" of data, consisting only of problem analysis and design (ref. 'environmental management', Section 1.1); explanatory work was "human-ecological integration" of data, something completely different and in fact not even possible because of the non-existence of identifiable people-environment systems.

[50] As Young (p. 77) puts it: "For a human ecology that focusses on all of humankind (....) the notion of human ecosystems seems almost impossible to conceive in a way that can be bounded, comprehended or studied in any realistic way."

At the same time, however, common sense and scientific authors (e.g., Hommes et al., 1984; Boersema, 1984) continued to point at the fact that explanations were crucial for finding more fundamental solutions to environmental problems than was allowed by the 'environmental management' perspective. This triggered a first conceptual step: explanation should be included in the environmental science, but this should be the explanation *of environmental problems*, not of people-environment systems.

In retrospect, this step seems almost too trivial to be called a step at all. It must be borne in mind, however, that the discussion (as paradigmatic discussions go) was contaminated by several issues of the same abstract character; I mention them here because they are still dominant in traditional perceptions of environmental science throughout the world. One of them is that problem-oriented work can only be 'applied', and hence not fundamental (Section 1.2). Another is the idea, exemplified for instance in Wolf (1986), that if you want to study complex phenomena such as environmental problems, you automatically have to follow a systems approach, and if you follow a systems approach, you automatically have to study people-environment systems. (Wolf here mentions Duncan's POET model as an example, the same one we will meet in Section 3.7.) Thus, if you look at things the systems way (methodologically), you must study systems (substantively).

Thus, it remained unclear how to explain environmental problems (e.g., to go into their social causes) without having to draw up an entire people-environment system, with all its inherent difficulties of non-relevance and non-existence, around every environmental problem one seeks to explain. I certainly couldn't blame environmental scientists for declining to do so![51] Taking a look around in the social sciences brought no solution; as will be gone into somewhat deeper in Section 5.1, social science studies were predominantly occupied, as they still are with amazing repetitiousness, by studying the environmental movement and measuring citizens' attitudes with respect to the environment, that is, matters obviously marginal when it comes to who and what causes environmental problems.

Some candles indicating directions out of the deadlock, in the meantime, were lit by non-social scientists (e.g., Udo de Haes, 1987; Van Asperen, 1987; NMP, 1989), who pointed at the social dilemmas of rational choice as a basic mechanism underlying environmental problems. And the light (at least, my light) broke through in an article by the ecological anthropologist Vayda (1983), triggering the second conceptual step towards the Problem-in-Context framework: to *drop the systems look* in the explanation of environmental problems.[52]

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[51] The small field of Third-world oriented studies was an exception, e.g., Opschoor (1987a), Fiselier and Toornstra (1987).

[52] Note that this statement does not pertain to the analysis of environmental problems, nor to modelling as causal chains and systems of phenomena that *are* causal chains or systems. Actor field chains (Chapter 5), for instance, can be modelled although they do not describe a social system. The systems look at nature and people can be criticized for many more reasons than that people-environment systems do not exist, but that is not the issue of this section.

Vayda, once a declared supporter of the people-environment system approach (Vayda, 1969), asserts that these programmes have been based on untenable assumptions about self-maintaining system properties, system boundaries and the interconnectedness of institutions, and they have not brought us much more than budget overflows and confusion about the proper research unit. As an alternative, he proposes the methodology of *progressive contextualization,* in which there is no other *a priori* research unit than the action to be explained, from which the researcher proceeds 'outward', identifying explanatory actors and factors wherever the search may lead. The example is from Vayda's own research in Kalimantan:

> "The investigations could start by noting such activities as tree cutting or forest clearing by migrant farmers and Dayak tribesmen; they could then proceed to relate them to factors as various as the operations of timber concessionaires, the demand for aloe wood and other forest products in such distant places as Hong Kong, and the previous migrations whereby relatives and friends who could help newcomers from other islands had become settled in frontier areas (....). Decisions about how far to go or how long to continue were made on the basis of such considerations as the resources available for research and the thoroughness or detail that the investigators felt to be useful or necessary for explaining the occurrence of certain activities to themselves, to their colleagues and to policy makers".

Out of this grew the action-in-context methodology for the social scientific explanations in the Problem-in-Context framework.[53] Although less outspoken, progressive contextualization is also the basic approach for the other two types of explanations of environmental problems, 'normative contextualization' and 'physical-scientific contextualization', as we will see later.

Two problems now remained to be solved by way of two more conceptual steps. The first one cropped up when I once explained a first version of the action-in-context schema to my colleagues. "This is interesting," they said, pointing at the blackboard full of concepts and arrows, "but where is the environmental problem?" This 'disconnection problem' was serious enough, because, contrary to social scientists, environmental scientists obviously are not there to explain actions in general, but need a fluent cross-over from environmental problem analysis to environmental problem explanation. Responding to this, an early version of Problem-in-Context (De Groot, 1988a) had the "environmental problem" written in; the actions to be explained obviously are the *problematic* actions, identified in the problem analysis. The description of the environmental problem remained without structure, however.

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[53] Although less outspoken, analogous conceptual steps later turned out to have been taken by Blaikie and colleagues (e.g. Blaikie, 1985; Biot et al., 1989) and Johda (1989), all of them working on Third World soil degradation problems. Blaikie and Biot put the physical symptoms of soil erosion at the centre and then propose to contextualize "forward" to productivity decline and other impacts, as well as "backward" to the actors, the land-use system and background factors. Johda starts out with the environmental problem as a whole and thus only needs to "proceed backwards", to "understand the factors and processes contributing to it". These steps, in Johda's words, may relate to micro-level decisions, meso-level programmes and macro-level policies.

In the meantime, colleagues and I had developed a conceptual picture we called the "chains of effects and norms", running parallel to each other and connected by "fact/value discrepancies". We used this picture on several occasions[54] as tool to conceptualize ecological standards, to design monitoring strategies, to analyze water management conflicts, and so on. Then suddenly, the 'disconnection problem' and the chains-of-effects-norms picture flowed together: the picture was not just a handy tool for several occasions, it was *the* structure of *every* environmental problem! Thus sprang up the Problem-in-Context framework in it almost full form, visible in De Groot (1990).

The last problem was a real mind boggier. You can, for instance, make a picture of how actors are doing certain things, and how actors (the same ones, or a government agency) perceive these actions as problematic, analyze this problem, design a counteractive strategy and implement that strategy, feeding back to the original actors. Conceptually, this is nothing difficult; what you do, in fact, is draw up a picture of a type of people-environment system. Only, this is nothing normative! Normative, somehow, is that you *yourself,* steered by the values you hold, identify what is problematic (in your own actions or somebody else's), design a countervailing strategy, evaluate it against values of efficiency, equity, sustainability or whatever, and propose or directly implement it. This procedure can be 'objectified' by discussing whether you used the appropriate models, ethically grounded procedures and non-personal values, but still, the discussion is about *what should be done,* not about *what other people happen to be doing.*

As was the case with the empirical analysis of actors analyzing problems and designing countervailing strategies, also the normative analysis and design can be put on paper; you than draw the picture of the values (e.g., policy objectives) that were your normative point of departure, the analysis of the problem thus defined, the problematic actions identified, and so on. But at the same time, the actors continue to design their actions not through *your* value perspective, but through their own.

Thus, there appear two exist two modes of description, or two levels of analysis: the objective/empirical and the subjective/normative. Somehow, however, these two modes of description have to be reconciled into a single-level analysis. In order to explain your (normative) problem, after all, you have to move to the (empirical) analysis of other people's value perspectives. Can the objective and the subjective be brought into a single-level Problem-in-Context picture? This will be the key question of the next section, in which we will go beyond the Cartesian incommensurability of objectivity and subjectivity, bringing them both up to the single, reflective level of 'subjectivity objectified'.

[54] E.g., Saris and De Groot, 1987; Van der Voet and Van der Naald, 1987; De Groot 1988c, Van den Berg and De Groot, 1988; Van der Voet et al., 1989; Van der Voet, 1991.

3.2 Flashes In The Noosphere

In this section, it will be shown how the Problem-in-Context image arises out of a more fundamental picture of the structure of 'everything human'. This serves to indicate that the conceptual framework is not some incidental, personalistic design but the environmental science variant of a more general phenomenon. It also lays the basis for solving the last problem mentioned in the preceding section. More practically, it helps to give the Problem-in-Context framework its proper shape, indicating what should be 'up' or 'down', and what basic types of problem contexts there are. This requires a brief sojourn at an abstract level. As the title of the section suggests, I will go there lightheartedly, for the simple Problem-in-Context purpose only.

Plessner, a philosopher drawing from a background in biology and the German hermeneutic-science tradition (e.g. De Groot, 1992b, Chapter 7), has formulated a typology of 'levels-of-life', out of which I take a few elements here, through the interpretation of Kockelkoren (1992).

At the first level, plant-like life organizes itself by the realisation of a border between its own assimilatory and dissimilatory processes and the outside world. From the point of view of the plant, the only 'outside' it may relate to is that what presents itself at the border. Insofar it may be said that a plant lives in a world, this world is an undifferiated medium.

Animal-like life is called by Plessner a 'closed' form of organisation, literary because the open border has become folded inside the body, realizing a real border between the body and the outside world, and also more metaphorically because the animal body encloses a central nervous system in which the body itself is represented, monitoring its own states. Through its sensory and motor faculties, the body becomes the mediator between this centre and the outside world, an outside world that has now arisen as a real *environment*, differentiated from the point of view of the animal into things associated with food, pleasure and risks. For practical purposes, we may distinguish between the social (own species) and the physical environment. The animal, then, lives in a twofold world, the social and the physical. From its own point of view, the animal itself is not part of the world; this is because its centre does not see itself.[55]

Human life adds consciousness to the animal picture, i.e., the capacity of the centre to see itself, making the human being, as Plessner puts it, again 'open', 'excentrical'. From this excentrical, reflective point of view the Self becomes seen as part of the world. Human world is thus threefold: a physical environment (consisting of natural things, artifacts and mixed phenomena), a social environment, and an inner

[55] Note that we are dealing with abstract ideal-types here. Neither differences within, nor overlaps between the real-world animal and plant kingdoms are discussed, nor the more fundamental question of possible overlaps (semi-consciousness or other-consciousness) between humans and animal life forms.

world in which the individual sees itself, the two environments and the interactions between them.

Environmental science being a science of collective problems and collective action, we may lift this picture to the collective level. Doing so, the physical and social environments only become larger; collectives relate to more physical and social things than individuals normally do. Conceptually, they remain the same. The individual inner worlds become what roughly may be called culture, i.e., the world in which humans see, discuss and decide upon themselves, their environment, their actions in there and, in endless regression, their ways of seeing, discussing and deciding. Culture, like individual consciousness, is *recursive* (Hofstadter, 1979). When analyzing an environmental problem situation, we make a conscious representation of the problem, environment, values, options and *actors;* the actors, in their turn, hold a conscious representation of *their* problem, environment, option etcetera, plus that they see themselves as having a problem, and so on. The conceptual framework of problem-in-context will thus be curved inside itself, holding a 'vanishing point' of endless regress. Abstract as this may seem, it will beautifully solve several practical questions.[56]

This simple picture suffices for the purposes of the present chapter. I am therefore not going to discuss deeper questions that may be relevant elsewhere[57], e.g., whether or not 'mind' may in fact be everywhere (Bateson), or whether physical things respond to the attitude of the beholder (Augustine). Let me only say that I hope the picture is neither idealistic, i.e., giving 'real', ontological status to mind only, nor materialistic, doing the same for the physical and social worlds.

Before introducing Figure 3A, then, it only remains to find some technically appropriate terms. The term system ('social system' etc.) has been avoided, being too biased toward to the idea that things are, or should be, structured wholes. Likewise arguments of non-neutrality hold against 'culture', 'structure', 'meaning' and many more. Given also an aesthetical preference for the same word type, I have followed Dutch landscape ecology and adopted 'physical sphere', 'social sphere' and 'noosphere', in which the latter is derived from the Greek nó-os (= mind) and may defined, largely following Schroevers (1982), as all human cognition, reflection and design, individually as well as collectively[58].

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[56] According to Kockelkoren (1992), Plessner thought it also solved metaphysical questions. There can be nothing beyond consciousness (that is, beyond man), he thought, because consciousness is conscious of consciousness, and so on, and you can never go higher. This is a mistake. There is nothing high or metaphysical in recursiveness. If you can see how you can see yourself seeing yourself, you still see yourself, not otherness, or God.

[57] The same holds for the more superficial questions of exactitude of definitions or the overlap between the three worlds (e.g.,is a painting physical, cultural, or both?)

[58] Note that I take the term literary; noosphere is the sphere of nó-os, the world of the mind. Schroevers includes also the physical impacts of mind-work, i.e., the artificial environment. This introduces a conceptual unclarity that is disruptive and not necessary here. In Figure 3A, the physical mind-products are part of the physical sphere, together with the natural and mixed phenomena (such

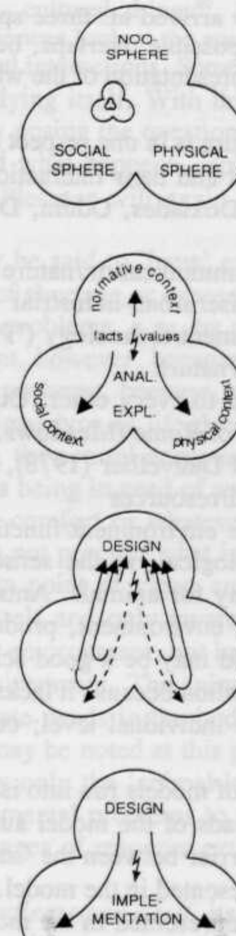

Figure 3A
Noospheric recursiveness, flashes, research and action. The **noosphere** is the reflective sphere of the mind. The flashes are discrepancies between perceived facts and perceived values, lying in the **noo**-sphere. In the explanatory **(contextual**izing) work spreading outward from a problem flash, the three spheres act as normative, social and physical contexts, into which the **noospheric** interpretations spread. Design is a noospheric action following analysis and explanation; implementation physically connects the noosphere with the social and physical spheres.

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as the **landscape).** Thus I more or less take the term away from its originator, **Vernadsky (1945)** who, according to E.P. **Odum** (1971), had defined noosphere as the physical world dominated by human mind "gradually replacing the **biosphere"**. Noosphere in my definition, parts of which are science and decision-making, sees, measures and discusses the physical world (as well as the social) but cannot replace it.

The top picture in Figure 3A is now arrived at: three spheres[59], drawn without their interactions and without specifying possible overlaps, being of no interest here. The noosphere carries inside itself the representation of the whole picture, which is repeated inside *that* picture, and so on.

In spite of its simplicity, the picture is in one respect basically different from most other images of people, environment and their interactions. In Goedman (1978), for instance, we find the models of of Doxiades, Odum, Duncan and himself, reading, respectively, as:

- individual/community/means/communication/nature
- production/protection/compromise/urban-industrial
- population/organisation/environment/technology ('POET')
- production/market/consumption/nature

in which every element is connected to every other. Other models of the same type are the well-known ones of the Club of Rome (Meadows, 1972) and the Dutch 'ecological model' of Van der Maarel and Dauvellier (1978), that read, respectively, as:

- population/pollution/land/capital/resources
- activities/needs/properties of the environment/functions of the environment.

These models are all typically ecological, in the sense that they could have been formulated in basically the same way for animals. Ants also have individuals, community, techology, communication, environment, production etcetera. The 'materialistic reduction' of the human world may be a good scientific strategy from time to time, but fails as a *general* representation because it lacks what makes humans human: reflectiveness (consciousness at the individual level; culture at the collective level; noosphere).

One of the difficulties this type of models run into is that reflectiveness, not being put on the paper, remains in the heads of the model authors and the model readers, giving rise to an unsurmountable barrier between the 'inner world' of the authors and readers and the 'outside world' represented in the model. Values, having their sources in the inner world, thus cannot be represented in the models. With that, it is impossible for the models to hold in themselves a representation of environmental problems, as we will see shortly.

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[59] The three spheres are conceptually equivalent to the four 'aspects' distinguished by what may be called the tetrahedronians in human ecology theory (Fuller, 1975; Golia, 1986; Caravello and Secco, 1989): physical, biological, social and spiritual. In Figure 3A, the physical and biological 'aspects' are lumped under 'physical shere', hence denoting everything material (animate and inanimate). This, by the way, is the only thing the problem-in-context framework has in common with the tetrahedronians; it is sad to see how they either keep on floating in high-holistic mists or fall down from it to the level of trivial reductionism. Caravello and Secco do so by inadvertively stepping on the well-known scale of nominal/ordinal/cardinal/rational measurement and sliding down at amazing speed, thinking that rational measurement is always superior. This is only so within the paradigm of reductionistic quantification, within which it cannot be seen that it is often much more relevant and difficult to 'be nominal', i.e., to establish qualitatively what or who something is, instead of measuring its size or distribution.

All sciences are noospheric, cultural things[60]. The physical sciences look at the physical sphere, the social sciences look at the social sphere and some other empirical sciences looks at socio-physical interactions. Some sciences, especially the humanities, are recursive: noosphere studying itself. With this in mind, Figure 3A may now be developed one step further by posing the question where environmental problems are represented in the model and what happens, 'spheres-wise', after they have arisen. The three-steps schedule of Plessner will again be used to climb up to noospheric heights.

Plant-like life forms may be said to 'have' environmental problems in the sense that there may be conditions of shortage or excess at the plant borders. The plant may sometimes even 'solve' these problems, e.g., by growing deeper roots. This is not so from the viewpoint of the plant, however, because it has no point of view. It can have no problems, even no bodily probems, because, as Plesner puts it, it only *is* body, it does not *have* one, as the animal type of life does.

In animal-like life forms, the central nervous system in which the body is represented may record the body as being in need of something. Typically, the animal then reacts by searching for food, comfort or whatever is recorded needing. If the social of physical environment does not procure what is needed, the animal may be said to experience, also from its own point of view, an environmental problem. Since the animal is not conscious of itself and only aware of an environment, it can see the problem only as 'lying *in*' the environment, not in the way it deals with it. The blame, so to speak, is put on the environment. The animal-type of environmental problems, in brief, arise out of immediate needs in the body-cum-body-centre and are seen as lying in the environment. It may be noted at this point that the 'materialistic systems' adherents, taking up basically only the 'animal-level' of humans in their conceptual models often confine environmental problems to those connected with 'animal-level' needs and the physical exchanges of resource extraction (from the environment) and waste (to the environment).[61]

Human life *can see and reflect upon itself,* its environment and its way-of-seeing. Environmental problems may in extreme cases be experienced, 'animal-like', as unreflected wrong-doings of the environment, but they typically arise at the *noospheric* level: humans see something wrong in the way humans relate to the environment - taking too much out of it, putting too much into it or changing it in other ways detrimental to the functioning of the 'socio-physico-noosphere'. Environmental problems, therefore (as all societal problems), are noospheric entities, *opposed pairs* of facts and values, i.e., discrepancies between the perceptions of how the world is or is becoming and of how the world should be. The noospheric discrepancies are drawn in Figure 3A as the flashy tension signs.

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[60] Once arisen, they also function in the social sphere, of course, then in their turn studied by the (noospheric) sociology of science, which in its turn starts to function as a social entity...

[61] This is not necessarily inherent in the systems approach; see, for instance, E.P. Odum, (1971, 3rd edition, pp. 510-516) about quality of life, culture and values.

It may be noted again that if we would be working with a model containing social sphere elements and physical sphere elements only, we would not be able to locate an environmental problem on the paper. We would be able to say: "An environmental problem is that something is wrong with one of these socio-physical interactions", but the problem ('wrongness') itself would remain in our heads or in our words only. That is because 'animal-level', noosphere-lacking models do not take the human stance, i.e., the excentrical stance of being able to put on the paper *the observer's own values*. It may seem paradoxical, but recognizing the intrinsically subjective, inner-world character of environmental problems is the only way to locate, externalize, discuss and thus objectify them.

At this point, it serves to define the concept of the *normative observer*. The normative observer is the agent whose value perspective leads the formulation of what the environmental problem is, and therewith the problem analysis, the identification of the problematic actions and the design of possible solutions. Although we may informally speak of the normative observer as "we", or "the researchers", we should note that the normative observer may in fact be anyone. If you are pondering whether the pesticides you use in your garden may cause an environmental problem, you are the normative observer (as well as the actor you observe, reflectively). In applied research, the researchers usually 'adopt' the value perspective (policy objectives etc.) of the agency they work for, and identify other actors, but often also the same government agency, contributing to its own problems. Section 3.4 gives a few more examples.

In our heads (formally, the head of the normative observer), the world as it is perceived to be (facts) and the world as it is perceived it should be (values) stand side by side, their discrepancies constituting the environmental problem. If we externalize this structure by putting it on the paper, facts and values continue to stand side by side. As will be further explained in Section 3.6, facts and values have therefore no different 'ontological status'; they are both *subjectivity objectified*, at a single level. In Figure 3A and in all other Problem-in-Context pictures to come, facts, values and their discrepancies ('flashes') can be drawn in the same figure without difficulty. This cannot be achieved in Cartesian, non-noospheric models, that picture the world outside (physical and social spheres) as something objective while the inner world remains fully subjective, unexternalized.

Douglas and Wildavsky (1982), Galjart (1988) and many other social scientists express the noospheric character of environmental problems by saying they are "constructs". Douglas and Wildavsky stress the role of science and open societal discussion (cf. Habermas, 1981), in objectifying the perception of environmental problems. This repeats what has in Chapter 1 already been defined as the demarcation between daily life knowledge and science (any science: empirical, normative or hermeneutic). Whether speaking about physical things, social phenomena or ourselves, science is there to bring perceptions of facts, values and their discrepancies closer to what these facts and values really are, in other words, to objectify them, bringing them closer to the objects themselves. In order to visualize the role of science in Figure 3A, we may restate it in the following way. Being reflective, the noosphere contains a symbolic representation of the full three spheres. As far as this representation is common sense or implicit, fully subjective knowledge, we simply do not draw it in Figure 3A. When science or other open, objectifying discussion comes into play, we can say that this 'objectifying movement' spreads 'over' the facts and values of the three spheres, covering more and more parts of the spheres under a noospheric 'blanket of science', without scientific knowledge ever becoming itself 'objective'.[62]

It is now easy to follow what happens in Figure 3A. Going from the top downward, we see how an environmental problem arises as a purely subjective 'tension flash' between facts and values in the noosphere. Sometimes, such a flash does not ignite a larger one on the collective-subjective level; it then dies out, scientifically justified or not, maybe to flare up later.

When the flash does not go away spontaneously, an objectifying process is set in motion: the problem becomes discussed and researched. Since there are three spheres for the objectifying blanket to spread into, it usually does so, although in countless variations of sequence and degree; the rest of this chapter goes deeper into many details. The essential thing to note here is that the process of objectifying is the same as putting the original, subjective problem flash into *scientific contexts,* that coincide with the three spheres. Emphasizing this, the term 'sphere' has been replaced by 'context' in the second picture of Figure 3A. Moreover, the term 'no-os' has been reduced to 'normative', making it more concrete. Values are indeed the most important noospheric context elements, playing a pivotal role in all environmental science research, but it should be kept in mind that cognitive paradigms, e.g. the holistic versus the reductionistic way of perceiving the world, are in fact also co-determining problem perceptions (De Groot, 1984b).

The second picture of Figure 3A shows the first two stages of the contextualizing process, *problem analysis* and *problem explanation.* The difference is that problem analysing stays relatively close to the original flash and problem explanation moves further into backgrounds. Typical *analytical questions* concern, *inter alia,*

- physical: sources, environmental transfers and impacts
- social: problem causers (actors), problem victims and degrees to which they are affected
- normative: ethical and economic assessments of how serious the problem actually is.

Typical *explanatory questions,* further probing into the three contexts, are:

- physical: the causes why nature cannot process or produce more than it does
- social: the reasons why actors act the problematic way they do
- normative: the grounds for upholding world views and values that have been used to define the problem.

[62] There are, of course, many degrees of scientific quality; some things in the scientific blankets may be first explorations, not much better than common sense. These gradations are not relevant for our present purpose, however.

Referring back to Vayda's term, the movement we make here is that of progressive contextualization. The three types of explanatory questions may therefore also be called, as in De Groot and Stevers (1992), physical-scientific, social-scientific and normative contextualization. Contrary to Vayda we do not start with actions and actors, however, but one step 'higher', i.e., with the environmental problem (hence: *problem*-in-context). Activities and actors are met in one of the three contextualizing pathways. Thus, we contextualize not only along the social-science route, but also along the physical-science path and the normative path that leads to ethics and normative economy. With this, the framework becomes truly interdisciplinary. The pathways are indicated by the three arrows originating from the flash in the second picture of Figure 3A.

During the analysis and explanation, one meets all kinds of elements and processes that my be changed in order to alleviate the problem in question. For instance, toxicant transfer routes may be interrupted, victims may be resettled, the assimilatory capacity of the environment may be enhanced or levies may induce actors to change their ways. These, together with values discovered in the normative context, form the input of what has here been denoted by the umbrella term 'design', which ends in decision-making about the actions to undertake. In many ways, design is more typically noospheric than empirical research, because compliance to values, not compliance to facts, is the ultimate quality criterium (ref. Chapter 1). In the third picture of Figure 3A, 'design' is therefore drawn in the noosphere top. The arrows indicate the 'transfer' of options, facts and values identified in the analysis and explanation.

The bottom picture of Figure 3A denotes the implementation of designs, that is, their transfer from the noosphere to the social and physical spheres. The hatched areas indicate the addition of new structures to the physical or social spheres or the better management of existing ones. The full-blown Problem-in-Context picture, Figure 3J, has the same basic structure as Figure 3A.

3.3 An Applied Studies Example

In the preceding section, the problem-in-context principle has been explored at a very general level. This section arrives at the Problem-in-Context framework from the other end, building it up as a generalization of applied research into a very concrete and well-known problem type. I have chosen an *applied* study example because of easiness of explanation; the researchers are simply using existing theory and methods, not trying to test or to build new ones. The research example will be more or less hypothetical, in order not to get mixed up in too much real-world detail, which would add only to complexity, not to insight in the basic line of reasoning that we are after. A few references to real-world research are put in where some complexity or 'proof is useful. Since all core terms will be formally defined in later sections, they need to be only loosely delineated here. Care has been taken, however, to explore the full epistemological scope of environmental science, i.e., to travel both the 'facts' and 'values' side of the the environmental problem, to go to some depth in the problem explanation and to go up to the design of solutions, enlivening the descriptions with small examples and wider views at selected spots. Going through this section is like a slow, step by step walk. Figure 3B shows the map of the problem-in-context landscape. The terms used in the figure will underneath be italicized when they are encountered in the description.

Facts and values make problem analysis

An environmental problem arises as a subjective 'problem flash' anywhere in the central block of Fig. 3B. If at the top of the block, the problem is formulated in terms of what is or may be happening to actual or expected victims. In the middle, the problem is put in terms of the environment going the wrong way, e.g., erosion processes going too fast or toxic concentrations being too high. At the bottom of the block, the problem is put in terms of activities, e.g., too high emissions or bad agricultural practices. Let's assume that the environment is the primary 'flash-point': somebody has created a stir that *the water reservoir behind a dam may silt up* in 15 or so years. In a way, the whole of Fig. 3B is created almost at this instance: people start discussing the interests that are at stake, the culprits who cause the siltation, the 'poverty trap' or 'rat race' the culprits are caught in so that they in fact have no alternatives, the solutions that should be applied whithout delay, etcetera; sociologists often call this the stage of political 'agenda-building' (Hisschemöller, 1986). The (applied) environmental science analysis that follows this stage is largely a scientific replay, counterplay or extension, in short a re-search of this first, everyday-level melody.

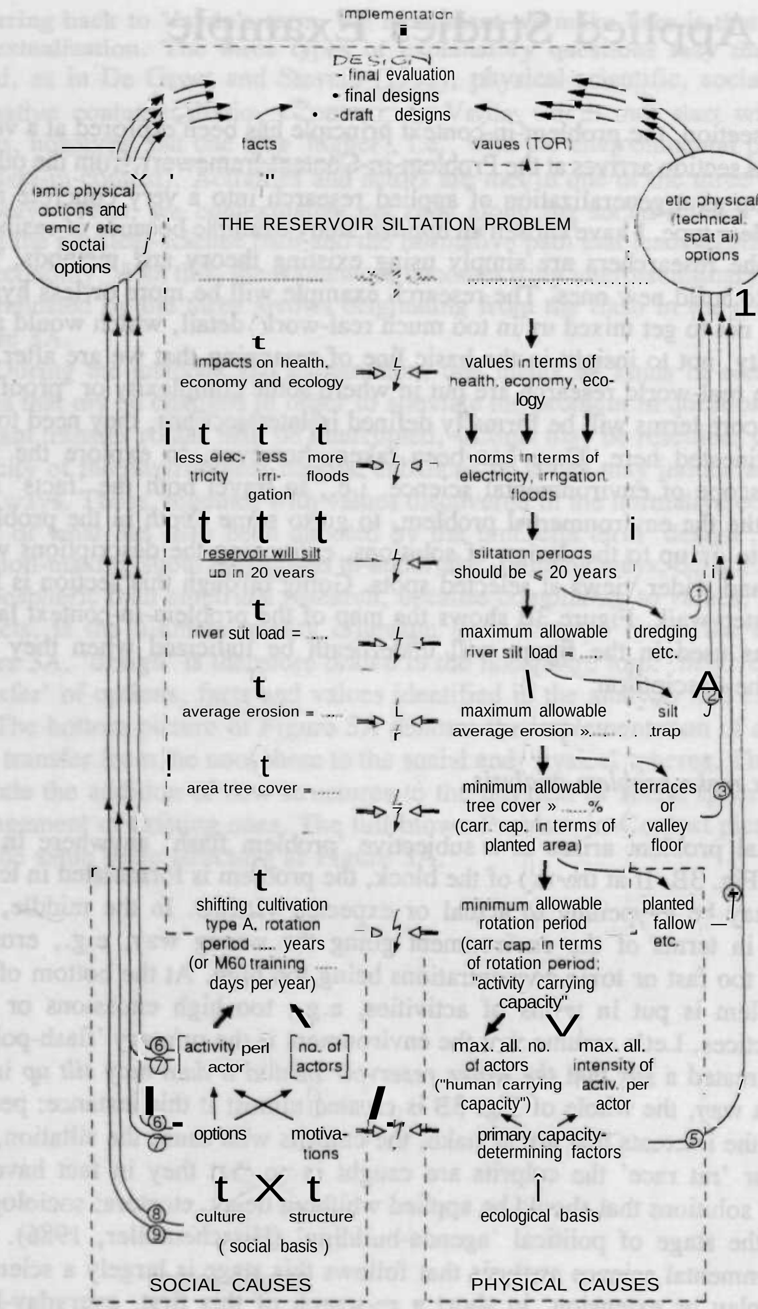

Figure 3B
An informal example of the Problem-in-Context structure

Dove (1986) describes an interesting case of agenda building concerning reservoir siltation. Government officials in Kalimantan (Indonesia), powerful enough to rule by decree what was on the agenda and what was not, had declared the silting-up of a certain reservoir to be an environmental problem, and with it the shifting agriculture (on the cogon grass and in the secondary forest) of the farmers in the watershed, who were alledgedly causing the erosion. In reality, erosion was neglible and the 'environmental problem' served only to supply arguments to establish central government control over traditional local rights.[63]

The 'scientific phase' of problem analysis usually starts with first checking some primary facts, e.g., carrying out a measurement of the *river silt load* in order to better estimate the silt-up period. Let us assume that in our case it is found that a rapid siltation indeed takes place, at a rate in which the reservoir will be silted up in *20 years.* Let us assume also that this figure is still regarded as a problem, the reservoir obviously being unsustainable. It is then expressed that the '20-years'-*fact* clashes with a *norm* in the same terms of siltation period: obviously, it is held that the *acceptable siltation period is longer than 20 years.* In Fig. 3B, this is depicted as the two horizontal arrows at the 'siltation period' level, the discrepancy of which results in the tension-flash sign. If that discrepancy would not exist, there would be no environmental problem, only a series of environmental facts. As facts, erosion and siltation are outside of the normative realm of good or bad. Confronted with values, they may turn out to be good things in many times and places. Egypt, Holland and many other countries would not exist without them, after all. Concerning more local and shorter-term phenomena, Drijver and Marchand (1985) have shown, for instance, that people and nature in the African floodplains, and possibly even the national systems that surround them, are better off with floods than without them, hence, better off without reservoirs, - or with reservoirs silted up. In other words, since dams and reservoirs are usually opposed by environmental groups all over the world, shouldn't they all silt up as rapidly as possible?

This small deviation exemplifies that it is almost always necessary to find out whether the phenomenon that triggered the first 'problem-flash' is really part of a problem. Let us assume that in our case this 'reservoir siltation impact assessment' is undertaken before further searching for the siltation causes. Then, we move upward in Figure 3B, predicting impacts in terms of, for instance, *less irrigation water* availability, *more floods, less electricity* and maybe others, e.g., drinking water supply or water quality problems. These effects may then be further translated and rearranged in terms of impacts on *health, economy* and *ecology,* including their long-term aspect (sustainability); here, we enter the realm of what in this study are called the 'final variables'.

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[63] At the local level, this translated into attempts to establish government-controlled plantations (with no less erosion, but profits going to the officials), and to settle farmers in the open grasslands, visible, as in Foucault's (1975) panopticum, to the 'central eye'. As often occurs in this type of cases, the government plantation turned out to be mysteriously fireprone and many farmers quietly withdrew again behind the forest veil.

The final variables will be discussed in later sections of this chapter and we will therefore not go into them here. The essential point is, however, that these variables are characterized by a direct normative relevance: they are the variables in terms of which we can usually assess to whom, in what way and to what extent a problem really is a problem. In other words, they are the variables that usually need no further normative justification. Health standards and criteria to assess impacts on protected species are examples. The impact assessment ends, conceptually, if facts are predicted in terms of these norms. The facts-versus-values discrepancies thus established, the topflash in Figure 3B, are the 'higher', the real ones, compared to the earlier assessment in terms of silt-up period.

The 'final' values in terms of health, economy and ecology are not the only values that may acquire scientific status in our problem analysis, however. Using them as a starting point, other norms may be derived which lie closer to the 'source variables', moving downward along the right-hand side of Figure 3B. In our siltation case, it is difficult to imagine how a norm concerning the acceptable *silt-up period* may be derived with purely scientific reasoning from the final variables, so that some political input will probably be necessary. Hence the dotted line at that step in Figure 3B. Once the acceptable silt-up time has been established, however, the next steps downward are easy. The *maximum allowable silt load* is derived from the allowable silt-up period and the reservoir volume, and the *maximum allowable erosion rate* by taking also the watershed area into account. Using the Universal Soil Loss Equation or some other model (Morgan, 1979) we may then derive a wide array of spatially differentiated land use norms which are here, keeping things simple, here collapsed into one: the *minimum allowable vegetation cover.* This is all standard procedure in land use planning; the tiniest-scale example I know of is reported in Ortolano (1984, p. 246):

> "For any particular picnic site, the percentage of ground cover consistent with the maximum allowable erosion rate was calculated".

Note, however, that a large-scale land suitability map, if its legenda lays down the imparatives of what *should be* the case from place to place ('for perennial crops only'; 'to be kept under forest') are conceptually the same thing, i.e., a set of norms, not of (actual and predicted) facts. In other words, we are still at the right-hand, values-side of Figure 3B. More will be said about norms-design and norms-derivation in Section 3.5.

Figure 3B shows a chain of seven flashes of discrepancy between values and facts, e.g., allowable river silt load versus factual (present or predicted) river silt load, allowable erosion rate versus factual erosion rate, minimum vegetation cover versus factual vegetation cover, etcetera. Going down these steps, we move from a problem formulation in terms of impacts and victims to a problem formulation in terms of 'sources', activities and carrying capacities, as we will see below.

Staying at the right-hand, values side of the figure, we can translate the minimum allowable ground cover to a *maximum allowable intensity of human activity.* In order to do so, we need knowledge about how the human activities in the case study area affect ground cover. In our tiniest-scale example, this concerns the impact of picnicing on picnic site cover, through which the maximum allowable picnicing intensity can be derived, in 'picnic-days per season' or something like that.

Taken up in the figure is another example of a conceptually equivalent thing, the *minimum allowable rotation time of a given type of shifting cultivation.* An example of yet another conceptually equivalent thing is Diersing et al.'s (1983) "Users guide for estimating allowable use of tracked vehicles on nonwooded military training lands", in which the *maximum allowable number of M60-days per year* are derived from a "maximum limit of satisfactory erosion control", physical properties of "ecological réponse units", and tank impacts on vegetation.

A term encompassing all these minimum and maximum allowable intensities is *activity carrying capacity.* We have seen from the examples how important it is to keep the activity specified, as well as the 'higher' norm from which the carrying capacity is derived. Moreover, carrying capacity is dependent on the 'ecological unit' it is specified for. Section 3.9 will go deeper into this matter. Here, it is only essential to note that a carrying capacity is here not a 'physical science thing', a fact, but a *norm* (in the derivation of which usually a lot of physical science has been applied).

Activities may always be broken down into the (multiplication of) the activity per actor and the number of actors. This holds on a world-wide scale, e.g., when it is discussed if the core of the environmental problem lies in technology (= how much environment is 'used' per person) or population. It also applies to our small-scale examples. The number of M60-days per year is the multiplication of the number of M60s and the number of days a tank spends in the field per year. Hence, the 'allowable number of soldiers in training' on a specific training site depends on the norms the allowable 'M60 days' were derived from, plus an assumption concerning how many soldiers go per tank. The same line of reasoning holds for the maximum allowable number of people which may enter the parc for their picnics, etcetera. Thus, we meet the concept *of human carrying capacity* in its small-scale, conceptually accessible appearance. Obviously, these little calculations may be blown up into conceptually difficult, technically complicated and politically sensitive human carrying capacity assessments for large regions; we will briefly touch upon these in Section 3.9.

In Figure 3B, the human carrying capacity is drawn inside brackets, because it is often not really relevant or possible to assess it; we may also go down directly to what has been called *the primarily capacity-determining factors.* In our examples, these are, for instance, the levels of biologically available nutrients and water in the soil, which determine the rate of regrowth of vegetation after being taken away by picnickers, shifting cultivators or tanks. These in their turn are dependent on more basic ecological structures and processes, such as the phosphate content of the mother rock, the number of deep roots bringing nutrients up, and the amount of rainfall washing nutrients down. This has been called the *ecological basis* in Figure 3B.

We may note at this point that the value-component has now disappeared from the picture. The 'factors' and 'basis' are just facts, not anymore something 'allowable' or 'acceptable'. The downward line of normation has been put to a halt here. Figure 3B shows this by the reversed directions of the arrows. Conceptually, we *could* continue on the line of norm-derivation, and calculate an 'acceptable rainfall' or an 'allowable mother rock'. This may make sense in some cases, but in the present cases it does not. The arrows change direction, therefore, for practical, not principal reasons.

Rounding off this first exploration of the 'values-side' of the conceptual framework, a few remarks remain to be made. First, we see small arrows with numbers attached originate from the conceptual elements; they denote the 'options for solutions' which will be treated later in this section. Secondly, the bottom area on the right hand side has been called *'physical causes'* of the environmental problem. The dotted line around it denotes that it is largely an abitrary matter where the problem proper is supposed to end and its causes to begin. The boundary area as indicated here lies around the activities and the related carrying capacities; this follows current practice, in which the wrong things that people do (= activities) are usually included in the problem formulation, but the reasons why they do so, or why nature responds the way it does (= ecological factors and basis) are usually called backgrounds, or causes.

We may now cross over again to the left-hand, facts-side of Figure 3B, starting with the river silt load measurement where we left off before. Going conceptually up the causal stream (and also physically upstream, in this siltation problem), we can measure, repeating the where-does-that-come-from question at each step, the factual *erosion rate* of the watershed and the factual *vegetation cover*. The vegetation cover is of course not the only factor behind the erosion; slopes, soils and climate are others. The vegetation cover is concentrated upon if it is judged to have the greatest explanatory power for the siltation problem, or may be the easiest to change in order to solve it. If this is not the case, the progressive contextualization takes another course or branches off in two directions, e.g., one focusing an vegetation cover and one on slopes and terraces.

Social causes

Causally behind the vegetation cover one finds the land use practice, e.g., as in Figure 3B, the *rotation period ofthe shifting cultivation.* Analoguous to the values-side of the picture, we may split the activity into the number of actors multiplied by the intensity of activity per actor. Since the whole of Chapter 5 will be devoted to the social causes analysis that starts with the activities and actors, the explanation may be kept very simple here.

Actors are the social entities (individual farmers, logging corporations etc.) who make the environmentally relevant decisions. Finding out who the actors are and how they are arranged is often not easy. The tank crews of Diersing *et al.*, for instance, seem to act a lot, but the environmentally relevant decision-makers are obviously somewhere else. In many other instances, there exists a complex pattern of actors-behind-actors and actors-against-actors, as further explored in Section 3.7. The picnicking families, on the other hand, may be easily understood as a single actor category in its decision-relevant context.

Whatever the case, all decisions by all actors are dependent on two major factors: the *options* the actors may choose between and the *motivations* they have for these options. Behind these lie the benefits and appropriateness that the actors perceive the options to have, the technology that actors command and more of such factors, which are in their turn connected to the *culture* and *structure* actors are part of, jointly called *social basis* in figure 3B.

Substantiating this somewhat within the bounds of our siltation case, we may point at the following self-explanatory relations. Through the motivation component, security of land rights is often of crucial importance for land and water conservation, especially in the Third World (Chambers, 1987). Also through the motivation component, government tax policies, subsidies and price policies influence land use decisions; Repetto and Gillis (1988) show that these incentives often encourage land degradation. Again through the motivation component, the fact that soil erosion may result in a significant productively decline only after hundreds of years (Biot, 1989) démotivâtes farmer for soil protection and brings them in conflict with downstream interests such as, in our case, irrigation. Through the options component, a decline of local autonomy decreases the range of alternatives that farmers have; research and extention may increase that range, and so on. Following the principle of progressive contextualization that we have adhered to from the very first 'problem flash', it is not necessary to deliniate and study 'the social system' first before we may discover, explore or even quantify these social causes linkages. Going step by step from the silting-up reservoir up to Diersing et al.'s M60 lands and up in the military hierarchy, for instance, we may directly identify the environmental relevance of declining political motivations for M60s, caused by a persistent lack of a national enemy. Hence, we do not need to make a model of the world before we may identify an environmental relevance of what happens in Moscow.

Options and the design of solutions

By now, we are coming close to the boundary between analytical/explanatory research and 'designing research', that is, the formulation of possible solutions. As may be seen in Figure 3B, this boundary is crossed by three types of noospheric things: facts, values and options. The first two have been discovered in the analysis and explanation; they only need to be summarized and rearranged to properly feed and guide the design.

Identifying the *options* for solution is the final step in the analysis and explanation.[64] Other terms for 'options' are: 'potential plan elements' and 'building blocks for solutions'. These terms stress that the options are not the designs (of plans, actions, projects, solutions) themselves. Designs are *combinations of selected options,*

[64] In fully integrated research (Section 3.5), the borderline between explanation and design is crossed without interruption. De Jong (1988) writes for instance: "The inventory of potentials [= options] is already the beginning of image-building [= design]".

on a higher system level than the options themselves. Thus, the fact that a full-fledged designing research follows the analysis and explanation makes researchers free to identify all options (social, technical, financial, spatial or whatever) which *could* contribute to solutions in whatever way, without bothering whether they may be only partial, or depending on other options, or maybe too advanced, etcetera. At the same time, it is important that we identify them *all;* missed now means lost for the design.

The basic method for identification is simply to follow again the whole path of analysis and explanation and ask a different question than before, namely, not the where-does-this-come-from question of explanation, nor the where-will-this-lead-to question of prediction, nor the what-may-be-derived question of norms derivation, but: *what may be changed here in a way that may contribute to a solution?* The two "may-s" in this formulation emphasise the mix of analytic rigour and creativiness that is essential for this research phase; it marks the penetration of the 'design attitudes' into the analytical sphere. In Figure 3B, some of the options-generating places have been numbered. They are the places where examples are taken from below.

(1) May the allowable river silt load be increased (without of course relaxing the silt-up period norm)? Dredging may serve this purpose. It may be too expensive and it is certainly the shallowest form of symptom abatement, but as an option amongst the others, it may be noted down anyway. At this point, the hypothetical researches of our case study may also remember protests against the dam and reservoir at the time it was constructed, concerning the drying out of a downstream floodplain and proposing a yearly freshet from the reservoir, to at least partially save the floodplain's natural values (e.g., De Groot and Marchand, 1982). Could a freshet be arranged so that it also carries away a lot of silt? A 'self-flushing' reservoir? Maybe. It is noted down too.

The discovery of the 'self-flushing option', whatever it may turn out to be worth later, exemplifies the mixed rigorous/creative research attitude of this phase; there exist, as it were, 'hidden options' which are not found when too tightly analytically-minded. The example also illustrates that the design phase usually triggers off new analytical questions. In this example, for instance, the feasibility of the option may be determined by the technical lay-out of the dam, the flush-ability of the silt and so on, - issues that probably have not been researched in the first analytical round.

(2), (3), (4) Going down the ladder, one identifies a silt trap as another symptom-abatement option and then, going deeper, possible changes in land use. Terrasses, bunds, windbreaks, contour ploughing, concentrating land use on the valley floor and suchlike measures are identified as options to accept a lower minimum vegetation cover without having to relax the acceptable erosion rate norm. Planted fallow is a means to increase the acceptable rotation period without slackening the vegetation cover norm, etcetera. The same game can of course be played with the tanks and the picnic sites.

(5) It may seem strange to think about options that may be generated from the physical 'factors' and 'basis', the very place where we stopped the norms derivation process because we regarded the ecological basis as given. In practice, this is always a subtle and temporary choice, however. Diersing et al. (1988), for instance, regard

the recovery period of the grassland vegetation after being tracked as given. Shifting cultivators, however, may seed or plant their fallow as a part of their farming system, reducing the recovery time. So could tanks, possibly, reseeding as they go.

There is another reason to pay attention to the physical basis of environmental problems not only for their explanation, but also during the search for options, because it gives us an insight in what are the most critical factors and vulnerable ecosystem components. With this in hand, we may look around for a less vulnerable ecosystem type, and sometimes shift the problematic activities over there. What we do then is seek a 'no-problem site', or the 'least-problem site' for a given land use type (picnicking, shifting cultivation, industrial development, dwelling or whatever). A map of 'least-problem sites' for a given activity obviously being conceptually equivalent to a suitability map of that activity, a wide field of linkages opens up at this point between the Problem-in-Context framework and physical planning (e.g., Ortolano, 1984).[65]

Turning back to Figure 3B, we may note that options for solutions have up till now been generated by posing 'generating questions' on the right-hand, values side of the figure. This has in fact been arbitrary. Going horizontally across to the facts-side of the environmental problem, the same options would have been found by posing the proper questions there. The same silt trap, for instance, is found by asking: is there a way to decrease the reservoir silt-inflow without changing the river silt load? The right-hand side of the figure has been chosen because it shows easier that the line of reasoning extends down into the physical 'factors' and 'basis'. There is also a more substantive reason for keeping to the right, as I will show presently.

As explained in the preceding section, noosphere is where people see, discuss and decide upon the environment and themselves. That people see themselves implies that the noosphere is 'recursive', endlessly folded inside itself: people also see, discuss and decide upon how they see, discuss and decide upon environment and people, among whom themselves, and so on. Up till now, our hypothetical problem siltation researchers have made for themselves a picture of environment, values, actors and options. But what will they find when they ask the actors about their reasons for doing what they do? Inside the actors' heads, the researchers will find another picture, 'folded in', of environment, values, actors and options. The full implications of this will be explored later. Here, going easy on a common sense level, the discussion will be resticted to the options-component of the matter only, being directly relevant for the silting-up case.

[65] Taken as a whole, the prodecure of norms derivation from the final variables down to carrying capacities has much in common with the procedures of land use planning and land evaluation (e.g., FAO, 1989; Araño, 1990, Tosi, 1987). A major difference is that land evaluation, because of its less problem-oriented character (brought about by its system studies origins), is less explicit, less flexible and much later with its values input, so that large amounts of data have to be inventoried and integrated, the systems way, before it may be clear what actually is the problem. In practice too, the values and the analysis are invariable those of outside agencies; Problem-in-Context analysis is flexible, able to also take up the value perspectives and knowledge of the land users themselves.

Let us call the options that the researchers have identified up till now the *etic* options, meaning, the options as they have arisen from the knowledge of the researchers and the values they adhere to. (The term etic will be formally explained in Section 3.7, as will be its counterpart, *emic*). We also note that the options identified up till now are *technical* in the broad sense of the word, as opposed to the social options that will be the subject shortly. Therefore, they have been summarized as the 'technical etic options' in the bundle of rising arrows at the far right-hand side of Figure 3B.

Now, crossing over to the 'options', 'motivations' and 'social basis' in the other corner of the figure, we find actors with options, a part of which may *also* be technical options for solutions, only the emic ones, that is, inside the actors' heads. A well-known example from our case study field of soil management is described in De Groot (1992b), Chapter 6; instead of the earth bunds proposed by researchers, Burkina Faso farmers referred back to an old practice and proposed to make bunds of loose stones, that are easier to make, less maintenance-intensive and equally well-working. Experiences like this have led to the well-known slogan "Combine people's knowledge with scientific knowledge" which may here be read as: take up (as separate units or fused) both emic and etic options in the designing research.

Four options-arrows, numbered 6 to 9, originate from the 'social causes' block. The number of four has been arrived at by simply combining the distinction between options and motivations and between 'direct' and 'indirect', meaning, respectivily, close to the actors themselves or farther away in social structure and culture. Thus, the options are:

(6) Direct options for influencing actors' motivations: change cognitive and evaluative knowledge of actors, e.g., by extension; help actors organise themselves in a way that may transcend their tragedy of the commons; establish long-term land tenure.

(7) Indirect options for influencing of actors' motivations: change prices, incentives, charges; spread a stewardship attitude, etc.

(8) Direct options for influencing the range of options that actors have: start on-farm trials and extension of appropriate farming systems; increase local autonomy so that actors can implement the good options they are motivated for, etc.

(9) Indirect options for influencing the range of options that actors have: design new options (ranging from M60 reseeding appliances to new land use systems); close off bad options by national regulation or regional zoning, etc.

Most of these options are *social* options; all have an etic variant (the options as they appear the most rational in the eyes of the researchers) and their emic counterparts (the actors' own proposals).

In Figure 3B, the collection of options travels upward, feeding into the next research phase, the design of solutions for the reservoir silt-up problem. As the figure shows, the design is also fed by the facts about social and environmental structures and processes that have been found in the analysis, as well as the values identified there.

Design is, essentially, the combination of options to form the higher system level of one or more proposed solutions (policies, plans, projects etc.). As an example, we

may turn to the case described by Mishra and Sarin (1987) and Chopra and Kadekodi (1991). The Indian city of Chandigarh, seeing the storage capacity of its reservoir decreased by 60% between 1958 and 1974, hired researchers in investigate the watershed and come up with solutions. The researchers found places where the hills were so heavily overgrazed that only 5 per cent of the slopes had any vegetative cover. Two small dams were built there, one to measure the erosion rate and one to measure the effect of gully treatment and planting. The nearby villagers showed keen interest in the water collected by these dams, which could be used for irrigation. This triggered the researchers to cross their disciplinary boundaries and extend their analysis into the 'social causes' block of Figure 3B. Implicitly, they thereby also dropped their restricted view on possible options, which had been largely confined to top-down, technical measures, like fencing off and planting the most rapidly eroding slopes.

A long and intensive design process ensued, pivoting around the basic idea that the researchers would assist in establishing more dams and the villagers would take the responsibility to protect the slopes, by selling their goats and stabling their cattle. This design was not made on the drawing table, but the 'participatory way', together with the local people, working through trial and error with both the technical and social options. The final result was a complex but balanced mix of technical elements (irrigation, new crops, commercial grasses for rope-making, fodder grasses, trees and fish) and social elements pertaining to water rights, equity between castes and organisations to manage the many collective aspects of the system, one of which is to subdue the free rider ('tragedy of the commons') problem. Through this 'social fencing' approach, as Mishra and Sarin call it, the sediment flow into the city reservoir has now fallen dramatically, the slopes produce economically valuable grasses, crop yields have quadrupled and the approach has been applied successfully in other Indian states. In the U.S., the 'Stewardship Program' for coordinated rangeland management (Cleary, 1988) shares many characteristics with the 'social fencing' approach; here also, a wide range of social and technical options and issues are dealt with at the local level, bringing together private interests of ranching, timber industry and conservation and public interests of county, state and federal level in a process of creative reconciliation. Annex 6.I of De Groot (1992b) gives an African example of resource management along the same lines: a social strategy of 'shared design', flexibly applying a wide variety of social and technical options. Section 3.11 will explore some more formal techniques for designing research. Here, with the eye on rounding off the treatment of Figure 3B, only a few terms concerning the internal structure of designing research need to be mentioned.

As has already been said in Chapter 1, the final test concerning the quality of a design is not that the design should be true; a bad design is as true as a good one. Good or bad is what counts, i.e., not the conformity to facts (truth) but the compliance to *values.* These values are the same as those identified in the analysis of the problem situation. In Figure 3B, these values are considered to be summarized into a *'TOR'*, a Terms of Reference for the design. Such TORs exist by that name in many design processes (in complex design cases growing into the size of a whole book). In other design processes, they remain more implicit or are discovered during the design process. In any case, the whole design process is values-driven and values-steered, as indicated in Figure 3B by the arrows emanating from the TOR.

The other three terms in the 'Design'-block in Figure 3B roughly denote often occurring research stages. The evaluation is called *final* evaluation because interim evaluations also guide the draft and final design stages. The evaluations found in environmental impact statements are an example of final evaluations; the interim evaluations, though in fact more important because they guide what becomes presented as the final design, are usually more hidden. It shows that the umbrella term 'Design' is in fact a *pars pro toto* name for a process in which designing steps are interwoven with evaluations; I have chosen the term because one of the final designs is what finally survives after the whole process and the decision-making that follows it.

One may have noticed that the term 'design' has also cropped up in the description of the *options*. This has not been a mistake. In fact, all options that become integrated to form the higher system level of a design are in themselves designs, made out of options on a next lower system level. In our examples, the reseeding appliance, the 'flushing freshet', the land use practices and the organisation to subdue the free rider problem have been cases in point. Environmental technology is of course an important supplier of 'designed options' for environmental science design; the social sciences contribute many options too, however, studying, for instance, types of regulation, types of tax incentives, types of organisations for collective action, and so on.

One final observation concerns Figure 3B as a whole. As you may have noticed, we have gone through the problem-oriented triad of analysis, explanation and design in three slow steps. In practice, this seldom happens. Jones (1970) refers to this under the heading of 'linear' and 'cyclical' research approaches. 'Linear' means that the whole analysis is gone through first before the design is undertaken. 'Cyclical' denotes that only a very preliminary, common sense analysis and explanation is made first, on the basis of which some draft designs are made, that in their turn steer a deeper, second-round research, through which the designs are improved, and so on. Jones associates the linear approach with research effectiveness and the cyclical approach with research efficiency. This is justified in the sense that if the whole analysis is completed before the design phase is started, no options can be missed and the design is therefore fully effective; at the same time, the research would be inefficient, because certainly much too many data will later turn out to have been gathered. In practice, no applied study with a design ('problem-solving') objective ever carries out its complete analysis first, simply because it is impossible to know what you need to know without an idea of the range of possible solutions. 'Too cyclical analysis', on the other hand, easily leads to designs based upon a superficial, prejusticed conception of what is at stake in a problem situation.[66]

[66] In practice, countless variations of the cyclicality that ensues may be feasible, depending on the research content and the research context. The following sequence may serve as a baseline arrangement.

It is in the art of applied studies to find the proper route of cyclicality[67]. As shown by the 'social fencing' example, a first-round analysis can generally be allowed to be relatively common-sense and qualitative in character, but should certainly explore the whole problem situation depicted in Figure 3B, rather than 'going scientific' on analytical issues that are relevant for a restricted set of options only, or inspired by what models happen to lie close at hand (ref. Section 3.11). In other words, the way to reach interdisciplinary comprehensiviness at a sophisticated level is to start out with interdisciplinary comprehensiviness at a common-sense level, not to start out with bits and pieces of monodisciplinary sophistication.

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1. Exploratory analysis and explanation. Getting grip on the whole problem situation, including 'far' backgrounds and exotic types of options, is crucial at this stage. Truth content, implementability and quantification should as yet be de-emphasized.
2. Exploratory designs. They focus on basic directions that seem feasible.
3. Main analysis and explanation. This second round may be narrower in scope (led by the exploratory designs) and more critical.
4. Draft designs, mixed with preliminary evaluations.
5. Identification of the key elements in the analytical basis and modelling these on state-of-the-art level.
6. Final designs and formal evaluations.
7. Summaries and presentations for public discussion and decision-making.

[67] Environmental scientists should be aware that the inefficiencies of linearity and cyclicality can easily serve purposes to postpone policy action by means of research. One way to postpone policy action is to ask for research that should investigate 'everything', linearly, on a high level of sophistication; this is of course never finished. The other way is by commissioning a very partial analysis, focused on a restricted set of options and a narrow, biased value set. The resulting designs are then, of course, burned down in public discussions, so that new research may be commisioned, again partial, again to be heavily critized, and so on. This is often the cheapest way for a government under public pressure to do nothing.

3.4 Range Of Application Of The Problem-In-Context Framework

In the previous section, Problem-in-Context has been illustrated from the soil and water conservation field. In Section 3.2, we have seen how the framework lies embedded in a very general image of science. This supplies a basic trust that the framework will be applicable in a wide range of circumstances and research types. In this section, it will first be tried to specify somewhat further what this range of applicability is. After that, we will go on a more active search for areas of *in*applicability, trying to delineate its domain.

Applicabilities: all problems, complexities and modes of research

The example of the previous section of course does not prove that Problem-in-Context is the basic structure of *all* environmental problems; neither can I here spend the rest of the study applying the framework on all environmental problems imaginable. By way of example, however, Figure 3C gives an impression of the acid rain problem, drawn the Problem-in-Context way. We see there the same 'final variables' of ecology, economy and health, the same structure of effects chain and norms chain, and so on. Some differences appear as well; they are details that have been suppressed in the previous example.

Acid rain and reservoir siltation are problems of intermediate complexity. Obviously, an analysis of the domestic waste problems of a village will require less data, and the global warming problem, with its immensely complex effect chains and many actors locked up in all kinds of contradictory relationships, will require much more. The basic structure of analysis, explanation and design, however, I hold to remain the same. One argument is the general and in fact common-sense character of the structure; another is simply the number of times I have tried it out in research and discussions. With respect to the explanatory (action-in-context) part of it, Chapter 5 gives some more examples. In the examples up till now, *complexity* has been suppressed in order to elucidate the basic issues. In real-world applications more complexity will usually be present. Below, I enumerate some of them.

- *Chains complexity.* In many cases, the step from one variable to another in the effects or norms chain is not the application of a simple close-effect relationship, but of a complex model with many variables and feedbacks. An eutrophication model, for instance, may have phosphate loading as input, but the rest of the variables may all be interwoven in feedback chains. This does not complicate matters conceptually, however. If the policy objectives and other value inputs have been properly analyzed before applying the model (as they should always be in problem-oriented work), one knows which variables to 'lift out' of the model and treat as impact variables. For the recreation objective, for instance, the Secchi disc depth will usually be one of them.

The same variable holds predictive power for assessing the ecological values of the lake (e.g. rare fish species).

- *Boundary complexity.* The environmental impact assessments, the usual point of departure of the analysis is a proposed activity (say, the construction of a highway), without other restrictions. Then, the impacts fan out, upward in the problem-in-context picture, from the activity to all final variables at all relevant sites. In the other extreme, one may take a point of departure at the upper end of the picture, e.g., the reasons why the natural value of a certain piece of forest are declining. In such a case, one identifies, fanning out downward in the picture, all activities at all sites that contribute to the forest deterioration. In both cases, there is no (conceptual) boundary problem. Matters are different when one specifies *two* points where the analysis should be 'tied', e.g., when asking what vehicle use (an activity) contributes to forest deterioration (an impact). Then, effects and norms begin to weave in and out of the problem-in-ontext picture, as shown in the acidicification example (Figure 3C) and as will be treated more fully in Section 3.9. By and large, these difficulties are practical and must be kept in check by good conceptual bookkeeping (or adapting the research question).
- *Activity complexity.* Often, an activity will not be a singular action (say, cutting a forest), but a complex system of interrated actions (say, a public transport system or a farming system). Assessing impacts or carrying capacities then requires the activity to be analytically decomposed into impact-relevant components. In other cases, an activity (say, private car use) requires decomposition not at the impacts side but at the explanatory side, because some sub-activities are caused by actors or types of motivations different from those of others. Sections 3.8 and 3.9 and Chapter 5 will go further into these matters, which are again technical, not conceptual.
- *Actors complexity.* Many problems are caused not by a singular type of actors (say, picnicking families), but by many types of actors (citizens, farmers, banks, government agencies etc.), tied to each other in a complex causal pattern. The unraveling of such patterns is often a core activity for the design of solutions. In order to properly deal with it in the Problem-in-Context framework, a full section has been devoted to it in Chapter 5.
- *Normative complexity.* In many problem situations, it is fairly clear what values steer the analysis, designs and evaluations. Many others, however, are more multifacetted or require a more systematic normative input. Through its reflectiveness and 'final variable' concept, problem-in-context provides the way to do so. Most of Chapter 4 is devoted to normative groundedness and consistency. Parts of it focuses on the operationalization of the final variables; another section focuses on the 'functions of the environment', a concept expecialy useful to structurize the steps between the environmental variables and the final variables. In some environmental problem situations, normative complexity will be less a technical matter than a requirement to find deeper and more general grounds; an example is the issue of distributive justice in the global warming problem. The concept here is normative contextualization, that runs from the problem-in-context framework to general and environmental ethics; the

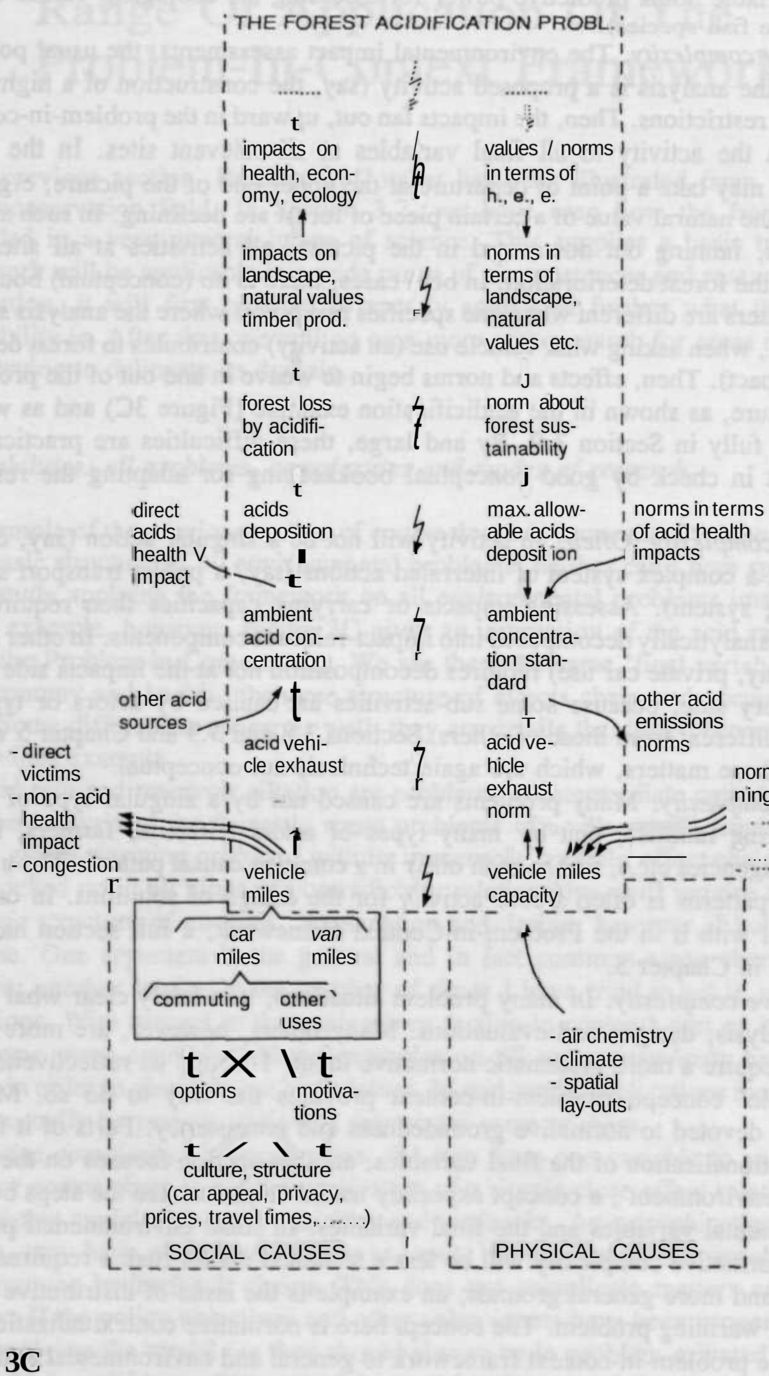

Figure 3C
An informal example of the Problem-in-Context structure.

framework itself therefore does not provide general guidance. Section 3.6 gives some examples, however, and Section 4.8 is an example in itself.

In Section 3.7, we will go into what will be called the 'etic' and 'emic' research modes. Here, some other of such modes will be briefly mentioned, in order to indicate that the Problem-in-Context framework is applicable to all of them, thus preventing that it becomes unnecessarily associated with only one or a few research types.

- *Theory and studies.* A good framework should be able to guide both general, theoretical research and specific case studies ('pure' or 'applied'). If it does, everything a research group does becomes an expression, in many variations, of the same paradigmatic thing. This ensures a fluent intertrade between the theory and the studies level and this, in its turn, is the key condition for scientific progress. In the previous chapter, we have seen Problem-in-Context at work in the structuring of theory exchange and the design of curricula. In the previous section, we have seen the same at the level of a case study.
- *Desk and field.* Problem-in-context may be used to organize or re-organize large quantities of secundary data. It may also be used as a guide to gather new data in the field; Chapter 5 goes somewhat further into some practicalities of field methods.
- *Quantifyingand qualifying.* Problem-in-context obviously can be used as a backbone for quantitative modelling; even social-scientific action-in-context results (Chapter 5) may be modelled if one would want to. At the same time, as Chapter 7 of De Groot (1992b) aims to explore, the framework may serve as the backbone for qualifying, more narrative research types.
- *Rapid and slow.* Rapid and exploratory research types require a framework that is all-encompassing, but in simple, basic terms. Slower, more detail-searching researches require a more detailed framework, without a decrease in scope. My Problem-in-Context representations aim to be flexible in this respect. The simplest formulation of the 'social causes' element, for instance is nothing less trivial than "Behind the activities lie social causes". Then, Figure 3J gives a 10-concepts, intermediate version. Finally, the 'actors field' and 'deeper analysis per actor' versions in Chapter 5 are 'social causes' blown up to the 30-concepts level; this is the version to write Ph.D dissertations and bore students to death with.
- *'Top-down' and bottom-up'.* As has been explained already in Section 3.2, the concept of the normative observer leaves open whose values are be used to formulate the environmental problem and the ensueing analysis, explanations and designs. It may serve to elucidate this point by a few more examples than given in Section 3.2.
  - Using the *general final variables* which have roughly been called 'economy, ecology and health' up till now but which will be made much more explicit in Section 3.9 and Chapter 4, one adopts the values inherent in the mission of environmental science, roughly coinciding, as we will see, with the value upheld by environmental policy. These value sets comprise economic and cultural values, but emphasize the 'speaking' in the name of future generations and nature.
  - On the other extreme, the normative observer may be defined by simply adopting the objectives and views of one or another *social agent.* Very often, this is a

government agency that has commissioned an (applied) research. In other cases, the value perspectives of minority groups are adopted (e.g., poor female farmers or the private car lobby). The latter case of often called 'advocacy planning'.

- In yet other cases, more *freely formulated* value perspectives define the normative observer. One example are the personal or radical perspectives that may be used to formulate counterbalancing problem analyses or explorative, 'pure' designs.

In practice, the value sets that generate problem analyses are often mixed. Two well-known examples are:

- Mixtures of the general final variables and a government agency's. This may be chosen when a government agency wants to express its embeddedness in general environmental policies from the very beginning of the research, or strategically pre-empt arguments of hostile agencies (Van der Voet, 1991). Another cause of such mixtures is that environmental scientists may refuse (often implicity, of course) to give up the value perspective of their mission.
- Mixtures of general final variables and those of target groups. A well-known example here are the 'partnership' approaches used in many rural problem and planning situations. If the environmental scientists would simply adopt the farmers' point of view, their research would crumble (substantively) to problem-oriented agricultural research; if environmental scientists do not express the voice of future generations and nature, in practice no-one will do it.

In contacts with farmers or policy makers, one should of course not ask them to supply a "norms derivation' with respect to a certain "final variable" or identify a "tertiary actor" with respect to a certain "activity component". In countless appropriate terms and variations, however, it is my contention that the Problem-in-Context framework is applicable to all research modes described here.

Inapplicablities: *no problem, no rationality*

I have been able to identify only two real, deep sources of inapplicability of the Problem-in-Context framework. Both are almost trivially logical, and both lie in the research context rather than the characteristics of the problem it tackles.

The first is that a Problem-in-Context framework fails *when there is no societal problem* in the concrete, common-sense meaning of the term. By way of illustration, we may take a look at the applied work of an architect. If somebody employs an architect to have a new house designed, he usually does not say he has "a problem" that should be neutralized (solved), but something positive, a potential that should be realized; the point of departure is not a problem but an *opportunity,* the existence of, say, a free budget and a building plot.

Obviously, the problem-driven environmental scientist and the opportunity-driven architect have much in common. Note, for instance, that also the architect works on the basis of a discrepancy between what the world is (facts) and what it should be or become (values). Through that, they share the phenomena of options, design, evaluation and so on. The big difference lies in the analysis and explanation parts ('problem' and 'causes' in the Figures 3B and 3C). The architect simply has no problem to be interested in; who cares about why actors once made the building site the way it is now, or what may be the building plot's carrying capacity for the activities that currently take place there, which may be that a few stray cats use it as their hunting grounds? As a result, the options that the architect uses in his design come from a different source than the analysis and explanation of a problem. This source is invisible in the problem-in-context framework as it has been developed until now. Obviously, the framework is not optimally adequate for the full range of situations the normative sciences deal with (ref. Section 1.3).

Should this have a consequence for environmental science? Should the Problem-in-Context framework, in fact the whole problem-focused paradigm of environmental science, be broadened to the extent that environmental scientists could also become 'environmental architects' able to design environmental improvement also where there is no substantial environmental problem? There is a good argument that it should not, namely, that there will be quite sufficient straightforward environmental problems with us for a long time. Why then bother about opportunity-driven instead of problem-driven analysis and design? Matters are not quite so simple, however. In practice, many environmental problem situations enclose opportunity elements or, to say it less abstract, environmental science researchers, on their way of analyzing and explaining their environmental problem, will encounter options that may not only contribute to mitigating or neutralizing their problem, but also to 'over-solving' it (e.g., restoring environmental qualities that were once lost) or 'co-solve' other than environmental problems. Closing one's eyes to those opportunities is an anwarranted extreme of the problem-orientation (a problem-fixation, one could say). By way of example, we may bring to mind the 'social fencing' example of the preceding section. There, it was a strength of the approach that the researchers had open eyes and ears for options that were in themselves not directly contributing to lowering the erosion rates, but enabled the design of a package that was good rural development work *and* solved the reservoir siltation problem.

In other cases, there exists a clearly environment-related problem situation, but no environmental problem in the strict Problem-in-Context terms. For instance, in the Mahaweli Ganga region of Sri Lanka, people traditionally had a 'home garden' around their houses, supplying a wide variety of food and non-food commodities to the family. The home gardens were bulldozered-over by the huge-scale Mahaweli Ganga irrigation project, that that has by now ended up as a failure (Siriwardena, 1991). There is quite a scope in this region for a restoration of a diversified village environment, especially because the necessary motivation and knowledge are still present in the local communities. Participatory research to investigate this would be someway in-between the problem-driven and opportunity-driven types, because it is primarily the combination of a *social* problem and an environmental *opportunity* that appeals here. An other type of 'mixed situation' occurs for instance in the Philippines, where the "idle grasslands", as people call them (Maus and Schieferli, 1987), are on the one hand a component in a regular environmental problem complex of deforestration, and on the other hand appealing because they are "idle", under-utilized by absentee landlords.

Opportunity-driven environmental design is clearly more at the heart of landscape architecture, 'nature development' designs, city design, agroforestry and other 'designing disciplines' within the normative sciences family than it is of environmental science. On the other hand, the above examples show that environmental science should at least be able to deal with mixed situations. Therefore, the problem-in-context framework should at least be formally open to non-problem, 'opportunity' inputs.

This openess could be achieved by adding a whole new dimension to the problem-in-concept framework, showing it to be the 'problems-extreme' of a series of frameworks that ends with the 'opportunities-extreme' of the environmental architect. The weight of such a conceptual construct would relate poorly to its usefulness, however, it seems. The solution I have chosen is to create openness by building-in a few 'doors' in the problem-in-context framework through which opportunities may enter, out of a conceptual universe I leave unspecified. Thus I have assumed that the opportunities-element in the situation the environmental scientist normally works in will be relatively simple compared to the environmental problem core, so that common sense or consultations of experts will give sufficient guidance, provided the opportunity element has been spotted in the researcher's conceptual framework. Concerning the cases where this is different, I assume that the environmental scientist will in practice work closely together with a city designer, irrigation engineer, landscape architect or suchlike whose options and whose aproach to analysis and design he may learn from (reject, reconsider, discuss, adapt etc.). The price we pay, then, is that the environmental scientist is not scientifically equipped to be a stand-alone designer of environments in non-problem situations.

Thus, I have chosen to add only one element at a pivotal place in the formalized version of the Problem-in-Context framework (Section 3.9), namely, the addition of 'opportunity options' to the types of the options one may identify. These do not arise out of the systematic problem analysis or explanation, but out of 'nothing', that is, common sense, cooperation with other normative disciplines, examples from elsewhere or discussions with outsiders and target groups. Moreover, I have kept the description of designing research (Section 3.10) general enough to apply also to 'opportunity, non-problem situations'.

The Problem-in-Context framework has been said in Section 3.2 to be reflective, that is, to put on paper the act and the result of the reflection by the normative observer of what may be wrong in the world, where this wrongness comes from and what to do about it.

As we saw a few pages before, the openess as to who the normative observer is constitutes a major applicapability asset. Analogously to the when-there-is-no-problem restriction to the framework's applicability, however, a reflective schedule crumbles with grim logic *when there is no reflectiveness.* Underneath, this will be explored further.

Normative science easily falls into the trap of what may be called naive rationalism: the assumption that actors will automatically adopt and implement the analyses and designs of researchers, because these analyses and designs have been based on a broad set of values and have applied the right models in the proper interdisciplinary way, and are therefore obviously 'better' than what the actors themselves could have achieved. To some extent, the Problem-in-Context framework facilitates researchers to avoid this trap, because it invites researchers to also explain the economic and political causes of the problem they work on, and conceptually enables researchers to respond to the actors' own values and views in participatory problem analysis and design. At bottom, however, the framework is inescapably rationalistic, for the simple reason that a logical, clear and unbiased structure is the very thing it tries to be. Science can *study* irrationality, but one cannot maintain to *be* scientific and be irrational at the same time.

Hence, although Problem-in-Context framework applications can range between big-science modelling and a discussion with village elders under a tree, the framework is applicable only insofar we and the other participants want to play the rationality game, trying to be explicit and systematic concerning both facts and values.

Naive rationalism may now be formulated as the belief that the often vague value statements that suffice for a problem analysis are automatically sufficient to build designs that satisfy the client group, and that the value statements that suffice for the designs are automatically sufficient to ensure their implementation. It is especially with respect to implementation that naive rationalism takes its toll, because implementation is in itself not a research activity and therefore easily drifts out of the researchers' cognitive field (Clay and Schaffer, 1984, p. 143). Consequently, the blame for non-implementation is put on "obstacles to implementation", "lack of political will" or other forces outside the research (Blaikie, 1990); non-implementation becomes to be seen as irrational. As Blaikie points out, the world of implementation (of bureaucracies, field workers and other implementors) is a world with its own problems and logic. This still begs the question, however, how we should bring this world into the research. After all, environmental scientists can be problem analysists, problem explainers and solution designers, they still cannot be implementors.

There exist three ways out of this, that I have ordered with respect to their degree of being radical.

(1) The first way out is to leave things as they are conceptually, but simply try to be less naive substantivily. By increasing the intensity of the participation of client groups in the designing research phase and by asking questions about implementation more persistently, more down-to-earth and realistic terms of reference for the design can be uncovered. The same effect can be achieved by enlarging the circle of participants, involving also the implementators themselves (e.g., lower-rank officials, the inspection agency, extension workers or farmers). All this will enable researchers to look further ahead than the self-contained beauty of their analyses and designs.

(2) A more radical approach can be formulated by means of Grindle (1980). It seems especially feasible when there are doubts concerning the depth and relevance of what participants can or want to tell us, also when their participation is intensified.

Participants may themselves be naively optimistic, or unwilling to reveal implementation failures, or refrain from having to confront nice, positive researchers with too 'dirty' real-world implementation practices. Then, the researchers should themselves study the "context of implementation" as Grindle calls it, in order to identify empirically the implementatory conditions for policy design. These conditions may then be added, implicity or explicitly, to the design's terms of reference. We could even go one step further than Grindle suggests and try to make the rationality of implementation also co-determine the analysis and explanation.

(3) The third way to combat implementation failure has been indicated by Blaikie (1990) and other Third World-oriented authors before him. Essentially, it breaks through the idea that implementation is not a research activity, and extends the cyclicality of the application of the problem-in-context framework to incorporate also the implementation. Thus arises the flexible, learning-by-doing programmes that Chapter 6 of De Groot (1992b) describes more fully, in which analysis, design, implementation, monitoring, re-analysis, re-design and so on become an ongoing process. Conditional for this approach is, of course, that the activities to be designed are not necessarily one big system (a dam, a space lab), but can be designed and managed as a set of largely independent elements and steps.

The learning-by-doing approach is only one that can really do away with implementation surprises, brought about by not fully knowing or not fully being able to incorporate the rationality of implementation. For many problem-in-context researchers, there will thus remain what may be called a hard-core non-rationality, hidden in the research context. For that reason, I have drawn a little cloud at the top of the problem-in-context Figure 3J, as a reminder that unexpected obstacles may jump up out of 'nowhere' after the design stage, and that applied studies should define some route to minimize that risk.[68]

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[68] Taking up an element of 'hard-core irrationality' in environmental science education seems a wise thing to do, because young people are probably especially prone to naively rationalistic analysis and design. It may be tried to simulate it in an applied-science exercise, for instance a policy design study. A few teachers could simulate the role of a client agency that partly plays the game of rationality with the students, but also a game of 'irrationality', e.g., rejecting draft designs without saying why, making a real-world decision that pre-empts the whole analysis, or pick a quarrel amongst each other so that planned research interactions with the group end up in complete confusion, and ask the students to find a responsive course.

3.5 Types Of Research In The Problem-In-Context Framework

Until now, the Problem-in-Context framework has been built up and illustrated with research examples that span the whole of environmental science, i.e., analysis, explanation and design, at the applied studies level. Many other studies have a more restricted scope, focusing on a specific area of the framework. In this section, these research types will be enumerated. They are vizualized using the most simplified version of the Problem-in-Context framework, Figure 3D. Then, the level of middle-range theories is briefly touched upon.

Starting at the lower right-hand corner of Figure 3D, we meet research into the physical causes of environmental problems. Emphasizing its usual core output, *environmental capacity research* seems a proper name. In the other lower corner, *social causes research* goes into the environmentally relevant interactions, options and motivations of environmentally relevant actors and the backgrounds in structure and culture. In the next section, we will discover the amazing feat (at least, it was amazing to me) that this social causes research is in fact the problem-in-context version of research into a *whole* people- environment system hence including a physical environment. Both environmental capacity research and social causes research need, and nearly always indeed use in a greater or lesser degree, the rest of the poblem-in-ocntext framework in a contextual role. For the environmental capacity research, this context is a necessary one, since environmental capacity is a normative concept (Ref. Section 3.9). Focusing for relevance is the contextual role of the problem-in-context framework for social causes research. It serves, for instance, to identify the activities that are the most problematic from the environmental point of view; it may identify etic options that may be discussed with the actors; and etic environmental measurements (of erosion rates, water quality etc.) may help in the understanding of their emic ('environmental perception') counterparts (Schefold et al., 1989).

In Figure 3D, we now arrive at the at the environmental problem block. First, research types will be distinghed that concentrate on either the facts side or the values side of the environmental problem (left or right in the figure). Then, research types are discussed that deal with both facts and values but emphasize either the lower ('sources') or upper ('impacts') area of the problem analysis.

The research types that have values (norms, objectives, standards, criteria etc.) as their major output may be given the umbrella name of ***normation***.

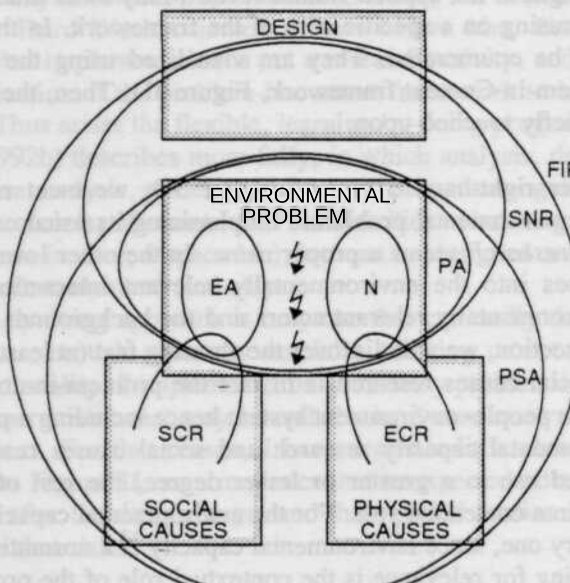

Figure 3D
Environmental Science Research Types

EA = Effects Analysis
N = **Normation** (design, analysis and derivation of norms)
SCR = Social Causes Research
ECR = Environmental Capacity Research
PA = Problem Analysis
PSA = Problem-Situation Analysis (analysis and explanation)
SNR = Shallow Normative Research (analysis and design)
FIR = Fully Integrated Research (analysis and explanation and design)

The most common line of reasoning in the normation field is to go 'downward', deriving norms in terms of emissions, capacities[69] etc. from 'higher' norms in terms of victims and impacts (human health, sustainability of production for basic needs, protection of rare species etc.). This line of reasoning has already been touched upon in the previous sections; other example will be given in Section 3.9. *Norms derivation* could be their common name, following GESAMP (1986), that shows how environmental capacities for marine ecosystems may be derived from water quality standards.

There exists a 'reasoning upward' type of normation research too. Then, one takes a number of generally accepted 'lower' norms (e.g., emissions standards) as the point of departure and calculates what 'higher' norms (e.g., standards in terms of immissions or impacts on nature) are apparently held. This is especially relevant if the 'lower' norms concern different activities, environmental compartments etc. but are relevant for a single target organism or ecosystem. For instance, we may take the standards for the concentration of a certain substance in drinking water, food and air, and then calculate the uptakes in the human body that are apparently considered allowable for the three intake routes. More often than not, one will find these allowable uptakes to be different; for instance, food residues will show to be allowed to be more dangerous than drinking water concentrations. In order to find out whether this is inconsistent or not, we may move to a one-step higher norm, e.g., a principle that the cost-effectiveness of toxic substance reduction should be equal for drinking water, food and air. Even if the three cost-effectiveness figures would also show to be in fact different, still some degree of consistency may be found by moving another step upward, introducing, for instance, the unavoidability of exposure as a principle that should be allowed to influence norms. 'Reasoning upward' this way from a set of innocent-looking 'lower' norms will show to be a way of probing into one of the weakest and most secluded areas of environmental policy: its conceptual clarity, substantive consistency and integration. *Norms-analysis* may be the best name for this subtype of normation research.

Zweers (1986), discussing the tasks of philosophy in the environmental field, has identified two, more or less opposed roles for philosophical reasoning. One is the critical, analytical function of identifying hidden assumptions and inconsistencies of values that are held. Our norms-analysis is the environmental science-level (that is, less general) counterpart of this. Zweers' second type of philosophical contribution is what he calls philosophy's "synoptic" function, i.e., the articulation of world views that may express and clarify world views held in society. On its own less general level, environmental science has a counterpart here too. In Chapter 7 of De Groot (1992b), for instance, the general concept of health-of-nature is brought in contact with empirical ecology, in order to formulate a health-of-nature concept at a more

[69] Strictly speaking, environmental capacity research also belongs to the normation research types. I have kept them apart because of the difference, in practice, between reasoning from the higher norms 'downward' and eventually reaching environmental capacity, and determining environmental capacity largely 'from below', out of the ecological basis.

operational level. *Norms articulation* seems the appropriate term for this subtype of normation research.

On the left ('facts') side of the problem-block we find the type of research that studies effects, moving one way or another between activity-variables and the 'final variables' concerning impacts and victims. Often, this research has a directional character, either seeking what a certain activity will result in (the *predictive* direction) or where a certain impact comes from (the *explanatory* direction), or doing both for different parts of the chain, as has been the case in the reservoir silt-up example of Section 3.3. An other research type in this field is purely descripive, i.e., environmental monitoring. The umbrella name of all these research types could be *effects analysis.*

Normation and effects analysis do not necessarily need support from the explanatory or designing parts of the framework. Diersing et al. (1988) show, for instance, that normation studies can be useful without knowing much about why the activities studied are in fact undertaken or what designs would be possible to rectify the problem. One phenomenon is quite worthy to note, however, namely, the necessity to have effects analysis guided by the other, values-side of the environmental problem. Effects usually branch off in many directions, growing into effect-trees rather than single chains. It seems almost trivial to say that chosing what effects to study at what level of detail should be guided by an assessment of their problem relevance, i.e., their opposition to norms. In too many applied studies (e.g. EIA), these choices are made on irrelevant grounds (ref. Section 3.11).

The need to have effects analysis guided by their values-counterparts points at a number of research types in which the facts and values that constitute an environmental problem are studied both, in a balance set by considerations of relevance. The proposed umbrella term of these research types is *problem research.*

The first subtype is plain *problem analysis,* that covers both the 'upper' facts/value oppositions close to the victims and the 'lower' ones close to the sources and actors. The reservoir silt-up and forest acidification cases have been examples.

The second subtype focuses on the 'upper' part of the environmental problem, i.e., the area of environmental and final variables. The general question is, therefore: does this given environmental variable, in its present or predicted state, signify an environmental problem in terms of health, sustainability or an other final variable? For instance, will present erosion rates in this given area cause an unacceptable decline of agricultural productivity on an unacceptable short term, or will they cause water quality problems downstream? Hence, is the present erosion rate unacceptable? Research of this type may be called *impacts-oriented problem analysis.*

The opposite of the impacts-oriented problem analysis may be called *sources-oriented problem analysis.* These studies focus on the relations between activities (land-use, emissions etc.) and environmental variables, again comprizing both facts and values (norms) in these terms. Swart et al. (1990), reporting on studies done for the Intergovernmental Panel on Climate Change, are an example. The article is confined to the relations between emissions and ambient CO_2 concentrations, but contains both facts and norms. Two lines of reasoning are placed side by side. The one is what the authors call "normative, top-down", using CO_2 concentration *objectives* as starting points and then calculating the maximum allowable C02 emissions; in our terms this is called 'reasoning downward' in a norms derivation. The other line of reasoning goes "bottom-up", taking expected emission reductions as the point of departure and then calculating the resulting ambient C02 concentrations. The C02 problem, then, is formulated as the two-steps chain of discrepancies between the expected versus the allowable emissions, plus the expected versus the allowable ambient concentrations. It is interesting to note that the combination of allowable (values-side) and expected (facts-side) emissions and concentrations enables Swart et al. to discover that the CO_2 problem is in fact a double problem; even when they use the emissions that may be expected when the CO_2 problem is fully recognized and international agreements are adhered to, there still remains a large discrepancy with the allowable emissions. Ortolano (1984, p. 72 *passim)* distinguishes two lines of reasoning conceptually equivalent to those of Swart et al., when defining "emission standards based on ambient standards" and "technology-based emission standards". Not bringing these into relation with each other, however, Ortolano cannot conceptually identify Swart et al.'s double problem phenomenon.

Rounding off the analytical research types, Figure 3D distinguishes *'Problem Situation Analysis'*. This term may be used to denote the combination of problem analysis and the two types of problem explanation (social and physical). This combination of analysis and explanation can be referred to with the single term 'analysis' by defining the *term problem situation,* as opposed to a problem, as: *An environmental problem situation is an environmental problem plus its backgrounds (causes) in society and environment.* Thus, analyzing an environmental problem plus explaining it is equivalent to analyzing an environmental problem situation.

Moving up the final step in the problem-in-context Figure 3D, we arrive at the 'design' block, consisting of *design* in the stricter sense and *evaluation,* of which EIA and cost-benefit analysis are well-known examples. Designing research will be treated in Section 3.11. As for evaluation, it may be noted that it is conceptually equal to repeated problem analysis; the designed activity or plan is fed into some 'low' area of the problem block or causes block, effects are then predicted 'upward' and assessed against norms (standards, criteria etc.) at a higher level. The prediction process may stop as soon as a sufficiently grounded norm is encountered on the way upward. For instance, if there exists a set of politically and scientifically well-grounded norms concerning toxic substances concentrations in a soil, the effects prediction process may stop there and effects may evaluated against these norms. Otherwise, one has to continue the risk analysis, for instance predicting human toxic substances intake and assessing these against ADI norms.

In practice, designing research hardly ever occurs as a stand-alone research type, because there hardly ever exists an analytical basis sufficiently large to supply all knowledge needed during the design process; this is again the cyclicality phenomenon. Therefore, designing research is almost always a final part of a more integrated research type that includes also analytical elements. This defines the two other 'integrated research types' that stand besides problem situation analysis in Figure 3D and the summary in Box 3.1.

In Chapter 1 we have distinguished a type of research usually called "environmental planning and management", coinciding, roughly, with analysis and design, without problem explanation. Calling this type of research by its usual name here would suggest that environmental planning and management is *logically* in that position, or even that it should be. Therefore, I have opted for the radical but not pinning-down term of *shallow normative research.*

Research that does embrace all elements of Chapter 1's triad (analysis / explanation / design) is *fidly integrated research.* There are of course many intermediate positions, explaining an environmental problem relativily shallow but sufficiently deep, with Ellemers (1987) in mind, who states that 'too deep' explanations are inefficient, leading to general background variables that do not yield practicable options for solutions. Section 5.3 goes deeper into this matter.

We have now seen that some research types apply the problem-in-context framework as a whole, while others apply some of its parts, e.g., an analysis of social causes or a source-oriented derivation of norms. In the latter cases, the non-emphasized parts of the framework structure the search for *contextual* insight with a lower degree of detail and sophistication, providing guidance to identify relevant questions and parameters for the core research. Further narrowing the scope of the research core, we enter the realm of the environmental specialisms (single-element, single-relation or single-aspect), such as environmental chemistry, environmental biology and environmental law. For these, the Problem-in-Context framework is context only. Excluding the environmental specialist research, the research types identified now may be summarized as in Box 3.1.

Needless to say, all these research types may be carried out both as specific case studies or at a higher level of generalness. Especially the 'middle range' level (ref. Chapter 1), focusing *on types of* problems, sources, impacts, environments, causes and policies rather than specific problems, sources etc., is an important field of current progress. More or less going down the list in Box 3.1, some examples are:

- Blaikie and Brookfield (1986) about the social causes of soil degradation, and Repetto and Gillis (1988), doing the same for deforestation
- Breman and De Ridder (1991) about the methodology to assess carrying capacities of Sahelian grasslands
- Copius Peereboom and Copius Peereboom-Stegeman (1989) analyzing the lack of consistency in standards for toxic substances
- Denneman et al., (1989) proposing and exemplifying a statistical method to assess the acceptable percentage of soil ecosystem species that may be affected
- Guinée et al. (1992) developing the methodology to assess the normatively weighted emissions associated with consumer products

Box 3.1

ENVIRONMENTAL SCIENCE RESEARCH TYPES

PROBLEM EXPLANATION RESEARCH TYPES
- social causes research
- physical causes (environmental capacity) research

PROBLEM-SIDES RESEARCH TYPES
- **normation** (values-side)
  - . norms derivation
  - . norms analysis
  - . norms articulation
- effects analysis (facts-side)
  - . predictive
  - . explanatory
  - . descriptive/monitoring

PROBLEM RESEARCH TYPES
- problem analysis
- source-oriented problem analysis
- impacts-oriented problem analysis

DESIGNING RESEARCH TYPES
- design
- evaluation

....

INTEGRATED RESEARCH TYPES
- problem *analysis* plus problem *explanation:* 'Problem Situation Analysis'
- problem *analysis* plus *design:* shallow normative research
- *problem analysis* plus problem *explanation* plus *design:* 'Fully Integrated Research'.

- Udo de Haes et al. (1991) discussing concepts and parameters for 'general' and 'specific' environmental quality
- Van Ast (1989) developing a flow chart for how to decide between different forms of financing water quality policies (e.g., through public funds, regulatory levies or insurances)
- Bouwer et al. (1983) reviewing the waste problems of the Netherlands in a way intermediate between 'shallow normative' and 'fully integrated' research.

Reports like 'Our Common Future' (WCED, 1987), whatever their shortcomings (e.g., Achterhuis, 1990; Trainer, 1989), are attempts to someway represent the 'fully integrated research' of the whole world. Studies like those of Blaikie and Brookfield, Repetto and Gillis, Bouwer et al. and WCED show the basic characteristics of the 'problem-ologies' mentioned in Chapter 2.

3.6 Values And Normative Contextualization

In the preceding sections, values have more or less casually been shown to play a core role in the Problem-in-Context framework. Without values (and their associated[71] norms, goals, policy objectives and so on), there would be no flashes of discrepancy between facts and values, and therewith no environmental problem to contextualize. The present section goes into the value aspect of the framework somewhat more fundamentally, in order to investigate the grounds that this Problem-in-Context element rests upon, as well as to clarify a more directly practical discussion topic and to exemplify the principle of normative contextualization.

There are approximately as many definitions of 'value' as there are philosophers (Rescher, 1969). Yet, they agree on the concept's basic characteristic to a degree sufficient for our purposes. Putting it the way of Rolston (1988), "value is the generic term for any positive predicate", or, in other words, a statement about a general characteristic of the world as it ought to be. The concept of *norm* belongs to the same realm of the "description of an alternative, ideal world" (Von Wright, 1986), but is usually regarded as more specific than the values that ground them; Kuypers (1979) mentions "criteria for evaluation, prescriptions" as forms that norms may take.[72] The Problem-in-Context framework follows this. The value of health, for instance, may become specified in ADI-norms. From time to time, the term 'values-side' is used as a *pars pro toto* for the whole 'alternative, ideal world', e.g., when speaking about the 'values-side' of the framework. It may also be noted that the terms 'criteria', 'standard', 'capacity', 'objectives' and others are also freely used at that values-side, in order to stay close to common usage in environmental science and policy. Also the term 'plan' belongs to the normative world, insofar plans describe, as they often do, what world is aimed at.

From the Enlightenment philosophers onwards (e.g., Von Wright, 1986), "Is" and "Ought" (facts and values) are viewed as separated by an unbridgeable gap. Trying to derive "Ought" from "Is" is the 'naturalistic fallacy', sinning, among other things, against basic logic. The survey of Doeser (1986) shows that the gap has not become philosophically more bridgeable in the meantime. We should not decry this; blurring the distinctiviness of facts and values would blur the conceptualisation of what constitutes human problems. The 'problem flashes' in the problem-in-context framework are

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[71] Strictly speaking, values do not necessarily lead to norms. See, for instance, Zweers (1987a) about the intrinsic value of nature and Engelhardt (1981) about the value of health.

[72] Teutsch (1985) and many others also regard norms as more binding (less "indicative") than values. Norms are often laid down, for instance, in laws and other government rules. It is questionable if this holds for all norms, however, and not a matter of importance here.

thus the tensions between "Is" and "Ought" at their respective sides of the gap; in Von Wright's words, they are the "point-by-point comparisons of the ideal and real worlds".[73]

Accepting the fact/value dichotomy seems at odds with 'deep ecology', other non-dualistic philosophy and hermeneutic science (e.g. De Groot, 1992b, Chapter 7), that try to bring our thinking into realms where the opposition is transcended. I agree that these realms exist, e.g. in deeply personal experiences (Zweers, 1986) and the 'ethno-metaphysical' world views that we all hold, but these realms are not the down-to-earth world, where I simply do smoke more than I should, and where environmental problems do exist.

In an other respect, however, the problem-in-context framework is really at odds with mainstream philosophy. Putting facts and values (norms) side by side on the paper, we have implicity assumed that they are side-by-side-able at all. This may not have struck you as peculiar. Anybody who says, for instance, that the mercury concentration in a soil is ten times higher than what the mercury concentration in that soil maximally should be, has formulated a problem by comparing a fact and a norm, and has implicitly expressed that the fact and the norm are basically equally real, or, as philosophy puts is, that they have equal 'ontological status'.[74]

Philosophy is there to question everything, especially the matters we take for granted. In some cases, however, it might be better to leave the world alone than to supply it with the wrong answers to questions not even asked. One of the issues I have in mind here is man's proper relation to nature. Another is the ontological status of values. The answer that mainstream philosophy has supplied us with is echoed, in countless places and variations, in non-philosophical literature when values, as opposed to facts, are described as "*only* subjective". Caplan et al. (1981, p. 1), for instance, pose the question: "Are health and disease *merely* value-laden constructs?" (italics mine.) Who would ever pose the question whether an atom, or even a scientific model of it, is *merely* a fact-laden construct? From a classroom setting, I remember an environmental philosopher who once empathically exclaimed: "Philosophers are no experts on values!" Values, in this view, are typically something on which everybody is his own, subjective expert. Can you imagine an astronomer exclaiming that astronomers are not experts on stars?

The ontological status of values, as observed by Partridge (1986), fills "a library of complex and technical philosophical treatises", with the general outcome as indicated above (Verhoog, 1988). How has this state of affairs come about? Is the status of values really that problematic? I hold it is not. Problematic is the position of mainstream philosophy in the Cartesian trap, the point of view from which one can

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[73] Dutch policy analysis authors express the same when saying that a policy problem is a discrepancy between an "empirical situation" and a "normative situation" (Terlouw, 1982) or between "an existing or expected situation" and "an objective" (Hoogerwerf, 1984).

[74] It may be, of course, that the mercury measurement (the fact) is much better grounded, scientifically, than the mercury norm. The reverse may be the case too, however; whatever the case, **it is** outside the ontological issue at stake here.

only see outside-world phenomena (facts) as cognitively accessible (and with it only empirical science as science). For Kant, for instance (Kuypers, 1979), everything that does not appear before the outward senses ('noumenon') is not knowable by reason. Thus, values come to be seen as "ontologically queer", not really real (Doeser, 1986).

Partridge (1986) shows that environmental science too has let itself be drawn into the Cartesian trap. He examined eight standard texts on environmental studies and found (despite the fact that environmental policy-makers are involved in values decisions every day) only one with a chapter on environmental ethics as a philosophical activity. In one other, ethics are present, but treated as the description of other people's ideas and willingness-to-pay, not as a discussion of grounds on which *we* should decide about environmental issues. This most elegant version of the naturalistic fallacy is the extreme to which one may reach in the Cartesian trap, desparately searching for the empirical, the 'objective'.

Before turning to the Problem-in-Context framework's way of solving philosophy's problem of the ontological status of values, we may pay some attention to Lucas' (1986) beautiful treatment of the "moral scepticism" that the disputed status of values results in. Lucas goes into the arguments (in which one hears the echos of Descartes and Kant) that values are not deductive, that only facts can be true, that only sense experiences can be meaningful, that only what has empirical content can be cognitive; that moral standards vary from place to place and from time to time and that values, if they exist at all, are ontologically queer. Lucas does so by playing the game of symmetrical consequences (much like Edward and Norman have done in the Annex of Chapter 1 concerning empirical and normative science). Many empirical questions, especially the important ones, are not deductively decidable either, Lucas says for instance; if you accept only deductible proof, don't count on the sun to rise tomorrow, or even that the sun exists. Concerning the question of meaning, Lucas remarks that theories of meaning are among the most opaque and speculative we may have, and adds:

> "Theories of meaning may of course be proposed, (..) but it does not follow that if moral statements are not adequately accounted for by the preferred theory of meaning, the fault lies with the moral statements (..). That people understand what is meant when moral terms are used is clear and incontrovertible. Any argument against the latter based on the former is deeply implausible."

Concerning the queerness of values, Lucas asks: "what is more queer, values or quarks?" And he adds that the validity of moral argument is not necessarily tied up with the existence of values any more than the validity of mathematical or physical arguments is tied up to the existence of Platonic universals, like the One or the Many.

Lucas concludes that a generalized scepticism is possible, though difficult to sustain; a *specifically moral* scepticism is not justifiable, although the arguments for it have been put forward by reputable philosophers. Brought back to Problem-in-Context terms, the value-side of societal problems appears to have no other ontological status than the facts-side; facts and norms are side-by-side-able.

The **Problem-in-Context** framework expresses this in its conceptualization of the environmental problem. The framework is a 'mixed model' in the sense that it combines elements from two sources, the outside and the inner world. This has been brought about, as indicated already in Section 3.2, by drawing up the framework not as a picture of the outside world, but as a picture of *the structure and the result ofthe reflective act.* More in detail, we may understand this as follows.

Facts have their source in the outside world. Through our pattern-finding capacities and theories, we form some conscious, structured picture of this world in our heads.[75] This subjective picture becomes more objectified if we first put it on paper or externalize it some other way, and then put it to test one way or another, in discussion with other people, in peer review, or in re-searching whether other situations fit into the pattern. The result (a descriptive statement, a concept, a model, a taxonomy or whatever) thus is "subjectivity objectified".

Values have their source in our *inner* world, but again we may form some conscious, structured picture of this world in our heads. Again, this subjective picture becomes more objectified if we first put it on paper or externalize it some other way, and then put it to test one way or another, in discussion with other people, in peer review or in re-searching whether other situations fit into the same pattern. Again, the result (a descriptive value statement, a normative model, a taxonomy of norms or whatever) thus is "subjectivity objectified".[76]

What we can do to facts and values separately, we can do to them in combination. Although originating from a different source, conscious but subjective facts and values may form opposed pairs and thus form a (conscious but subjective) *problem* in our heads. When put on paper and discussed, again in whatever way, also the problem becomes "subjectivity objectified". This is what anybody does who formulates and discusses a problem, and also what the Problem-in-Context framework formalizes conceptually, laying down the structure and the result of the reflective act that concerns both facts and values.

Summarizing, we may accept that facts and values have different sources; unreflected (unknown), they lie hidden in the undifferentiated World and Self. Reflected, they acquire equal status as conscious, structured interpretations, that may become externalized ('put on paper') and objectified in scientific discussion. Pairwise, but without their distinction becoming blurred, they define the (environmental) problem.

In Section 3.2, *final variables* have been defined as the variables which usually need no further normative justification. If we say, for instance, that economic growth is a

[75] For a more formal description, see Harris' definition of emic knowledge in the next section.

[76] Different sources make for different science, of course. As Partridge (1986) states, philosophy has a different 'laboratory test' (peer review in scholary journals) and different appropriate evidence (the standards of sound grounds and reasoning) than do the empirical sciences. But the astronomer and the philosopher are equally experts and non-experts in their fields. They are experts because they can guide people to the best available scientific insight and crititicisms. They are non-experts in the sense that they cannot prescribe people what to finally think about either stars or values.

good that needs no further justification, the contribution to economic growth is the variable by which to assess the value of an activity or a plan; it is the final variable of the assessment. In such a case, however, we may decide not to accept that economic growth is intrinsically good, and ask: why should we hold economic growth as good? What are the grounds on which we can justify economic growth as a value? This type of question, in which we step beyond what *usually* needs no further justification, has in Section 3.2 been called *normative contextualization.* We also found there that normative contextualization is one of the three routes to explain an environmental problem. If people wouldn't care about future generations, for instance, there would be no unsustainability problem.

For problem-oriented environmental science, therefore, normative contextualization starts out from the final variables of environmental science, 'unfinalizing' them so to speak, departing on a road that leads into ethics, environmental philosophy and normative economy and then leads back to the final variables, making them more defensible or critically rectifying them. In applied studies, the same movement is made, but usually more in terms of policy objectives instead of final variables, and more general government aims taking the place of more general ethics. Below, I give four brief examples, two of which are taken from later chapters of this study. They are arranged from purely 'pure' to purely applied, i.e., from a free scientific endeavour (with lots of practical implications, as normative theories go), to a case study bounded in a context of direct applicability.

(1) In environmental science and environmental policy (ref. Section 3.8), the intrinsic value of people and the intrinsic value of nature are common final variables. Taking some distance from these two, it may be asked: could not there also be intrinsic value in the *relationships* between people and nature? Based on common sense intuitions and some policy documents, we could say yes to this question. Then, returning to the final variable level, the addition of 'relationship value' to the final variables leads to different problem formulations and policy designs, e.g., designs with less separation between farming and nature protection areas. At this point, we may also take a next step, as illustrated for instance in Chapter 8 of De Groot (1992b), trying to further contextualize the answer to the first question. May there be areas not in common sense but in real philosophy where 'relationship values' are recognized or criticized? Going this second and wider round, it shows that there are, and this round does not only result in a further grounding of the 'new' final variable, but also in new ways to analyze problems and relate to people in problem explanations and solutions.

(2) In economic evaluations, the final variable is usually some output of a cost-benefit analysis. At present, debates are going on as to how to account for the objective of sustainability in cost-benefit analysis, i.e., the proper way to trade-off the benefits of future generations against those of the present. Because of the conceptual difficulties encountered in this strategy, it seems wise to take some distance here, and ask: what could be the grounds to take up sustainability into the cost-benefit framework at all? The objective of sustainability may for instance be compared to a pledge to keep up my house for my children. What I have promised then, it seems, is not to enter into calculations in which I trade off my children's future enjoyments against my

present benefits, but simply go and buy the paint to keep up the house! From this first intuition onwards, it shows (ref. Chapter 4) that classical economics, ecological economics and ethics offer well-grounded arguments supporting and operationalizing the notion that cost-benefit analysis and sustainability indeed lie in two different moral realms.

(3) If a factory is predicted to have to close down because of a new environmental levy or standard, the loss of jobs is usually noted down as a final effect, to be evaluated against some norm in the same, final variable terms. Why should this actually be done, however? There does not exist an economic policy objective concerning employment in specific factories, but only concerning state or national totals. As Huppes and De Groot (1983) show, these total figures, because of substitution effects, are likely to be quite different from the specific factory's lay-offs.

(4) From time to time, wise government agencies reflect upon the consistency of their daily policy actions. One characteristic question then is a question of norms derivation: Is our policy with respect to the various actors (e.g., the issuing of permits) really consistent with our policy objectives (our final variables)? A second question characteristically concerns a normative contextualization: How do our policy objectives relate to more general policy objectives, general theories of justice and general values held in society? Both questions serve the practical use of increasing the legitimacy ('explainability') of the agency's policies. Van der Voet et al. (1989) are an example, studying the cases of heavy metal pollution and eutrophication for the Dutch Inland Water Agency.

3.7 Social Causes As Reflected EMIC Order (Or: People-Environment Systems Regained)

As we have seen in the previous section, Problem-in-Context is a framework that lays down on paper the result of the reflective act with respect to environmental problems. Section 3.2 has shown that reflectiveness leads to recursiveness, the endless mirroring of levels reflecting upon the way we reflect, and seeing ourselves seeing ourselves. This section aims to uncover the full detail and potentials of the reflection phenomenon. We will pin-point the 'recursive area' of the framework, and with that solve the still latent 'last problem' of Section 3.1, the problem of how to put into a single framework the 'two worlds' (the actors' own values, perceived environment, feedback actions and so on, - and the values, environment, feedback actions and so on of the change-oriented, normative observer). Doing so by means of a little excursion into anthropology, we will also come to see the Problem-in-Context framework as a conceptual system that embraces both the normative and the empirical, 'people-environment systems' approaches to the environment.

Reflectiveness, emic, etic

Reflection is a two-level affair, a *relative position* of two levels with respect to each other. Since reflectiveness leads to recursiveness, the levels as such should be left unspecified in order to avoid confusion. Hence, we should primarily tie ourselves to a coupled pair of relatively abstract terms and not to level-specific terms like 'the world', the 'Ding-an-sich', 'the mind' or whatever. Although reflectiveness has been discussed in many disciplines, I found it surprisingly difficult to find a concept that describes the principle in its basic simplicity, without serving as a camel's nose bringing in a mass of largely irrelevant and confounded meanings, requiring a cleaning-up exercise quite out of bounds with our simple purposes here. One way out would be to ignore all camels and do with a purely idiosyncratic analysis. The other way is to pick out a relatively small and relatively clean camel and wash it up a bit. This takes some time, but at least we then keep connected to a discussion with scientific flesh and blood. In this section, our little camel is the distinction between "etic" and "emic", found in anthropology's market place of concepts (Headland et al., 1990).

The emic/etic dichotomy stems from linguistics, on analogy with the "emic" in *phonemic* and the "etic" in phon*etic* (Harris, 1969, p. 569). "Phonemic" refers to what a sound signifies in the mind of speakers and listeners of a speech-community. "Phonetic" refers to the 'sound forms' that we may write down when we make ourselves conscious of what it is we *hear*, observing language from the outside. Thus, "etic" with respect to "emic" denotes the level of the *observer*, who observes the "emic" level of people and their interpretations of themselves and their surroundings. It may therefore be defined that

ETIC = the world according to the observer

EMIC = the world according to the observed.

'The world' here denotes both the inner and the outside worlds (values and facts). Note also that observation may be *self*-reflective. We may write the phonetic of our own language, for instance. An other example is when a policy agency evaluates its own activities; it then studies and judges (ETIC) itself as an actor among the actors. The evaluation criteria then are the ETIC values, with respect to the EMIC values of the policy that is evaluated.

As is usually the case with concepts that involve notions of reflectiveness, consciousness and recursiveness, the emic/etic dichotomy is of an almost trivial simplicity and very hard to grasp at the same time. In order to illustrate the latter, we may take a look at how in anthropology our little camel got to carry a confounded load of three more meanings, which may all be sensible in their own right, but are all different from each other and from the pure idea of reflectiveness defined above. In order to keep track of that pure idea, the definitions mentioned above will be referred to as ETIC and EMIC, in capital letters. In Harris (1969, p. 571, p. 575), emic and etic are defined as:

- "*Emic* statements refer to the logico-empirical systems whose phenomenal distinctions or "things" are built up out of the contrasts and discriminations significant, meaningful, real, accurate or in some other fashion regarded as appropriate by the actors themselves."
- "*Etic* statements depend on phenomenal distinctions judged appropriate by the community of scientific observers."

The funny thing that has happened here is that observation (ETIC) has been confined to *science*. Emic and etic do then no longer form a dichotomous pair; non-scientific observations, e.g., the stance that outsiders (or the actors themselves) take when pondering why the actors are doing something, is neither emic nor etic. Even scientific research remains 'nothing' until "judged appropriate by the scientific community".

More severely, the definitions places the players (actors and scientists) on prefixed levels. Actors are emic, science is etic. This is in confusing contradiction with two obvious facts. Firstly, actors may look upon themselves and their environment in ways often scientifically superior to those of "the community of scientific observers". Third World farmers, for instance, often simply know better, as shown (among many others) by Uphoff (1986). Secondly, science itself may of course be regarded as just as emic as the actors' "logico-empirical systems". Scientists follow the emic of science, or, as Sahlins (1976) puts it, the "antrophologist's etic is his own society's emic." Retrospectively, Harris' definitions of emic and etic and the ensuing discussion have served the purpose of raising the issue of anthropological *hybris*, but once that issue had been settled, the concepts were not of much use anymore. Note, however, that *our* definitions do not raise or settle this issue at all. Actors form ETIC images when reflecting upon themselves (or researchers!), who are then EMIC to them. Scientific research is ETIC when it observes, but turns into EMIC, by definition, when viewed from the outside.

After having defined the emic/etic dichotomy as 'of the actors' versus 'scientific' it is only a small step further to make the dichotomy denote 'in the mind of the actors' versus *real.* Harris may again serve as an example. Discussing three "emic rules" that Frake (1962) has "derived", as Harris puts it, from Subanum swidden farmers as accounting for the spatial distribution of Subanum households, Harris (p. 602) states that these emic rules cannot account for the variety of spatial patterns found, so that

> "Somewhere the emic rules must confront the etic reality of how much is produced [on the swiddens] under the given techno-environmental conditions".

If Harris would have used his own definitions consistently, this statement would say that the logico-empirical system of the actors must confront the reality of the community of scientific observers. One wonders how the Subanum ever survived in pre-anthropologist times.

Harris' third usage of the terms emic and etic is in 'emic' and 'etic' *modes of research,* adding the final pack of confusion to the load under which our little camel once succumbed. In Harris' own definitions, all research (if accepted by the scientific community) is etic; yet, he distinguishes between etic and emic research types. The following example shows what he actually means by these terms. (I have allowed the quotation to be somewhat luxurously long, in order to be able to use it again later on.)

> "Let us take as an example the ideal behavior by which captains of certain Bahian fishing boats are said to locate the ocean spots over which their boats anchor and the fishing lines are dropped. Identification of the proper spot, as small as a room, seven or eight miles out at sea, is supposed to depend upon the lining up of two or more pairs of landmarks. The memorization and sighting of these landmarks is the special responsibility of the captain, whose reputation can be measured by the size of the catch, ability to attract and hold good crews, and keenness of memory and eyesight. Now it is quite possible to describe this whole complex as actual behavior in terms of the emically significant categories of spots, landmarks, eyesight, and memory. Indeed, once can *actually* see and hear the captain look for the landmarks, maneuver the boat into position, order the sails down and the anchor dropped; and one can actually watch the fishing commence over the "spot". Actual culture here corresponds to a large degree to ideal accounts of it. But both accounts are emic. There is another way to look at the performance in question. The clue to this additional perspective resides in the fact that when the captain locates the spot and the men start to fish, they not infrequently fail to catch a single fish. On such occasions the captain explains that the fish are not home, that they have gone visiting elsewhere, and he orders the boat off to another spot. The etics of the matter do not commit us to a description of this behavior in terms of the captain's emically appreciated skills. One also observe the constant use of a plumb line, and there is a widespread knowledge of the relationship between type of bottom, water depth, and type of fish likely to be found in broad zones as opposed to "spots". An etic account of the fishing complex

includes a description of the patterns of behavior by which the captain maneuvers his craft, but the activity involved in his peering at the horizon does not carry the meaning it has in an emic account of actual behavior. Instead of accepting the emic version of actual culture as an adequate description of what it takes to be a successful captain of a fishing boat, the etic categorizations open quite a different ethnographic trail. An analysis of the relationship between age of captain, size of catch, and stability of crew reveals that younger, more active and vigorous men who do not drink, who work hard, and who manifest a "protestant" kind of behavior (an eminently etic category since they are all "Catholics") are the ones who are likely to be successful captains around whom the reputation for keen landmark sighting and good "spot memory" will develop."

Here we see that Harris implicity adheres to the following definition (in which our own ETIC and EMIC are added in order to get a clear picture of their relation to the emic and etic research modes).

Emic research = research (observation, hence ETIC by definition) that tries to come as close as possible to the actors' own life world and interpretations (the actors' EMIC, by definition).

Etic research = research (observation, hence ETIC by definition) that tries to interprète activities and actors in a way as closely as possible in touch with scientific terms and ways of seeing (the scientific community's EMIC, by definition).

These definitions show the concepts of emic research and etic research to be interprétable in terms of our EMIC and ETIC, albeit denoting essentially different things. Because of this, it suffices to note only two matters here, the first of which rounds off the unburdening and cleaning of our little emic/etic camel of reflectiveness, and the second of which introduces the core issue of this section.

(1) 'Emic research' versus 'etic research' does not denote a true dichotomy, but the extremes on a continuous scale. Both research modes are observation and interpretation (ETIC), only trying to keep more or less in touch with the actors' or the scientific conceptualizations, respectivily.[77] One may therefore also try to move more

[77] Note that Harris (whose objective it is to defend etic research approaches against the claims that only emic research, 'true to life', yields valid insights, and who is therefore inclined to emphasize their difference rather than their continuity) in fact poses two different questions in the fishermen example, one regarding the actual 'spotting' and one regarding the causal backgrounds of good spotting. Going emic with the first question and etic with the second suggests more separation than actually exists. Both questions could have been treated in both the emic or the etic research mode or somewhere in between, for instance discussing the backgrounds of good spotting with the actors themselves, putting the Weberian concept of 'protestant' in more emic terms.

or less in-between[78], combining the explanatory validity of the emic research mode with the easy link-up to general theories, provided by going etic.

(2) More importantly for the present section, it may be noted that all descriptions, whether of swidden cultivation or of fishing, and whether of the emic or etic research *type, include environment.* Put in more general terms: if we (or the actors themselves) explain the actors' activities, this explanation includes an environment-of-the-actors, associated to the actors' choices to carry out their activities. *An EMIC environment, in other words, is a pan ofthe 'social causes' block ofthe problem-in-context framework.* In our research, we observe this environment through the words or practices of the actors and may describe it more or less close to the actors' or our own conceptualisations, in both cases lifting it to the observational ETIC level of the research. There, it comes to stand side by side with an a conceptually different environment, an environment which is not a part of the social causes block, but the environment studied in the 'problem analysis' block (chains of effects and norms) and the 'physical causes' block (carrying capacity research).

What is the conceptual nature of these 'two environments'? How do they relate to each other? Are they related at all? Should environmental science research really learn to work with two environments, or should they be made to overlap as much as possible, in order to arrive at a unified description? The EMIC environment obviously being something primarily in the heads of actors, is social science the science to study it? In view of anthropology's apparent difficulties to come to terms with the reflectiveness phenomenon, it seems warranted that the explorations in this section continue to be cautious.

Let's imagine that it has been identified as a possible environmental problem that a fishing community has overfished species A and is now shifting to species B as the main catch. The catches are abundant at the moment, but the market is unstable and it is feared that the actors are in fact on their way to also deplete the B stocks; in terms of our final variables, the productivity may be unsustainable. It is also feared that a decline of species B, that is much more an ecological key species than was A, may result in drastic ecosystem changes, aggrevated by the fact that catching species B is more destructive to other species' habitats than catcing A has been. Because of this, also a number of small, endemic species may become extinct. Moreover, the local sea environment serves as 'breeding chamber' for a species C, of economic value to fisheries elsewhere; this function may also be affected by the switch to B.

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[78] In Chapter 7 of De Groot (1992b), the scale between the emic and etic research extremes is categorized as: "hermeneutic"/"interpretative"/"intensive"/"quantitative". In the anthropological field, truly emic studies of the ways that people see and arrange their environments (e.g., Van Beek (1989) about the Dogon, Schefold (1988) about the Mentawai and Oosten (1988) about the Inuit) are of special relevance to broaden our horizons concerning the immense vatiety of ways in which people may interprète the environment, thus enabling us to listen better to what people have to say and increasing our chances for successful participatory designs. In Chapter 6 of De Groot (1992b), the dimension of distance-to-actors is defined as a scale of 'intensity of participation' that runs from "the autocratic researchers' model", via "shared design" to "self-help promotion".

Now, what does the environment consist of that will be analyzed when we go through the problem-in-context framework? First of all, the causal chains between the activity "catching B" and our final variables (long term productivity risk, decline of fisheries elsewhere, endemic species survival) have to be established. These will introduce into the research the autecology of species B, including the conditions at the place where it spawns, possibly far removed from the local environment. Some ecosystem model that includes species B and the endemic species will also be required, as well as the species C juveniles. Thus, the carrying capacities for B, C and the endemic species may be estimated, and explained further, if relevant, in terms of more basic ecological factors.

At the 'social causes' side of the problem-in-context picture, we go into the reasons why actors carry out the "catching B" activity the way and the intensity they do. Of course, many social technological and economic factors underlie the actors' choices, but we are here especially interested in the environmental factors. What does this actors' environment (EMIC environment) consist of? For one part, it will be much wider than 'our' environment, analyzed above. Probably, not only fishing at sea may be an option for the actors, but also the intensification of other activities at sea, on the river or on land, e.g., trade, river fishing or the enlargement of current slack-season irrigation or coconut plantations. Thus, the EMIC environment, also when we seek to explain the fishery problem only, includes far-off islands, river levees, inland swamps and all their associated productivities (in the actors' estimations). For an other part, the actors' environment is smaller than the environment analyzed above, because it largely excludes, for instance, the habitats of species C and the endemic species. Even where the environments overlap, the actors will emphasize different elements in different ways, focusing, for instance, on difficulties of 'spotting' species B locations, the dangers of going far from the coast in the typhoon season and so on.

Put in general terms, we have now arrived at the following.
(1) First, there is some reflective observer (a researcher, a policy agency or whoever). In empirical science, this observer ideally works with only methodological values, such as validity and replicability. In normative science, however, the observer also works from a set of ethical (societal, substantive) values; in the fisheries case, for example, the interest of future generations, rare species and fisheries inside and outside the region. This makes the emic/etic dichotomy in normative science more fundamental than in the empirical science, as we will see shortly. In order to express this, we may call the observer the *normative observer.*[79]
(2) Through the views and values he works with, the normative observer defines and analyses an environmental problem, to which an environment is connected (in the fisheries case: the ecosystem model containing species B, C and the endemic species).
(3) The environmental problem is caused by activities, behind which lie actors; explaining the problem thus requires explaining why the actors carry out the problem-

[79] If we want to express that the observer also intends to intervene into the world (the typical stance of policy agencies), we may speak about the 'normative agent'.

relevant **activities**. This in its return defines an **environment-of-the-actors,** connected to the **actors'** options and motivations (hence: views and values). In the fisheries example, this environment included species B, river levees, far-off islands etc.

Although as yet without name, the two environments are now well-defined conceptually, answering the question about their conceptual nature. It may be noted that when studied, both environments arrive at the **ETIC** level of the research. Also, both are **noospheric** interpretations, "subjectivity objectified". Hence, they are conceptualized different from the pair of the geographer Gold (1980), who speaks about the **"objective"** versus the "behavioral" **environment.**[80] In basic terms, we have also **answered** the question how the environments are related. In the chain of progressive **contextualisation,** they are linked together through the 'activities' and **'actors's elements;** later sections and figures will give more detail. The two environments may formally be named and defined as follows:

- the *normative environment* is the environment connected to the values and views of the normative observer defining and analyzing an environmental problem
- the *environment ofthe actors (or: the EMIC environment)* is the environment connected to the explanation of why actors carry out the problematic activities (in the case of environmental science: cause the environmental **problem).**

The answers to the other questions now also come into view. Should environmental science learn to work with two conceptually different environments? The answer is, obviously, **yes.** If we do not only want to know what an environmental problem *is* (analysis), but also where it comes from (explanation), which quite practically leads to better predictions and better solutions, then we should have them both. A good conceptual framework or any other research theory for environmental science holds the two environments with full clarity about their conceptual **distinctiviness.**

But (is the next question), granting their conceptual distinctiviness, should it not somehow be tried to *make* them the same, **substantively?** Isn't a unified description always better? Here, the answer is less obvious. The key is that the substantive difference between the normative and the EMIC environments is brought about by the difference between the views and values of the normative observer on the one hand, and the values and views of the actors on the other. Thus, the difference between the two environments only collapses if the normative observer adopts the values and views of the actors, **i.e.,** of those who caused the environmental problems in the first place. Identifying with and becoming the advocate of problem causers may be necessary or even warranted in some cases, but should be the result of practical and ethical delibe-

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[80] **Golds's** "objective environment" coincides with the 'physical field' of Figure 3E. As a non-normative scientist, Gold does not conceptualize **the** environment of the normative observer; his "objective environment" is connected with the physical-geographic way of seeing and the **etic** research mode of studying the environment of the actors. The same **helds** for the "effective environment" of the cultural **ecologist** Netting (1985), that coincides with Gold's "behavioral **environment".**

rations[81], not something strived at for general reasons. Primarily, the difference between the two environments is simply the consequence of the difference in normative and cognitive positions, and should be left that way in order to avoid ethically muddled research and policy making.

We are now in a position to draw up the complete picture of the emic and etic levels, not only with respect to the environment, but with respect to all facts and values. This will also shed light upon the role of different types of science, solve Section 3.1's 'last problem', and show the pivotal place of 'action' in connecting the emic and etic worlds. The picture will look at the problem-in-context framework from the side, as it were, vizualising the different levels of reflectiveness and sources of data.

Figure 3A in Section 3.2 has distinguished a physical field, a social field and a reflective noosphere (people looking upon people and the physical field) This has been repeated at the top of the figure that will be explicated now, Figure 3E.[82] The actors' reflection constitutes the ETIC level with respect to the EMIC social and physical fields. The ETIC level thus includes all facts and values that the actor observes and objectifies in order to design and decide upon the actions to undertake. The designed actions are implemented 'into' the physical and social fields, thus forming feedback loops with respect to the upward arrows of perception.

The second picture of Figure 3E shows the position of the physical sciences, which is conceptually a simplified version of the upper picture of actors' daily life. There is only the upward arrow of perception, and this perception only concerns the physical field[83].

The third picture shows the somewhat more complicated situation of the social sciences. The actors' reflectiveness has now become the EMIC level with respect to the ETIC of the research. The full-drawn arrows represent the emic research mode; the dotted arrows represent the 'bypassing', etic research mode. Both incoporate a perception of the physical field, because actors perceive the environment and use that perception in the design of their actions.

The description of this EMIC environment is usually carried out by social scientists, as we saw, for instance, in the fishery example. A physical science input may often render good services, however. Local people may, for instance, know so much more about their environment than the social scientist that their answers become unscrutable, or physical science measurements may deepen the understanding of what

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[81] Adopting should be distinguished here from understanding. Understanding the actors' values and views, that is, being able to see through the actors' eyes, contributes to understanding EMIC environment. This however, does not do away the differences between EMIC environment and the environment connected to the nornative observer's own values, e.g., policy goals.

[82] In order to keep the figure sufficienty clear, the 'inner world' souce of values has been left out.

[83] It may in fact more appropriate to speak of a more abstract 'physical-science research mode', because it is also possible to look at the social field in the physical-science way, ignoring the self-reflectiviness of people (see picture 3). In practice, this is then called social science, however, named after the object rather than the epistemology.

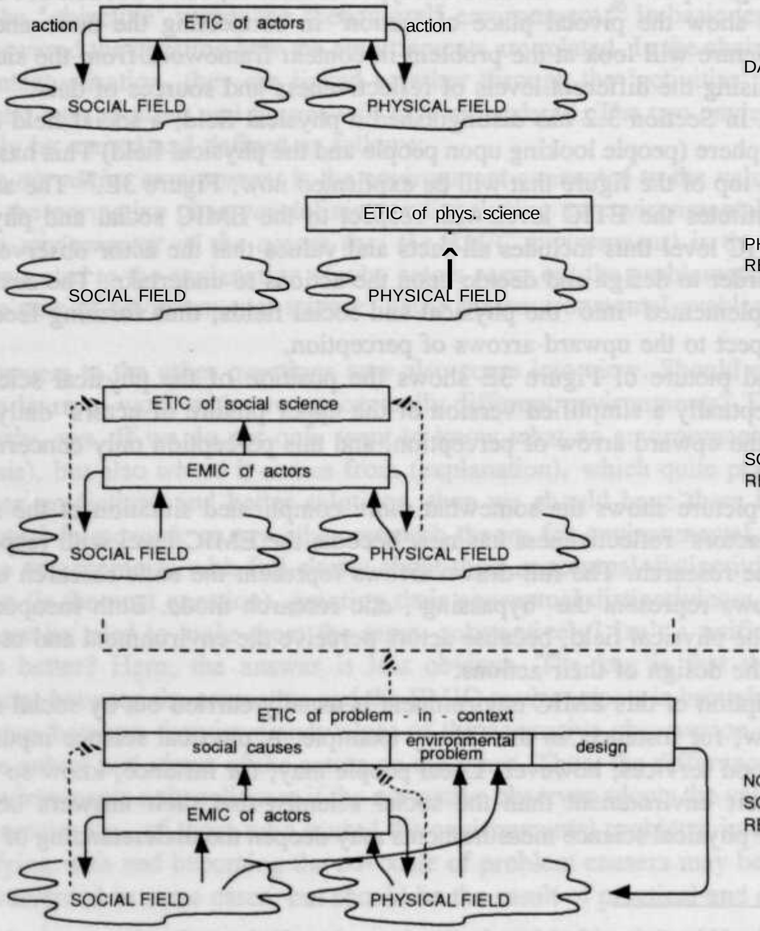

Figure 3E
Reflective levels of everyday life, physical science, social science and normative science research. The upward arrows denote perception; the downward arrows denote action.

actors do. Vayda (1983), for instance, used physical scientist to measure regeneration rates of small and large swiddens in order to acquire more detail in understanding farmer choices. Physical science remains the *assistant* here, however (Galjart, 1988).

The bottom picture of Figure 3E gives the position of the problem-oriented, normative sciences, expressed the problem-in-context way. Normative science here appears as a higher-level repetition of the actors' ETIC or the upper picture, including the 'action'-arrows running back to the social and physical fields. This is no coincidence. Contrary to physical and social science, normative science holds values about how the world should be, and through these, the formulation of problems and the design of actions. Social science and physical science are the scientific-level 'replay' of people's *cognitive* faculties only; normative science is the scientific replay of the full human repertoire, cognitive and action-bound. More in detail, we see that:

- the 'ETIC of social science' (including the environment of the actors) now functions as the social causes of the environmental problem;
- the environmental problem, generated by the values of the normative observer and including the normative environment, is studied by looking *directly* at the physical field,[84] the physical-science way,
- 'design' is here the umbrella term for 'preparing for action': design, evaluation and so on; the 'action' arrows represent decision-making and implementation.

Analoguous to the assistance of physical science concerning the EMIC environment, social science approaches may be of help to study the normative environment, e.g., in eliciting from the actors their 'local knowledge' about the normative environment or technical options for solutions. Farmers' knowledge about indicator species for soil types is a well-known example. The normative observer's values and physical science methods remain the ones that guide the research here, however.

Actors are not only looked upon by observers, they also look back, interpreting the observers, who are then EMIC to them. This is not inconsistent with our definitions, since ETIC or EMIC does not denote "of the researchers" or "objective" or "local people" or something like that, but purely "of the observer" versus "of the observed". Thus, the dotted-line meta-level of the bottom picture of Figure 3E indicates the next level of reflection in the endless chain of noospheric recursiviness. The level contains, for instance, future generations who once will look at us carrying out our research and implementating policies; all this research, design and action becomes a social cause of the problems *they* study. The level is also the position of research ethics and the design of methodologies. The double position of actors (as the observed but also as the observer's observers) helps to clarify practical research interactions in the field. Usually, for instance, actors want to be forthcoming, giving the 'right' answers to what they have conjectured that the researchers seem to want to hear. This may introduce significant biases in social data gathered (Chambers, 1985; Nederhof, 1981).

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[84] As the arrow shows, we here also look at the social field in the same, direct way. This is the social impact component of problem analysis, explicated in Section 3.9.

The bottom picture of Figure 3E also finally solves the 'fourth problem' of Section 3.1, the problem that it seemed impossible to conceptually reconcile at a single level the spontaneous respons of actors to their perceived environmental problems, and the 'policy respons' of the normative observer. Figure 3E (bottom) shows these two responses as originating from a different level indeed. The one is the 'action' arrow originating from the EMIC world of actors, the other are the higher-level, policy action arrow of the ETIC, normative observer. At the same time, however, we see that the EMIC world is also 'lifted up' into the problem-in-contex framework's ETIC, there being studied as the social causes of the environmental problem. This includes the action arrows; the problem-in-context framework holds both society's own feed-back arrow and the policy action feedback arrow, as one circles nested inside the other (e.g., Fig. 3J).

The EMIC world-of-actors that is lifted into the problem-in-context ETIC does not only hold the EMIC environment, but of course also the actors themselves, their interactions, social structure and so on. In terms of the title of this section we may say that the 'social causes' block of the problem-in-context framework is the reflected ('lifted-up') EMIC order.

Since the EMIC order holds people and an (EMIC) environment, it seems logical to say that this EMIC order is the same thing as the people-environment system studied by geography, human ecology and other empirical disciplines. We will see shortly that it is indeed, quite literary. Continuing on this section's track of cautious, slow exploration, it will first be shown how and where the multi-level reflectiveness results in the recursive 'vanishing point' that was loosely identified in Section 3.2.

From now on, we will again look at the problem-in-context framework 'from above' instead of 'sideways'. Looking sideways has enabled to show the levels that lie above and below the problem-in-context level. Looking from above makes the levels less visible, but allows for more detail in the framework picture itself. The vertical 'action' arrows then become horizontal feedback lines.

Recursiveness and systems equivalence

In the forest acidification Figure 3C, the normative environment and the EMIC environment of the actors have already been encountered implicity in the terms 'congestion' in the problem analysis and 'travel time' in the problem explanation; it is easy to see that these are two different interpretations of the same 'physical field' phenomenon. We know now that travel time should here be measured primarily as the travel time as it is perceived by the actors, analoguous to geography's 'mental maps' (e.g., Downs and Stea, 1988), and congestion should be measured in a perspective set by the normative observer's values, e.g., its detrimental effect on national income and air quality.

In Section 3.3, we have also met already what has loosely been called 'etic' and 'emic' options for solutions, identified, respectively, in the course of the problem

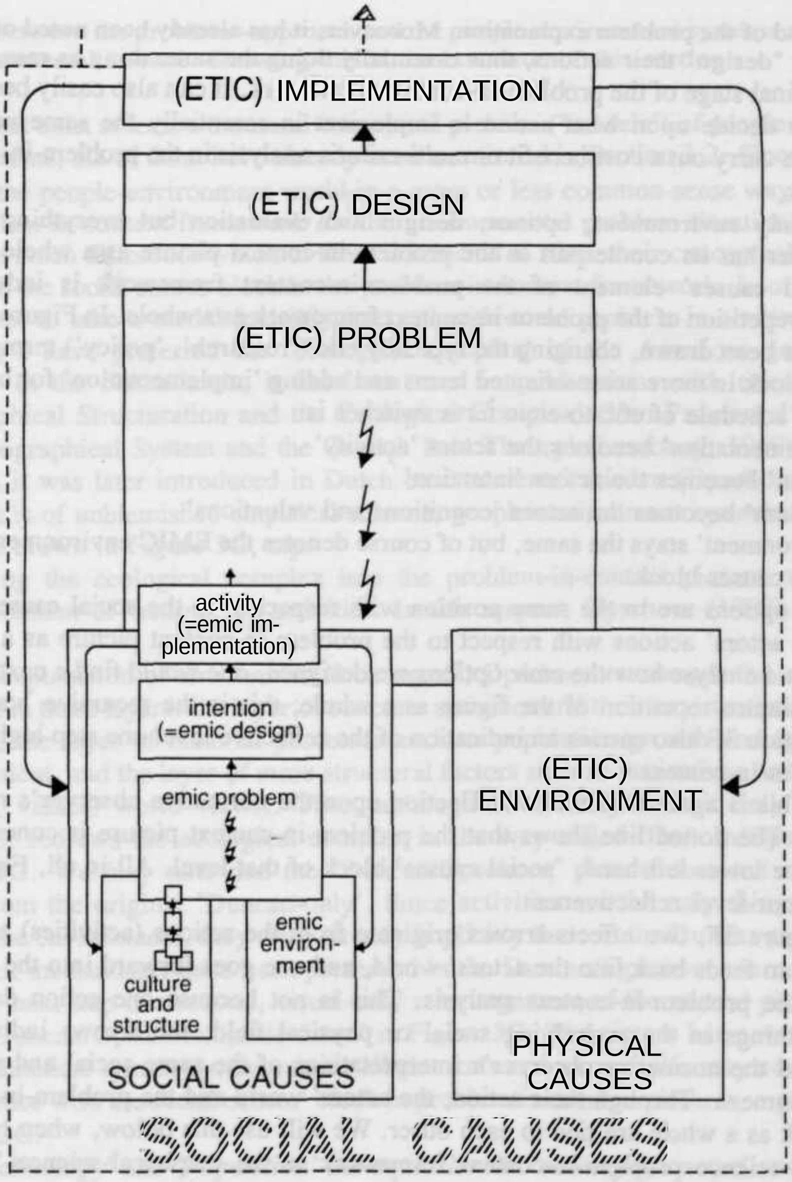

Figure 3F

The **Problem-in-Context** framework drawn as a four-level recursiveness. The actions that cause the (ETIC) problem of the normative observer. These actions, in their turn, are responses of the actors to their own **(EMIC)** problems, and so on. At the highest reflective level (dotted lines), the **problem-in-context** analysis, explanation, design and action of the normative observer are in the social causes of the next-level observer.

analysis and of the problem explanation. Moreover, it has already been noted off-hand that actors "design" their actions, thus essentially doing the same thing as researchers do in the final stage of the problem-in-context framework. It can also easily been seen that actors decide upon what action to implement in essentially the same way that researchers carry out a cost-benefit or multi-criteria analysis in the problem-in-context framework.

Not only environment, options, designs and evaluation but everything of the EMIC order has its counterpart in the problem-in-context picture as a whole. Thus, the 'social causes' element of the problem-in-context framework is indeed the recursive repetition of the problem-in-context framework as a whole. In Figure 3F this finding has been drawn, changing the typically etic ('research', 'policy') terms of the problem block in more actor-oriented terms and adding 'implementation' for beauty's sake. The schedule of etic-to-emic term switches is:

- 'implementation' becomes the actors 'activity'
- 'design' becomes the actors 'intention'
- 'problem' becomes the actors 'cognitions and valuations'
- 'environment' stays the same, but of course denotes the EMIC environment in the social causes block.

The emic options are in the same position with respect to in the social causes block as are the actors' actions with respect to the problem-in-context picture as a whole. If one would analyse how the emic options are designed, one would find a next-lower-level, miniature repetition of the figure as a whole; this is the recursive 'vanishing point'. Figure 3F also carries an indication of the reflective level one step higher than the problem-in-context
picture. This is again the level of reflection upon the normative observer's research or policy. The dotted line shows that the problem-in-context picture is conceptually equal to the lower left-hand, 'social causes' block of that level. All in all, Figure 3F shows a four-level reflectiveness.

In Figure 3F, two effects-arrows originate from the actions (activities) element. One of them feeds back into the actors' world, and one goes forward into the effects-chain of the problem-in-context analysis. This is not because one action does two different things in the underlying social or physical field; the arrows indicate the actors' and the normative observer's interpretations of the same social and physical field phenomena. Through their action, the actors' world and the problem-in-context framework as a whole are tied to each other. We will use this below, when tying the normative-science problem-in-context framework to the empirical-science 'people-environment systems'.

Figure 3F is a theoretically satisfying version of the problem-in-context picture, because it shows the recursive reflectiveness. I is also a good practical version if we want to highlight the difference between actors' conceptions of problems, options etc. versus our own conceptions of problems, options etc.. For most research purposes, however, a re-arranged version is preferable, as we will see in the next section. Also, it is not directly visible yet that Figure 3F carries inside itself the clarification of the relation between the problems-approach and the people-environment systems-approach to environmental science. Showing this is the last issue of this section.

There must exist at least a thousand conceptual pictures ('models') of people-environment systems; six of them have already been mentioned in Section 3.2. Since they all arrange the people-environment world in a more or less common-sense way (as does the problem-in-context framework for the environmental problem situation), it does not make much difference which of them is selected to show their conceptual equivalence with the social causes block in the problem-in-context framework. In order to be certain not to take a model invisibly infected with some problem-in-context way of thinking, I have preferred the 'ecological complex' of the American geographer Duncan. In the Netherlands, it has been used in publications with titles such as 'Geographical Structuration and the Ecological Complex' (Van Paassen, 1962) and 'The Geographical System and the Growth Pole Theory' (Lambooy, 1969). Hence, although it was later introduced in Dutch environmental science (Opschoor, 1987a; 1989), it is of unblemished empirical science, people-environment systems origin. It has been drawn in Figure 3G, top.

Fitting the ecological complex into the problem-in-context picture requires a visible element of 'action', or activities. In this respect, Opschoor (1989) leads the way.

For the explanation of environmental changes[85], Opschoor rearranges the ecological complex in three layers: the layer of concrete activities and their environmental consequences, the layer of material processes such as population growth and technology development, and the layer of more structural factors such as institutions and ideology (culture, values, world views). Thus, although he actually does it only verbally, Opschoor redraws the ecological complex in the way called 'Duncan/Opschoor' in Figure 3G. We may note that the 'Duncan/Opschoor' picture does not essentially differ from the original 'Duncan-only'. Since activities are the only things that can change the environment, they were already implicitly there in the Duncan picture. All feed-back mechanisms have been preserved in the Duncan/Opschoor rearrangement.

The next step is a second, visual-only rearrangement of the second picture. It is called 'Duncan/Opschoor upside-down' in Figure 3G. The picture has now lost much of its aesthetical symmetry, but retains all elements and arrows. We may now note the equivalence with the social causes' block in problem-in-context pictures, e.g., Figures 3B and 3C:

- 'Technology' and 'Population' are equivalent to 'activity per actor' and 'number of actors', respectivily, and are found at the same level in both pictures
- 'Organisation' and 'Culture' are equivalent to 'structure' and 'culture', respectivily, and are also found at the same level in both pictures.

Even 'Environment' is present in Figure 3G as a conceptual replica of the EMIC environment in the recursive problem-in-context Figure 3F.

[85] Note that Opschoor does not say 'problems'.

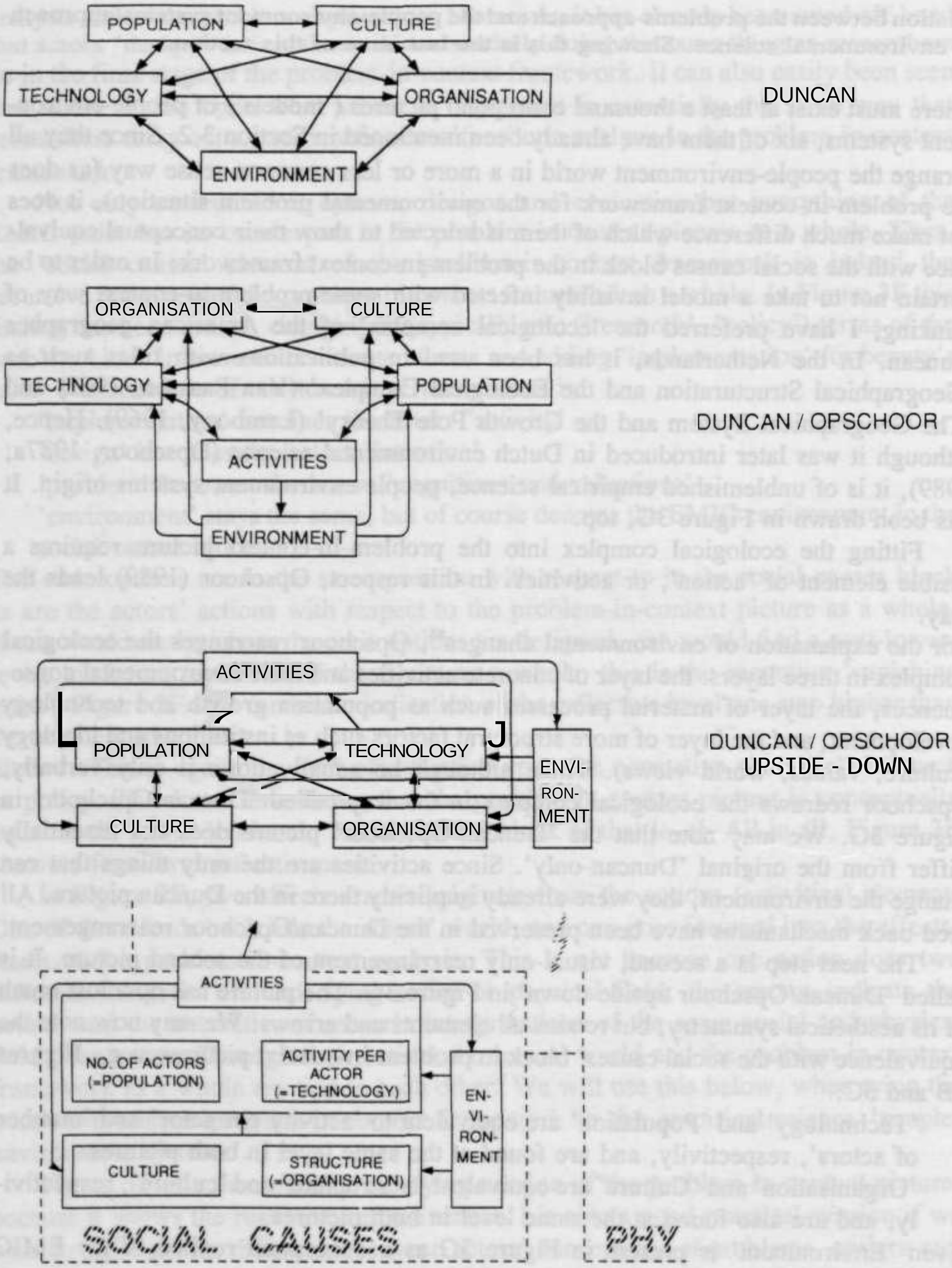

Figure 3G

From Duncan's people-environment system model to the action-in-context structure. People-environment systems, studied the action-in-context way, are the 'social causes' in the problem-in-context framework.

In Figure 3G (bottom), the picture of 'Duncan/Opschoor upside-down' has been drawn as part of the problem-in-context framework, demonstrating that Duncan's picture (and with it all people-environment models of the empirical approach to the environment) is indeed conceptually equivalent to the 'social causes' element in the problem-in-context framework (and with it the whole of the problem-oriented approach to the environment).

Conceptual equivalence is not to say, of course, that we should study the EMIC order in the people-environment systems way, if we seek to explain an environmental problem. As explained in Section 3.1, there is no need, and usually even no good, in trying to define boundaries, draw up a picture of what is hanging together with everything else and then try to fill all these elements with data. Instead, we can still study the EMIC order in the progressively contextualizing way, starting out from the problematic activity and then *find out* what hangs together with it, and in what ways. The conceptual equivalence has shown that *there is nothing in the people-environment systems approach that cannot be found the progressively contextualizing ('action-in-context') way.*

In Chapter 1, it has been shown that what is usually called 'environmental management', or 'shallow normative science' as in Section 3.5, dominates the normative-scientific approach to the environment. Roughly, this approach concerns the analysis of problems and the design of solutions only. On the other hand, we have the large fields of empirical-scientific study of people-environment systems, coinciding, by and large, with geography, ecological anthropology and human ecology. Through our analysis of reflectiveness, the Problem-in-Context framework has now shown to hold *both* these fields. The Problem-in-Context framework, therefore, enables research to draw in theories and data from both these fields without conceptual difficulties, and with that from the social, physical, technological and ethical sciences.

Problem-in-Context represents, as said before, fully-fledged normative science. It now has shown that the framework, encompassing as it does the empirical sciences, can also be said to represent fully-fledged science *tout court.* Obviously, this opens up many possibilities for discussions with mainstream philosophy of science. We leave the foundational explorations here, however, and turn to the more practical matter of operationalizing and formalizing the framework.

3.8 Formalizing The Social Causes

The preceding sections have aimed at building up a basic understanding of the problem-in-context principles. It has therefore not been necessary to define each concept or identify each tacit assumption. A conceptual framework should ideally possess a high degree of logical rigor, however, in order that it may organize our thoughts also in complex or vague problem situations. The present section and the next section aim at tightening the conceptual reins, leading up to the framework's summary in Section 3.10. The section focuses on actors, options, environment and other concepts in the 'social causes' block. The treatment will be compact and apodictic, because depth, detail, more formal definitions, discussion and literature references will be provided in Chapter 5.

Like 'systems' or any other concept by which we try to describe the social world, the concept of 'actors' expresses and leads to a certain perspective, a bias in seeing that world. Through the concept of 'behaviour', for instance, we study, and therewith assume and come to see, people and other social entities as input-output machines (sophisticated and poorly predictable, but machines nevertheless). Through the concepts of 'action' and 'actors', we study, and therewith assume and come to see, people and other social entities as reflective and choosing. 'Behaviour' emphasizes heteronomy, 'action' emphasizes autonomy.

My adoption of action and actor as the core concepts is therefore not only a technical choice for efficient research, but also a normative stance. I *want* people to be actors; there is simply no hope if we (and governments, and other people) would only 'display behaviour'.[86] At the same time, however, I want to steer clear of voluntaristic extremes and of the humanistic image of man as a free-floating 'self-design'. Tying actors to *contexts* (structure, culture) is a means to stay aware of, and operationalize in the research, people's partial heteronomy and boundedness.

The concept of actors has loosely alternated with 'people' in the preceding sections, but this is in fact a dangerous thing to do. *Actors are social entities that act*, in other words, social entities that may reflect and decide upon what to do. The concept of actors thus denotes more, as well as less, than 'people'. Many actors are not individual people but collective entities, e.g., private firms, village councils or government agencies. On the other hand, many individual people are not actors concerning the things they may actually be seen doing, e.g., if they are hired to fell trees for a logging corporation or to herd cattle belonging to an urban elite family, and do not involve in problem-relevant sideline activities. The concept of actors leads us more efficiently to an explanation of activities (and hence environmental problems) than

[86] It is not without meaning that the popular version of the Dutch Environment Policy (NMP, 1989) is titled: To Choose or to Lose".

does the concept of people[87]. An other advantage of the actor concept is that, although rather abstract itself, it forces us to be concrete about the degrees of freedom that social entities actually have with respect to the environmental problem at hand. One cannot be 'people' in a restricted sense, but one can be actor with respect to one activity and no-actor with respect to another, and anything in-between; social entities are actor to the extent that they can implement options. The concept thus also leads us fluenty to increasing or restricting of the actors' array of options as an opportunity in the design of solutions.

This being clarified, it still leaves us with a substantial problem. In the examples up till now, the number of actor categories has been kept deliberately low, loosely specifying only simple categories like private car owners or village inhabitants. Often, however, an environmental problem is caused by a wide variety of actors who, to make matters worse, interact in complex ways. In a regional analysis of a deforestation problem, for instance, big landowners may be found to close off fertile valley floor land, pushing farmers uphill; logging companies may be found to fear that their forest lease is vested in weak government and opt for the grab-it-and-run strategy; their logging roads may be found to pull farmers into the forest; the local pioneer communities may be found to assess their land claims vis-à-vis government actors as too weak to justify investment in good soil management - or follow a reverse tactic, making terraces and planting trees in order to strengthen their land tenure claim[88]; tribal forest people may be found to join forces with forest protection NGOs in a last attempt to regain their dignity. Such an analysis cannot do without some degree of 'mapping' the problem-connected actors. As Chapter 5 will exemplify in more detail, 'mapping' the actor interactions can be carried out without taking recourse to some 'social systems' approach. Holding fast to Vayda's rule that we should start out with the actors that decide upon the concrete problem-relevant activity, we may first identify the 'primary actors' who make the concrete tree cutting decisions; then, we may identify 'secondary actors' behind the primary actors, simply by posing the question what actors (if any) influence the primary actors' options or motivations. In the example above, the government will become an actor behind the logging company because it influences the company's motivation to grab and run. The big landowners will show up as actors behind the farmers because they influence the farmers' range of options, and so on. Thus, the options and motivations of the primary actors become contextualized in a two-dimensional 'map', the *actors field,* that comprises secondary actors, tertiary actors and so forth.

It is often important to distinguish between *actual* and *potential* actors. Actual actors (primary, secundary etc.) are those who contribute to the causes of the environmental problems; together, they form the actors field in the explanatory, social causes block

[87] This is different, of course, when it comes to the identification of victims, not causes, in an other part of the problem-in-context framework.

[88] This interesting reversal of Chamber's (1988) rule that tenure insecurity leads to low environmental investment is reported by Sajise (1987).

of the problem-in-context framework. Potential actors, on the other hand, are those connected to the design of the problem's solution. These categories may overlap, of course, but potential actors which are not actual ones are of special importance to identify. Potential actors may play a destructive role, e.g., when powerful groups grab resources made more valuable by small farmers' investments or by the construction of a rural road (Cook, 1985). Other potential actors may play a beneficial role, e.g., when a new common resource management body is formed in order to overcome dilemma of collective action, as has been the case in the 'social fencing' example.

The action-in-context perspective leaves room for a wide variety of 'actor models', i.e., preset theories describing how actors are supposed to see the world and decide what to do. These actor models vary along many dimensions. One of them is, for instance, the degree to which actors are supposed to consciously assess and weigh all alternative actions and their consequences. An other dimension concerns the values actors are supposed to apply in their perceptions and decisions; the so-called 'rational choice' of the *homo economicus* model is an example here; Chapter 5 will supply others. As will be shown there too, a formalized actor model will often be more of a ballast than an asset. Common sense, mixed with a qualitative and research-based understanding of actors and an empirical inference of their decision principles, will often work better than adherence to some prefabricated decision model. Therefore, it is chosen in Figure 3H to leave out the formal 'problem' and 'design' elements in the social causes block defined in the previous section (Figure 3F), and confine the figure to a 'model' that does not describe the decision process itself, but only the two decision process inputs and their context: *actors decide on the basis of what they see as their options for action and the motivations they have for these options. These options and motivations are in their turn embedded in a context of structure and culture* (markets, power relations, available technology, environmental knowledge, world views etc.).

We now arrive at Figure 3H that summarizes and formalizes the social causes structure of the environmental problem. It has an intermediate complexity in the sense that it is in-between the ones drawn up till now and the elaborated version of Chapter 5. The figure has been arrived at by dropping the 'design' element from Figure 3F (being too voluntaristically biased, as if people are designing actions all the time) but retaining the environment and environmental problem which indicate the recursiviness of the emic and etic perspectives, then mixing it with Fig. 3B and adding the 'sub-activities' and 'actors field' concepts.

The dashed-line elements below the 'activity' (=action) indicate optional subdivisions. Sometimes it comes in handy to separate the number of actors and the intensity of activity per actor, sometimes it does not. Sub-activities are sometimes important to analyse, sometimes one lumped activity suffices. Sometimes there are only one or two relevant actors or actor categories, sometimes a complex actors field has to be investigated. Each actor or actor category has of course its own options and motivations attached, as well as its own perceived background structure and culture (which may largely overlap, if actors live in the same place).

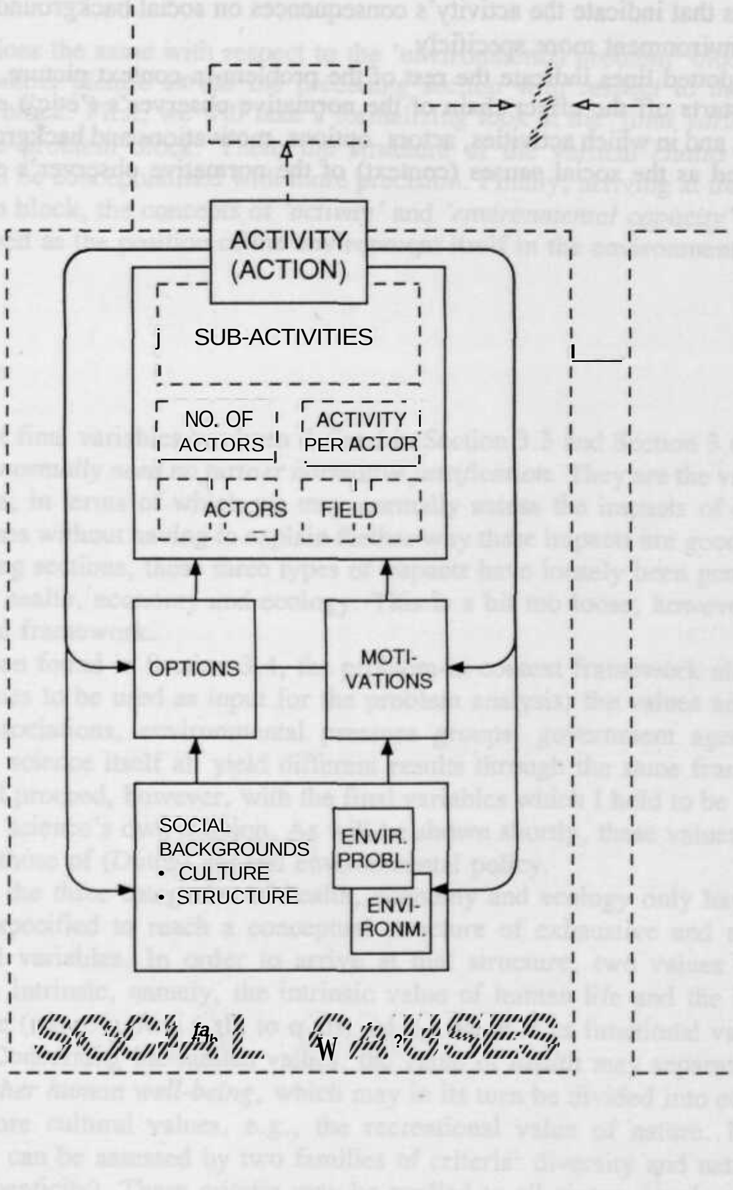

Figure 3H
The **action(or activity)-in-context** structure of the 'social causes' element of **the Problem-in-Context** framework

'Environment' and 'environmental problem' are parts of the social background of options and motivations, highlighted here in order to keep track of the fact that they indicate the *emic* environment and problem (environment and problem in the actors' eyes). Everything, after all, in the social causes block has that character, also the feedback lines that indicate the activity's consequences on social backgrounds, and on the actors' environment more specificly.

The dotted lines indicate the rest of the problem-in-context picture, in which the activity starts off the effect chain of the normative observer's ('etic') environmental problem, and in which activities, actors, options, motivations and backgrounds become interpreted as the social causes (context) of the normative observer's environmental problem.

3.9 Formalizing The Environmental Problem

This section does the same with respect to the 'environmental problem' block of the **problem-in-context** picture as did the preceding section with respect to the 'social backgrounds' block. First, we will take a formalizing look at the *'final variables'* at the top of the problem block. Then, the structure of the vertical *chains* running downward will be conceptualized with more precision. Finally, arriving at the bottom of the problem block, the concepts of *'activity'* and *'environmental capacity'*, will be clarified, as well as the position of the environment itself in the environmental problem.

Final variables

The concept of final variables has been defined in Section 3.3 and Section 3.6 as: *the variables that normally need no further normative justification.* They are the variables, in other words, in terms of which we may normally assess the impacts of environmental processes without having to explain further why these impacts are good or bad. In the preceding sections, these three types of impacts have loosely been generalized as impacts on health, economy and ecology. This is a bit too loose, however, for a real conceptual framework.

As has been found in Section 3.4, the problem-in-context framework allows for any set of values to be used as input for the problem analysis; the values and views of farmers associations, environmental pressure groups, government agencies or environmental science itself all yield different results through the same framework. This study will proceed, however, with the final variables which I hold to be those of environmental science's own mission. As will be shown shortly, these values largely coincide with those of (Dutch) general environmental policy.

Basically, the three categories of health, economy and ecology only have to be renamed and specified to reach a conceptual structure of exhaustive and mutually exclusive final variables. In order to arrive at that structure, two values may be assumed to be intrinsic, namely, the intrinsic value of human life and the intrinsic value of nature (nature's own right to exist, independent of its functional values for humankind). Concerning the human values, the value *of health* may separated from the value of *other human well-being,* which may in its turn be divided into economic values and more cultural values, e.g., the recreational value of nature. Nature's *intrinsic value* can be assessed by two families of criteria: diversity and naturalness (integrity, authenticity). These criteria may be applied to all system levels of nature in which we may recognize intrinsic value, e.g., species, ecotopes ('ecosystems') and geotopes ('landscapes'). This way, we follow a Dutch core document of environmental policy, the 'Plan for the Integration of Environmental Management' (PIM, 1983), in which it is laid down that

"Integrated environmental policy is the protection and the improvement of the quality of the (physical) environment as a condition for human *health and [other] well-being,* as well as the protection of ecosystems, nature and landscapes, for human use but also *out ofrespectfor nature as a value in itself*".(Italics added)

It may be noted that this set of final variables does not follow the World Conservation Strategy (IUCN, 1980) and 'Our Common Future' (WCED, 1987) which recognize human values only. In 'Caring for the Earth' (IUCN et al., 1991) we see nature's intrinsic value re-installed.

As has been touched upon in Section 3.6 and is explored further in De Groot (1992, Chapter 8), values are not necessarily confined to humans and nature separately; value can also be recognized in harmony and intensity of their relationship. Although I think this is a desirable addition to the final variables set, it is certainly less widely recognized, and it is therefore put between brackets in Box 3.2.

The concept of *sustainability* of course also belongs to the final variables set, but it is of a different conceptual order from those above. The latter are 'time-free', so to speak, and sustainability adds the time, especially the long term, element to each of them. Farmers incomes, for instance, are not only relevant as they are now, but should also not be undermined by slow erosion or accumulation of heavy metals. The (human, functional) value of nature as a gene pool for future medicines and crops is typically a final variable that comes to life through the sustainability concept. Box 3.2 summarizes the exploration; Figure 3I (top) vizualizes it. Drawn in there too is the wider context of the final variables, the research of which is normative contextualization, following Section 3.6. Chapter 4 as a whole goes deeper into the final variables and allied concepts.

Box 3.2

FINAL VARIABLES
for environmental science are effects and norms in terms of:

- human health
- other human well-being
  * economic
  * cultural
- well-being of nature
  * diversity and naturalness
  * of species, ecotopes and geotopes
- (harmony and intensity of people-nature relations)

all of them for now and future generations (sustainability).

Chains and boundaries

The second issue of this section is general structure of the vertical chains in the environmental problem block. In the reservoir siltation and the forest acidification cases (Figures 3B and 3C), we have noticed that several arrows of causes, effects and norms go outside or come from outside of the environmental problem boundaries. What do these arrows indicate and what are their conceptual consequences?

First, it may be clear that the number of arrows going to or coming from outside is largely a matter of how the environmental problem has been defined. If we study, for instance, the impact, explanations and possible solution of PCB-emissions in relation to a number of fish-eating fresh-water animals, we work with fairly narrowly defined chains of causes, effects and norms, and much of what we will study will 'go elsewhere' or 'come from elsewhere'. The PCBs will, for instance, have effects on other ecosystem components and travel also to the sea. And the decline of the animal populations will also be caused by non-PCB factors, from outside our problem situation.

Figure 3I depicts the 'weaving in and out' pattern that generalizes this. It is a generalized, arbitrary slice of the environmental problem block of the problem-in-context framework. The figure is confined to only one step in the effects and norms chain, so that the abstract terms of 'causes' and 'effects' could be used. 'Causes' are of course effects in relation to underlying causes, and 'effects' act as causes in relation to effects further up in the chain. Analogously with the norms, 'higher norms' are derived from still higher ones and 'derived norms' act as higher norms for derivation further downward.

By way of illustration, we may again take 'Dutch PCB emissions' as the cause and take the otter population as the final effect variable. Then, the first 'in-problem' effect is the Dutch fresh-water PCB concentration. This concentration has other causes too, however; 'weaving-in' are, for instance, the German PCB emmisions in the Rhine. And the Dutch emissions have other effects as well; 'weaving-out' are their contribution to the marine PCB concentrations.

The figure is almost symmetrical; the norms-side mirrors the effects-side, except that, as a consequence of the reversed direction (causality) of the vertical arrows, divergence at the effects-side turns into convergence at the norms-side. On the effects side, taking Dutch PCB emmissions as an example, effects *diverge* from the PCB emissions to the 'in-problem' effect of the fresh-water concentrations and the 'other effect' of the marine concentrations. At the norms-side, a norm for Dutch PCB emissions is determined by the convergence of what may be derived from the norm concerning the 'in-problem' fresh-water concentrations and from the norm concerning the marine concentrations; of course, the lowest of the two should be taken, because that one is limiting, or 'critical', as Ortolano (1984) puts it. Reversedly, a convergence of two causes into one effect results in a divergence of one norm in terms of an effect into two separate norms concerning the two causes.

Udo de Haes and Van der Voet (1987) show that the divergence of one 'higher' norm in two or more lower ones may crop up as an unexpectedly political aspect in

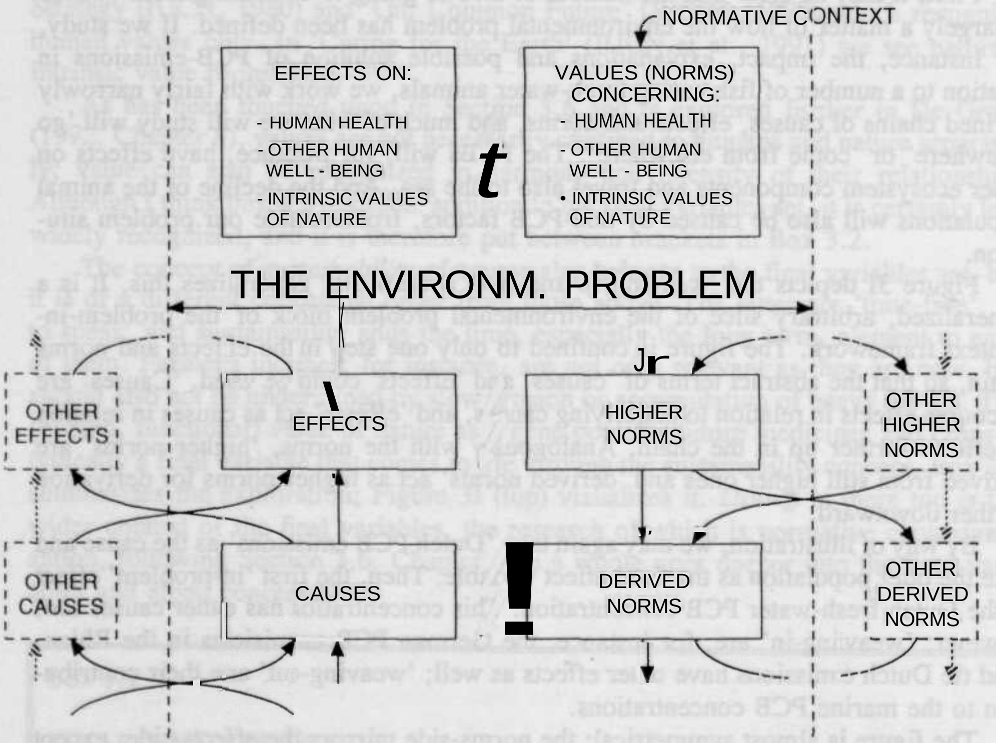

Figure 3I
Basic structures in the environmental problem element *of* the **Problem-in-Context** framework. Visible at the top are the final variables of environmental science. The flashes denote **the** fact-value **discrepancies.** On the left, **the causality** runs upward in chains of causes and **effects;** on the right, **the** causality runs downward in chains of higher and derived ('lower') norms. If an environmental problem is defined by specifying more than one element in **the** norms or effects chains, relations with 'outside' facts and norms weave in and out across the problem **boundary.**

a norm derivation study. For the support of court decisions concerning the establishment of new pig farms in the Netherlands, Udo de Haes and Van der Voet calculate a maximum allowable number of pigs in a region (conceptually: a carrying capacity), on the basis of the acidifying effect of pig manure (because of its emission of ammonia). Starting from a higher norm of a maximum allowable acid deposition of 1600 mol H^+ per hectare per year and applying data on deposition velocities, they work downward in the norms chain to a maximum allowable ambient air concentration. Then, applying a distribution model, they work further downward to a maximum allowable ammonia emission and finally, applying data of ammonia emission per pig, to the maximum allowable pig numbers. So far, this is a straightforward norms derivation. The snag, however, is that the acid deposition is not determined by ammonia emissions only, but is a determined by a convergence of factors that also include acidifying SO_2 and NO_x, caused, among others, by traffic and industry. Therefore, the norms diverge; one cannot allow agriculture, traffic and industry to *each* 'fill' a norm of 1600 mol; the 1600 mol has to be apportioned, sharing out some portion of the 1600 mol to each of the three sectors. Alternatively, if a European-scale acidification model is applied to derive a emission standard for Europe as a whole, the norm could be apportioned first between countries and then between sectors.

Arriving at the bottom of the environmental problem block, the concept of 'activity' (or 'action') requires some formalizing attention. Its definition is simple; 'activity' refers to everything actors do to the environment or, to say it more formally, everything that crosses the boundary between the actors' intentions and the environment. Activities may therefore be quite small-scale, singular phenomena, such as a single actor weeding a field, driving a car or drilling a borehole. These singular activities may be generalized as weeding, driving or drilling by categories of actors; they then rise in scale but stay singular. Other activities may be complex systems in which singular activities act as elements, e.g., the running of a refinery plant, the implementation of a provincial drinking water strategy or the carrying out of a multi-crop farming system. In these cases, it is often useful to analytically decompose the activity into more singular 'activity elements' that link up to known dose-effect relationships (e.g., De Groot, 1985, concerning a drinking water strategy, decomposed at three system levels)[89]. Figure 3J shows this by the optional, dotted-line box attached to the 'activity' element.

Of more substantive importance, the conceptual analogy *of processes* and *products* may be pointed at, that is of special relevance for the pollution problem field. The term 'activity' has a tendency to focus research and policy on *how* things are being produced, but a focus on *what* things are being produced and what materials they are composed of may result in more cost-effective pollution policies. Van den Berg et al. (1986) indicate, for instance, that technically easy shifts toward more environmentally friendly product alternatives and product compositions for industrial lighting, car

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[89] Care should be taken that the higher system level characteristics are set aside first, before listing the component activities; see Section 4.3.

paints, milk packaging and other product types result in a 50 per cent reduction of emissions to soil, water and air.[90]

As Guinée and Huppes (1989) show, a product may be treated as an activity by breaking down its life cycle into a series of stages that starts with the mining of the primary resources and ends with the product disposal. These stages all result in emissions that may be fed into the problem-in-context picture analoguously to the emissions of activity components. In the social causes block, 'options' and 'motivations', when applied to products, become the functionally equivalent product alternatives and the market motivations of sellers and buyers, respectivily. Consequently, Kortman and Muis (1990) state that a market ('social causes') analysis should usually accompany a product impact study (the product's 'environmental problem' assessment). A further analogue is that for products, the multiplication of 'activity per actor' and 'number of actors' becomes the product's composition and number of products sold, respectivily. Thus, a problem-in-context analysis and design for a products-oriented pollution policy may be carried out as any other.

Environmental ('carrying') capacity

The last conceptual issue to be tackled in the present section concerns the position of the environment in the problem-in-context framework and the 'environmental capacity' concept in particular.

Concerning the former, it may be asked why the environment is drawn in the right-hand corner of the problem-in-context pictures. Are not environmental parameters also found all over the central, environmental problem block, determining all the upward and downward chains of effects and norms? This is indeed the case. The deposition velocity of SO_2 from the air to the soil, to mention only one example, is used as a dose-effect relationship to step from ambient air SO_2 concentrations to SO_2 depositions in acidification effect chains. In the inversed form of an effect-dose relationship, it is used to step from maximum allowable depositions to maximum allowable ambient air concentrations in the normation chain that runs parallel to it. The deposition velocity could therefore be drawn in the problem-in-context picture as a co-determining factor, in-between the SO_2 deposition effect and the ambient SO_2 norm. This has been avoided, for the simple reason that it would then be visually in the way of the 'problem flashes', the discrepancies between facts and values that make up the environmental problem's backbone; better visualize these than the dose-effect relationships that nobody will overlook anyway. In order not to arrive at a picture without environment explicitated somewhere, the dose-effect relationships and all other

[90] In the Netherlands, 'product-oriented' policy has become distinguished form the still more usual 'process-oriented' pollution policy. Both are source-oriented, but the first targets on what is produced (leaving aside how this is done) e.g., through product quality or labels, and the second targets on plant emissions, leaving aside what enters or leaves the plant through the gates. The policy instrument of 'substance deposit money' proposed by Huppes and Kagan (1989) is a recent result of product-oriented thinking.

environmental properties have visually been lumped as 'physical causes' in the right-hand corner, thus emphasizing the more fundamental, basic ecosystem characteristics. Environment as a whole, however, continues from there 'under' the whole of the environmental problem block, as symbolized by the shape of the physical causes block in Figure 3J. This, as we have seen in Section 3.7, is the 'environment of the problem analysis', not the 'environment of the actors'.

Many dose-effect relationships express not only natural ecosystem properties, but are co-determined by human action on the ecosystem. The SO_2 deposition velocity, for instance, is largely natural, but co-determined by human releases of ammonia, that 'catches' SO_2 from the air (Van Breemen et al., 1983). We have already used this phenomenon as a source of inspiration for identifying options for solutions. Thus, every element in the problem block is in fact determined by three types of factors: (1) the lower direct cause in the effects chain or the 'higher' norm in the norms chain, (2) natural environmental properties and (3) man-made environmental properties. This has been visualized at the only place in the final problem-in-context picture (Figure 3J) where I found it important enough to trade off against the increased complexity: at the environmental capacity element. Environmental capacity, having accumulated many environmental dose-effect relationships in the course of its derivation from the final variables, has a tendency to look like an intrinsic ecosystem property, and is often treated as such. One example of its triplicate determination may suffice here.

Imagine a stretch of environment that could be either semi-natural forest or grassland. Then, what is its environmental capacity. First, the assessment requires a assumption of which of the two land-use possibilities the carrying capacity should refer to, in other words, the land use *aim*. If the environment is to be forest land, a carrying capacity in terms of cattle per acre is senseless. Secondly, this aim has to be specified in more detailed objectives. For instance, should the forest serve a nature conservation objective? Then, the carrying capacity should be in terms of, for instance, allowable number of tourists per day. And what are the priority species to be protected? If these are hornbill birds and orang utangs, for instance, a high percentage of old-growth, large trees and very little disturbance should be provided for. The allowable number of tourists per day then is lower than if the diversity of plant species would be the key objective. Hence, different normative emphases in the final variables (different 'value inputs') yield different carrying capacities.

The same may be seen from the line of reasoning connected to the alternative grassland use of the environment. If (and only if) we specify that the only value the place should serve is food production by means of cattle, and if we treat soil fertility, cattle breed etc. as given, a carrying capacity in terms of maximum number of cattle per hectare may be calculated. But still then, this carrying capacity will be different if we put in either a maximum-production or a risk aversion strategy, with respect to the food production which is also a value decision. Moreover, if the area is a vulnerable watershed, its carrying capacity may very well be lower if we also apply supra-local values concerning erosion and the area's hydrological buffer capacity.

In many cases, carrying capacity calculations often attempt to go one step further, also specifying the 'allowable' number of people in the region. Another value-input then co-determines the result, namely, the income these people are supposed to earn. The same number of cows that may support ten subsistence pastoralists may suffice for only one rich rancher. Here too, different values (aims, minimum allowable incomes etc.) result in different environmental capacities. Because of its co-determinatedness by the 'value-input', *environmental capacity is a normative concept,* a standard like any other along the norms chain. Forest management practice and fertilizer application are obvious examples of human influences on the forest and grassland capacities; soil types and processes are examples of their natural counterparts. In Figure 3J, the latter, non-normative influences have been analytically separated in 'primary environmental capacity-determining factors' and 'the ecological basis'. This reflects the pathway of progressive contextualization, repeatedly asking the where-does-that-come-from question. With respect to the grassland capacity, for instance, primary factors are the available soil moisture, soil phosphorus, or whatever factor is 'in the minimum'. Taking available soil phosphorus as an example, this factor is in its turn determined by the fertilizer gift, the mineralisation of leaves and dung and the available phosphate stock in the grass root zone. One explanatory step further down, one finds the number of deep-rooting trees that bring phosphorus up, the rain that leaches it down and the mother rock characteristics, thus probing into the 'ecological basis' that we may bring into the study to the degree and in the way set by the study's overall objectives and the foregoing problem analysis.

In Figure 3J, the dashed lines indicate the optional separation of environmental capacity into (1) environmental capacities in terms of number of actors (farmers, tourists, car drivers etc.) and (2) in terms of activity per actor (cattle per farmer, disturbing activity per tourist, kilometers per car driver, etc.), analoguous to the first subdivision at the activity side. If the 'activity' stands for products brought on a market, the distinction of course becomes the allowable number of products (pertaining to 'volume policy') and product quality standards (e.g., the allowable cadmium content).

A formal definition of environmental capacity may round off the present section. Baldwin (1985), although without giving it a name, uses a typical pollution-field version of the concept: "The ability of the natural environment to accept wastes and pollutants without significant damage to social or ecological systems". Here, the value component is expressed by "without significant damage", while the final variables concern "ecological and social systems". My own definition basically complies with Baldwin's, although the applicability is broadened, the final variables more specified and without 'systems' being necessary (for the well-known reasons and because individuals also count). Thus, the concept may be defined as:

> *environmental capacity (or carrying capacity) is the allowable intensity ofan activity* (either putting things into the environment, taking things out of it or directly changing the environment's structure), *derived from norms in terms of sustainable health, other human well-being and intrinsic value ofnature, and co-determined by human inputs and natural properties of the environment.*

As has already been remarked in Section 3.3, the human input is here treated as given. If we do not, it becomes part of the activity we may calculate the environmental capacity of. Fertilizer input may thus be treated as given, or we may calculate the minimum input that ensures sustainability of yields (the typical Third World case), or we may calculate the maximum input that prevents nitrate or phosphate pollution (the typical industrialized world case). Environmental capacity is in the majority of cases a maximum the environment can handle sustainably; sometimes, it is a minimum the environment needs to sustainably perform its functions or support ecosystems of high intrinsic value.

In Section 3.3, we have encountered the concept of *human* carrying capacity. Semantically, this should be a specified version of general environmental capacity as defined above. It may be defined as:

> *human carrying capacity is the maximum number of people that can make a sustainable living off the land, with an allowable income and allowing space for biodiversity.*

'Living off the land' here is specified as the activity the human carrying capacity is about. This complies with current usage (e.g., Mahar, 1985; Proctor, 1990; Daly, 1990); for an approach that includes also industrial activity, energy and so on, the Annex of Chapter 4 may be refered to. Primitive as the agricultural focus may seem, it emphasizes what, alongside with biodiversity, is probably the world's most fundamental environmental problem: the loss and degradation of productive ecosystems and soils.

'Living off the land' is to be understood as including external energy inputs (e.g., fertilizer). This is not only practical but also fundamentally sound, because energy is not one of the world's fundamental environmental problems (ref. the Annex of Chapter 4). At the same time, however, 'living off the land' should be taken without external economic subsidies; the farming system itself has to provide for the income to buy the external inputs. Even Sahara rocks, after all, can yield crops if subsidized heavily enough, and too many countries in Africa have once been presented as the continent's grain shed without specifying how much this would cost and who was obliging to pay. This implies that sensible assessments of human carrying capacities can only be based on first specifying farming systems, existing or potential, that are both sustainable and economically feasible,[91] i.e., providing for the expenditures on inputs and the income a farmer or herdsman needs (on top of his own subsistence harvest, if any). Once such a basis is provided, the human carrying capacity is calculated simply as the inversion of the number of hectares a farmer needs to earn a specified (e.g., basic needs) income. Human carrying capacity assessment then becomes, as it should, mildly dependent on food and input prices and on agricultural infrastructure, and heavily dependent on soil quality and the ecological quality of the farming (or cattle, or fishing) system.

The human carrying capacity concept is often used in attempts to assess whether a region or a country is overpopulated. Even when calculated in the conceptually

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[91] Thus including the necessary expenditures on sustainability, e.g., fallows, terrace maintenance, manure recycling and (typically for Western-world systems) measures to prevent ground water deterioration and on-farm biodiversity loss.

sound way, however, human carrying capacity is only half of the story, notably the agricultural one; industry and services add the other half. They may cater for the majority of the population without, as the Annex of Chapter 4 shows, adding to unsustainability. They may earn the funds necessary for themselves to be sustainable (e.g., preventing toxic emissions), as well as pay the agricultural prices that may allow the agricultural sector to invest in its own sustainability. Thus, even a place like Hong Kong is not necessarily overpopulated. Summarizing we may say the following. (1) A country is unsustainable if it does not pay for its (urban and rural) sustainability, e.g., too busy making war or bathing in luxuries. (2) A country is overpopulated if it *cannot* pay anymore for its sustainability. Almost the whole world is in category 1. Driven, *inter alia*, by the greed of their elites, the international debt burden and church ideologies about child numbers, more and more countries are entering the second.

3.10 Problem-In-Context Summarized

A shortest possible version of the **problem-in-context** framework has already been given in Section 2.5. The present section aims to give a medium-size summary, mainly for reference purposes, connected to Figure 3J. Because of this purpose, the language is formal; anyone who has read the preceding sections may skip this one, since it does not add new information or structure with respect to the material already given or to be given in later chapters.

Problem-oriented environmental science belonging to the family of disciplines with a primarily normative aim, environmental *problems,* not people-environment systems, are its core object. Its theory is substantive theory about, and epistemological theory for, the analysis, explanation and solution of these problems.

Environmental science is an interdiscipline, with potentials to grow into a (high-level) monodiscipline different from the sum of the environmental specialisms because environmental problems and their solutions as a whole are more than the sum of their parts. The degree to which environmental problems and solutions can be studied and designed in the interdisciplinary or monodisciplinary way (largely coinciding to with the degree to which they are study-able and designable at all) depends on the strength of integrative environmental science theory (framework, concepts, models etc.).

Environmental problems are built up as discrepancies between how the world is ('facts') and how it ought to be ('values', 'norms'), as recognized by a normative observer (government, societal actors, environmental science itself or some 'participatory' mixture). The most binding problem formulation is a discrepancy in terms of the 'final variables' that, as is implicit in environmental science's mission, express facts and values of human health, other human well-being (economic and non-economic, such as wilderness solitude) and the intrinsic value of nature; of the latter, diversity and naturalness (integrity) are the core criteria. The concept of sustainability adds the long term aspect to all final variables.

As in any problem formulation, facts and values have equal 'ontological status' in the problem-in-context framework. Both are subjective interpretations (of the outside world and the inner world, respectively), and both become objectified in scientific and social debate following their being put on paper.

Close to the final variables, the environmental problem is described in terms of impacts and impact norms. One step closer to the activities that cause the environmental problem lie the facts and norms in terms of the functions of the environment and in terms of environmental variables. 'Source-oriented' problem descriptions speak in terms of activities and their norms counterparts (environmental capacities, of the 'activity' and 'human' type). On the effects-side, the causality runs upward from activities to final variable impacts. On the norms side, causality runs downward, 'lower norms' being derived from the final variable ('intrinsic') values. Describing this full structure is the *analysis* of an environmental problem (or problem complex or

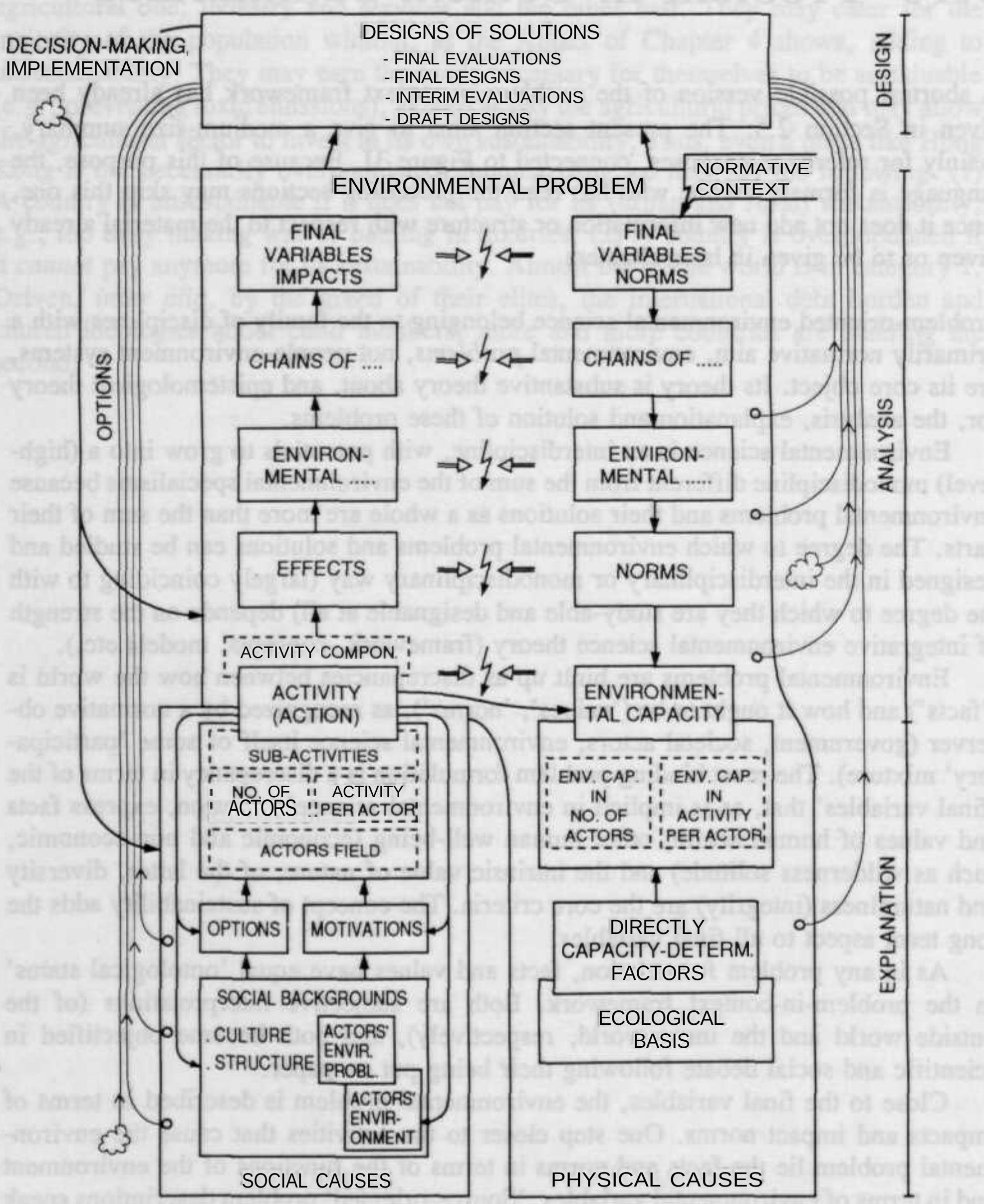

Figure 3J
The **Problem-in-Context** framework: **the** analysis, explanation and solution of environmental problems in a single structure for theory building, education and research. Section **3.10** is the full legend.

problem type). More partial research types are, *inter alia,* effects analysis and normation.

Explaining an environmental problem implies its contextualization in three directions:

(1) Normative, investigating the grounds on which we hold and operationalize the final variable values the way we do.

(2) Physical-scientific, investigating why the environmental capacity is not larger than it is.

(3) Social-scientific, investigating why actors (decision-making social units) carry out the activities the way they do.

In all the directions, the contextualization may be 'progressive', that is, searching wider and deeper step by step, led by considerations of relevance. These considerations may vary widely, depending, among other, on whether the research is meant to be directly applied or a more fundamental exploration. Ethics, physical science and social science are the 'leading sciences' in the three respective directions, but mutual support will often be helpful.

It can be shown logically and empirically that the social-scientific explanation holds the full concept of people-environment system (albeit without systems assumptions being necessary), thus including the actors' own (EMIC, explanatory) interpretation of the environment related to their decisions. In problem-oriented research (and possibly any research), people-environment systems may best be 're-written' and studied the action-in-context way, which implies:

- identifying the actors behind the problem-relevant activities
- identifying the options they may choose between and the motivations attached to these options
- identifying actors and factors influencing these options and motivations
- and the Wider cultural and structural phenomena in which these are embedded.

Technical, social and spatial options ('building blocks for possible solutions'), both in the actors opinions ('emic') as of the normative observer ('etic') are identified during the course of the analysis and explanation, marking the cross-over to designing research. This research type is also fed by the facts and especially the values that also gave rise to the problem analysis. Design in the stricter sense is the selection and combination of options to form the higher system level of a plan, a policy or a project; evaluation (impact assessment, cost-benefit analysis etc.) normally follows it. Analysis, design, explanation and evaluation are often carried out cyclically. In most practices and textbooks, however, the ethics, social science and design methods needed to carry out integrated research on a balanced level are sadly missing.

The Problem-in-Context framework is valid for all types of environmental problems and modes of research, and able to guide specific studies, generalized 'problemologies', theory exchanges or curriculum design. Its applicability is restricted, however, if and insofar:

- the fact/value discrepancies have the character of a (positive) opportunity instead of a (negative) problem
- the normative observer does not want to be rational.

The first restriction is partly counteracted by staying on the look-out for 'opportunity options'. The second restriction is partly counteracted by staying alert concerning 'implementatory conditions'. In Figure 3J, the restrictions are vizualized by the little clouds, symbolizing outside sources of knowledge and surprise.

The Problem-in-Context framework can be shown to be logically recursive, the 'social causes' holding a complete representation, in endless regress, of the problem-in-context picture as a whole. This arises from the fact that the framework is reflective ('noospheric'), i.e., putting on paper the structure and the result of the reflective act, investigating what might be wrong in the world, why this is so and what might be done about it. By the same token, two well-known research types show up as extremes within the framework: 'shallow normative science', largely coinciding with what is usually called environmental management and planning, and empirical people-environment systems research. Through the Problem-in-Context framework, research and education can draw from both worlds, interconnecting them on a single conceptual plane.

3.11 Designing Research

In the literature, the term 'decision-making' is used in two senses: a narrow sense refering to the choice process only, and a much broader sense that includes the whole sequence of problem analysis, design, evaluation and choice (e.g., Quade, 1975). Likewise, the term 'design' is used in a narrow sense (the 'formulation of alternatives' or equivalents) and in a broader sense, that includes also the problem-analysis and evaluation (e.g., Hoogerwerf, 1984). The Problem-in-Context figure 3J follows the *pars pro toto* tradition; 'design' is used as an umbrella term for design and evaluation.

This section focuses on design (or: 'designing research') in its narrow meaning; evaluation will get some attention at the end of the section and more fundamentally in Section 4.9. Design in the narrow sense is defined as *the selection and combination of options to form the higher system level of one or more possible solutions.* This process is fed and guided by facts and values, identified in the preceding problem-analysis and problem-explanation. The options are usually also identified in the course of the problem-analysis and problem-explanation but may also, as explained in Section 3.4 with respect to opportunity-driven design, have jumped into existence out of 'nothing'. Other terms for options are "potential plan elements", "building blocks for solutions" or "components" (Alexander, 1982). The 'possible solutions' of the definition may be technical designs, but more typical in environmental science, they denote more general plans, policies, projects, strategies or other courses of action, by government agencies or self-organized actor groups. The design principles to be explicated in this section remain the same irrespective whether options or possible solutions are of a technical, social, cultural or (as they often are) of a mixed character (Alexander, 1982).

Relevance, nature and range of design

As Lichfield et al. (1975) and Marchand and De Groot (1986) assert, any evaluation and choice cannot be better than the quality of the alternatives to be evaluated. It is therefore unfortunate that designing research is very much a neglected research type. Concerning government planning practice, Steiner (1975, p. 351) writes that "a most serious and probably warranted criticism of government agency decision procedures is that they tend to devote little or no effort to generating the alternatives among which they choose", which causes, according to Steiner, "large losses in efficiency". Concerning general planning theory, Alexander (1982) observes that the literature usually "dismisses the design of alternatives in a sentence or two prior to focusing on their evaluation".

Environmental management and planning literature forms no exception to this general rule. Wathern (1988) simply says that "intuitive methods" should be used for the development of plans. Baldwin (1985) enumerates options for solutions in fields such as water pollution, energy resource management and waste management, but the question of how these options should be selected and combined into plans is reduced to imperatives like "one must convert goals and policies into action proposals" and "the planning staff, in conjunction with public administrators, experts and citizens, should analyse the implementation tools and strategies" (p. 82) and "strategies should be developed" (p. 124). Ortolano (1984), in spite of the title of this book 'Environmental Planning and Decision-making' is even more exclusively devoted to (physical-science) models and evaluation. How the policies to be evaluated actually come into being is left in the dark[92].

Also in the Netherlands, the literature (e.g. Heuer, 1980) complies with Alexander's observation of the neglect of design, even if titled, for instance, 'The Design of Public Policy' (Hoogerwerf, 1984) or 'Planning Methods and Techniques' (Pols and Voogd, 1989).[93] Taking a look at environmental science more specifically, it shows that the attempt of Udo de Haes and Saris (1984) to draw attention to 'integrated policy studies' (in which design is the core activity), remained an isolated phenomenon in a sea of analysis and evaluation. Dutch government-sponsored research programmes are still largely restricted to physical-science modelling, even when called "integrated environmental research" (Zoeteman and Langeweg, 1988)[94].

This section can of course only shed a very modest light in the gap created by the neglect of design in the general literature and in environmental science research. Yet, by showing some general design principles I hope to make design theory more accessible for further study and application. Doing so, I will rely on the fact that, as is the case with the epistemology of any other type of research, design theory builds upon common-sense, natural faculties. To mention one example, the daily life activity of making a holiday plan is also the selection and combination of options (places to go, things to do, modes of transport etc.), led by facts (maps, wheather expectations, prices etc.) and values (fun, peace, spiritual enrichment etc.), to form the higher system level of the holiday plan.

Design thus being nothing special or esoteric, why then do methodologists so obviously keep their hands off it? This, I think, is largely because, unlike analysis and evaluation, it cannot be fit into the deductivistic mainstream idea of what is scientific.

A system that is taken apart into two or more separate elements looses one or more of its 'system properties'. A clock, for instance, does not tick or show the time anymore after being disassambled. Reversedly, if you put two or more things together, you create a new Gestalt with new, 'emergent' system properties. And since it is very rare that a single option can be declared a proposed solution, design typically involves

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[92] An exception is a sieve analysis method presented to solve location problems.

[93] More than 90% of the space in these texts goes to information systems, analysis of policy goals, analysis of spatial flows, mathematical evaluation techniques etc., in other words, analysis and evaluation, not design.

[94] See De Groot (1989b) for a comment on Zoeteman and Langeweg's view.

the combination of options into something new, and therewith the creation of properties that were not there before. As we will see shortly, these properties are usually the most important characteristics of a design. Designing research, in other words, is essentially and very visibly an *inductive* research process, from which a creative, 'pattern-finding' element cannot be removed.

Induction (in designing research but in empirical research too) implies that the research result can never be *proven* to be the best result possible. Any inductive research, regardless of its sophisticatedness or budget, runs the risk that some outsider may look at the research result and see a solution that is better, also when the outsider applies the same facts and values as those upon which the design has been built.

Everybody who has been involved in empirical research knows that most of this research proceeds the inductive, 'bottom-up' way: researchers *try out* which data transformations, correlations etc. 'work'. To publish these results, however, one has to fit into the deductivistic mainstream and report a 'reconstructed logic' out of which the pattern-finding trials have been removed: the 'testing' rhetoric. If reporting an inductive research strategy cannot be avoided, the induction has been made acceptable by covering the creative element under a blanket of high-tech and high-mathematics methods, for instance, computerized cluster analysis. Popper may have said that science proceeds by "conjectures", this is not the way Kuhn's "normal science" plods on.

It is no wonder, then, that methodologists shy away from something so visibly inductive as design. It is striking that when they do treat design methods, they usually either (1) suggest that some deductivistic, 'top-down' approach is possible (e.g., dividing policy objectives into ever more specific sub-objectives and sub-sub-objectives[95], or (2) mention only the high-tech and high-mathematics approaches of computerized permutations and optimalisation (e.g. Pols and Voogd, 1989).

All this has severe practical consequences. Concerning empirical research, it gives rise to perpetual difficulties in interpreting reported statistical levels of significance, for instance[96]. Concerning design methods, students and researchers are either led astray or are offered methods at a level of sophistication that can never be reached in practice. I know of only one environmental design process supported by mathematical design techniques (De Groot, 1985), and that happened to be a case unusually accessible to quantification. Forester (1989), Landy et al. (1990) and Schoof (1988), who studied urban planning, EPA policy making and Dutch environmental planning, respectivily, mention not a single sophisticated case. As a result, researchers fall back to unsystematic common sense approaches, never to be accounted for in their policy documents and resulting in Steiner's "large losses in efficiency". For this reason, my treatment of designing research will lie at a level between unsystematic common sense

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[95] For instance, Hoogerwerf (1984).

[96] If you try out 100 correlations, you can't help finding at least one with a *5%* level of significance, even if your data are completely random. Now, if you report this correlation as a succesful deductive test of a hypothesis, who will endorse your finding? Most referees will.

and irrelevant sophistication; it will be, I hope, enhanced, reflected, improved common sense and common practice.

The term design is often associated with a fairly restricted field, both substantivily and epistemologically, namely, the development technological things by researchers working in more or less splendid isolation, on the basis of a more or less clear-cut terms of reference. As has already been briefly indicated, design is a far more general phenomenon. Substantively, complex laws and regulations, spatial zoning plans, military strategies, research programmes and financial policies are all designed (or: 'formulated', 'drafted', 'developed' etc.) one way or another. They all share the basic characteristic of being systems with system characteristics that have emerged by the selection and combination of lower-level options, and the same design methods and problems essentially apply to them all. In order to more fully come to grip with the range of application of design approaches, the 'design field' may also be described in terms of a number of more epistemological dimensions.

A first dimension is a scale that runs between the extremes of the design of a brand-new policy or project (say, a new incentives system or a big land reclamation project), and the day-to-day adjustments of 'incremental' planning. Most environmental design situations lie somewhere in-between.

A second dimension is the well-known scale that runs between the extremes of "rational planning" and "the politics of muddling through" (e.g., March, 1982). This scale is in itself a mix of three oppositions, namely, of ideal versus real, of transparency versus insecurity and of planning rationality versus self-interest. At the "rational" extreme, the oppositions are mixed so that there arises the ideal model of transparent planning (i.e., researchers knowing all facts and values) and decision-makers diligently sticking to their democratic responsibilities. At the "muddling-through" extreme arises the claim that in the real world, planning is done by researchers groping in the dark and decision-makers scheming in the arena of "uninhibited pursuit of selfish objectives" (Landy et al., 1990). Most design situations, of course, lie somewhere in-between; Section 3.4 has already gone into the dangers and remedies of naive rationalism, *i. e.,* a too idealistic assessment of the context and role of a designing research assignment.

A third dimension is the "depth", as De Groot (1992b, Chapter 6) calls it, of the participation of target groups in the design process. Here, it suffices to note that the scale runs from the autocratic (researchers-do-all) position to the support of self-help, and that 'target groups' may denote the general public, decision-makers or anything in between.

Lastly, there exists a scale of designing research types that runs between the applied designs on the one hand, and the more pure, theoretical exercises on the other. Although the directly applied studies are of course far more numerous, also the more general, more fundamental, more 'testing', more explorative and more Utopian designs are a rich and relevant field, for which the universities, in my opinion, have a special responsibility. In Annex 1.II, Norman's effort to find the Essential Bicycle is an example of general, fundamental design work. Designs of a post-materialistic society

(Steenbergen, 1983b), of low-energy economies and even blueprints for survival (Goldsmith, 1972) play an important role to focus public debates. Countless 'ecological' houses, on paper and in reality, test and demonstrate advanced design ideas. Recently in the Netherlands, the exhibition 'The Netherlands As Design' showed long-term images of the country, based on four alternative world views. De Groot (1988c) explored the physical planning consequences of the partnership-with-nature world view for the Dutch lowlands.

Needless to say, the position of a particular design study in this wide variety of design situations has consequences for the choice of design methods and accompanying communication strategies. We may turn to Forester (1989) for an illustration. He distinguishes between five design situations, on a scale that largely coincides with the scale between the "rational" and "muddling-through" extremes. Forester's most muddled situation is called "Rationality Bounded by Structural Distortions" of communication and power relations. This situation calls for

> "strategies that anticipate and counteract structural inequalities (...). Some strategies focus on the regulation of capital (....). Others seek to empower the disenfranchised (....). Still other strategies seek political restructuring ( ). (p. 62).

Since most people in power will not be eagerly awaiting policital restructuring, this situation will probably have many special featuers with respect to research tactics and ethics. Yet, designing research it still is.

Design techniques

In the following, I will first concentrate on the common core of design epistemology by way of an informal example; then a number of design methods will be enumerated, and finally I will focus on the 'value input' of the design process. In the example, the options are literary 'building blocks' for solutions.

Imagine a fairly large and high lecture room and a group of students that has been given the following task: "Make a design to put this thumb tack into this high ceiling". How will the students approach this task? Everybody will start looking around for options, and chairs and tables will be immediately identified as such, based on a basic design idea to build a pyramid on which somebody may climb up to put the thumb tack in the ceiling.

During the period that the details are sorted out, some studens might develop hesitations about the quality of the basic design idea. Isn't the pyramid a too cumbersome, un-elegant solution? Have all the potential options really been identified?

"A balloon!" ventures someone who has come into the right mood, but this option is voted down immediately. An other student proposes: "We should be able to do something with a stick or something .... Look! Let's take that long pointer over there. We loosely attack the thumb tack at the end, pointing upward, with a bit of adhesive tape .... Like this .... See, if you now hold the pointer at the other end, you can bridge two more meters in a second, and without danger that you fall down!" This

Option is adopted without further discussion and it turns out that a construction of four tables, on which four chairs are put to support one other table, on which one chair is put in order to carry a tall student with the pointer, can bridge the 6½ meters to the ceiling.

In this informal design process, knowledge of numerous *facts* has been applied, although this knowledge has been so common sense that it went without saying. Everybody knew, for instance, that the tables and chairs were strong enough to carry each other and were sufficiently equal in height to keep the different layers of the pyramid stable. If it would have been doubted, for instance, whether the rather pointed legs of the table would not break through the chair seats, a little empirical 'research' experiment would have been carried out.

Two basic *values* have guided the design process. They have been revealed already by the student who advertised the pointer option: the construction time and the construction stability. Note that both apply to the system level of the construction as a whole. They are 'emergent', system level characteristics.

In their design the students have implicity expressed their weighing of the construction time and stability values. This may be demonstrated by slightly complicating the design assignment, turning it into the task to design a construction for two different hypothetical client groups, a group of aged people and a group of flashy youngsters.

After some discussion, the students will decide that aged people will put less emphasis on the construction time, but will stress the stability value. Thus, the students may design a very broad-based pyramid consisting of a first level of 16 (4 x 4) tables, on which 9 (3 x 3) tables, on which 4 (2 x 2) tables, on which one table, all levels supplied with a chair next to it in order to facilitate safe climbing. The most daring of the aged people will then go up with the stick, and reach almost 7 meters. For the youngsters, the students will go to the other extreme and design a construction that needs only one table and one chair. Standing on a table, four youngsters may lift up a chair on which stands the tallest group member holding the stick, reaching more than 7 meters in no-time and lots of pleasant risk.

Besides illustrating our definition of design (the combination ... etc.) and the system characteristic concept, the example shows the value-drivenness of design: the same facts (tensile strengths, law of gravity etc.) and the same options (tables, chairs etc.) yield different designs when different values or value trade-offs are 'put in'.

The student who invented the pointer option was one with a design talent. He or she did spontaneously what most people will be able to do by means of a more explicit design method, called 'abstract oppositions' underneath.

Although I try to avoid textbook-like lists in this study, a brief enumeration of some easy design methods may be in order here, because of the gap in existing textbook literature. In order not to complicate matters I will assume that the problem analysis and explanation (facts, values, options) are sufficiently complete, as well as the design's terms of reference. These conditions are often not satisfied, giving rise to all kinds of cyclical and participatory research set-ups. These, however, do not interfere with the design methods as such, and will therefore receive separate treatment later. The design methods have been grouped in four clusters, that are roughly put in order of increasing level of sophistication. Combining them is often quite feasable, since they all have their particular strengths and restrictions.

The natural approaches: Pattern Finding

Natural approaches are typically 'enhanced common sense', facilitating to do more systematically what everybody does intuitivily when facing a design problem. As a basic characteristic, they all are ways to break down the 'big jump' from the options to the system level of the design into more manageable steps, i.e., intermediate patterns of options.

(1) *Find system levels,* either in whatever is to be designed or in the problem situation. Each system level will consist of the lower-level components plus its own-level 'system' characteristics. The patterns thus identified may sufficiently clear to allow common sense to do the design job, or it may be found that the design may be built up by working on the separate levels, each with its own, most suited design method.

One well-known example is the ecological system levels distinction between populations, ecotopes and landscapes. Another is geographic, between local units and larger regions (e.g., De Groot and Van Tilburg, 1985). An example of system levels in 'whatever is to be designed' concerns the provincial drinking water strategy described by De Groot (1985). The system levels were:

- the 'technical units' of artifical recharge ponds and wells, deep-well fields, reservoirs etc.
- the 'projects' of administrative and technical wholes, consisting of technical units plus the system characteristics of the overall infrastructure, water quality, pricing policies etc.
- the 'strategies' of provincial policy making, adding the system characteristics of water exchange infrastructure and arrangements, efficiency and equity.

At the technical units level, designs were made by a largely common sense trial-and-error approach supported by array of small empirical models and rules-of-thumb, informally optimizing the trade-offs of costs, water quality and impacts on natural values, in a way comparable with sieve analysis (see below). On the projects level, the design was supported by a computer programme able to deal with ordinal rankings of technical units with respect to the values of supply security, nature impacts, landscape impacts etc. On the strategies level, quantitative simulation (see below) was the core approach enabling a large number of different alternatives to be assessed against the relevant values. Since the possible number of combinations of units, projects and connecting infrastructure was almost without limit, elements of creativity remained present even at the strategies level[97]. A variant of the system levels separation is given by Schoof (1988). He separates the environmental problem from the "secundary" problem of administration, financing and personnel. Thus, the design of a solution for the environmental problem precedes and guides the treatment of the agency's own troubles, also when, as Schoof advises, the two-step procedure is gone through cyclically. Obviously, this approach is only feasible for researchers not too susceptible to naive rationalism.[98]

(2) *'Work up ' options,* forming patterns of options with respect to the relevant values. The simple version of this approach is to simply rule out single options, because they are undoubtedly inferior as a component in any reasonable alternative. The balloon option in the thumb tack case has been a case in point. This simplest of routes is a dangerous one too, however, since many options develop their strength only in combination with others. In final resort, single-option characteristics are irrelevant; only the system level characteristics of the design count, e.g., its total cost-effectiviness or system stability. A 'softer', but more fertile approach is to group options with respect to leading values, e.g., their cost or environmental friendliness. These patterns will help to build up extreme ('mono-value') alternatives and compromise alternatives as well. For instance, it may be found that medium-cost alternatives can afford to take up only one of the high-cost options.

(3) *'Work down' values,* forming the same type of patterns, in the top-down way, as compared to the bottom-up thinking in the preceding approach. The top-down method is often quicker, but leaves less room for creative solutions, because options get less chance to speak for themselves.

Top-down approaches are often the only ones mentioned in literature written by physical-science or social-science authors. Kuypers (1980), for instance, calls it "the analysis of the design assignment" that especially includes the values (goals, norms, boundary conditions etc.), that may be decomposed into "goal trees", to the branches of which options may be connected. Spatial 'sieve analysis' (e.g., Ortolano, 1984), is an other example, from physical planning. The basic idea is to draw on a map the area where activity A is acceptable in terms of value X, then in terms of value Y, then of Z, 'sieving out' more and more possible locati-

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[97] Alternative strategies were largely built by means of guiding principles e.g., 'low cost', 'landscape-protective', 'compromise A', etcetera. These strategies were composed of the same designs at the lowest, technical units level. This was, of course, not really consistent. A real low-cost strategy, for instance, should be composed of low-cost variants of technical units. Each technical unit had only one design, however. Fortunately for the designers, no-one noticed, or cared enough.

[98] It is interesting to quote Schoofs argumentation for the two-step approach. "From the point of view of policy makers and administration science, the secundary problems are always put at the centre (. . . .). Environmental problems cannot be solved, however, from conceptualisations or theories of administration science and policy making". This is clearly a mission statement characteristic for much of (Dutch) environmental science. In a way, environmental scientists consciously want to be naively rationalistic.

ons (= options, in this case), so that finally the optimum location is found." The general line of sieve reasoning may of course also be applied to wider problems than location-searching; the 'maps' one makes then are only more abstract.

(4) *Compatibility analysis* (e.g., Friend and Hickling, 1988) is the general term for finding patterns of options not by thinking 'up' to values or 'down' from values, but 'horizontally', linking options that seem to work well together, or even need each other to work at all. The spontanaous arrangements of chairs, tables and people arising in the thumb tack example is proof that also compatibility analysis has a natural, common sense basis. More complex design cases require more careful, conscious patterning activities. In all cases, compatibility analysis is a way to build patterns of options somewhere in-between of the separate options and the full design.

(5) *Draft designs* differ from the results of compatibility analysis in that they do make the step towards the full design system level. This step is facilitated by not taking it really earnest. Draft designs are just trials, made to explore the boundaries of the 'design space' and the basic merits of solutions one has in mind, or to elicit value discussions with client groups, or to check if the available options seem able to essentially do the job, and so on. The basic idea here is the same as with the brainstorm method described unterneath: a lowered level of self-criticism and group-criticism ("just trials") has facilitating power.[100]

Rules-finding approaches

Rules here concern guidelines, principles, 'laws' and suchlike that may direct options-patterning activities (with which they must always combined to yield the design result). Often, explicit rules-finding is unnecessary. In the thumb tack example, no-one bothered about finding rules, because everybody already knew sufficiently how much load a chair may carry, or how to combine chairs and tables in a safe way. A reflective, rule-finding activity could have ensued, however, if someone had exclaimed: "This is no way to support a table at that height!", or if the aged people would have refused to climb the broad-based pyramid the students thought safe enough.

Rules do not need to be strictly true, as long as they have a heuristic capacity and prevent designs going the wrong way.[101] The well-known rule that Everything Must

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[99] Ortolano is of a special interest because he connects the concept of carrying capacity to the sieve analysis. Thus, the scope of the planning process may be broadened to encompass not only a fixed activity A, but also the acceptable intensity (size, degree, density etc.) of A.

[100] At the extreme, draft designs become 'rapid prototypes' (Barendse et al., 1989), designed expressly for no other reason than to give momentum to the design process in its earliest stages. The Centre for Environmental Studies uses this method to overcome the design fear of non-technological students in project teams.

[101] In fields rich in money and poor in knowledge, e.g., corporate management, you may make a living selling rules with heuristic capacity, irrespective of truth content.

Go Somewhere is untrue, fortunately, in cases of pollutant decay and transformation. Nobody will ever forget *that,* however, and the rule serves to prevent designers to propose solutions that only shift pollution from one environmental compartment to another. My personal favorite in the field of design rules is that every physical option needs a social structure to carry it. This rule prevents designers to propose technical solutions in a social vacuum; as exemplified in de Groot (1992b, Annex 6.I), social plan elements are often much more difficult, but also much more the key, than the physical options.

(6) *Deductive rules-finding* is the search for appropriate theories and the attempt to apply them 'downward', to the level of the design situation, supplementing the rules that the designers have already accumulated during their education and job experience. Applying biogeographic 'island theory' (Shafer, 1990) to the design of natural areas is a well-known example, as is the rule that financial policy instruments are usually more efficient, but less effective, than direct regulation.

(7) *Inductive rules-finding* is the analysis of concrete example cases in order to to formulate a more general rule, applicable to the design problem at hand. The analysis of successful and failed designs in the same problem field may be a fertile route, especially because the examples then lie on the system level of complete designs. It should be kept in mind, however, that all concrete design problems and contexts are different. The analysis should therefore include these contexts, and the analysis should be undertaken as an inductive theory building exercise, based on a set of as many examples as possible, - not as a desparate search for *the* example to replicate. Examples analysis is often undertaken not as a part of a specific design study but as a theory building study in its own right, generally focusing on a single problem field, e.g., soil and water conservation or domestic waste recycling.

Enhancing creativity

In some design processes, the step from the options level to the design system level does not come by itself, even after intensive patterning activities and attempts to find facilitating rules. In others, doubts remain whether all the potentials hidden in the design situation have been grasped. Then, methods to enhance creativity may be called to help. Curious as it may seem at first sight, these methods are common practice in design studies in the 'hard' technological field, but virtually undiscovered in the 'soft' world of policy and social strategy design.

(8) *'Abstract opposites'* is a line of a reasoning characterized by moving up to a reflective level, find a new, 'opposed' route there, and move down again to the level of the concrete design. The finding of the pointer option in our design example, for instance, may be broken down into the following thought steps:

- **What is the general, 'abstract' characteristic of the options defined up till now (tables, chairs, balloon)? They all seem to work with the principle of moving** up a person who holds the thumb tack....
- The opposite of this would be to leave the person down but move the thumb tack up.
- Back at the options level, what might then new principle lead to? Shooting the thumb tack into the ceiling, someway, or bringing it up with some kind of stick....

The same thought movement may of course also be applied to patterns of options or to the design system level itself. The core step is always to grasp a relevant common characteristic implicit in the options, patterns or designs formulated to that moment.

(9) *Brainstorm and allied group methods* seek to strengthen the researchers' creative capacities by means of group interaction. The brainstorm is the best-known of these creativity techniques. Brainstorms differ from normal group sessions in that participants focus on generating a large quantity, not a high quality, of design proposals. Group criticism should be suspended; group reactions towards proposals should be supportive and associative. Other techniques (e.g., Jones, 1970; Eekels and Roozenburg, 1978) work by means of metaphor associations, questionaires and more 'forcing' approaches. Their names, 'Removing Mental Blocks', 'Functional Innovation', 'Synetics' and the like, give an idea of their general character.

Quantifying approaches

The most common and natural design methods (Pattern Finding) may roughly be denoted as semi-quantitative. Creativity enhancement methods lie on a more advanced level, there focusing on a qualitative extreme. Quantifying methods lie also on the advanced level, but at the opposite end.

(10) *Simulation* (in problem-in-context terms: modelling the environmental problem) fills the majority of pages of quantifying literature on planning and design (e.g., Loucks et al., 1981). Simulation is in fact no design method in the strict sense of the term, because it does not select and combine options, or identify strategies to do so. Roughly speaking, the idea of simulation is to supply a designing research team with impact assessments at push-the-button speed; hence the term 'computer-aided design' (CAD). These assessments may be used in combination with any other design method, for instance, informal pattern-finding sessions together with client groups.[102] As such, it is of course always an advantage to dispose of impact assessment at computer

[102] Interestingly, the more advanced computer models and representations of impacts become, the more flexible and accessible they may be made for policy makers, land users and public interest groups. High tech then becomes a democratic asset, allowing for more intense participation.

speed, even when the models only very partially encompass the relevant options, effects and values, as they usually do. Problems arise when designers and policy makers make the very human mistake to confuse model sophistication with model comprehensiviness and restrict the design activity to the quantified elements only.

(11) *Combinatory design* is the next step of quantification. In this approach, the speed of computerized (simulated) impact predictions is used to run a computerized procedure of blind combination of all compatible options (e.g., Voogd, 1979).

(12) *Quantified design* arises when the computer also indicates which combination of options is optimal, with respect to a given, quantified value set. Linear programming (e.g., Loucks et al., 1981) is the best-known technique in this field. It requires options to be defined as degrees of intensity (size, surface etc.) of activities, and impact relations to be defined as linear functions. Then, the algorithm determines the set of intensities that best satisfies the 'objective function' (a quantified value statement, e.g., "maximize net financial benefit").

Generally speaking, the degree to which quantified procedures are able to represent the whole problem situation and all design potentials decreases when moving up from simulation, via combinatory design to quantified design. Combinatory design, for instance, is more restricted than simulation because it closes off the researchers' capacity to find new options. Moreover, it leads researchers into narrowing their effort to supplying the computer models with the detailed data they require, and ignore the non-linear, non-financial, non-physical-science, non-technical and poorly known elements of problem situations and designs. Though not theoretically necessary, the quantified irrigation design approach of Loucks et al., (1981), for instance, typically leads to the top-down water management systems so narrow in cognitive scope and rationality (Drijver and Marchand, 1985) and so naive concerning the social structures they have to build upon that they are now a declared failure for the whole of Africa.

Rounding off this section, attention will be paid to the terms of reference of designing research and to plan evaluation.

'*Terms of reference*' is the umbrella term for a more or less formalized input from outside, especially the client agency of applied design studies. Terms of reference may specify the study's budget, prescribe evaluation methods and many other issues, but the most important terms-of-reference statements are those which aim to substantively steer the outcome of the designing research. Roughly speaking, these steering statements come in three types, one of which often proves problematic.

(1) The most straightforward terms of reference statements lay down quantified values *(norms)* concerning the design to be made. In our thumb tack example, a norm could be, for instance, that the "construction time should be less than 5 minutes". A famous terms of reference, triggering off 13 years of designing research, concerned the 1949 Citroen 2CV car; as tradition has it, it read: "Design a low-cost vehicle that can transport two farmers, fifty kilos of potatoes and a bag of eggs over a bumpy rural road with a velocity of 30 mph., a fuel consumption of 1:33 and without breaking the eggs; how the vehicle will look is absolutely unimportant". More common examples lay down, for instance, the maximum budget for the solution or its minimum cost-effectiviness (or benefit-cost ratio, or internal rate of return). Environmental norms say, for instance, 'no deterioration of water quality', or lay down a minimum recreation capacity. Note that these statements always refer to the system level of the design as a whole, not the separate options.

(2) A second type of terms of reference statements are more qualitative and often refer to interwoven sets of values and views rather than single ones; *strategies* may be their umbrella name. Often, these value sets are laid down by means of specifying a societal category the design should be especially suited for. In the thumb tack example, the "aged-people design" belongs to this type. In other cases, strategic key words like "ecodevelopment alternative" or "environmentally friendly alternative" perform this function. The "partnership with nature" view in De Groot (1992b, Chapter 8) also belongs to this class.

(3) A third type of terms of reference statements *specifies the options that* should be applied in the design, e.g.:

- "a transport alternative using public transport"
- "a drinking water alternative, primarily using groundwater"
- "a no end-of-pipe technology plan".

This type of terms of reference statements focuses on the means instead of the ends, and is therefore basically inferior to the other two. In the end, no-one cares about groundwater or surface water, public or semi-private transport or end-of-pipes, but about water quality, mobility of aged rural people and so on, that is, about values, not physical plan elements.

Gemeente Rotterdam et al. (1984), is an example of the effect of a design, guided by an options-specifying terms of reference. It concerned the design (location and shape) of a large-scale depot for toxic harbor sediments. This depot was to be designed by a combination of the technical features, such as high dikes/low dikes, island/peninsula and North/middle/South. Consequently, a large number of alternatives were formulated and evaluated in a massive computerized procedure. A simple sieve analysis working with the same three core values as did the official study (total cost, pollution risk and nature impacts) revealed that the best locations had been left out (Gemeente Westvoorne, 1984).

Another example comes from a group of students working on an agricultural re-allotment scheme in a region with the very narrow, long-stretching grassland parcels typical for the Dutch polder landscape. They found that paved tractor paths were the best option to overcome the economic disadvantage of these parcel shapes, without doing significant damage to the nature values usually found at the far ends of the parcels. Later, the group was told by the government agency designing the official reallotment plans that all designs incorporating paved paths were inadequate, "Because paved paths are not an officially recognized option".

In both cases, the prescription or exclusion of options functioned to hide a powerful interest. In the case of the harbor sludge depot, it was the interest of the harbor and industry barons to have all possible depots be built in the sea, increasing their costs (to the national community) but also increasing the area of land potentially to be reclaimed for industry purposes at low cost to the industries. In the polderland case, the economic interest of big-farms-and-square-fields was lying behind the 'officially recognized options'. One of the most effective uses of power is to generate a large array of designs (the larger the better, in order to show one's democratic effort and exhaust the public discussion), but in fact generated only by permutation of prescribed options; this prevents having to reveal one's true objectives. For environmental scientists, understanding design processes is not only important for making better designs, but also for the discipline's critical public function.

Fully specifying the terms of reference at the outset of a designing research is usually quite difficult. It may turn out, for instance, that a design may affect social groups or values not recognized beforehand. Or a norm taken up in a terms of reference may be sufficiently specific to guide the design process in its early stages, but be too vague for later choices. In applied design studies, the terms of reference are therefore usually specified in the course of the study, in close contact with the client group. Exploratory designs are often good tools to organize the interaction process and keep the researchers away from too naive rationalism, because the concreteness of the draft designs usually facilitate client groups to clarify their value priorities (Heuer, 1980).

Taking a case from my own experience, a student group designing a domestic waste recycling strategy for the Leiden municipality (De Groot and Mulder, 1983) may serve as an example. A major terms of reference norm was that anything to be designed should be 'budgetary neutral'. Many questions concerning this norm cropped up during the design process. Some of them concerned the time scale, e.g., whether or not budgetary neutrality should also apply to the experimental and running-in project stages. Others concerned the spatial scale and system levels, e.g., the incineration plant that the municipality shared with other towns, or the question whether or not benefits accruing to other municipal agencies should be included. These questions were formulated and negotiated in formal and informal contacts between the students and the municipality.

Ex ante evaluation has already been said in Section 3.5 to be essentially equal to repeated problem analysis. A designed project or policy is used as input to go through the analytical problem-in-context schedule, and effects are assessed against their respective norms, most often in terms of the final variables. Evaluation thus lies much closer than design to normal physical and social science procedures. Compared to design, it is also less intensely and less necessarily interdisciplinary. As has been discussed in Chapter 2, design is impossible to carry out on the basis of one component discipline. In an evaluation, disciplines may often focus each on separate final variables in a more multidisciplinary arrangement, leaving the final integration to the decision-makers. Because of this, evaluation is richly endowed with methods, reviews, inventories of models and so on, often written in a framework of environmental impact assessment. One remark seems to be warranted here, however. It concerns the observation of Rago *et al.* (1983), that "environmental impact assessments are often characterized by extraneous data collection, irrelevant statistical procedures, misapplied models and concomitant ambiguity in conclusions"; my own experience is no different (Gemeente West-Voorne, 1984). As discussed in De Groot and Udo de Haes (1987), this might be attributed to the fact that impact assessment is lead too much by an unspecified quest for certainty. This induces the collection of detailed data required by sophisticated models, instead of concentrating the scientific effort on relevance for decision-making. Relevance can be achieved by first concentrating on an identification of what will be the normatively relevant output variables ('final variables') of the impact assessment, and then make a preliminary estimation of impacts in these terms. A cost-effective choice of data to be gathered and models to be used can only be based on such a 'normative pre-assessment'. Unfortunately, semi-official prescriptions of the research steps of environmental impact assessment (e.g., Baldwin, 1985 and VROM, 1984) only weakly guide researchers to relevance; the final variables[103] are typically given attention in the middle of the research sequence, not at the beginning, and hence do not steer the research process as a whole.

[103] "Environmental goals" and "the information requirement of policy making", in Baldwin and VROM, respectively.

Chapter 4

VALUES, FUNCTIONS, SUSTAINABILITY

This chapter focuses on the operationalisation of the 'final variables', i.e. the normative core concepts of problem-oriented environmental science.

In the first seven sections, the attention goes to the content of the final variables, the logic of their structure and the consistency of working 'up' and 'down' between them and parameters of environmental quality. The sections 4.1 to 4.4 lay the technical basis. Section 4.5 focuses on contextual assessment procedures, relevant for environmental science as a whole and as a preparation for Section 4.6, that deals with the operationalisation of the intrinsic value of nature. The functions of the environment, conceptually positioned between environmental parameters and the final variables, are an important structuring tool for problem analysis; Section 4.7 enumerates them.

The last two sections and the Annex focus not on the 'time-free' final variables but on the final variable that adds the time aspect to all the others: sustainability. The emphasis here is on the urgent problem of how the concept of sustainability may survive in a crucial area that seems intrinsically hostile to it: economic decision-making. Section 4.8 indicates that the concept of sustainable national income can be operationalized in a theoretically grounded and practicable way. In Section 4.9, I aim to show that with regard to decision-making about projects and policies, sustainability and the intrinsic values of nature, being issues of equity rather than efficiency, can be and should be decided upon outside the realm of cost-benefit analysis. The Annex, finally, elucidates how one simple parameter, the square metre, can bring the foundational parameters of sustainability into normative modelling, calculating, for instance, what regions contribute to world (un)sustainability.

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Q. And how do the [environmental] problems get concentrated attention?

A. By laying a firm foundation for coherent substantive research - assuming, of course, that the [environmental] problem is well-structured.

Q. I suppose all this is a pretty highly organized activity.

A. Oh, it has a highly developed hierarchical structure, if that's what you mean. You may, however, be referring to the functional patterns.

Q. I guess I was.

A. They 're highly developed too.

Q. Where does all this go on?

A. In various settings - laboratory experimental settings, field settings, participant-observation settings, or Navajo reservations.[104]

4.1 Introduction

If you are playing a game of chess and your aim is to win, the appropriateness of a move you are considering is always, in last resort, assessed in terms of the contribution it makes to winning the game. In terms of Chapter 3, win-or-lose is your *final variable.* Environmental Impact Assessment, predicting and evaluating the consequences of a proposed activity in terms of the final variables of environmental policy, is the environmental analogue of the chess move appraisal.

Because the win-or-lose variable is the final variable, it also serves as a beginning. A value statement in terms of the final variable ('I want to win') serves as the point of departure for designing appropriate chess moves: 'Since I want to win this game, I should make this move now'. Analogously in environmental policy, value statements in terms of the final variables serve as the points of departure for policy design.

In the problem-in-context picture Figure 3J, these two lines of reasoning are depicted, respectively, as (1) reasoning upward towards the final variables on the

[104] Taken from Bereldsen, "The Cliché Expert Testifies on the Social Sciences", manuscript privately circulated circa 1950s, found in Dubin (1969).

'facts-side' and (2) reasoning downward from the final variables on the 'values-side' (the 'should-side').

Thus, the final variables stand in a pivotal position in problem-oriented environmental science. Conceptual structures in terms of final variables are the 'great structurizers' of environmental problem analysis and policy design. If these structures are muddled, that is, if the aims of environmental policy are not packed into some logically and substantively sound list, all analysis and design will be built on sand. If anywhere, the final variables and their conceptual environs are the place to demand conceptual clarity, logical soundness and groundedness in empirical science and ethics. At the same time, here these demands are much harder to meet than elsewhere, say, in the realm of physical-science modelling. It is easier to distinguish between soil, tree and ecosystem than it is to find your way in the realm of final variables, with its characteristic conceptual clusters of 'values of nature', 'economic functions', 'environmental quality', 'sustainability', 'efficiency' and so on. For this reason, the whole of this chapter is devoted to getting a clear and grounded map of the final variable region, leading the way to consistent, flexible and ethically grounded applications in environmental quality assessments, the derivation of environmental standards, drafting of terms of references for policy design, cost-benefit analysis, normative modelling and so on.

The final variables of environmental science have been introduced in Chapter 3; they are reiterated here for ease of reference. The final variables express intrinsic values of (1) humans, (2) the environment and (3) the people-environment relationship, with the concept of sustainability added to emphasize the long-term aspect. Then, separating the first value into three, the list of final variables is arrived at, represented in Box 4.1.

> **Box 4.1**
>
> **FINAL VARIABLES FOR ENVIRONMENTAL SCIENCE**
> are facts and norms in terms of
> - human health and safety
> - human material well-being ('economy')
> - human immaterial well-being ('culture', 'spiritual values')
> - intrinsic values of the environment
> - (intrinsic values in the people-environment relationship)
>
> for now and future generations ('sustainability')

Specifying this somewhat further, we may say that

- 'human health and safety' typically become expressed in epidemiological assessments, ADI standards, flood risks, and so on
- 'material human well-being' is roughly connected to the procurement of economic goods and services and may be operationalized in market prices, shadow prices, social rates of discount, and so on
- 'immaterial human well-being' is connected to more intangible goods provided by the environment, such as varied and meaningful landscape, meaningful employment, aesthetic values, spiritual growth in contact with nature, and so on
- the 'intrinsic value of the environment' may refer to intrinsic values carried by cultural artifacts; in environmental policy, it is usually more connected to the intrinsic values recognized in nature (roughly, its own right to exist), as it may become operationalized in criteria such as integrity and diversity
- the 'intrinsic value in people-environment relationships' is not often recognized in philosophy and formal policy statements; 'relationship qualities' may be expressed in terms of closeness and non-dominance in people-nature interactions.

It may be noted that in this conceptual schema, concrete things and processes may have a wide array of values attached to them. A well-designed building, for instance, may support human health and safety, facilitate the efficient production of goods, carry a cultural value and may sometimes (if it is a 12th century chapel, say) command our protective response even if it performs none of the above functions. Likewise, again going down the list, a mangrove forest may protect against floods, it may provide timber and shrimps, it may be the spiritual home of a tribal culture or of nature lovers, it may be a habitat for rare species and it may harbour relationships of people and nature working together in closeness and harmony. Both the building and the forest here count double and more but, the list of final variables being homologous, this 'double counting' is not conceptually muddled, as it is in some cases to be discussed later. Section 4.3 will provide a logical derivation of the final variable list, proving its exhaustiveness and homologousness.

4.2 Final Variables, Functions, Quality: The Basic Relations

The final variables, as said, express the values in the environment or served by the environment, treated as final, that is, *intrinsic,* for most practical purposes. Because of this status of the final variables, it may be intuited that other normative concepts expressing what the environment means to us ('functions of the environment', 'environmental quality') should somehow either be an alternative way to express the same intrinsic values, or be more extrinsic, more *instrumental* with respect to the final variables. Putting it in the visual terms of the problem-in-context picture 3J, the latter relationship is that 'functions' and 'quality' are lower, leading up to the final variables which stand at the top. This, indeed, seems to be the basic relationship. A "food production function" of the environment, for instance, is instrumental to the final variables of health and material human well-being. And the environmental quality variable 'soil fertility' expresses the fact that the environment has a property that leads to food production and, through that, to health and material well-being.

This simple notion is not shared everywhere. We will arrive at an alternative way of thinking by having a brief look at three concepts respectively: policy aims (final variables), sustainability and quality of the environment.

Dutch environmental policy, roughly stated, has always encompassed the full final variable set, represented in Box 4.1[105]. We see them clothed in their *statu nascendi* formulations[106] in a book published in 1971, entitled "Criteria for Environmental Management", in which the first-generation Dutch environmental scientists tried to arrive at a full set of policy objectives (Vink, 1971). In the policy document PIM (1983) quoted already in Chapter 3, "human health and well-being" are present alongside "respect for nature as a value in itself". Udo de Haes (1984), and again in the revised edition of this text (Udo de Haes, 1991), enumerates the "relevancies" of the environment as "health and safety", "use possibilities" and "intrinsic relevance". The policy documents NMP (1989) and NBP (1990), analogously, both speak of the "values of public health and well-being and the intrinsic values of plants, animals and ecosystems".

For the purpose of this chapter, it is important to note that finial variable formulations of this kind, although basically encompassing everything valuable, leave room for other normative concepts such as sustainability, functions, environmental

[105] Except the relationship value, but that is of no importance to the discussion here.

[106] E.g., on page 12, "(...) production in the economic sense; the social interest; the cultural interest (...)" and on the concluding page 175: "(...) food production; supply of sunlight, oxygen and carbon dioxide; lowering the levels of toxicants and noise; recreation; protection of nature in the biological sense [=species and ecosystems as values in their own right]".

quality and carrying capacity to be defined according to their common-sense meanings and then be connected to the *full* set of final variables, as I do with respect to sustainability in Box 4.1, with respect to carrying capacity (environmental capacity) in Chapter 3 and as I will do with respect to environmental quality and functions later.

Ten Brink et al. (1991), describing their 'AMOEBA approach' for assessing aquatic ecosystems, are a good example of connecting other normative concepts to the full set of final variables. They start out by listing "three categories of valuable characteristics the sustainability of which is desirable" amounting, roughly, to the final variables list of this section ("production for economic reasons", "species diversity for ethical and aesthetical considerations", and so on). All this, they then state again, should be sustainable. From there on, 150 "target variables" are derived (we would say: environmental quality variables), together with the "concrete objective" in these terms (we would say: environmental quality norms). For the North Sea these variables include, for instance, algal species, the seal, wild mussel beds, the herring and the Brant goose, irrespective of the final variable from which these are derived. The AMOEBA itself is then a visual presentation of the discrepancies between the facts and values (presence and norm) in terms of these variables. Finally, it is shown how policy statements in terms of "steering variables" are derived further downward, e.g. with respect to toxic emissions, fishing techniques and area protection (we would say, environmental capacities).

In the meantime, leading international documents took a different position. Connected perhaps to the well-known conceptualization and discussion of conservation versus preservation (e.g. Passmore, 1974), the intrinsic value of nature tended to become a discredited policy aim. An illustration is the "World Conservation Strategy" of the International Union for the Conservation of Nature and Natural Resources and the World Wildlife Fund (WCS, 1980), in which nature is present only in its instrumental resource aspect ("the sustainable utilization of species and ecosystems"; "living resources conservation"). This stance is highlighted in 'Our Common Future' (WCED, 1987). As analyzed by Achterberg (1991) the aims expressed in this document are completely anthropocentric, in spite of some scattered references to obligations to "other living beings". It is not for this chapter to discuss the strategic and moral aspects of proclaiming man as the only creature that "commands an accounting". Let me add only that the new policy document of IUCN, UNEP and WWF, 'Caring for the Earth' (IUCN et al., 1990) has allowed nature to step back in, cloaked in new language and vision, i.e. of community and care (ref. Section 4.5 and De Groot 1992b, Chapter 8).

Through the WCED report, the concept of sustainability became firmly associated with anthropocentric values only, especially those of the socio-economic kind ('material well-being', in Box 4.1). In The Netherlands, this line is followed in Opschoor and Van der Ploeg (1990). Conceptually, the association has the weird consequence that it becomes impossible to speak of a sustainable place on earth for non-human creatures.

Formally, the concept of environmental quality, in Opschoor and Van der Ploeg as well as elsewhere[107], remained defined as relating to all final variables. In practical usage, however, the consequence of associating sustainability with socio-economic values only is that the concept of environmental quality becomes associated with cultural values and the intrinsic value of nature only. Politically, the situation now reproduces the old 'conservation versus preservation' conceptualization; the socio-economic values associated with sustainability are of course the more basic and environmental quality is the more additional, ephemeral value. Thus, a pre-defined and general value hierarchy has been created. Pre-defined, abstract value hierarchies are risky possessions, as Section 4.5 will indicate. Conflicts between values are real enough, but it is better to respond to them at the more concrete level of real-world problem situations. Matters are made even worse when conflicts are created because of conceptual ambiguity; concepts should support discussions, not funnel them into pre-arranged antitheses.

Summarizing, we are now in a position to define the intuitive concepts in a more grounded fashion:

- the 'final variables' express all possible aims of environmental policy (or: everything the environment is valuable for or valuable in), without a pre-arranged value hierarchy
- among these, 'sustainability' expresses the long-term emphasis on all others
- and 'environmental quality' encompasses all parameters in the environment conducive to, or themselves expressing, the final variables[108].

The last concept needing some positioning here is the *functions* of the environment, often used as an 'organizing concept' in economic evaluations, impact studies and policy formulations, either as an alternative to final-variable concepts or in a supportive role. The basic definition of a function being "a task in the broad sense" (Bouma and Van der Ploeg, 1975) or "a capacity to satisfy needs" (Van der Maarel and Dauvellier, 1978), the functions concept obviously lies in an intermediate position between environmental quality and the final variables; the final variables express what the tasks are for, and what the needs are. Thus, a term like 'production function of the environment' takes in a large number of environmental quality parameters and delivers them, as it were, to a large number of socio-economic values (goods, services etc.). Similarly, a term like 'processing function' takes in another large number of environmental variables and 'delivers' them to the maintenance of human health, the socio-economic value of organic waste recycling and so on.

Thus, we arrive at the basic ordering of the three concepts, depicted in Figure 4A. It has been drawn so as to be isomorphic with the central part of the problem-in-context

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[107] E.g. Udo de Haes (1991), Bouwer and Groenenberg (1991), as well as the policy documents NMP (1989) and NBP (1990), dealing with general and nature-oriented environmental policy, respectively.

[108] Thus, environmental quality also comprises what Bouwer and Groenenberg (1991) call 'future-value' (not: future value); the gene pool is an example.

picture 3J, with the final variables at the top. Two variants are drawn, in order to indicate that the insertion of the functions concept is facultative[109]. Economists and physical planners, for instance, often use the functions concepts, but Environmental Impact Assessments usually go directly from the environmental quality to the final variables.

As explained in the Chapters 1 and 3, the final variables are typically a bridge between the environment and economy, philosophy, medicine and other disciplines. Hence, if making these connections is relevant to a research or education project, impact assessments and general discussions should reach up to that level. On the other hand, if environmental quality standards have been derived properly from these variables downward, assessments may be kept in these 'lower' terms. 'Final-variables thinking', 'functions thinking' and 'quality thinking' can all be self-contained, exhaustive and coherent. This is not to say, of course, that they can be freely *mixed.*[110]

It may be noted at this point that I have here made no distinction between 'nature'and 'culture' or between the 'natural environment' and the 'man-made environment'. Nature and culture interpenetrate too much to generate a sensible dichotomy at this general level. Naturalness ('wildness') and 'culturalness' are around us everywhere, but at the same time hardly any concrete environmental entity or system is simply natural or cultural; Section 4.6. will consider this in greater detail. A natural/cultural dichotomy in the area of final variables, functions and qualities of the environment will therefore be a conceptual burden rather than a help, especially since the two would have to be re-integrated anyway at some lower level of evaluation and design.

The terms of 'value', 'function', 'quality' all have a basically positive connotation. In not using more abstract and neutral terms like "normatively relevant aspects" or something similar, I simply follow the theoretical and policy-oriented literature, for reasons I will explain further on. Adhering to the positive connotations rigidly, as if the

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[109] As showed in Section 3.3, 'societal interests' (agriculture, nature protection, recreation, urban development etc.) is another concept often used as an intermediary for the classification of environmental impacts and norms. This could have been drawn as a third alternative.

[110] An EIA assessing impacts in terms of, say, 'health', 'agriculture', 'soil quality', 'flora' and 'processing functions' ends in the conceptual morass of double-counting many phenomena and ignoring many others. The same principle of non-mixability also holds with respect to organisational structures. Matters would be fairly clear, for instance, if there were Ministries of Final Variables (health, nature, economy etc.) and Ministries of Conditions (environment, education, internal affairs etc., each safeguarding its own set of conditions for all Final Variable Ministeries, each receiving its primary aims from them ('norms derivation'), each adding its own secondary objectives of integration and each translating t[illegible]ds to society). Compare this with administrative realities almost everywhere.

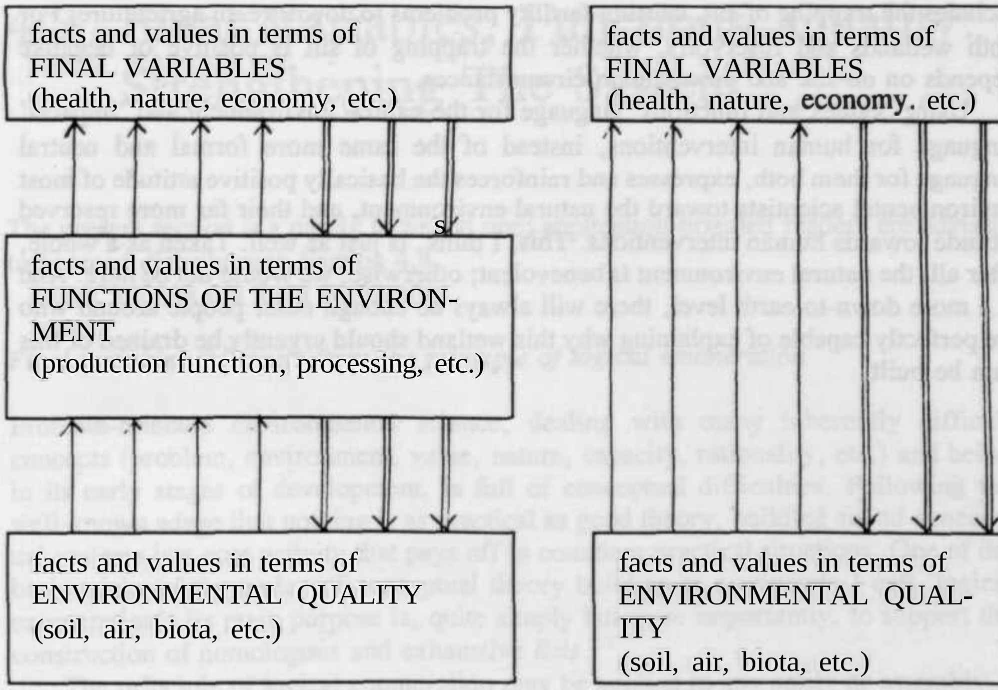

Figure 4A
Two variants of the conceptual arrangement of final variables, functions of the environment and quality of the environment. All three concepts refer to all values of the environment (intrinsic and instrumental); 'sustainability' refers to the long-term aspect of all. Both variants are drawn as a rephrasing of part of Figure 3J. All arrows denote causal relationships; the single arrows relate to the factual phenomena (effects, etc.), the double arrows relate to the normative phenomena (values, norms, standards, etc.). In one variant, the functions concept act as an intermediary between environmental quality and the final variables; in the second, impact assesment and norms derivation go directly between these two.

environment can only be positive, leads to inconsistencies, however. If we say, for instance, that the function or value of the ozone layer or a row of coastal dunes is to protect people against cosmic radiation or floods, respectively, we thereby imply that cosmic radiation and floods have negative aspects too. And if we say that a value or function of a river is to provide a means for transportation, we cannot deny that at certain times and places, the river is an obstacle as well. If we say, to take a final example, that a wetland has the value or function that the water flowing out of it is 'purified' or 'clarified' compared to the water flowing in (less detritus, less toxic substances, less silt), we cannot consistently put this on a rigidly positive list and then, when speaking about men-made reservoirs, make a list of negative 'impacts' that includes the trapping of silt, causing fertility problems to downstream agriculture. For both wetlands and **reservoirs,** whether the trapping of silt is positive or negative depends on on-site and downstream circumstances.

Using 'values and functions' language for the natural environment and 'impacts' language for human interventions, instead of the same more formal and neutral language for them both, expresses and reinforces the basically positive attitude of most environmental scientists toward the natural environment, and their far more reserved attitude towards human interventions. This, I think, is just as well. Taken as a whole, after all, the natural environment *is* benevolent; otherwise, we would not be here. And at a more down-to-earth level, there will always be enough other people around who are perfectly capable of explaining why this wetland should urgently be drained or this dam be built.

4.3 Final Variables, Functions, Quality: Strengthening The System

The present section is a purely technical one; application-oriented readers are advised to proceed directly with Section 4.4.

Final variables following from the principle of logical enumeration

Problem-oriented environmental science, dealing with many inherently difficult concepts (problem, environment, value, nature, capacity, rationality, etc.) and being in its early stages of development, is full of conceptual difficulties. Following the well-known adage that nothing is as practical as good theory, building sound conceptual systems is a core activity that pays off in countless practical situations. One of the basic tricks of the trade of conceptual theory building is a principle I call 'logical enumeration'. Its main purpose is, quite simply but quite importantly, to support the construction of homologous and exhaustive *lists*.[111]

The principle of logical enumeration may be applied to any entity or assembly X ("this watch", "this discipline", "these organizations", or "all that is valuable in the world"). Logical enumeration starts out by applying some enumerative concept E to the entity or assembly under consideration. The enumerative concept may be anything ("red" or "human") but a core criterion here is, of course, that is should be substantively relevant. Keeping up homologousness and exhaustiveness now seems to imply that X may be enumerated as:
- "the E-elements or aspects of X"
- "the non-E elements or aspects or of X".

This, however, is the reductionistic way of thinking. It is easy to see that one may now apply a subsequent enumerative concept, and another, and end up with a picture that the entity or assembly under consideration in fact consists of a huge number of minute particles *only*. The holistic extreme, on the other hand, is to refuse to subdivide anything, because everything is a whole. The proper rule is that applying an enumerative concept does not result in two, but in *three* new categories; subdividing without falling into the reductionistic trap is to conceptually set aside the system characteristics ('wholeness') of the entity under consideration, so that they are not lost, conceptually, in the separation process. Hence, the application of E to X yields:
- "the E-elements or aspects of X"
- "the non-E elements or aspects of X"
- "the E/non-E relationships in X".

[111] Another use is the deconstruction of unsound lists.

Usually, when conceptually subdividing a loose assembly or system (say, 'all vehicles' into 'vans' and 'non-vans'), the relationships component will not carry much weight. The reverse is usually true when conceptually subdividing a highly integrated entity (say, the human body); many systems and situations are somewhere in-between, as De Groot (1992b, Chapter 7) elaborates further.

The second element of logical enumeration is that new enumerative concepts may always be applied to the existing list in order to generate further differentiation. The new concept may be applied to any number of the elements in an existing classification. Applying a concept D, for instance, to the first element of the list above (and switching to a more abbreviated notation), we get:

- E of X:
  - *D of E of X*
  - *non-D of E of X*
  - *D/non-D relationships in E of X*
- *non-E of X*
- *E/non-E relationships in X.*

Jointly, the italicized 'final items' of the list now generated are still a fully homologous and exhaustive representation of X. This remains the case if another enumerative concept is applied to one or more of the already existing elements. As a rule, the formal application of enumerative concepts to an item on a list should be continued until the item is limited and concrete enough to serve as it is or to be enlarged further by simple common-sense, 'non-logical' enumeration.

Finally, there are some rules for finishing-off a logically enumerated conceptual structure. The first of them is that the structure may always be collapsed into a one-dimensional list comprising only the final items. One then loses the insight of the 'generating structure' but the classification becomes easier to handle. The second rule is that elements which are deemed too unimportant, empirically or normatively, may be removed from the list, making it more operational (but less adaptable to changing circumstances). Finally, the formal names of the items may be changed into shorter and more common ones, thus avoiding having to continue speaking about, say, the "D/non-D relationships in E of X division" or the "D of E of X discipline". The formal descriptions are conceptually superior because they are perfectly defined through the concepts of E and D only, but typically they should be used as formal definitions, organisational principles and so on, kept away from daily use.

The final variables are defined in terms of the intrinsic value of "people" and of "environment". In order to make sure that values cannot be double-counted or 'lost' in between the two concepts, "people" and "environment" should here be defined as their logical complements; "environment" should be defined as non-people or the reverse. Environment, following Udo de Haes (1991), Bouwer and Groenenberg (1991) and many others, may be defined as *all physical phenomena (outside the human body) that humans relate to:* (hence including natural, artifactual and mixed phenomena). Consequently, "people" has to be defined as everything the environment is not, i.e. to include the *human body, mind, social relations and culture.*[112] Now, we see that the following enumeration is indeed a logical enumeration of what the world consists of:

- human body, mind, social relations and culture (= "people")
- the physical phenomena (outside the human body) people relate to (= "environment")
- people-environment relationships.

And we see that people-environment relationships are not logically confined to physical interactions, but involve people's more spiritual responses to the natural and the artifactual environment.

Final variables derive their status from that they describe the world in *normatively* relevant terms (environmental policy aims or, in more general wordings the values recognized by the normative observer). Taking up all three categories of the enumeration above in the final variable list (Box 4.1) recognizes the normative relevance of all three. The conceptual status of the intrinsic values of humans and environment requires no further elaboration here.[113] The concept of the intrinsic value of people-nature relationships, however, may require some attention here. The following example may clarify what such a value may be. Imagine two persons, one rich and one poor, and imagine that a sum of money is transferred from the rich to the poor person. If in this situation we say that the transfer has a positive net value because the relative cost of the rich person is much less than the relative benefit of the poor person, we can make this calculus because we recognize the intrinsic value of the two persons separately. This calculus is independent of the type of relationship involved in the transferral, hence, independent of whether the money has been transferred due to some outside regulation (e.g. a taxation), or whether it has been stolen by the poor person, or whether the money has been a gift. Now, if we say that this does in fact make a difference in the moral judgement of the situation, we thereby recognize that intrinsic value can also be found in the relationship; the act of giving *adds* to the net positive balance. Intrinsic value in people-environment relationships (e.g. that these relationships be harmonious) is not of a different order, conceptually.

In Box 4.1, the final variable of "people" has been separated into three categories, "health and safety", "material well-being" and "immaterial well-being". Here, I will briefly focus on the definitions, also providing some arguments for choosing these categories along the way.

Taking *health* as the first final variable follows a tradition visible in countless policy documents, environmental impact statements and so on. What is usually meant there is not health in general, that is, the total effect of environmental influences, life style, primary health care and so on, but 'environmental health', i.e. *the absence of*

[112] The two definitions are not perfect complements, formally. Two 'holes' exist in between, namely, the physical phenomena we do not relate to and the non-physical relationships and 'culture' of non-human creatures. This causes no problem here.

[113] With respect to the intrinsic value of nature, see Chapters 7 and 8 of De Groot (1992b).

environmentally transmitted disease (in the broad sense of physical and mental malfunctioning), relating to such matters as radiation, toxic substances, noise, waterborne diseases and so on. Keeping matters logically enumerated implies that the other contributions of the environment to health (e.g. the procurement of food) will have to be accounted for through the other final variables. Now, the logical enumeration of "people" is:

- "environmental health" of "people" (= the absence of environmentally transmitted disease of the human body, minds etc.)
- other aspects of "people" (= the human body, etc.)
- the relationship between these two.

At this point it becomes relevant to again distinguish between what in this list may exist empirically and what may carry intrinsic value (hence, may serve as a final variable, an aim for environmental policy). Then, we see that the 'relationship' component certainly does exist empirically; it comprises, for instance, all human actions that influence environmental health. These actions are of course the subject of environmental policies and norms, but they are so because of reasons derived from health and other intrinsic ("final") aims; I cannot imagine an environmental policy-maker or ethicist proclaiming that these relations are good or bad, or should be strong or harmonious, for any *intrinsic* reason.[114] Therefore, crossing over from an empirical to a normative description, the relationships component may be dropped. Also, the "other aspects of people" may then be confined to the intrinsically valuable aspects only. Summarizing these under the term "other human well-being" (PIM, 1983), the list now becomes simplified to:

- "human environmental health"
- "other human well-being" (economic, spiritual etc.).

We have now come one step closer to the list in Box 4.1, still under logical control and with the formal definitions in place.

The final subdivision applies to the 'other well-being' component. Again, the relationship component is important for empirical modelling, but may be neglected as a separate intrinsic value. Sometimes, a distinction is made in either the material/immaterial components, in which the latter are associated with cultural values, or in the marketed/non-marketed components, in which the former is associated with economics. More often, as in Janikowsky and Starzewska (1991), the two distinctions are mixed in a way not sufficiently coherent to serve as a sound basis for policy and assessment. We may note, for instance, that services are components of immaterial well-being although they are marketed. For a formally sound conceptual schema, either the one distinction or the other should be adhered to, or the one after the other, in a two-step logical enumeration.

In Section 4.1 the distinction between marketed/non-marketed components of human well-being has been taken as the criterion for subdivision. Then also, the distinction is roughly between the well-being arising from the environment that reaches

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[114] A policy principle of *prudence* with respect to toxic emissions may be thought of as an exception here (e.g. Perrins, 1991) about the "precautionary principle" in decision-making.

us (or that we reach) through the hands of other people, versus the well-being arising out of direct appreciation of the environment. Calling the two categories 'material' and 'immaterial', respectively, is an incoherency I have allowed because these terms, in my mind, convey a more substantive meaning. Making choices here is obviously a fairly overseeable matter, if the basic logics are adhered to.

The functions concept

Functions, roughly, are types of instrummental values, deriving their meaning from the intrinsic values they serve. Analogously to what we have seen with respect to sustainability in the preceding section, the functions concept is often associated with human intrinsic values only. In Adamus et al. (1987), for instance, functions are formally restricted as being "for society". In lower-level listings, however, "endangered species" creep into the enumeration. R.S. de Groot (1986) does likewise, slipping in "rare species" somewhere in his functions enumerations.

The functions of the environment are often used as an 'organizing concept' in economic evaluations. In that context, two conceptual questions sometimes arise, namely, whether a distinction should be made between 'potential' and 'actual' functions, and what should be the difference between 'functions' and 'benefits'. Both questions are largely matters of sound conceptual bookkeeping.

As for the first question, whether functions are potential or actual is largely a matter of proper specification of domain. A general list of wetland functions, for instance, should comprise all actual functions performed by the sum total of wetlands in the world, plus the potential functions in the temporal sense, i.e. wetlands being an option for uses as yet unknown. If this list is then applied to a specific wetland A, the whole list should be regarded as potential, and the list of "functions of wetland A" should comprise only the functions that wetland actually performs, plus again the potential functions in the temporal sense.

The distinction between 'function' and 'benefit' marks the step from a functions analysis to a cost-benefit analysis. If a wetland performs a function of organic waste removal, for instance, we may put that on a simple dichotomous scale (yes/no), or we may state to what extent it performs this function as a percentage of its environmental capacity, or we may calculate how much BOD is removed per day. In all cases, it remains functions analysis. Attaching a benefit to the function is a next step, bringing in new variables. The benefit may depend, for instance, on the number of people living downstream. Or, if we calculate the benefit as the cost of having to build a purification plant of the same capacity, the outcome depends on market prices and, at a deeper level, on the decision to assume that the plant would have been built, or should have been built, if the wetland were not there.[115]

[115] With respect to wetlands, Adamus et al. (1987) arrange the same concepts in somewhat different terms.

4.4 Working In The System: Parameter Identification And Aggregation

What is relevant in the environment itself, that is, what are the parameters of environmental quality, depends on the higher normative principles laid down in the final variables. And, conversely, aggregating environmental quality parameters into a more condensed quality assessment is, or at least should be, aggregation 'back up' towards the final variables. The present section aims to describe and discuss this process of going down and back up, i.e. environmental quality parameter identification and aggregation for assessment, respectively, in two subsections. Since the assessment of environmental quality is conceptually equal to the assessment of (predicted) *changes in* environmental quality due to some (proposed) activity, EIA methodologies will be included in the second subsection.

From final variables to environmental quality parameters

As Bouwer and Groenenberg (1991) assert, the Latin root meaning of 'qualitas' is non-normative. We still use this denotation, for instance, when we say that somebody is a member of a certain committee "in his quality of being mayor" and in a term like "qualitative research", meaning that the research focuses more on what something is than on its distribution. Later, the term quality also took on a normative denotation. We use that meaning, for instance, when we say that something is "a quality product". It is this denotation that predominates in environmental science and policy. We see it, for instance, in terms like "water quality law" or "Council on Environmental Quality"; quality, here, is always something that is *aimed at,* not just a description of how the environment happens to be. A quality assessment then always entails some comparison between environmental conditions as they are and the conditions as desired (the norms).[116] The linguistic proof is that we may evaluate a water quality as "high" because of *low* toxic substance concentrations. The term 'high' denotes that the factual (low) concentrations lie close to the (low) desired ones.[117]

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[116] Thus, the concept of environmental quality is in fact simply the complement of the concept of environmental problem, if we state the environmental problem in terms of environmental parameters, not actions or impacts (Fig. 3J); both are comparisons of the actual and desired world. If quality is low, the problem is 'high'; if facts and norms match perfectly, the quality is perfect and the problem is zero (Udo de Haes, 1984).

[117] Taking a closer look here, we find that when speaking about "high" or "low" quality, we take quality as an open concept which may vary between zero and perfect. In a term like "quality product" the quality concept is closed, we could say; it can mean good quality only. I use the open concept throughout, following the usage that we do not speak about "a quality water" or "a quality landscape"

The facts and values (norms) that make up environmental quality are facts and values in terms of environmental quality characteristics (or parameters). These may be defined as *all characteristics (or parameters) of the environment causally related to the final variables or, alternatively, to the Junctions of the environment.* The term 'parameters' here is in wider use than 'characteristics'. The drawback of 'parameter' is that it tends to focus the attention on relatively reductionistic, 'little' characteristics, such as the ones found in the well-known lists of water and air quality[118]; I will use the terms interchangeably. The quality characteristics, as said in the preceding section, concern all final variables, from health and economy to the more spiritual and ethical ones. So, environmental quality characteristics are the sulphur dioxide in the air, the maize in the field, the fish you can catch and sell, the wind that cools you off, the mountain that is your challenge, the great whales that share the world with you.

The term *'causally* related' has been used for a special reason, namely, to distinguish the concept of environmental quality characteristics or parameters from the concept of what I here call environmental quality *indicators.* This distinction is important to avoid confusion and double-counting, as the following example will show.[119]

Searching for an environmental quality parameter for temperate lakes from the final variables downward, one of the first parameters we may identify is the occurrence of commercially interesting fish, say, the trout. Then, we see that the trout may also be linked to a more spiritual final variable, say, something like 'wilderness value', connected to the possibility of lone hikers to live off nature in close, direct interaction. Third, the trout is an intrinsic value of its own. (Note that this is not a case of undue double-counting; 'trout value' really is these three.) This is the simple situation depicted in the top picture in Figure 4B: the trout is causally connected to three elements (small circles) in three final variable blocks, and the identification of the trout as a quality parameter runs along the three dotted lines downward.

Next, ecological models or experience may show that the trout is always there if dissolved oxygen concentrations are high enough. It might then be decided, for instance because it is cheaper to monitor, to take dissolved oxygen as the quality parameter, as shown in picture 2 of Figure 4B. The trout is simply passed through by the dotted lines and dissolved oxygen acquires all 'trout value'. (Note that taking them both would be a case of undue double counting.)

The next picture (3) shows the situation arising when it is discovered that dissolved oxygen is not only causally linked to the trout, but also to the fate of toxic substances entering the lake; high dissolved oxygen concentrations prevent toxicants dissolving out of anoxic sediments, for instance. Now, through some 'toxicant'

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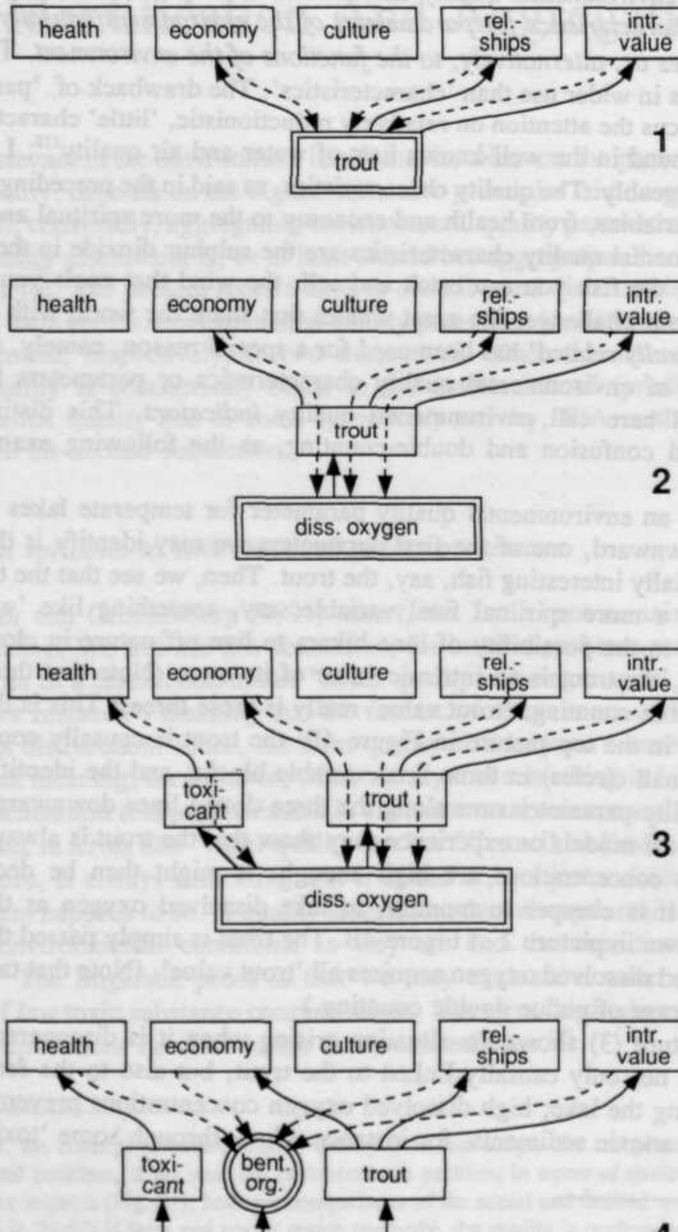
as we do with products.

[118] See, for instance, House (1990) for the UK water quality parameters (dissolved oxygen, dissolved arsenic, total coliforms, etc.).

[119] I use the distinction between parameter and indicator here only for the conceptual purpose of this section. Therefore, I ignore the wide variety of existing definitions, typologies and terminological discussions.


health
economy
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1
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economy
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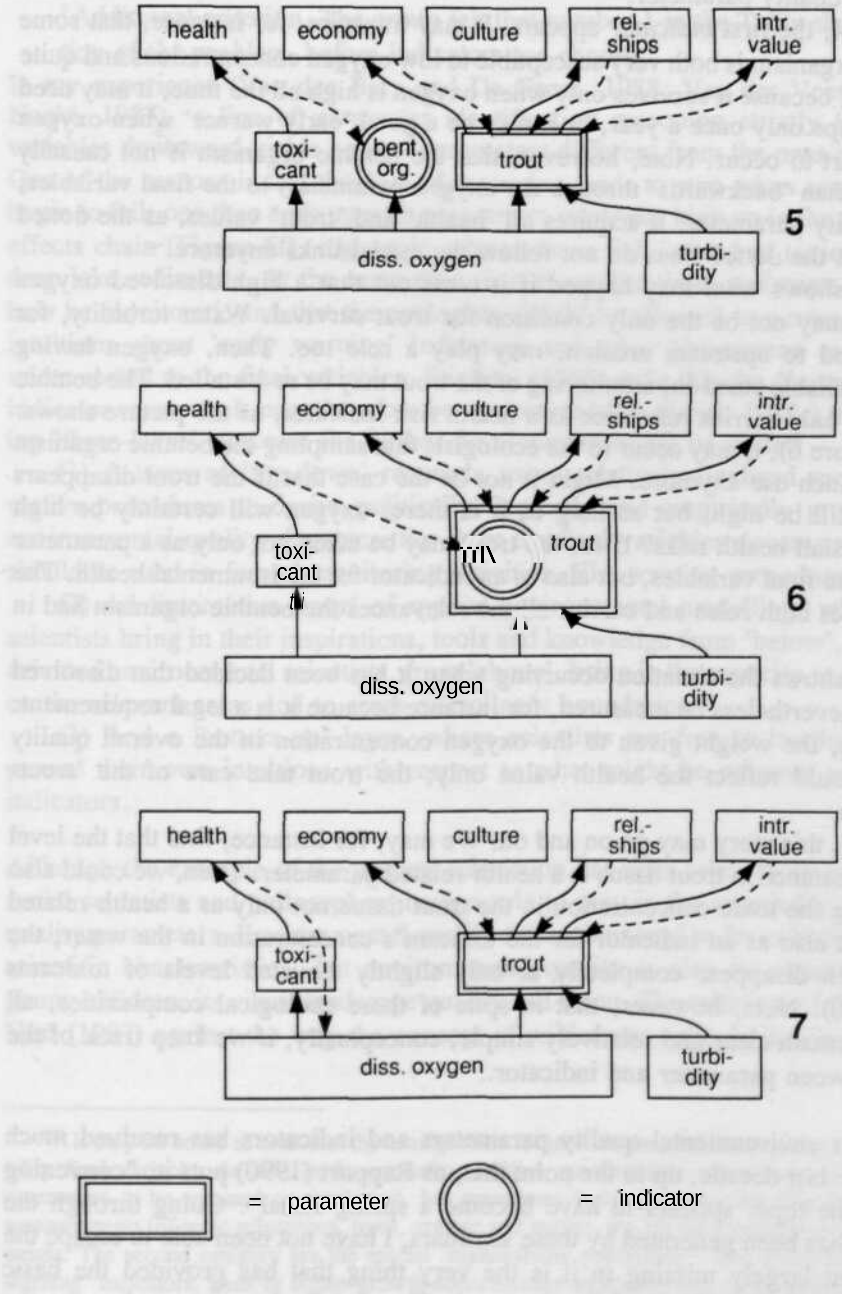

Figure 4B

Parameters and indicators of environmental quality. At the top of each picture are the final variables. The upward lines are **empirically-causal**, the downward lines are **normatively-causal**, as in all **Problem-in-Context** figures (e.g. **3J**) variable, dissolved oxygen also acquires a health value; it still remains the only environmental quality parameter.

In picture 4, the first *indicator* appears. It may transpire, for instance, that some small benthic organism is both very susceptible to low oxygen concentrations and quite easy to sample; because it survives only when oxygen is high all the time, it may need sampling perhaps only once a year, or it may be a good 'early warner' when oxygen instabilities start to occur. Note, however, that the benthic organism is not causally related (other than 'backwards' through the oxygen parameter) to the final variables; it is not a quality parameter. It acquires all 'health' and 'trout' values, as the dotted lines show, but the dotted lines do not follow the causal links anymore.

Picture 5 shows what may happen if it turns out that a high dissolved oxygen concentration may not be the only condition for trout survival. Water turbidity, for instance, related to upstream erosion, may play a role too. Then, oxygen having become an unreliable stand-in, monitoring of the trout may be re-installed. The benthic organism now only carries relevance as a health risk indicator, as the picture shows.

Next (picture 6), it may occur to the ecologists that sampling the benthic organism is not really much use anymore. Might it not be the case that if the trout disappears oxygen may still be high, but as long as it is there, oxygen will certainly be high enough to forestall health risks? If so, the trout may be taken not only as a parameter for its own three final variables, but also as an indicator for environmental health. The trout now serves both roles and carries all the relevances the benthic organism had in picture 4.

Picture 7 shows the situation occurring when it has been decided that dissolved oxygen must nevertheless be measured, for instance because it is a legal requirement. In such a case, the weight given to the oxygen concentration in the overall quality assessment should reflect the health value only; the trout take care of the 'trout-related' values.

Obviously, this story may go on and on. We may, for instance, find that the level of the toxic substance in trout tissue is a health-related parameter. Then, we could also consider taking the toxic concentration in the trout tissue not only as a health-related parameter, but also as an indicator for the toxicant's concentration in the water; the trout may even disappear completely at only slightly elevated levels of toxicants (Hodson, 1990). Note, however, that in spite of these ecological complexities, all pictures can remain clear and relatively simple, conceptually, if we keep track of the difference between parameter and indicator.

The search for environmental quality parameters and indicators has received much attention in the last decade, up to the point that, as Rapport (1990) puts it, "convening seminars on the topic appears to have become a spring ritual". Going through the literature that has been generated by these seminars, I have not been able to escape the impression that largely missing in it is the very thing that has provided the basic simplicity, relevance and logic of the pictures in Figure 4.B: the connectedness to the final variables, i.e. the relationships between the parameters and environmental objectives and problems. This impression is nicely summarized by a working group of one of these seminars (Day, 1990), that had been given a Table Of Practical Criteria For Parameter Selection to work on:

"Additional criterion. The group felt that number 1 in the Table should be *definition of the problem,* before indicators are chosen."

In my experience (Van den Berg and De Groot, 1988; Van der Voet and Van der Naald, 1987), a line of parameter identification reasoning strictly from the final variables downward yields a set of parameters different from the ones in current use. One of the reasons is that this line of reasoning tends to stop when empirical models begin to fail; one then ends up with parameters relatively high up in the environmental effects chain (Figure 6J), e.g. toxic substances in fish instead of toxic substances in deep lake sediments. At the same time, it is clear that these sediments should somehow be monitored, and that the ecologists should be allowed to pursue and test their intuitions about 'early warning' indicators and other phenomena as yet formally unconnected to the final variables. Stigliani (1988) calls this the "bottom-up" line of indicator research. It may therefore be conjectured (De Groot, 1988c) that the following 'three-layer' structure for further development might be useful:

(1) A layer of 'top-down' research, using relatively finalized models and normative procedures to derive politically, logically and empirically grounded sets of environmental quality characteristics from the final variables downward. The results should be used in formal monitoring activities, EIA scoping procedures and so on.

(2) An 'interactive layer' of applied environmental modelling, where specialist scientists bring in their inspirations, tools and knowledge from 'below', and problem-oriented environmental scientists, from 'above', bring in the capacity to focus research on the relevant areas and to cross disciplinary boundaries.

(3) And a 'bottom-up' layer, where scientists are free to lay foundations and pursue their own intuitions with respect to what might be relevant parameters and indicators.

Although the example of the present subsection has been taken from ecology[120], also social scientists and philosophers have a role to play in the search for environmental quality parameters. Environmental quality discussions tend to focus heavily on natural-scientific characteristics, but environmental quality is also its education value for young children, its visual landscape quality and so on. The criticism of the philosopher Vest (1987) against the way the concept of wilderness solitude has been operationa-

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[120] It may be noted as well that the example has focused on environmental qualiy, not the sustainability final variable. As said in the preceding section, sustainability often does not add to a set of parameters to be assessed or monitored, but sometimes it does. As for the first category, repeated measurements (of toxic substances, trout, organic soil matter, etc.) is the approach to identify long-term trends. The second category are the special 'sustainability parameters'. One group here are the 'early warning' indicators, such as lichen growth abnormalities indicating that forest dieback may be imminent. A second group concerns the direct measurement of processes that do not add to or substract from present quality but irreversibly after future quality. Low but persistent soil erosion rates are an example (Piekarz, 1990). Another is the ground water level in peat soils used for agriculture; the dryer the soil, the faster it oxidizes away.

lized by environmental agencies (De Groot 1992b, Chapter 7), for instance, is a discussion of how to derive landscape quality parameters from the 'solitude' element in the 'cultural value' final variable.

In the Netherlands, the 'top-down' component has become well-visible in recent years. Ten Brink et al. (1991) is an example; Latour and Groen (1991) is another[121], focusing on the environmental quality of the Dutch peat lowlands and coastal dunes. Latour and Groen start out with the general aims of environmental policy but then, contrary to Ten Brink et al., they do not try to derive environmental quality characteristics directly from them. Instead, they inventory all area-specific policy statements made with respect to the lowlands and the dunes[122], and work these into an integrated 'target image' of these regional environments. These 'images', although they are relatively simple landscape descriptions in terms of gradients, dynamics, patterns, interweaving of functions, naturalness and so on, besides being more specific, offer more richness and coherence than do the usual lists of disparate, general and reductionistic quality parameters. From their landscape images further downward, Latour and Groen have to (or at least they assume they have to) operationalize environmental quality into a parameter-by-parameter list, but this list still retains much of the richness of the landscape images. I emphasize this point here as a primer for the next section; letting go of abstract reasoning and instead responding to the environment more contextually is not only something discovered by philosophers, but also, independently, by applied environmental scientists.

From environmental quality back up: normative aggregation

When environmental quality parameters have been monitored or when changes in environmental parameters have been predicted, they usually have to be aggregated into some kind of more condensed quality index or evaluation, e.g. in a State of the Environment report or an environmental impact statement. Aggregation is often regarded as problematic, because of its "subjective" character. This type of conceptualization has already been discussed in Section 3.6 and other places (the 'Cartesian trap'). Through it, one cannot deal properly with what aggregation is there for, namely, for the same reason that the environmental parameters are being measured in the first place, i.e. to be *normative,* and in that sense 'subjectivity objectified', as is empirical science.

The aggregation of data can only be done properly in the perspective of some higher principle, a 'theory' of some kind. Roughly, the aggregation of environmental data can only be consistent if it is either radically guided by the normative principles of the final variables, focused on normative relevance for society, or guided by the

121 To Latour and Groen, Nip et al. (1990) is an English introduction.

122 In general environmental policy, physical planning, nature policy and water policy documents.

empirical principles of scientific ecology, focused on scientific progress in models and theory. Often, data can be interpreted and aggregated in both ways. Still, both directions of aggregation are very different. In between, confusion lurks.

I will first argue this position by means of two stark examples. Then I will cross over to the more common and subtle ways of missing the mark partially. The first example is the model proposed by Gilliland and and Risser (1979) to describe the "total impact" of projects and policies. This "total impact", which Bisset (1988) finds "non-controversial" because only scientific data are required to assess it, concerning nothing more than the primary production of the project or policy area; the more primary production is reduced, the more negative is the "total impact". It is good, therefore, to convert old-growth forest into maize fields, and to eutrophy lakes. What Gilliland and Risser do here is to take a way of data aggregation that has served well in the perspective of an ecological theory (the 'Odum school' of energy flows), and declare it to be relevant, even superior to all others, in the normative perspective of what is good or bad action. The energy measure, they assert, is superior because it is "objective"; it does not "involve the biases of someone's value system".

Looking down upon the primary production parameter from the normative perspective of the final variables, we see that primary production is indeed connected to some of them, but only partially, indirectly and in varying ways. The problem with Gilliland and Risser is that they are hooked on what they regard as "objective" (viewing nature as an energy machine). All diagnosis, all analysis of environmental problems, all impact assessment and all proposals for solution are normative from the very beginning, however, that is, co- constituted by "value systems". The point is how to deal with this the proper way, and not to take refuge in some "objective" corner, thereby implicitly proclaiming as superior the value system that is the most subjective of all, namely, one's own. As has been discussed in Chapter 3 with respect to the concept of 'normative observer', it may from time to time be quite warranted to follow a "biased value system", e.g. to formulate an environmental problem through the normative eyes of small farmers or the Sierra Club. In many other cases, a more generalized (intersubjective, societal, 'objective') standpoint is the one to adopt, e.g. using the final variables or functions as they are explicated in environmental policy and in this chapter. Both ways, data aggregation is values-led.

The second example of disconnection between data and values concerns the aggregation of environmental quality parameters in non-normative categories, summarized from De Groot and Udo de Haes (1987). Bird species are usually recognized as all contributing to the final variable of intrinsic value of nature. Therefore, a species-by-species prediction of changes in bird numbers is an unproblematically relevant step in making an EIS. Let us now assume that a prediction of the impact of the conversion of a forest into a park-like suburban development is as follows:

- increasing: 10 very common 'suburban species', with a total of 1000 individuals
- declining: 6 rare forest species, with a total of 100 individuals.

These numbers may be integrated in a general category of "avifauna". The score will then be positive, in terms of number of species (+4) and in number of individuals

(+900). An other way to do it is to separate the birds in two categories, suburban species and forest species, and say "suburban species up, forest species down ", yielding the impression of a balanced net impact. Needless to say, these types of aggregation open up wonderful possibilities for suburban developers to manipulate EIS outcomes. In the second type of aggregation, for instance, the outcome is the same for any size or lay-out of suburban development. Taking a real-world example from the Netherlands, applying the second type of aggregation to the construction of a huge disposal site of toxic harbour sludge results in "mud-wading birds +, other birds - ", for all site variants (Gemeente Westvoorne, 1984).

The problem here is that the categorization of bird species bears no connection to the final variables. Operationalizing the intrinsic value of nature (Section 3.6.) results in normative criteria like naturalness and rarity. Whether or not birds prefer suburbs or mudflats is simply not the normative issue. Keeping up the connection between the birds and the final variable, that is, keeping the categorization relevant for an EIS or any other decision-oriented document, requires that the birds are categorized in rarity classes, weighed for their 'rarity value' or treated in some other sound normative way, and not manipulated into "objective" categories to the developer's liking.

One of the recurrent themes in environmental science literature and practice is the aggregation of environmental quality parameters by means of *indexes.* A discussion of this tradition is the third example promised, showing "the more common and subtle way to miss the mark partially". As I will try to show, my criticism will here not concern the phenomenon of indexing as such, but rather the way it is commonly applied.

A characteristic example of indexing is the U.K. "Water Quality Index" and other water indices discussed by House (1989). The four stages of the development of an index as formulated by House are "(1) parameter selection, (2) the transformation of the parameters on the same scale, (3) the development of parameter weightings and (4) the selection of an appropriate aggregation function." We may note here that there do not exist fundamental differences between this approach and much of what I have proposed up till now. I prefer to see stages 2 and 3 as a comparison of factual parameter values with parameter standards in which all available knowledge has been formally accounted for rather than trusting expert scaling and expert judgement weighing, but the essence is the same, *viz.*, to put the factual measurement or predictions on a normative ('quality') scale. Further, I prefer to see stage 4 as the application of some empirically grounded integrative model rather than the application of some relatively empty "aggregation function", but again the essence is the same, *viz.*, the condensation of the many normative scores into one (the 'index'). Furthermore, the procedure obviously does not suffer from the defect of the bird species example; because the procedure is standardized, no-one can escape from the normative truth by taking recourse to some arbitrary categorization.

Then, what can be wrong here or, for that matter, with all the other water, air and soil quality indexes reviewed by, for instance, Bisset (1988) and Driessen et al. (1991)? As a first step towards the answer, I will first quote Bisset's major criticisms with respect to the indexing approach, then rephrase these criticisms and then expose the problem and the alternative. Bisset writes:

"It is argued that the subjectivity involved in the [index] computations is hidden within a spurious objectivity"

and:

"One important drawback to the [index] methods is the manner in which they compartmentalize and fragment the environment."

Rephrasing this, my criticism is:

(1) Expert judgements with respect to empirical scientific matters are often necessary and not inherently problematic; it is unacceptable, however, when these judgements automatically imply a normative weighting between the final variables (e.g., trading off economy against culture, or human health against nature), as current index methods do.

(2) Current index methods compartimentalize environmental problems into non-normative, hence irrelevant categories.

(3) Current index methods focus attention almost exclusively on fragmented, reductionistic parameters, hence on only a part of what is relevant.

As for the last of these three, I refer back to the previous subsection and to the principle of logical enumeration (Section 4.3), which together permit a parameter identification that keeps track of exhaustiveness and higher system levels. Hence, I leave it aside here. As for the first two of the three, the following example will indicate that they point to what is in fact a single basic problem. Let us assume that the air over a certain region holds the following three problem-relevant substances:

- PAHs
- SO2
- NH3.

Working these three into an air quality index obviously requires a substantive amount of empirical-scientific modelling or expertjudgements. For instance: how carcinogenic are the different PAHs with respect to each other? Do they work synergistically with SO2? How much does NH3 contribute to the deposition velocity of SO2? How vulnerable are the region's forests to acidification? In this field, expert judgements are not inherently more problematic than models; both can be ungrounded, both can be biased by 'school-isms' and so on. Now, let us have a look at the impacts of the three substances. Roughly, they are:

- PAHs: human health
- SO2: acidification and human health
- NH3: acidification and fertilization (=eutrophication).[123]

[123] It may be noted that this list is mixed in the sense that it contains the final variable of human health and the non-final, 'thematic' variables of acidification and eutrophication. The thematic variables offer an opportunity for thematic indexing. Well-known examples, for instance, are the Ozone Depletion Potential, the Global Warming Potential and the 'acid equivalents', in which different substances are weighed with respect to their contribution to ozone depletion etc., and added up. A condition, of course, is that the substances work additionally in reality; indexes for eutrophication, for instance, should take not the addition but the minimum of the phosphate and nitrate contributions, as

These impacts may be translated further in final variable terms. We may do so noting that acidification has a large impact on timber production (hence, 'material welfare' or 'economy') but that its impacts on nature, in the Netherlands at least, are in fact less outspokenly negative. What nature suffers much from, at least in the Netherlands again, is the eutrophy effect of NH_3. This effect, at the same time (but under the term of fertilization) is roughly positive for timber and other primary production. The resulting impacts in terms of the final variables (leaving out cultural values, relationship values and sustainability, for the sake of simplicity) are therefore:

- PAHs: human health (-)
- SO_2: economy (-); human health (-); nature (-/O)
- NH_3: economy (-); human health (-); nature (-/0); economy (+); nature (-).

This, of course, is nothing new empirically. The list shows, however, that *any weighting ofthe air quality parameters into a single air quality index implies a weighing of the final variables.* Making the index, human health, economic values and intrinsic values of nature are implicitly traded off against each other. I do not of course deny that such weightings of the basic aims of environmental policy are always necessary to reach environmental policy decisions, but doing it here and in this way is about the worst place and way imaginable. It is the wrong place because the weightings are mixed with technical-empirical expert judgements from which they should but cannot be separated. It is the wrong way because the weighing is done *in abstracto,* without the contextual knowledge that comes with speaking about concrete problems and concrete decisions (see the next section).

How to escape from this dilemma? Should the general public, politicians and ethicists be involved in air quality index-making? That will not work. The whole matter is simply too technical. Moreover, it still remains the wrong way; people, politicians and ethicists certainly can make grounded decisions, but only when they have a full overview of concrete problem situations, not when they are forced to make trade-offs little by little and without concrete knowledge (again, see the next section). Should indexing therefore be avoided completely? That would exclude the possibilities of unproblematic weighting of technical-empirical matters, which in itself is quite useful. The way out is not to drop indexing, but to drop the *air quality index.* What are needed are indexes not for environmental compartments or components, but *indexes for final variables.*

If we have a certain region, then, reviewing the environmental quality there would not result in a water quality index, an air quality index, a forest quality index and so on, but a health quality index, economic quality index, cultural quality index and so on, with respect to the region's environment. Each of the latter type of indexes (which may of course also be more qualitative presentations or narratives) is integrated

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shown by De Groot (1983) and De Groot et al. (1987). The thematic indexes of course have their own validity difficulties, but the indexes being purely empirical, these difficulties are not normative (such as the implicit trade-off of final variables). By the same token, they can always be taken as empirical 'pre-aggregations' towards the final variables. By the same token, too, they are left out of the discussion of this section.

without involving major value judgements. The integrations are possible because each final variable has its own coherent 'backbone'. Health indexing accounts for all pathways of all toxic and otherwise harmful agents. Economic indexing sums up all the environmental contributions to agriculture, forestry, recreation and so on. Cultural 'indexing', more narrative but no less coherent, goes into the educational, spiritual and history-expressing qualities of the landscape and its separate components. 'Nature indexing' assesses qualities in terms of naturalness and 'relationship indexing' goes into the intensity and non-dominance of people-environment interactions. And a sustainability index adds the long-term perspective to it all, both in terms of trends in the other indexes and in terms of its own process-oriented parameters (cf. the previous section).[124] The same six indixes may be used not only for environmental quality assessments, but also for the indexing of substance emissions and waste, for integrated environmental labelling of products, for activities to be assessed in EIA, and so on.

Adopting the 'final variables approach', in my opinion, holds a number of substantial advantages over the present-day situation. Several of them have been indicated already, e.g. the certainty of covering all the basic aims of environmental policy and the avoidance of arbitrary categories of aggregation in which trade-offs between these basic aims are hidden. There exist a number of additional advantages that will not arise immediately, but amount to the sustenance of a process of coherent and critical 'index building'. Such a process, which is no more special than a normal process of theory building in any scientific field, has never taken place with respect to indexing and allied appraisal methods. It is noteworthy, for instance, that all EIA methods reviewed in Bisset (1988) and all 24 EIA methods evaluated by Thompson (1990) were designed in the 1970s and have not since been developed further. They simply sprang up out of the immediate need to have something for EIA-making and quality assessment and proliferated into a wide array of disconnected and arbitrary approaches. After that, 20 years of stand-still followed; there is hardly a better proof of the disadvantages of viewing environmental science as an applied science only, lacking a level of more fundamental, longer-term theory building.

In this light, advantages that do not arise immediately but sustain a process of coherent and critical 'index building' may prove to be even more important than the advantages carried by the 'final variables approach' as such. These long-term advantages arise because the final variables approach is externally and internally *connected*. By 'externally connected' I mean that the final variables, and with them the indexes built to express them, are each linked to lively and important theory fields. A human health index, for instance, is linked to theories of health (cf. De Groot, 1992b, Chapter 7), the acceptability of risks and empirical-epidemiological testing; 'material welfare'

[124] Note that, essentially, all indices can make use of all environmental parameters relevant to them. Some, such as carcinogenic toxicants, may be relevant for only one final variable. Others may be relevant for several final variables at the same time. A bird of prey, for instance, will be taken up into the 'intrinsic value of nature' index, but may also be of cultural-symbolic value as well as contribute to agricultural stability.

assessment is directly connected to a wealth of developments in environmental economy; an 'immaterial welfare index' can immediately respond to philosophical value explorations like those of Rolston (1988) and criticisms like those of Vest (1987), and so on. This way, index building will become a lively intertrade between the practical assessment needs and realms of more fundamental discussion, to the benefit of both.

The 'final variable approach' is, as I said, also internally connected. By this I mean that if the same six final variables constitute the core outputs of assessment in all fields (EIA, product appraisals, environmental quality assessment emissions indexing and so on[125]), all the different variants that will undoubtedly be developed will still be allied and within 'critizable reach' of each other, thereby fulfilling another condition for progress.

Obviously, a cross-over to final variable indexes entails a rethinking of ingrained patterns. On the other hand, many elements of new patterns already exist. In the field of health, especially, where index builders can rely on relatively well-developed and traditional knowledge, integrated indexes are beginning to emerge spontaneously. Giroult (1988) gives an overview of disease agents, risk groups, pathways etc. that should go into an integrated health assessment. VROM (1990 a, b) is a semi-official attempt to formulate an environmental health index, aggregating data concerning noise, carcinogenic and toxic substances in the air, stench nuisance and safety risks.[126]-[127] Guinée (1992) present a simple method to assess emissions, not environmental quality, in he direction of environmental health. They divide the emissions by the associated environmental quality standards (e.g. MAC for emissions to the air), arriving at cubic metres of air, water and so on polluted to the standards limits.

First attempts to arrive at a some grounded index, formalized-quantitative or more qualitative, are also visible in the interpretation of environmental data in terms of the final variable of the intrinsic value of nature. The assessment criteria in Eagles (1984), Udo de Haes and Canters (1986) and others will be discussed in Section 4.6.

Market prices and shadow prices are the long-standing tools of economics to aggregate environmental benefits in an index representing the final variable of material welfare. A brief discussion is provided in Section 4.9. Here, it may be noted that if the 'non-economic' final variables are catered for in their own quantitative or narrative indexes, and if these indices can be handled in a multi-criteria analysis or some other,

[125] It might be considered to leave carbon dioxide out of the system, because of its weight and the special character of its impacts. All other existing indices can be brought into the final variables system.

[126] Excluding health pathways through soil and water, the index is only a partial index. This is caused by the fact that the index is meant as a tool for zoning around industrial plants and suchlike projects. If a comprehensive health index were to be constructed, there would no longer be a need to use a partial index. In use for zoning purposes, the 'air pathways' would prove to be the most critical in most cases, but soil and water would enlightingly prove to contribute their share in spatial variability as well.

[127] It may be noted here that I do not often mention safety and nuisance elements in the final variable of environmental health. This is only so as to not burden the text with too much detail.

less formal and more contextual overall assessment approach, there is no need to stretch the cost-benefit analysis to also cover the final variables it is less suitable for.

All the approaches touched upon here can (and should, in other contexts) be critized for being crude, partial, opaque, and so on. In that sense, they do as yet not differ much from the traditional indexes aggregating data into non-normative categories. Yet, because they strive to be coherent 'final variable approaches' they all are fundamentally superior and, as the Dutch say, 'future-rich'.

4.5 The World Will Speak Through Us When We Let Go Of The Metaphysical Voice

Environmental Impact Assessments are often rounded off by some form of multi-criteria analysis (MCA). The basic idea of MCA procedures (e.g. Voogd, 1983) is that the various plan alternatives are characterized by their predicted impacts on impact variables (the 'criteria'), for instance the final variables of human health, economic costs and benefits, the landscape, species diversity and so on, and that the decision is reached by assigning weights to the criteria. With respect to this procedure, the policy analyst Heuer (1980) asserts that, in practice, it never works this way. Policy makers cannot give, or flatly refuse to give, a *general* trade-off weight of nature against economy, landscape against health or whatever. Instead, they ask: "What *is this thing* I am supposed to decide upon by giving you my trade-off weights? Tell me about the problem, the conflict, the adversaries, the arguments and views, the causes and solutions!" Then, on the basis of this substantive insights, decisions are usually reached, leaving the sad policy analyst only with the possibility of calculating *ex posteriori* what the trade-off weights have been in this situation (in the next, they will be different). If the problem proves to be too complex or fundamental to reach a decision in one go, the decision-maker may ask the policy analyst to play around with the MCA chart a little in order to organize the deliberations. He may also ask for more details about the problem situation, or visit the area and organize a hearing in order to get the stories as rich and first-hand as possible. In all this, the general criteria play an important role; the stories, for instance, are about health, costs, benefits, species diversity, landscape and so on. But the criteria act as guides for the stories to be told, not as final assessment criteria and, more characteristically, the decision is reached not by abstract manipulations of the MCA chart, but by listening to the *concrete* problem, put in the concrete context of its history, its causes, its solutions.

This, in a nutshell, is the procedure of contextual ethics. The title of this section, taken from Cheney (1989b), suggests that this procedure will work best if we, as environmental scientists, let go of the idea that we need generalized, abstract ("metaphysical") value hierarchies and theories to force the world into our prefabricated structures. Being open to the world, we can listen to the multitude of voices emanating from it, and speak forth that listening.

The purpose of this section is to first clarify the nature of contextual ethics somewhat further and relate it to some ongoing development in philosophy and science, and then show how it can be put to work in environmental science practice.

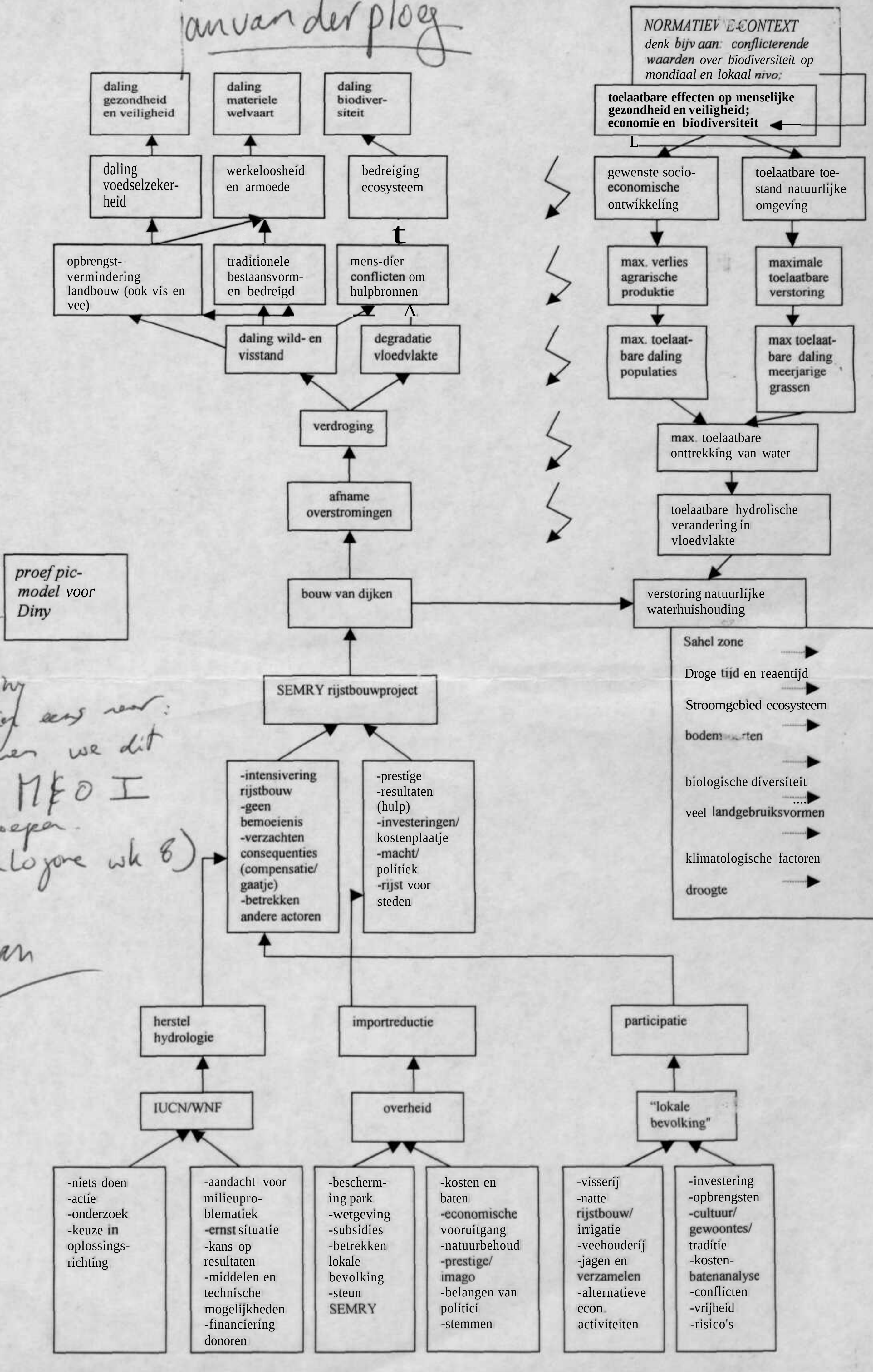
The position of the present section in the chapter as a whole has the following background. First, I have declined to start out with it, in order to avoid the suggestion that all final variable work should be approached in narrative, 'postmodern' ways. For the next section, however, we need the insight. The resulting position in the middle of the chapter also bears a symbolic significance; contextual ways of reasoning may not hold a position of primacy over traditional, 'abstract' ethics, but neither are they an afterthought, a dessert to the final variables meal. In my opinion, it is important for environmental scientists to know how to walk both roads, and find creative ways in between.

The procedure of contextual ethics, and the rehabilitation of the narrative

Cheney (1987) analyzes the moral situation existing when we eat food (say, a carrot) grown in our garden. There is a problem here, we could say. If we say that nature has intrinsic value, i.e. a right to life, then so has the carrot. We have an obligation to protect this right to life, but we break this obligation when we eat the carrot. How may these rights be adjudicated? Should we say there is a value hierarchy, with human rights superseding carrot rights? Or should we strike some balance between our obligations toward the carrot and our property rights? (We grew it in our garden, after all.) In any case, some conflict exists, and some guilt must remain when we decide to eat the carrot. This, Cheney asserts, is not inherently so. Rather, conflict is *structured into* the situation by the vision and language of rights and obligations. In a different vision, and speaking in a different voice, we may approach the situation by asking, as Cheney does, whether eating the carrot may be an "appropriate response" not to a set of rights and obligations, but to "a world I have come to know and cherish". If it is, there exists no conflict at all.

In the previous section, we have discussed the concepts of 'final variables' and 'environmental quality parameters'. This is a type of language that leads to conceptualizing the world in abstract universals. With respect to whales, for instance, the logical thing to say would be that the environmental quality parameter is "the *Balaenidae* stock" or something like that. In this clause, *'Balaenidae'* is an abstract category and 'stock' is just a number, abstracted from the person who counts and from those who are counted. At the particular spot where the whales are mentioned in the previous section, however, there is not the *Balaenidae* stock, but the "great whales that share the world with you". This image is different in that it speaks the language of the concrete (the whales, the world, and you). At the same time, it is different in the moral image it conveys, the adverb "great" associating with 'to cherish', rather than with to count, and the verb "share" speaking the language of relationships, not obligations.

The whales clause is an example of the fact that in moral theory and practice, matters of methodology (e.g. the contextual procedure) tend to go hand in hand with matters of content. In Cheney (1987) and Jack and Jack (1989), for instance, the 'ethics of rights and obligations' is contrasted to the "ethics of care". These, as jan van der ploeg



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discussed extensively in De Groot (1992b, Chapter 8) and summarized in Section 4.6, are different throughout, from the first moment of conceptualizing the world and the self, then to the conceptualization of what are moral problems and their causes, and finally to the procedures to solve them. Here, I will separate the substantive and the methodological sides as far as possible, concentrating on the latter.

The procedure of abstract ethics, in short, is the balancing of conflicting rights and obligations by means of some abstract calculus of fairness. The basic requirement for this procedure is the existence of a system of justice. This system consists of an array of real-world institutions (roughly, the legal system and the political machinery of decision-making) but at the heart of the system are the generalized principles of justice, the value hierarchies and the "fairness equations", such as multi-criteria analysis, cost-benefit analysis and likewise normative mathematics. This system is used to 'feed' problems into: first, the relevant characteristics of the problem are selected, then these characteristics are used to fill in the equations of fairness, and subsequently the system provides the answer. Moral work, in this picture, is to build the system of justice and to learn how to 'simplify problems into it'.

The procedure of contextual ethics, in contrast, is not to 'feed' the problem 'up' into the abstract principles, but to 'feed' the abstract principles 'down' into the problem, guiding the representation of the problem in relevant directions, but keeping the analysis at the level of *this*, concrete, problem, the description of which is enriched with more detail and more context, until the representation of problem-in-context is found to be "compelling", and solutions follow from it. The basic requirement here is the existence of a moral community that can do the contextualizing work and endorse the solutions; moral work, here, is to build the moral community and learn how to listen to the full richness of problem situations.

It may have struck you by now how contextual ethics lie close to the ethics of daily life. We seldom say that our "moral community" has reached a "compelling representation" of a problem situation, but what we do when we call in our friends to 'talk things over' is essentially the same procedure. In fact, much of contextual ethics is a philosophical rehabilitation of daily life (and female) ways, against the "modern" (= Cartesian) vision of man the isolated bundle of rights, alienated from all sources but his own ratio.

With the rehabilitation of contextual ethics comes the rehabilitation of the narrative. Telling the stories of the problem situation, as opposed to filling in the equations of justice, is the contextual key tool. Thus, closely intertwined with contextual ethics is the 'post-modern' emphasis on science and politics as the enhancement of the multitude of stories, the voices of the world that can be heard after the abstract, "totalizing" discourses of modernity have been "deconstructed". Environmental science does not need to follow post-modernism in all its extremes (e.g. Tyler, 1990)[128] before it can profit from its inspirations. We do not need to deconstruct modelling before we can see through the implicit but all-pervading message that the 'systems look' at the environment is the only one scientifically legitimate (Gough, 1990). We do not need to deconstruct the problem-in-context framework, abstract though it is, before we can see that "final variables", "norms chains", "secondary actors" and so on can also be the underlying framework for problem-oriented environmental story-telling; much of De Groot (1992b, Chapter 7) is devoted to this matter. As we will see there, narrative ways of doing environmental science can also be grounded in older traditions than post-modernism, such as hermeneutics and qualitative social science.

Contextual reasoning in application

Needless to say, contextual reasoning holds much practical potential for problem-oriented environmental science; further theoretical enquiry will certainly open up many new areas of application. There exists a number of areas that seem to be of special importance in this respect, because they link up easily with contextual inspirations, or are in fact developing them spontaneously. Below, they are briefly reviewed.

(1) As explored in De Groot (1992b, Chapter 7), narrative procedures seem to have a special relevance in EIA and allied, *decision-oriented studies.* For some evaluation criteria (e.g. naturalness, as the next section explains, but also others in the field of the 'non-material well-being' final variable), a narrative procedure is inherent in the criterion itself. For the others, contextual approaches may be applied as seen fit, either to complement or to replace the traditional, multi-criteria-like outcomes.

(2) *Environmental education,* at least in the Netherlands, has been split into a 'modern' variant of teaching facts about environmental problems and a 'traditional' variant of direct contact between the child and nature (Huizing, 1990). Environmental science, dominated as it still is by the Cartesian 'system image' of machine-like nature, has never had much contact with the 'traditional' field, characterized by its emphasis on "experienced nature" (Spaargaren and Mol, 1990). Today, as reflected for instance in IUCN et al. (1991)[129] and Blight et al. (1990), environmental educators are beginning to realize that the 'traditional' ways are in fact the post-modern ones. In the same vein but at the university level, Sturgeon (1991) gives a noteworthy account of rediscovering poetry, ethics, society and personal involvement in the environmental science classroom.

(3) Jiggings (1991) describes recent developments in analyzing and solving rural environmental problems together with farmers, using a "soft systems" approach,

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[128] In radical post-modernism, for instance, all discourses are taken to be completely "local, immanent and incommensurable", as Tyler puts it. In other words, no positive role is ascribed to general criteria, even not the guiding role I ascribe to them in the description of contextual ethics.

[129] Indicative of the rise of the 'ethics of care' that comes naturally with contextual methodology, the document is called "Caring for the Earth" (without acknowledging the feminist sources).

aiming to "defuse conflict" and to "improve relationships" by way of "creating a rich picture" of the problem situation. This almost perfect description of the contextual procedure indicates that *participatory analysis and planning* is another area lying in wait for connections between contextual theory and environmental science applications.

(4) Already mentioned in Section 4.4 are Latour and Groen (1991), who derive environmental quality standards from integrated, narrative 'target images' of a lowland and a dune landscape. Cheney (1989b) addresses the question of how we, after the post-modern deconstruction of the totalizing discourses of modernity, can rebuild anything through which we "can lay claim to having access to the way things are", and proposes as one possibility the "bioregional narrative", the negotiated stories of land and people. This encounter between the applied environmental scientists and the ecofeminist philosopher, *bien étonnés de se trouver ensemble,* suggests that here also, fertile linkages between theory and application may be built without long-drawn efforts.[130]

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[130] In the Netherlands as well as elsewhere, a distinction is often made between 'general' and 'special' environmental quality. The general standards then consist of the nation-wide basic norms related to all final variables. 'Special' environmental quality is region-specific, tuned to the region's own potentials and responsibilities. Larsen et al. (1988) derive 'special' water quality standards for ecoregions following a purely quantitative approach. The bioregional narrative is very different, but an interesting alternative candidate for 'special environmental quality' assessment. Special quality then should not only be geared toward nature protection (as it is in the Netherlands), but to all final variables, including people-nature relationships.

4.6 Operationalizing The Intrinsic Values Of Nature And People-Nature Relationships

In Section 4.1, "nature" and " people-nature relationships" are included among the final variables, i.e. among the variables that have intrinsic value for the normative observer. The present section aims to further operationalize these concepts, in order to enhance their applicability in policy design, impact assessment, norms derivation and so on. The focus, therefore, is not on the normative contextualization in ethics or ecological theory. Insofar as we need this context, I will simply refer to the places where it is given, notably in Chapters 7 and 8 of De Groot (1992b).

'Nature', 'naturalness' and intrinsic value carriers

Nature, it may be said, is what you find in nature areas. Or, taking a somewhat broader look, nature may be enumerated as trees, lakes, mountains, bears, and so on, without using a strict wilderness criterion. Both ways, 'nature' is a classificatory concept, used to define a certain category of things, juxtaposed to categories like 'man' or 'culture'. Both ways too, nature is something you can go to, or be with. This conceptualisation of nature as a category of things is the usual meaning of the term in daily language and in the language of most environmental scientists and philosophers. Its advantage is its concreteness, in the first instance at least. On closer inspection, however, ambiguities creep in. A park, for instance, is it nature? Or a forest where all trees, as they are in the Netherlands, are in fact planted, is it nature? Or an extensively grazed meadow in the Netherlands, where plants, in high diversity, are free to establish themselves but which could not be there without continuous management of polder water levels: is it nature?

In the answers to these questions, the concept of natue as a category of things loses its concreteness. Terms appear like 'real nature', the 'semi-natural landscape', and 'nature management' as the final *contradictio in terminis.* It appears, then, that we may arrive at a less troublesome conceptualization by starting out with a concept that is more abstract in the first instance, but may lead to a more fruitful and graceful result in the end. This conceptualisation takes not *nature,* but *naturalness* (or wildness, or self-ordering, or spontaneity) as its point of departure. We then arrive at the image of nature not as a category of things, but as the naturalness in everything. Value, then, is not in bounded spaces (this wilderness area, this eagle), but in space throughout, in which wilderness areas are the most complete, and thus the most cherished, expressions of naturalness. As Birch (1990) puts it:

"Wilderness reserves should be understood as simply the largest and most pure entities in a continuum of sacred [i.e., natural] space that should include, for example, wilderness restoration areas of all sizes, pocket-wildernesses in every schoolyard, (..) cracks in the pavement (..)".

What we cherish, then, in pockets and cracks is not that they are pockets or cracks, but the self-organizing life that expresses itself through them. In this conceptualization, nature policy is not the management of nature reserves and 'semi-natural' landscapes, but the fostering of naturalness everywhere. When operationalizing such a policy at a practical level, wilderness areas will prove to require a layer budget than are cracks in the pavement, but many differences between the two types of policy will continue to be present. In the 'naturalness' conceptualisation, for instance, the enhancement of 'urban' nature close to home will appear not only as a means to sentisize children and adults towards preservating 'real' nature, but also as an aim in itself. And deeper down, the 'naturalness' conceptualisation is much more expressive of the image of Rolston (1989: 130), in which nature is not only the collection of 'emergent' creatures and systems that share the world with us, but also the source from which we too have arisen, and to which we are still deeply connected. Moreover, the 'naturalness' conceptualization is much more conducive to the long-term vision of Birch (1990), in which nature is taken out of its "incarceration" in wilderness areas and the Sundays of our life, and is re-installed as the "holiness inhering in the place where one lives".

Operational criteria for the intrinsic value of nature, it seems, should be able to fully express the 'nature' conceptualization of traditional nature policy objectives, but should also be interprétable in the 'naturalness' conceptualization of alternative nature policy, which I hold, intuitively, to be more 'future-rich'.

Operationalizing the intrinsic value of nature works chiefly by specification of appropriate *criteria* for evaluation. Before we can apply criteria, however, we have to know what to apply them to. What, in other words, are the 'target entities' of nature policy? Or, putting it more philosophically, what in nature can we have duties towards? In laws and policy documents, we find individual organisms, species, ecosystems and geological/geomorphological structures as policy target elements. At the same time, there are questions as to what these units are exactly and also whether all of them are really 'morally considerable' in their own right. For that reason, they will be briefly reviewed here.

The protection of individual organisms holds only a weak position in nature policies, associated as it is with animal protection of the 'Society-for-the-prevention-of-cruelty-to-animals' type. Nature policies are about the protection of species, not individuals. This firm stance is not without its own problems, however. Putting the locus of value on the individual organism is not confined to the society for the prevention of cruelty to animals. Ethically relevant, for instance, is that each individual animal (domesticated or not) has *telos,* some degree of awareness and the capacity to suffer, while the species has not *(viz.* De Groot, 1992b, Section 7.7). Moreover, there is the argument of Callagher (1988), who denounces species protection as the "disdain of the biologists". What most people enjoy primarily when a wild bird visits their garden, Gallagher asserts, is *that bird,* not some abstract species entity. There do exist sound arguments, therefore, to say that nature policy should enhance simply *numbers* of wild animals and plants, irrespective of species, or with species at second place.

But what would such a policy lead to? If, for instance, we see a wolf killing an elk, what should we do? Run to protect the elk? But then, what to do if the wolves starve? Feed them? With what? With elks, e.g. by taking out the weakest and oldest from the population? But wasn't that already what the wolf was doing? At the higher level, we want elks and wolves (species) to continue, and their natural relationship (the ecosystem) through which both the wolf and the elk species maintain their evolutionary fitness.

Species are not mere categories of individuals; they are the identifiable long-run streams of life. At a higher level, we see the individual as an instance incarnating the species genome. As Rolston (1988:149, 151) puts it:

> "The genetic set, in which is coded the individual's *telos,* is as evidently a property of the species as of the individual through which it passes. (...) The species too is a historic process with a vital individuality pursuing a pathway through the world (...), a storied achievement."

A biologically informed ethic, Rolston concludes, sees primarily the species as the ethically binding survival unit. Additionally, we may observe with Rolston and with Sagoff (1988) that legal courts in practice vigorously uphold the species point of view; an emphasis on species is obviously not something conceptualizable by biologists only.

What we see and value in nature is individuals *and* species. With the wild bird in our garden, the individual comes first; the life stream it expresses is the additional source of value. When, on the other hand, Rasa (1985) decided to study the mongoose, the species came first; then, in the field, came the family ("Diana and Co.") and finally the individuals, Diana, George, Moja, Mbili and all the others, expressive of the same genetic set and yet different one by one, as an additional source of wonder and admiration.

Nature policies, in my view, should be expressive of both individual and species value. Separating these two into distinct 'numbers' and 'species' sub-policies or subsets of evaluation criteria does not seem a wise course, however. Without pursuing the issue at a philosophical level, I intuit that the concept *ofpopulation* may serve as an appropriate confluence of individuals and species thinking. The following reasons apply.

- 'Species' is an abstract concept. Species do not have a concrete size. Populations do, however, in a way that each individual counts. Also, far above species extinction thresholds, environments with large populations are better than environments with small numbers of the same species.
- Populations are populations *ofspecies;* contrary to 'individuals thinking', in which is it rightfully maintained that each individual carries the same *telos* and hence the same value, 'populations thinking' allows nature policies to differentiate between the common and the endangered.

- Populations are natural units; contrary to species and individuals, they do not exist in zoos.
- Populations carry the long-term perspective; populations remain fit because individuals die selectively. With this also comes the notion of carrying capacity. If a carrying capacity is exceeded, each extra individual still counts, but in a problematic way. 'Populations thinking' thus leads to the maintenance and enhancement of carrying capacities as a key element in nature policies.

Populations, therefore, may be thought of as the first final variable, the primary 'target entities', of nature policy.

The *ecosystem* concept is the next candidate for describing policy target entities. First, we must note here that in empirical ecology the concept lacks a notion of scale. Ecosystems have boundaries identifiable as "relationship density minima" (CENW, 1984), but these may be as wide as the North Sea or as bounded as the bacteria community on our teeth; see, for instance, Odum (1971) about the succession of a dunghill community. For empirical theory, this makes sense; for normative theory it does not. In normative literature (ethics, policy statements, etc.), we encounter descriptions of value residing in three more specified types of ecosystems, notably:

- The 'primary units' of the landscape, called *ecotopes* by Troll (1950) and Stevers et al. (1987). Typical ecotope types are, for instance, brackish creeks, alpine meadows and hickory-oak forests.
- Then, there are the secondary and higher units that may be typified by their homogeniety or characteristic heterogeniety: the ecodistricts, ecoregions, ecozones, biomes and so on (e.g., Bailey, 1983; Klijn, 1991). Taking them all together, we may use *ecoregions* as the umbrella term.
- Stressing the process rather than the pattern aspect, we also find the more foundational notion of the ecosystem as the carrier of bioevolution, the "source" in Rolston's term. The process-oriented conceptualization of the ecosystem as bioevolution expresses values which are not only intrinsic, but at the same time crucial for sustainable human development. It will therefore be re-encountered in the Annex of this chapter.

The question here is: are these systems nature policy targets in their own right? As explained in De Groot (1992b, Section 7.7), there is much to say for evading the question of intrinsic value at this point. First, we may regard the ecosystem as simply the sum-total of the species it holds, and conclude that ecosystem protection is the protection of the many inconspicious species that usually slip through the net of species-oriented nature policies. Secondly, populations so obviously need the ecosystem in order to function as populations at all that population protection includes ecosystem protection without further explanations being necessary.

Other ways of reasoning (e.g. De Groot, 1992b, Section 7.7, and Rolston, 1988) arrive at the conclusion that ecosystems (especially the closely-knit ones) do have an intrinsic value of their own, not because they have their own *telos* and hence their own interest, but because they have their own *dignity.* Through the dignity concept, it also becomes theoretically accessible that geo(morpho)logical structures and processes can be policy targets, i.e. worthy of protection, coinciding with the common intuition that places like Mount Fuji or Antarctica are somehow 'more' than our backyards, and that not every river or estuary is lying waiting to have its geomorphological dynamics dammed and tamed.

Finally, without necessarily going into the question of whether processes (as opposed to entitites and their structures or pattens) can be intrinsic value carriers, it should be noted that the ecosystem concept cannot go without the processes notion. The traditional emphasis on ecosystem structures and pattens leads to policies that try to fix things in places and niches where they are assumed to belong because they are there at present. Modern ecological theory and research (e.g. Hengeveld, 1990; Van Zoest, 1991; Botkin, 1990) indicate that species are constantly on the move, and that ecological balances are forever shifting, often permanently far removed from 'equilibrium' states. Nature protection is not only about the patterned results of natural dynamics, but also, and maybe even more, about protecting the dynamic processes themselves.

Summarizing this subsection, we can say that nature policy (policy to protect and enhance the intrinsic value of nature)

- should not only be conducive to the conceptualization of nature as an assembly of species and system entitities, but also to the conceptualization of nature as the naturalness of everything
- and that nature policy should be targeted towards patterns and processes in and between populations and ecosystems (including abiotic features of special quality).

The remainder of this section will be devoted to the development of *criteria* and *procedures* to operationalize the intrinsic values of nature and people-nature relationships, bringing them one step towards the practicalities of policy-making. Criteria are qualitative norms; they describe what is normatively relevant without, however, pinpointing a certain threshold value dividing the acceptable from the unacceptable, as quantified norms do.[131] Hence, criteria perform all the functions that other unquantified final variables do; they describe policy objectives, they prescribe the terms in which proposals should be evaluated (e.g. in EIA), they form the basis for norms derivations reasoning 'downwards' from objectives to environmental quality and activity variables[132], and guide the design of new policies.

Below, we first define the two 'families' of criteria with respect to the intrinsic value of nature. Then, the focus is on the operationalisation of these two families

[131] The Acceptable Daily Intake (ADI) is a well-known example of a quantified norm; it first qualifies what is important (e.g. mg Cd intake per day) and then quantifies the threshold (e.g. 0.1 mg Cd intake per day). With respect to the intrinsic value of nature, only few quantified norms exist. A well-known example is the 'Ramsar norm', specifying that a wetland is of international importance if it supports 1% or more of the global population of a bird species.

[132] With respect to Dutch nature policies, see for instance DHV/RIN (1991) about parameters such as 'density of footpaths', 'cubic metres of extracted groundwater' and so on.

separately. Finally, we turn to the operationalization of intrinsic value in people-nature relationships.

Two families of criteria for the intrinsic value of nature

If we conceptualize nature as a collection of discrete species and system entities, and if we then concentrate on such well-known criteria as diversity and rarity, we fall into the 'zoo trap', i.e. the idea of nature policy as the preservation of as many species as possible, irrespective of the degree of artificial inputs that preservation requires, and the preservation of ecosystems in the state and place they are, irrespective of natural tendencies to climax states and dynamic breakdowns, e.g. by fire. These policies have come under criticism in recent decades (e.g. Boster, 1990; Van Zoest, 1991). The most important ground for this criticism, in my view, is that having conceptualized nature as an collection of things, the first thing we must do is restore the perspective of nature as naturalness. In brief, to *let nature* (as a collection of things) *be nature* (as naturalness).

There exist, therefore, two core criteria to operationalize the intrinsic value of nature: naturalness and diversity (e.g. De Groot, 1987; Kockelkoren, 1990a). Needless to say, naturalness and diversity are often at odds with each other in practical nature management discussions. If, for instance, natural forest fires tend to destroy 1,000 ha of forest each time, and we have only 1,000 ha of a rare forest type left, what should we do? Or if a rare and species-rich type of wetland vegetation is on a succession course to a common and less diverse vegetation type, should we go and supress that succession?

Space does not permit me to go into this discussion here; I will be satisfied if a proper operationalization is reached of the two criteria separately. Through such operationalization and by taking a good contextual look at the concrete problem situation, creative solutions will often be found. With respect to the wetland succession problem in the Netherlands, for instance, it has been decided to shift away from constant suppression of the succession, and instead to re-start the succession by rigorous but local dredging away of all vegetation, so that the area displays a shifting pattern of succession stages from open water to forest, in each of which the succession story is unfolding unsuppressed.

The operationalization of naturalness

Naturalness criteria may be found in the literature in a wide variety of conceptualizations. In Dekker (1990), Canters and Udo de Haes (1986) and Clausman and Den Held (1984), we find references to naturalness as:

- the degree of absence of human influence
- the degree to which the ecosystem is running on solar energy only, without external inputs
- the degree of completeness, in the sense that all niches of the ecosystem are filled

- the degree of completeness, in the sense that all trophic levels are present
- the degree of unbrokedness of gradients
- the degree to which the ecosystem is self-regulating and self-maintainings
- the degree to which species have established themselves spontaneously and maintain themselves, irrespective of what human activity may be the cause
- the degree to which human influences remain within natural dynamics.

As a group, these criteria obviously convey several relevant notions. Taken one by one, however, the criteria appear too weak to act as really operative normative tools. Many completely natural ecosystems, for instance, run on a constant inflow of energy and other inputs from outside; spontaneous fires, floods and other natural extreme events (Wigley, 1985) break gradients to a much greater degree than most human actions; completeness, as Dekker (1990) points out, is a concept that cannot be grounded in empirical ecological theory. Moreover, the criteria are obviously contradictory.

At a deeper level, a problem with many natural criteria is that they hinge on the image of the ecosystem as a self-maintaining unit, "running" on something, with niches that can be "empty". As said in the previous subsection , and discussed extensively in De Groot (1992b, Section 7.7), this image is incompatible with empirical ecology. When a climate changes, for instance, it is not the ecosystem that starts shifting but the species, at different paces and in different directions, so that new ecosystems are formed both where the species originate and where they arrive, together with new arrivals from other places. Insofar as ecosystems are stable, they are stable because they are maintained by strategies *(telos)* at the species level, not because they maintain *themselves,* seeking some equilibrium.

From these two problems with current naturalness criteria, two conditions for a more adequate operationalization appear. First, it seems, naturalness criteria should be derived, and derived consistently, from a single 'generating concept'. Secondly, this concept should be free of the image of ecosystem self-maintenance. In Section 7.7 of De Groot (1992b), *health* is taken as the generating concept, tuned down (because of the second condition) to a 'weak version' as far as ecosystems are concerned. Here, we will first look into this concept, and then relate it back to naturalness.

Health, as is shown by De Groot, is conceptualized at three levels:
- health is effective performance of tasks
- health is self-maintenance, autonomy, the capacity to respond
- healthy is that which functions in accordance with its inlaid design.

Of these, the first is equal to instrumental, not intrinsic value; it is therefore treated in the next section, "functions of nature" (without, for that matter, calling it naturalness or health). The second conceptualization, which could continue to read "self-maintenance" with respect to populations but should be tuned down to "stability" with respect to ecosystems, is also not a very fortunate one. If a population becomes locally extinct, for instance, is that unnatural? Island theory (MacArthur and Wilson, 1967) shows that often it is not. The same applies to forest fires or rapid successions from one ecosystem type to a very different one. Or, if a coastal dune ecosystem is eroded by a severe winter storm, is the ecosystem unhealthy or unnatural if it cannot 'cope' with it? And healthy again the moment the storm dies down?

As in De Groot (1992b), the third conceptualization of health is the one to be preferred. Thus, the question becomes: this functioning of populations and ecosystems *according to their inlaid design,* how does it relate to naturalness, and how can it be operationalized? To this, the following may be added.

The term 'inlaid' (or 'enfolded' or 'ingrained') stands for what is natural. It is not *our* design that counts, but nature's own.[133] As we will see, this does not remove man from the naturalness picture; it only removes much of man-the-designer. In order to grasp what such an inlaid design may be, we somehow need to take the inside point of view, contrary to the other two conceptualizations of health, which can be judged from the outside. As De Groot (1992b) puts it, health is a hermeneutic concept.

In order to operationalize the concept of naturalness through the concept of health, then, we must somehow be able to build up an image of what the 'inlaid design' of a certain situation is, and use this image as a template (a reference) against which to judge the actual situation. With respect to ecosystems, the active agent of the inlaid design cannot be sought at the ecosystem level; ecosystems develop, but they do not develop themselves.

In De Groot (1992b), a contextual procedure is proposed to arrive at the template image. 'Contextual', as in the previous section, here means that the heart of the matter is to tell the story of each concrete situation to be assessed, in which abstract notions such as general criteria serve only as guides for the storytellers, not as the final assessment criteria. The point of departure and the active agents in these stories are not the ecosystem, but, respectively, the "virtually unchanging" abiotic characteristics of a place, and the "species belonging to that place", which include man. Since the role of man is the most contradictory element in the naturalness criteria quoted before, it seems wise to concentrate on this first.

The guiding criteria for the inclusion of man are that man behaves "just like another species", equipped with his own repertoire and intelligence, and that he is "responding to the place", not dominating it. If these criteria had to serve as final assessment criteria, they would be unsatisfactory[134]. They have an intense guiding power for contextual assessments, however, e.g. to mark the difference between large-

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[133] The term 'in accordance with its design' is taken from Boorse (1981). The terra 'inlaid' has been added because Boorse is speaking about human health only, where it goes without saying that one's health cannot be measured against what someone else has designed one to be. This is made clear by terms such as 'autonomy' and 'wholeness', closely associated with the same health concept (Section 7.7).

[134] It may be noted, for instance, that "without dominating it" is a theoretically inconsistent addition. Species, obviously, do sometimes simply conquer places and dominate them. Usually, this is only on a local scale, but this is a contingent argument. The notion "without domination" has been slipped in for the practical reason of not becoming too far removed from current naturalness criteria and for the higher reason of partnership with nature (ref. the final subsection).

scale fisheries for world markets and coastal fisheries for family subsistence (penguins do it!). This is one example of the easiest type of stories; others concern the naturalness of small dams for group maintenance (beavers do it), or eutrophying a local area around a village (cormorants do it). Other stories will involve a discussion about the uniquely human repertoire (fire-making, tool-making, reflectiveness), and yet other stories will be much more complex and in need of critical discussion, up to the level of the "regional narratives" of the previous section; see also the examples in De Groot (1992b, Sections 7.7 and 8.7), about voluntarism.

Having thus grasped how to deal with the degree to which human action may be assessed as "belonging to the place" in question, we may now summarize the contextual procedure of De Groot (1992b) in full.

- First, we must assess the abiotic reference or, as De Groot puts it, the *place* the state of which we want to assess the naturalness of. This place is defined by its virtually unchanging natural abiotic characteristics (including recurrent events), i.e., climate, lithography and slope, droughts and hurricanes, etc.).[135] Places defined thus are a Sahelian floodplain, a temperate zone delta level area, a sub-arctic shallow lake, and so on. (There is no need of course, for these descriptions to coincide with offical landscape type taxonomies.)
- On this basis, we can draw up the list of "species belonging to the place", i.e. all the species that could fit into the place, at one time or another. These include the pioneer species, the climax species, the large predators that may walk through from time to time, the migratory birds that are only there a few weeks per year, the parasites that are 'waiting' to attack, and so on. The list will usually include man, in the way described before.
- From these two sets of 'data', the reference image can be built up, telling the story of the place's natural development. This story will of course include probabilistic elements and many expert judgements, even when the best of ecological knowledge is used. Also, differences may arise as to what are the defining abiotic characteristics, what is to be seen as "responsive" human action, and so on. Building the reference image is an interactive process, moving between ecological data, ecological theory and moral vision. In my view, such discussions, because they focus directly on the concrete heart of the matter, will be much more fruitful than abstract debates about 'stability', 'integrity', perfectly formulated criteria and so on.
- Against the reference image, the actual state of the place can be evaluated, assessing the degree to which it is part of the story of the place's natural development. The assessment may be facilitated by distinguishing, as in the first subsection,

[135] It could seem that the assessment procedure is circular at this point: to assess what is natural, we must first find natural characteristics. This is not the case, however. We use that which is unproblematically natural (e.g., that it rains erratically in the Sahel) to assess what is problematically and relevantly natural (e.g., the degree of naturalness of a certain Sahelian forest ecosystem).

between populations[136], ecosystem characteristics (especially ecotopes), and between structure (pattern) and process.

Obviously, the contextual procedure is not only applicable to assess the naturalness of situations, but also to design the 'naturalness element' of nature management and, one step more active, the physical design of naturalness restoration (or 'nature development', as it is called in the Netherlands, where every square metre and drop of water has in the past been brought under control with an almost pathological compassion; nowadays, we almost as diligently design re-eroding dune valleys, re-meandering rivers, re-swamped polders and re-mudded lakeshores). In general terms, the outcomes of the contextual procedure will be in accordance with well-accepted principles to carry out naturalness restoration in as natural a way as possible, namely, to restore the basic abiotic characteristics (in our terms, the place) and to give all species belonging to a place a chance to settle when their time has come, e.g. by means of connecting the place to others ('ecological infrastructure'). The results of this subsection are summarized in Box 4.2.

The operationalization of diversity

Expressive of the intrinsic right of life forms to continue on this earth, diversity is the second great foundation of nature policy. As discussed before, it is often also the great antipode of naturalness at the level of practical policy decisions. The same occurs in the epistemological field. Contrary to naturalness, diversity can be assessed 'from the outside'; to assess diversity, we do not need to understand nature, we merely count. Hence, there is no contextual procedure with criteria to guide it; diversity criteria are

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[136] Note that populations cannot be assessed outside the whole-story context. Seen in isolation, the inlaid design of any population is simply to grow. Therefore, populations must be assessed within the context of the place (e.g. carrying capacity) and the other species that belong to the place (competition, succession, symbiosis, etc.). By way of example, we may take a look at the stinging nettle in the Dutch coastal dunes. We find the stinging nettle underneath nitrogen-fixing shrubs, along paths, at the entrances to rabbit holes, and massively along artificial ponds, where water from the lowland rivers is being pumped in (Van Dijk and De Groot, 1986), in order to be pumped up again for public water supply after passing some 100 metres through the natural sand 'filter'. The stinging nettle is a "disturbance species" (Stevers et al., 1984), but the contextual procedure will obviously include it in the set of species belonging to the place. The rabbits disturb too, after all, and the nitrogen-fixing shrubs are no disturbance at all. Without rejecting the stinging nettle *per se,* the contextual procedure will tell us how to evaluate the stinging nettle situation. Most likely, nothing unnatural will be found with the stinging nettles underneath the bushes and at the rabbit hole entrances. The story of the paths will be much more nuanced; man is a path-making species as are many others, and human paths are not necessarily signs of unresponsive domination. The artificial pond situation will be found to be downright problematic. Not *per se* because the ponds are artificial; rabbits also dig. Neither, *per se.* because of the scale of the water supply infrastructure; sand grouses also carry water to their young over long distances. The threshold of unnaturalness is crossed, however, by the combination of scale and intensity of the intervention: no 'just another species' can be imagined that overhauls the basic abiotic functioning of a place at that order of magnitude.

Box 4.2
OPERATIONALIZING THE INTRINSIC VALUE OF NATURE

NATURALNESS

- *Guiding criteria*
  - Naturalness includes human action, insofar as humans behave as 'just another species', responding to the place
  - Naturalness is built on place, i.e. the basic, natural abiotic characteristics of an area
  - Naturalness is built by the species belonging to the place
- *Contextual assessment/design procedure*
  - Define the place, and thereby the species belonging to it
  - From there, build up the dynamic reference image (the story of the place's natural development)
  - Compare this with the actual situation and development (populations and ecosystems, structure and process)

DIVERSITY

Not contextual but direct assessment, with as criteria:

- Species and ecosystem richness
- Endangeredness (= expected global rarity of species and ecosystems); the core criterion
- National/regional expected rarity of species and ecosystems (but carefully)
- Encounterable species and ecosystem richness

direct *assessment* criteria. In this subsection, the following topics will be touched upon:

- emperical 'versus' normative diversity
- the question of how to account for all species
- the question of intrinsic value differentiation
- the relation between diversity and rarity
- and the criteria themselves, one by one.

The results are summarized in Box 4.2.

Empirical ecology uses diversity measures for many purposes, e.g. to build up ecosystem typologies or as indicators for pollution. In these studies, the diversity measure is made up of two components, i.e. species richness and the evenness of their distribution, combined to form a variety of indices; Magurran (1988) gives an overview. For normative purposes, however, diversity as species (or ecosystems) richness holds the logical primacy to express the intrinsic right of life forms to continue (Magurran, 1988). This is also the choice made in normative assessment studies, or 'conservation evaluation schemes', as Usher (1986) calls them in his overview. As we will see later, evenness of distribution and other characteristics such as susceptibility will also play a role in normative assessment, but with a derived status, not in a side-by-side relationship.

When predicting, measuring or evaluating diversity, the logical thing to do is to take in *all* species, or ecotopes, or whatever else the assessment is about. For species especially, this is a practical impossibility. The best way to circumvent this problem is to split the assessment in two, one part focusing on some set of directly 'measurable species' and the other trying to catch the rest by means of some indicator. What may be appropriate indicators depends on what species are in the 'directly measurable' set. The usual situation will be that this set is filled by relatively large species of higher plants and animals. Typically then, some indication of micro-habitat diversity is what one should be after for the second part of diversity assessment. In its turn, micro-habitat diversity may be indicated by either ecotope or micro-gradient diversity (Samways, 1990), or the species diversity of some taxonomie group. As said in the first subsection, taking ecotope diversity has the advantage that one focuses on something that is not only a sum-of-microhabitats indicator, but also something with a value on its own. Taking a taxonomie indicator group, on the other hand, may sometimes be easier. In and around the tropical rainforest, the fruitfly (*Drosophila*) group is quite accessible to measurement and at the same time thought to be a good overall 'micro-species' diversity indicator, because the group contains both generalists and specialists.

Next, there is the question whether normative diversity assessments should be stratified by species group. In other words, should all species count equally in an undifferentiated diversity measure, or should 'higher' groups (say, birds) be set apart from 'lower' ones (say, worms), not because of their empirical difference, but because birds have more intrinsic value, per species? Zweers (1987) asserts that intrinsic value is primarily an undifferentiated concept; we should be reluctant to favour one type of species over another. The modern catchword 'biodiversity' has the same undifferentiated character. The consequence of this standpoint would be that nature comes to coincide largely with insect protection, and beetle protection especially; probably, more beetle species (most of them unknown) are driven to extinction every year than there are bird species in existence. On the other hand, there is the unshakable human notion, visible already in Genesis 1, that value in nature is differentiated; species are, as Rolston (1989) would put it, greater and lesser "storied achievements". Strange as it may seem, I know of no systematic treatment of this matter; contrary to the much-discussed naturalness-versus-diversity issue, no-one seems to bother much about this one (yet). Without help, the only thing I can offer here is a personal proposal. It is to (1) confine undifferentiated diversity to the field where simply *genes* count one by one, i.e. the (instrumental) value of the gene pool for future medicines, crops etc., and (2) to differentiate when it comes to intrinsic value, but in an as subdued as possible way. One way to do this is to separate the diversity assessment into a 'high' and a 'low' part, as in the previous paragraph, and leave the rest for further discussions (if any).

The final question concerns the relationship between diversity and the other, much used and obviously allied, criterion of rarity. The most straightforward conceptualization of this relationship is to say that the rarity criterion is a *practical derivative of* the diversity criterion; if we have a limited budget to spend on diversity upkeep, we should spend it where it is most needed, i.e. the rare species and ecosystems. (Note that this is not a differentiation in the sense that rare species are assumed to carry more intrinsic value than common ones.) Rarity is therefore a biased interpretation of diversity. As shown in greater detail in De Groot (1986), it is important to bear in mind that the rarity bias may be steep or less outspoken, depending on the arithmical transformation adopted to transform species abundance (e.g. the number of individuals or the number of sites where it is found) on a rarity scale. Traditional scales tend to put a great deal of emphasis on the very rare species, and thus easily lead to a very strong bias of attention and budgets to preserving these species in isolated nature reserves, missing out (in the Netherlands, at least) on the dramatic decline of the slightly less rare species in the landscapes outside the reserves. Secondly, it should be borne in mind that rarity varies with the spatial scale adopted for the rarity assessment. Any area selected from the earth surface has a different sequence of what is rare and common in that region. Regional rarities may be common on a global scale; locally common species or ecotopes may be endemic, and endangered on a global scale.

Box 4.2 gives four criteria with wich to operationalize the diversity concept. For a sound interpretation of each of them, the foregoing paragraphs are a necessary background. Here, the four criteria will be discussed one by one.

The first is simply *species and* ecosystems (especially *ecotope) richness,* with ecotopes standing either as an indicator of the sum of micro-habitats of inconspicious species, or also as a value in itself. The advantage of this criterion is that it links up well with empirical ecology and with a general description of the ecology of the area in question. The disadvantage is its poor linkage to the practical necessity to focus budgets and decisions on rare species and ecosystems. The criterion, therefore, is to be used either as a subsidiary one or in situations where budgets (e.g. protection priorities) or decisions (e.g. in EIA) are not directly at stake.

The second criterion of the diversity family is ***endangeredness,*** further defined as *expected global rarity.* This is the core criterion, expressing most directly our wish for other species (and ecosystems) to continue on earth. The reason for taking expected global rarity and not simply global rarity is that account should be taken of trends and risks; some species are rare but safe, others are less rare but threatened nonetheless, e.g. because of a rapid deterioration of habitat or too scattered a global population. "Expected", therefore, expresses that some assessment should be made of the position of a species in, say, 20 years' time. Tools for such an assessment (e.g. Clausman and Wijngaarden, 1984) are (1) simply measuring and extrapolating population, abundance or habitat trends, (2) taking into account the evenness of a species or ecosystem distribution, or the degree to which is confined to specific areas, (3) taking into account the species or ecosystem susceptibility to external factors and (4) assessing the long-term viability of (sub)populations by means of biogeographical theory.

The third criterion is *national/regional expected rarity,* in which 'expected' denotes the same as before. The criterion has only a derived status with respect to the previous one, but it is added to express the responsibility of decision-making bodies to care for their 'own' rare species and ecosystems. The term 'national/regional' should therefore be interpreted as the area ofjurisdiction of the decision-making body in question (Europe for EC policies, a state for state policies, etc.). This, at least, is as the responsibility of decision-making bodies is commonly interpreted. At the same time, this operationalization may lead to policies that miss the mark of, or even run counter to, the core criterion of global rarity, as indicated above. In the Netherlands, for instance, a criticism is that national policies focus too much on species and landscapes that happen to be rare on the national scale but can be found in large numbers and areas in neighbouring countries, while neglecting the lowland region, where most people happen to live and which most people, in a national myopia, think is nothing special. For this reason, "but be careful" has been added in Box 4.2 to the national/regional rarity criterion; it is not that decision-making bodies should just take responsibility for the rare species and ecosystems within their area ofjurisdiction, but they should also be careful not to take simply that same area when defining what these species and ecosystems are.

The fourth criterion, *encounterable species and ecotope richness,* is of a different order. Primarily, the criterion expresses not an intrinsic aim of nature protection policies, but the protection of its most fundamental means, i.e. its social and cultural basis. This basis is that people can *meet* nature, and nature that you meet is the diversity of fishes you catch in your fishing net when you are young, the diversity of flowers along the sand path, the sounds of the untouched tropical forest at night, the silent bog. 'Encounterable' species and ecotopes are not trivially the selection of those species people can shake hands with or be sentimental about, because human response to nature is multilayered and multifacetted. Yet, it is a selection, different from the selection of rarity. And with it comes also a different way of looking at spatial scales and lay-outs; in this criterion, the bias is towards unfenced nature close to home. The bottlenose dolphin is not an endangered species; yet, policies conducive to its reappearance in the North Sea should not only be cherished for naturalness reasons, but also for reasons of 'encounterability'. The dolphin being a species with which human identify easily, it re-establishes a linkage between people and the sea ecosystem it is part of.

In practical assessments, the four criteria may be applied in many mixed and derived forms, without changing their basic character. Assessing the intrinsic diversity value of a wetland area, for instance, we may follow the four criteria more or less strictly, e.g. focusing on the global and national rarity of the ecosystem type it represents and the species it harbours. The Ramsar Convention does it differently, focusing on the number of bird species of which a high proportion of the world population depends on the wetland, e.g. as a migration 'stepping stone'. Implicitly, this is an application of the second criterion, expressing how many bird species would become rare or extinct without the wetland.

An important choice in practical assessment concerns the degree to which one allows all criteria (including naturalness) to bloom and tell their own story. A fully-fledged assessment is obviously the best choice for broad and long-term decision-making. At the other extreme, small-scale interventions and a low EIA budget may neccesitate focusing from the start on some sharply delineated 'stacked selection' of criteria, e.g. the naturally occurring rare-and-encounterable species. The price then paid is the poor understanding of all motivations involved, and poor conveyance of these motivations to the public. In my impression, the second road is taken a little too often, and I hope that the present section has opened up possibilities for designing better adapted assessment strategies.

Criteria for people-nature relationships

Imagine a piece of wild pioneer nature, evolved in some forgotten corner of the urban fringe. You may go there and assess its value through the naturalness and diversity criteria described in the preceding subsections. Now, imagine that you do not find only an ecotope with species, processes and so on, but also signs that a group of children play regularly in this place: a narrow path, a piece of rope high up in a tree, a hide-out under the brambles, the traces of a small fire. Added to the place, then, is de fact that it is also a place of relationships between people and nature. Would you then intuit that added to the *value* of the place there is the *value* of it also being a place of relationships? If you do, you acknowledge that intrinsic value is not only in people and nature separately, but also in their encounter. Such an acknowledgement with obviously change the way one evaluates urban fringe situations, as it will the evaluation and design of farm practices, tourism, parks, fishing, nature reserves and so on.

De Groot (1992b, Chapter 8) explores the issue of good relations ('partnership') of people and nature in greater depth, setting it at the centre of a fully-fledged world view. Here, I will only mention two assessment criteria, both of which are fairly obvious. As in any relationship, the relationship between people and nature carries positive value to the degree that it is characterized by:

- *involvement* (intensity, dailyness).
- *non-dominance* (appropriate response).

These characteristics were there in the forgotten corner of the city fringe; the eutrophic pioneer ecosystem was not dominated by the children's play (which is not to say, of course, that hide-outs, holes and campfires are to be allowed in fragile ecosystems; responses should be appropriate).

In policy-making practice, the formal status of the relationship value, although expressed in various policy documents and practices, is as yet weaker than the criteria of naturalness and diversity. 'Relationship assessments' are therefore not likely to be undertaken as an independent source of normative information side by side with naturalness and diversity. At the same time, however, informal bits and pieces of the relationship notion creep up in many practical and philosophical discussions, indicating that at least some minimum should be included in all evaluations and designs. My way to stimulate this, as you may have noticed already, has been to slip this minimum into the naturalness and diversity criteria (e.g. the role of man in naturalness, and encounterability in diversity). This implies that if involvement and non-dominance of people-nature relationships are included as an independent set of criteria, the implicit relationship components in the naturalness and diversity assessments should be tuned down, in order to avoid double-counting.

4.7 Functions Of The Environment

The functions of the environment, as we saw in Sections 4.2 and 4.3, are the tasks performed by the environment for the realization of the values expressed in the final variables (the intrinsic values of human health and welfare, of nature, etc.). Structurally, classifications of functions play an important organizing role between the environmental quality parameters and evaluation in terms of final variables, e.g. a cost-benefit analysis, a multicriteria analysis or a more narrative account. In the present section, the emphasis will be on one of these classifications, called 'CPSH+PR' after the first letters of its major components. In the second part of the section. I consider another classification approach ('IEIE').

If a classification of functions is to work properly as a structuring support in an environmental (problem) analysis, it should meet some basic criteria of homologousness, exhaustiveness and relevance of the categories. Only classifications complying sufficiently with these criteria will be discussed in this section. Others, such as those of Ledec and Goodland (1988), Turner (1988), Bon (1986), Dixon and Sherman (1990) and the 26-items list of "functions and uses" in Eagles (1984) have been used as a background source to check the completeness of the classifications supplied here.

Sources of the CPSH + PR classification

In the 1960s, Odum referred to the capacity of the environment to process organic waste as a "public service function of nature". The functions concept is a recurrent theme in the environmental literature from that time onwards. In the Netherlands, classifying the functions of the environment grew into a "little tradition", starting in the early seventies[137] and finding its still most widely quoted form in Van der Maarel and Dauvellier (1978). It is summarized on the next page.

The overall impression of this list is that it is indeed a balanced picture of most of the major tasks performed by the environment. On second sight, however, some cracks begin to show. Many of them are of a minor character[138]; they will be repaired without discussion in the classification of the next subsection. Three issues require more attention, however. The first two concern the non-exhaustive character

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[137] See, for instance, Westhof (1971), Hueting (1974) and the overview of Bouma and Van der Ploeg (1975).

[138] E.g. enjoyment of nature is largely a recreation activity; this overlap gives rise to double-counting. 'Information' is not a fortunate term for cultural and spiritual orientation and enjoyment. Dilution and absorption of pollutants lie too close to be separated in two function categories. What the environment supplies with respect to waste disposal is not only isolation, purification, etc., but also open space to dump it.

FUNCTIONS OF THE ENVIRONMENT, 1978 classification

- Production functions
  . abiotic (energy, minerals, etc.)
  . biotic (wildlife, fish, timber, etc.)
  . agricultural (crops, cattle, intensive forestry, etc.)
- Carrying functions
  . carrying urban and rural constructions
  . isolation and dilution of waste and pollutants
  . carrying recreation activities
- Information functions
  . cultural orientation function (of landscape, etc.)
  . enjoyment of nature
  . research and education
  . signal function (e.g. pollutant indicators)
  . information reservoir (especially the gene pool)
- Regulation functions
  . purification (absorption, filtration, biotic processing)
  . stabilization (protection against cosmic radiation; reducing climatic variations; regulating water flows; retention of soil; biological equilibria)

of the list, the third concerns its homologousness.

Strictly speaking, the functions list is not anthropocentric; 'production' may be interpreted as also including the production of grass for antilopes and insects for birds; trees may be regarded as a 'rural construction' to build a nest in. Yet, given the overall tendency of humans to be human-centred if not actively reminded that we may not be the only value the earth carries, some explicit reference to natural values needs to be provided, using a term like 'preservation', 'habitat' or any other term unequivocally conveying the functions-for-nature notion.

The second weak spot in the 1978 functions list is the poor representation of the sustainability concept. Sustainability comprises two basic connotations: that of the continuability of current activities, and the deeper connotation of 'reservoir', i.e., the maintenance of the bioevolution and options to respond to future needs and problems. The continuability component does not add a function to the functions list.[139] The

[139] Using a dune ecosystem as a filter for drinking water supply is uncontinuable, for instance, leaving the next generation with a polluted ecosystem and as many toxicants coming out of the dunes as were pumped in. Identifying this is not a matter of some other function of the dunes, however, but

'reservoir' component of sustainability, however, is of a different order. The 1978 classification, for instance, rightfully has an 'information reservoir' function in its 'information' list. The omission here is that it does not contain a 'reservoir' component in the other classes of functions. One way or another, a good functions classification should also conceptualize that there are 'production reservoirs', 'carrying reservoirs' and so on, additional to the continuability of production, carrying etc. functions.

The third problem of the 1978 classification is that it is not sufficiently homologous. This especially concerns the regulation functions. As has been pointed out already by Bouma (1972) and Ottenhof (1974), these functions come before the other three function types; they are "conditional". The agricultural production function, for instance, benefits from the water regulation and nutrient Sorption capacity of the soil; counting both the agricultural production and the regulation functions is counting the effect and the cause, hence counting double. On the other hand, if one takes a look at how the regulation functions are actually described in the literature, the notion of regulation usually goes together with the notion of some bounded area (say, a wetland) being functional for another area. The wetland, for instance, besides the production, carrying and information functions that manifest themselves inside the wetland itself, also serves the function that water flowing out of it is of better quality than the water flowing in. The classification, therefore, can be made homologous by introducing some notion of 'internal' and 'external' functions. As we will see later, this is somewhat more complicated than simply saying that the first three functions types are internal and the fourth is external. The solution here is to keep the wording more abstract, adding to the regulation functions the clause "as far as not accounted for already in the production, carrying and information functions". Thus it will be done in the next subsection.

R.S. de Groot (1986) has proposed some modifications which are useful to mention here as a preparation of the next subsection, either because they indicate problems yet to be solved, or because they are simply improvements which may be adopted. First, the vague notion of "carrying" has been clarified by specifying these functions as "providing space and substrate". De Groot also removes agriculture from the production functions and adds it to the carrying functions set; this is not really an improvement but it indicates the hybrid character of the production functions as formulated in 1978. As a result, two types of production functions will be distinguished in the next subsection. To the carrying functions set, De Groot adds "providing space and substrate for nature conservation". This double-counts with his addition of "habitat" to the regulation functions set, but it shows how the notion of function-for-nature as an intrinsic value can be added to the list. 'Habitat function' is the concept more often encountered (e.g. in the listing of Nip et al., 1992); it will be taken up in the classification of the next subsection.

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the long-term aspect of the purification function.

The CPSH+PR classification

Somewhat implicity, the terms 'carrying', 'production' and so on involve a picture of people-environment relationships as a classifying principle. The term "carrying", for instance, implies a picture of the environment as a passive provider of space, substrate or backdrop for buildings, waste dumps, motor cycle rallies and so on; people are the only active factor. In the "production" notion, the environment is much more actively involved; production in agriculture and forestry is an interactive process. The degree to which the environment is an active participant in the people-environment relationship may be used as a classificatory principle to define the six function types in the CPSH+PR-classification. This way, the functions are defined as follows below. They have been arranged stepping from the most passive to the most active role of the environment.

- **Carrying functions** are characterized, as just stated, by the environment providing nothing more than space, substrate or backdrop for human activities.
- **Joint production functions** are defined by the types of relationships in which human decisions and inputs remain a dominant factor, but in which the environment is also actively involved, providing, for instance, soil fertility and the will-to-develop *(telos)* inherent in plants and animals.
- **Natural production functions** are characterized by the fact that the environment now produces (or has produced in history) largely on its own; human beings are only the harvesters. Harvesting, in this function category, is confined to physical entities (oil, wildlife etc.).
- **Signification functions** are defined by the fact that the environment again largely 'produces' on its own and human beings are only the 'harvesters', but 'harvesting' now lies in the cognitive and spiritual realms, e.g. those of science, cultural orientation and spiritual participation. The term 'signification' has been chosen as a reference to both the relatively superficial concept of 'to signal' and the deeper concept of 'to signify'.
- **Habitat functions** are those of which not humans, but the other intrinsically valuable inhabitants of the earth are the prime beneficiaries; habitat function is the provision of their ecological home.

Before proceeding with the next two function types, it may be noted here that the habitat function stands in a conceptually uneasy relationship to the other function types. 'Habitat' is in fact nothing but carrying function, joint production function etc. for plants, animals and ecosystems. I have included the habitat function for defensive reasons only; one day, it may go without saying that of course "carrying function" is also space and substrate for the swallow's nest and the sequoia's roots, and that of course the "signification function" of a landscape is not only ours but also that of the wolf's freedom.

The next two functions are those we should count only, as stated earlier, insofar as they are not already included as underlying the other four.

- **Processing functions** are characterized by all the relationships in which people benefit from the capacity of the environment to undo the harm or risk inherent in human actions. In many of these functions (e.g. dilution, sequestration), the environment is relatively passive. In others (e.g. chemical transformation or the processing of organic waste), the environment plays a more active role.

- **Regulation functions** refer to the capacity of components of the environment to dampen harmful influences from other components. Often, this takes the form of a shield against too high levels of something, e.g. cosmic radiation or floods. In other instances, it is the dampening of processes that tend to go too fast or fluctuate too widely, e.g. soil erosion, the development of pests or river flow fluctuations.

In Box 4.3, the CPSH+PR classification is summarized, giving not the definitional images but some informal sub-classifications and examples, including the 'reservoir' notion discussed in the proceeding subsection. The examples, of course, are only a few characteristic elements out of very long lists. Wetlands literature, having a long tradition in 'functions thinking', is an especially rich source of information in this field (e.g. Roggeri 1992). From the examples it can be seen that some function types are not rigidly separated. The provision of wildlife for hunting is usually a natural production function, but when wildlife populations are maintained by means of winter feeding, the situation moves into a joint production direction. I prefer to leave this situation under the natural production functions, thus accepting a certain amount of human interference in the natural processes. Consequently, some 'timber stand improvement' or 'assisted natural regeneration' is accepted for forestry to still count as natural. I draw the line however, as the examples show, between these light interferences and the heavier ones of game ranching and plantation forestry. These arbitrary boundaries can be drawn differently without impairing the classification.

The habitat function, as said earlier, has been created by collecting and setting aside the elements from the carrying, production etc. functions that are relevant for natural ecosystems and non-human species. Analogously, a separate 'reservoir function' could be created by collecting and setting aside all reservoir functions, or a separate 'recreation function' by combining elements from the carrying and signification functions. Here too, choices can be made in a conceptually sound way.

The signification functions are the only item for which the Box 4.3 format is too confined to make the listing speak for itself. Rounding off this subsection, I discuss them in some more detail.

The first subtype, "signal functions" is conceptually distinct from the others in that it concerns a number of parameters indicating patterns and processes underlying one or more of the other functions; they could also have been included as elements of the other functions ('carrying indicators' etc.). One group of signal functions concerns the *spatial* indicators used by scientists, farmers, seamen etc. since time immemorial: certain grasses indicate good pasture, certain weeds indicate degraded soils, dolphins indicate the tuna, and so on. The second group comprises the *temporal* indicators - the environmental heralds and early warnings of good and bad things to come. In the Logone floodplain in Cameroon, for instance, the arrival of a certain bird foretells that the rains will come soon, and the arrival of a certain fish triggers off the

Box 4.3 FUNCTIONS OF THE ENVIRONMENT, 'CPSH + PR - classification'.

The functions below the dotted line should only be counted insofar as not accounted for already in the functions above. The definitions of the functions are given in the text.

CARRYING FUNCTIONS
- *construction functions*: providing space and substrate for urban, industrial, infra-structural and rural constructions
- *transpon functions*: providing space and substrate for water and land transport
- *waste disposal function:* providing space and substrate for waste disposal
- *anthropocentric recreation functions:* providing space, substrate and backdrop for anthropocentric outdoor recreation (water-skiing, jogging etc.)
- *space and substrate reservoir function:* the existence of unfilled-in space to respond to future needs and problems

JOINT PRODUCTION FUNCTIONS
- *agricultural production functions:* providing water, soil fertility, solar energy and *telos* for arable farming
- *intensive and extensive animal rearing functions*: providing water, nutrition and *telos* for cattle, game (on ranches), sheep, chickens etc.
- *other joint production functions:* providing nutrients etc. for the plantation and garden types of (agro)forestry, aquaculture etc.
- *joint production reservoir function:* providing soil fertility, genes, etc. for future use, future crops etc. in an ongoing bioevolution

NATURAL PRODUCTION FUNCTIONS
- *natural forestry functions:* providing water, soil fertility, solar energy and *telos* for timber, firewood etc.
- *natural fisheries functions*: providing water, nutrition and *telos* for game and commercial fish
- *wildlife functions*
- *'minor products' functions:* providing water, nutrients etc. for medicinal plants, forest fruits, rottan, sago, resins, rubber, bamboo, flowers etc.
- *drinking water function*: providing safe and plentiful drinking water sources
- *abiotic natural production functions:* providing solar energy, wind energy, water flow energy, etc.
- *natural production reservoir functions*: providing stocks of minerals, fossil fuels, and peat; providing species and genes for future uses (e.g., medicine) in an ongoing evolution

SIGNIFICATION FUNCTIONS

- *signal fonctions:* providing spatial and temporal (e.g. early warning) indicators
- *scientific signification fonctions:* providing geological and historical records and all other material, micro and macro, biotic and abiotic, for research and for education, through which the world comes to presence
- *cultural orientation functions:* providing the seas, forests, prairies, deltas etc. through which cultures develop their specific characters
- *relationship fonctions:* inviting and facilitating intense but non-dominating relationships between people and nature, directly or indirectly
- *participation fonctions:* inviting and facilitating the experience of nature's beauty and process, directly or indirectly
- *contemplation functions:* providing places and occasions of special aesthetical, sacramental and solitude value, directly or indirectly
- *signification reservoir functions:* the as yet undiscovered invitations and possibilities to enrich the story and the experience of the world

HABITAT FUNCTIONS

- *providing the conditions* (space, energy, food, predators, cyclicality *etc.) for the development of species and ecosystems* acknowledged as intrinsic value carriers:
  . the small-scale habitats of area-bound species
  . the large-scale worlds of mobile species
  . the conditions for ecosystem development
- *habitat reservoir fonction:* providing space, rhythms, patterns and mechanisms for the bioevolution to continue

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PROCESSING FUNCTIONS

- *abiotic processing fonctions:* dilution, photolysis, sorption, sequestration etc. of waste and toxicants
- *biochemical processing functions:* uptake of excess substances, carbon and nitrogen cycles, biochemical detoxification etc.
- *biotic processing fonctions:* mineralization of organic waste, humification etc.

REGULATION FUNCTIONS

- *shield functions:* providing protection against too high levels of radiation, hurricanes, floods etc.
- *dampening fonctions:* dampening of processes that tend to be too fast or too fluctuating (soil erosion, development of pest populations, river flow peaks etc.)

ceremonies of the fishing season. In the West, early warners such as graphically enhanced ozone layer pictures and growth abnormalities in lichens (Hutchinson, 1990) or fish (Rapport, 1990) trigger the ceremonies of decision-making.

Rolston (1988) is an especially rich source with respect to the other signification functions. About recreation and science, for instance, he writes (p. 7):

> "For some [people], nature is instrumental to an active human performance; they want only terrain rough enough to test a jeep. (....) For others, the qualities of nature are crucial in contemplating an autonomous performance. They watch the fleecy cumulus building over the Great White Throne in Zion, listen for the bull elk to bugle, applaud the genial skills of the hummingbird at the bergamot, or laugh at the comic ostrich with its head in the sand. For the one group, nature is a place to *show what they can do;* for the other, values are reached as they are *let in on nature's show* - a difference surprisingly close to that between applied and pure science".

Taking this distinction first with respect to science, it shows that the "scientific functions" as a part of the signification functions should refer to the pure sciences, i.e. the research that enables us to tell the stories of the world in ever-increasing detail and depth. Characteristic examples are the research of geology, archaeology, field biology and astronomy, research that differs from direct and personal observation and contemplation essentially only by its more advanced theories, tools and pool of information. The description in Box 4.3 borrows a quotation from Chapter 8. Applied research is research instrumental to the carrying, production etc. functions of the environment; it is not explicitated in Box 4.3.

The next signification functions subtype in Box 4.3 comprizes the "cultural orientation functions". Contrary to the other signification functions, they emphasize the collective social level. Cultures do not only develop landscapes; they also develop *in* landscapes, shaped in natural and human history. As Rolston (p. 349) puts it:

> "The logic of the home, the ecology, is finally narrative, and the human career will not be a disembodied reason but a person organic in history".

The next three function subtypes are the "relationship", "participation" and "contemplation" functions. All three refer to the capacity of the environment to invite not only physical relationships, but also more spiritual involvement. The sequence of the three functions roughly coincides with this involvement taking more voluntaristic or more receptive forms; behind them lie what in De Groot (1992b, Chapter 8) is discussed as the partnership, participation and oneness-with-nature world views and experiences, respectively.

Partnership relations may be found in agriculture, in play, in the wilderness hike - in fact, in all places where the environment invites and facilitates intense but non-dominant relationships, and people respond to this invitation. Partnership nature, in its most characteristic form, is relatively resilient nature, nature strong enough to enter in dynamic interplays.[140]

Participation in nature is, as Rolston puts it, the consciousness and the experience "to be let in on nature's show". Participation nature, be it close to our home or in far-away wilderness, is nature that invites and facilitates this experience. In its most characteristic form, it is the mature ecosystem, the unfolded diversity of life forms and landscape elements.

In the wording of Rolston (p. 25), "nature generates poetry, philosophy and religion not less than science". As is the case with the other functions of the environment, much depends on what human beings bring to the occasion, but on the other hand, the environment offers places and circumstances especially conducive to the discovery of poetic and sacramental value. The "contemplation function" of the environment is spatially differentiated, as are the others.[141,142]

External junctions and the IEIE classification

As we have seen, the inclusion of the processing (P) and regulation (R) functions in the CPSH+PR-classification is associated with a notion *of external* functions, that is, of one area doing good work for another. Taking a closer look here, we see that this phenomenon is not confined to processing and regulation. Many wetlands, for instance, are said to have a "fish breeding chamber function"; counting this function, or even mentioning it as a function at all, is not sensible when the fish are caught inside the wetland itself. The breeding chamber then is simply one of the ecological processes underlying the fisheries subtype of the natural production functions. Often, however, the breeding chamber serves to stock other water bodies with juvenile fish. In that case and to that extent, there is an external production function.

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[140] Some, but not all, of this is beautifully captured in Rolston's (1988) "character building value" and "dialectical value".

[141] The brief survey of the environment's signification functions started out with Rolston's two types of recreation. By now, we have discovered that recreation runs all the way from its most anthropocentric forms mentioned under the carrying functions, via the relationship and participation functions down to the sacramental experience in wilderness solitude, i.e. re-creation in its deepest sense. At the same time, recreation is not the only activity through which these functions are realized; they also involve, for instance, many non-dominating practices in modern and traditional farming, the primitive hunter, the field biologist, children and adults in playful encounter with the natural world, the monk's desert solitaire and the sudden insights that may grasp us on our way to work. In that perspective, I do not think it is fruitful to create too explicit a "recreation functions" category. Partnership, participation and wonder should be stimulated, but integrated in real life, not in a separate leisure-time compartment.

[142] The clause "directly or indirectly" has been added to the relationship, participation and contemplation functions. The term "indirectly" refers to the fact that remote areas and inaccessible species, and even the accessible and common ones for much of what they signify, live with us, and are encountered and valued by us, through the photographs and narratives of other people.

Functions analysis will almost always focus on a specific area or type of area, not the environment in general; learning how to handle the internal/external distinction as consciously as possible therefore serves an evident practical purpose.

In AWB (1988), functions are distinguished as "on-site/off-site" and "marketed/non-marketed". The objective of this classification, it is said, is to explicitate function types that are often overlooked in economic evaluations. The same motivation is present in Marchand (1987) and the IEIE classification developed subsequently (Marchand and De Groot, 1988; De Groot 1990b). Given a bounded area of any size, internal and external functions may be formally defined as follows.

- *Internal fonctions* are the functions of which the benefits to carriers of intrinsic value materialize inside the area, i.e., these intrinsic value carriers have to be inside the area to gain the benefits of the functions.
- *External fonctions* are the functions of which the benefits to intrinsic value carriers materialize outside the area.

Here, the formal term 'intrinsic value carriers' denotes people and all other entities we recognize the intrinsic value of, which may be, roughly, species and ecosystems (Section 4.6). In that sense, the definition differs from the "rule of thumb" found in Claridge (1991), that external functions "provide a benefit that people gain without necessarily having to go to the area". My choice to incorporate external functions also include functions for the otter and the mangrove forest is consequent to the principle of keeping people and nature together as long and as close as possible, in normative analysis as in reality.

The relative weight of the internal and external functions will vary widely with the size of the area under study. If the area is so small as to contain only a water purification plant, for instance, its functions will be external save for the occasional bird catching a worm on the lawn. If, at the other extreme, the area is as large as a continent, its functions will almost all be internal.

The definitions of the CPSH + PR functions, as may be traced in the previous subsection, have used the principle of logical enumeration (Section 4.3) only partially. Strictly speaking, we can only trust that enough wisdom has been accumulated in its history to make the listing logically sound. The internal/external distinction, having no history by comparison, should apply the principle more rigidly. External and internal being defined as perfect complements, one question remains to check the logical soundness: distinguishing between internal and external only, do we not ignore *relationships* between internal and external functions?

At first sight, relationships between internal and external functions indeed seem to be significant. Consider, for instance, the silt trapped by a wetland, originating from the inflowing river. This silt will usually enhance the wetland's internal function of agricultural production, and the same silt-trapping phenomenon will also influence the wetland's external functions, either negatively because the silt cannot support downstream agriculture, or positively because the silt will not clog mangrove ecosystems or suffocate seagrass fields. Taking another example, the vegetation on coastal sand dunes performs an internal habitat function and also stabilizes the dunes in its external storm protection function. Taking a second look at these examples, however, it shows that they cannot count as function-to-function relationships. The internal and external functions are based upon a common environmental parameter (silt, vegetation etc.), and their positive or negative correlation is established only through these.

The same argument holds for interrelationships that do not lie causally before the functions but after them. Food produced within the area, for instance, is counted as an internal function; the fact that some of the food will be exported to places outside the area and will perform further functions there is true, but not relevant to the analysis. The principle of not double-counting says that one should count functions on a single causal layer, unmixed with functions performed before or after the accounted functions. Concluding, the division into internal/external can do without a 'relationships' component.

The IEIE classification, based on the internal/external distinction, is a simple typology. It comes into existence by applying a second enumerative dichotomy to the internal functions, namely, the distinction between *intensive* and *extensive* functions. These are formally defined as follows.

- *Intensive functions* are those for which a considerable input of environmental resources per unit of output is required for the benefits to materialize.
- *Extensive junctions* are those for which a less considerable input of environmental resources per unit of output is required for the benefits to materialize.

This distinction, it may be noted, differs from more usual concepts of 'intensive' and 'extensive' land use. The key term, 'environmental resources input', relates to fossil energy, the embodied fossil energy in cement and fertilizer, scarce resources like timber, metals and so on, but excludes labour. Putting it more informally, the demarcation is that intensive functions are 'environmentally intensive'; much environment from elsewhere is put into them. Thus, support of ecological agriculture is defined as an extensive function of the environment, and deep-sea fishing is defined as in intensive function, even though they are joint production and natural production functions, respectively. Capital inputs may sometimes be used as an economic indicator of the intensive/intensive distinction, but then it should be borne in mind that a thousand dollar computer, for instance, will have an environmental resource characteristic quite different from a thousand dollars worth of fertilizer. Embodied energy is another, and more widely applicable, indicator of the environmental intensity of functions; see Giampietro and Pimentel (1991) for many interesting figures and ideas, and the Annex of this chapter for further discussion.

The definitions leave open what is to be regarded as 'considerable'. Irrigated cropping systems and industrialized animal husbandry should always be called intensive, of course, with extensive grazing lying at the other extreme. In between, a boundary may be chosen that fits the area under consideration.

Several reasons exist for distinguishing between intensive and extensive functions. First, the extensive functions are less visible and tend to be neglected or completely overlooked in economic evaluations (Marchand, 1987). Secondly, they are socially different; the intensive functions are less accessible to the poor and often imply far-reaching dependencies on capitalist **institutions.** Thirdly, they differ in environmental terms. Pollution, for instance, is largely confined to the intensive functions. **Also,** high capital outlays per hectare will usually impair the flexibility of land use, and hence the deeper aspects of **sustainability.**

The **IEIE** classification now becomes:
- *intensive internal **functions***
- *extensive internal **functions***
- *external functions.*

Often, this simple structure will suffice to enumerate the different functions performed by the environment in a given area. At the same time, this also marks a weakness of the IEIE classification; it does not tell, ***substantively,*** what the functions to be enumerated could be. The categories are conceptually perfect, but substantively empty. The CPSH+PR classification, on the other hand, has a complementary character: it is, as we have seen, no conceptual miracle, but all its component terms have much more real-world meaning. Obviously then, the CPSH+PR typology provides a key to identifying substantive functions within the conceptual IEIE categories. To apply this key, simply make a table with the three IEIE categories on one axis, and the seven or 29 CPSH+PR categories on the other, and try to fill the 21 or 87 elements.

Two classifications resembling IEIE

This subsection has been included merely to facilitate reference to other classifications in current use. Most readers are advised to skip this purely technical material.

Focusing on wetlands, **Claridge** (1991) presents an overview summarizing and improving much previous wetlands work. The author starts out with the three-layered structure also present in Figure 4A. First comes the **"endless"** list of "wetland characteristics" (some of which, in our system, would be called environmental quality parameters). The characteristics give rise to "benefits" (which are called functions in this chapter), and these benefits then comprise the input for the "assignment of value" which is, in this chapter, the layer of the final variables. The "benefits" (= functions) are then separated into three types, in which the internal/external distinction plays a major role. The schema is summarized below, with **Claridge's** terms between the quotation marks.

"Benefits" **(=** functions)
- "Uses" = "direct use" = internal C and P and some **S.**
- "Functions" = "indirect use" = external C and P, plus PR (but for people only).
- **"Attributes"** = "non-use" = most **S,** all H.

Barbier (1989) presents a classification that, with minor variations, is at present in common use in environmental economics (e.g. Bergstrom et al., 1990; Costanza et al., 1989). The basic idea is to first separate the human-oriented functions ("use") from functions oriented toward the environment as a value in itself ("non-use" or "existence"). The "use" functions are then separated into "direct use", "indirect use" and later use ("option value"). The resulting total is usually called "total economic value", not functions. The enumerative lists provided, with terms such as "fuelwood", "storm protection" etc., show that only the term differs here, not the concept. The relationships with CPSH+PR and IEIE are summarized below.

"Values" (= functions)
- "Direct use" = internal C and P and some S, except the reservoir components
- "Options" = reservoir components of C, P, S, H.
- "Non-use" (= "existence", "bequest") = some S, all H, but without their external and reservoir components.

Taken as a whole, these classifications display a weakness similar to my own IEIE typology; the abstract categories are not filled with logically and empirically grounded enumerations of what these functions entail substantively. Hanley and Craig (1991) provide an illustration of one of the practical consequences this may have. Trying to assess the option and non-use value of 'The Flow Country' in Scotland, with 400,000 ha the largest body of blanket peat in the northern hemisphere, they mailed a questionnaire asking about willingness-to-pay for the moor's survival. Respondents were "told in the introductory letter that afforestation would displace many of the birds currently breeding there (which respondents were also told about)." How much more could the respondents have been told on a more substantive and exhaustive (hence, CPSH+PR-like) basis!

A second point of interest here is that the two lists indicate a tendency to isolate first the functions which are the easiest to assess economically, then define the next-easiest, and so on. This magnifies a risk well-known from cost-benefit analysis and other economic assessment methods, namely, the relegation of the more difficult functions to a category of "p.m." or "intangible" or simply forgotten values. Costanza et al. (1989) are an example. They start out fully acknowledging the option and non-use values, then mention them only with a question mark in their first summary, and then leave them out in their quantitative conclusions.

4.8 Economie Evaluation, I: Sustainability In The National Accounts

When facts in terms of final variables are known or predicted, they can be compared to norms in these same terms and aggregated into a more overall normative picture. This, roughly, is evaluation. Multi-criteria analysis (MCA) and more contextual approaches to evaluation have already been touched upon in Section 4.5. This section and the next will focus on the third type of evaluation procedures, notably economic evaluation, which amounts to relating as many as possible of the final variable facts and values to the measuring rod of money. In both sections, special attention will be given to the final variable of sustainability, because of the well-known problem that economic concepts (e.g. GNP) and methods (e.g. CBA) essentially ignore the long-term impacts of the decisions for which they are supposed to lay the normative ground.

Section 4.9 will focus on project and policy appraisal, i.e. the ex ante evaluation to support micro-economic decisions. The present section is different in two respects; it concerns the macro-economic level and it focuses on obtaining a proper picture of events that have taken place already, aggregated at some macro level. Thus, the national accounts, and within these the Gross National Product (GNP) especially, will be the focus of attention.

Discussions about the meaning of GNP and other national accounts, as well as proposals to adjust these in order to account for the depreciation of environmental assets and functions constitute one of the major areas of environmental economics, the reasons being that (1) GNP is usually regarded as the key measure of a nation's welfare and that (2) GNP poorly (some would say "perversely") reflects environmental degradation. Roughly, environmental degradation is reflected in GNP only insofar it leads to more inputs (e.g. fertilizer) necessary to maintain production. Even worse, these costs, as well as defensive activities, do not subtract from GNP but add to it, giving rise to the seemingly weird effect that environmental degradation *raises* the welfare measure.

In the GNP discussion, conceptual problems are intermingled with issues of operationalisation. Conceptually sound categories may be impossible to define in the national accounts. Theoretically sound procedures may be so counter-intuitive that no-one will understand them. And on the other hand, 'practical' solutions may be so shallow that it may be better to have no solution at all (Daly, 1988). The sport of GNP juggling, and the aim of the present subsection, is to arrive at a GNP adjustment or some other modification in the system of national accounts that is sufficiently practicable as well as sufficiently underpinned to be theoretically defensible.

Since it makes little sense to jump into conceptual waters without an indication that the results may have a practical outlet, the matter will be approached in two steps. I will first focus on a definition of *GNP categories* that seems sufficiently operational and theoretically relevant. On that basis, I will focus on the more difficult question of what to *do* with these units, e.g. subtract them from GNP, or add them to it, or set them apart in an auxiliary account, or do nothing at all because GNP already reflects them properly.

Operational and relevant GNP categories

Economic categories that play a role in the GNP discussion are costs, capital and benefits. I shall focus on them in that sequence.

With respect to the environment, costs are usually associated with the so-called 'defensive expenditures'. These are all expenditures incurred (by households, governments and firms) to prevent the environment from deteriorating or to mitigate the impacts of deterioration. For households, a characteristic example is the purchase of double glazing to mitigate increased street noise levels. For governments (and many non-profit organisations) it is the whole apparatus and costs of pollution control, the upkeep of wilderness areas, the increased costs of health care due to pollution, and so on. For firms, typical examples are end-of-pipe technologies and the costs involved in pollution and waste prevention. In agriculture, forestry and allied sectors, defensive expenditures are the costs of maintaining the productivity of the soil, the regeneration capacity of the forest, and so on (products and wages involved in fertilisation, upkeep of terraces, reforestation, etc.)

Defensive expenditures are usually defined somewhat narrower than I do here, focusing on the end-of-pipe-like and symptoms-abatement measures (e.g. Hueting, 1991 and Pearce et al., 1989). This is not really consistent. A farmer terracing his land is no less defending soil quality than his neighbor who, end-of-pipe-like, catches eroded soil downhill and brings it back up. A new product that is slightly more expensive to make but needs a smaller waste recycling outlay is no less defensive than the waste recycling.

In order to prevent confusion with the current narrow operationalisation of defensive expenditures, this type of cost may be called the 'maintenance cost of environmental capital'. In order to distinguish between this cost and the 'normative' costs that will follow shortly, the term can be *empirical maintenance expenditures of environmental capital.*

The end-of-pipe elements in the empirical maintenance expenditures are relatively easy to measure (e.g. Peskins, 1991). Successful environmental policy, however, implies that end-of-pipe solutions are supplanted by more preventive and integrated technologies; better engines instead of bad engines with and end-of-pipe catalytic converter, 'environment-conscious' product design instead of waste outlays, and so on. At the national accounts level, these 'internalized' costs are virtually impossible to separate from the whole of the production costs. This, however, does not pose a dilemma between conceptual clarity and practical operationalibility. As we will see, a sensible adjustment of GNP may be arrived at without touching the empirical environmental capital maintenance expenditures, in any definition. It may sometimes be interesting to try to eke out these expenditures from overall production expenditures, but this can remain outside the GNP adjustment discussions.

The agricultural, mining, government, forestry and other 'environmental sectors' of the economy do not only spend money on environmental quality upkeep, but also on *extraction from* the environment. Households do the same; the expenses made for going to an outdoor recreation area are expenses for 'extracting' the recreation benefit from the environment.

An important feature to note with these *expenditures ofextraction from environmental capital* is that they will usually rise with environmental depreciation; more labour, energy, travel time, etc. will have to be put in to reap the same quantity of oil, crops, recreation, fish, etc. But when these costs rise as part of a GNP, it cannnot be concluded that the environmental capital is depreciating; the rise may also be caused by intensification of the sectors without environmental degradation taking place (roughly, more outputs compensated by more maintenance inputs, or more recreational travel to areas that have no trouble accommodating the intensified use).

Environmental *capital* (flow resources like clean air, renewable stock resources like forests and non-renewable assets like oil), and especially its depreciation, is another major category in GNP discussions. Environmental depreciation is a decrease in environmental capital. A measure for this depreciation thus would amount to measuring the value of the environmental capital at one time, and comparing that value with the value at a later date.

Some environmental stocks, renewable and non-renewable, have a market value. Measuring depreciation then is fairly straightforward, as shown, for instance, by Repetto et al. (1989) with respect to the forests, soils and oil of Indonesia. The basis of the calculation is the physical forest stock decline. There exist two alternatives to find the monetary value of this depreciation, however. The first is to compare the past value with the present one: depreciation = (past price x past stock) - (present price x present stock). In this way, because of the increase in timber and other stock product prices, the value of a stock may prove to have risen even if the stock itself has declined. The other way of calculating is to multiply the physical stock decline by the present stock product price: depreciation = present price x (past stock - present stock). This way, there is always a value decline if there is a stock depreciation. In the words of Maler (1991), "the change in the value of the stock" is not "the value of the change of the stock". Maler also shows that the second calculation is the appropriate one.

Most environmental assets (clean air, the landscape, wilderness, species diversity etc.) are not marketed. In that case, shadow prices seem to be called for. As explained in the next section and in Hueting (1991), construction of shadow prices valid enough to go into a GNP is impossible. The alternative way of calculating is based on the environmental policy targets (such as standards and other normative principles), formulated for these resources. As stated by Maler, "in general it is much easier to estimate the cost of achieving these targets than it is to estimate the loss from not achieving them. The cost of achieving the targets could be used as a crude approximation of the true social value". Obviously, the ease of operationalization is here paid for by a conceptual jump that is fairly unclear. It is as if, for instance, the money I spend on upkeeping my house indicates the value of the house. We will see later that the jump holds a surprising advantage, however. But first, we take a look at what authors that work through this approach are actually doing.

Uno (1988)[143] calculates how much it would cost to reduce current emissions so as to meet emission targets, and then subtracts these costs from GNP. Although this seems quite a reasonable thing to do, we may note that *current* pollution control measures are included in GNP as an addition, not a subtraction! It also seems quite reasonable to say that the extra pollution control needed to achieve the targets should be added to, not subtracted from, the pollution control measures already undertaken to raise environmental quality to the current level.

Hueting (1991) gives an example of the same approach, but focusing more on sustainability than on environmental quality. His reasoning is that if a country has committed itself to sustainable development and hence to the non-depreciation of natural capital, it makes sense to calculate how much it would cost to indeed keep up this natural capital, and subtract this from GNP. Hueting's example concerns soil capital, and the amount to be subtracted is the sum of terraces to be built, slopes to be reforested, drainage systems to be installed, officials to be appointed, the benefits foregone by planting less destructive crops or accepting less output, and so on.

Hueting's method is not applicable to non-renewable resources; keeping up an oil stock would amount to not extracting any oil. El Sarafy (1989) offers an escape here, at the cost of assuming complete substitutability of natural and man-made capital. The idea is that some portion of the net receipts of resource extraction should be set aside so as to generate an income over an infinite number of years, equal to the income (minus the amount set aside) generated by the resource extraction during the resource lifetime. As an example, if the real rate of interest is 5 % and an oil stock is extracted at a rate that gives the stock a lifetime of 40 years, $ 140 should be set aside for every $ 1000 earned, in order to have an income of $ 860 over an infinite number of years. If the real rate of interest is only 2% per year, $440 of every $ 1000 should be set aside to earn a sustainable income.

With respect to the depreciation of environmental capital, we now have two basically different approaches, that of Repetto et al. and that of Uno/Hueting/El Sarafy. There are three reasons to prefer the latter. First, the approach of Repetto et al. is applicable only to marketed resources (or by reducing a resource to its production-for-the-market value). Uno, Hueting and El Sarafy, taken together, are applicable to all resources and even to nature in its non-resource (intrinsic value) aspect.

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[143] To be found in Pearce et al. (1989)

Secondly, the outcomes of Repetto et. al.'s method will fluctuate strongly and rather arbitrarily, because they fluctuate with world market resource prices. The outcomes of Uno/Hueting/El Sarafy will also shift over time, e.g. when technologies for environmental clean-up become cheaper or fertilizer becomes more expensive. However, these shifts are smaller in magnitude and more tied to the 'real economy'.

Thirdly, the relationship of Uno/Hueting/El Sarafy to the purposes of GNP adjustment seems more clear, conceptually. If, for instance, I owned an oil well in my back yard and I were to extract 1000 litres and sell it for a dollar per litre, Repetto et. al would tell me that my capital is now $1000 less. This is true, of course, but should I substract that amount from my income? Then I would have to subtract $1000 from every $1000 I earn from the oil, and the oil well proves not to be an asset at all. El Sarafy, on the other hand, would tell me that I have to subtract, say, $200 for every $1000 earned, and set it aside in order to create a sustainable income of $800 for all years to come. The approach of Uno/Hueting/El Sarafy is more 'GNP-connected'.

For flow resources, renewable stocks and non-renewables, respectively, the methods of Uno, Hueting and El Sarafy calculate the *expenditure involved in a nation's commitment to sustainable development, insofar as the targets involved in that commitment are not already met by current measures.* Therefore, they may be defined as the *normative expenditure of maintenance (sustainability) of the environmental capital* at a desired quality level, as specified in the national targets of emissions, wilderness reserves, production forest areas, soil fertility and so on, and assuming perfect substitutability of the non-renewable resources.[144]

As said, GNP discussions do not only involve expenditures, but also the value of environmental capital and the benefits that people derive from the environment. In that sense, the results up to now may seem disappointing. Because of the conceptual jump from capital depreciation to normative expenditures, we have ended up with a set of expenditure categories that are fairly operationalizable, but are still expenditures only. Have we in fact only pushed the problems out in front of us? Do we still have to calculate the value of the environment and of environmental benefits? How could we do this, calculating, for instance, the true value of the Earth and all it contains? Should we ask everybody for their 'willingness to pay' for everything and then add it all up?

The difficulties here are unsuperable. For a sensible adjustment of GNP or other elements of the national accounts we do not need even to begin to discuss these difficulties, however. The expenditure categories suffice. Consider, for instance, the house I live in. This house is capital, with a market value and, the house now being 430 years old, a socio-cultural value that is hard to assess. We may note that the house (the capital) is what I draw my 'residence benefits' from. Moreover, we may note that the house has an inherent capacity to desintegrate. Although 430-years-old houses, in

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[144] As an example, cleaning up the polluted soils in the Netherlands (emergency spots only) is an outstanding debt of $ 30 billion. Taking 20 years to pay off the debt, $ 100 should be substracted from GNP per capita.

my experience, are especially good at it, entropy increase (disintegration, breakdown, wear and so on) is inherent in all capital; capital needs maintenance expenditures. Now, assume that I have promised my children to upkeep the house for them at some sufficient quality level. What economic calculations does this promise entail? There is no need to address my present or their future benefits, nor is there a need to estimate the house's market or true value. The promise is to *upkeep* the capital, that is, to keep on incurring the (empirical) maintenance expenditures I am incurring already and add to them, if the present state of the house is below par or declining, the (normative) expenditures that are necessary, either by putting in more goods and labour, or by giving up benefits that rest on too intensive activities. And this, in the final resort, is environmental policy: the promise, and with it the act, empirically or normatively, to keep up the Earth, as a whole and nation by nation, at a sufficient quality level.

Searching for a sensible GNP adjustment

At this point, we arrive at the question of how to bring the expenditure categories into the system of national accounts. Should they all be substracted from GNP? Or partly? Or does GNP already reflect them properly? Or should the environment go into a separate 'satellite account'? Current proposals cover all these alternatives, as well as pleas for pluriformity (Norgaard, 1989). A major problem in this area is that the national accounts themselves are conceptually unclear. As Norgaard explains, GNP and the other national indicators are not consistently derived from any economic theory and even if they were, they would be incompatible with rival economic theories. The national accounts are a "historical mishmash", as Norgaard puts it, in which neoclassical and Keynesian ideas are mixed with the needs of tax collectors. Therefore, any insight into how to relate our expenditure categories to GNP first requires that we understand better what GNP itself in fact is, conceptually. Daly (1988), for instance, argues that GNP does not reflect welfare at all, but is the addition of all the *costs* incurred in a society. If we accept this, it becomes quite logical that the empirical expenditure of environmental capital maintenance (pollution control, etc.) is already included in GNP as an additive element, but the normative costs of maintenance, counter-intuitively, should also be added to GNP! First of all, then, we will take a look at Daly's arguments; as we will see, they provide the basic insight sought here, without us having to follow Daly's GNP adjustment proposal.

The current GNP measure essentially follows the proposals made in the 1920s, of Pigou. Daly (1988) refers back to a discussion between Pigou and Fisher, who maintained that (1) benefits ("services", welfare) arise only from capital, (2) capital has the inherent tendency to depreciate and (3) consumption, production and investments are not directly related to benefits; they are the costs of capital upkeep, renewal and growth.

Obviously, the concept of 'expenditures of maintenance of environmental capital' and the example of my house have already been borrowed from Fisher's argument. Daly proceeds by stating that the current GNP measure is an amalgam of the following types of money flows:

GNP = some benefits + throughput + investments

in which 'some benefits' refer to the rented assets and 'throughput' to consumption and production. Now, states Daly, consider that throughput is a cost and investment is a change in stock. What sense does it make to *add up* these categories? It is as if a merchant's bookkeeper adds up receipts plus expenditures plus change in inventory. Economics requires the comparison of costs and benefits, not their addition. Consequently, Daly proposes to switch from the single GNP measure to three conceptually clarified accounts: a benefit account, a cost account and a capital account. In these, amenity services of the environment go into the benefit account, the costs defined as our 'empirical expenditures on environmental capital maintenance' go into the cost account and the environment itself goes into the capital account. The 'normative costs of environmental capital maintenance' find their natural place as an addition to the cost account.

The difficulty with this system is that it is very hard to operationalize; it is more a proposal for econometric research and experiment than for present-day GNP adjustments. Armed with Daly's insight, however, we can return to the more practical level. The clue is given by Daly himself, who states that

> "In a world of unemployed carrying capacity, (...) throughput is an index of capital stock, and consequently an indirect index of service [benefits] rendered by the capital stock."

This argument, we may note, holds not only for the environment, but for all capital. For instance:

- The general level of education may be considered as a part of the 'human capital' of a nation. The level of education has a constant rate of 'depreciation', because people forget and die. Now, if a nation spends much on education, this indicates that it supports a high level of educational capital, and will enjoy the benefits thereof accordingly.
- If consumer goods such as cutlery, TV sets, house paints, books and holiday travels are assumed to have a constant rate of depreciation (getting lost, becoming outdated, worn out, forgotten) and if a nation spends a lot on these, the consumers may be assumed to maintain a high stock of them, with benefits accordingly.

In this picture, GNP still remains a measure, by and large, of costs, but costs as an indicator of benefits:

GNP = benefits + ***througput-as-benefit-indicator*** *+* ***investments-as-benefit-indicator*** [145]

[145] Not quite consistently, Daly also seems to accept his interpretation of GNP as a welfare indicator. Daly and Cobb (1989) have calculated an adjusted GNP by subtracting pollution effects and depletions of natural capital. Subtracting costs from GNP is only consistent with interpreting GNP as a welfare measure.

and adding up the three categories is not illogical at all. The basic condition, however, is that consumption, production, environmental maintenance costs etc. *are* good indicators of high levels of capital, and thus benefits (welfare). In the two examples above, this assumption seems reasonable. But is this also the case with respect to the environment? Or do we not even have to know this? This, more or less, is the final question of the matter. But before tackling it, it seems wise to first acquire some more footing in the two recent proposals for GNP adjustment.

Pearce et al. (1989) put forward to adjust GNP in the following way:

adjusted GNP = conventional GNP — household defensive expeditures — monetary value of residual pollution — depreciation of environmental capital (functions, renewables, non-renewables)

We may note, first, that Pearce et al. do not suggest also subtracting *current* pollution control and other capital upkeep measures (e.g. forestation). Implicitly, they accept conventional GNP as a benefit (welfare) indicator, including these current expenditures. Secondly, we may use the 'normative approach' of Uno/Hueting/El Sarafy to obtain the value of residual pollution and capital depreciation. Doing so, we also include the household defensive expenditures (they double-count with the monetary value of residual pollution, states Maler, 1991).

The normative expenditures of environmental capital maintenance as they have been defined here also include the expenditures for the upkeep of intrinsic values of nature, which is not exactly the "functions" of Pearce et al.. Assuming that they have nothing against this, the proposal may be summarized as simply:

adjusted GNP = conventional GNP — normative expenditures of environmental capital maintenance

in which conventional GNP includes the empirical expenditures of environmental capital maintenance.

Maler (1991), in a technically more sophisticated analysis than Pearce et al.'s, builds up the GNP measure in terms of prices (p), quantities (q), time expenditures (1), wages per hour (w), valuations (v) and other basic parameters. Maler starts by separating environmental capital (flows such as clean air, renewable stocks such as forests, and non-renewable stocks such as oil), and then builds up the picture of GNP and defensive expenditures, government pollution control, maintenance of renewables and so on, in the basic terms. The result is summarized below. (I keep some references to Mäler's mathematical formulations in order to facilitate cross-reference to his article.)

(1) Production declines because of environmental degradation or depreciation (e.g. a smaller fish catch or less forestry products) are already reflected in conventional GNP (as pq_1), and should therefore not be subtracted[146].

(2) Although defensive expenditures of households and the public sector (pq_2) are included as a positive contribution to conventional GNP, they should not be subtracted

[146] This is also noted by Nentjes (1991).

in order to avoid double-counting with the (depreciation of the) value of environmental services (V^c_{y1}, see below).

(3) All wages paid in the economy ($wl + wl_2 + wl_3$) should be subtracted from conventional GNP.

(4) The value of goods used in order to keep up the stock of environmental capital (pq_3), e.g. fertilizer and forest replanting, should be subtracted from conventional GNP.

(5) Not all environmental functions are reflected (as production, pq_1) in conventional GNP. The direct use of flow (y_2) resources by households, valued at the household valuation $V^c_{y1} + V^c_{y2}$, should be added to conventional GNP.

(6) The value of the change in stocks ($V_2.dy_2/dt$) should be subtracted from conventional GNP.

For a good comparison with the proposal of Pearce et al., some further interpretations are necessary, starting at point 3.

(Ad 3) It seems "startling" as Maler puts it, that all wages paid in the economy should be subtracted from GNP, if we want GNP to be a measure of welfare. Roughly, it amounts to the net national income (NNI) being substracted from GNP, and the result, for any GNP, will be approximately zero. Another way of arriving at this point is by noting that Maler has started out by separating environmental capital from the other capital, and then arrives, as we will see below, at the proposal that the empirical cost of keeping up that capital should be subtracted. If he had started out by separating any other capital from the rest (say, cutlery, machinery or human capital), he would have concluded that the cost of keeping up *that* capital should be subtracted. In fact, *everything* should be substracted. What has happened here is that Maler has in fact built up a picture in the Fisher/Daly conceptualization, with a cost (wl) and a benefit (pq) component, and then, instead of separating these into a cost account and a benefit account, subtracts them from one another (calculating, as it were, the profit a nation makes). This is not consistent; the method used should be either Pigou's, with costs used as indicators of benefits, or Fisher's, with two separate accounts.

Let us assume for a moment that it makes some sense to subtract the wages involved in defensive expenditures (wl2) and the upkeep of renewables (wl3) from conventional GNP, in order to see what it will lead up to.

(Ad 4) The value of the goods involved in keeping up the renewables may be combined with wl_2 and wl_2, adding up to the empirical cost of maintaining the environmental capital. This is the first major category, then, that Maler proposes to be subtracted from conventional GNP.

(Ad 5) Adding the households' valuation of the environment to GNP for year 1 and repeating that for year 2 amounts to drawing up a picture of GNP decrease because of environmental degradation. Thus, one might as well subtract the value of the degradation right away.[147]

[147] Faber and Proops (1991) also follow the course of addition of environmental capital value to GNP, arguing that it is conceptually more consistent and socially more fruitful to show a nation its (decling) wealth than to show only the declining of its wealth. This argument is interesting, but the

(Ad 5 and 6) Subtracting the value depreciation of the households' valuation, together with subtraction of the value of the depreciation of stocks, is equivalent to subtracting the normative costs of environmental capital maintenance, as it was the case with Pearce et al. (1989).

Summarizing, Mäler's (1991) proposal for GNP adjustment is:

GNP-adjusted = conventional GNP — empirical expenditures of environmental capital maintenance — normative expenditures of environmental capital maintenance

in which conventional GNP again includes the empirical expenditures of environmental capital maintenance. The reason for rejecting this proposal has already been given in the paragraph 'Ad 3'. Roughly, if one follows Pigou, only the normative expenditures should be subtracted. If one follows Fisher/Daly, there should be a separate cost account and benefit account, the first of which already includes the empirical expenditures, and to which the normative expenditures should be added.

A grounded and operational GNP adjustment

'Following Fisher/Daly' would imply a major overhaul of the systems of national accounts, which, quite apart from its political feasibility, is as yet impossible to operationalize econometrically. The first thing to find out, therefore, is whether 'following Pigou' is basically acceptable with respect to the environment. In other words, to what extent may conventional GNP be interpreted as a welfare (benefits) indicator with respect to the environment? And once we have found this out, how can the situation be improved?

To arrive at the answer we must distinguish between the two types of environmental expenditures that are included in conventional GNP, i.e. the empirical expenditures of environmental capital maintenance (pollution control, fertilizer, wilderness protection etc.) and the expenditures of the extraction of benefits from the environmental capital (outdoor recreation expenditures, fisheries inputs etc.).

With respect to the maintenance expenditures, the situation is relatively simple. If pollution control or any other maintenance measure is installed, it amounts to anywhere between the supplanting of a function that nature first provided for free or a truly additional measure. Hence, benefits range from 'zero' to 'full', but benefits they always are. Conventional GNP always counts the benefits as full. Hence, it accounts *poorly,* but not in the wrong direction. It seems wise to accept this at the moment and bring in adjustments for the supplanting of natural functions at a slower Pace, together with analogous cases in which conventional GNP accounts poorly, e.g. when markets supplant informal and subsistence economies.

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environmental wealth is as yet impossible to value with a degree of unequivocality necessary for national accounts.

The situation is different with respect to the extraction expenditures. For the sake of clarity, we may distinguish between two extreme situations, both characterized by a deterioration of the environment (say, a decline of a fish stock). First, we may assume that the extraction expenditures remain the same. The fishing fleet, for instance, remains the same and continues to fish in the same way. Then, production will drop. This is reflected in GNP, as we saw in Mäler's analysis ('pq_1'). At the other extreme, we may assume that production is kept constant by an ever-increasing extraction expenditure (larger ships, longer distances). Conventional GNP will then *rise,* until the environment is almost completely exhausted and the extraction activity is abandoned. Here, GNP is *perverse,* indicating not welfare but the reverse, driving a society towards unsustainability. Experience shows that real-world situations tend to be close to the perverse extreme. Hence, accepting GNP as a welfare indicator here seems unacceptable, both on theoretical and moral grounds. Therefore, we cannot follow the UNEP and the World Bank, proposing to put the environment in some "satellite account" (Pearce at al., 1989), from where it will never enter core economic figures and decisions.

If conventional GNP is partly a poor and partly a perverse welfare indicator with respect to the environment, should it be dropped, after all? Then what will be installed in its place? The way out here is to remove from GNP its capacity to be a perverse measure. From the above, we see that perverse indication of welfare is impossible if natural stocks are constant. Thus, the way out is to express *inside* GNP the target of sustainable development. As concluded earlier, the way to do so is to say:

Adjusted GNP = conventional GNP — normative expenditures ofthe environmental capital maintenance

This adjusted GNP, then, is a poor indicator of sustainable dvelopment, but acceptably poor, and freed of the risk of perversion that comes with its basically 'Pigouian' character. It may be noted that substantively, this adjusted GNP is the same as was proposed by Pearce et al. (1989). The difference is that we now have the insight in what it in fact expresses, its assumptions and weak spots, and the arguments why it is the best one nevertheless. Following Pearce et al., the name for this 'adjusted GNP' might be "sustainable GNP" or "sustainable national income", the best approximation, for the moment, of sustainable income as conceptualized by Hicks in the 1940s.

Operationalisation, as we have seen, can be by way of the method of Uno/Hueting/El Sarafy or allied approaches, for flows, renewable stocks and non-renewable stocks. A physical State of the Environment reporting system is a necessary basis, e.g. the physical accounts as exemplified in Pearce at al. from Norway and France, or the Canadian SOE system. To apply the method of Uno/Hueting/El Sarafy, it is not necessary to enumerate in these accounts all the natural wealth of a nation, but only what is lacking, as measured against the policy targets of environmental quality and sustainability.

4.9 Economie Evaluation, II: Sustainability And Project Appraisal

The preceding section has focused on how to arrive at a proper indicator of welfare at the macro level. In the present section, we move to the micro level of projects, programmes or other policy actions. Moreover, we step from *ex post* to *ex ante* evaluation. The tool that economy provides us with here is cost-benefit analysis (CBA), with its variants of 'net present value', 'internal rate of return' and 'cost-benefit ratio' and its levels of 'financial', 'economic' and 'social' calculus (Van Pelt *et al.*, 1990).

CBA stands in an uneasy relationship with the environment. Most of the benefits of environmental quality and the functions of nature are not traded on a market where social preferences are expressed in prices. The intrinsic value of nature is even harder to assess economically. And with respect to the time dimension, the obligations of sustainability ('intergenerational justice') contradict the fact that individual people, in ordinary economic decisions, discount the future to a degree that costs shifted to future generations count for almost zero.

All these problems are intensively discussed in environmental economics. The best overview of the results, to my knowledge, is OECD (1989). That progress is being made does not imply that real solutions are on the horizon, however. As an example, we may take a look at the 'contingent valuation' method of valuing the environment. Roughly, this method amounts to asking people how much they would be prepared to pay for a specified environmental improvement, or for the prevention of a specified degradation of the environment. As a first indication of the difficulties encountered here, OECD (1989) shows that the second way of phrasing the question results in values given to the environment that are 2 to more than 10 times higher than those resulting from the first way of phrasing. Obviously too, because people will implicitly refer to their income when responding to willingness-to-pay questions, they will give lower valuations when asked about 20 items at the same time than when asked about one item one month, the next item the following month, and so on. Hueting (1991) criticizes the approach, saying that it is never possible for a sum of individual preferences to reflect the true value of the slow, large-scale and barely visible processes that sustain life on our planet. Sagoff (1988), refering to the often high percentage of 'protest bids' in willingness-to-pay surveys, points to the fact that in the economic approach, people are treated as isolated "bundles of exogenous preferences" rather than as thinking beings capable of reaching informed public decisions; this approach may be inappropriate from the very beginning, on legal and empirical[148] grounds.

With respect to the discounting of the future, the aim of conservation is often thought to consist in precribing that a lower or even zero discount rate be used in

[148] Cf. Section 5.7.

CBA. But as remarked by Norgaard (1991), nature protection is often well-served when the large future benefits of a development project (say, a hydroelectric dam) are heavily discounted against the small but present benefits of a wilderness area[149]. A discount rate of zero leads to the conceptually difficult consequence that any disaster now is acceptable if it results in an unending stream of infinitesimal benefits forever after (Sawyer, 1986). Moreover, can economists simply override the fact that people do prefer the present to the future? (Pearce and Turner, 1990). Should then a discount rate be set somewhere between zero and the normal rate of 5 to 10 percent, say, at 2 percent? Still, then the irreversible waste of any resource does not in fact count after a 100 years or so (Hueting, 1991b). Should, then, the discount rate be differentiated, dependent on the type of project or the impacted entity? Gijsberts and Nijkamp (1987) show that this is technically feasible, but at the same time the whole problem is downgraded to a "tinkering", as Van Pelt *et al.* (1990) call it, with arbitrary discount rates. No wonder, then, that in spite of all intelligent discussions and beautiful modelling, the rate of discount still "presents some of the most difficult moral and economic choices" (OECD, 1989).

Dilemmas can often be solved by moving to a deeper level of analysis. This is precisely what Norgaard and Howarth (1991) do when they say that the discount rate question as such has been misframed; we will encounter their arguments later in this section.

After this long introduction, the objective of the present section can come into view. My point of departure is the intuition that the type of discussions touched upon until now are attempts to incorporate the environment into an instrument that will never fully accommodate it. The application of CBA, it seems, needs to be embedded in a more overall approach. Such an approach should not only comprise CBA, but also a different 'logic', a different frame of mind to deal with the difficulties and dilemmas.

The overall approach I aim to expound may be called, following Page (1991b), "a two-tier value theory" or, in more homely terms, the principle of *'First we take care ofthose who depend on us, then we go out to enjoy ourselves'*. As we will see, nothing really new will be developed; I only intend to deepen, amalgamate and show the practicability of a number of current insights.

Below, we will first discover the 'different logic' at a more or less superficial level, focusing on some familiair issues and my own response when I first encountered them. In the next subsection, we move to the deeper level of analysis that Norgaard and Howarth already indicated. And finally, we turn to practical implementation in project appraisal procedures.

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[149] Contrary to the suggestion of James (1989), this argument against a lowered discount rate still holds when all benefits of the wilderness area are properly reflected in the CBA.

Ignacy Sachs once explained to me the trick, well-known in World Bank circles, of how to define the most feasible irrigation system. First, you compare a system that includes a drainage subsystem with a project without drainage. Without a drainage subsystem, all soils in the irrigation system will be salinized and stop yielding in 20 years' time. But since that will be discounted away and the system without drainage being much cheaper and requiring less water, the system without drainage will show up as being much more feasible in any cost-benefit analysis. Twenty years later, there will be a new project: the construction of a drainage system in order to reclaim the lost soils. This system will, of course, be much more expensive than if the drainage had been incorporated from the outset, but since the alternative is to abandon the whole irrigation system, the drainage project may prove to be quite feasible. If not, it is rational to abandon the irrigation system and leave the soils in their degraded state. CBA shows the feasibility and rationality of resource destruction.

My reaction to this was indicative of my engineering background. Puzzled by the outcome of the economic evaluation, I did not start thinking of ways to incorporate sustainability in the evaluation calculus itself (e.g. by lowering the discount rate), but wondered: how can economists justify comparing unsustainable to sustainable irrigation projects et all? And, one step earlier, how can irrigation engineers put up for evaluation an unsustainable design, i.e. a basically immoral proposal? Sustainability should be *worked into the designs* that leave the engineers' hands. If that is provided for, the economists are free to apply a CBA with a discount rate of 2% per year, or 20% per year, or anything in between. Goodland and Ledec (1985) also refer to engineering practice in their discussion of 'Safe Minimum Standards'. A 'Safe Minimum Standard' is defined by them as "any (non-economic) criterion which a project must meet to be environmentally or socially acceptable". And their example is that "a bridge is commonly designed with a safety factor of three or more to accommodate the unexpected and the unknown".

Note that in Goodland and Ledec's example, the safety standard is embodied in all bridge designs. Bridge alternatives are not offered to society by saying: "This alternative costs so much and takes so many deaths per year, and this alternative costs so much and takes so many deaths per year; now take your pick". All bridges are safe; safety is a value internalized in the civil engineering habitus[150]. Analogously, sustainability can be a value internalized in all the relevant designing disciplines.

Economists, working as they are within a non-designing discipline, find this hard to conceptualize. Implicitly or explicitly, they assume that simply all kinds of designs are brought for the evaluation procedures. 'Safe Minimum Standards' is then a defensive

[150] In my own education, as is probably the case with civil engineering everywhere, this paradigmatic internalization is so strong that it is never ever discussed. There is no external 'code of conduct' prescribing that safety should be taken care of.

tool to rule out bad designs, a "filter to strain out the underisable" (Daly, 1987)[151], before they enter the cost-benefit analysis.

As long as designs that do not meet environmental standards are indeed brought up to economic evaluation, a filter will provide a crucial service. Basically, however, it remains a reactive instrument, with an end-of-pipe character, incapable, in the long run, of developing the pro-active power of internalization of sustainability in the actual design of policies and projects.

'Safe Minimum Standards', in the "filter" conceptualization, leads to the image of *constrained maximization* of net present value (or profits, or whatever) (e.g. Ledec and Goodland, 1985). In this image, the environment is what poses the constraint. The environment, in other words, is here a passive and negative entity, standing in the way of full human development. This, roughly, is the environment as it was in the debates of the 1970s (Pearce *et al.*, 1989). We are, then, like a farmer who sees the land not as a value to trust and to work with, but as a constraint to something else that should be maximized. Taking matters somewhat closer to home, we may of course draw up an endless list of all the constraints our own bodies impose on us; but living is not a 'body-constrained maximization' of consumption or happiness. The body is not a bundle of constraints, and neither is the environment.

In the final subsection, we will again pick up the issue of the environment-in-the-design versus the environment-in-the-constraints "filter". First, though, we will explore the deeper reasons why it is necessary to separate cost-benefit analysis from the question of *to what* the cost-benefit analysis should be applied. The latter, in either its 'design' or 'constraint' conceptualization, is the "first tier" of the next subsection.

Two-tiered value theories

Economics is about the optimal allocation of scarce resources; in the words of James (1989), economy is predominantly *efficiency-oriented.* In this subsection, we will focus on some recent articulations of the argument for 'two-tiered' evaluation, based on the argument that morally and practically sound decisions are based on more than optimal allocation (i.e. more than CBA) only.

In the inspiring summary of Daly (1991) and the more in-depth analysis of Underwood and King (1989), we find the argument grounded in the difference between macroeconomics and microeconomics, and between optimum allocation and maximum scale. Macroeconomics focuses on the sum total of transactions in an economy, rather than on the relative prices and volumes of the separate transactions and economic entities. For these, we have microeconomic processes and microeconomic theory. At the microeconomic level, scale is a core concept; rational producers, for instance, continue to produce until the profit on the next unit produced is zero. At the

[151] For other examples of the "filter" conceptualization of safe minimum standards, see Pearce *et al.* (1989), OECD (1989), Goodland and Ledec (1985), James (1989) and Pearce and Turner (1990).

macroeconomic level, this leads to optimum allocations and an inherent tendency of growth, i.e. an increase in the scale of the economy as a whole. Is there a maximum scale (size) of the economy as a whole, relative to the size of the ecosystem? In reality, of course there is; civilizations can crash ecologically, as may the world system in the future. But is there also a conceptualization of maximum scale in macroeconomic *theory!* There is none.

This situation, Daly continues, resembles the loading of a boat. When a new load arrives, the weight has to be distributed optimally over the ship. The next load is again distributed optimally. And so on, until the ship sinks, but *optimally, of* course.

Norgaard and Howarth (1991) approach the matter by way of the discount rate discussion. Discounting, they assert, makes much sense; it is normatively rational and empirically a good descriptor of how individuals and firms behave. Environmental and resource economists, however, have struggled with the discount rates for decades, because of the paradox that normal (high) discount rates encourage resource depletion. To make matters worse, environmentalists sometimes argue for *higher* discount rates, because the higher they are, the smaller the threat of hydroelectric dams and other harmful developments. Some consensus now seems to be growing that a dual approach is called for (roughly, this is the 'Safe Minimum Standards' of the preceding subsection), but this uneasy compromise "deserves deeper theoretical examination".

Norgaard and Howarth then proceed by building up an economic model of overlapping generations, in which resource trnasfers between generations are explicitly considered. They conclude that (1) the intergenerational resource transfers cannot be evaluated by efficiency criteria and (2) each distribution of resources between generations results in a different set of prices, quantities, as well as a discount rate, relevant for applying conventional cost-benefit analysis.

Norgaard and Howarth conclude that the paradox of the discount has arisen because the problem has been misframed. There is nothing wrong in discounting; it takes care of efficient distribution of our resources. This is a matter to be distinguished, however, from the passing on of resources to future generations, so that they be *their* resources. In the words of Norgaard and Howarth:

> "Questions which are fundamentally matters of equity should be treated as such. If we are concerned about the distribution of welfare across generations, then we should transfer wealth, not engage in inefficient investments [e.g. by juggling with the discount rate]".

Sustainability is the transfer of natural resources to future generations, i.e. an aim of intergenerational equity. Sustainability cannot be adressed within an efficiency (e.g. CBA) framework. This holds not only for the sake of Sustainability, but also for the sake of efficiency.

Page (1991) formulates his "two-tier value theory" as a general principle of societal arrangements. Legal principles that stand the test of time, Page starts out, are built on a basis different from those of more temporary arrangements. The latter are the products of well-defined interests of people in a relationship of negotiation. The former are built on a process in which people abstract from their personal positions and preferences, conceptualizing themselves closer to Rawls' "original position" behind the "veil of ignorance".

The first tier of institutions and arrangements sets the conditions for the second tier to develop safely. Thus, markets and the liberal state develop within the first-tier conditions of constitutional rights, equity, principles of non-fraudulent information and so on. In the old days, Page continues, we did not need a sustainability principle in the first tier, since we neither had the technology nor the numbers to rapidly deplete the resource base. Now, however, we do.

A rate of discount is something belonging to the second tier of "specific preference satisfactions", not to the first tier of "broad equity", which includes equity across generations. Traditionally, in economic analysis such as CBA, the value of sustainability is tied to the discounting problem. "But in the two-tier view, we do not use discounting to define and evaluate sustainability. We use concepts of sustainability to set constraints on markets. Once we have done this, we discount at normal rates".

With respect to the practical implementation of the two-tier system, Page points to two basic principles. The first is *non-interference* between the two tiers. A redistributive (equity-oriented) income tax or a regulatory (sustainability-oriented) energy tax, for instance, which are typically first-tier instruments, should not be "corrupted" by special privileges that affect the day-to-day workings of markets and decision-making of the second tier. The second implementation principle is that *different decision procedures* be established for each tier. The 2/3 majority necessary to change a constitution is an example. Another element here is that the first tier should be regarded as a system of broad principles, in which the focus is on the essentials (e.g. basic needs) and the long term, but *open* at the same time, with scope for decisions being reached by flexible rules of thumb. The way a firm sets its R&D budget is the example used by Page here.

A final observation in this subsection concerns the famous principle of 'Pareto-improvement'. As explained by Pearce (1983), the original Pareto criterion was that policies may be accepted when nobody is rendered worse off. This rule is called "strict Paretian improvement" at present. Second, we could argue that a policy is acceptable if the ones who become better off actually compensate those who suffer. This is the "Paretian rule with actual compensation". Third, we could argue that it is only necessary that there is a net overall benefit, i.e. that the ones who become better off *could* compensate the ones who suffer. About this, Pearce states that:

> "This is the Kaldor-Hicks compensation test and it is this which is typically regarded as underlying CBA as conventionally practiced. Quite whether such a rule even deserves the title "Paretian" is arguable, but we can follow Mishan in referring to it by its now conventional title of a requirement for a "potential Pareto improvement"."

The three Paretian rules may be connected to notions developed in the present and the preceding subsections.

- The "strict Paretian" rule is associated with the idea of sustainability as the preservation of a constant natural stock for future generations. It is also associated with Page's first tier of basic rights, basic needs and "broad equity". If, as we shall do in the next section, we define the first tier as taking care of the *weak* (nature, the poor and future generations), the criterion is relaxed somewhat; we leave it to the rich and strong to compensate among themselves potentially only, e.g. through CBA.
- The "Paretian rule with actual compensation" is allied to the method of El Sarafy encountered in the previous section with respect to non-renewable resources. In this middle ground, we also find CBA employing the 'compensation project' method (if these compensation projects are actually in the design and actually implemented, of course).
- The "potential Paretian improvement" allows the poor to become poorer as long as the rich become even richer. It is also, as Pearce states, regular CBA and neoclassical, 'utilitarian' economics.

The strict Paretian principle is usually condemned by mainstream economists (as it was, in 1983, by Pearce) as untenable, leading to "total inaction". As will be shown in the next subsection, this is a mistake.

First we take care of those who depend on us

Does a 'strict Paretian' rule lead to "total inaction"? Mainstream economists might have feared it would lead to *their* total inaction, but even that is a mistake. Markets where nobody is forced to sell or to buy (e.g. because of poverty) are 'strict Paretian' markets, as Sagoff (1988) points out. Through Sagoff (1988) and Page (1991), we can build up a general picture of what, instead of "total inaction", are the operational characteristics of the first tier in a two-tier value system. After that, I will return to the narrower subject of this section, the appraisal of projects and policies.

Sagoff (1988) can be read as a defence of basic environmental standards, typically a first-tier element, against the inroads of economists who try to lift the standards into the second-tier CBA orbit. "Intangibles", the economists say, should be made tangible by means of willingness-to-pay and other methods, so that we know their real value and they may be efficiently traded off against other values. But the Clean Air Act and other current legislation does not permit, much less require, the basic air quality standards to be taken up in a cost-benefit or other 'balancing' test. The standards are set as a normative constraint on economic development.

The Endangered Species Act is Sagoff s example of the most clear-cut first-tier statute of all. It requires all federal agencies to "insure that actions authorized, funded or carried out by them do not jeopardize the continued existence of such endangered species". Not in spite of but because of this unequivocality, Sagoff continues, the statute has worked well:

"Developers by and large have found mitigating strategies to protect the species that their projects might otherwise eradicate. Conflicts have given way so quickly to deliberation and negotiation on a case-by-case basis, indeed, that a special Endangered Species Committee, set up to grant exemptions, has met only twice, and very few cases have been litigated under the act."

The interesting thing to note here is that the rigid law has had creative effects rather than led to "inaction". Excluding species protection from being drawn into the realm of willingness-to-pay, abstract CBA calculus and trade-offs with overwhelmingly strong economic interests, incorporated species protection in the case-by-case *design* of projects and compensation measures.

National constitutions typically formulate rights in 'strict Paretian' terms. Practice shows that well-working constitutions lead nations to action rather than to inaction. At the same time, in these nations many long-standing legal institutions, rules and debates are especially geared to put the 'rigid' first-tier principles into fluent practice. Nobody maintains, for instance, that firms are obliged, as Sagoff puts it, to "pay hundreds of millions of dollars to provide a tiny improvement in workplace safety". But note that the 'trade-offs' of this type are kept in the legal realm, decided upon by courts and public consent, not by a CBA; the primacy remains with the first-tier institutions and rationality[152].

First-tier principles are foundational but *open*, as Page asserts. They are amendable in public debate and negotiabable (though not by calculating and balancing net present values).[153] As we saw in Section 4.5, there exist two different ways to arrive at such amendments and decisions, *viz.*, abstract and contextual ethics. In the first, the concrete problem situation is 'fed up' into abstract formulas of justice, formulated primarily as a balancing of rights and obligations. In the second, the abstract principles are

[152] As an example, Sagoff mentions the EPA policy principle that costs incurred because of health regulations should not be "grossly disproportionate". In Sagoff (1989), an excellent account is given with respect to property rights and the eminent domain. Natural property right theory puts property rights in the first tier; utilitarian theory puts them in the second tier, "defending property rights not as a matter of principle or of basic justice, but only insofar they promote the efficient allocation of resources". Sagoff distinguishes between use value and market value, and allocates these in the first and the second tier, respectively. With that, me right to use, exclude and alienate property in use value terms becomes protected against second-tier arguments (e.g. concerning efficient markets) that governments may bring forward in order to justify eminent domain takings. At the same time, property rights do not hold a priority position with respect to the needs of other 'inhabitants' of the first tier, such as future generations, nature and the poor. There is no right to destroy first-tier use value in order to create (second-tier) value (e.g. to drain a wetland of high natural value for profit), if the first-tier procedures of public decision-making have been properly followed. And consequently, too, no obligation then exists to compensate the would-be wetland developers for the profits they could have made. The same logic applies to the well-known phenomenon that farmers demand (and receive) compensations, at market prices, for not poisoning the groundwater with pesticides and excess fertilizer, not killing birds with mowing machines, and so on.

[153] Norton (1992) makes the mistake to think that first-tier principles, because they are not negotiated in the economic realm, are un-negotiable.

'fed down' into the description of the concrete problem situation, and the solution to the problem in found at the concrete level of the problem situation itself, formulated primarily in the language of differences and care, rather than and universals and rights. Page (1991) briefly mentions these two modes of moral reasoning as "contract" and "community", respectively. Thus, shall we formulate sustainability in terms of rights of future generations and intergenerational contract? Or in terms of care for future generation and intergenerational community? Shall we conceptualize our attitudes and duties toward nature in terms of rights or partnership? In my view *(cf.* De Groot 1992b, Chapter 8), contextual ethics should have primacy throughout the first tier, with more legalistic ('rights') modes of reasoning in a position to fall back on if contextual ways to find solutions fail[154]. Thus, my formulation of the two-tier principle: *first we take care of those who depend on us* (= first tier), *then we go out to enjoy ourselves* (= second tier).

The ethics of care lie close to our day-to-day ways of responding to problems. An everyday life example may therefore further clarify the two-tier principle. Consider that we have two young children and want to go out to the nightclub. What we do then is not include the children in the 'cost-benefit analysis' of which nightclub to go to; rather, we take care of them first, by calling in a baby sitter or through any other arrangement, and then go out to enjoy ourselves, free from worries or obligations with respect to the kids.

This example, simple though it is, elucidates why the rule of *strict* Paretian improvement, not the 'optimum' rule, has traditionally been associated with the liberal state (Kneese and Schulze, 1985). 'Optimum' Paretian improvement, that is, that something is good simply if it has a net benefit for society as a whole, is the totalitarian perspective, in spite of its superficial association with the market economy[155].

Expressing the concrete character of contextual ethics, the two-tier value system in my formulation is personified, speaking about 'those who depend on us'. Thus, the abstract principle of sustainability takes on the face of future generations. And the abstract principle of basic needs[156] takes on the face of the poor. The third important member of the first-tier family is nature, in its intrinsic value aspect.

In the appraisal of projects and policies, the three first-tier family members often prove to be in conflict with one other. There are no detailed recipes of how to proceed in these cases, but the preceding analysis does give some important principles to support resolution.

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[154] Even the courts we then fall back on follow much more contextual types of reasoning than one would expect from the legalistic language they use (De Groot-Van Leeuwen, 1991).

[155] What is happening in Eastern Europe at present is that the free rein is being given to the second-tier market mechanisms without first-tier institutions effectively being in place.

[156] See Norgaard and Howarth (1991) on the analogue between the basic needs approach and the sustainability principle.

(1) The first thing to keep in mind is that first-tier conflicts really *are* first-tier conflicts, to be solved before net present values or any other cost-benefit calculus comes in.

(2) The conflict is fundamental but may therefore be formulated in what Page has called open terms. Decisions on a basis of rules of thumb are better than non-decisions because details and certainties are lacking.

(3) The first path to take is to seek contextual ways conflict resolution. The first task then, is not to build abstract value hierarchies and learn how to make the calculations of adjudication, but to build the moral community and learn how to listen to those without a voice.

(4) If conflicts cannot be resolved this way, sustainability, nature or basic needs should not be shifted to the second-tier deliberations. There, they will function as *add-ons* in a cost-benefit or multi-criteria analysis (e.g. as "intangibles", or as additional costs and benefits estimated by some willingness-to-pay or other method, or as additional criteria); equity obligations cannot be met as add-ons in decision systems built for efficiency purposes. If conflicts cannot be resolved in the first instance, they should still be kept within the 'juridical' mode of reasoning: organize a hearing, consult your children, play court, go to the field to see the ecosystem that the problem is about, go to the poor to learn and negotiate - anything, but not cost-benefit analysis.

(5) All the while, the focus should be on resources, nature and human needs in their own real terms, not market values.

(6) Design, much more so than appraisal, is conducive to contextual reasoning. In the typical design setting, people are gathered around a table not to exchange rigid arguments about something already given, but to jointly and creatively formulate something new, focusing on the concrete problem situation. Thus, *redesign* is always the final course of action to choose if no design can pass the equity "filter". As Sagoff has indicated, this course will work all the better the clearer it is that there is no escape through the equity filter into the waters of hanging price tabs on the first-tier principles and redefining the problem as an efficiency problem.

Henry (1989), based on experiences in France, the UK and the Netherlands, illustrates several of the points raised here, with special emphasis on the fact that cost-benefit analysis in practice, rather than being a tool to rationalize political arguments, serves to express political power positions in a rationalized form. One obvious element here is the setting of shadow prices. More interesting, because more hidden, is the conceptualization of the CBA structure as a whole. In CBAs made for river 'improvement' purposes, for instance, a flooding risk norm with respect to farmland of less than once in 10 years is usually set as a constraint. No public safety being at stake here, Henry asserts that no reasons exist to give this flooding risk an *a priori* (first-tier) status; this status simply expresses the social power of the drainage engineers. The same holds, for instance, for many of the design standards used by road construction engineers.

Another example concerns the French national electricity company, an agency so unassailable that it can make designs for hydroelectric power stations without taking the environment in account, and draw up a CBA without an environmental constraint and with the environment priced at virtually zero. The optimum is then presented as the overall best variant. If the environmental department wants to have something changed, this is acceptable (within bounds, of course), but the electricity agency has to be compensated out of the environmental budget; it is allowed to buy back, budgets permitting, what has in fact been stolen. Superficial political power is to win struggles; deep political power is to have your rules accepted as the norm, so that there is no need to struggle.

Henry's final example is from the Netherlands. It concerns the extension of Den Helder harbour into the Wadden Sea. After years of public struggle, it was decided that a thorough CBA should be made. A first-tier arrangement was agreed upon first, however: no harm should be done to the ecosystem in any harbour extention variant. As it turned out, no variant was economically feasible within this constraint. Still, this was accepted. Because the demand for more harbour space remained, however, the municipality went over the port with a fine-toothed comb and found a solution there, to the satisfaction of everyone, including the Treasury. Quite in line with Sagoff s U.S. experiences, Henry concludes that the constraint became the solution. Redesign had been the key, not weaker constraints on the CBA.

A well-known complaint of civil servants in environmental deparments is that they cannot really enter the game of decision-making if they cannot put price tags on nature and natural resources. Behind this is a conceptualization of decision-making as a bidding game for efficient allocations, and the power of the other participants to reinforce that conceptualization. At a superficial level and in certain cases, price-tagging the intrinsic value of nature or the willingness-to-pay for future generations may possibly be of help. At the deeper and longer-term level, however, entering decision-making processes as if they were a bidding game is to already have lost. The deep and long-term course is to establish that preservation and sustainability conditions must be met before bidding can start. I hope I have supplied here some reasons as to why this is important, some arguments for the discussion and some practical ways to give shape to the alternative.

Against this background, is there a positive role left for CBA? Of course there is. In fact, in my own first years of engineering practice, I made a hundred of them, in order to get proposed sites for rural bridges on a priority list. The 'costs' were set as the height of the abutments plus twice the bridge's span; the 'benefits' were the number of houses served by the shorter route, taken from a topographic map; no need to discount, of course, since all bridges would be of timeless quality. Using the 'benefit'-'cost' ratio listing to ward off local politicians who came lobbying for bridges on the roads that coincidentally led to their own houses, how I loved to be the embodiment of Rationality!

On a more serious note, the environment should obviously continue to play a role in CBA even when CBA is used as a second-tier tool. The environment is not only future generations, nature protection and basic environmental standards. Many aspects remain associated with what I called 'enjoying **ourselves'**, i.e. the efficient allocation of amenity functions of the environment, all environmental deterioration and depletion that remains above the first-tier norms, all environmental improvements (e.g. 'nature development') that may be regarded as more than a making good of first-tier losses in the past, and so on. In this second-tier realm, all theoretical progress and balanced application of the shadow-pricing methods that this section started out with is to be applauded. The discount rate problem, however, can only be resolved by two-tier thinking and practice. The first tier is outside the discounting realm; in the second tier, we discount at normal rates (or start a discount rate juggling game, but then for tactical reasons only).

ANNEX 4.I

Sustainability As The Foundational Modeling Variable

In current literature, the concept of sustainability is nearly always paired with 'development'. The paired concept "sustainable development" is often said to be a *contradictio in terminis* and indeed, contradictions can only be escaped from if 'development' is defined different from economic growth in the sense of an ever-increasing physical throughput of the economy (Daly, 1990).

In Chapter 3 and Section 4.3, the concept of sustainability has been defined as the long-term aspect of all final variables (health, economic services, spiritual growth, diversity of nature, etc.). This definition coalesces with sustainable development if we define 'development' as improvement of a country's or a region's situation in terms of these final variables; the major development indicators then lie closer to the general quality-of-life statistics (Milbrath, 1989) than they do to GNP. This way, we do not only reconcile 'sustainability' and 'development' conceptually. In real-world terms, quality-of-life parameters such as the 'human development index' are much more initimately linked than is GNP to sustainability-enhancing phenomena such as low birth rates (Sadik, 1991). Kerala, a 30-million-people state of India, is a real-world combination of low birth rates, high quality of life, low GNP per capita, equity and sustainability that deserves more attention in development debates (Alexander, 1991). Defined this way, development and sustainability are not inherently at odds with each other, and sustainability can be studied without constantly keeping in touch with development implications.

Pearce et al. (1989), based on a survey of 24 literature sources, refer to sustainability as *the maintenance ofthe natural resource base offuture generations.* The present Annex will be built on this sustainability notion. One focus will be to explore this concept further: what it is not, why it does not include man-made resources, and so on. The second focus will be on the question of operationalization, especially on the level where most policy decisions are taken. First of all, however, I will explain why I treat sustainability, as the title of this Annex states, as the *foundational* variable, and why this is important.

The deep level of analysis

Problem-oriented environmental science, in my perception, has grown out of a direct involvement in environmental problems, with the emphasis on the plural. The present study is primarily intended to structure, broaden and deepen this work, considering, for instance, the overall framework for interdiscipliary research, the addition of a problems-explaining branch, and the philosophical foundations. But still, the plural remains, that is, a focus on the multitude of problems of, say, aquifer depletion, the decline of the ozone layer, disapperance of forests, toxic waste dumps, desertification, water euthrophication and air pollution, at the local, regional and (sometimes) global level. In the background, problem-oriented environmental scientists have always felt the presence of scientists speaking in singulars: *the* environmental crisis, *the* future of the earth, *the* root of the problem. To make connections between the plurality of environmental problems and the singular environmental problem, however, is not easy.

It is the great merit of ecological economics[157] to be now pouring theory and tools into the gap between the plurality of environmental problems and the singular, fundamental aspects of the environmental crisis. 'Sustainability' is the door through which almost all the ecological economists have come. Sustainability, therefore, is the key opportunity to become acquainted with thinking in more singular, foundational terms, and connect that thinking to policy decisions. I will therefore refrain from trying to operationalize the concept of Sustainability by means of 'component reductions', e.g. distinguishing between social, ecological, economic, geographical and cultural Sustainability (Sachs, 1989), or focusing on specific entities like forests or irrigation projects (Hoogendam et al., n.d.). Of course, I do not deny that it can be quite sensible to discuss the social Sustainability of irrigation projects, but here I will keep up the foundational perspective as long as possible.

Seeking the singular, the deep parameter of Sustainability implies that we should keep proper track of the *domain* of the resulting models or theory. Seeing deep is not the same as seeing everything. In this respect, it appears that three levels of environmental problem analysis may be distinguished:

- a 'superficial level' of detailed, 'all-seeing' environmental problem analysis, in which a wide variety of parameters is studied and aggregated, if relevant, into a smaller number (e.g. the final variables)[158]
- an 'intermediate level' of environmental problem analysis, in which parameters are chosen for their relatively foundational character and interpreted that way (e.g. fossil energy use, vegetation structure types, total health risk, claims on agricultural land).[159]
- and a 'deep level' of analysis, in which it is tried to characterize the fundamental processes connected to sustainability.[160]

Costanza et al. (1989) provide an illustration of what happens if one makes a fallacious jump from one level to another. They propose that the ecosystem energy capture (gross primary

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[157] Usually, I refer to environmental specialist sciences as *environmental* chemistry, law, economics, etc. Here it serves to make a distinction. Environmental economics, roughly, is in many respects a normal environmental specialism, normal science also in the sense of Kuhn, studying cost-benefit analysis, optimal rates of resource depletion, externalities, incentives etc., within the bounds of the neo-classical paradigm. Johansson (1987) is a characteristic product; a general source is the 'Journal of Environmental Economics and Management' (Academic Press). Ecological economics, found in the much younger journal (Elsevier) and book (Columbia University Press) of the same name, is the revolutionary science in Kuhn's sense, based (negatively) on the criticism that neo-classical approaches are fundamentally unfit to deal with the Sustainability problem and (positively) on the work of Georgescu-Roegen and others on energy and entropy, the "thermodynamic school" as Victor (1991) calls them. See also Christensen (1989) and Colby (1991) about classical, neoclassical, Keynsian and ecological ('neomalthusian') economics.

[158] This is typically the level of, for instance, EIA, an instrument expressly designed to make us see everything.

[159] This is typically the level of regional modelling, e.g., Van den Bergh and Nijkamp (1991).

[160] Pillet et al. (1987) describe three levels of depth of analysis in energy studies (exergy level, embodied energy level and entropy level); the first one applies to the efficiency of specific thermodynamical systems; the second and third roughly coincide with the 'deep level' above.

production), a typical 'deep level' parameter, to be taken to stand for the "total value" of a wetlands area. Total value, however is the sum of everything, that is, the aggregate of the 'superficial level' parameters. It cannot be said that a wetland has the same total value as a maize field that happens to have the same gross primary production, for the same reason that you cannot be summarized as the energy expenditure of a 150-Watts bulb. The 150 Watts may be a good summary of what your body contributes to the physical non-sustainability of the world, but that then is the 'deep level' of sustainability, not your "total value".

The 150 Watts parameter is a singular parameter and simple to measure. Its difficulty lies not in measuring it but in developing a sound notion of what it stands for. Developing the proper operational parameters, therefore, is primarily an abstract struggle; if the concepts are clear, the parameters will follow. It is on this road that I will continue.

Nature at the deep level ofanalysis

The intrinsic value of nature is one of the final variables. *Logically* then, sustainability also comprises the sustainability of nature. This is the general position taken in the present chapter, and also the position of Opschoor and Reijnders (1989) with respect to sustainability more specifically. Obviously then, nature will play a role in intermediate-level sustainability assessments of regions or activities. What happens, however, if we take the 'deep view'? We then abstract from specific natural entities like concrete forests or single species. Does that imply that nature will be abstracted away completely, in the sense that it will be visible only in human-centered, functional aggregates like 'biomass' or 'photosynthesis'? Will the old-growth forests be equated to pine plantations?

One way out here is to separate human survival from the survival of nature. Sustainability analyses will then be completely human-centered, and nature will somehow have to be brought back in later. It is more fruitful, however, to try to keep nature (real nature, nature in its diversity and evolution) *inside* sustainability analyses, also at the deep, foundational level. This subsection focuses on the question of how we might do so. Current literature supplies several hints on the basic notion that we need for keeping nature inside foundational sustainability analysis. Such a notion can be arrived at sooner, however, by first drawing up an analogue with social systems.

If we take a deep (but empirical) look at the long-term success and longevity of societies and other social systems, the difference between centralized and decentralized systems is one of the first things that strikes the eye. *Decentralized* cohesiveness has a very concrete long-term survival value; centralized decision-making is good for the army, for temporary repair actions in too chaotic societies or for other short-term purposes[161].

A core characteristic of decentralized societies is their seemingly inefficient excess of decision-making bodies, productive units, economic linkages, education, opinions and so on.

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[161] According to some (e.g. Jeurgens, 1991), the environmental issue justifies centralized action in Duth society. I agree with this, but in the sense that parliament, speaking for the people, should bypass the Dutch 'middle field' of vested interests and advisory committees, usually a well-working system of decentralized cohesiveness, but unable to really respond to the novel, deep and urgent environmental issue. Parliament then would play the role of the king in medieval societies, i.e., the direct resort of the people, bypassing, keeping in check and sometimes overruling the normal working of the nobility and clergy 'middle field'.

Powers are separated so that decisions have to be made five times over; markets produce a mass of unnecessary goods and unfit firms that fail; artists produce things understood only by other artists; future engineers are taught Greek poems; freedom of speech produces the most mediocre of opinions to be voiced massively. Efficient systems, it seems, would be centralized: a single decision is executed by the best-suited economic unit, people are not taught 'useless' things they do not need for the work they are best suited for, and so on. Yet, these systems fail in the longer run; they are unsustainable because they are inflexible, locked in the efficiency of a single rationality on a single course. In the long run, however, no rationality can be complete, and no course can be preset.

In order to cross over fluently from social systems to the physical-social system that a sustainable earth will be, it serves to formulate more abstractly what that extra survival ingredient of decentralized social systems. Roughly, it is:

- an 'overmeasure' of diversity (of power centres, ways of life, knowledge, etc.)
- an 'overmeasure' of room for the autonomous *telos* (will to live, will to express) of individual units (businessmen, philosophers, political groupings, artists) to unfold.

For *physico-social* systems, the overmeasure consists of three components. First, the social 'overmeasures' we just identified. Then, an 'overmeasure' (a stock of alternatives) of people-environment relationship types and views. And thirdly, an 'overmeasure' in the physical subsystem, which would be, on analogue with the social subsystem, an "overmeasure of diversity" and an "overmeasure of room for the *telos of* individual units to unfold". Upon reflection, these abstract notions are the very same thing as *nature,* not as generalized biomass, but as the multitude of concrete life forms and ecosystems. Moreover, the two components (diversity and room to unfold) are the equivalents of the two major criteria through which the intrinsic value of nature has been operationalized in Section 4.6.

Concluding, a sustainable earth is not only a system of properly arranged patterns of just-right energy and mass flows. It also needs an overmeasure of diverse and free naturalness. This long-term instrumental value of an ongoing bioevolution coincides with why we value nature intrinsically.

Current literature, as said, supplies clues that may be combined to build up the same image. Several authors, to begin with, emphasize the need to incorporate a notion of flexibility in the sustainability concept. One of them is Page (1991), who mentions the "preservation of options", almost in passing, in a world sustainability context. Van den Bergh and Nijkamp (1991), when briefly discussing the problem of long-term uncertainty in regional modelling, mention the "option value (flexibility value)". Gallopin et al. (1988), largely based on ecological system concepts, emphasize the role of resilience in a system's sustainability; closest to our notion of 'diverse and free naturalness' is their "evolutionairy capacity", the loss of which is equated to "the loss of germplasm and of general ecological variability, increased simplification and homogenization of ecosystems due to management and increased ecological stress". Pearce et al. (1989), based on concepts in agro-ecosystems research, discuss "sustainability as resilience" as the capacity to respond to external disturbances, "a feature often lacking in man-made capital". The economist Daly (1991) deserves a quotation of greater length:

> "In a finite system subject to the conservation of mass, the more that is brought under economic control, the less remains under the spontaneous control of nature (..) [The idea of "Managing Planet Earth] implies that it is the planet that is at fault, not human numbers, greed, arrogance, ignorance, stupidity and evil. We need to manage ourselves more than the planet and our self-management should be, in David Orr's words, more

akin to child-proofing a day-care centre than to piloting spaceship earth (...)• Our manifest inability to centrally plan economies should inspire more humility among the planetary managers."

The philosopher Jonas (1979) sketches how ethics have always been built upon the image of the human 'polis', set as an enclave in an unscrutinable natural context. Now is the first time in history, Jonas proceeds, that a single human 'polis' encompasses the whole earth. There is no more external wildness to draw upon if the polis fails; nature should be internal in our ethics and models.[162]

Now that we have gained some grip on what nature on the foundational level of sustainability models may be, operationalizing its intrinsic value and its 'deep function' as a source for long-term human development is a straightforward matter. Roughly, pollution levels acceptable for human health can be assumed to be also sufficiently low for nature to develop. The only remaining condition, then, is essentially to provide *space* for the evolution to continue, be it in more or less isolated wilderness reservations or integrated in the interactive landscape. Because space will be the core parameter I propose below for all other elements of foundational sustainability models too, 'nature space' can simply be taken up in them[163].

Resourcesubstitution

The next issue is the interchangeability (substitution) of natural resources with human resources (machinery, fertilizer, knowhow, etc.), a classic theme in ecological economics. Sustainability has been defined here, as in most other literature, as constancy of *natural* capital. Obviously, the assumption is that natural resources cannot be substituted with human ones to a degree sufficient to be relevant for sustainability models and discussions.

The assumption of non-substitutionability runs counter to a key axiom in neoclassical resource economics (e.g. Dasgupta and Heal, 1979), in which technological progress is assumed to essentially take care of natural resource exhaustion, provided we invest enough in that progress. In view of the the present-day rates of decline of renewable and non-renewable resources this optimism seems irresponsible, empirically and morally. The arguments of ecological economists (Pearce et al., 1989; Daly, 1991; Victor, 1991; Boulding, 1991; El Sarafy, 1991; Kawaniya, 1987; Mayumi, 1991; De Vries, 1989; Cleveland, 1991) may be summarized in three types:

- There are many functions performed by the environment (Section 4.7) for which substitution at some less than astronomical cost is simply not conceivable. Recreating the ozone layer or taking over the climate-regulating function of oceanic phytoplankton are

[162] Reijnders (1992) is an interesting case in that he draws attention to the "macrofunction of nature", a neglected area of environmenta policy. Stating that "it is necessary to maintain very large quantities of wild nature", he makes a sharp distinction between that nature and the subdued nature of agricultural systems. This runs counter to current practice in sustainability thinking, that focuses on biomass, primary production etc. Reijnders makes the step toward wild, diverse nature not because of my association with flexibility and resilience, but because of its association with Gaia-type functions in global cycles.

[163] We arrive then at a picture close to Odum's (1971) four landscape compartments, but with "protective environment" in a different and deeper interpretation.

examples. Another is that artificial photosynthesis costs 33 times more energy than it produces.

- Normal technological progress does result in a steady improvement of the energy efficiencies of thermodynamic machines. These improvements are thermodynamically bound to the level of percentages, however, not orders of magnitude. Moreover, due to the steady decline in the abundance of fossil energy, minerals, fisheries, water and topsoil resources, the *net* energy efficiency of the extraction of these resources is on a steady worldwide decline. The number of barrels of oil that can be extracted from U.S. sources by means of an energy expenditure of one barrel, for instance, is back at the level of the 1920s, and plummeting[164].
- Substantial substitutions, therefore, can only come from abnormal technological progress, of the fundamental character of, say, cold fusion.

In a vehicle about to crash against a concrete wall, it is not intrinsically wrong to keep up the hope that the wall will go away spontaneously. The major thing to do, however, is to start steering. Empirically and ethically sound sustainability analyses exclude substitutability of the basic natural resources. Underneath, three categories of resources will be regarded as having this basic, unsubstitutable character. They are (1) energy in all its forms, (2) the other functions of the environment as enumerated in Section 4.7, such as soils for food production, and (3) nature, in its foundational aspect treated in the preceding subsection. *Within* these categories, low thresholds of substitutability are assumed to exist; the walls *between* the categories, however, we can climb only very partially.

Towards a foundational sustainability analysis

Now that we have laid a basis as to what a foundational notion of sustainability might be, we are ready to operationalize the concept in a more analytical model. The two basic matters to be settled then first concern the *scale* and the *variables* of such a model. Below, I treat them in that sequence.

Sustainability models should be applicable not only at the global level. In practice, the units of "maintenance responsibility" (Sawyer, 1986) will lie at lower decision-making levels, e.g. countries, industrial sectors or even single products or activities. This implies that sustainability models should be able to distinguish between the sustainability of the unit of analysis (country etc.) itself and the 'sustainability impact' the unit has on its surroundings. By way of example, consider a country rapidly depleting and exporting its forest reserves. In doing so, it 'exports sustainability' in the sense that it helps the timber-importing countries to keep up their own forest capital (their 'internal sustainability', we might call it), at the same time being unsustainable itself, internally. The reverse example is described by Braat and Steetskamp (1991), who made an ecological-economic model of a province of the Netherlands. This region, after having mined most its own natural capital (mostly peat and forest) in the 19th century, now imports large quantities of fossil fuels and livestock fodder and exports not only many industrial products and meat, but also substantial emissions of ammonia and

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[164] Cleveland (1991); see also Paruelo et al. (1987) about Argentina oil, and Cleveland (1991) and De Vries (1989) about minerals, water extraction, agricultural production per unit of fertilizer, and so on.

other pollutants. At the same time, internal resources like ground water have become polluted far above national and WHO environmental quality levels, and natural qualities have dropped dramatically. The overall picture here (indicative for general developments in industrialized nations) is that the region has kept up its economic growth by importing sustainability from outside (oil, fodder), exporting unsustainability to outside (emissions), internally depleting its depletable resources and polluting the remainder. This example shows that a good sustainability model should not only account for open boundaries (import and export) but also for pollution; pollution should be a sustainability parameter or, better still, should be accounted for in the single, foundational sustainability parameter. As we will see, such accounting is partly performed by way of environmental quality standards.

Obviously, it makes little sense to focus a model on internal sustainability. Rich regions can maintain their own resources by importing oil, timber, etc. from outside and deliver the waste somewhere else. The important variable is the *contribution to the total sustainability ofthe earth* by the region, which is the sum of the net (un)sustainability the region exports plus (because the region is also simply a part of the earth system) the region's internal (un)sustainability[165]. And, as said, this contribution should be assessible not only for regions, but also for any other 'world sub-unit' such as economic sectors, firms, products, or the consumption patterns of rich and poor people, through a single 'open boundary calculus'.

All this may sound like a plea to start an immensely complex scientific programme. It is not, really. The 'Life Cycle Assessment' approach for products, for instance (Guinée, 1992) accounts for mineral resources, embodied energy, emissions, space requirements etc. of all stages of the product between mineral mining and product disposal. This is the product's contribution to total-earth sustainability, which only becomes complex, especially in terms of data requirements, if a 'superficial' (all-detail, multi-parameter) assessment is aimed at.

In all ecological-economic, 'deep-level' sustainability models, *energy* is taken as the basic variable, in one of its parameter forms such as embodied energy, exergy or entropy. This variable is chosen because in the last resort, the earth system is driven by solar energy[166], directly or in fossil form[167], incorporated in biotic and abiotic cycles. Energy, therefore, 'captures' much. As we will see later on, for instance, it can account for pollution. Other baic sustainability factors mentioned above, however, lie outside the energy realm. As we saw, this concerns many functions of the environment, out of which the procurement of food and essential minerals are probably the most important here. For all practical purposes, we will continue to need high-quality soils, not only fertilizer or other energy equivalents, to feed the world population. As for the essential minerals, energy can account for the rising

[165] According to Opschoor and Reijnders (1989), this is an un-attainable goal, because of the massive allocation problems and data requirements. This only holds at the 'superficial' and 'intermediate' levels of sustainability modelling. See for instance Van den Bergh and Nijkamp (1991) for characteristicly 'intermediate level' requirements.

[166] Or, as Tsuchida and Murota (1987) and Murota (1987) put it more fundamentally correct, by the influx of low entropy solar radiation and the outflux of high entropy heat, i.e., net entropy production.

[167] For an analysis of the fossil fuel requirements of nuclear energy, see Chapman, 1975.

energy cost of their extraction when they become scarce, but we cannot use energy to create them.[168] And, as we saw too, energy does not capture biodiversity.[169]

How important is it that the energy variable does not capture soils, minerals and biodiversity? The answer is: it is crucial. The fact is, energy does indeed drive everything, *but it is not scarce,* nor is its expenditure (apart from the pollution that often, but not intrinsically, accompanies it) in any way a threat to sustainability. That fossil energy may be in much more abundant supply than once thought (e.g., Andriesse, 1991) is slowly dawning at present. More importantly, the simplest of calculations (Dostrovsky, 1991) show that the solar energy influx, when tapped, for instance, through the 'solar-hydrocycle' with the solar equipment installed in desert regions, can satisfy all the energy needs for a world population much larger than it is now, without using up precious soils needed for agriculture or biodiversity, already with current technologies. For a foundational sustainability analysis, energy is an out-of-focus parameter. (As we will see later, energy can be used as an intermediate variable to work toward what really is important, but that is quite another matter.)

Then, what *is* important for world sustainability, i.e., fundamentally dangerous or scarce? It does not require much looking around in the literature and in the world to find at least the basic categories, which basically repeat what was stated already above:

- *Pollution,* especially of carbon dioxide, CFKs, heavy metals and other non-degradables, as well as acids and other substances that burden productive ecosystems. Below, pollution will be accounted for through the concepts of "solar space" and "ecospace".
- *Productive ecosystems,* i.e., agro-ecosystems, forests, fishing grounds and so on. Soils are the especially vulnerable factor here. Productive ecosystems are the "renewable resources" emphasized by many policy-oriented, less 'energetic' ecological economists (e.g., Pearce et al., 1989; El Sarafy, 1991; Opschoor and Reijnders, 1989). Below, these resources will be accounted for as "ecospace".
- *Biodiversity,* the ongoing bio-evolution, as discussed in a previous subsection. This will be "nature space", below.[170]

All this, obviously, has outspoken policy consequences. (It shows, for instance, that energy levies may be harmful to sustainability rather than beneficial; they hamper, because they make more expensive, the use of energy for matters that really count, e.g., pollution prevention; the much-needed environmentally relevant shifts in energy-using sectors such as transport and electricity production are best brought about by emission levies only.[171]) Here, however, we will focus on the implications for foundational sustainability modeling. In the next section, we will use the energy measure to model energy matters (there is nothing against these matters, although it is not the key parameter), but we will use energy especially to account for pollution and fertilizer. Partly through energy, partly through environmental

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[168] In the words of Georgescu-Roegen, "matter matters, too" (Judson, 1989).

[169] For a far-fetched attempt to include everything in the energy measure, see Scienceman (1987).

[170] I here exclude the essential materials and water (important especially in semi-arid regions like the Middle East). Substantively, I do so only on weak, intuitive grounds. Methodologically, I have the better reason not to complicate the analysis here; if the need is felt, they can always be added.

[171] Other applications of the principles found here concern, for instance, hydroelectric power and energy out of biomass; they produce something that is not scarce while costing fertile soil and space for biodiversity.

quality standards and partly without intermediate variable, we will work toward the parameter that captures the three key matters of sustainability.

All by the square metre

We will now make the last step towards the examples that will round off the analysis. In order to keep a clear view on the basic principles, I will ignore all matters of detail and quantification. Many of these typically concern pattern variables; in terms of biodiversity, for instance, a hectare of tropical rainforest is quite different from a hectare of tundra; I will keep 'nature space' as an undifferentiated parameter, however. To take another example, it will simply be said that the use of fossil fuels can be sustainably substituted by a certain area of solar power installations, leaving it to others to work out the details of energy transfer efficiencies, the effect of distance from source to demand area, the problem of seasonal variations, the energy embodied in the solar energy equipment itself, the regional variations in solar energy influx, the quality differences (exergy) of the energy types and so on, in short, the design and quantitative aspects of the 'solar-hydrocycle'. The examples of this Annex will be examples of principles.

In a previous subsection, the sustenance of the bioevolution, assuming that pollution can be accounted for elsewhere in the model, has been reduced to a matter of space, in the simple sense of providing square metres of the earth's surface. This space-for-nature can not be translated into energy-for-nature. The other way around works, however; energy requirements can be translated into space requirements. This is because the influx of solar energy, as well as the outflux of latent heat, is a 'surface mechanism'; it is Joules per square meter. Also pollution can be translated into space requirements; we then take, for instance, energy as the intermediate variable - not describing the *effects* of pollution in energy terms, but describing the energy requirements, and therewith the space requirements to *prevent* pollution. Also the preservation of renewable resources is, in the last resort, a space requirement. In short, the square meter is the deepest sustainability parameter, the common denominator of the analysis[172]. Underneath, the steps from energy, renewable resources and pollution to space will be explained.

Input of non-renewable energy, directly or embodied in products, can be converted into the space it would take to supply the same amount of energy by means of solar energy equipment, either using some average estimate or a more grounded and differentiated conversion factor, as said above. Let us call this parameter *solar space.* In the case of energy *input,* the sign is negative: 'solar space required'. Output of non-renewable energy, directly as coal or oil or embodied in products, is 'solar space provided', analogously.

Inputs of renewable (biotic) resources do not have to be converted into energy first and to space next; fodder inputs, timber, firewood, etc. can be directly expressed in the square

[172] My major inspiration for this comes from Giampietro and Pimentel (1991), who calculate the "embodied space in fossil energy used", by means of equivalences such as 1000 kcal of fossil energy being 0.7 m2 year of "biosphere space-time". Slight hints to the same effect can be found in Daly (1991, p.40), Mayumi (1991) and Cleveland (1991, p. 297).

metres of ecosystem, which we may call *ecospace*, required to produce them sustainably. Either some rough average of net primary and secondary production can be taken, or a more differentiated calculus of different ecosystem types at different latitudes, soil qualities and so on. Either way, fertilizer inputs go into the non-renewable ('solar') account. Output of renewables again has a positive sign; it is ecospace provided for other regions.

The capacities of real-world ecospaces to produce biomass or assimilate waste vary by several orders of magnitude between, say, a semi-desert ecosystem and fertile, well-watered clay soils. Thus, if we say, for instance, that a country imports biomass to the equivalent of 1000 km^2 of ecospace, we should know what type of ecospace we refer to. Following Cleveland (1991), square metres of empirical ecospace may be converted in square metres of *standard ecospace* by means of some production or assimilation standard. We could take, for instance, the crop (kcal/ha.year, or W/m^2) that may be harvested, with good agricultural practice, without fertilizer, from relatively fertile land; this figure lies in the order of magnitude of 0.1 W/m^2 (Giampietro and Pimentel, 1991). Thus, 20 m^2 of land capable of 0.02 W/m^2 is equivalent to 4m^2 of standard ecospace. This way, we can also account for the crucial phenomenon of degradation of natural production and assimilation capacities, by acid rain and other pollution (Klaassen and Opschoor, 1991), by overexploitation or by removal of protective vegetation cover. These capacities being in continuous decline all over the world, we can say that in terms of standard ecospace, the Earth is continuously shrinking.

It is very difficult to assess the effects of pollution on the environment in energy terms. Moreover, a sustainable world cannot be a world of environments impacted by pollution; it will have to be a world of pollution prevention. Against this background, pollution may be accounted for in sustainability modelling in two different ways. The first has been suggested by Kümmel (1989) and beautifully exemplified by Kümmel and Schlüssler (1991). Roughly put, they calculate the *energy requirement of pollution prevention,* i.e. separating and disposing of the pollutant, including the pollution generated by the pollution abatement process itself; also the carbon dioxide production of the burning of fossil fuels can be completely accounted for this way, as shown by Hendriks (1991). Through this 'energy cost of pollution prevention', emissions of harmful substances can go into the energy measure and through that be converted into the *solar space* parameter.

The second way to transform pollution into the square metre dimension is through the concept of environmental capacity, especially the pollution assimilation capacity of the environment. Consider, for instance, the well-known case of discharge of bio-degradable waste or eutrophying substances into a lake. Given the area of the lake and the pollution quantity, we can calculate how much the oxygen level or some other environmental quality parameter will drop. Conversely, we can calculate the lake area needed to sustainably assimilate the pollution without a drop below the relevant environmental quality standard. This is the area of *ecospace* required by the pollution quantity. All other calculations, e.g. concerning acid emissions and terrestrial ecospace required, are conceptually equivalent.

For any given type of pollution, a choice obviously has to be made whether to account for it through the solar space or through the ecospace route. This choice will often be unproblematic; diffuse pollution of bio-degradables will go into the ecospace, industrial point sources can for the greater part be treated in Kümmel's energy cost of pollution prevention, with the remainder taken care of by natural assimilation. (Electric cars, therefore, are a major means to transform unpreventable diffuse pollution of non-degradables into preventable ones; the cars themselves do not pollute and the energy used to fill the batteries is generated at a central plant where all pollution can be prevented by spending some more energy.)

Regions may export emissions by way of water and air flows. Doing so, they burden other regions with "solar or ecospace required". Regions also assimilate emissions originating outside their boundaries; if so, they provide ecospace or solar space for elsewhere.

To some extent, ecospace needed for emission assimilation may overlap with ecospace needed for renewable resource (biomass) production or space needed for the ongoing bio-evolution. Organic waste, for instance, may enhance bioproduction, and nature reserves may provide some pollutant assimilation without degrading. Optimizing this phenomenon is of course a basic strategy to arrive at a sustainable relationship between rural and urban/industrial areas; for the sake of simplicity, no overlaps will be assumed in the examples of the following section.

Waste may be dealt with in the same way as pollution. The only difference is in what is left over after the waste has been treated so as no longer pose a chemical threat to environmental quality. This residue, surprisingly, boils down to *space* to dump it. As Kümmel and Schüssler show, this space may be reduced to zero by applying energy in order to recycle the waste into the economy or send it off to outer space. This energy, however, is equivalent to a lot of space, larger, usually, than the dumping sites. The difficulties here are not conceptual; the example below, therefore, will consider emissions only.

The intrinsic value of nature and the instrumenatal value of the ongoing bioevolution, as said, simply require space. This *nature space* is usually of a different type from the ecospace required for renewable resource production: more wilderness than pasture or crop field. Again, there will be some overlap (e.g. seminatural wetlands processing organic waste), but for a basic analysis, nature space and ecospace can be kept apart. Nature space could be converted into "standard nature space" in order to take care of quality differences, e.g. through the number of species per hectare. Because the principle has already been demonstrated with respect to ecospace, nature space will not be standaridized in the following section.

A spin-off of the square metre calculus is that we may also account for a matter of growing importance in densely populated areas, the space taken up directly by housing, roads, industry, mining and so on. *Urban space,* as we could call this non-solar, non-eco and non-nature category (in which we may also include the space required for waste dumping) is the last of the 'space types' required for a foundational analysis.[173]

Square metre modelling

This final section will concentrate on some examples that are one step towards a quantifying, modelling 'square metre calculus' of sustainability at the foundational level. Although very simplified, they are typically the subroutines that may become combined into real-world

[173] Finally, it may be noted that the space types are connected to the functions of the environment discussed in Section 4.7, albeit on a somewhat more foundational level. Urban space is loosely connected to the carrying functions, nature space to habitat, ecospace to processing and joint production functions, and so on. At a more intermediate level of analysis, spaces will prove to be often multifunctional; nature space can also provide for recreation and watershed protection, ecospace for signification and so on.

models of farms, industries, cities, regions or the world. I will confine myself to the examples because they illustrate sufficiently how the preceding subsection's principles can be handled quantitatively.

The output of the illustration will be in terms like "standard ecospace provided" or "solar space required". With this type of output, we may answer *empirical* questions (historical, present-day or predictive), of which the leading one is: what does this region (or sector, or any other subunit) contribute to world sustainability? If this question is answerable, all kinds of allied questions may be answered too, e.g.: if we spend more energy in preventing further environmental quality decline in this region, will the external effect be that the environmental qualities of a greater area will be threatened in the longer run? Or: what will be the sustainability contributions of improved technologies or better land use? Or: what should the size of Japan be if it were to sustainably take care itself of all the energy, emissions, forest space, etc. embodied in its imports (with the energy etc. embodied in its exports substracted)?

Secondly, the output provides for the answering of *design* questions, which is, roughly, the piecing together, on paper, of sustainable regions, a sustainable world or products and practices which are less a sustainability burden.[174] In this respect, it may be noted that the sustainability norm that is set depends much not only on whether the resources in question are renewable or non-renewable, but also on the boundary of the subunit one takes. A big city, a primarily industrial area or, for that matter, any heterophic organism can never contribute positively (in physical terms) to world sustainability. Cities need nature and rural areas. Hence, it is not intrinsically wrong that the 'real size' of cities or industrialized nations is much greater than their geographical size. Wrongness arises when, as is the usual present-day case, the exchange system as a whole becomes unsustainable, or when the exchange itself becomes parasitic, colonizing.

In order to get a basic feel of the analysis, some simple cases will first be taken. The first one is an area of 100 km^2 of solar energy equipment, provided with a plant for maintenance and renewal. Figure 4C gives the situation and sets some drawing conventions. The double line denotes an arbitrary region the installations are part of, taken to be empty space (US=0; NS=0; standard ES=0) exept for the 100 km^2 of empirical solar space ('SS-empirical'). We assume that the maintenance plant does not need any outside inputs except energy and also that emissions arising from the plant's processes are not exported but taken care of following Kümmel's route, that is, applying energy to prevent them. In the Figure, the plant takes up

[174] The question could be asked whether output parameters like "net solar space externally required/provided" are in fact empirical or normative. In that respect, we may note that even if we take empirical energy needs, empirical emissions production figures etc. (in past, present or future), for the *conversion* to square metres following the preceding subsection, the sustainability norm (sustainable environmental quality) is the key. As an example, we may consider the large quantities of cattle feed, imported by the Netherlands, grown in the USA and Thailand. In our analysis, we convert this to ecospace *required for the sustainable production* of this biomass, not the actual space-in-use for the production, which may be based on soil mining or on fertilizer levels resulting in unacceptable nitrogen levels in the groundwater. Even if some simple average production figure of the ecospace (kg biomass per acre per year, plus solar space embodied in fertilizer) is used to quantify the model, this still should be taken as an estimate of sustainable production. If we do not, the whole model crumbles, conceptually. The concept of sustainability asks for a normative interpretation of reality, and the model should do just that.

the equivalent of 15 km^2 solar space; 60 km^2 worth of energy is exported ('solar space provided', SS-prov), and 25 km^2 is used internally in the region ('SS-excess', drawn below the region). The space drawn outside the region (left, right and below) is the region's contribution to the sustainability of the world. In this case, the balance is positive (85 km^2; 25 km^2 excess internally and 60 km^2 provided externally), and sustainable.

Next, keeping the analysis in solar space only, we may consider the more difficult case of non-renewable energy exploitation, say, a stretch of desert land out of which 100 km^2 of solar space (the equivalent of the yearly oil production) is being pumped up. This case is more difficult because the oil obviously provides sustainability to the world, but is itself not sustainable resource. The upper picture in Figure 4D gives the situation, using the conventions set in the preceding figure. The desert land is supposed to be completely empty; hence, also without solar installations (SS-emp = 0). Exported oil amounts to 85 km^2 'solar space provided' externally (SS-prov). Pumping up the oil and undoing the emissions arising from the process (again assuming Kümmel's method) requires 15 km^2 solar space. The empirical solar space being zero, a solar space shortage ('SS shortage') is present of 85 + 15 = 100 km^2. This shortage is offset by the oil supply, drawn with a dotted line to

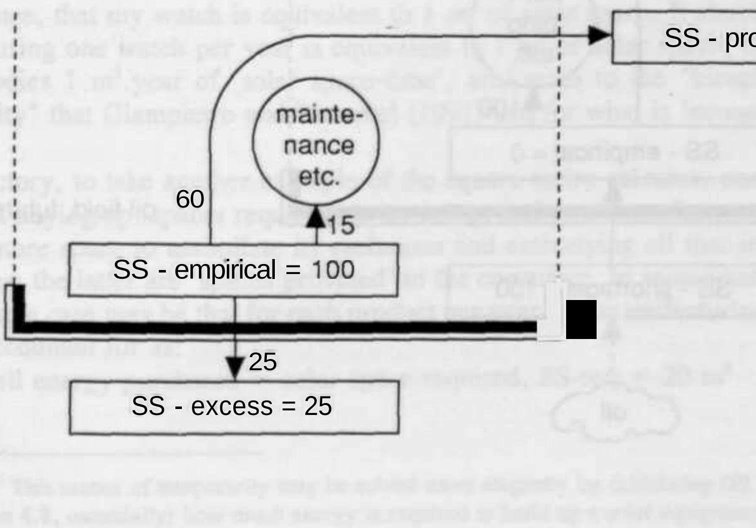

Figure 4C
An example solar equipment installation of 100 km^2. SS is 'solar space'

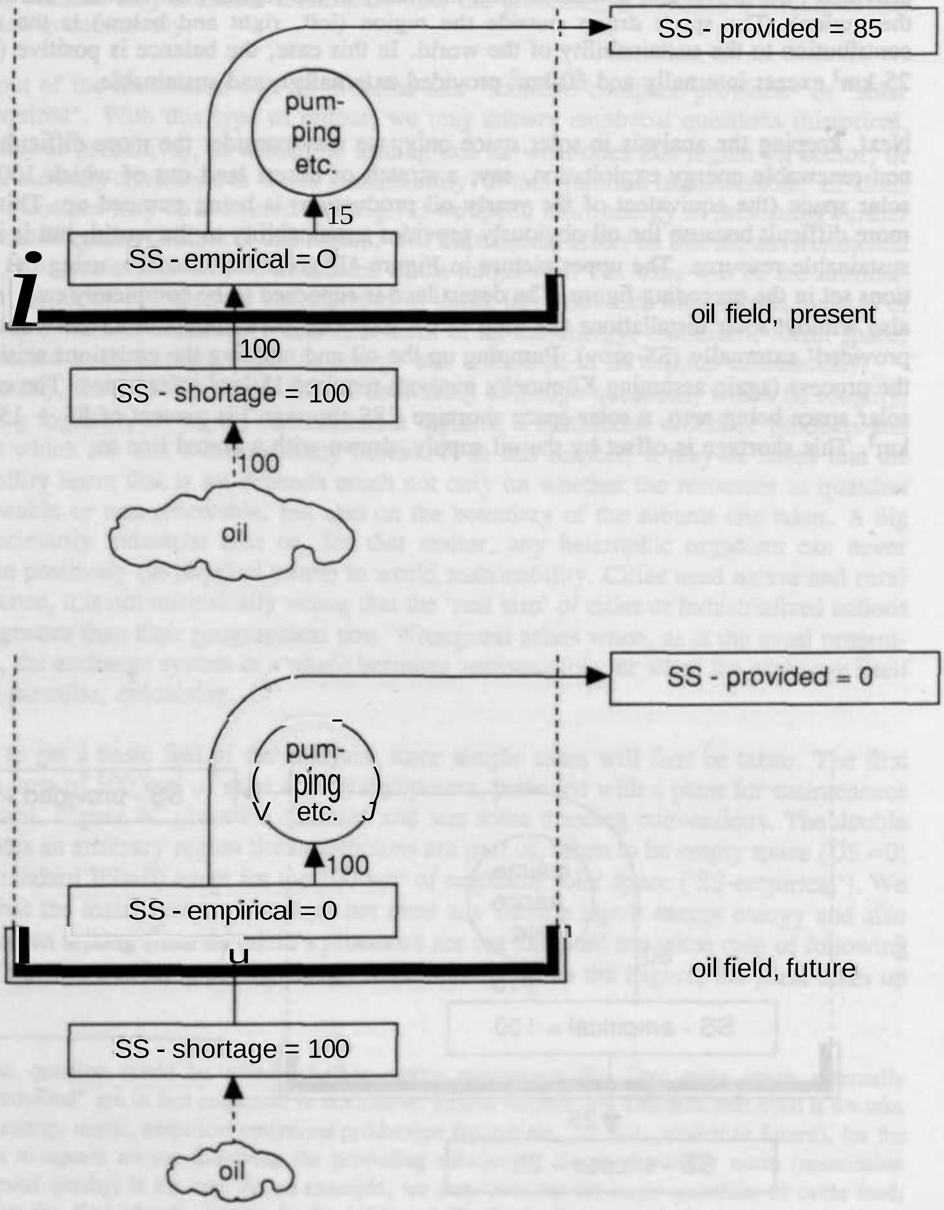

Figure 4D

An example oil field with a present net oil production equivalent to 85 km^2 solar space (if the equivalent of 15 km^2 is also used to prevent all pollution)

indicate its temporality.[175] The contribution to world sustainability is, again adding up the elements drawn outside the region, 85 - 100 + 100 = 85 km^2 of solar space, but temporary.

The lower picture in Figure 4D shows the situation when the oil has become 'exhausted' , that is, so hard to get or of such low quality that as much energy has to put into the extraction and pollution prevention process as is being pumped up. The contribution to world sustainability has become zero (0 - 100 + 100).

A next example considers a product. When we buy a product, we buy embodied fossil energy, embodied emissions, embodied renewable resources and embodied 'urban space', that is, the fossil energy that has been used in all mining and transformation processes leading up to the product, the emissions that have taken place during these processes, the timber, cotton and other products inside the products or used in the process of making it and the space used directly by mines, factories, etc. Following the principles of the previous subsection, all this may be aggregated into the basic space categories. Embodied fossil energy goes into solar space (Kümmels route) or ecospace if assimilated; waste generated is treated as emissions, with urban space used up for the remainder; natural resources go to ecospace; urban space remains as it is. All these are 'space required', a negative contribution to sustainability[176]. When the product is used and disposed of, simply more 'spaces required' are added to the picture. If the product is recycled, this substracts from to spaces required, although recycling can never fully balance them, following the second law of thermodynamics.

In product analysis as in any other modelling effort, it should be kept in mind that it is resource *flows* (kg/year, watts, kcal/day, etc.) that are equivalent to solar space and ecospace, not the kilograms, Joules etc. themselves. Hence, I cannot say, for instance, that my watch is equivalent to 1 m^2 of solar space. It should be said either that using one watch per year is equivalent to 1 m^2 of solar space, or that the watch embodies 1 m^2.year of 'solar space-time', analogous to the "biosphere space-time activity" that Giampietro and Pimentel (1991) use for what is 'ecospace-time' here.

A factory, to take another example of the square metre calculus, can be regarded as a unit buying up 'spaces required' in its energy and semimanufactured inputs, requiring more space to assimilate its emissions and embodying all that in the products it makes; the latter are 'spaces provided' to the consumer. In somewhat more detail, an example case may be that for each product per year, the manufacturing processes may be accounted for as:

- fossil energy purchases = solar space required, SS-req = 20 m^2

---

[175] This matter of temporarity may be solved more elegantly by calculating (El Sarafy's method of Section 4.8, essentially) how much energy is required to build up a solar equipment of 100 km^2 during the lifetime of the oil stock, and include that in the picture, which then is without temporary elements (Van der Loo, pers. comm.).

[176] Agricultural equipment is a product type that starts to contribute to sustainability when it is put to work, but that should be accounted for in a wider analysis of land use systems.

- purchase of renewables = ecospace required, ES-req = 0 m^2
- emissions not prevented through spending energy, ES-req = 10 m^2
- urban space (the factory itself), US-req = 1 m^2.

Embodied in the semimanufactured input goods we may find:

- embodied fossil energy, SS-req = 1000 m^2
- embodied renewables, ES-req = 50 m^2
- embodied emissions, ES-req = 30 m^2
- urban space (mining etc.), US-req = 10 m^2

The result in the product per year is:

- SS-prov = 20 + 100 = 120 m^2
- ES-prov = 6 + 10 + 50 + 30 = 90m^2
- US-prov = 1 + 10 = 11 m^2.

In the 'embodied' calculus, the chain of ever-increasing space requirements runs up to the consumer; a product label might show how much space the consumer buys up and will use up during the product's lifetime and disposal, given a standard lifetime (products per year). The responsibility of the manufactures is to keep these spaces as low as possible, by purchasing low embodied-space semimanufactured goods and adding as little space requirements as possible. The responsibility of governments is to enhance attitudes and to create incentives, e.g. shifting from income tax to 'sustainability taxes' on consumer products and services, based, for instance, on a square meter calculus (Kümmel and Schüssler, 1991).

'Nature space' (the space required to maintain the bioevolution and safeguard nature's intrinsic values) has not yet figured in the examples. Implicitly, it was assumed that nature was sufficiently protected, so that 'urban space required' was in fact not nature space occupied. Nature space figures prominently in the analysis of regions (of any size), to which we now turn.

Figure 4E shows a region, following the same conventions as in the previous figures. The picture is extremely simplified, focusing on a few key relations only. The upper picture of Figure 4E shows the region as an area of perfectly balanced low-input agriculture, without fossil fuel inputs; a factory (F) transforms 100 km^2 of solar space into fertilizer, irrigation energy and so on, enhancing the agricultural production with 200 km^2 of ecospace. All other internal relations have been left out. The other characteristics are as follows.

- The region has a geographical area ('A-emp') of 2000 km^2. Of this, there is 100 km^2 of urban space ('US-emp'; roads, housing, etc.), 500 km^2 of nature space (NS-emp), 100 km^2 of solar space (SS-emp; solar energy installations, hydropower, wind power, etc.) and 1200 km^2 of ecospace (ES-emp; cropland, grassland, production lakes, etc.). The ecospace, on weighted average, is somewhat below standard quality. The standardized ecospace (stES-emp) is 1000 km^2, resulting, since we do not standardize the other space types, in the region's area in sustainability terms ('A-sust') of 1000 + 500 + 100 = 1700 km^2.

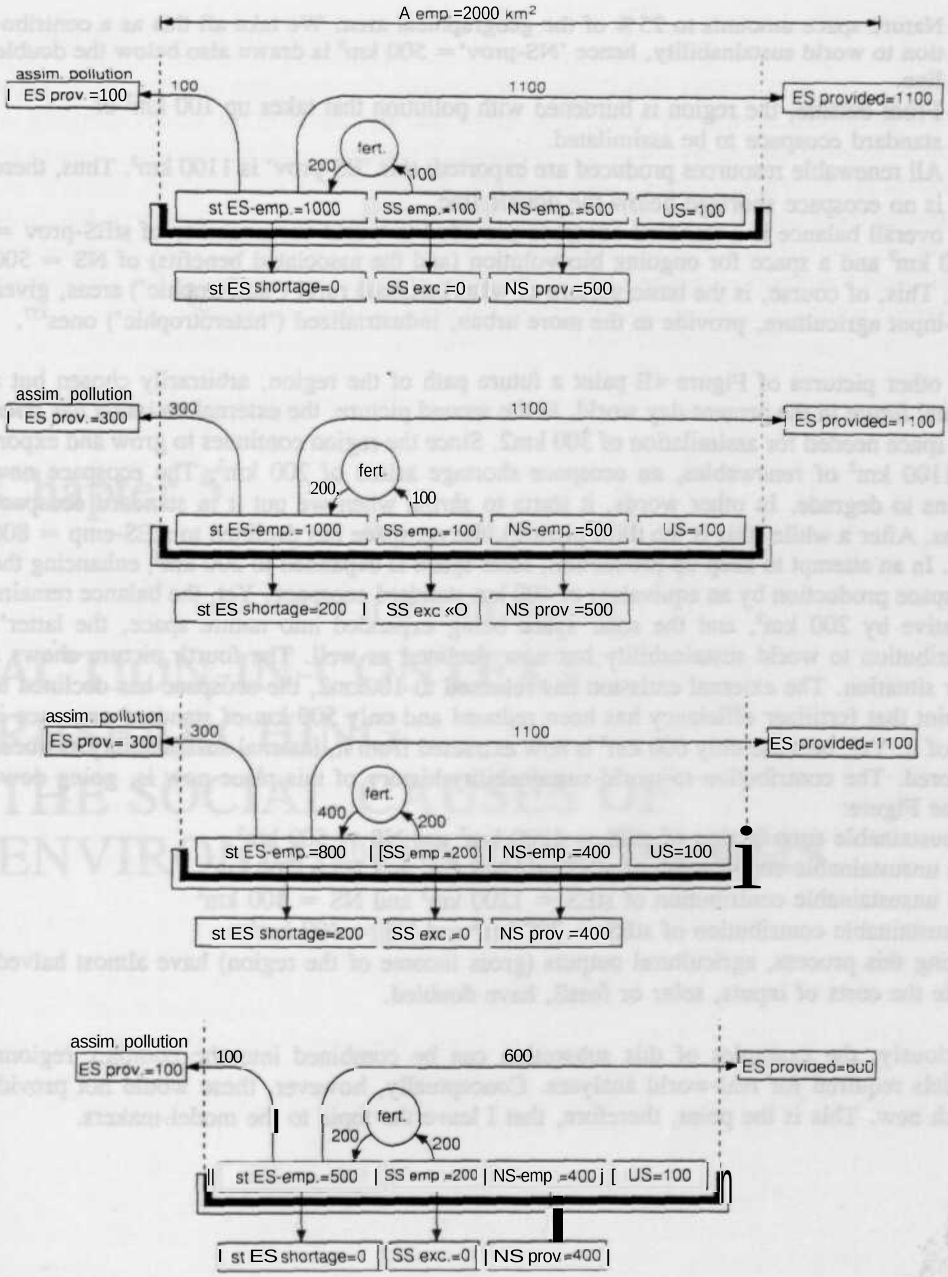

Figure 4E

Four points in time in the history or future of a region with a geographical area of 2000 km². Because of the impact of outside pollution and over-exploitation, the area's ecospace is overcharged and shrinks in standard ecospace terms. Later, sustainability is restored at a lower level of production and a higher level of fertilizer cost.

- Nature space amounts to 25 % of the geographical area. We take all this as a contribution to world sustainability, hence 'NS-prov' = 500 km^2 is drawn also below the double line.
- From outside, the region is burdened with pollution that takes up 100 km^2 of standard ecospace to be assimilated.
- All renewable resources produced are exported; this 'ES-prov' is 1100 km^2. Thus, there is no ecospace shortage below the double line.

The overall balance is a standard ecospace provided to world sustainability of stES-prov = 1200 km^2 and a space for ongoing bioevolution (and the associated benefits) of NS = 500 km^2. This, of course, is the basic picture of what balanced rural ('autotrophic') areas, given low-input agriculture, provide to the more urban, industrialized ('heterotrophic') ones[177].

The other pictures of Figure 4E paint a future path of the region, arbitrarily chosen but a normal future in the present-day world. In the second picture, the external emission has risen to a space needed for assimilation of 300 km2. Since the region continues to grow and export its 1100 km^2 of renewables, an ecospace shortage arises of 200 km^2. The ecospace now begins to degrade. In other words, it starts to *shrink* when we put it in standard ecospace terms. After a while (this is the third picture), the ecospace has declined to stES-emp = 800 km^2. In an attempt to keep up production, solar space is expanded to 200 km^2, enhancing the ecospace production by an equivalent of 400 km standard ecospace. Yet, the balance remains negative by 200 km^2, and the solar space being expanded into nature space, the latter's contribution to world sustainability has now declined as well. The fourth picture shows a later situation. The external emission has returned to 100km2, the ecospace has declined to a point that fertilizer efficiency has been reduced and only 500 km of standard ecospace is left of it. Yet, because only 600 km^2 is now extracted from it, internal sustainability has been restored. The contribution-to-world-sustainability history of this place now is, going down in the Figure:
- a sustainable contribution of stES = 1200 km^2 and NS = 500 km^2
- an unsustainable contribution of stES = 1200 km^2 and NS = 500 km^2
- an unsustainable contribution of stES = 1200 km^2 and NS = 400 km^2
- a sustainable contribution of stES = 700 km^2 and NS = 400 km^2.

During this process, agricultural outputs (gross income of the region) have almost halved, while the costs of inputs, solar or fossil, have doubled.

Obviously, the examples of this subsection can be combined into the complex regional models required for real-world analyses. Conceptually, however, these would not provide much new. This is the point, therefore, that I leave the topic to the model-makers.

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[177] Many linkages, which I must leave unexplored here, therefore exist with the work of geographers such as Boserup and Wilkinson.

Chapter 5

ACTION-IN-CONTEXT:
RESEARCHING
THE SOCIAL CAUSES OF
ENVIRONMENTAL PROBLEMS

If solutions to environmental problems are to constitute more than symptoms abatement, it is of pivotal importance that there is due insight into the social causes of these problems. In order to gain this explanatory insight, the activities causing the environmental problems have to be **'contextualized'**, that is, linked to the actors carrying out these activities, then to the factors influencing the choices of these actors, then to the actors in their turn influencing these factors, and to the social, political, cultural and economic patterns underlying all of this. **Epistemologically**, this research has to be guided by social science theory and yet be grounded in the actors' real-life **situations**. This chapter explores a way to do so, building up a general structure for explanatory research: **action-in-context** as part of the **Problem-in-Context** framework.

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Q. Just what do you do as a social scientist?
A. Oh, many things. Some of us hypothesize and others hypothecate.
Q. And what about the others?
A. There aren't any others - except, of course, those who analyze the general context of action.
Q. You mean observe how people act?
A. Well, if you want to put it that way. However, we prefer to see behavioral manifestations in their context of acts, either objective or subjective. That allows us to relate them, of course.
Q. What to?
A. Why, to ongoing theoretical developments.
Q. I'm not sure, Mr. Arbuthnot, that I know what you mean by a context.
A. You mean a general context.
Q. Do I?
A. I think so. You see, all contexts are general.
Q. Pardon me.
A. By context we mean culture, or attitudinal atmosphere, or behavioral climate, or the situation mode - in short, just general context.[178]

5.1 Introduction

In Chapter 3, the problem-in-context framework has been developed as a general structure for problem-oriented, interdisciplinary research. Going from top to bottom in the schema summarizing this framework (Fig. 3J), we can identify the various types of social-scientific research that can make a direct contribution to the environmental science field.

(1) At the top, we have the *normative ('prescriptive') theories* and methods pertaining to the design, evaluation and implementation of solutions. Well-known issues include the participation of target groups (De Groot, 1992b Chapter 6), normative theories of rational choice (e.g. Levi, 1986) and cost-benefit analysis.[179]
(2) Close to the final variables of material and immaterial human well-being, we find *'social impact assessments'* (e.g. Freudenburg, 1989) of environmental activities

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[178] From B. Bereisen, "The Cliché Expert Testifies on the Social Sciences", manuscript privately circulated *circa* 1950s, found in Dubin (1969).

[179] As indicated in Chapter 3, there is, sadly, very little focus on theories and methods for the *design* of social and economic strategies. Compared to the countless sophisticated ways of *evaluating* plans, it is usually left in the dark how these plans have in fact come into being.

and plans. These may concern landscape quality or livelihood security, for instance.

(3) The analysis of the environmental problem proper is pre-eminently a physical-science activity, but social scientists may assist in *eliciting 'local knowledge'*, from farmers and other inhabitants of a region, about environmental patterns, history, causal chains and associated technical options for solutions (e.g. Brokensha, 1980).

Down at the 'social causes' block of the schema, matters become rather more complicated. Chapter 3 has shown that there are in fact three ways to describe this Problem-in-Context element. At an abstract level, these three ways are conceptually equivalent, but at the lower level of actual research, they give rise to quite different questions and approaches.

First, it has been shown that the problem-in-context framework is recursive, holding its own image inside itself. The 'social causes' block is that 'internal repetition' of the framework as a whole, pertaining not to how the normative observer defines, analyses and reacts to environmental problems, but to how *actors* do so. This leads to social science research type 4. Secondly, the 'social causes' block is conceptually equivalent to people-environment systems, in which the environment is not that to which the normative observer's environmental problem relates, but the environment connected to the actor's activities and interpretations; this leads to social science research type 5. And finally, the 'social causes' block is also simply what it says it is (research type 6). Hence, the list of social-scientific research types continues as follows.

(4) Research concerning the ways in which actors *define and deal with environmental problems,* e.g. the environmental attitudes of the public (Nelissen, 1987), the building of the political agenda (Hisschemöller, 1986), the environmental movement (Cramer, 1988) or environmental policy making (Landy et al., 1990).[180]

(5) Research concerning the ways in which *societies interact with their general resource base*, e.g. in history (Pfister, 1990) or in the Third World (Johanson and Anderson, 1988).

(6) Research concerning the question why actors *cause environmental problems;* this is the type of research drawn in Figure 3J, the action-in-context way. It is also the subject of the present chapter. By way of reminder of the principles already explored in Chapter 3, the basic idea of action-in-context is as follows:
- to proceed from the problem-relevant actions (or problem-relevant activities; these terms are used interchangeably)
- to identify the decision-making social entities (actors) directly behind these actions
- to study the range of options available to the actors and the motivations attached to these
- to identify the (secondary, tertiary etc.) actors exerting influence on these options and motivations (the 'actor field')

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[180] Dunlap and Catton (1979) give a review focusing mainly on research types 2 and 4.

- and to tie each set of options and motives to underlying cultural and structural factors.

Thus, actions are linked to contexts ('micro to macro') in a flexible, 'progressively contextualizing' way. In the present chapter, all the steps will be treated in greater detail. Moreover, some new elements will be added (e.g. guiding principles for choices along the progressively contextualizing route, secondary analysis and actor models).

Spaargaren and Mol (1990), following Spaargaren (1987) and Nelissen (1979), classify social science research concerning the environment along two axes. One of these comprises environmental attitudes, movements and policies (my research type 4). The other pertains to the societal causes and consequences of environmental problems (my research types 6 and 2). Based on U.S. and European sources, Spaargaren and Mol conclude that, regrettably, empirical research is overwhelmingly concentrated along the first axis, while explanation of how environmental problems are caused only receives attention in abstract, empirically poorly grounded macro-theories. The present chapter may go some way to fill this gap. Writing about the Dutch situation, the *eminence grise* of Dutch sociology recently expressed the urgency of this explanatory research type 6 (Van Doorn, 1990):

> "Concerning the environmental problem, everybody professes to support vigorous policies. The citizen is well aware by now that it will cost a lot and that government has a very tight budget. What he would like to know, however, is what tough interests and what policy intentions stand in the way and what pressure groups are creating the greatest obstacles by what means".

Leonard (1985), writing about deforestation and desertification in developing countries, asserts that our understanding of these problems themselves (the problem analysis, in problem-in-context terms) is much more advanced than our understanding of the mechanisms that cause them:

> "Far more than once was the case with pre-industrial societies (.....), scientists working in developing countries have a sophisticated understanding of the various cause-and-effect relationships that exist in the processes of environmental degradation and destruction. Soil scientists know which soils are most vulnerable and can predict with reasonable accuracy the outcomes under varying agricultural techniques (...). Foresters know, by and large, the adverse local conditions to expect if forests are clearcut or subjected to other methods of harvest. Biologists, chemists, or public health officials can assess generally the tolerances of various bodies of water to absorb and degrade pollutants (.....).
>
> A key question then is: *Why do people take, and governments permit, actions that undermine the productive potential of the natural environment* even when the consequences are often quite predictable in advance or, at worst, easily discernable at some intermediate point of time?"

At this point, it is useful to briefly reflect upon the question of why it is that research into the societal causes of environmental problems receives so little attention. Why is the key question addressed so sporadically? Why does social-scientific empirical research, as found by Spaargaren and Mol, focus on relatively ephemeral phenomena such as citizen attitudes and green parties, and why do theorists remain at the abstract level of macro-theories? Three reasons may apply, one of which pertains to environmental scientists, the other two to their social science counterparts.

Environmental scientists, in my experience, associate research on societal causes with impracticability. The environmental problems these scientists work on (e.g. the lowering of the groundwater table in a region or toxic emissions into a lake) are usually considered much too *specific* for social science knowledge to be of relevance. Behind the environmental problems, the environmental scientist discerns a multitude of choices and strategies on the part of farmers, boards of directors, interest groups and government agencies, rather than the single-cause explanations of macro-theories ("alienation", "Christian world views", "centre-periphery") or the attitudes of the general public. Of course, most environmental scientists will acknowledge that these general phenomena have something to do with the environmental problem they are working on, but what exactly? How is their specific environmental problem connected to the general phenomena? It is in the realm of such connections that practicable social options for solutions are usually found, not in the general fight against alienation or the general education of the public. Not finding inspiring options for solutions in social science theory and research, environmental scientists tend to cast it aside.[181]

As to why *social* scientists themselves neglect research into the social causes of environmental problems, one reason may be more internal to their discipline, while the other may be more external. Starting with the latter, we may note that powerful institutions, groups and people are, by definition, usually the ones who, in the last resort, bear the burden of final responsibility for environmental problems. Government actions, for instance, range across the full scale between active abatement of environmental problems and active involvement in their creation, e.g. through infrastructural works, disruption of local resource management systems, sponsoring of the rat race of ever-intensifying agriculture and fisheries, tax exemptions for private transport, subsidies for deforestation and so on (Repetto, 1988). Empirical research exposing the hidden actors and mechanisms of power (which is, after all, what is entailed by 'social causes') will not be popular in many government and elite circles. Thus, why fund it? It is much better for social scientists to stick to theories too abstract to be dangerous, or to emphasize the niceties of society such as the environmental movement or environmental policies, or, as Spaargaren (1987) puts it, for them to conceptualize the

[181] Most environmental scientists are natural-science trained. This, however, does not seem a convincing reason for their neglect of social science explanation of environmental problems. Practice, at least Dutch practice, shows that if environmental scientists do discern practicable elements in social science explanations, these are used without restraint, for instance, by the biologist Udo de Haes (1987) or the physicist Pulles (1990).

cause of environmental problems as primarily a problem of values (attitudes) on the part of the general public.[182]

In terms of social science itself, too, staying away from the social causes of environmental problems also seems a safe course to take. The virtually endless number of articles and books about the environmental movement shows that doing easy-going descriptive work is quite sufficient to get published. Most research into environmental attitudes is quantitative and routinized to such a degree that it could in fact be almost completely automated: draw up a long list of small questions almost the same as last time, select the random sample of respondents, put the questionnaire in the mail, send a reminder, read the responses into the computer, push the button "Statistics: All", pick out the significant correlations and compile the draft report. But research into the social mechanisms and reasons behind environmental problems, with its complexities of causes behind causes and actors behind actors, with its intermingling of micro and macro levels and of culture and structure, with its necessarily small samples and qualitative interpretations, its difficulty of finding an honest relationship with actors who may not like what you are after, the type of analysis for which V.J.D. de Groot et al. (1990) even claim there is no scientific method at all - *how to do it?* Overcoming some of these difficulties is the aim of the present chapter.

A few remarks of a more technical nature go to round off this introductory section.

The action-in-context framework to be elaborated in this chapter is the 'blown-up' version of the 'social causes' part of the problem-in-context framework of Chapter 3. By way of introduction, several basic characteristics have already been discussed in that chapter, e.g. the relation to people-environment systems (3.1; 3.7), the emic/etic distinction (3.7), the range of applicability (3.4) and the criteria for framework design (3.1). Concerning the last of these, special care has been taken to maintain the linkages with the environmental problem analysis and with common sense reasoning, so that the framework may be useful not only to professional social scientists, but also to natural-science trained environmental scientists. If social-scientific explanation is rendered systematically accessible to environmental scientists, it is my hope that more substantive interactions between these two disciplinary fields will be stimulated, to the benefit of both.

All this implies, as I will argue more fully later, that keeping a certain distance to specific social science theories is indicated. The full emphasis will be on the epistemological matter of *linking up* the environmental problem explanation to the *various* social theory fields, avoiding tying the explanation down within a single social science paradigm. This represents an attempt to organize the orchestra of theories to work in concert, so to speak, rather than arrange a solo performance by one of them.

[182] The textbook review of Nelissen and Kok (1991) treats exactly these things: (1) general theory about the "science/technology/capitalism system", (2) the attitudes and behaviour of the general public and (3) "active society", confined to the nice things that the environmental movement, government, citizens and industry do to alleviate environmental problems.

5.2 First Principle: Actors, Viewed Holistically

Farmers cut trees; farmers make terraces. Governments destroy floodplains; governments protect national parks. Business firms dump their toxic waste at night, and voluntarily develop improved technologies during the day. Environmental problems are made, and solved, by *actors*. The social science explanation of environmental problems thus consists in explaining why actors act in the problematic way they do. Each and every actor is, in turn, influenced by other actors and by the system characteristics of society. In themselves, however, these system characteristics are inactive; they do not see, decide or implement. Theories of social system characteristics, speaking, for instance, in terms of integrative functions, gross national product, the protestant spirit, bureaucracy or incorporation, relevant though they all may be, cannot be the prime focus of social science explanation. To come to grips with the causes of environmental problems requires that actions, and then *actors*, be the basic point of departure, focusing first on actors' interpretations, options and decisions. The next explanatory step is to tie these actors to other actors and to system characteristics ('micro' to 'macro'). This step is usually seen as pivotal in the explanation of environmental problems (Spaargaren, 1987), as well as being one of the major challenges for contemporary social theory in general (Knorr-Cetina and Cicourel, 1981).

Actor-oriented approaches have a broad basis in the social sciences (De Groot, 1988b; Orlove, 1980)[183]. Vayda's (1986) article "Holism and Individualism" gives a polemical overview of the actor-versus-system issue in ecological anthropology, and may serve here to clarify two elements of my treatment of the subject. Discussing the work of Rappaport (1984), Vayda denounces the tendency to ascribe *telos* (homeostatic goals and capacities) to social systems, ecosystems and people-environment systems. System level characteristics may be causes and effects of individual people's actions, but only individual people can have adaptive strategies; only individual people can act. With respect to the work of Jochim (1981), Vayda goes into the issue of *functionalism*, that is, the tendency to explain people's actions through their consequences, e.g. their 'survival value'. Actors are themselves functionalists to some extent, of course, in the sense that people usually involve the expected consequences of their actions in their decision-making. However, these are the consequences as envisaged and valued by the actor, which may quite different from those retrospectively seen and theorized

[183] In anthropology, the decline of the 'systems' paradigm and rise of the actor-oriented approaches is usually referred to as the shift from structuralism to transactionalism. Thoden van Velzen (1973) has given an elegant critique of the actor-oriented 'Big Man paradigm' in political anthropology, which may well be used to identify weak spots in the actor-oriented paradigm as a whole. Several of Thoden van Velzen's criticisms are implicitly obviated in the action-in-context framework; the two remaining ones will be explicated and discussed at the end of Section 5.6.

upon by the researcher. System level consequences, for instance, may be largely unknown and unintended by the actors. Vayda illustrates this with Rappaport's famous case of the periodical mass slaughter of domestic pigs by a New Guinea tribe. According to Rappaport, these people carry out this slaughter because they know that the carrying capacity of the environment has come under stress due to rising pig numbers. In Vayda's interpretation, the slaughter ceremonies release *social* stress, built up inside the village, not in the environment. The 'survival value' of the ceremonies is thus not their cause. Just because people happen not to have an environmental problem because they carry out a certain activity, this does not mean that they have followed a "strategy" to "solve" the environmental problem; they may have been solving quite a different problem, or may not have been solving any problem at all.[184]

With respect to Vayda's argument that only individual people, not social systems have *telos,* I partly disagree. I do not deny actorship to a certain class of social systems, namely, those that are in fact especially created to be actors, equipped with their own information system, decision-making structures and implementatory devices: village councils, business firms, government agencies and so on (Hindess, 1986). As economists rightly say, the economics of corporate strategies is micro-economy ('actor-economy'), not macro-economy ('systems economy'), even if the corporation has thousands of individual employees and may operate world-wide. I will return to this is in Section 5.4.

As illustrated by the title of Vayda's article, actor-oriented approaches are often associated with reductionism. In one sense, namely, by not explaining system level properties directly from other system level properties, actor-oriented approaches are indeed reductionistic, even if one acknowledges the 'actorship' of the larger social entities mentioned above. This is not the complete picture, however. One way to define 'holistic' and 'reductionistic' is in terms of the system level at which one starts the explanation. The other way to define 'holistic' and 'reductionistic' is in terms of the *way of looking* at the object. Looking the reductionistic way is looking at certain aspects only; looking the holistic way is looking at the object in its wholeness, that is, not viewing the object as a cybernetic machine or as a set of roles, elements, attitudes or rationalities, but keeping inside the epistemological perspective the full array and integratedness of the object's capabilities. To my mind, the ideal actor-oriented approach involves, as a basic point of departure, actors being looked at *holistically,* i.e. without a preset role focus, ('farmer', 'parent'), model of rationality ('homo economicus') or any other narrowing perspective. Thus, this chapter, although standing firmly in the actor-oriented, 'micro-foundations' tradition (Hechter, 1983), certain-

184 Putting it in problem-in-context terms: the prevention, rise and disappearance of environmental problems, and hence the activities defined as problem-relevant by the normative observer ('ETIC') are not necessarily, or perhaps even usually, causally related to the EMIC motivations, options and environment of the actors. The "environmental policy cycle", in which environmental problems are depicted as being solved only if and because environmental policy acts upon them (De Groot, 1989b; Simonis, 1989) is the naively voluntaristic normative counterpart of Rappaport's and Jochim's empirical functionalism.

ly does not stand in its mainstream of giving an absolute *apriori* primacy to the *homo economicus* ('rational choice') model for the explanation of actions. This point will be returned to in the coming sections, to be fully discussed in Section 5.7. There, it will also be shown that, having started out by viewing the actors holistically, we may subsequently choose to take more narrow, reductionistic courses. Here I will give only four arguments for my non-mainstream position, explaining why it is important. The arguments hinge on what I see as the gradual, but fundamental difference between people and all other possible objects of study. They will be epistemological, ethical, practical and empirical, respectively.

High-level systems are usually viewed and studied reductionistically, e.g. focusing on energy flows, money flows, functional units or spatial patterns. It is almost impossible to proceed any other way; who can claim to understand Society, Earth or History as a whole? With respect to people, matters are different, as is discussed more extensively in De Groot (1992b, Chapter 7). On the one hand, people are much more complex than any social system (or physical science object): endlessly facetted, hopelessly inconsistent, deeply integrated, reflective, unpredictable, elusive, the self-centered bookkeeper one moment, the magnanimous caretaker the other, independent, but always eager to be praised .... On the other hand, people offer to the researcher one characteristic that counterbalances this complexity: the simple fact that the researcher himself belongs to the same class of creatures. *All* of us are endlessly facetted, hopelessly inconsistent and so on, and, exactly by merit of this, epistemologically accessible to one other to a degree that social systems, ecosystems or inanimate things are not.

(1) *Epistemologically*, then, the heart of the holistic stance is that the researcher puts into action the great holistic research tool he possesses: himself. Thus, we use our own integratedness and full array of capabilities, including those of the heart, in order to understand other people's integratedness and full array of capabilities, and to communicate that understanding. This may take the form of a long and intense project of hermeneutic, 'deep' research *(D& Groot*, 1992b, Chapter 7), but it is also the natural and simple way of explaining people in daily life. In understanding and explaining somebody else's action, the basic approach is through the question of what you yourself would have done, if you had been in that frame of mind, with those options, in that position. It is also the unproblematic first step of what we will encounter in the next sections as Vayda's (1983)[185] 'rationality principle: to "put yourself in the place of the actors"[186].

[185] Based, upon others, on Popper (1972).

[186] It may be clear, therefore, that terms like holism and wholeness here do not denote 'deep', in the sense that in looking holistically at actors we should always search for the deep self, world views and so on. The "full array" simply means all motivational factors for action, not only those of some theoretical model. For example, Elster's (1989) "social norms" are not deeper than the "rational" reasons he mentions. Yet, including them is a more holistic view. The holistic point of departure is a 'first principle'; "going deeper" (Section 5.6) is optional, to be taken up in a progressively contextualizing route as the research requires.

(2) *Ethically*, the holistic stance holds definite advantages over reductionistic approaches. Looking at people in their wholeness is looking at people the way we want to be approached ourselves. *Subsequently*, we are often not averse to being looked at as performing a certain role (a patient, a parent) or acting within the bounds of a certain type of rationality. Why treat other people differently from how we want to be treated ourselves? (Ryan, 1970, p. 121)[187].

(3) At the *practical* level, as mentioned earlier, in order to overcome the present-day hiatus between environmental and social science, it is important that social science explanation move beyond being merely the esoteric art of social scientists to become communicable and accessible to environmental scientists. In my experience, the best way to chase environmental scientists away from social science is to try to convince them that it should all be done according to the rules of functionalism, or symbolic interactionism, or the broadened behaviourism of quantitative social psychology, or neo-marxism, or neo-classicism, or Chicago schoolism, or whatever. A point of departure close to daily life and common sense is a crucial link-up.

(4) *Empirically* too, a holistic stance, close to common sense, holds many advantages. Macro-theories and theoretical paradigms ('-isms') are in permanent conflict and internal crisis (e.g. Booth, 1985); actor models are one-sided (Section 5.7); network approaches lead research in often irrelevant directions (Section 5.5). Together, they represent a vast and dynamic body of knowledge. Each of them may in fact be more sophisticated than the actor-in-context framework expounded in this chapter, but each of them is a very dangerous bet if relied upon alone. I have envisaged the actor-in-context framework as being a non-reductionistic, 'non-theoretical' skeleton of unshakable simplicity, a skeleton for appropriate theories to be hooked on, and for actor models and other reduced, paradigmatic ways of looking to be built-in gradually, at the appropriate pace.

As was the case in the previous section, I will round off the present one with a more technical remark. Action-in-context, as the name suggests, approaches social science explanation 'from the inside out'; Vayda's (1983) term *is progressive contextualization*. Proceeding 'downwards' from the environmental problem analysis (Figure 3J), one specifies the problematic activity, identifies the actors connected to that activity and then ties the actor's choices to other actors and system characteristics. An alternative approach might be 'from the outside in'; context-around-action, one could then say[188]. The reason I have opted for the action-in-context approach is mainly practical. The activities and actors stand at the pivotal position between the environmental problem analysis and the environmental problem explanation, and hence also at the pivotal position between the natural and the social science disciplines. Starting from

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[187] The ethical argument runs parallel to the fascinating non-authenticity of many social science theory makers, mentioned in Chapter 3: they proclaim models of people as the insatiable, self-centered *homo economicus*, or proclaim that the individual is just "a construct", "compulsively expansive"; this then holds for all people, except, of course, the speaker (Gouldner, 1970).

[188] De Jong (1988) calls these two approaches "anascopic" and "catascopic", respectively.

the pivot and moving outwards thus guarantees environmental relevance and the interdisciplinary link-up. If these two conditions are satisfied some other way, there is nothing against starting the analysis, for instance, somewhere in between, at the 'meso' level. One could, for instance, inventory Repetto's (1988) "perverse incentives" that stimulate forest destruction in a certain country. Then, **contextualizing** outwards, one might ask what actors are behind this incentive system, what their options and motivations might be, what actors and factors are behind these, and so **on.** From the same incentive system **'inwards'**, we may ask how the incentives work as a motivational factor for the actors deciding upon actual forest destruction. One then has to identify the relevant actor categories, their alternative options, and so on. Doing so, one essentially draws up the same **action-in-context** pattern as would have been drawn up by starting out from the forest destruction activities **'outwards'**.

5.3 Guidance And Field Methods

The two basic epistemological characteristics of action-in-context are the explanatory principle of putting yourself in the position of the actor, and the search principle of progressive contextualization, working from the problematic actions outwards (Vayda, 1983). On the contextualizating road, many choices have to be made. Shall we split this action or actor category into two subtypes? Shall we accept this motivational factor as just a factor, or probe farther, trying to identify the actors behind it (Section 5.4)? Shall we spend long hours (we ourselves as well as our research subjects) in order to separate the structural from the cultural elements in this motivational factor (Section 5.5)? In this matter, Vayda (1983) stresses that researchers should rely on their experiential judgement, without the constraints of having to conform to predetermined models or methodologies[189]. By way of auxiliary support for the experiential core, Vayda proposes a "surprise principle" as informal criterion to guide choices along the contextualizating path.

In the present section, I explore these informal criteria a little further, in order to give the action-in-context framework a somewhat stronger methodological footing than Vayda deems necessary. First I treat some principles that should hold for all types of action-in-context research. Then, I focus on some special aspects of applied and more 'free' research, respectively. Finally, some remarks will be made about field methods. By and large, this section is written at a rather technical meta-level. An alternative reading route may be to skip this section, focusing first on Sections 5.4, 5.5 and 5.6, which describe the action-in-context approach itself.

General guiding principles

The first general guide for making choices along the contextualizing route is called "discriminatory relevance" by Van de Vall (1987), defined as "the degree to which a variation of the variable results in a change in the [policy] problem". In our case, *environmental problem relevance* seems the appropriate term, guiding the research towards actors and factors that really make a difference to the environmental problem. To do so properly it is necessary that some physical science assessment of the environmental problem, however rough, is present before the social science explanation is undertaken (cf. Section 3.5). A cyclical research approach constitutes another tool with which to keep the relevance factor under control. A subcategorisation of an actor category that may seem relevant at first sight, for instance, may turn out not to make a significant difference later; then, the subcategories may be re-collapsed into one.

[189] See, for instance, Menzies (1982) for examples of predetermined schedules of what to ask and what to conclude.

The second general guide is to let the way the research proceeds be *steered by the growing insights* accumulating during the research itself. Methodologists of qualitative social research (e.g. Maso, 1987) often advise shutting the growing insights off completely from outside theory sources in the first round of a cyclical research approach, bringing in theoretical categories and interrelationships only after taking full account of the actors' own categorisations and interpretive frameworks.[190] *'Grounded theory'* is the common name for the result of this strategy.[191] In between the research rounds, decisions are made on re-interpreting existing data, on allowing theories to 'creep into' the research, and on going back to the actors with new questions or even, as in the 'constant comparative method' of Glaser and Strauss (1967), on drawing a new sample from the actor category, stratified according to the evolving insights. Needless to say, the grounded theory approach is preconditional for the 'holistic point of departure' ideal of the preceding section.

Irrespective of how cautiously one makes use of them, *theories* are of course the third source of guidance in progressive contextualisation. In the early stages of research, theories should be sufficiently broad and vague to put the research on fertile tracks without funnelling it.[192] More specific models naturally come into play at a later stage. As shown in the acid rain example of Section 5.5, for instance, geographic 'location theory' supports the explanation of acid rain emissions.

The fourth general guiding principle is to *look for and enhance contrast* in the research. One example is to look for actors who appear to be in the same circumstances as those first identified but who do not carry out the problematic activity, or the reverse, actors who seem different but act in the same way. Another example is to try to explain an activity in two more or less opposed ways, e.g. a quantifying way focusing on economic factors and a qualifying way focusing on cultural factors. The 'principle of contrast' is of course relevant for any kind of scientific research, but it has a special value in explanatory research. Explanatory research tries to build op some image of "intelligible connections" (Vayda et al., 1991) between actors, factors, actions, events. Whether this takes the form of a purely quantitative induction or a purely qualitative account or anything in between, all this research easily falls victim to the researcher's and the reader's human capacity to see pattern and find logic almost anywhere. It is good to be able to tell a coherent story as to why somebody does something; it is better to explain also why his neighbor does not do the same

[190] In Chapter 3, this has been discussed in terms of the 'emic' and 'etic' research modes.

[191] According to its protagonists, the grounded theory approach, because of its closeness to the actors' own reasoning, is crucial for explanatory validity. A well-known criticism of grounded theories is that they are only of limited domain ('local theories'). This does not hold for the cyclical approach of Maso, however. Moreover, it is better to be locally grounded than generally wrong.

[192] See, for instance, Bouwer (1990) on "social roll-off mechanisms", "ecological interdependency" and the "science-technology-capitalism system".

thing. It is good to show how economic factors influence divorce rates (Brinton, 1983); it is better to show how cultural factors are also involved.[193]

The 'principle of contrast' may also greatly enhance the relevance of explanatory research for identifying options for solutions; even when they are only a small minority, actors who do things differently may yield crucial insights (or may themselves become crucial) for problem-solving-action.

Guiding principles for applied research

Much environmental science research is of the *applied* type, that is, aiming to contribute directly to solving an environmental problem, through environmental policy or some other kind of action by the normative observer.

Van de Vall (1987), based on an extensive review of empirical research concerning the utilization of applied social science research in policy making, concluded that utilization is greater:

- if the research is not quantitative, but of the *qualitative* kind, with a more narrative than tabulated output
- if the research does not use formal theories and deductions from a high level of abstraction, but inductively builds up concrete *'local theory'*
- if the research is not confined to empirical analysis only, but also includes a policy *design* phase, carried out in close cooperation with the policy makers.

Thus, it appears that the general guideline o*f following a "grounded theory" cycle has to be given even more emphasis in applied research.* Conjecturing an explanation for this, Van de Vall states that although general theories and models may have a claim to universal applicability, they reduce the social world at the same time, focusing on one or a few aspects only. The "unilateral research set-up required by these theories", as Van de Vall puts it, "runs counter to the wholeness of the [environmental] problem". Policy makers are confronted by that wholeness at a concrete level, and tend to keep up the holistic perspective, discarding treatment of the problem in terms of reduced universals.[194]

A second, and well-known, guiding principle for applied research is to focus on the variables able to be manipulated by the policy agency for which the research is being done: the manipulatable variables, 'policy variables' or 'causal manipulanda', as Cook and Campbell (1979) call them. The inventory of Van Gageldonk (1987) shows that policy research authors generally associate these variables with the 'policy

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[193] Implicitly, this repeats the holistic 'first principle' of the previous section. See also Vayda (1992): it is better to ask what factors influence a certain action than to ask what factors of a certain class (views on nature, for instance) influence actions.

[194] This argument, we can see, pertains to the second of Van der Vall's three 'ifs'. As for the first, De Groot (1992b, Chapter 7) elaborates upon the human capacity to respond to and remember qualitative research results (images, metaphors, narratives). The third 'if relates to De Groot,(1992b, Chapter 6).

instruments' enumerated in Section 5.8 (incentives, public education, regulation and so on). *(Environmental) policy relevance* is the common name of this guiding principle, acting as a special focus within the *general problem* relevance criterion. In view of the fact that policy relevance is already heavily emphasized in administration science literature (e.g. Ellemers, 1987) and environmental science practice, there is no need to elaborate on its importance here. On the contrary, it is worth saying a few words of warning against too heavy and narrow emphasis.

The policy relevance criterion tends to focus research on the factors and actors manipulatable by the specific agency commissioning the applied research.[195] These are only a subset of the factors and actors causally related to the environmental problem as a whole, and may well be a marginal one. Then, a focus on environmental policy relevance in fact weakens the study's environmental problem relevance. Specifying the relationship between these two guiding principles a step further, a picture of four concentric sets of variables and actors may be drawn up. The first set is the specific agency's remit or reach of manipulation. A second, wider set includes the factors and actors able to be influenced by environmental policy in general (all sectors, local to national level). A third, still wider circle contains the factors and actors within the reach of policy fields other than environmental policy, say, transportation, technology development or agriculture. The fourth circle, finally, contains all actors and factors found through the environmental *problem* relevance criterion, manipulatable or not.

Now, if a study does not only focus on the narrow, 'direct' policy relevance of the first set but also pays attention the the second, the study may identify measures to be undertaken by environmental policy sectors and levels other than the commissioning agency. If the third set is included, too, causes and possible solutions related to non-environmental policy agencies and their policy repertoire also come into view. Contributions to solutions identifiable here, e.g. abolishment of problem-causing subsidies or the redirection of agricultural research, may in fact be far more cost-effective than working within a sectoral environmental policy framework. Moreover, maintaining the full environmental *problem* relevance as a guiding principle (the fourth circle) may point to new policy sectors or instruments yet to be developed, which may in some cases be more urgent than anything else.[196]

It is part of the professional responsibility of environmental scientists and practitioners to keep an open view of which boundary to choose, independent of the incidental policy setting one finds oneself in. As Popper (1957) has explained, there is much to say for the 'piecemeal engineering' that goes with a relatively narrow policy relevance focus. If the focus is too narrow, however, the pieces become so

[195] Van de Vall (1987) says it tends to focus research on what is manipulatable in the short term, and adds that "the media confront us daily with concrete policy measures that a few years ago would not even have been tolerated as a noncommittal policy advice".

[196] Analogous arguments hold, of course, for work in the 'design' section of the problem-in-context framework, e.g. concerning the range of alternatives to be included in EIA (Wathern, 1988: 24,204).

small that engineering becomes an endless, shallow tinkering by fragmented policy units.

Guiding principles for 'pure ' research

We have now identified four general guiding principles and two points of special attention for applied research. Next, the points of special attention of relatively 'pure', theory-building research will be briefly touched upon.

First, of course, it is important to establish a *more intensive intertrade with theory.* This is not to say that we should drop the non-theoretical, 'grounded' approach of the first research round, but that we should be more alert to opportunities for improving or falsifying current theories and methods in the second and later rounds. We may, for instance, compare the present situation with predictions made twenty years ago, or try to interpret a pattern in terms of the centre-periphery theory, or follow two methods in parallel in order to compare their workability and results. As a general rule, more *tension* should be worked into the research: tension between common sense and theory, tension between people's actual choices and those called 'rational' by theoretical choice models, tension between theories and methods, tension between emic and etic interpretations, and so on. Policy makers are (rightly) interested primarily in more or less middle-of-the-road interpretations of data; tension, however, is what science grows on.

As mentioned, Vayda (1983) emphasizes the *surprise principle* as a guide to where researchers should focus their attention after the first research round in the 'grounded' strategy. Quoting Hill (1970), Vayda says that progressively contextualizing routes need not and should not be planned in advance:

> "For myself I depend very much on my naive feelings of surprise - holding that the most surprising "events" are most worth to pursuit. To do research is to search anew for ideas one missed last time when formulating the packet of conscious, pre-conscious and unconscious assumptions one carries to the field".

Vayda also connects the surprise principle to the assumptions that policy makers carry to the field; the principle, therefore, also plays a role in applied types of research. Its natural stronghold is in more science-oriented research, however. Policy makers tend (rightly) to be interested primarily in the most problem-relevant data; on the other hand, surprises are (rightly) the data that get published.

Field methods: the qualitative point of departure; biases; informants

The action-in-context framework may be used to systematize existing knowledge and identify gaps. In its simplest form, you then simply sit at your desk, using the framework to organize and probe your own knowledge. Another way to fill the action-in-context schedule is with secondary and tertiary data only, through a mixture of literature reviews and sessions with experts. Gathering primary data in the field will often be necessary for the simple reason that existing knowledge is not detailed enough, and in other cases will be desirable for higher scientific reasons (theory testing, methodological progress etc.). Rounding off the present section, let me make a few remarks concerning methods for this *field* research, to supplement what has already been said in the 'guidance' part of the section. I will of course not attempt a systematic review here, confining myself to a few matters of relevance to action-in-context explanations. First, let me make a few remarks about the qualitative approach in general, and then discuss some more specific field techniques.

Clearly, *qualitative* methodologies hold a place of primacy as a point of departure in action-in-context research, because they allow one to listen to actors or other data sources without imprinting preset categories upon them. In this methodological field, one should search especially for the relatively moderate sources, such as Maso and Glaser & Strauss, already mentioned. 'Advanced' approaches like linguistic analysis (Silverman, 1985) and ethnomethodology (Garfinkel, 1967) may be inspiring when one wants to uncover deeply hidden structures of actors' reasoning and practices, but they will usually be too far removed from practical action-in-context analysis.

A primacy of qualitative approaches does not of course rule out the use of numbers. As a rule, there are no objections to *quantifying what the actors themselves quantify* in support of their decision making. Since hardly any actor applies multiple regression formulae or quantifies things that do not express themselves in easily countable ways, 'grounded' ('emic') quantification usually amounts to simple calculations involving easily quantifiable phenomena, such as market prices, crop production, expected fines for non-compliance of environmental regulations, travel times, hours involved in gathering the daily firewood, and so on. For instance, in order to understand the difficulty poor shifting cultivators in the tropical rainforest have in crossing over from wild rice to agroforestry crops, it may be calculated what the expected incomes will be in the lean years when the growing trees have begun to overshadow the rice but do not yet yield (e.g. Conway 1988). Proceeding as the actors themselves do, such a calculation ignores discount rates, shadow prices and other quantifications of formal cost-benefit analysis. The latter type of factors may be accounted for more qualitatively, together with all other unquantified or semi-quantified considerations the farmers bring to bear on the decision. Such considerations may include the status aspect, the division of benefits between men and women, the wish to show a honourable face to officials, the responsibility to leave a sustainable livelihood to the children, the idea that the community as a whole may use the agroforestry to undermine the legitimacy of the forest department trying to evict them from their illegal settlement (Sajise, 1987) and so on.

In later phases of research, when a sufficiently grounded understanding of the actors' perspectives has been gained, consideration may also be given to quantifying decision making in ways the actors themselves do not. Staying for a while in the tropical rain forest, Boster (1984), as an example, reports on the possible reasons why Aguaruna tribeswomen maintain more than 100 manioc varieties on their shifting cultivation fields. Going through the fields and discussing the pros and cons of each variety one by one, it showed that the women had fairly clear-cut reasons for growing the few varieties that took up the majority of the field area, but that "both the actors and the researcher", as Boster puts it, "ran out of distinct reasons" for the large number of minor varieties; "the informants shrug or say the variety is pretty". Then, Boster made up a list of 30 attributes relevant to manioc variety choice, inventoried the full 3,000 yes/no scores on whether a variety displayed the attribute or not and then put it all in a cluster analysis and a multiple linear regression analysis, showing that the total variance is indeed explained by only the top few varieties; the rest shows no pattern. Boster concludes that the actors do not only have a variety-by-variety type of reasoning, but also maintain diversity as such, "for its own sake". Boster does not report explicitly whether he has 're-grounded' this conclusion by discussing it with the actors themselves, but he reports that "older women in particular take pride in their knowledge and ownership of a range of different varieties of manioc, and they serve as distributors of the rarer varieties to younger women".

At this point, we may note that Boster has focused on the actors' options (the varieties), the choice-relevant attributes of the varieties (the motivations) and actual planting behaviour (the activity), three central action-in-context concepts. Taken as a whole, the action-in-context schema prescribes fairly specifically *what* data one should be after in the field and how to relate these data to one other (e.g. Figure 5D).[197,198,199] The action-in-context framework does not have a specific set of techniques as to how exactly one should go about gathering the prescribed data in the field.[200]

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[197] For instance, the schema has no "attitudes" as a variable supposed to determine "behaviour", as does the model of Fishbein and Ajzen (1979), the standard model for environmentally-oriented social psychology research. It relates options and motivations directly to actual activities. Thus, people do not show 'inconsistent' behaviour in the trivial way artefactually generated by the Fishbein/Ajzen model, i.e. because people do not comply to an invalid explanatory model. If you ask me my attitude toward smoking, I will tell you it is negative. Yet, I smoke. Hence, I am 'inconsistent', and attitude-focused research can go no further. If you want to understand why I smoke, however, observe when I do it and ask why I actually smoke. Maybe the answer will be that the physiological advantages of smoking predominate. Maybe it is my way of expressing a Freudian death wish. In any case, you will get much more explanatory information than from my attitude.

[198] As a second example, the action-in context framework de-emphasizes going into the 'choice model' of the actor in detail right from the start, relying primarily on common sense and the principle of 'putting yourself in the place of the actor'. Instead, it emphasizes detail and certainty in the inventory of options and motivations, because it is through these that linkages to secondary actors and macro-structure are identified.

[199] Thirdly, action-in-context emphasizes not getting stuck on the primary actors (the actors found first behind the activity); secondary and further actors behind the primary ones may in fact hold more real (and hence also more explanatory) power over the activity in question.

[200] In teaching action-in-context, special care, in my experience, should be taken at this point. On the one hand, there is nothing against students internalizing the framework to the degree that they start dreaming about it. On the other hand, the risk should be avoided that certain *conceptual* sequences (first options, then motivations; first problematic actions, then primary actors; first primary actors, then secondary actors, etc.) begin to function as strict *field research* sequences, as if it were only allowed to search for motivations after everything is known about options, or as if it were only allowed to see

Basically, the existing literature can be relied upon here, however. Thus, I will only briefly touch upon a few field techniques, summarizing some points that may be of special relevance for action-in-context work.

In any explanatory social science research, answering the why-question concerning activities is what one is after. Probably, no other question is more prone to the bias of actors modeling their answers to what they think the researcher likes to hear, or hiding their real reasons for fear of what might be done with the information. This holds especially if why-questions are put to actors *directly,* asking for first-person explanations. The penetrating character of repeated why and why-don't-you questions may easily arouse irritation, ridicule and 'wild' answers (Maso, 1984). Another important source of bias is that actors will want to show they are *competent* members of their community; thus, they may model their answer strongly by what they think is socially expected from them (Mills, 1940). Women may stress their responsibilities of care, men may give macho reasons in an all-male group setting, and probably the most widespread bias of all is to model the reasons one gives for one's actions on the template of rationality in the Western world view: the cost-benefit calculus of the isolated *homo economicus* (Goodin, 1981).

There are several ways out of this bias risk. The most basic is the one formally prescribed by the action-in-context framework itself: *de-emphasize the direct why-questions* and emphasize the much more neutral inventory of the actor's options and the pros and cons of each of them. As an element of support for the explanatory principle of 'putting yourself in the place of the actors', the why-question then still retains relevance, but much of the bias-generating tension is removed.

A second strategy is *participation* in the daily life (or office life, or laboratory life, as in Knorr-Cetina, 1984) of actors. The advantages are that (a) it removes distrust, misunderstanding and other sources of bias, (b) it creates much more time and informal situations in which to ask questions and (c) especially if participation includes the actions under study themselves (tree cutting, commuting, negotiating over regulations), participation provides for a deepened context of understanding.

Thirdly, *projective methods* (e.g. Ligett, 1983) are an option for offsetting the bias risk of why-questions. Projective methods change the interview situation from a researcher concentrating on an actor into a situation in which the two of them together concentrate on a third party, discussing, while focusing on a picture of tree cutting, for instance, what the people in the picture are doing, why they might be doing it, whether the actor would do it differently, and so on. This moves the discussion away from the specific situation the actor is in and thus elicits more generalized information (the actor himself or herself moves to a 'theory level'). It also allows for easier

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secondary actors after everything is known about the primary ones.

Analogous considerations apply to the language; terms that are pivotal for learning action-in-context and explaining to other scientists what one is doing may be inappropriate for the field. In an application of problem-in-context in rural Mexico, for instance, Gastelum (1992), a native speaker, encountered many obstacles with repect to the term 'problem'. No Mexican farmer finds it appropriate to admit that he or she has "problemas". But *"batallas"* (struggles), oh yes, batallas we have so many...

discussion about action and choice variants, for expression of reasons the actor might not otherwise wish to admit to him or herself, and for smiles about other people's illogicalities which the actor, naturally, is free of. The other people's action to be discussed may of course also be packaged as a story, a video or, less preferably because of its more abstract character, a 'hypothetical case'.

Finally, the role *of informants* (village leaders, 'community gatekeepers', NGO spokespeople, local government officials etc.) must be mentioned. It is often thought that informants are indispensable in the early field research phase. In that same phase, however, the research is very vulnerable to getting trapped in the conceptions and suggestions (honest or otherwise) of informants. The alternative is to simply follow the action-in-context recipe rigidly, i.e. (1) defining the problematic or otherwise explanation-worthy activities, (2) finding out who does these activities, (3) finding out, partly through these people, who are the decision-making primary actors, (4) investigating their options and motivations, and so on.

In many instances, it may not yet be sufficiently clear what the relevant activities are, because the problem analysis is still too vague, for instance, or because we want to know more about the actors' own problem perceptions. Then, a preliminary assessment may take place, preferably not through some traditional survey, but using participatory approaches such as LEARN (Njiforti et al., 1991), 'Participatory Environmental Mapping' (Mascarenhas et al., 1991) or 'Agro-Ecosystem Analysis' (Conway, 1986). All three are designed to include envionmental problems, not only social structure or the environment itself. All three are also designed especially for rural Third World situations, but their basic principles are transferable to other field work.

In my experience, maybe the greatest difficulty in applying the action-in-context framework in the field is the fact that it sometimes runs counter to how social scientists have been trained. Roughly, they are focused on people and social groupings, not problems, problematic actions and actors. Imagine, for instance, a social scientist aiming to do problem-explanatory research while living in a village of pioneer shifting cultivators. The first tendency then is to sample the people: who lives here, what types of people may be distinguished, etc. This is the wrong starting point. The first thing to do is to sample problematic actions, e.g. the types of shifting cultivation fields; this typology should be problem-oriented, focusing, for instance, on the fields' erosion characteristics. Then, the relevant actors can come into view; some may prove to live in the village, and others may not. In fact, where they live is is only important insofar as it proves to be an explanatory factor connected to their options and motivations with respect to the problematic activitiy.

A second tendency is to give an *a priori* primacy to what the actors themselves define as problems; this is also a wrong starting point. The normative observer, when speaking in the name of future generations, nature or supra-local interests, has every normative right to also define what is problematic, and whether to adopt the actors' value perspective or the normative 'outsider perspective' given in the final variables of environmental science is an open ethical and practical question, *cf.* Section 3.4. (As stated earlier, what the actors find problematic or not has *explanatory* primacy, but that is a different matter.)

5.4 The Core: Actions, Actors, Options, Motivations

In this and the next two sections, the full actor-in-context schema will be established in a more comprehensive form than that given in Chapter 3. As a reminder, the schema in its simplest form is shown in Figure 5A. Compared to the figure in Chapter 3, some terms and feedbacks have been left out. One element has been added, namely, the dotted circle inside the 'actor' block, depicting the actor's mode of processing his options and motivations into a decision for action. This is where you put yourself if you follow the principle of'putting yourself in the actors place'; the element may be replaced, if necessary and feasible, by a more formal 'actor model' in subsequent research cycles (Section 5.7). The 'effect' in the figure may be the beginning of the effect chain in the environmental problem, as in Figure 3J. Then, the actor is a primary actor. The effect may also be an influence on options and motivations of another actor. Then, the actor is a higher-order actor in the actor field. This section focuses on the four core concepts in Figure 5A; the next section goes into the discovery of the actor field by repeated application of the core concepts; the subsequent section structurizes the as yet amorphous connection to 'culture and structure'.

Actions

The concept of 'actions' requires only a little technical elaboration here, partly summarizing from Chapter 3.

The general definition of action is intentional behaviour. Phrased somewhat more specifically, *an action is a behavioural unit about which an actor has made a decision.* Actions usually have many subcomponents; the criterion for being counted as a single behavioural unit is only that the actor regards the subcomponents as sufficiently interconnected to be treated in a single decision-making thought or negotiation process. Hence, actions may be very restricted units (shall I spray pesticides today?) or much more complex (shall we give up farming?), or anything in between (which crops shall we sow this year?). In any case, what the actors think and talk about is an (informal) design. "Crop X", for instance, may stand for the whole sequence of buying seeds, ploughing, planting, weeding and so on.

The term 'decision' is used here in a loose sense. Some kind and degree of normative reasoning has to underlie an action, but this need not be fully reflective, systematic or formal.[201]

[201] Hence, not each and every unit of environmentally relevant behaviour is an action, accessible to explanation through the action-in-context framework. Some units may never have been reflected upon

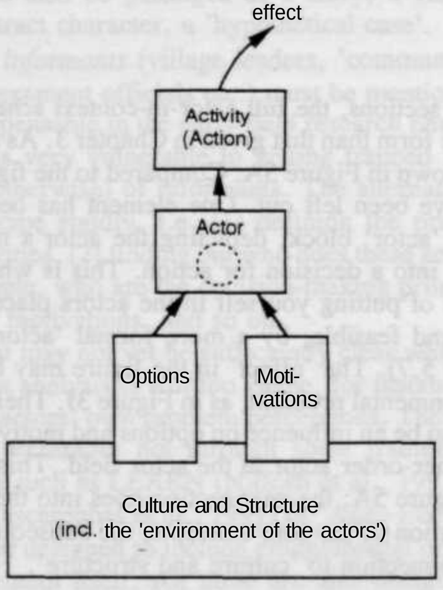

Figure 5A
Action-in-context in its simplest form.

In environmental science, the term 'activity' is often used instead of '**action**'. 'Action' is then associated with more singular events, and 'activity' with more regular or generalized categories of action (say, the activity of commuting). Often, environmental science is more interested in categories of action than in the singular events (say, why this actor commutes **today**). Studying the broader categories may of course entail using different research techniques from those used in studying singular actions (e.g. more subdividing, categorizing, statistics), but the **action-in-context** framework holds for both action types.

Action-in-context is applicable to any type of action, including, for instance, actions which only indirectly influence the environment (say, the implementation of an

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or be caused by purely physiological factors. To my mind, such behaviour is never significantly policy-relevant.

incentive system to stimulate in-plant waste recycling). As already mentioned, however, it is advisable to start the analysis with actions involving *direct,* physical interaction with the environment, after sufficient physical-science and normative knowledge has been gathered about the environmental problem itself. (In the Problem-in-Context Figure 3J, one then arrives at the environmentally relevant action from the top downwards.) Only thus can proper link-up with the physical sciences and pinpointing of the most problem-relevant actions be ensured.

The concept of action, and thus the range of applicability of the action-in-context framework, may be further substantiated as follows.

- Actions may be historical, actual or future (planned, proposed, considered).
- The manufacture, use and disposal of *products* can also be treated as actions. The same holds for services; skiing holidays are also behavioural units with environmental consequences, actors, options etc.
- Also deliberate 'non-action' is action, e.g. deliberate non-maintenance of an irrigation system, deliberate non-compliance with an environmental regulation, or a deliberate non-decision. Even if things take their course without actors knowing that they do, an actor will usually be involved; the process will usually be found to be the unintended consequence of actions.

Actions often have to be decomposed in order to open them up properly to action-in-context explanations. This is illustrated by the following three examples.

- Often, action categories consist of subcategories working more or less *additionally,* but subject to different social mechanisms (different actors, different motivations etc.). The category 'tree removal' may, for instance, be subdivided into 'large-scale logging', 'small-scale logging', 'removal for traditional shifting agriculture', 'removal for sugar cane plantations' and so on. (Note that these action categories do not necessarily coincide with actor categories.)
- In other cases, actions are *nested* inside one other. For instance, a decision to spray a certain pesticide is nested within a 'larger' decision to plant the crop that needs this type of pesticide. In such cases, either the crop or the pesticide may be investigated as the focus of relevant action, or both, depending on the research and policy context (see the previous section) and on what the actor himself or herself distinguishes as a decision-making unit.
- In other cases, it may be relevant to conceptualize and separate the action in the form of a *multiplication,* i.e. a number of actors multiplied by the intensity of the activity per actor (e.g. the intensity of cattle herding = the number of cattlemen multiplied by the number of cows per cattleman). Obviously, the analysis of these two types of actions may lead in very different but equally relevant directions. In the example, the first route of analysis leads to cattle-herding strategies, 'commons' problems and so on. The second leads to migration decisions, family size decisions and so on. As already mentioned in Chapter 3, the multiplication concept here provides the major connection between environmental and population policies.

Usually, defining the most relevant action category and the most appropriate subdivisions will require careful thought, but it will also be a fairly straightforward matter. In a cyclical research process, categorizations may be lumped together or refined as insights develop.

Actors

As has been explained already, *actors* are not simply **"people"**, but all social entities that act, individually or as a collective ('corporate', **'institutional'**). Stated formally, *social entities are actors with respect to a certain action (activity)* ***if*** *they exercise a* ***significant*** *decision-making capacity with respect to that action (activity).*

What is 'significant' depends of course largely on the research objective. In most **deforestration** studies, for instance, it will not be significant which precise tree is cut on which day. In such cases, therefore, the forest labourers and foremen will not usually be relevant actors; significant decision-making capacity lies at some higher level, at the timber corporation's headquarters, for instance. Alternatively, however, the labourers and foremen may transpire to be illegally cutting and selling a significant number of small trees on their own initiative; then, of course, they are also actors in the deforestation process. The definition of 'actors' also shows that secondary actors may be found behind the primary ones. Behind the timber company, a licensing government agency may exert a significant influence on the **deforestation.** And behind that actor, World Bank policies may be found to exert a significant influence as well. This is the actor field of the next section.

The 'first principle' stated in Section 5.2 asserts that actors, especially if they are individual people, should be viewed as holistic entities. With respect to a certain activity, this holistic entity is then seen as focusing on a certain objective, i.e. what the activity is considered (by the actor) to be good for. It is in terms of that objective that alternative options and their respective pros and cons are defined.

If commuting is the action under consideration, for instance, the actor may be assumed to be focusing on a "going to work" objective. Implicitly, we then assume that, no matter how car-addicted the actor may be, he may at least have considered other transport options. Also, narrowing the objective to "going to work by private car" would obviously decrease the study's policy relevance. In other instances, however, a common-sense definition of the actor's objective may lead us astray. With respect to African farmers, **Reardon** and Islam (1990), for instance, show that environmental development projects have failed because the farmers are assumed to consider farming options only. African 'farmers', Reardon and Islam state, are in fact people who happen to be farming in order to make a living, but who may switch over to any other activity (rural trade, informal urban work) when circumstances change. Thus "making a living" is the proper objective to ascribe to the actor, even when one is seeking to explain some farming activity. In practice, the surest way to avoid this type of mistake is to ascribe to the actor as few as possible, but to start out by listening and observing very carefully, with as few theoretical pre-conceptions as possible, as the guiding principle of grounded research prescribes.

Identifying the parties having significant decision-making capacity over an activity is sometimes a much more slippery exercise than in the two examples above (the timber corporation and the commuter). By way of illustration, I take you to a situation that might well have been part of the Sukhomajri example of Section 3.3, identifying the actors connected to the goats on the watershed slopes. It is South Africa around 1950, however, as reported by Holleman (1986).

"Sitting with our backs against the rough poles of the circular cattle corral, we were sharing, together with five or six other homestead heads, a large pot of beer which he had ordered one of his wives to place before me as a token of welcome. A few yards away, a couple of youngsters were struggling to force a reluctant she-goat into the goat's pen, kicking up a lot of dust. The headman shouted to a young woman that her goat was spoiling our beer. She hastened to help put the animal inside. He explained that she was his younger brother's wife, mother of one small son, hard-working, and good at making clay-pots, too. In fact, that was how she got this goat. I asked a few questions. It appeared that she sold or bartered her pots in the neighbourhood. She raised some chickens, too, which she sold at the small district centre of Nongoma. When she had earned eight shillings she bought a young she-goat, now grown and about to have kids ... It was not an uncommon form of enterprise, for several other women in the neighbourhood were doing likewise. Here was an obvious opportunity for discussing property rights of married women with a panel of knowledgeable men. The following are some extracts from my field notes:

Q: "The goat therefore belongs to her?"
A: "It belongs to her, for she made the pots and found the money".
Q: "Her husband approves?"
A: "He approves; he loves her for she is a good wife."....
Q: "She can sell the goat if she wants to?"
A: "She can sell the goat."
Q: "Without telling her husband?"
A: "She will first ask her husband."
Q: "And if he says 'No'?"
A: "Then she cannot sell."
Q: "But why not? You said it is her goat because she earned it herself."
A: "It *is* her goat, but she is [like] the child of her husband. That is why she cannot sell without asking him."
Q: "Does this mean that the goat really belongs to the husband?"
A: "So it is. The husband is the *umnini* (owner) of the woman, the woman is the *umnini* of the goat, therefore it is really the husband who is the *umnini* of the goat ... It is because he agrees to her making pots that she found the money to buy the goat. So it is really through his *amandla* (power, authority) that she has this goat."
Q: "If he is the real owner, could he sell the goat?"
A: "He could sell it if he wants to."
A: "Without asking his wife?"

A: "She is his child, he need not ask her."

Q: "So this is the true law of the Zulu, that a husband is the owner of property *(impahla)* like a goat which his wife has earned with her own labour, and that he can sell this property without asking her?"

A: (with some solemnity, all men present nodding in agreement) *"Impela! Umthetho wesiZulu!"* (Indeed, the law of the Zulu!)

Methodologically, I had now travelled some way along the "descriptive" road to what appeared to be practice, and followed the "ideological" line which produced a "legal rule". Now the test.

Q: "Could you tell me about any examples of this having happened?"

A: "Of a man selling his wife's property without consulting her? *Ngeke* (never)! He would be like a rogue stealing from his wife."

Q: "But you all agreed that he could do so under Zulu law *(ngomthetho wesiZulu ...)*."

The headman thoughtfully took a pinch of snuff before he replied. "You do not understand," he explained patiently. "You asked about the law of the Zulu and we told you the truth. But it is also like this, that a man who likes to live peacefully with his wife knows that he should always discuss such matters with her. *Uzau khuluma nendlu*" (lit. one should talk with one's 'house')."

Then, Holleman proceeds by describing a case of dispute resolution by the village elders, the forum of appeal if 'talking with one's house' does not result in a peaceful resolution.

Here, ownership (hence, actorship) has first been found to be associated with the women, then with the men, and finally with them together, under customary rules of reasonableness, guarded by the elders. If a drastic reduction of the number of goats is an option in the research, as was the case in Sukhomajri, the households and the village elders are probably the proper choice of actors. On the other hand, for questions about where the goats are grazing or about any initiative to gradually increase the number of goats, the women seem to be the right choice. Again, going the grounded way is the best research strategy; who is the correct actor with respect to what is best decided in the field, by careful and open-minded observations and questions, as Holleman exemplifies.

If Holleman, right after entering the village on his first day of research, had asked "Who decides about the goats?"[202], only the men would have lined up. Generally, if one 'blindly' asks who decides about something, men *always* line up. This brings us to the question of gender, an issue permeating social science research from the simplest field interaction through to interpretation of national statistics (Boesveld et al., 1986). In this chapter, I focus on gender at two points, with reference first to the very practical matter of actor identification, and second to the deep but no less penetrating

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[202] Or "Who are the farmers?" as Gay (1983) proposes as a general point of departure of Third World village research.

question of what objectives and world view one ascribes to or 'interprets into' the actor, in Section 5.7.

Male domination runs through every vein of society. If you want to quantify it, listen to male-female conversations and compare how many times you hear men interrupting women, and women interrupting men (Schwartz and Jacobs, p. 88). Because of the accumulation of 'little mechanisms' like these, research, even if intended to be gender-neutral, easily deviates into gender-biased directions if neutrality is not actively guarded. Surveys and data interpretations working with 'neutral' *a priori* research units like 'households', 'farming systems' or random 'respondents' thus tend to overlook women's domains, women's views, women's tasks and the position of women as environmental problem causers (actors), problem victims and problem solvers.[203]

The action-in-context framework counterbalances gender-bias risks by prescribing identification of the relevant *actions first,* only then focusing on the data suppliers, defined as the actors with respect to these actions. Thus, this home garden, this commuting, these goats, these products: who does it, who works it, who owns it? This is basically the same strategy as followed with respect to the informants in the previous section. Thus, the actions-first prescription, designed originally to ensure interdisciplinarity and problem relevance, also stands the researcher in good stead in the gender and informants issues. Concerning many other practical gender aspects, Eichler (1978) is a useful source covering both Western and Third World situations.

Options and motivations

We now arrive at the third and fourth concepts of the action-in-context core, *options* and *motivations.* The two are well-distinguished conceptually, but usually come in mixed pairs, e.g. when actors say:

- "This manioc variety [option] is good for beer making [motivation]."
- "I go by car [option] because it gives more freedom [motivation]."
- "A real leader just doesn't do [motivation] a thing like that [option]."
- "Why should we comply [option] to this environmental regulation? It doesn't even solve the environmental problem!" [motivation]

The third and fourth examples indicate that with respect to options not likely to be chosen, it is often a more or less arbitrary matter whether the option is included in the

[203] In field research, gender-explicit *sampling* is a way to offset gender bias, seeking, for instance, a 50% female representation or stratifying the sample. Also, the *interview setting* should be looked into. Since 'women's affairs' (sources of informal income, gift exchanges, views, methods of conflict resolution, networks) are often criticized or appropriated by men if brought out in the open, it is advisable to interview women as far out of male sight and hearing as possible, preferably by a female researcher. If it seems unavoidable that men will participate or hover around, a tactic employed by one of my colleagues is to split the research team and keep the men busy with something they will not be able to refuse, e.g. an interview about business, cars, village politics, cattle or some other prestigious subject.

research, with a negative motivation attached to it, or the pair is left out altogether. Roughly speaking, shorter lists of options (focusing on the most common, reasonable and implementable ones) may be more acceptable in rapid explorations than in research seeking a deeper and more generalizable understanding. Below, options and motivations are elaborated separately.

The *options* in the action-in-context schema are basically just a list of *possible actions considered (by the actor) as being connected with an objective of the actor.* Observation, common sense and the actor's statements will often suffice to identify the options. The following few remarks will serve to support such identification.

(1) The formulation of the actor's objective serves an important function in identifying the proper options list. Roughly speaking, the recipe is to (a) explain the action by formulating the objective it is connected with and (b) draw up the list of all other options connected with that objective. As the example of the previous section indicates, explaining a farming activity on the part of African farmers requires that the options list also includes non-farming activities such as trade and migration, subsumed under a general livelihood, rather than farming, aim. Care should also be taken not to assume (and thus talk an actor into) aims lying within a narrow *homo economicus* perspective (man the isolated utility hunter), *viz.* Section 5.7.

(2) That options, as the definition states, are "considered as being connected" to an objective is a part of the definition consciously left vague. The core of an options list will be a number of options the actor actively takes up in his deliberations and will rapidly talk about. Second, there may exist a set of options known by the actor, but not actively considered by him or her for reasons relatively obscure to the researcher, e.g. because the option is said to be "old-fashioned". Thirdly, there will be options to which the actor attaches a positive motivation, but that are somehow unavailable, e.g. because they are prohibited, or profitable only after investing capital the actor does not have. Fourthly, there may be options unknown to the actor that could be brought to the attention of the actor by the researcher himself, e.g. a new agroforestry system. The coming sections will consider this in greater depth. Here, it suffices to note that discussing the second set of options with actors will deepen the understanding of the actor's choices, and that the third and fourth sets support the identification of the 'actor's field' (who is closing off that option?) and the policy relevance of the research.

(3) As specified by the 'action' definition, options are considered by actors as whole units (if not, there are two options). Thus, whether an option is simple ("going by bus") or complex ("join forces and stand up for our trees"), there is no need to go into the sub-actions per option separately. On the other hand, it should of course be clear what option image the actor has in mind when discussing its pros and cons. "Going by bus" is an activity so commonly known that a single specification of the travel time will suffice to explicate the full option image. "Standing up for our trees", on the other hand, may require extensive qualifications.

Finally, the concept of *motivations* requires some elaboration. It will already have become clear that I do not take this term to signify something deep (e.g. 'drive'), using the concept in a sense close to that of social psychology. Eiser (1986:84), for instance, distinguishes between 'intrinsic' and 'extrinsic' motivation, denoting, respectively, the degree to which an action is good or bad in itself (enjoyable, moral etc.), or good or bad because of rewards and punishments. The definition for the action-in-context framework is:

motivations are the normatively relevant (to the actor) operational characteristics of the options under consideration (by the actor). Again, the following few remarks will serve to support this concept.

(1) Generally, motivations are built up of two elements. The first is qualitative, namely, the *dimension* in terms of which a motivation is formulated; it tells us what is important about an option. The second element is a *quantification* of the dimension; it tells us where the actor places the option along the dimensional axis. Quantifications do not need to be precise or put on a cardinal scale. Business firms may often make a formal cost-benefit analysis about investment decisions, but many other environmentally relevant decisions are made on a basis of relatively rough motivations like the following simple examples:

- "good [quantifier] for beer making [dimension]"
- "not really [quantifier] appropriate for a good member [dimension]"
- "a high [quantifier] price [dimension]"
- "half an hour [quantifier] of uncomfortable travel time [dimension]"
- "quite [quantifier] risky in the long run [dimension]".

As with options, motivations come in a wide range of interpretability. The last of the examples above, for instance, is already more complex then the first. What exactly does the actor mean by "quite"? And by "risky in the long run"? For a business firm considering a strategy of non-compliance with environmental regulations, "risky in the long run" may be associated with building up a bad relationship with the environmental agency, or the erosion of the firm's public image. For a farmer, "risky in the long run" may be associated with survival in extremely bad years (the 'minimax' rationality), but also with undermining the intrinsic fertility of the soil, transforming it gradually into a mere substrate dependent on external inputs.

In general, once the relevant dimensions are properly understood by the researcher, the quantifications will be comparatively easy to establish. Consider, for instance, the values that fanners may attach to land. Land may be viewed as a pure commodity among others; or as the source of artisinal pride; or as partner in a working relationship; or as the living resource to pass on to future generations; or as the skin of the living Earth (e.g. Bolhuis and Van der Ploeg, 1985; Ebenreck, 1983). If farmers say, for instance, that "our earth does not like rice" (Van den Breemer, 1984), this qualitative dimension alone may be rich enough to fill a chapter of a dissertation and powerful enough to do a major part of an explanatory job.

(2) Motivations, defined as the *operational* characteristics an actor applies in an informal choice process, are relatively shallow 'surface phenomena'. This implies that actors should not be expected to be consistent in the sense of applying a coherent set of motivational dimensions to every option; motivations will often prove to be superficially contradictory. More unified motivational patterns, it is commonly

assumed, are to be found at a deeper level. Social psychology, for instance, speaks of 'self-schemata' (Eiser, 1986:242) and symbolic interactionism of 'identities' (Stryker, 1981:23).

Dealing with this in explanatory research implies first of all (as is the case throughout the action-in-context schema) starting research the 'grounded' way, fully listening, not merely noting down the words that fit into *your* model. Secondly, the more shallow, operational and hence inconsistent the formulation of motivations is accepted to be, the more care should be taken not to unduly generalize research results to other realms of action (objectives, sets of options). If generalization is a research objective, the research has to go to deeper levels. Section 5.6 provides the concepts and an example; Section 5.7 develops some ideas about three types of deeper motivational patterns.

5.5 Going Farther: The Actors Field

In the preceding section, we have concentrated on the four elements of the triangular actions/actors/options/motivations schema. Until now, this triangle has been a free-floating unit; there is not yet much *action-in-context.* Connecting the action to that context is the next explanatory phase, and the subject of the present and the next section.

Linkages with the context may be found in two directions. One is to spread 'horizontally', exploring how the actor's options and motivations are influenced by the decisions of *other actors.* Basically, this is done not by going deeper into the structures that underlie the actor's options and motivations, but by jumping as quickly as possible to the other actors, each of whom has his own set of options and motivations. The pattern of actors thus found is the *actor field.*

The second direction is 'vertical', studying how and to what degree the options and motivations of each actor are connected to the actor's culture, environment and social structures (micro and macro). Because this is done actor by actor, the natural sequence is to go horizontally first, and vertically later. This explains the sequence of the present and the next section, 'going farther' and 'going deeper', respectively.[204] In both sections, the full emphasis will be on how the actor is influenced by context, not the reverse. Visualized in the Problem-in-Context Figure 3J, the focus is on the 'up' process, from context to activity, not the downward feedback loops.[205] This is not to deny, of course, that actors are involved in the creation of the contexts they are in (e.g., Giddens, 1986[206]). The focus is simply a consequence of this chapter's objective of explaining why actors do environmentally relevant things, not explaining culture or structure.[207]

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[204] Obviously, actual research patterns will be more mixed and cyclical, following the general guiding principles of Section 5.3.

[205] The most relevant feedback loop in most problem-in-context work will be the large one in Figure 3J, i.e. through the designs and decision making of the normative observer. Environmental policy making is an example.

[206] Giddens also stresses that contexts do not only curtail actors, but also facilitate their development and are often conditional for their very survival. All this has a perfect analogy in ecology, as discussed in Chapter 7. The ecosystem (say, the forest) does not develop and maintain itself, but through the 'telos' of the individual 'actors' (the trees). The forest system characteristics deny many 'options' to many tree species (e.g. light is excluded from the same pioneer species that once established the forest, and the forest limits the expansion of individual species), but at the same time, the ecosystem is conditional for most of the 'actors' survival.

[207] This marks another major difference between the action-in-context framework and studying a full people-environment system. Officially at least, the system studies go full circle: how structure influences activities, and how activities influence structure. Consequently, the action-in-context framework, even when providing for more powerful explanations and explanatory theory, will not yield powerful long-term predictions. It will predict reasonably well how actors will react to changes in their

Underneath, the thread of Section 3.8 will be taken up again. First, I will informally introduce the basic ideas of the actor field by means of two Third World examples. These act as a primer for discussing some potentially relevant elements from social science theory. Finally, two actor field concepts are discussed in more detail and exemplified, switching over to a Western world case. For readers aiming at the basic insight only, the first subsection suffices.

Two introductory examples

Let us take as a hypothetical but not unlikely example that farmers in some Third World province are generally growing an unsustainable crop, with only a few of them switching over to a more sustainable system, say, a tree crop. Why is this percentage so small?

Going into the field, we first have to establish whether the actors need to be categorized in some way, e.g. into rich and poor, or men and women. It appears that the small percentage of farmers growing the tree crop are all land-owning farmers, distinguished from the category of tenants. This categorization suggested by the field also carries some theoretical weight, since it seems likely that these groups may have significantly different options and motivations, given their different autonomy and tenure security situation.

Observing and discussing options and motivations with the actors (and as yet not going into either of these in real depth), it appears that, for the land-owning farmers, the tree crop is an available option but it is usually rejected because of its lower productivity (in money terms). For these farmers, obviously, the pivotal factor is motivational, rather than in the options sphere, and the prices received for both the unsustainable and the tree crop show up as important elements in the list of motivations for these crops. Here, they may be treated simply *as factors.* At this point, then, exploration comes to a halt. Alternatively, the prices may be treated as effects of actions of other *actors.* Then, exploration continues. Viewed this way, the price for, say, the unsustainable crop appears to be built up of two components, created by two different actor types. One is a market component, established by the forces of supply and demand; the other is a subsidy. Now, leaving the market component for what it is[208], we may concentrate further on the subsidy. The subsidy has been

context (e.g. an environmental policy measure); after that, however, the actors will themselves start changing their context, and there is no formal action-in-context way to predict in which direction the interactive system will spiral away. This, curiously as it may seem, may be regarded as as advantage. Not possessing a predictive model or theory, one is forced to fall back upon the explanatory insight, complemented by informal predictive reasoning. Such a mixture may well prove to predict rather better than the theory and models of, say, marxism or development theory, both of which, as as has been demonstrated clearly enough these days, perform rather poorly.

[208] Because, for instance, it does not seem 'manipulatable' (policy-relevant). This, as stated by the principles of progressive contextualization, is an open choice. Market forces may be quite manipulatable in other cases, or they may be of such importance for predicting future actor choices that a fuller

decided upon by, say, the Department of Agriculture. Thus, the subsidy may be viewed as a new action, by a new actor, the Department, with its own objective, options and motivations. The objective may be national self-sufficiency with respect to the crop, the options may be state farms, input subsidies, output subsidies and so on, and the motivations may be the expected cost-effectiveness of the options, their profitability for powerful client groups, and so on. All this is connected to the Department's own cultural and structural context, which will of course be quite different from that of the farmers. This, and nothing more complicated, is the basic trick of exploring the actor field:

- viewing one or more elements in a list of options or motivations not just as factors, but as the effects of actions by one or more other (secondary) actors
- identifying these actors and the objective they have for their action, and with this a new set of actor/options/motivations triangles
- elements of these may in their turn be 'actorized', that is, viewed as effects of actions by yet other (tertiary) actors, and so on, establishing networks of influence in countless variations of pattern.

We also see now that these 'actor field' patterns may also be termed: patterns of social causality, the patterns of power.[209] Through construction of an actor field behind the factors that influence the primary actors' choices, these choices are taken up in a wider explanatory account.

Returning to the example of the subsidy, it is quite likely that the International Monetary Fund, for instance, could be identified as a strong influence on the subsidy options and motivations of the Department, and hence as a tertiary actor with respect to the land-owning farmers.

With respect to the other farmer category, the tenants, we may well find that the subsidy is not accessible to them, so that they should in fact be more motivated to plant the tree crop. Could it be that they are not motivated because of their insecure tenure position, not knowing whether they may reap the benefits of their investment (Chambers, 1988)? This may turn out not to be the case; on the contrary, they may tell us, they are quite willing to plant trees, for the very reason that permanent crops strengthen their tenure position. And this, they may say, is also why the landlords

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market analysis is warranted; see the acidification example later in this section.

[209] 'Power' is here used in its basic sense of social influence, i.e. the actor's ability to realize what the actor wants (e.g. Coleman, 1986:56). In terms of the set of social power types given in Eiser (1986:39), taken from French and Raven (1959), the subsidy is a form of 'reward power'. The full set is (1) *coercive power*, stemming from the ability to dispense or permit punishment, (2) *reward power*, stemming from the ability to dispense or allow rewards, (3) *legitimate power*, stemming from role obligations to follow the actor, (4) *reference power*, which occurs when the actor commands the frames of reference of the target actors (their definition of the situation, self-evaluation etc.), (5) *expert power*, occurring when the actor is seen as a superior source of knowledge and ability and (6) *informational power*, depending on the persuasiveness of the information conveyed by the actor. Types 3 to 6 are of special relevance for tracing more subtle, but potentially no less effective, linkages in the actor field.

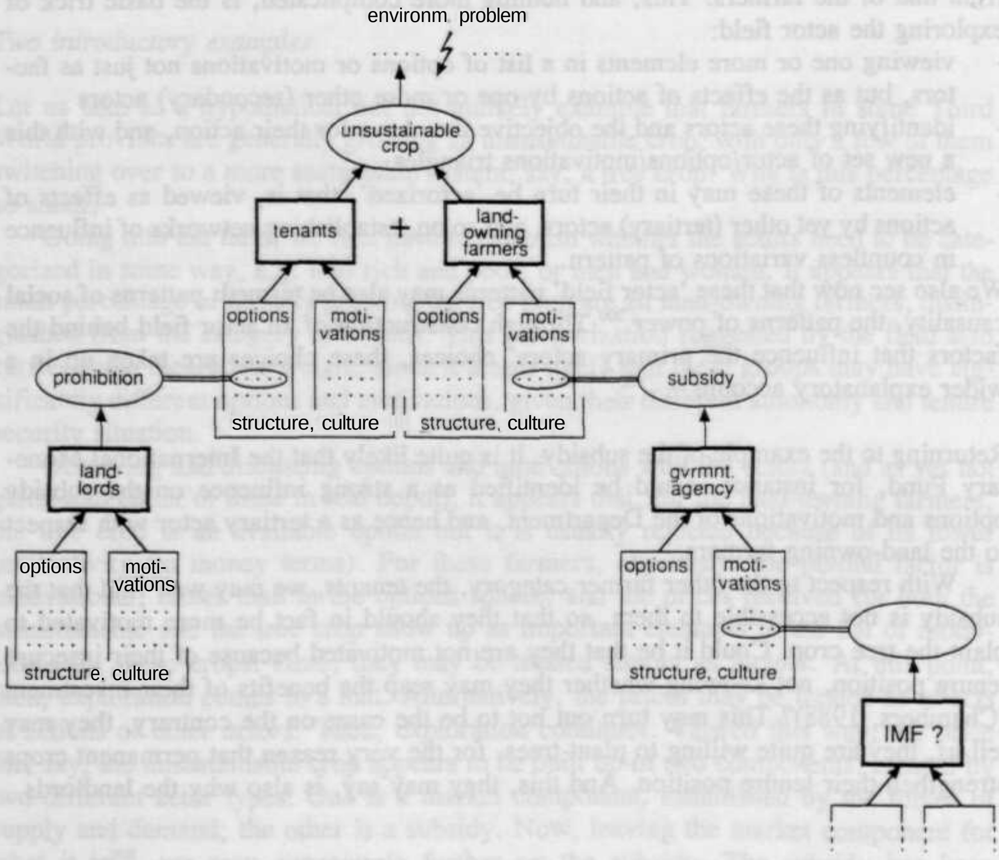

Figure 5B

An example actors field. Options and motivations of tenants and farmers co-determined by landlords and government, with the IMF as tertiary actor, each connected to its own structural and cultural background factors.

have prohibited them from doing so (Sajise, 1987). The landlords, then, are secondary actors with respect to the tenants' options; explaining the prohibition more fully requires going into the full set of relevant options and motivations of the landlords.

Figure 5B visualizes the structure now identified. The lightning symbol symbolizes the entry into the environmental problem block of the Problem-in-Context picture as a whole (Figure 3J). A plus-sign has been drawn between the tenants and the land-owning farmers, indicating that they basically produce side by side, adding up to total production. For technical reasons, the 'prohibition' and 'subsidy' elements of the options and motivations have been repeated left and right of the two central triangles, lifting them out of the primary actors' culture and structure of which they essentially remain a part.[210]

In the figure, the five actors are left separate, each 'locked' in its own context. The actor field works without in any way being a system (something with its own boundaries, feedback loops, coherence and independence with respect to other systems). It may be left that way; there is no obligation to study interconnections other then those already in the figure.[211] This is not to say, of course, that studying social systems cannot be an important contribution to the explanation. Social micro- and macro-systems find their natural place in the next section ('going deeper'). Sometimes, an actor field itself may suggest what social system to look for. This may be exemplified by taking a brief look at an overgrazing problem in Botswana, simplified from Opschoor (1987).

In many respects, the actor field we can draw up from Opschoor's description[212] is similar to the preceding one. Cattle herders are categorized into rich and poor. The European Community, through a beef subsidy, is connected to the motivations of the rich cattlemen; government here has an intermediary role (secondary actor). The rich cattlemen cut off the poor cattlemen's option to go to more arid lands, because only they possess the necessary herd size to rent an 8 by 8 km^2 block of these lands from the government. The rich owners are here secondary actors with respect to an option of the poor owners, while government is a tertiary actor.

A difference from the previous example is that we meet the rich cattlemen twice; as a primary actor side by side with the poor cattlemen on the communal lands, and as a secondary actor cutting off the poor cattlemen's option. Thus, we may intuit that something more than neutral addition may be going on between these groups, and taking a closer look at the communal lands, it transpires that the cattle of the rich owners have access to significantly more hectares per head than poor owners' cattle.

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[210] The repetition and connection of the triangular substructures show that the structure as a whole can readily be computerized, with 'prohibition' and 'subsidy' as connecting triangle labels.

[211] Consequently, as Vayda explains, there is no need to assume, defend, search or make conditional system properties such as boundedness, homeostasis, purpose or stability.

[212] For Dutch-speaking readers, it is interesting to see how Opschoor uses Duncan's model of people-environment systems for his descriptive and predictive purpose, while I, based on Opschoor's material, here draw up an actor field as the starting point for an explanation of the situation.

This is caused, among other things, by a slow process of appropriation of the 'communal' water holes by the rich; the water holes, obviously, are not effectively protected by the government. Thus, a kind of 'unity', 'systemness' of actors is suggested by the actor field: rich cattle owners, government and EC in an interwoven pattern of, as we might say in actor-in-context terms, interlocked objectives, options and motivations.

Social science theories for actor field research

The most widely quoted overview of the relation between 'micro' and 'macro' (actor and structure, or system, or context) is the book edited by Knorr-Cetina and Cicourel (1981). Mainly focusing on conceptual issues, it discusses such questions as whether macro-theories should be confined to parameters of space, time and numbers only, and the degree to which macro-properties are the unintended consequences of micro-decisions. In a broad sense, all these matters are of some relevance to the actor field discussed in the present section. They do not, however, address the heart of the matter under scrutiny here[213], that is, how to identify actor fields better than we have until now - better, in other words, than systematized and sensitized common sense.

All authors in Knorr-Cetina and Cicourel's book depict relations between actors and between actors and contextual systems as 'situational', that is, as episodes of face-to-face encounters. I find this remarkable. It is my impression that face-to-face and other direct interactions constitute only a part, and perhaps even a minor part, of the ways in which actors influence one other. A levy, for instance, may influence the decisions of countless actors without there being any direct contact between the issuer and the recipients. In the Botswana case of the rich and poor cattlemen, no direct contact, nor even an exchange of anything[214] need take place for the linkages to exist. In the case of the tenant farmers and the landlords, some general threat to evict the tenants if they plant trees has to get through to them for the prohibition to work, but it seems quite irrelevant how this is done, either in face-to-face interaction, or by

[213] The issue of unintendedness of consequences, for instance, is more relevant to the question how macro-properties arise out of micro-actions than it is to the reverse, which is the primary subject of the present section. In our example of the unsustainable crop, for instance, it is quite unlikely that enhancing unsustainability was an intended consequence of the subsidy for the unsustainable crop. Probably, the crop was just viewed as a high-yielding variety, and national food sufficiency was the aim of the subsidy. Yet, asking why the fanners planted it, the subsidy was traced as a motivational factor behind an unsustainable crop. Taking a real-world example, the levy on industrial wastewater in the Netherlands has been intended, at least officially, as a 'financing levy' only, but has worked as a regulating levy (Huppes and Kagan, 1989). Concluding, studying the actor's objective is relevant in order to arrive at a valid explanatory picture of the actor's motivations, but whether an effect has been intended or unintended does not interfere with identifying the linkages between actors. Putting it in terms of Figure 5A, an 'effect' may be intended or unintended, but an effect it remains.

[214] This is a major objection to using social exchange theory (e.g., Emerson, 1981) for actor field identification. This does not mean, however, that concepts and research from this field (such as the concept of 'position' in an exchange network) may not prove to be of supportive value.

spreading the rumour, or putting it on the local radio, or informing a middleman. If I were to draw up a general 'law' of social influence (power), I would say that direct, visible, face-to-face interactions are the least efficient power linkages. Indirect rule of actors' options and motivations is the efficient way, and within this category, the invisible threads are the most valuable, both to protect as an actor and to discover as an actor field researcher.[215]

In less theoretical actor-oriented literature, I have found four concepts that should, given their names, be of interest for identifying of actor fields: "social networks", "policy networks", "linkages" and "interfaces". In the following, I consider to what extent these concepts can contribute to the actor field concept.

(1) *Social network* theories and studies, as far as I have been able to trace (e.g. through Boissevain and Mitchell, 1973), are confined solely to direct, personal interactions between actors. The networks are networks of who-meets-whom, who-knows-whom and so on, through kinship, friendship, neighbourliness and similar bonding, reinforcing the impression already gained above: actor-oriented researchers tend to be actor-oriented to the degree that they seem to lose sight of the more abstract, indirect types of linkages, which look more like the "media of interchange" of Parsons and other functionalist, system-oriented theorists whom they (rightly, in the general sense) oppose.

For an actor field study, social network approaches may be relevant as a *secondary* tool, i.e. to further investigate the extent to which actor categories are socially intertwined. In the Botswana case, for instance, a study can be undertaken as to whether the rich cattle owners, government and EC representatives indeed interact socially, or perhaps even overlap, to the degree that initial exploration of the actor field has given reason to suspect. Using social networks as the *primary* tool to identify an actor field, however, is inefficient or even ineffective. Networking with some poor cattle owners as the point of departure, for instance, would probably only identify clusters of other poor cattlemen.

(2) The *policy network* approach, of which Glasbergen (1989) is the protagonist in Dutch environmental science, is a variant of the social network approach, focusing on policy as a process of social interaction. The basic idea is, in Glasbergen's words, that "the researcher divides the [environmental] problem complex into a number of aspects, and locates the relevant policy agencies for each of these aspects. Next, the central question is to what extent the network thus constructed functions as a unity and what determines this extent"[216]. A Popperian merit of this approach is that its relevance is falsifiable, and Glasbergen does indeed do just this in his own case studies

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[215] Good propaganda goes unnoticed. Deep paradigms shape student outlooks without arousing discussion. And, as a provincial padrone/politician once explained to me: "Remaining popular is not really difficult, basically: you take from the people in the dark, and give it back to them during the day". For an empirically grounded analysis, see Foucault (1975) on the legal system.

[216] Behind adoption of this as the central question is the functionalist and neo-corporatist image that, morally, networks *should* work "as unities", that environmental problems are caused by policy "fragmentation" and will be solved by policy "integration" (Huppes, 1989).

(without, curiously, stopping to be a policy network protagonist). In all three[217] case studies, policy actors are shown not to cause the problem and neither to be able to solve it; problems are caused by powerful private actors in concert with non-environmental policy makers, quite beyond the reach (geographically or in terms of power) of the policy network actors located as "relevant to the environmental problem complex". Having no significant decision-making capacity, they are, in our definition, in fact not actors at all.[218]

(3) The concept of*social linkages* draws its inspiration from two sources: (1) the numerous problems that policy implementation meets on its way downwards from the national to the local system levels, and (2) the growing importance of non-state linkages within and between Western and developing countries. The linkage concept, officially at least, is not confined to direct, personal networks only. Galjart (1989), for instance, includes indirect linkages through other actors' motivations and options (e.g. restricting their "behaviour alternatives"). Unfortunately, the approach is as yet underdeveloped in the methodological field, having only produced some general 'protocol' suggestions (Nas, 1989) and opinions (Speckmann, 1989).[219] Thus, although linkage research, because of its actor-orientedness, will rapidly yield results of some substantive relevance to actor field explorations[220], it does not contribute to the development of the actor field concept or method as such.

(4) *Social interfaces* form the core concept of a Dutch cluster of researchers (Long, 1989). These are defined as the pivotal points where social systems or groupings meet and interact. Being strictly actor-focused, the approach falls into the

[217] In the first case, the local farmers, backed by the Ministry of Agriculture, dominate local politics and effectively block all 'policy network' attempts to even articulate themselves. In the second, a whole network is quite integrated to solve the problem but lacks the money, and the power to raise it. In the third, farmers are so powerful that they can demand money for not poisoning the environment. The money, of course, is not there; neither is the power to ignore the farmers' morbid normative logic.

[218] It is possible, of course, that this phenomenon of inadequate focus is not intrinsic to the policy network approach in all its variants. Be this as it may, the Glasbergen example supports the actor field approach in the sense that it shows the crucial importance of pinpointing the real sources of problem-causing power first, concentrating on real actors and actors behind actors before plunging into visions, and the work of, "activating" and "integrating" narrowly defined policy networks.

[219] Nas' protocol consists of a number of questions, e.g. "what are the most important linkage actors?" By and large, they coincide with the action-in-context approach, but at a less specific level than that of this chapter. Speckmann opiniates that linkage research should study all systems (not actors) involved in a set of linkages, going from fanning system research, for instance, up to studying the national policy system; consequently, linkage research can only be done by a team. In the two actor field examples of the previous subsection, there was nothing so inherently big or complicated as to be accessible by a research team only.

[220] Van der Linden (1989), for instance, shows that notoriously indolent and fragmented bureaucracies may suddenly yield very high outputs if seized by a motivational spirit. This is as a relèvent message, as Van der Linden says, for World Bank officials who think that 'institution building' is a development panacea, as it is to researchers mesmerized by policy "fragmentation" and "integration". For actor field researchers, Van der Linden's finding is an indication that it may be better to focus on policy actors' motivations than to focus on their precise structural positions in the state apparatus.

trap that seems to go almost automatically with actor orientation, confining the contextualization of the action to actor-to-actor, face-to-face interactions only. Compared to the social network approach, it sensitizes the researcher to the relevance of social category linkages, as opposed to going round and round within the same category. Compared to the actor field approach, it de-sensitizes the researcher to inclusion of non-personal and less visible social influences. Thus, the story becomes monotonous: interface research is likely to yield relevant substantive material for actor field explorations, but, as Von Benda-Beckmann et al. (1989) also state in their critical appraisal, no "general methodology can be built on it".

Concluding, the overall tendency of the actor-oriented approaches seems sufficiently clear[221] to continue using my own term 'actor field', characterized by linking actors through influences on options and motivations instead of linking them directly, actor-to-actor. In the remainder of this section, therefore, we are basically on our own again. The objective of this remainder is only to get some more exercise and 'feeling' for the concept, first going into some cases where distinguishing the actor field may appear somewhat unclear, and then applying the concept to an element of the social context of the acid rain problem.

'Loose' and 'close' actors

Once one gets the knack of it, identifying an actor field will often prove a fairly straightforward matter, as it was, for instance, in the previous examples. In the preceding section, however, we had a case (the Zulu goats) where there was cause for hesitation. Generally, such cases may be divided into two types, whith 'loose' and 'close' actors, discussed briefly below.

DiMento (1989) has observed that whether or not commercial firms comply with an environmental regulation is influenced by the turn-over rate of the firms' personnel. A firm as a whole may logically be expected to have a long-term perspective, but when its decision-making staff is usually staying with the firm only a few years, the firm tends to behave more like a short-lived entity. Organisations, and especially large ones like corporations and government departments, while remaining actors, are typically *loose actors*, within which individual people, branches, agencies, factions and so on may have to distinguished in order to explain the actions under consideration. Wolters (1989) distinguishes three levels of decision-making within multinational corporations, but adds that the number of levels to be applied in a specific research effort is an open question; firstly, the number of levels actually at work is an empirical matter that cannot be decided beforehand, and secondly, the number of levels one needs to take into account depends on the research question, i.e. what it is one wants

221 Analogous conclusions might be drawn concerning 'figuration sociology' (Goverde, 1986) and the methods for tracing social power (e.g. the positional method and the decision method) mentioned in the study 'Digging for power' by Helmers et al. (1975).

to explain. This suggestion, of course, is quite in line with the general actor-in-context principles. Sometimes, it may be sufficient to regard a loose actor as a single entity. We treat a loose actor as a single entity when we say, for instance, that a logging company opts for the grab-it-and-run strategy with regard to its tropical forest concessions because the concession, although officially without a time limit, is vested in a weak government and under rising public pressure, and because the company has many profitable options for re-investing the quick earnings, and hence does not depend upon the forest for its survival.

In other instances we may, for instance, be dealing with a local factory of a multinational firm. It may then be feasible to treat that factory as a separate actor, while tying a subset of its options and motivations to the general level of the multinational as a whole[222]. The intracorporate links may then be shown to work, for instance, by making available a specialized purification technology, or by an intracorporate incentive system that démotivâtes compliance, and so on. As always in the identification of an actor field, there are two options: either to leave these factors as they are, or to view the source of these factors, the multinational's general management, as a new actor, with its own incentive system options and motivations. In the first case, we cannot explain why the intracorporate factors are as they are. This may be quite acceptable; how far we want to go depends on what we want to know.

The same holds, *ipso facto,* for any loose actor, be it a government, a government agency, an environmental organisation or whatever. In all cases, the basic lines again run through the options and motivations, with social networks in the background as a possibly useful source of secondary explanations, as was the case in the Botswana example. In fact, identification of actors within loose actors is no different from identification of actors in the actor field as a whole, and they can be taken up in larger fields without special treatment.

The other type of potentially problematic actor arrangements is what I have called *'close actors '* above. By this I mean a configuration of actors do not differ much from one other, e.g. not a configuration of, say, farmers, government agency and IMF, but a configuration of a parastatal, a ministry of economic affairs and a president's office or, as was the case with the Zulu goats in the preceding section, women, men, their decision-making interaction and the village council. A full explanation, it seems, would mean distinguishing between all these actors and studying all their objectives, options, motivations and so on, gathering a mass of data with only little internal differentiation. On the other hand, leaving out some actors could impair the study's explanatory power. A strategy in such cases might be to not leave actors out, but to lump some of them together into a more abstract 'quasi-actor' category. In the case of the goats, for instance, one might leave the women as the primary actors they are,

[222] In yet other cases, it may transpire that the local factory's actions can only be understood if it is viewed as the producer of a certain good X, under influence of two intracorporate actors: the national general management (comprising the goods X, Y, Z) and the supranational management of the X-division; we then get a three-actor field.

but lump the other three into a (secondary) 'household' actor. And in the case of the parastatal, consideration might be given to lumping all three actors together into a single 'parastatal circuit' quasi-actor, following Wright Mill's (1956) theory that the higher one moves up in society, the more all actors in fact become one in terms of background, outlook and social network, irrespective of their outward conflicts and their official division of tasks.

This 'quasi-actor' strategy is a strategy of reification. 'Households' and 'circuits' do not themselves act; they are researchers' constructs that leading easily to explanations in which the constructs are ascribed a life and a rationality of their own. It should therefore be always kept in mind what a quasi-actor in fact stands for. In the case of the Zulu goats, for instance, the household is something like "the male-female decision-making interplay concerning goats, usually under male dominance but under the general village rules"; such a definition is still far removed from viewing 'the household' as the pivotal social unit of the village, going around holding 'household' surveys, relating everything to the 'household' economy and so on, as is usual in social geography as well as 'farming systems' and allied system-oriented types of research (Fresco et al., 1990; Conway, 1984). Moreover, as always in actor field exploration, it remains an empirical question whether the secondary 'household' actor really plays a significant role. One should not be amazed, for instance, that when it comes to goats, the women will prove to always win in the end, provided they pay a fixed tribute to the men (say, one goat a year) and a sufficient amount of symbolic reference to the male 'decision'-making system.

A concluding example

Rounding off the present section, let us briefly explore a segment of the actor field of a typically Western-world problem, acidification, thus to gather some evidence for the wide applicability of the actor field approach. It also provides an opportunity to refer back to some of the concepts discussed previously, and exemplify a few points at which to 'hook on' social science theory, as discussed in Section 5.3.

Going 'down' the acidification effect-chain of the problem-in-context framework (Figure 3J), we identify *commuters* as an actor category contributing a substantial portion of total acid emissions. Figure 5C gives the part of the commuting actor field discussed below; at the outset, we only identified the commuter, on the left-hand side of the picture.[223] Writing out the explorative lists of options and motivations is fairly easy. The options distinguished in Figure 5C are private car, public transport, bicycle, taking a job closer to home and moving closer to the work location. Motivations are

[223] We might now consider subdividing the commuter category into problem-relevant subcategories, e.g. those who live relatively close to or far from a railway station, or into income categories; keeping things simple for this first exploration, though, we can continue with only one general commuter category, postponing subcategorizations until we have more empirical and theoretical ground underfoot.

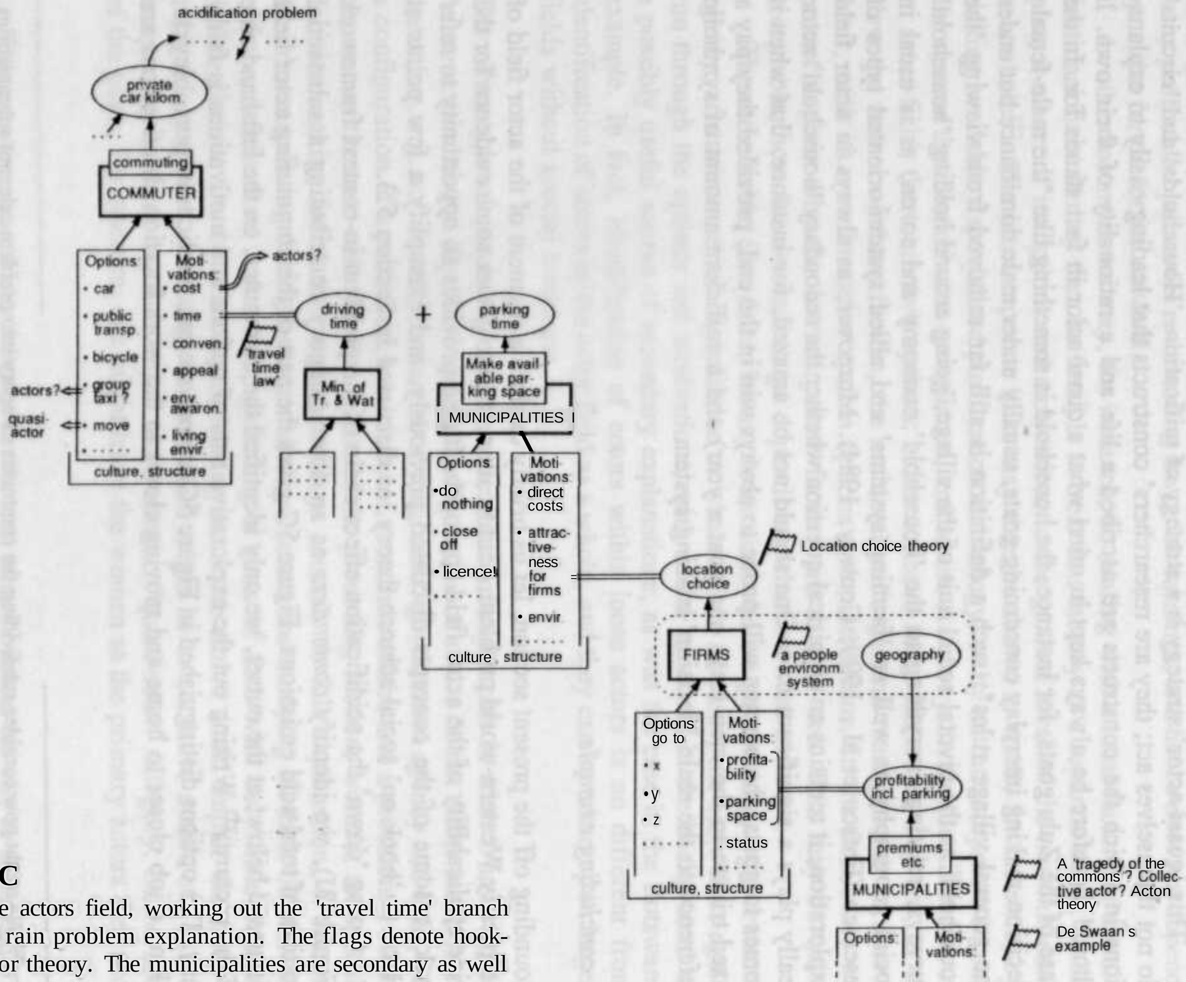

Figure 5C

An example actors field, working out the 'travel time' branch of the acid rain problem explanation. The flags denote hook-on points for theory. The municipalities are secondary as well as quaternary actors.

travel costs, travel times, travel convenience and something relatively vague but maybe no less important, 'car appeal', associated with status and the experience of freedom. Possibly, environmental awareness about acid rain and other car-related problems may also play a motivational role. With respect to the option of moving house, the quality of the local 'living environment' of the present and potential place of residence is the final motivational factor in the list.

From the options and motivations lists, qualitative and incomplete as they still are, branches off a bundle of several actor field segments; Figure 5C follows one of them. But before we take off in that direction, let us first identify some other actor field segments and aspects.

(1) The actor's environmental awareness will partly overlap with the environmental components and processes that the normative observer (ref. Chapter 3) has studied in the course of the acid rain problem analysis: deteriorating forests, dead lakes and so on. But no matter how big or small the overlap in fact is, 'acidification' here refers to what acidification is in the interpretation of the actor, not of the normative observer (e.g. the research team or the policy agency). The other environmental component in the list, the local 'living environment' of the actors' present and potential place of residence, is composed of, say, city parks, noise levels and the visual landscape around the town; these elements are not part of the environment analyzed in the environmental problem at all. Chapter 3 has dealt with this 'environment of the actors'.

(2) Moving house is obviously not an option decided upon by the commuting individual alone, but rather in some wider process of family ('household') decision-making. Several ways exist to treat this 'close actors' case; the easiest is to leave the actor field as it is but include a number of family considerations in the commuter's motivations to move.[224]

(3) In the Netherlands, due to a biased regulatory and subsidy system, the taxi is a luxury out of reach for commuting purposes. Guided by the 'surprise principle' mentioned in Section 5.2, one might wonder why some group taxi system (say, a space wagon bringing eight people from their doorsteps to their working places) is in fact not on the options list. A few calculations will show that a group taxi could be economically feasible in many cases, especially if free lanes were provided for. What are the technological, financial and regulatory structures behind this option's unavailability? Going into this may reveal an actor field segment in which the major opposition is between the economic interests and cultures of the semi-state bus companies and the more wheeler-dealer taxi entrepreneurs.

(4) Travel *cost* and travel *time* are obviously both very strong motivational factors. The actor field segment connected to the travel *cost* may be built up by first separating

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[224] A second approach is to make the family quasi-actor into a secondary actor behind the commuter. A third (probably the best in this case) is to view the family quasi-actor as a second primary actor, next to the commuter. In order to do so, we may separate the 'private car kilometres' into 'commuting distance' multiplied by 'percentage of commuting distance travelled by private car' (the modal split, as it is called), with the family tied to the first factor, and the commuter to the second.

travel costs into their price components, e.g. car production costs, car tax and road tax, gasoline production and distribution costs, gasoline excise and gasoline consumption per kilometre. Then, seeking secondary and farther actors behind each of these components, one will begin to unravel one of the Western world's most powerful interest conglomerates.

(5) As for deciding whether to put more effort into the travel cost or the travel time factor, guidance is given by the principles of Section 5.3, but also by a theory source, 'hooked on' at this point. First, we may note that the private car is an economically very preferential good. Price policies (with respect to gasoline, parking costs etc.) wil therefore have to cut very deep to have any real impact. At the same time, regulation of prices is not an area of strong government legitimacy in the Western market economies. With respect to travel *times,* matters are different. There is, for instance the 'law' of Hupkes (1977) that people have spent and will spend an invariable amount of time per day on travelling; hence, if you want people to travel less kilometres, decrease their average velocity. Average velocities, at least in a crowded country like the Netherlands, are largely a matter of the availability of travel *space* (roads, free lanes, parking space) and the allocation of space is one of the strongest and most generally accepted government domains.[225] It is this 'travel time' factor for which Figure 5C shows three steps of the actor field segment.

Travel time may be divided into *driving time* (including congestion delays) *and parking time* (including looking for a parking place and walking to the working place).

The actors most directly linked to the *driving* time are (in the Netherlands) the state and provincial Traffic and Public Works agencies. For a basic analysis, these actors could be taken as a single category.[226] As for the *parking* time component, the municipalities are an important actor, especially with respect to parking space in and around the inner cities. Concentrating on this actor, Figure 5C enumerates the 'parking policy options' as: (1) doing nothing, (2) converting parking space into park areas, sidewalks, bicycle space and so on, (3) using a parking licence system to allocate space to city inhabitants only and (4) (re-)negotiating parking space offered to firms and offices considering establishment in the city. The municipalities' motivations centre on, among other things, (1) the quality of the city environment, (2) the direct costs of conversions, surveillance and so on, (3) general environmental con-

[225] Drees (1990) comes to the same conclusion that travel *space* policies are a priority area with respect to private car use. Note that, guided by common sense and the action-in-context principles, one may actively reproduce this conclusion without having read the analysis; with respect to the UK, see Joseph (1991).

[226] For a more detailed explanation, the agencies may be treated as loose actors, divided into several levels. Then, the municipalities, in their role of co-determining urban circulation velocities, could also be taken up as a secondary actor alongside the state and provincial authorities. Furthermore, parliament and the conglomerate of private car interest and pressure groups could be taken up in the quaternary background.

siderations, e.g. about acidification and (4) employment and status connected with the establishment of firms.

Figure 5C proceeds with the latter factor; firms are then the tertiary actor. Their options are, simply, to set up shop (or move out of) municipalities x, y, z and so on. Their motivations will concern, among other things, status aspects, the attractiveness of the city environment, profitability and parking space for employees. The latter two are partly interchangeable; the municipalities may be put behind them as a quaternary actor. Most of the firms' motivations to choose for one municipality or another will be determined by geographical factors such as the closeness of suppliers, markets, harbours and so on, but municipalities influence these choices by handing out establishment grants and free parking space, competing with each other for the firms' favours. Having arrived at this point, we come to see the municipalities in a dual (secondary and quaternary) position, divided within themselves and against each other. The environmental aims of their 'parking policy' are at odds with economic aims.

Moreover, establishment incentives and free parking space provisions have a very limited rationality; the municipalities consume their money and space in order to increase their share in the number of firms that may be 'cropped', without, however, increasing the total crop. This, typically, is a 'tragedy of the commons', thus spurring us to search for some collective actor to safeguard collective rationality. Does some intermunicipal or provincial decision-making body exist with respect to establishment incentives and space provisions?

Figure 5C shows that three theory sources may be tapped in this area. First, of course, general theories of collective action, in which the 'tragedy of the commons' is one of the basic dilemma situations. Secondly, case studies of intermunicipal policy making may be of special relevance, for instance, the historical study of De Swaan (1988) about municipal care for the poor, a situation that is the neat reverse of that concerning the firms: the poor's options and motivations are much like those of the firms, but the municipalities dreaded them flocking to the first municipality setting up a welfare system. Thirdly, there is geographical 'location theory' (e.g. Abler et al., 1971), which is basically a normative theory of where it would be rational (as defined by the theory) for firms to establish themselves, but which may also be used to (partly) explain what firms actually do.[227]

All in all, Figure 5C shows the informal face (with unfilled-in spaces, flags denoting possibly relevant theory sources, question marks and so on), typical for exploratory research phases, dictated by common sense, general action-in-context principles and perhaps some consultations with experts. In later phases of cyclical research, the explanatory structure around the commuter will become more refined, simplified,

[227] The geographical elements in the location decision of firms once again illustrates that the term 'structure' in the actor-in-context schema always includes the physical environment, in its manifestation as 'environment of the actors' (Section 3.7), i.e. connected to the actors' options and motivations. For the firms' location decisions, the actors' environment consists of roads, harbours, demand areas and so on, interpreted in terms of travel times etc., very different, obviously, from the environment of the commuters with respect to decisions to move house, and even more different from the 'environment of the problem analysis' (the air, forests, soils and lakes of the acidification problem).

filled-in and **quantified,** supported by the **action-in-context** guiding principles and data gathered through interviews, observations and literature. Then, by way of 'secondary analysis' already discussed in the Botswana case, different actor field segments may also be interconnected, joining them, for instance, through actors that appear in more than one segment or actor that belong to the same social network. Quantitative modelling of parts of the actor field is of course more difficult than modelling the **problem-in-context** elements which run from the primary actor, ***upwards*** in Figure 5C (roughly, the 'traffic system' and its environmental impacts), but not principally out of reach.

5.6 Going Deeper: The Single-Actor Schema

Social-scientific explanation, by and large, connects micro-level decisions to other micro-level decisions and to macro phenomena, or, in other words, relates actors to structure and culture. The construction of the actor field behind the action to be explained, following the principles laid down in the preceding section, is the first step in the explanatory process. The structure of an actor field is in itself already a problem-relevant slice of the structure of society. Even more importantly, the actor field specifies what actors are important in what ways. Therefore, we now no longer need to identify 'the' general context of an action in one go, but can build up this context (or set of separate contexts) by going from one specific actor to another, focusing each time on contextual factors (culture and structure) as they pertain to the specific decision of that actor. In the commuting case of the preceding section, for instance, we identified the municipalities as important actors. Having also identified why they are important, we do not need to study, for instance, their autonomy in general, but primarily their 'parking space policy autonomy'.[228]

The present section will focus on this actor-by-actor analysis, identifying, studying and interconnecting the cultural and structural factors that underlie their choices. It is designed to answer such questions as:

- if this actor considers only these options, why only these?
- all prices, options and other 'objective' factors being equal, why then do these actors act differently?
- if we supply this actor with new options or prohibit existing ones, will the actions change?
- how do the overall characteristics of this society (e.g. mentalities, basic geography, class segregation) connect to the concrete actions of this actor category?

In later research stages, it may be feasible to re-arrange and re-interpret the actor-by-actor findings in a way analogous to the 'secondary analysis' already encountered with the actor field. Being of a less pivotal character than the actor-by-actor analysis itself, this secondary analysis will receive only minor attention.

The actor field exploration of the previous section has proceeded chiefly by way of example exercises. Contrary to the actor field, the 'going deeper' analysis of the present section has a standard structure, and we will simply go through it step by step, with examples playing only a minor role. The standard structure is given in Figure 5D, which is nothing but an expanded version of the action-in-context framework presented in Chapter 3 and provided with somewhat more formal definitions, thus enabling more conscious data gathering and more systematic and detailed interpretations.

[228] Put in solution-oriented terms, the actor field identifies the likely policy *target groups,* while the 'going deeper' analysis identifies the options of policy *content.*

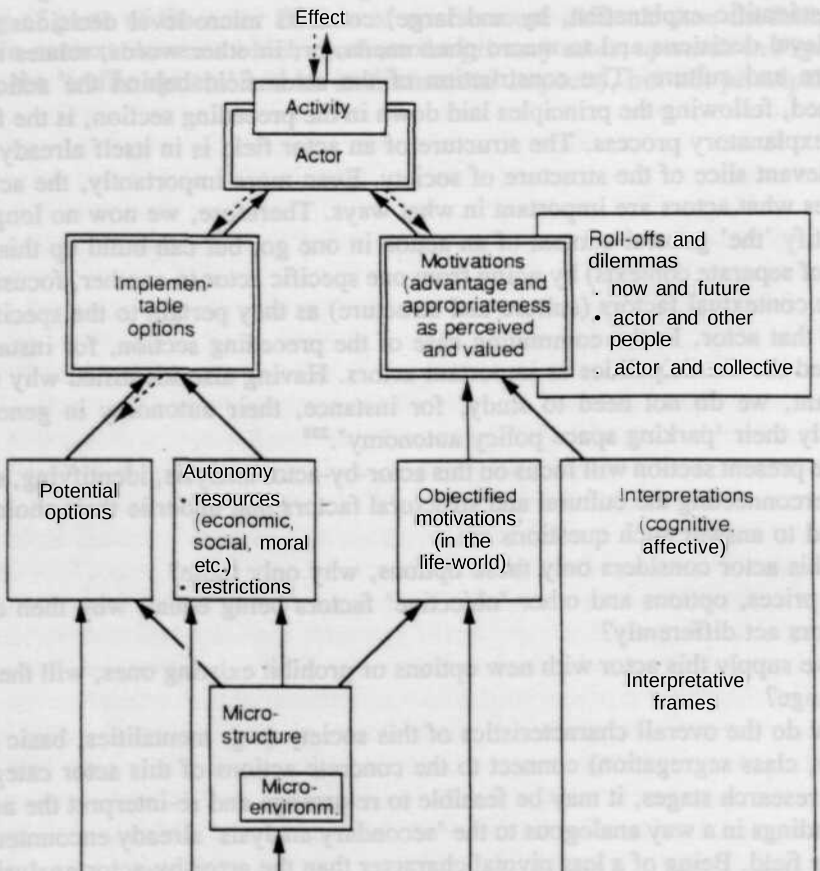

Figure 5D
The single-actor schema of the action-in-context framework. The dotted line indicates the usual direction of explanatory research.

Whole libraries are filled with literature hinging on the key concepts of Figure 5D: culture, structure, life-world, action, autonomy and so on.[229] To my knowledge, though, there does not exist what this section seeks to provide: a practical framework concerning how to *do* research joining these concepts *to one other*. At the same time, nothing new or revolutionary will take place in this section; as in the rest of this chapter, we will remain at a very basic, 'enhanced common sense' level.

In Figure 5D, the dotted lines represent the direction of the first round of a progressive contextualization proceeding from the action in question. This is also the sequence in which the elements of Figure 5D are discussed below, layer by layer and, within the layers, element by element. The section ends with a subsection called "next steps", discussing some connections not taken up in Figure 5D and some typical directions of secondary analysis.

First layer: effect, action, actor

The first layer (effect/action/actor) is the same as that of the previous Figure 5A, discussed in Section 5.4. The term 'effect' is the only one requiring further attention here. If the actor is a primary actor in the actor field, the activity causes the environmental problem studied by the normative observer; 'effect', then, is shorthand for the environmental problem. At the same time, 'effect' then stands for the feedback to the actor's own culture and structure (including environment), as discussed in Chapter 3. When the actor is a secondary, tertiary or further actor in the actor field, the effect links the decision of the actor to options or motivations of other actors.

Problem-relevant effects may be the *intended* consequences of an activity. This holds, for instance, for hunting; killing the animal is both the actor's objective and the problem-relevant effect. Mostly, however, actions will not expressly be designed to cause, say, soil erosion, health problems or poverty. In the cases treated in the previous section, for instance, the commuter's objective was simply to go to work, not to contribute to acidification, and the subsidy for the unsustainable crop will most likely have been motivated (and hence be explainable) by its being a high-yielding calorie provider, not by its being unsustainable. Therefore, finding out the objectives of actions is always a separate research step; if we derive aims directly from effects, we automatically wind up with conspiracy explanations.

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[229] These concepts have been defined in almost as many ways as there are social science theorists. Reviewing them is quite beyond the scope of this section. Thus, although I will include a few literature references here and there, the reader will basically have to trust that the way I use 'actor', 'world view', 'structure' and so on is not fundamentally out of tune with their general connotation in social science. As for their precise definition, however, all terms I use are, in the final resort, defined internally, designed to be logical within the action-in-context framework itself. For instance, I may define some A and some B, then C as the difference between these two, then D as everything influencing C, and then E as everything non-D. Care should be taken, therefore, not to transplant terms uncritically outside the framework, nor to criticise the framework too easily because it defines terms differently from how some theory or school does.

Second layer: implementable options and motivations 'as interpreted'

The second explanatory layer of the schema ('implementable options' and so on) comprises terms that are only somewhat more specific then the general 'options' and 'motivations' of Section 5.4. Here, therefore, only the specific additions will be discussed.

Implementable options are the options the actor would be able to carry out if he wanted to, to the degree and within the time frame relevant for the study.[230] Roughly, the implementable options are what an actor *can* do, as opposed to the wider set of things the actor *might* do, which is in the next explanatory layer. The implementable options are in the higher layer for two reasons. First, these options are the ones the actor will consider most actively, and hence will talk about most readily. They are therefore the most natural elements to start out with in initial contacts with actors. Secondly, and more importantly, the implementable options in themselves already have some explanatory power. Typically, one then says: "The actor can do A, B or C, and prefers B", followed by a statement in terms of motivations for A, B and C. Typically, too, one will then run into the criticism that "This may be so, but why can't the actor do D, E or F?" In other words, the explanation is as yet superficial; D, E and F are in the deeper layer.

Next, *motivations* are specified in terms of *"advantage and appropriateness"*[231] as interpreted by the actor. This formulation is in fact an 'actor model' in a very subdued form. Basically, "advantage" stands for the *homo economicus* type of motivations and "appropriateness" stands for all other types. Most actors, for instance, will deem it appropriate to respond with trustworthiness when one is trusted, and to treat children in a perspective of care rather than costs and benefits. Thus, the terms point forward to Section 5.7; I have included them here to prevent interpretations from going in flat *homo economicus* directions only.

The phrase "as interpreted by actor" is formally superfluous. After all, everything in Figure 5D is primarily as interpreted by the actor (EMIC, as it is called in Chapter 3); it has been added here because this is the most important place to put it in as a reminder, and in order to distinguish it more explicitly from the 'objectified' motivations in the next layer.

Roll-offs and dilemmas are attached to the motivations element. There is no arrow, indicating that there is no causal relationship; the two terms only summarize a list of motivational mechanisms that are often regarded as being of special relevance in the

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[230] I add the 'degree' and 'time frame' criteria here because what is implementable is never strictly bounded. A commuter, for instance, may not be able to switch his mode of transport overnight. The same holds for a farmer changing crops or an agency changing policies. If these changes are within reach in one or a few years, they may be taken as 'implementable' in most studies, however.

[231] Of course, these terms include negative advantage and appropriateness (costs and improperness).

social causation of environmental problems, and therefore patterns to be on a special look-out for during the research (e.g. Tellegen and Wolsink, 1992). Moreover, they are typically a hook-on point for many social science theories and examples from elsewhere, as shown, for instance, in the preceding section with respect to the municipalities. 'Roll-offs' stands for the Dutch 'afwentelingsmechanismen', meaning that for some action, the benefits largely accrue to the actor but the burdens are 'rolled off elsewhere in space or time.[232] The term 'dilemmas' stands for all situations where the potentially best option is beset by uncertainties that may make the option one of the worst; the prisoner's dilemma is a well-known example. In Figure 5D, roll-offs and dilemmas are separated into three types, which may be exemplified as follows.

- *Now and future*
  - Roll-off type: burdens are shifted or left to future generations.
  - Dilemma type: future benefits of an investment are large but uncertain (e.g. a farmer considering investing in soil upgrading but faced by tenure insecurity, or a logging company considering investing in 'timber stand improvement' but faced by the insecurity of the officially eternal forest concession).
- *Actor and other place*

  Most often, the 'other place' will mean other *people,* individually or collectively. The 'other place' may also mean *nature* (species or other intrinsic values).
  - Roll-off type: burdens are shifted or left by the rich to the poor, or by upstream farmers to downstream lakes, or by the centre to the periphery, and so on.
  - Dilemma type: prisoner's dilemma and similar situations (e.g. an option is only good if other people can be trusted).
- *Actor and collective*

  'Collective' here means a social configuration the actor himself is part of.
  - Roll-off type: the 'free rider', the 'tragedy of the commons' and all other situations where burdens are spread out over larger wholes (e.g. from local to regional).
  - Dilemma type: the same, but added to it a possibility that the collective or system the actor is part of may strike back or collapse.

It may be noted here that the roll-offs and dilemmas are 'logics' largely pertaining to *homo economicus* rationality only. Therefore, the world abounds in situations where roll-offs and dilemmas exist only as risks, not realities, e.g. because people cooperate, establish collective institutions and trust each other to keep their word; see, for instance, Achterhuis (1986) and Buck Cox (1985) about the historical reality of the commons, the case study of Shepherd (1989) and the overview of Ostrom (1990) about the present, and the next sections about theoretical backgrounds.

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[232] In pollution cases, as Bouwer and Klaver (1987) indicate, roll-offs are often accompanied by tactics of diluting, hiding and relocating the sources. In most other cases (e.g. the depletion of the Third World forests), roll-offs are applied by actors powerful enough to do it in the open.

Third layer: potential options, autonomy, objectified motivations and interpretations

In the next explanatory layer of Figure 5D, and again starting at the left-hand side of the figure, the *potential options* are the first element found. They are defined as everything the actor *might* do with respect to the objective at hand. The 'implementable options' of the preceding layer are a subset of the potential options.

Often, it will not be immediately clear whether some possible course of action should be included as a potential option. Taking the taxi, for instance, should it be regarded as a potential option for commuting? The answer is largely a matter of practical judgement. Omitting options will save research time, since they do not need to be specified and researched for their motivations. On the other hand, guiding principles of problem relevance, contrast, policy relevance and 'surprise' may indicate drawing up longer list of potential options. Discussing why an actor does not consider a certain option may deepen the understanding of why he does consider others. Also, these discussions may inspire researchers and actors to find a related option that is more feasible (for instance, the group taxi). Generally, it seems wise not to be too strict in the early stages of the research, omitting only those options that are very obviously too narrowly feasible or far-fetched. In a second round, options can always be dropped.

In the figure, potential options are divided into those *known* and those *unknown* (to the actor, of course). Known options comprise the implementable ones, but also those known but rigorously out-motivated by the actor (e.g. as old-fashioned, or too dangerous, or because a real leader just doesn't do a thing like that). Unknown options may be recent scientific designs (say, a new agroforestry system or incentive system) or methods applied elsewhere (say, an in-household system of separating domestic waste fractions). Strictly speaking, unknown options will not explain much about the actor's choices. Including them may be relevant for enhancing the policy relevance of the research, however, if the options discussed with the actor are selected for their potential contribution to the environmental problem. This point also shows that 'potential options' typically has a relatively large input by the researchers themselves ('etic', in the terms of Chapter 3), and a hook-on point for technological theory and knowledge.

The next element in the third explanatory layer is the *autonomy* of the actor, with respect to the action at hand. In the literature, 'autonomy' is sometimes used in a broad sense, referring to both the options and the motivational field. It then also comprises, for instance, moral autonomy as opposed to moral heteronomy (that is, being motivated towards something because other people say or show they are). Here the term is linked to options only. Roughly, it is the degree to which the actor can make true or protect what he, she or it wants to be true or protected. Stated formally in action-in-context terms, autonomy is the degree to which the actor can implement potential options towards which he is motivated; 'implementational capacity' might be an alternative term.

Figure 5D makes a subdivision into two types of 'autonomy factors'. The first is termed *resources*; they are formally defined as everything that contributes to the actor's implementational capacity. The constituent elements are all well-known; they may be summarized as follows:

- economic resources: (access to) capital, credit, budget, capital goods
- social resources: leadership position, social support, social network, acknowledged professional expertise
- cognitive resources: (access to) knowledge and information
- environmental artefactual-physical resources: (access to) shelter, land, trees, fishing grounds, waste recycling facilities and so on
- moral resources: support of acknowledged policy aims, traditions, religion, rights
- psychological resources: self-esteem, will power, daring (entrepeneurship)
- physical resources: time, health, bodily strength

and, as an addition for collective actors only, because they may fail because of internal disorganisation:

- organisational resources: the degree of internal integration (cognitive coherence, control over members), internal legitimacy of leadership, and so on.

This enumeration is not conceptually perfect in the sense of the terms and categories being logically exclusive and exhaustive. It is typically a list designed to work as a reminder during research, not a conceptual basis for theory building. Compared to most literature, it places somewhat less emphasis on economic and environmental resources (roughly, being rich) and somewhat more on the less conspicuous elements of autonomy, so as to encompass the full range of what Bourdieu (1986) has called economic, cultural and social capital.

Increasing the resource base upon which environmentally desirable actions draw is an environmental policy option often used in 'community-based' action in the Third World.[233]

Decreasing the resource base upon which environmentally *un*desirable actions draw is always a policy option, too, restricted, strictly speaking, only by ethical boundaries (e.g. decreasing actors' health). Thus, undermining the social resource that goes with the institutionalized access to knowledge, either by a direct attack on professional expertise or by building up a countervailing research capacity, is an option for action and policy alongside the other, more conspicuous options (e.g. regulation or levies). Another of these options is to undermine the organisational resources of a section of your organisation that you do not like (e.g. an environmental section) by re-organising it permanently.

Some autonomy-decreasing factors are of special relevance to the design of environmental policies and have therefore been included in Figure 5D under the term

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[233] The environmental programme described in Annex 6.I of De Groot (1992b) is a programme of autonomy enhancement of environmentally motivated actors, building these motivations on the physical, cognitive and moral resources of the poor and primarily focusing on enlarging the actors' organisational, psychological and cognitive resources, with economic resource elements, such as credit, in a supportive role.

restrictions. Prohibitions (formal, informal and traditional, such as taboos) and the prescriptions and standards that go with environmental licences are an example. Moral obligations to protect the environment (the negative counterparts of the 'rights' in the resources list) are another. Of course, only *effective* restrictions count here. If a formal prohibition or other restriction carries no moral, financial or other consequences for the actor, it has no role in the explanatory analysis.[234,235]

The next two elements in the third explanatory layer are attached to the 'motivations as interpreted' element. Roughly, the three elements in the motivational triangle relate to one other in the same way as the three elements on the options side; 'interpretation' is the difference between the lower and the upper 'advantage and appropriateness' elements ('objectified' and 'as interpreted'). Making this distinction is especially important because it marks the separation between structural and cultural factors, as we can see in Figure 5D.

The first element found is *'objectified' advantage and appropriateness.* The new term here is 'objectified'. It denotes that which results when we, preferably together with the actors, peel off, as far as we can, the interpretative mantle from the 'motivations as interpreted'. In formula form: 'objectified' = 'interpreted' minus 'interpretation'. At an abstract level, this may sound conceptually difficult. In daily life, however, 'objectifying' is a process that all actors and researchers essentially know how to perform. Even if we usually describe faces of friends, say, in highly interpreted terms like 'beautiful', 'strong', 'expressive', we will also be able to describe these faces in more objectified ways, more in terms of, say, a police report.[236] Another example may be taken from DiMento (1989), who reports that commercial firms, when considering whether or not to comply with environmental regulations, will tend to respond differently to criminal sanctions than to non-criminal ones, even if the expected economic cost of non-compliance (say, the fines or the levies) are equal. Criminal sanctions have a higher deterrent power, but also evoke a greater risk that

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[234] Analogous to what has been discussed with reference to the potential options, a practical choice has to be made when a restriction lies somewhere between the totally effective or ineffective, as is often the case. For instance, tropical forest timber licencees may be prohibited from simply cutting trees without replanting. Formally, then, timber stand improvement is the only option available to timber licencees. Yet, they usually prove to follow a grab-it-and-run option because in practice, the prohibition only works as an extra cost, namely the price of paying your way along the timber checkpoints, the harbour officials and so on. In these cases, the prohibition, in its pay-your-way manifestation, in fact functions in the 'motivations' element of Figure 5D.

[235] As a more technical point, it may be remarked that autonomy, although only connected to 'implementable options' in Figure 5D, may also play some role in the motivational field. An example is the fact that a low level of resources may motivate actors to follow a risk aversion strategy, that is, to be motivated towards options with a worst possible outcome that is not too bad, even when its average outcome is less advantageous or appropriate. More of these 'missing connections' of Figure SD are treated in the last subsection.

[236] Hence, the term 'objectified' here (as in Chapter 3) does not refer to fundamental discussions of 'objective' versus 'subjective', or 'subjective' versus 'real'.

the regulation will be completely rejected. Discussing with the actors why this is so will bring the purely economic costs in the 'objectified' element of Figure 5D, and the difference between the civil and criminal nature of sanctions (for instance, the rejection of being treated as a potential criminal) in the 'interpretation' element. As a general rule, the 'objectified' element will often contain descriptions of motivational factors in simple quantified terms, such as economic costs and benefits, working time, travel time, calories in food and firewood, expected toxic substances intake, numbers of good relationships, kilometres of distance and so on.

The element of objectified advantage and appropriateness also includes the phrase *in the life-world.*[237] Life-world is defined as all decision-relevant phenomena the actor encounters, ranging from, say, the gasoline price at the pump to the actor's recreational lake or the actor's family. Thus, life-world is a collective term for a selection of elements *out of* the actor's contextual microstructure and macrostructure. Formally speaking, Figure 5D could do without it; what else besides decision-relevant phenomena could there be to interpret? I have included it, nevertheless, for three reasons. First, confusion sometimes arises (for instance, in De Groot, 1990) as to how to call that set of things relevant to the actor's decision; being 'everything around the actor', should not it be called microstructure? Secondly, adopting the term helps to protect against too automatic systems thinking; microstructure and macrostructure are systems (loose systems, often, but with their own boundaries, system characteristics and so on), but life-world, including its environmental elements, is not. All of its elements may themselves be *parts of* micro and macro structures (including ecosystems), but life-world itself is an aut-ecological, not syn-ecological phenomenon.[238]

The last element at the third explanatory level is *'interpretation'*, defined as the cultural and psychological opinions and ways-of-looking that give weight, coherence, shape and colour to the 'objectified' motivational factors. *'Cognitive and affective'* has been added as a reminder that interpretation is more than a cognitive process, as suggested by such frequently used terms as 'perception' or 'cognitive filter'. Often, the cognitive and affective aspects of interpretations will be closely intertwined. People who discover that they are living in houses built right on top of a covered-up chemical waste dump will often show very fierce reactions, much fiercer than might be explained by the 'objectified' health risk only. The objectified health risks appear to be greatly enlarged in the actors' cognitive interpretations. This is probably connected to an affective source: people are threatened in their basic sense of their capacity to

[237] The term is taken from the German sociologist Schutz (e.g. Schwartz and Jacobs, 1979: 195).

[238] Thirdly, the term life-world elucidates some other important terms in social scientific literature, such as 'incorporation', 'alienation', 'fragmentation of the life-world' and 'penetration of the state into the life-world'. They all refer to the fact that in modern society, the life-world tends to become filled with elements of the actor's *macrostructure*, that is, as will be defined below, systems the actor does not meaningfully participate in. Examples are landscapes filled with agriculture ruled by and working for anonymous world markets, and the penetration of regulations designed in far-away political processes and enforced by faceless bureaucrats.

rule their own lifes. The intrusion of a dark power into the very soil you live on makes the toxic substances poisonous to more than 'objectified' health only. As a general rule, large discrepancies between 'objectified' motivational factors and their 'as-interpreted' counterparts (actors exaggerating, ignoring and so on, when viewed from the outside) will often point to strongly affective sources of interpretation.

As drawn in Figure 5D, the element headed by 'interpretation' extends into the fourth explanatory level without causal arrows. This has been preferred in order to avoid the suggestion that people have separate boxes of 'interpretation', 'world view' etc. inside their heads, and in order to indicate that here the researchers, too, should shift their interpretation and language away from concepts like 'factors', 'causes', 'systems' and so on towards the concepts and language of interpretative sociology and philosophy. The actor's interpretations are then to be seen as the emergent expressions of deeper, underlying world views.

Fourth layer: microstructure, macrostructure, interpretative frames, self-image, world views

At the fourth explanatory level we arrive at the 'culture and structure' basis of an actor's decisions. Before treating the elements in Figure 5D separately, let us first have an overall look at them.

The concepts of structure and culture are virtually all-pervading in social science. With respect to the explanatory purpose of this chapter, for instance, we may note that 'grand theories' about the roots of the environmental crisis usually emphasize either structural aspects (e.g. neo-marxism) or cultural phenomena (e.g. White's well-known 'historical roots' in Christian religion). This phenomenon of confining theory to either structural or cultural determinants is also visible in actor-oriented literature, e.g. in rational choice theory and symbolic interactionism, respectively. With this in mind, Orlove (1980) ends his overview of ecological anthropology with a plea for the discipline to entertain a more balanced position on the role of structure, culture and environment.[239] Thus, this is one of the crucial points for the action-in-context approach to be a balanced methodology, not funnelling researchers into a single, biased direction; *culture and structure should both be fully present in the action-in-context framework.* Checking this requires some technical elaboration.

From the overview given in Cardwell (1971), it can be inferred that *culture* may be defined as the *socially transmitted and acquired knowledge, belief, an, morals, law*

[239] His actual words are "the role of social organisation, culture and biology", but these are the equivalents of what are here termed structure, culture and environment. Environment, in our definitions, is part of structure.

and any other capabilities and habits of actors.[240] Culture, then is located in society at two levels:

- inside the actor ('acquired')
- outside the actor, captured, as it were, in the process of being 'transmitted': the content (not the institutions) of science, religion, art, law etc.

By means of these two 'locations' of culture we may define two logical complements of culture, lying, as it were, on both sides of it. The first is: everything non-cultural inside the actor. The second is: everything non-cultural outside the actor. These two, logically filling the space of everything there is except culture, delineate 'structure' and 'idiosyncracies', respectively. Hence:

- *structure* is everything outside the actor, including physical artefacts and the natural environment, and including the institutions and products of science, religion, art, law and so on (thus excluding their content)[241]
- *idiosyncracies* are the 'self-generated', not acquired knowledge, beliefs etc. of actors.

Now, we can take a look at Figure 5D and check if it indeed contains all three concepts now defined. We then see the following.

- 'Interpretations', 'interpretative frameworks', 'world views' and 'self-image' clearly contain the core of culture, in its 'inside-the-actor', acquired aspect. Culture in its external, collective aspect is absent; it will be discussed further in the next subsection.
- 'Interpretations', 'interpretative frameworks' etc. will only seldom be *purely* cultural; many will also have idiosyncratic components. The latter will especially come to the fore in explaining differences between individual actors. As such, they will often be of less relevance than the more general and stable cultural components, since environmental science is usually concerned with relatively stable activities of relatively large actor categories.[242]
- Not all culture is captured in the 'interpretations', 'interpretative frameworks' etc. elements of the figure; potential options, for instance, although only connected to the 'structure' elements, will also have a basis in the acquired, cultural knowledge

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[240] Here, I follow the classic definition of Tyler, 1871, cited in Cardwell. This definition is in basic agreement with that of Nesbit, but differs from those of Abrahamson and Lundberg in that it excludes the material products (artefacts, towns, landscapes) of knowledge, beliefs etc. This is not problematic for the question pursued here, because these products are fully included in our definition of *structure*. Hence, they are fully in the action-in-context framework.

[241] We may note that we can come to know structure only through people's minds (hence, culture). This includes our own interpretations, the interpretations expressed by research respondents and the more objectified interpretations (data and theory) of science, and all possible mixes and in-betweens (cf. 'emic' and 'etic' in Chapter 6). Spatial structure, for instance, may be structure directly interpreted from what we see around us, or the 'mental maps' of the actors (Downs and Stea, 1977), or the objectified maps of geography. Structure it stays all the way, however.

[242] Large collective actors will often be an exception; 'corporate culture' may be idiosyncratic to a significant degree.

of the actors. Since I do not expect researchers to become confused at this point, I do not regard it as a serious problem.

Concluding, it can be said that the action-in-context framework satisfactorily lives up to Orlove's requirement that it does not bias researchers towards developing only structural or only cultural explanations.[243]

After this brief exploration of the culture concept, we may turn to *structure*, the first elements found in the fourth layer of Figure 5D. The concept is substantiated below, in a form that may serve as a research checklist.

Social structure consists of:

- social entities that may themselves be actors: people, family, corporations, the state, churches, the institutions of law and so on
- relational fields between these: personal networks, institutional networks, war, formal power hierarchies, global interdependencies, markets, causal networks (the 'actor field' of the previous section) and so on
- categories of actors sharing one or more characteristics: classes, age structure categories, status categories, occupational categories, religious categories, tribes and so on
- spatial patterns of the above elements or other characteristics (unemployment, trade flows, diseases and so on).

Physical structure consists of:

- man-made physical infrastructure: roads, telecommunications and so on
- products and spatial patterns of people-environment interactions: cities, landscapes and so on
- spontaneous ('self-ordering') structure: nature.

Of these, only the first and the last category may cause things in the direct sense of the term; only these have *telos* and the equipment to see, decide and move something else. *All* categories, however, may indirectly cause things. An individual actor, for instance, will think twice before moving with his family to a region with a high unemployment rate; a corporate actor may reach the opposite decision based on the same spatial pattern. Both ways, the spatial pattern of unemployment, a macro-structural ('system') characteristic, co-determines the decision to move.

For the action-in-context framework, the most important distinction within the structure concept is between *micro-structure* and *macro-structure,* as shown in Figure 5D. Why this is so will become clear after they have been defined.

Often, micro and macro are equated with small or large in the spatial sense. The state, for instance, is then always macro. For explanatory work, this is not a relevant criterion, however. If we want to explain why an actor responds differently to the 'small' or 'large' systems he is participating in, small and large have to be defined in

243 Phrased in economic-anthropological terms (Emerson, 1981), the framework encompasses the formalist and substantivist points of view. For an analogous discussion with respect to actor models, e.g. rational choice theory versus the influence of social norms (culture), see Section 5.7.

an explanatory relevant way. Then, the assumption may be that the actor will respond differently to systems that do or do not respond *to him. Micro*-structure (social and physical) then becomes the structures in which *the actor makes a difference,* while macro-structure is where the actor does not. Typically in social micro-structures, actors know each other, they are involved in many and multi-level exchanges at the same time, and often develop a sense of belonging and solidarity. Because of this, micro-structure reciprocity is fundamentally different from the single-commodity reciprocity of the market place[244], and social control is a characteristically micro-structure phenomenon.

The difference this makes is shown, for instance, by the countless well-managed common property resources in the world, for instance, the grazing lands, forests and water resources run and protected against outsiders by rural communities. All these, as far as I know, are 'micro-commons', managed by actors who know each other and control each other by means of their multi-level interdependency. 'Macro-commons' do not seem to exist, or rather, they are the 'collective goods' and the 'free access' situations for the analysis and management of which quite different concepts and instruments apply (externalities, levies and so on).

A second example of the relevance of 'micro' versus 'macro' may be taken from the protection of meadow birds in the Dutch lowlands, one of the Netherlands' outstanding natural values. Somewhat simplified, two systems are at work to stimulate the farmer to protect the meadow birds breeding on his land. One is a micro-strategy: local volunteers, in close social contact with the farmers, count the nests, mark them with small sticks in the grass so that the farmer may mow around them, and so on. The other one is a macro-strategy: a regional incentive system, implemented from a distance by relatively anonymous civil servants. Both systems, although limited by lack of funds and other such factors, work well. Mixing them, however, is tricky; the response of the farmer to a micro-approach may be incompatible with his response to a macro-approach. This will be returned to in the next section.

Now, we see that 'micro' is conceptually independent of physical scale. A worldwide scientific community of specialists is a micro-structure to its members. A multinational corporation drafting a cost-benefit analysis for a new investment is a single-actor situation, and the economy of it is rightfully called micro-economy. Even more importantly, we see that for explanatory work, the distinction between micro and macro is *actor-dependent.* For most individual people, for instance, war is a macro-phenomenon that just overcomes them. If we want to explain why a war has started and how it is waged, however, we should first look at who the actors are (the states, the generals) and then analyze the war as a micro-situation, a strategic interplay of actors responding to one other. The same holds, for instance, for the oil market. It is

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244 Emerson (1981) explains this difference in terms of the domains of economic (market) theory and social exchange theory, i.e. theory of the patterns of reciprocity between actors in social networks; Sahlin's (1974) "generalized exchange" is often seen as the 'most micro' form these exchanges may take. The concepts of Gemeinschaft and Gesellschaft roughly denote the same micro-macro distinction.

a macro-structure for almost all actors, but a micro-structure for OPEC member states.

As an example from the environmental field, consider the North Sea. For the individual fisherman, the North Sea fishery is macro-structure. His actions do not make a significant difference, either to the North Sea or to the other fishermen, whom he cannot influence or make some 'sustainability deal' with. For the states surrounding the North Sea, however, the North Sea is micro-structure. They could manage the North Sea as a commons, and why they do not do so must differ from why the fishermen do not.

Concluding, some social and physical structures, patterns and processes will always be micro to the actors that participate in them. The family, for instance, would not be family if it were otherwise. The 'perfect markets' of economy are always macro, by definition. For very many structures it is an open question, however, whether they are micro or macro for the actors under consideration. This also holds for the design of solutions. Sometimes, for instance, solutions are found through a micro-translation of macro-situations. We saw this, for instance, in the case of meadow bird protection. In other instances, solutions may be found by 'macro-ing' actors, so to speak, so that the problematic situation is made into a micro-situation[245]; national fishery organisations could, for instance, work out a non-governmental solution for the North Sea fishery problem.

Finally in Figure 5D, we encounter the deeper levels of the element headed 'interpretations' : the *'interpretative frameworks '* and *'self-image,world view '*.

Interpretative frameworks denote the patterns underlying the actor's specific interpretations in specific decision situations, e.g. the way the farmer sees his land (as a commodity, for instance, or as a source of craftsmanship's pride), the deeper images and meanings a commuter associates with his car, the actor's basic attitudes towards the government institutions he deals with, and so on. The 'domains' or 'modes' of moral reasoning, to be discussed in the next section, are another concept to describe interpretative frameworks. One step deeper lie the actor's self-image and world view, defined as the images of the fundamental structure of the self and of the world. Basically, these are what 'keeps the actor together' as an actor.[246]

Chapter 7 of De Groot (1992b) is largely a discussion of how to approach research in this field, so that there is no need not go into the matter here. The same holds for world views, Chapter 8 of De Groot (1992b) giving an overview of what they are and why philosophers and social scientists often identify them as a fundamen-

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[245] Or, as Section 5.8 puts it, the 'free access' macro-situation is changed into a 'commons' micro-situation.

[246] The concepts of 'interpretative frameworks' and 'self-image' have their counterparts in social psychology, namely, the 'self-schemata' and 'self-concept' of Markus (1977). In the words of Eiser (1986: 242), "self-schemata are defined as the cognitive structures embodying networks of meaning associated with particular attributes, that together coalesce to form the self-concept."

tal root of the environmental crisis. This section is therefore rounded off by a simple example from the commuter case, reasoning 'downwards' in four steps.

Arriving at the element 'motivations as perceived and valued' of Figure 5D in the course of a progressive contextualisation, we may find, for instance, that one reason for preferring the private car to the bus is that one always has to wait for a long time for the bus. Then, in the course of 'objectifying' this motivation, it may turn out that this waiting time is usually ten minutes, and also that in his private car, the commuter usually also has to wait ten minutes, stuck in a traffic jam. Obviously, in the 'interpretation' element, there are two types of waiting, a 'bad waiting' that tends to enlarge the 'objectified' waiting time, and a relatively 'good waiting' that tends to go unnoticed in the actor's primary accounts. What might be the more general pattern, the 'interpretative frame', underlying this? At this point, we may conjecture that the following difference between waiting for the bus and waiting in a traffic jam is significant. Waiting for the bus is waiting in the trust that others (the bus) will *come;* others are taking the positive lead; the waiting, we might say, is passive, receptive. Waiting in the traffic jam is waiting for others to *go,* and doing what we can to hasten this; the others are negative, stand-in-the-ways; the waiting, we might say, is active, aggressive. This conjectured dichotomy of interpretative frameworks may be empirically grounded in several ways. We may discuss it with the actors, or we may explore whether it also has explanatory value for other things the actors do, or we may try to find a correlation between the conjectured frameworks and other characteristics of actors, say, their age, class or sex. It does not seem unlikely that we may find the values our actors attach to the two types of waiting to be correlated with gender characteristics. If this were indeed be the case, we may pursue the explanation one step deeper, tying the interpretative frameworks to actors' self-images and world views in some more general masculine/feminine schema, as discussed in the next section and Chapter 8 of De Groot (1992b). That way, we would establish an empirical link between decisions of commuters and deeper, cultural phenomena ('roots').

Next steps

This section has been a step by step discussion of the 'going deeper' component of action-in-context, depicted in Figure 5D. In drafting that picture, I tried to accomodate all the basic concepts of relevant social science, but from then onwards, I paid more heed to Ockham's razor than to the law that everything is connected to everything else. In other words, the number of causal linkages between the elements (concepts) has been kept to a minimum. Roughly, I have emphasized the causal linkages that lead *directly* up to the decisions with respect to the action to be explained. Following these linkages downwards, one finds the options, motivations and so on as they happen to be at the time the decisions are made. For this reason, for instance, the large element of 'interpretation, interpretative frameworks, world view' stands unconnected to other elements in Figure 5D; actors are found to simply have them.

Obviously then, a next research step may be to ask how all these 'instantaneous' options, structures, interpretations etc. have come about. Then, causal linkages other than the ones depicted in Figure 5D may turn out to be relevant. Focusing for a while longer on the element of 'interpretations, interpretative frameworks' etc., the following influences may be identified.

- When actors find themselves doing something against their priority motivations or norms of appropriateness (for instance, because there is no other option), they may begin to ease this tension of 'dissonance' (Eiser, 1986) by adapting their moral norms or cognitive interpretations. In terms of Figure 5D, 'action' then influences 'interpretative frameworks', forming a feedback loop.
- Somewhat analogously, Elster (1989) states that actors may partly adapt their preferences to the opportunities they have. In terms of the figure, 'options' then becomes causally linked to 'motivations'. Also, Elster states, actors may partly adapt their social norms (in our terms, interpretations concerning appropriateness) to their motivations of self-interest (in our terms, advantage).
- At a deeper level too, structure of course influences culture (world views) in many ways. Class consciousness and cultural adaptations to the physical environment are examples.
- The same causal linkages work the other way around as well. Options, for instance, are created by what actors are motivated towards, e.g. on a small scale, by the continuous crop experiments of Third World farmers or, on a larger scale, by science and technology policies. Structure and culture 'reproduce' each other, remaining semi-autonomous at the same time.

A second example concerns the concept of environment as part of the 'structure' element in Figure 5D. This environment is defined primarily as the decision-relevant environment, as seen and valued by the actors.[247] The more actors one includes in the actors field (cf. previous section), the wider will become this "decision-making environment", as Vayda (pers. comm.) calls it. Still, it remains the environment as seen and valued by the actors. A next research step, then, may be to ask how this environment works or has come into being, irrespective of whether the actors are aware of these patterns and processes (e.g. sea currents or geological movements). Then, one moves into the wider context of the "explanatory environment", of which the decision-making environment is a subset.

None of these 'next steps', I should repeat here, are obligatory. Whether or not the researcher undertakes them is a matter of choice, to which end the guiding principles of Section 5.3 have been designed.

The action-in-context framework is sometimes criticized for being a-historical. The 'next steps' discussed above shed some light on this criticism. Action-in-context is indeed a historical in its primary round. Through both its 'actor field' and 'going deeper' components, one identifies and studies the relevant social world as it presents itself at the given moment of analysis, and there exists no prescription for proceeding

[247] EMIC, in Chapter 3.

further. The next steps, however, open up all kinds of ways for building historical explanations, all of which may be relevant within the bounds of the guiding principle criteria.

Let us, by way of example, consider the case of farmers growing rice in a swamp environment where growing coconut or gathering sago seems much more rational, both in economic and sustainability terms. It may transpire that the growing of rice is caused by outside political and cultural pressures, which in their turn may be explained, a-historically, through the options and motivations of the secondary, political actors in the actor field, as shown, for instance, by Persoon (1989) with respect to rice and sago in Siberut. In other cases, there may be no such identifiable pressures, as is the case, for instance, in West Sumatra, where Javanese immigrant farmers continue to grow rice in spite of rapidly decreasing yields, side by side with their Buginese neighbours who make a better and more sustainable living by watching their coconut trees grow (Tanaka,1986). In this case, explanations are historical; the Javanese reproduce a 'rice culture' that once was economic and sustainable in their homeland.

Another way to 'historicize' the action-in-context framework is by repeated, historical application. Taking another example from the Third World, consider the case of the Mandara mountains in North Cameroon, most of which are still densely populated and beautifully terraced, but from which people are migrating out to the surrounding plains, causing the terrace systems to fall apart (Riddell and Campbell, 1986). In such a case, a normal action-in-context analysis may of course yield much of the necessary explanation. More depth, however, may be gained by asking the question why the farmers ever moved to the mountains in the first place. Then, one can apply the action-in-context framework to the circumstances (options, motivations, environment, secondary actors, tenure, security etc.) existing about a hundred years ago. In terms of the guiding principles of Section 5.3, 'seeking contrast' may be seeking contrast through historical data.

Thoden van Velzen (1973) has criticized the actor-oriented approaches on four grounds:
(1) an "insular vision" of the actor, neglecting his bondages to wider society, (2) a "one-dimensional" view of the actor, planting in the actor only the advantage-seeking *homo economicus* type of rationality, (3) an a-historical approach and (4) a "taking for granted" of inequalities in society, mixed with a focus on the powerful only.

Looking back at this point at the action-in-context framework, we may note that the development and operationalisation of the actor field concept (Section 5.5) effectively seems to counter the first criticism. As for the second, it has already been indicated that there is no need to make *homo economicus* assumptions for the action-in-context framework to be unfolded; the next section will deal with this in greater depth. The third criticism can be qualified, as indicated above. The fourth criticism requires some attention here.

First, it cannot be said that action-in-context focuses on powerful actors from the outset. It starts out with the actors directly connected to the actions under consideration, be the commuters, women, small farmers or any other category. Subsequently, however, action-in-context is consciously designed to lead the researchers to the actors with power; the causal linkages of the actor field are power linkages by definition. That, after all, is what explaining social events and activities is all about'. In that sense too, inequalities are taken "for granted", kept away from the researcher's possible urge to change them. That urge, in the last resort, is better served by researching the patterns and workings of power than by disclosing the resources and networks of the poor, the powerless and the oppressed.

There are two ways to supplement (not alter) this basic standpoint. One is suggested by Thoden van Velzen and remains within the bounds of explanatory research. The other comes into focus when the matter is viewed at the level of the problem-in-context framework as a whole.

The suggestion of Thoden van Velzen is simply to pay more attention to actors (categories, groups, strategies) that do not enter the picture of power at first sight. On a second look, these actors may prove to have all kinds of more diffuse influences, e.g. by posing a constant risk that opposition may flare up. One then draws up a more subtle actor field than by considering the more visible actors only. An example of what Thoden van Velzen has in mind may in fact already have been given in our treatment of actor identification in the case of goat-keeping considered in Sections 5.5 and 5.6 with respect to gender and 'close actors'.[248]

Certainly not all social categories of potential interest can be drawn into explanatory research this way. With respect to many environmental problems, there will be categories of people that are just pawns or just victims, without significant power in reality and hence without explanatory power in explanatory research. At the level of the problem-in-context picture as a whole, however, we note that explanatory research (action-in-context) is not the only area of social science relevance; the full list has been enumerated at the outset of this chapter. The normative variables of problem-in-context provide a full opportunity for researching and visualizing people not only as problem causers but also, be they the same or different people, as problem victims and potential problem solvers.

In fact, many 'bottom-up' solutions to environmental problems are found by making actors out of pawns and victims.[249] Here, I may refer back to the concept of *potential actors* treated in Section 3.8.

In the previous section, it has been said that the primary actor field analysis may be rounded off by a *secondary analysis,* focusing, for instance, on the question to what extent identified actors belong to one or several elite networks. The same applies to the 'going deeper' analysis per actor. 'Next steps' of this kind are distinguished from

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[248] The identification of more diffuse and 'latent' actors may be seen as part of the guiding principle of giving contrast to the research data (Section 5.3).

[249] Analogously, many 'top-down' solutions are found by turning problem causers into (co-)victims, e.g. through levies, juridical liability or other means to 'internalize' the externalities of their actions (Section 5.8).

the preceding ones in that they do not entail the search for new data, but rather work as a rearrangement and reinterpretation of the data already found. Secondary analyses will be especially worthwhile when the actor field and the analysis per actor are combined, that is, after one has gained the overview of options, structure, interpretations and so on for all actors involved. Inspirations as to what secondary questions to ask will usually arise during the research. There follow some general examples of possible directions to take.

- *Role of the state.* Taking all government actors together, environmental and non-environmental, what is their impact? Do they work against one other? Do they exhibit a single frame of interpretation with respect to the problem? What categories of people (rich, poor, men, women etc.) are the prime beneficiaries of state action?
- *Macro-structural contexts.* Each actor will be connected to several macro-structural systems, processes, patterns; viewing these together, can they provide a joint description of 'the' macrostructural context? How do institutional, economic and geographic elements relate to one other?
- *Culture versus structure.* Which of these plays the most important role? Are they in some way, linked?
- *Micro versus macro.* Do micro-structures play a role significantly different from macrostructural factors? Could the strengthening or creation of collective actors be a policy option to 'microfy' the problem situation?
- *Roll-offs and dilemmas.* Which of them is the most important? Do they show an overall pattern (e.g. centre-periphery)? Do or could local commuties act as a shield against depletion of the environment by far-away actors who are unattached to the environment?
- Do *present policies* address the most important actors and factors?
- And finally, the general *round-up of options* for action and policy is the cross-over to the 'designing research' follow-up of the explanatory analysis, as discussed further in Section 5.8.

5.7 Actor Models

Actor models are more or less formal sets of ideas about how actors process facts and values to reach a decision. Obviously then, the application of an actor model is at the core of any actor-oriented explanation of environmental problems. Yet, it is not illogical that this section on actor models should follow the previous three, which laid down the core of the action-in-context procedure. As explained earlier, an actor model has in fact already been there all along, namely, the human-ness of the researchers themselves. Putting it in more direct terms, if you have not been at a loss for an actor model for understanding the preceding sections, this has been so because you have already taken yourself, supplemented with your everyday knowledge about other people, as the implicit actor model. Action-in-context can be fully elaborated simply with 'actor', not 'actor model', at the top of Figure 5D and all others.

There are three reasons, however, for including this additional section. The first is that it provides an opportunity to give a number of examples supporting my advice not to slip away too easily from everyday knowledge into one of the actor models prevailing in social science theory. The second reason is to explicate the basic content of these models and discuss their implicit consequences. And finally, I will try to formulate a 'model' of my own, not because it is something new with respect to your everyday knowledge, but because it is slightly more formal and theory-rooted, so that it may serve as a second step in a 'grounded' research approach.

Rational choice theory

Dominating social science theory from Hobbes onward (not only economics, but also sociology, social psychology and anthropology) is the model of the actor as *homo economicus*[250]. It roughly says that actors analyze each problem situation in terms

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[250] The environmental disciplines are no exception. Hawley's "compulsively expansive" actor has already been mentioned. Another interesting case is Hardin's (1968) "Tragedy of the commons". In environmental science circles, this article was not received as one inspiring view amongst others; it had a paradigmatic impact resonating to this day. Often, for instance, instruments for environmental policy are still conceptualized as only either coercion or incentives, that is, either taming the self-seeking, advantage-oriented actor, or influencing his balance of personal costs and benefits. Hardin's picture of the iron logic of the tragedy of the commons resonated deeply with the culturally rooted image of *homo economicus* as the bearer of true, real rationality (Goodin, 1982). Against this background, it is not surprising that the countless contributions toward more realistic theory (e.g. Runge, 1984; Galjart, 1982) and research exemplifying well-working commons (e.g. Cox, 1985; Shepherd, 1989) or large-scale organisations based on benevolence (e.g. Titmuss, 1973, comparing the English and U.S. systems of blood donation) were only slow to have an impact. We will have to live for a long time with ideas such as the one lamented by Kimber (1981) at the end of his analysis of 'rational' choice theory, "that the Council for the Protection of Rural England is really organized, not to protect rural England, but to provide wine and cheese parties for its members".

of costs, benefits and individual advantage. In a more detailed form, the model states that:

- actors have a number of clear-cut objectives and means to satisfy them;
- these objectives concern the actor's self-interest only, not other people's or the quality of relationships;
- these objectives are 'flat', one-dimensional; utility (advantage, gain) is what counts, not, for instance, care for others, trustworthiness or a special cause one may be dedicated to;
- the means are characterized by continuous 'utility functions', more of which always mean more satisfaction; actors, in other words, are insatiable, and scarcity is therefore a predominant feature of the world around them;
- decisions are not reached contextually (that is, staying close to the story told by the specific problem situation), but by weighing costs and benefits in an abstract calculus;
- this calculus is not assumed to describe one aspect of human reasoning, at work alongside others in a strength co-determined by the type of problem situation, but *the* human rationality, of everybody, fully, all the time.

At the collective social level, the model automatically gives rise to the picture of the isolated, expansive ego surrounded by other isolated, expansive egos in an environment of scarcity. Actors then have to be protected against one other by assigning to them not only rights, but also obligations. Conflicts between actors are then adjudicated through another abstract calculus, which is the collective-level counterpart of the individual-level *homo economicus,* the 'ethics of balancing rights and obligations'. These ethics will be discussed later in this section, contrasted with the contextual 'ethics of care'.

The *homo economicus* actor model is usually referred to as *rational choice theory*. It implies that if you approach a problem situation in terms of, say, compassion, self-esteem or the protection of a collective good, you are either considered irrational or you are confronted with a *homo economicus* theory stretched to such limits that it encompasses everything, e.g. telling you that you obviously have a psychic need to be compassionate out of self-interest, and that you obviously have calculated and weighed the costs and benefits of satisfying it.[251] The term 'rational choice theory' also illustrates the model's normative tinge: all people, including policy

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[251] See, for instance, Goodin (1982) about the 'internal cost of lying'. Most of the 'attitude and behaviour' models of social psychology belong to this 'stretched homo economicus' class, in which moral considerations are 'egotized' by including them in the cost-benefit balance; see, for instance, Eiser (1986, Chapter 4, especially p. 64). These models, because of their broader character, require more data gathering but are subsequently better predictors than the strict 'economicus' model. Discussing them does not serve heuristic purposes in this section; they may be taken as a 'third stage' model in the sense explained later in this section.

makers, *should* describe and handle problem situations the flat *homo economicus* way.[252]

In many respects, flat man theory looks like flat earth theory; that theory is also good enough in some cases, and it, too, can be stretched very far to 'explain' ill-fitting facts in ever more far-fetched and complicated arguments. Once caught into the flat man theory web, social scientists usually do not escape; let me take Douglas (1987) as an example here.

The major theme of Douglas' book it set by the observation that

> "The theory of rational choice, developed on the axiomatic structure [of the sovereign individual] has unsuperable difficulties with the idea of solidarity" (p. 8).
>
> "Something is going on in civic affairs that the theory of rational choice does not capture." (p. 30).

Thus, the creation of collective goods cannot be accounted for in current rational choice theory. Usually, Douglas goes on to say, theorists who acknowledge this restrict the domain of rational choice theory, exempting from it the small-scale organisations[253] in which "interpersonal effects" may arise (p. 21). Douglas rejects this exemption. With this, I basically agree; if other rationalities accompany the *homo economicus* in micro-situations, there is no reason to assume that they would not do so in macro-situations, especially when research suggests that they do.[254] Douglas, however, arguing that rational choice theory is the only possible basic model[255], proceeds to subsume also all micro-situations under *homo economicus* reasoning:

> "The individual cost-benefit analysis applies inexorably and enlighteningly to the smallest micro-exchanges." (p. 29).

Then, what is it that rational choice theory does not capture, in micro as well as macro situations? What, if not 'interpersonal effects', can account for the creation of collective goods? *Trust* is what does it, Douglas states, the "certainty about the other person's strategies" (p. 55), What is the basis of this certainty? Shared knowledge and shared beliefs, a "system of knowledge" (p. 30). And how does a system of knowledge arise?

> "How a system of knowledge gets off the ground is the same as the problem of how any collective good is created." (p. 45).

Then, how are collective goods created? There is no answer. There cannot be, because this is the very problem the analysis started out with. As Hechter (1990) concludes, "the chasm between the [real-world] issues and the game-theoretic analyses [of

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[252] It is, of course, also because of this normative tinge that homo economicus theories should be approached critically. That is not my argument here, however.

[253] Roughly, the 'micro-structure' of the previous section.

[254] See, for instance, Titmuss (1973), Kimber (1981) and the bee programme quoted in Chapter 6 of De Groot (1992b).

[255] For reasons I will set out later.

rational-choice theory] seems no less wide today, after a long period of research effort, than it was more than a decade ago".

The theory of the flat *homo economicus*, like flat earth theory, goes round and round, or winds up in impossibly complex explanations for the simplest of things. Flat earth theory has an alternative, in which the earth is round and the reasoning is 'flat': it easily accounts for both the flat-earth experience of daily life and the more general, scientific observations. A 'round man theory', analogously, assumes people to be 'round', not one-dimensional, in order for theoretical reasoning to go 'flat', accounting for everyday experience and also providing a broadened basis for theoretical understanding.

Contours of an alternative

An actor model that more fully acknowledges what is human may be built up by distinguishing between different modes of describing situations of choice and deciding upon them. Elster (1989), for instance, asserts the reality and autonomy of reasoning in a 'social norms' domain, as opposed to reasoning in a 'rational choice' mode. Analogously, Goodin (1982) distinguishes 'moral domains'; Jack and Jack (1989) speak of 'moral visions'; Cheney (1987) of different 'ethics'. *Homo economicus*, accompanied by its collective-level 'ethics of rights and obligations'[256], will certainly be one of these modes or domains, because it is an obviously consistent mode of reasoning that plays a role in many of our decisions. The contours of two other modes may be intuited from Douglas (1987), by looking at some terms in which she frames her problem with rational choice theory and its 'solution'. *Solidarity* is a problem, *trust* a solution, and this solution is reached "without invoking (...) a need to maintain *self-esteem* or the pleasure *of giving*." Associating solidarity with giving[257] and trust with self-esteem for reasons and in ways I will elaborate later, the following three moral modes or moral domains (ways of describing and acting upon problem situations) may primarily be distinguished:

- 'homo honoris' mode (H): self-esteem, trustworthiness, wish to be respected by others, ...
- 'homo economicus' mode (E): self-interest, costs and benefits, abstract calculus, ...

[256] Strictly speaking, homo economicus could be called the negation of being ethical or moral. Yet loosely calling all domains 'ethics' or 'moral modes', I comply with the above authors. The formal definition of the domains, however ('modes of describing ....' etc.), is independent of what one considers to be moral or ethical.

[257] See, for instance, the gift economy, associated with the ethics of care, versus the market economy, associated with the ethics of rights and obligations, in De Groot (1992b, Chapter 8).

- 'ethics of care' *mode* (C): community, partnership, responsibility, contextual 'calculus',. . . . .[258]

Below, I will formalize these three somewhat more exactly and put them in an overall picture. First, however, I will give them more substance by means of a few examples. The examples, in a way, advertise the 'honoris' and 'care' rationalities.[259] This is because 'economicus' is already being advertised sufficiently, not because I think that the 'honoris' or 'care' modi are intrinsically better, morally. (Endless and violent family feuds, for instance, may be geared by 'honoris' reasoning. Care may come in contents and intensities with which children are choked rather than developed.) The examples begin with three typical everyday statements and conclude with five more complex cases from the literature. The capitals H, E, C refer to the three modes of reasoning.

(1) "I wish I were home...." (That is, a place where one is respected (H) and cared for (C) for what one is; *homo economicus* has no home).

(2) "A man of honour, a real leader, just doesn't do a thing like that." (H).

(3) "Arranging things this way seems quite efficient when considering the two of us separately (E), but at the same time, we won't really *meet* any more then." (C).

(4) DiMento (1989), reporting on the behaviour of business firms (which one would expect to be very E-inclined actors) has already been quoted with respect to the difference between the response to criminal and civil sanctions, a typical H-induced difference. Other H-influences on the compliance to environmental regulation are the findings that compliance decreases if "environmental commands to highly paid, highly respected corporate executives are created, communicated and enforced by people with lesser status"; but "administration that appears informed, fair, efficient and smooth generates respect for the regulator." In a 'honoris' perspective, giving in is often not so difficult as it may seem, but only if a respectable adversary allows for a honourable peace.

(5) In the Third World, rice grown in large-scale irrigation schemes is usually a men's crop. Siriwardena (pers.comm.) indicated that what happens to the money paid out to the men in one of these schemes depends largely on the social situation. If paid out to the men in the field, most of the money is spent on drink and showy personal articles, fostered, as we may imagine somewhat speculatively, by an all-male 'H-atmosphere'. If paid out inside the home, the money seems to enter into a different moral domain, and is shared with the family without quarrel (C). A difference like this could never be explained by assuming a single E-domain, since they are the same men with the same objectives, the same money and the same opportunities to spend it.

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[258] It may be noted that I here do not follow several other possible classifications of domains, e.g. (1) the anthroposophical triplet of economic sphere/legal sphere/cultural sphere, or (2) the classification of homo religiosis/estheticus/faber, or (3) quadruplets related to Parson's AGIL scheme or 'media of interchange'. My reasons here are largely intuitive, relating to heuristic value, pervasiveness and relevance.

[259] For other C and especially H examples, see Elster (1989: 107-125).

(6) Jack and Jack (1989) investigated the distribution of two types of moral reasoning, the 'ethics of rights and obligations' (E at the collective level) and the 'ethics of care' (C) in a sample of U.S. lawyers. They found a statistical tendency for E-reasoning to be stronger in male lawyers and C-reasoning to be stronger in female lawyers, but also found that across their whole sample, responses to moral dilemma situations shift toward E in criminal law cases, and toward C in domestic law cases. Thus, people display a certain personal preference for processing problems in one moral perspective[260], but their moral responses also depend on which perspective the problem situation appeals to, analogous to the domain of 'entry' in the previous example.

(7) In the case of the Aguaruna manioc growers quoted in Section 5.2, we have seen that for the top four varieties, an E-strategy is followed. With respect to the rest of the manioc varieties, a generalized diversity pattern exists, associated with actors taking pride (H) in being a provider (C).

(8) Bolhuis and Van der Ploeg (1985), based on research in Italy and Peru, found that fanners, even when working under equivalent circumstances of markets, soils and so on, follow two contrasting farming strategies, "conceptualized as coherent patterns of interconnected folk [= emic] concepts used by farmers to interpret the conditions under which they operate, and to structure their labour process" (Van der Ploeg, 1986). The first strategy, called "I-domain", focuses on high and stable yields, to be reached through craftsmanship and care for the land ("cura" is the Italian term); it is C in my terminology. The second strategy, called "E-domain" coincides with what is also E in this section; in this reasoning, profit is the objective, land is only a commodity among others, and the basic strategy is flexible response to external market fluctuations.[261]

Up to now, matters have been described in terms of 'modes of reasoning', 'domains', 'calculi', 'perspectives' and similar concepts, all indicating that the basic picture is of more or less self-contained frameworks of interpretation that cannot readily be mixed or added up. If you see the world in one perspective, you cannot see it in another at the same time; if a problem situation is 'processed' in one domain, it cannot be in another. If you relate to somebody else as a friend (C), you cannot at the same time ask direct financial payment for everything you exchange (E).[262]

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[260] Jack and Jack's sample, roughly speaking, was single-culture and single-class. It is likely that other samples will display not only a gender influence on moral mode preferences, but also class and culture predispositions (Komter, 1985).

[261] Interesting but more complex parallells exist between H-E-C and Sahlin's (1974) three modes of reciprocity.

[262] This basic intuition is also visible in the Annex of Chapter 6, dealing with a participatory environmental programme in the Third World. There, it is simply stated that, if trusted, we will feel pride in being trustworthy (H), and if approached as homo economicus, we will start looking for gains (E).

Jack and Jack (1989) show empirically that people indeed follow different thought patterns depending on the type of case and context. The elements in these thought patterns (world view, type of responsibility, problem solving strategy etc.) cohere together within the pattern much more strongly than with outside elements; the patterns are thought *systems* in the true sense of the word. At the same time, Jack and Jack show respondents to be able to 'run' a specific problem situation through more than one thought system and somehow combine the outcomes in their final decision. How the choice and combination of calculi takes place remains unspecified.

Goodin (1982) gives an exploration concerning this question. Contrasting the domain of homo economicus with a domain of "taking morality seriously", his division of modes of moral reasoning is different from the H-E-C-scheme I use here. In the examples he gives from the "taking morality seriously"-domain, however, much of what is C-reasoning here shines through[263], as well as some H-elements. First, Goodin shows how rational choice theorists have tried to incorporate moral reasons in their E-models, as a simple addition to the costs and benefits balance. Then, quoting examples from daily life and social psychology, Goodin states that people do not work that way: "taking morality seriously" cannot be mixed with cost and benefit reasoning. A host (H) may go to almost any length to attract and please guests, but never offers money (E). Conversely, too, when financial incentives become attached to voluntary moral action, the action becomes "polluted", as Goodin calls it, and the action may simply be dropped. Money and "taking morality seriously" are incompatible. Goodin emphasizes this non-additionality, against the prevailing cost-and-benefit models, concluding that "material incentives destroy rather than supplement moral incentives". On the one hand, some of the examples in the (1) to (8) list above support this conclusion (e.g. in Bolhuis and Van der Ploeg: if farmers become more incorporated in the market-economy (E), land becomes a commodity, shifting from the C to the E-domain).[264] On the other hand, Jack and Jack and other examples suggest that Goodin is overstating his case[265]. It is unlikely, for instance, that DiMento's "people of lesser status" will be able to switch an executive's reasoning to a purely H mode; probably, H-elements here add on to or subtract from an E-oriented basic reasoning. Analogously, Vermeulen (1991) found that personal contact between executives and regulators had an additional effect on the effectiveness of an environmental subsidy.

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[263] Goodin's work was written before the publications of Gilligan (ref. Chapter 12), on which the 'ethics of care' formulations of Jack and Jack and many others are based.

[264] The field experience mentioned in Kerkhof (1990), that farmers may prove to plant more trees if financial incentives for tree planting are removed, points in the same direction. Eiser (1986, Ch. 4) reports a number of social-psychological experiments in which incentives resulted in a reduced task output, because external incentives destroy internal motivations for the task.

[265] Possibly, this is also caused by the difference in defining the domains. In the H-E-C-scheme, for instance, the 'ethics of rights and obligations' that goes with the E-mode at the individual level is not intrinsically less seriously moral than, for instance, the 'ethics of care'.

All in all, we have now arrived at a basic idea of three domains of interpreting things and situations, and a basic intuition that the character of these things and situations somehow influences the domain in which they are treated. Moreover, the domains seem to be partly separate, but also to partly overlap, forming areas of more mixed, 'additional' reasoning. The middle picture of Figure 5E is an attempt to visualize this.

Before moving to a discussion of Figure 5E as a whole, two questions will be briefly addressed:

- why three moral domains, and why *these* three?
- and what are they, in more detail terms than the suggestions given until now?

I have opted to take three interpretative perspectives basically in order to avoid the suggestion of a rounded-off, closed pair, logically and substantively; three is the 'open' number. My three, I think, are real and they are important, but that does not imply that there are no others equally real and important, depending on the research problem or the cultural context. In the next chapter, for instance, focusing on interpretative thought styles specifically with respect to nature, we will distinguish between six views on the relation between the actor and nature, under which three more basic 'ethics' will shine through: 'rights and obligations', 'care' and another one, which is not the third one of this section.

In the H-E-C-scheme, E and C have been chosen because of their linkages to theory and empirical research. *Homo economicus* (rational choice theory; the ethics of rights and obligations) is the touchstone which no serious research and critique can ignore. The 'ethics of care' is an offspring of feminist research and theory building, the best summary of, as Gilligan (1982) puts it, the "other voice" (of women, and inside all of us). Putting in *homo honoris* is a more personal choice, supported by Elster (1989), whose list of social norms comprises many 'honoris' elements (codes of honour, work norms etc.). *Homo honoris* is certainly not an all-male affair, as shown (in my culture) by the struggle for female self-esteem. Also, as suggested for instance by the 'mother-mill' example in the Annex 6.I of De Groot (1992b), women have their own ways of showing off amongst themselves. Furthermore, homo honoris is not necessarily a marginal, additional-only set of reasons and ways. In the European Middle Ages, chains of reciprocal words of honour were the very backbone of society, running all the way from the emperor down to the peasant. In the summary of Ryan (1970):

> "Thus in Marx's analysis, it was not mere prejustice which made the feudal nobility see the world in terms of reciprocal obligations, sanctified by Catholicism and adorned by the morality of courtly love, chivalry and honour. (...) To see personal allegiances, not in terms of honour but on the basis of profit and loss would already be to be a bourgeois".[266]

Inclusion of the *honoris* mode of defining the world and acting upon it may facilitate the understanding of actors anywhere. It may also facilitate a more general 'cultural

[266] For a wealth of details on medieval social structure, see Bloch (1961).

jump'. Almost certainly, I would guess, for instance, *honoris* reasoning can be shown to be statistically more prevalent in the cultures, Catholic and Islamic, around the Mediterranean than it will be around the North Sea.

Now, we arrive at the more formal substantiation of the three moral domains. For the *economicus* mode, I focus on the collective level here, since the individual (lone actor) model has already been mentioned at the beginning of this section. In the following table, E and C have simply been taken from the literature; the H characterizations are more home-spun, supported by Elster (1989) and the previous examples. Because of its source in non-environmentally oriented research, the table does not speak explicitly about the environment, excepting the ecosystem concept in the C-column, where it stands as a metaphor of people-to-people relationships. This does not impinge on its value, however. Firstly, much of what happens to the environment is caused by people-to-people affairs. Secondly, as we saw already in Bolhuis and Van der Ploeg, the environment (in their case, land) is implicitly included in the moral domains, in ways not essentially different from other actors or purely social problem situations. Below, I will explore this somewhat further.

In its *sustainability* aspect, the environment takes on the face of future generations. The morality of rights and obligations frames the future generations phenomenon in an abstract, formal language of rights, and arrives at an abstract, formal problem (e.g. Parfit, 1984): how can people that do not exist have rights? How can we then have an obligation toward them?

In order to see how future generations function in the ethics of care perspective, we may compare them to another type of 'non-actors' in the ethics of rights perspective, namely, animals and young children (non-rational, non-autonomous). With respect to them, the ethics of rights poses an analogously problematic question: how can such beings have rights? Now, imagine two parents standing before their new-born child. If you, as they, stick to this concrete situation (and contextual reasoning means sticking to the concrete situation), you see that nobody will frame abstract questions about rights or care (e.g. how can care be?) at all. *Appropriate* care is the question here (to be answered contextually), not care as such. Going back to future generations, the question for actual parents standing before their actual child is not essentially different from questions of parents-to-be about their future children, or the question our parents had with respect to us, or the question of all of us standing before all of them yet to come. Care can be appropriate or inappropriate care, but the web of care spreads in all directions, in time as it does in space.

Apart from this time dimension, the environment may be separated into its *instrumental* function (use, utility, resource) and the *intrinsic value* of nature (ref. Chapter 4). In De Groot (1992b), Chapter 8 goes much deeper into how these relate to the moral domains, but roughly the following may be said.

Calling something a utility, a resource, is already framing your relationship to it in the E-mode. In an ethics of care perspective, 'using' somebody or the environment is appropriate if it serves, as Ebenreck (1983) states, "to bring into action and service" without doing harm, in a working-together relationship; see also the Bolhuis and Van

THREE MORAL ORIENTATIONS ('DOMAINS')
Source of E and C: Jack and Jack (1989)

	Morality of rights (= *homo écono-micus* at the collective level) (E)	Morality of care (C)	Morality of honour (H)
Social world	Autonomous, separ-ate individuals, mar-ket economy	Interdependent web of (boundaryless) community, gift economy	Bounded own group (kin, profession etc.), word of honour, godfather-ship etc.
Driving social force	Competition, gain	Cooperation, compromise	Self-esteem, group pride; 'noblesse oblige' (duty to care)
Moral problem	Conflicts of rights and obligations between separate individuals	Conflict of responses in network of relationships	Loss of face, disintegration of group, endless feuds with outside world, failure to defend the weak
Moral goal	Fair resolution - maintenance of rules	Avoid harm - maintenance of relationships	Honourable peace - maintenance of group structure
Values	Rights, obligations, fairness, due process	Harmony, empathy, community, active response to others	Respect, loyalty, chivalry, trust-worthiness
Reasoning	Formal, abstract, hierarchial, objectifying	Personal, contextual, holistic, engaged, future-oriented	Formal, dichot-omous, subjec-tifying, code of conduct
Symbol	Balance scales of justice	Ecosystem in har-monious equilibrium	?

der Ploeg example about land as a commodity (E) and as an object of artisanal ('working together') pride (C).

The intrinsic value of nature is not acknowledged in some E-variants, but if it is, the basic connotation is with 'rights of nature' or a generalized 'right to live', which then becomes operationalized in formal, non-contextual (situation-dependent) scales of rarity and naturalness often encountered in environmental impact statements. In an ethics of care perspective, nature is, if the interpretations in De Groot (1992b, Chapter 8) are correct, the nature of partnership, to which we respond contextually, within a basic framework of closeness and non-dominance.

How the environment might function in the *homo honoris* morality must remain more speculative here, as were the other *honoris* characteristics. Some parts of the environment, it seems, may be taken up in the strong commitments of internal *honoris* bonds ('My home is my castle'; 'our land', 'our soil'). Other parts of the environment may be taken up in the externally oriented 'noblesse oblige' aspect of *honoris* morality; the fact that man is more perfect, more noble than nature entails a duty to defend it and care for it, as the very expression of that nobleness.

Now, Figure 5E emerges. Its main structure shows three circles, indicating three degrees of having a formal actor model, coinciding with three stages in what has been called a 'grounded' research approach, which starts out as far away as possible from theoretical presumptions. The circles represent the actor, the model is written inside.

In the first stage, the 'model', as has been explained, is basically *you*, that is, putting yourself in the place (aim, options, frame of mind, context etc.) of the actor. The figure makes explicit two obvious criteria for doing this properly: the "you" should be "reflective" and "generalized", that is, trying to take a fresh distance from time to time, self-critical, discussing findings with colleagues, checking interpretations with the actors themselves, keeping track of one's own normative position, and so on.

In many cases, no other actor 'model' will be necessary. In applied research, sufficient insights may have been gathered for understanding and acting upon the problem situation at hand. Pure-science studies, too, often stick to this level. As shown by Glaser and Strauss (1976) and many others from the qualitative sociology field, one can follow grounded paths of re-interpretation and interpretation-led re-sampling without a formal actor model, and still generate theory. In De Groot (1992b, Chapter 7) it is discussed that methods of hermeneutic research can safeguard scientific validity without taking recourse to generalized, nomothetic methodologies.

In many other cases, it will be appropriate to try making the explanations more *critical*, more *general* or more *theory-linked*. Then, once a basic understanding has been reached using the "you-model", one may move to the middle model of Figure 5E, the picture that has been the subject of this section. It has the following characteristics:

- the three domains of reasoning, H, E and C, are drawn inside the actor
- they partially overlap, acknowledging the fact that it will sometimes not be possible or feasible to allocate reasons to precisely one domain, and especially the fact that responses of actors are often not strictly in the H, E or C domain, as

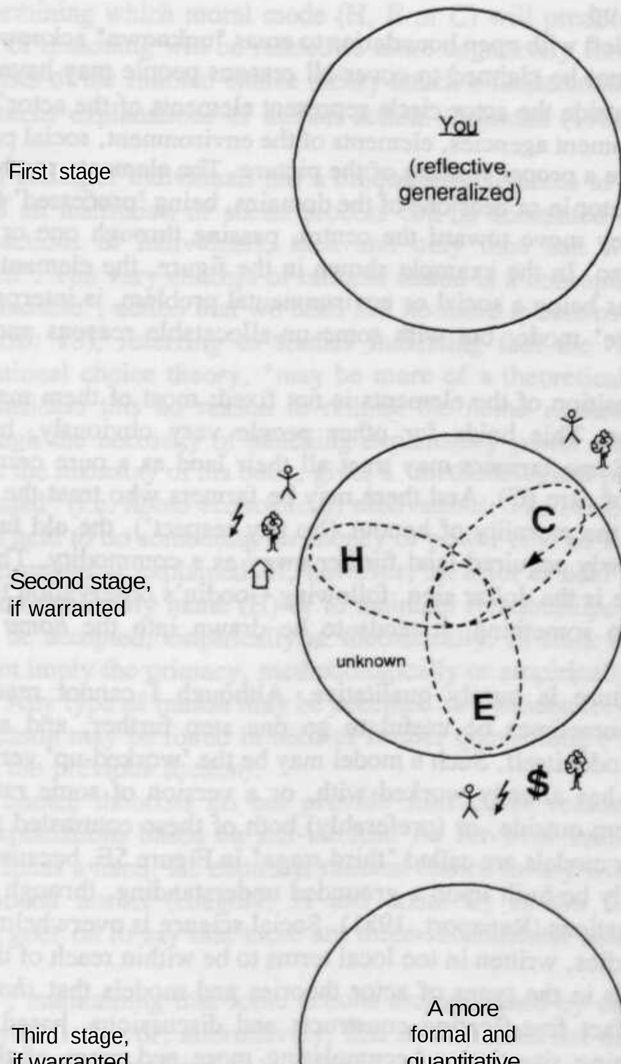

Figure 5E

Three possible stages of actor model in a grounded explanatory approach. H, E and C denote the 'honoris', 'economicus' and 'care' moralities, respectively.

discussed earlier, but to some extent mixed, with considerations from different domains adding up

- the domains are left with open boundaries to areas "unknown" acknowledging that H, E and C cannot be claimed to cover all reasons people may have.

The little symbols outside the actor circle represent elements of the actor's life-world (other people, government agencies, elements of the environment, social problems and so on). They facilitate a proper reading of the picture. The elements can be conceived of as 'entering' the actor in or near one of the domains, being 'processed' (interpreted, decided upon) as they move toward the centre, passing through one or more other domains as they do so. In the example shown in the figure, the element symbolized by the tension sign as being a social or environmental problem, is interpreted largely in the 'ethics of care' mode, but with some un-allocatable reasons and E-oriented reasons additional.

Note that the position of the elements is not fixed; most of them may be treated in different domains. This holds for other people very obviously, but also, for instance, for land. Some farmers may treat all their land as a pure commodity (E), others as an object of care (C). And there may be farmers who treat the land around ancestral shrines in the morality of honour ('to pay respect'), the old family land in the C-mode, and newly acquired land further away as a commodity. The only fixed element in the figure is the dollar sign, following Goodin's observation that if money becomes attached to something, it tends to be drawn into the *homo economicus* domain.

The H-E-C-picture is purely qualitative. Although I cannot readily imagine examples, it may sometimes be useful to go one step further, and also formally quantify the actor model itself. Such a model may be the 'worked-up' version of some H-E-C-scheme one has already worked with, or a version of some rational choice model borrowed from outside, or (preferably) both of these contrasted to one other.

Quantified actor models are called "third *stage*" in Figure 5E, because empirically valid results can only be built upon a grounded understanding, through stages 1 and 2, of real-world situations (Rapaport, 1981). Social science is overwhelmingly rich in 'first stage' case studies, written in too local terms to be within reach of theory. Social science also abounds in the types of actor theories and models that *should* be 'third stage', but are in fact free-floating constructs and discussions, based, at best, on laboratory and gaming situations. Accumulating more and more of these is easy. Progress, however, comes by making the connections, through the middle level.

The position of the H-E-C model

In this final subsection, I will explore how the H-E-C model relates to a number of other areas of social science theory. First, we will renew a discussion started in the first subsection, concerning the absolute primacy given by theorists to the 'rational choice' mode of reasoning (E). Via a brief speculation about the reason behind this preoccupation we arrive at theories giving primacy to cultural factors instead of the ('structural') *economicus* factors, and the question whether there might be some 'rule of rules' determining which moral mode (H, E or C) will predominate. Finally, the moral modes of reasoning will be related to more cognitively formulated modes.

Protagonists of the rational choice theory attach a fundamental superiority to the *homo economicus* explanations of human action. Coleman (1986: 1), for instance, asserts:

> "Rational action of individuals has a unique attractiveness as the basis for social theory. If an institution or social process can be accounted for in terms of the rational actions of individuals, then and only then can we say it has been "explained". The very concept of rational action is a conception of action that is "understandable", action that we need ask no more questions about."

Hechter (1983b: 18), referring to studies indicating that the 'free rider', a core element of rational choice theory, "may be more of a theoretical than an empirical problem", considers this no reason to rethink the *homo economicus.* Even Elster (1989), although the necessity of attaching explanatory power also to 'non-rational' motivations is the mainstay of his book, gives a "methodological primacy" to "selfish, outcome-oriented" (i.e. *homo economicus)* motivations. The basic picture is thus that if any actor is held to do something for money or power (E), no further questions are necessary; the matter is explained. If, however, an actor is held to do something in order to defend the family name (H) or to maintain relationships (C), these answers cannot really be accepted, empirically or theoretically. In stark contrast, the H-E-C model does not imply the primacy, methodologically or empirically, of any one mode of reasoning. Any type of reason may be accepted as a satisfactory explanation; also, any type of reason may be found in need of further questioning ("going deeper" as it was called in the previous section).

Rational choice theorists do not provide substantive reasons for the primacy attached to explanations based on self-interest. As for what such reasons might be, Elster (1989) lends a hand. He contrasts rational choice theory with theories that give primacy to social norms (roughly, H and some C) as the final explanation of action[267], and goes on to say that there are three fundamental solutions to this opposition:

- "eclectic", maintaining that some actions are explained by one theory and other actions by the other or, alternatively, that most actions are determined by both
- reducing norm-oriented action to a form of self-interested action
- reducing self-interested action to a social norm among the others.

Obviously, the H-E-C approach represents the first of these positions, as does Elster.[268] The term "eclectic" is not very fortunate one here, however; H-E-C does not allow one simply to opt for any mode of explanation that is to ones' liking, but obliges the researcher to show empirically which mode or what mix holds true.

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[267] Theories associated with Durkheim, Weber, Polanyi, Parsons and symbolic interactionism (e.g. Cardwell, 1971).

[268] Somewhat inconsistently with his own "methodological primacy" of rational, selfish choice.

The third position is untenable in the sense that it does not solve anything with respect to empirical research. Even if it were true that present-day Western culture is constantly engraining in us the social norm that acting out of self-interest is the only acceptable or true reason for acting, it still does not solve the question of why in many instances we do not act (only) out of self-interest. Yet, the third position gives us the insight that rational choice *theory* may indeed be an expression of that very culture: only a basis for action rooted in the self-interest of the alineated, male, Cartesian ego does not require further questioning.

The H-E-C model, as said, does not provide an overall rule for ascertaining which mode of reasoning the actor will follow to interpret a given thing, person or problem. Figure 5E has only taken up Goodin's principle, that may be summarized as "if $, then E"; all other connections remain to be established in the research. Thus the model does not include a 'rule of rules'; it is not a Unified Theory, so to speak. For Douglas (1987), quoted already in the first subsection, this has been the reason for rejecting H-E-C-like theory. In more detail, she writes:

> "We can sweep away any invoking of processes that encourage self-sacrifice because it satisfies a psychic need to maintain self-esteem [H, we would say] or provides the pleasure of giving pleasure to others [C, we would say] (....) If they work sometimes and sometimes not, the question is just pushed back into the form of asking what switches on the public-spirited emotional attitudes."[269] (p. 31).

Douglas then, as might be expected, takes up Elster's second position, sweeping the H and C domains out of the realm of theoretical and empirical inquiry and installing *homo economicus* as the model that should explain everything, "down to the smallest micro-exchanges". But let us ponder for a moment her question of what "switches on" something for treatment in the H, E or C mode.

Throughout this chapter it has been suggested that some 'rule of rules' does seem to exist, an intuitive idea of what leads things to be interpreted in one moral domain rather than another. I indeed think there does, but of an empirical status that makes it dangerous to use it as a guide or assumption in research. The 'rule' is an extension of Goodin's principle, and may be formulated thus: actors tend to interpret things and situations in the moral domain, signalled as the appropriate domain by the thing or situation itself. Thus, an E-response to a financial incentive system, a C-response to a child in acute danger[270], an H-response to derision of a national symbol, as well as the everyday wisdom that people will respond to you in the mode that you emanate yourself. The weakness of this rule may be demonstrated by the response to children. On the one hand, we have, for instance, Cheney (1987), Jonas (1979) and Norton (1991), who take children as a prime example of 'things' we treat in the 'ethics of care' (C) domain; this is supported by the empirical finding of Jack and Jack (1989)

[269] Douglas is here focusing on the question of how to explain the creation of collective goods. Hence the positive framing of what she sweeps away. In the H-E-C-scheme, H and C are not 'public-spirited' only.

[270] Confucius' 'proof of the goodness of man.

that lawyers indeed tend to this moral mode in cases of child custody problems. On the other hand, we have Tierney (1986), who found that women may account for the number of children they wish to have in purely *homo economicus* terms (the child as an investment that pays off later). Note also that financial incentives, children and national symbols are in themselves very strong 'expressers', contrary to many things in the environment.

In physics, there was once a time that atoms were found to be built up of neutrons (N), electrons (E) and protons (P). Everybody was proud of this N-E-P-model, and rushed to research it in order to underpin, specify and falsify it. Nobody thought of rejecting the P-E-N-model because it was unknown what switches something on to be a N, E or P. On the contrary, the more unified theories now slowly emerging, beginning to grasp some elements of what switches things on to be an N, E or P, are unthinkable without the hundreds of scientists who have researched and discussed the N-E-P-model. Humans being immensely more complex than neutrons, should social science be ashamed if its own unified theory takes a little longer?

The last issue of this subsection is related to the fact that H, E and C, or any variant of these, are primarily defined as *moral* modes or domains. Does this imply that the actor's *cognitive* frames of interpretation are outside the H-E-C-scheme? In other words, is the H-E-C-scheme confined to how actors choose among things, not touching upon the 'data' the actors gather and how they arrange these data into a choice-relevant pattern? This is only *partially* so. Moral modes are perspectives telling the actor what in the outside world is important, and thus what information to look for and how to process it. The E-mode 'prescribes' looking for costs and benefits and putting them in a balance. The C-mode 'prescribes' looking for relationships and putting them in a more narrative, contextual account. In Jack and Jack's research, the E-mode proved to be more past-oriented (who is to blame?) and the C-mode more future-oriented (restoration of relationships). Thus, moral modes, in H-E-C or any other arrangement, automatically incorporate many cognitive elements.

On the other hand, there certainly are cognitive ways of perception that I cannot imagine as being related to moral modes. A well-known example is the fact that people tend to interpret random phenomena as cyclical (e.g. taking a probability of once in a hundred years as a repetition of once every hundred years). Another example of 'cognitive heuristics', as Eiser (1986) calls them, is that people tend to prefer and remember causal relationships rather than statistical relationships in explaining events. These matters will always remain an additional source for explaining people's actions.

At a deeper level than perceptions and heuristics but still in the primarily cognitive realm lie what one may call 'cognitive modes' or 'cognitive frames', the cognitive counterparts of the moral domains this section has discussed. One example is what is often said to be the 'nomad way' of visualizing the world, as opposed to the agricultural and urban outlooks. The 'nomad world' does not consist of a pattern of land *areas*, but of a network of *lines and places* (Chatwin, 1987). Another example is our habit of thinking that to be scientific, we have to conceptualize almost everything as *systems*. Because of their relatively fundamental character (depth), these cognitive modes 'attract' values, as it were. Hence, matters are reversed with respect to the moral modes. Moral modes are primarily evaluative and thus partially prescribe what we see; cognitive modes are primarily ways of seeing and thus partially prescribe what we value. Therefore, contrary to the relatively shallow matters of perception, explaining actions by means of cognitive modes stands in a more or less competitive relationship to the moral modes approach for explaining what actors do.

The deeper one goes, the more one enters into the realm of what actors hold to be the fundamental structure of the world and the self (world views and self-image, in Figure 5D), and the more the cognitive and the moral fields will coalesce.

5.8 Round-up: Policy Options

Generally speaking, every actor and every factor influencing a problem-relevant activity is liable to be influenced in order to change the problem-relevant activity. This then holds for all actors identified in the actor field connected to the problem-relevant activity (Section 5.5) and all factors on which the choices of these actors depend (Section 5.6).

As an illustration, let us briefly focus on the "autonomy" factor, visible in Figure 5D. *Ceteris paribus,* that is, keeping constant all other factors such as the actor's motivations and potential options, the actor's choices will tend to become more environmentally friendly if we increase the actor's implementatory capacity (autonomy) with respect to environmentally friendly options the actor is motivated towards or, conversely, decrease the actor's autonomy with respect to the environmentally damaging options. In the first area (simply going down the list given in Section 5.6), the policy options are, for instance, credit facilities, the support of NGO networks, facilitating access to information, land reform, the supply of glass recycling containers, alleviating central government pressure on local traditions and leadership, increasing people's self-esteem and daring, increasing time budgets and supporting the actors' capacity for integrated, collective action. Some of these options may sound somewhat far-fetched and abstract, but note that the environmental programme described in Annex 6.1 of De Groot (1992b), as down-to-earth as it is successful, in fact applies most of them. On the other side, the *autonomy-decreasing* policy options are the negative counterparts of the previous ones; *regulation* is a well-known collective term here but, as discussed already in Section 5.6, non-legal policy options may be effective as well. If one has no legal means to cancel a misused forest concession, one may decide not to find the funds, alas, to repair the bridge leading into it.

Returning to the conceptual level, it may be noted that the policy options are different from the options of the actors, used in explaining the actor's choices. The actor's options are only one element in Figure 5D, but policy options are attached to all the figure's elements. This is again the recursive character of the problem-in-context framework, discussed in Chapter 3. Thus, the formal definition of policy options is: *all options for action of the normative observer.* With that, it also becomes clear that 'policy option' is in fact a *pars pro toto* term also denoting options for projects and options for non-administrative normative observers (e.g. an NGO or a group of farmers analyzing their own local problem). Repeating another element from Chapter 3, it may be borne in mind that policy options *are potential* plan *elements;* combining policy options up to the system level of plans or policies as a whole, as well as the final choice as to which of the options will actually be part of these plans or policies is the subject of the later, designing research phase.

Types of policy options are often categorized under the name of *policy instruments*, such as 'directives' or 'incentives'. The literature (e.g. Van Manen et al., 1990; Bressers, 1989; Van Soest, 1991) usually follows a line of thought roughly equal to the problem-in-context framework; "directives", for instance, are then directed at the actor's options, and "incentives" at the actor's motivations.

On the basis of Chapter 3 and the present chapter, a typology of policy instruments may be drawn up. It is given in the table below. Substantively, the table gives more than the sum of all literature on policy instruments that I am aware of.[271]

The first major type of options follows directly from the problem analysis. There, we identify options for alleviating the problem without changing the problem-causing activity. These *physical policy actions*[272] often have a symptom abatement character (say, dredging without addressing the source of the pollutants), but on the other hand, they are the only line of action left to the policy maker if the activity in question has already stopped but the environmental damage is still there, for instance, as a result of dumping, mining or a disaster. In other cases, physical policy actions gain time for more fundamental, source-oriented policies to become effective (e.g. liming an acidifying lake). In other instances, physical policy actions are the finishing touch of more fundamental policies. If a large portion of the phosphate load can be taken off a lake, for instance, ecological on-site measures may help the lake to recover more fully. As the table summarizes, the physical policy options come in essentially five subtypes, characterized as:

- *Interrupting causal chains* in the environment or from the environment to human victims (e.g. purify river and ground water into drinking water; interrupt ground water flow leading from a dump site; evacuate people; make houses more soundproof; lead eutrophicating substances away from the susceptible lake).
- *Decreasing environmental burdens* (e.g. by dredging polluted sediments or decreasing groundwater extraction).
- *Increasing environmental capacities* to withstand burdens (e.g. lime acidifying forest floor; inject oxygen into lakes or sediments; plant trees to combat erosion; start deep well infiltration to counterbalance ground water substraction).
- *Integrated ecosystem restoration and management* (e.g. undertake 'biological management' of eutrophicated lakes, restoration of strip mines, 'assisted natural regeneration' of logged-over forest or overgrazed savannah).
- *Government add-ons to societal activities* are a special case of interrupting causal chains, directly attached, end-of-pipe-like, to the sources. They are especially feasible if source activities cannot be changed, physically or politically. One subtype here are *waste treatment* systems. From the point of view of environmental policy, *mitigating measures* added-on to non-environmental policy activities (roads, dams etc.) are also in this category.

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[271] This has been one of my personal criteria for the quality of the Problem-in-Context and action-in-context frameworks.

[272] Enumerated here instead of in Chapter 3 in order to produce the full table in one go.

TYPES OF OPTIONS FOR ACTION ('POLICY INSTRUMENTS')
following the **Problem-in-Context** structure

1. *Physical policy actions* (identified in the problem analysis)
   - interrupt causal chains (purify, isolate, evacuate etc.)
   - decrease environmental burdens (dredge, clean up etc.)
   - increase environmental capacity (lime against **acidif.**, trees against erosion etc.)
   - integrated ecosystem restoration and management
   - governmental add-ons (waste treatment, mitigating measures etc.)

2. *Policy options directed at the actors' options*
   - increase the number of potential options (technological research, extension etc.)
   - increase the actors' **implementatory** capacity (autonomy): their economic, social, cognitive, environmental, moral, psychological, physical and organisational resources and access to them
   - decrease the actors' implementatory capacity **(autonomy):** the negative counterparts of the list above, with *direct regulation* as the most important subtype (zoning, prohibitions, standards and conditions for licences and concessions, assigning of quotas etc.)

3. *Policy options directed at the actors' structural context*
   - with macro and **E-emphasis:** *financial and juridical internalization*
     . price-reducing: subsidies etc.
     . **price-neutral:** deposit money etc.
     . price-increasing: levies, taxes etc.
     . juridical liability
     . environmental investment security (land rights etc.)
   - with micro and C-, **H-emphasis:** *social internalization*
     . micro the macro (decentralize 'free access' into 'commons' situations; bring adversaries in face-to-face contact, etc.)
     . scale up actors ('free access' macro becomes a 'commons' micro)
     . intensify the 'care' and 'honour' consequences of good and bad actions and things (product information; publicize promises; praise the caretakers, etc.)
     . joint problem analysis, policy design and responsibility (partnership; participation; covenants, etc.)

4. *Policy options directed at the actors' culture*
   (frames of interpretation, world views)
   - information and education (show impacts etc. of environmental problems)
   - tell the story and show the beauty of things valuable
   - support the spread of an environmental ethic (views and practices)
   - protect experiential nature close to the home.

In the problem analysis, we do not only identify options for direct physical intervention, but also the optimum intensity of the problem-relevant activity (the environmental capacity), leading to the options for reaching that optimum intensity. These can be identified by making any horizontal cross-cut through Figure 5D, for each actor in the actor field. Making the cross-cut where Figure 5D is most fully differentiated (that is, at the third level of explanation) and lumping the first two elements together for simplicity's sake, we arrive at three major policy option types.

Policy options directed at the actors' options are the first of these. The first subtype focuses on increasing the number of potential options that actors know. The support of environmentally friendly technological research is a fundamental course of action here, concerning, for instance, agroforestry systems, waste technologies, energy-saving materials and processes, ways in which farmers can incorporate nature protection measures into their regular agricultural practice, and so on. After that, the new options have to make their way from the universities and field stations to within the actor's cognitive horizon; extension, diffusion, outreach, demonstration are key terms here.[273]

The second and third subtypes of options-directed policy have been discussed already in Section 5.6 and in the example at the beginning of the present section. It may be noted that some of these have a physical character, e.g. the fencing-off of a nature reserve or the supply of small-scale waste recycling tools to households or neighbourhoods; they are distinguished from the 'physical policy actions' mentioned above by the fact that, here, government does not undertake the environmental action itself, but (de-)facilitates actions of actors, through physical influence exerted on actors' options.

Next, we enter into the motivational realm, in which policy options directed at the 'objectified' motivations of actors come first. As previously discussed, the 'objectified' motivations arise from the actors' contextual microstructure and macrostructure; avoiding the slippery term 'objectified', the options are called *policy options directed at the actors' structural context.* As the table shows, I have subdivided these options by coalescing the distinction between micro and macro of Section 5.6 and the distinction between the H, E and C 'moral modes' of Section 5.7, thus treading on the path that Douglas (ref. Section 5.7) has rightly forbidden. This way, however, the table is kept simple without having to drop one of the two distinctions, which are both quite relevant. As a reminder of the looseness of the association, the term "emphasis" has been added.

Thus, the first subtype is given by the structure-oriented policy options *with macro and E-emphasis*, in which "E" is the *homo economicus* moral mode. With one eye also

[273] For a new option actually to be adopted, actors of course also have to be able to implement them and be motivated towards them. This is yet another example of the general rule that successful policies are usually mixes of options, not stand-alone bets. *Participatory technology development* directly in the field, the factory or the actors' organisation is a means to mix innovation, implementability and motivation in a single research action.

on the 'roll-off mechanisms and dilemmas' visible in Figure 5D, the policy options are summarized *as financial and juridical internalization* of externalities. Levies and subsidies are of course in this category, but also the 'price-neutral' deposit money mechanism. Juridical liability and environmental investment security, numbers four and five in the table, are one other's mirror. Juridical liability stands for all legal constructions aiming at security of costs of actions 'rolling off' environmental damage onto other actors or the future. Environmental investment security stands for the security of future benefits of planting trees, making terraces and so on, of special importance in the Third World because of the often uncertain tenure situation there.

The structure-oriented policy options *with micro and C-, H-emphasis* have *social internalization* as their alternative term. "C" and "H" refer to the 'ethics of care' and the 'ethics of honour' moral modes, respectively. The first two subtypes given in the table have been discussed in Section 5.6; the second two are more directly based on Section 5.7.

In the final resort, environmental policies will never be able to regulate and incite people very far into directions they do not understand and value. Therefore, policy options of the fourth type, those *directed at the culture of the actors,* have a diffuse but very down-to-earth relevance, often underrated in day-to-day policy making. The subtypes of options given in the table are not very systematic, but should convey the basic idea. The first item, *environmental information and education,* is primarily cognitively-oriented, telling people about mechanisms, causes and so on that are difficult to recognize in everyday experience; roughly, this is factual knowledge about environmental problems. The second item, *tell the story and show the beauty of things valuable* is more affectively-oriented, and more about the environment itself (especially nature) than about environmental problems. Here, 'the story' and 'the beauty' are of course much more than children's books and visual pictures only; they include the stories of evolution and creation, the 'bioregional narrative' of the place we belong to, the intricate networks and processes of ecosystems and Gaia, the unspoilt expanses of the universe, the myriad of life forms in a child's fishing net. Implicitly, I have made a choice here not to approach people primarily with duties ('deontological ethic') but with what is valuable ('axiological ethic'), so that the appropriateness of specific actions may be defined more situation-dependent ('contextual'). The third item of culture-oriented policy options is to *support the spread of an environmental ethic,* standing for many opportunities related to a number of philosophical views, of which De Groot (1992b, Chapter 8) gives an overview. These opportunities concern, for instance, stimulating the articulation of more or less professional environmental philosophy, the amplification of the voice of 'lay' people such as ecological farmers or field biologists who may articulate environmental views close to everyday experience, and the physical and financial protection of the livelihoods, places and activities from which these views grow. The last item on the list is *to protect experiential nature close to the home,* especially for children, i.e. nature that is not on television but is concrete life you can meet, and use, and be with. This, perhaps much more so than telling people about pressing environmental problems or far-away nature reserves, is a basis for all future environmental policy.

Virtually all policy instrument authors state that policy instruments should be mixed in order to be effective; in terms of Section 3.11, they are options that should be combined into the higher system level of a plan. Drijver and Zuiderwijk (1991) give a empirical example of concerted state, region and village action from Zambia, resulting in improved floodplain management. Seldom mentioned is the fact that mixing is not without limits; as explained in the previous section, policy instruments may sometimes annihilate rather than reinforce each other.

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Samenvatting

Probleemgerichte milieukunde richt zich op milieuproblemen, dat wil zeggen, een type maatschappelijke problemen. In Hoofdstuk 1 van deze studie, *'Introduction'*, wordt gezocht naar een beeld van wat de milieukunde als probleemgerichte wetenschap zou moeten zijn en wat er het meest nodig is om de milieukunde naar dit ideaal te brengen.

De begrippen 'theorie' en 'wetenschap' worden in het dominante (Cartesiaanse) wetenschapsbeeld beperkt tot de empirische doelstelling, dat is, de constructie van (veronderstelde, voorgestelde) waarheid. De rest is slechts 'toegepast', of 'kunde', of 'technologie', of 'studies'. Dit wetenschapsbeeld werkt als een zelfbevestigende val; de probleemgerichte milieukunde zou, om een echte wetenschap te kunnen worden (en daarmee de maatschappij te kunnen dienen met meer praktische kwaliteit en kritische reflectie) af moeten zien van haar probleemgerichte doelstelling, en daarmee feitelijk van zichzelf.

Een alternatief wetenschapsbeeld ontstaat door niet de aard, maar de *kwaliteit* van kennis als criterium te nemen; wetenschap omvat dan het gehele menselijk intellectuele repertoire, op het kwaliteitsniveau boven dat van de dagelijkse kennis en methoden. In dit beeld zijn normatieve wetenschappen conceptualiseerbaar; zij richten zich op de (kwaliteitsrijke) constructie van waarden, dat wil zeggen, de constructie van het (veronderstelde, voorgestelde) juiste handelen. 'Toegepast' zijn in dit beeld alle studies, empirisch en normatief, die zich richten op direct gebruik in de maatschappij of in een andere discipline, en 'zuiver wetenschappelijk' zijn alle studies, eveneens empirisch of normatief, die zich richten op de versterking van het eigen vakgebied.

Er bestaan drie soorten normatieve wetenschap: (1) ethiek, (2) probleemgerichte wetenschappen zoals de milieukunde en (3) ontwerpgerichte wetenschappen zoals de technologieën. Probleemgerichte milieukunde, in deze conceptualisatie, is idealiter de wetenschap (dus voorzien van een eigen theorieniveau) van de analyse, verklaring en oplossing van milieuproblemen, werkend in nauwe samenhang niet alleen met de empirische wetenschappen en ontwerpgerichte wetenschappen waarvan zij veel kennis toepast, maar evenzeer met de ethiek, waarvan zij in belangrijke mate een operationalisatie zou moeten zijn.

De huidige milieukunde in Nederland is grotendeels probleemgericht en bezig met het opbouwen van een eigen theorieniveau; deze studie wil hiervan een ondersteuning zijn. Tegelijkertijd echter is de ontworsteling uit de Cartesiaanse val nog lang niet compleet. Een onderzoeker die zichzelf ziet als slechts bezig met empirische milieustudies kan verklaring slechts zien als de (weinig relevante) verklaring van het milieu, en waarden slechts als een reflectie op, niet als deel van het onderzoek. Hierdoor heeft de milieukunde nog te sterk de kenmerken van 'environmental management', dat wil zeggen, de natuurwetenschappelijke modellering van het milieu en het op basis daarvan genereren van technische oplossingen, die vergeleken met de natuurwetenschappelijke onderbouwing normatief zeer zwak zijn gefundeerd, en grotendeels voorbijgaan aan de maatschappelijke oorzaken (de verklaring) van de milieuproblemen.

De doelstelling van deze studie is, de milieukunde te ondersteunen in de groei naar een meer volledig ontplooide normatieve wetenschap. Dit houdt in dat (1) de 'waardenkant' van het vakgebied beter moet worden onderbouwd en geoperationaliseerd, dat (2) de mogelijkheid tot het verkrijgen van inzicht in de maatschappelijke oorzaken van milieuproblemen moet worden vergroot en dat (3) het aldus ontstane complex van normatieve, natuurwetenschappelijke en sociaalwetenschappelijke kennis bij elkaar moet kunnen blijven in een geïntegreerd 'paradigmatisch raamwerk' voor theorie-ontwikkeling en interdisciplinair onderzoek. Omdat voor een interdisciplinair vakgebied de samenhang van onderdelen van het grootste belang is komt eerst het raamwerk aan de orde (Hoofdstuk 3). Daarna volgen de normatieve theorie (Hoofdstuk 4) en de methodologie van de verklaring van milieuproblemen (Hoofdstuk 5).

Hoofdstuk 2, '*A Discipline for Interdisciplinarity*', is een relatief lichtvoetige uitwerking van Hoofdstuk 1 en opstap naar Hoofdstuk 3. Aangetoond wordt dat interdisciplinariteit te lijden heeft gehad van het Cartesiaanse wetenschapsbeeld: zodra de milieukunde eenmaal geconceptualiseerd is als een normatief vakgebied tussen de andere normatieve vakgebieden, verliest het begrip interdisciplinariteit tegelijkertijd zijn *a priori* associatie met toegepaste studies en zijn ondertoon van utopisch ideaal. Besproken wordt allereerst dat zich aan het einde van de bekende reeks monodisciplinariteit - multidisciplinariteit - interdisciplinariteit - .... niet een complexe 'transdisciplinariteit' bevindt, maar de eenvoud van een nieuwe monodiscipline. De stap van interdisciplinariteit naar nieuwgevormde monodisciplinariteit is echter slechts een stap die nuttig is uit oogpunt van doelmatigheid. Het is de stap daarvoor, van multidisciplinariteit naar interdisciplinariteit, die het ontwerpen van gegronde oplossingen mogelijk maakt.

Dat een vakgebied in staat is tot het uitvoeren van interdisciplinaire studies is echter geen criterium voor wetenschappelijk succes; waar het om gaat is het kunnen uitvoeren van interdisciplinaire studies op een kwaliteitsniveau boven dat van de 'common sense'. Het bezit van eigen interdiscpilinaire theorie is daarbij de cruciale factor, en voor de opbouw van deze theorie moet een vakgebied-in-wording een 'paradigmatisch schema' bezitten dat de kritische uitwisseling van theorie met andere disciplines structureert. Dit wordt geïllustreerd met Probleem-in-context, het schema dat onderwerp is van Hoofdstuk 3. De legitimiteit en het kunnen verwerkelijken van een nieuwe normatieve interdiscipline hangen (naast allerlei tactische en praktische zaken) af van het tempo waarmee (in de 'geleende' universitaire tijd) het theorieniveau wordt opgebouwd, en van de associatie van het vakgebied met een maatschappelijk probleem van voldoende eigenheid, omvang en duur.[1]

Hoofdstuk 3, '*Problem-in-Context*', behandelt een conceptueel-methodisch ('Probleem-in-context') raamwerk dat paradigmatisch uitdrukt wat 'volledig ontplooide probleemgerichte milieukunde' is, en tegelijkertijd concreet genoeg is om een gids te zijn voor interdisciplinair onderzoek. De eerste twee paragrafen leggen de theoretische basis voor de hoofdstructuur van het raamwerk. Eén centraal probleem wordt in deze paragrafen nog niet opgelost. Dit betreft het feit dat normatieve wetenschap niet primair de probleem-definiërende waarden van andere actoren bestudeert (dan zou zij empirische wetenschap zijn), maar de eigen waarden, de eigen morele verantwoordelijkheid, van de probleem-definiërende 'normatieve beschouwer' als vertrekpunt heeft. De waarden van de beschouwer spreken dus niet alleen reflectief *over* het onderzoek, maar co-constitueren het object van onderzoek zelf, i.c. het milieuprobleem.

Omdat conceptuele knopen op het niveau van concrete, toegepaste studies vaak impliciet worden opgelost, wordt in de derde paragraaf het Problem-in-Context-schema eerst aan de hand van dergelijke studies (op het gebied van bodemdegradatie) opgebouwd. We maken daar tevens kennis met de praktijk van effectbeoordeling, norm-afleiding, het concept 'milieucapaciteit', de overgang van probleem-analyse naar probleem-verklaring en dergelijke. Op basis daarvan volgen twee meer technische paragrafen over de toepasbaarheid (het 'domein') van het raamwerk en de typen onderzoek die het raamwerk omvat. Gesteld wordt onder andere dat het raamwerk geschikt is voor alle milieuproblemen in alle mogelijke soorten van onderzoek, maar dat (omdat het raamwerk een uitdrukking is van een probleemgerichte rationaliteit) toepassing faalt waar er geen probleem is of de normatieve beschouwer niet rationeel wil zijn. In dit kader komt onder andere de verhouding tot de ontwerpgerichte wetenschap en de implementatie van beleid aan de orde.

In paragraaf 3.6 wordt een nadere beschouwing gegeven over de co-constituering van het object van de milieukunde door de waarden van de normatieve beschouwer. In de Cartesiaanse wetenschapsopvatting kan een object dat mede door de waarden van de beschouwer zelf wordt geconstitueerd niet worden geconceptualiseerd, omdat slechts de buitenwereld, niet de binnenwereld van de beschouwer, wetenschappelijk toegankelijk is; waarden en feiten liggen in de twee incommensurabele werelden van het objectieve en het subjectieve. Wie echter zegt dat een bepaalde situatie een probleem vormt, duidt hiermee aan dat de wereld zoals hij geïnterpreteerd wordt te zijn verschilt van de wereld zoals hij geïnterpreteerd wordt als behorende te zijn; hiermee wordt impliciet vastgelegd dat feiten en waarden,

[1] In Nederland hangt dit samen met de rechtvaardiging van zelfstandige 'kundes' aan de universiteit. Nieuwe 'kundes' horen daar thuis (evenals de oude zoals geneeskunde en rechten) voor zover zij een zelfstandig waardevol theorieniveau ontwikkelen, in samenhang met de ethiek en de fundamentele elementen van de empirische disciplines. In zoverre kundes en empirische vakgebieden slechts 'toepassingsterreinen' zijn, behoren zij bij overheidsgebonden onderzoeksinstellingen en het HBO.

hoewel ze principieel gescheiden blijven, op één 'ontologisch niveau' kunnen worden gebracht: het reflectieve niveau van de geobjectiveerde subjectiviteit.

De scheidslijn tussen waarden en feiten vormt de ruggegraat van het Probleem-in-context raamwerk. Aan de 'waarden-kant' van de scheidslijn liggen de normatieve vertrekpunten (de 'eindvariabelen') en de daaruit afgeleide ketens van normen, die eindigen in formuleringen van de milieucapaciteit, d.w.z., de toelaatbare intensiteit van menselijk handelen. Aan de 'feitenkant' liggen de effect-ketens die beginnen bij het menselijk handelen en eindigen in formuleringen in termen van de eindvariabelen. Tezamen vormen zij het milieuprobleem. Effectstudies en normafleidingen maken gebruik van dezelfde natuurwetenschappelijke kennis (veelal 'milieumodellen').

De eindvariabelen zijn gedefinieerd als de variabelen die gewoonlijk geen verdere normatieve rechtvaardiging behoeven; zij staan in termen van menselijke gezondheid, welvaart, culturele waarden, de intrinsieke waarde van de natuur en de duurzaamheid van dat alles. 'Normatieve contextualisatie' is de activiteit van de normatieve beschouwer zoekende naar de diepere rechtvaardiging van de door hem gehanteerde eindvariabelen. Deze activiteit leidt stap voor stap ('voortschrijdend contextualiserend') naar de wereld van ethiek, milieufilosofie en normatief-economische reflectie; par. 3.6 geeft enkele voorbeelden, en par. 4.7 is als zodanig een voorbeeld. Normatieve contextualisatie is een van de routes waarlangs een milieuprobleem wordt verklaard; indien de normatieve beschouwer geen waarden zou inbrengen zou er immers geen milieuprobleem en motivatie voor een oplossing zijn. De tweede verklaringsroute ('natuurwetenschappelijke contextualisatie') vertrekt niet vanuit de eindvariablelen maar vanuit de milieucapaciteit, zoekend naar de oorzaken waarom het milieu niet meer kan 'leveren' of verwerken.

De doorgaans belangrijkste verklaring van een milieuprobleem stelt de waaróm-vraag ten aanzien van het door de probleem-analyse als problematisch aangemerkte menselijk handelen. In Hoofdstuk 3 worden de eerste aanzetten gegeven tot de voortschrijdende contextualiserende verklaringsmethodiek, maar wordt de meeste aandacht besteed aan het feit dat de sociaalwetenschappelijke verklaringsroute conceptueel equivalent is aan de bestudering van het 'mens-milieusysteem', dat wil zeggen het object van ecologische antropologie, geografie en andere empirische wetenschappen, echter zonder dat (meestal onhoudbare) systeem-aannamen nodig zijn. Een nauwgezette demonstratie hiervan, geënt op het van oorsprong linguïstische begrippenpaar emic/etic, vult paragraaf 3.7. Het overig materiaal van Hoofdstuk 3 omvat meer technische behandelingen van probleemgrenzen, draagkracht, methodieken voor (beleids-)ontwerp en dergelijke.

Hoofdstuk 4, '*Values, Functions, Sustainability*', richt zich op de normatieve operationalisering en onderbouwing van de eindvariabelen van de milieukunde. De eerste drie paragrafen behandelen de gelaagde structuur van milieukwaliteit/milieufuncties/eindvariabelen. De meeste aandacht gaat hierbij uit naar het vanuit de eindvariabelen definiëren van relevante milieukwaliteits-parameters en, omgekeerd, de re-aggregatie van gegevens over milieuparameters naar de eindvariabelen toe.

Getracht wordt onder andere te demonstreren dat veel verwarring en congressen kunnen worden voorkomen door een heldere formulering van de eindvariabelen en (vooral) een consequente binding van de milieuparameters aan de eindvariabelen.

Paragraaf 4.5 gaat kort in op contextuele ethiek, omdat dit nodig is voor de volgende paragraaf en omdat het voor de milieukunde in het algemeen vele praktische relevanties heeft. De contextuele procedure tracht te blijven bij de concrete probleemsituatie (in zijn context), en daarbij, narratief, te komen tot een moreel bindende representatie van die probleemsituatie; deze (post-Cartesiaanse, 'postmoderne)' procedure is inhoudelijk verbonden aan de ethiek van verantwoordelijkheid, die in oppositie staat tot de abstraherende procedures van de 'ethiek van rechten en plichten', zoals die in de milieukunde onder andere tot uitdrukking komt in multi-criteria en kosten-baten analyses.

Op basis hiervan kan in paragraaf 4.6 de intrinsieke waarde van de natuur in meer operationele criteria worden uiteengelegd. Er blijken twee belangrijke 'families' van criteria te bestaan: natuurlijkheid en diversiteit, die ieder betrekking hebben op verschillende systeemniveaus in de natuur. Voor de operationalisatie van natuurlijkheid wordt een criteria-geleide narratieve procedure voorgesteld, geënt op het begrip gezondheid, en zonder de mens uit te sluiten. Diversiteit daarentegen kan met meer directe criteriatoepassing worden geoperationaliseerd; 'mondiale bedreigdheid' is van deze criteria de belangrijkste, maar de diversiteit van 'ontmoetbare' natuur dichtbij huis is daarnaast een zelfstandige invalshoek.

De functies van het milieu zijn een belangrijk structurerend concept voor milieu-evaluatie en norm-afleiding. Paragraaf 4.7 bestaat vooral uit een opsomming van deze functies, gebaseerd op ouder Nederlands werk en meer recente milieufilosofie. Daarnaast wordt enige aandacht geschonken aan de meer technische verbindingen met indelingen die met name worden gebruikt voor economische evaluaties.

De eindvariabele 'duurzaamheid', dat wil zeggen milieukwaliteit en hulpbronnen voor toekomstige generaties, is het onderwerp van de laatste twee paragrafen en de Annex van Hoofdstuk 4. De belangrijkste bron voor deze onderwerpen is de 'ecologische economie', die zich verzet tegen het feit dat de gangbare economie slechts oog heeft voor optimale allocaties en niet voor de absolute omvang van hulpbronnengebruik, met als bekende metafoor de optimale allocatie van steeds meer lading op een schip, zodat uiteindelijk het schip zinkt, "- but optimally, of course".

Allereerst gaat de aandacht naar het verwerken van duurzaamheid in de belangrijkste macro-economische eindvariabele, het Bruto Nationaal Produkt. Het is onmogelijk maar bij nader inzien ook onjuist om de waarde van het milieu of de afname van die waarde in het BNP op te nemen. De beleidsdoelstelling van duurzaamheid is niet een belofte om deze waarde empirisch te berekenen, maar om het natuurlijke kapitaal door te geven aan toekomstige generaties; wat van het BNP moet worden afgetrokken zijn, normatief, de kosten die deze belofte met zich meebrengt, voorzover ze niet reeds worden gemaakt. Voorstellen daartoe, door anderen reeds gedaan op intuïtieve gronden, hebben een sluitende theoretische basis. Het milieu behoeft niet, zoals de Wereldbank voorstelt, te blijven steken in een 'satellite account'.

Op micro-economisch niveau woeden de discussies over hoe duurzaamheid moet worden opgenomen in kosten-baten analyses; de daarin gebruikte disconteringsvoet heeft een goede empirische grondslag, maar reduceert het belang van toekomstige generaties tot vrijwel nul. Deze problematiek is onoplosbaar binnen de normatieve rationaliteit van de kosten-baten analyses; de verantwoordelijkheid voor toekomstige generaties (evenals voor de natuur en de basisbehoeften van de armen) ligt in een ander moreel domein. Dit morele domein ('equity' in tegenstelling tot 'efficiency') wordt eerst benaderd vanuit het intuïtief principe van 'safe minimum standards' in technisch ontwerpen. Vervolgens komen de theoretische invalshoeken voor 'tweestaps-waardentheorie' en strikte Pareto-optimaliteit aan de orde, en vindt de definitieve formulering van de twee domeinen en hun relatie plaats. De praktische relevantie van deze uiteenzettingen reikt, zoals overal in deze studie beoogd, van de abstracties van Wereldbankbeleid tot aan de bekende dagelijkse situatie waarin de ene ambtenaar zegt: "Zo komen wij niet verder! Hang eens een prijskaartje aan die natuur van jou!", waarop de andere ambtenaar niet hoeft weg te gaan teneinde zoveel mogelijk 'willingness-to-pay' gegevens te verzamelen, maar kan antwoorden: "Ik ben bereid een prijskaartje aan mijn natuur te hangen indien jij een prijskaartje hangt aan je kinderen."

De Annex van Hoofdstuk 4 gaat in op duurzaamheid als variabele in fundamentele modellen van wereld-duurzaamheid en de bijdrage daaraan van regio's, sectoren, produkten en processen. In de voorbereidende paragrafen wordt uiteengezet wat het 'fundamentele niveau van analyse' is, en wat verantwoorde aannamen zijn met betrekking tot de substitueerbaarheid van hulpbronnen. In ecologisch-economische modellen is energie de centrale parameter, omdat energie de wereld in al zijn facetten 'aandrijft'. Voor beleidsgerichte modellering is het gebruik van energie als sleutelvariabele echter zinloos; energie is niet schaars en zal dat ook nooit worden. Modellen en beleid moeten zich richten op wat wel de sleutelvariabelen van duurzaamheid zijn: emissiepreventie en de bescherming van produktieve ecosystemen en biodiversiteit. Voor het beleid betekent dit dat energieheffingen fundamenteel inferieur zijn aan emissieheffingen. Voor wat betreft de modelbouw laat de Annex zien, dat de fundamentele duurzaamheidsparameters niet worden samengevat in de Joule, maar in de vierkante meter aardoppervlak.

Hoofdstuk 5, '*Action-in-Context*', richt zich op het formuleren van een aanpak voor de identificatie en analyse van de maatschappelijke oorzaken van milieuproblemen, 'voortschrijdend contextualiserend' van het problematische menselijke handelen naar de achterliggende actoren, factoren, cultuur en structuur. Dit type onderzoek zal, nu de technische oplossingen van milieuproblemen uit het initiële traject van kosten-effectiviteit komen, van steeds groter belang worden voor de milieukunde. In de voorbereidende paragrafen wordt onder andere ingegaan op het belang, 'reductionistisch' te zijn in de zin dat actoren en niet systemen de centrale eenheid van analyse zijn, maar 'holistisch' in de zin dat actoren niet worden gereduceerd tot keuzemodellen; het mens-zijn van de onderzoeker is het eerste en belangrijkste onderzoeksinstrument.

Voortschrijdend-contextualiserend onderzoek kent geen vooraf bepaalde systeemgrenzen of sleutelvariabelen; daarom moeten op de voortschrijdende route vele keuzen worden gemaakt. Paragraaf 5.3 gaat in op de praktische en theoretische criteria voor deze keuzen, en bespreekt enkele principes voor veld-onderzoek. In paragraaf 5.4 wordt ingegaan op de vier onderdelen van de kern-eenheid van het handeling-in-context raamwerk: te verklaren handelingen, waarover wordt beslist door actoren, die kiezen op grond van de motivaties die zij hechten aan de handelingsalternatieven (opties) die zij hebben.

De direct milieu-beïnvloedende handeling is het scharnierpunt tussen het milieuprobleem en de maatschappij. Omdat handeling-in-context vanuit deze handeling vertrekt (iets anders hoeft er uiteindelijk niet verklaard te worden) wordt de direct milieu-beïnvloedende handeling de 'primaire handeling' genoemd, waarover een 'primaire actor' beslist. Achter deze actor liggen andere, medeverklarende actoren, bijvoorbeeld machtige landheren of overheidsinstanties. Handeling-in-context onderzoek bestaat uit twee gedeelten: het opsporen van hoe de primaire, secundaire, tertiaire, enz. actoren geschakeld zijn, en de diepere analyse per aldus geïdentificeerde actor.

'Sociaal netwerk'-onderzoek genereert schakelingen van actoren die actor-tot-actor contacten weergeven. Voor verklarend onderzoek, dat uit is op het vinden van lijnen van beïnvloeding (d.i. macht) is het echter niet primair van belang of actoren rechtstreeks met elkaar in interactie staan; macht werkt primair via het kunnen beïnvloeden van opties en motivaties van anderen, en daarmee, of de ander dit weet of niet, het sturen van diens keuzen. Het 'actorenpatroon' is de naam die in deze studie aan de actoren-schakeling via de beïnvloeding van opties en motivaties wordt gegeven. In paragraaf 5.5 wordt eerst het principe met twee voorbeelden uit de Derde Wereld geïllustreerd; daarna worden enkele mogelijk relevante sociaalwetenschappelijke schakelingsconcepten besproken. Vervolgens komen in meer technische zin enkele typen van moeilijk 'ontwarbare' actoren aan de orde, en wordt de behandeling afgesloten met een iets ingewikkelder voorbeeld over zure regen in Nederland.

Paragraaf 5.6 gaat in op de tweede stap van handeling-in-context onderzoek: de diepere analyse per actor in het actorenpatroon. Dit gebeurt 'laag voor laag', van de (voor de actor) meest émergente opties en motivaties naar hun verwevenheid in maatschappelijke structuur en cultuur. Er wordt hierin onder andere aandacht gegeven aan sociale dilemma's en afwenteling, de technische definities van micro, macro, cultuur en structuur, de rol van wereldbeelden en (als 'next steps') de eventuele volgende onderzoeksstappen, die zoeken naar meer algemene patronen en verdieping door theorie.

Paragraaf 5.7 gaat in op een vraag die in paragraaf 5.1 bewust is onderdrukt: is er, na het eerste principe dat het zich verplaatsen in de actor door de onderzoeker de sleutel is voor verklarend onderzoek, nog een meer formeel en theoriegefundeerd 'actormodel' te formuleren? Dit blijkt het geval; de 'rational choice theory' is hievoor echter, mede gezien haar falen om het voor de milieukunde zo belangrijke verschijnsel van collectief handelen te kunnen verklaren, te eendimensionaal. Gekozen wordt voor een 'model' dat een slechts semi-gestructureerd mengsel is van drie 'morele domeinen': dat van de (Cartesiaanse, rational choice) 'homo economicus', dat van de 'homo honoris' en dat van de 'ethics of care'.

Het actorenpatroon identificeert mogelijke beleids-doelgroepen; de diepere analyse per actor identificeert mogelijke beleids-inhoud. Deze typen beleidsopties kunnen worden gegroepeerd tot een lijst van 'beleidsinstrumenten'. Paragraaf 5.8 geeft deze lijst, gebaseerd op (en daarmee tevens ter kwaliteitscontrole van) het schema van de 'diepere analyse'.

Het tegelijk met dit proefschrift te verschijnen boek 'Environmental Science Theory', uitgegeven door Elsevier Science Publishers, bevat naast de tekst van het proefschrift drie extra hoofdstukken:
- 'Participation in Environmental Management'
- 'Interpretative Directions for Environmental Science'
- 'Partnership with Nature: A Philosophy for Practice'.

CURRICULUM VITAE

Wouter T. de Groot werd op 20 juli 1949 te Rotterdam geboren, volgde het voorbereidend wetenschappelijk onderwijs van 1961 tot 1966 en daarna, tot 1974, de opleiding tot civiel ingenieur aan de TU Delft, waar hij afstudeerde op een onderwerp uit de grondwatermechanica. Van 1974 tot 1977 droeg hij verantwoordelijkheid voor ontwerp, logistiek en bouw van bruggen in West-Kenia. Sinds 1977 is hij plaatsvervangend wetenschappelijk directeur van het Centrum voor Milieukunde van de Rijksuniversiteit Leiden, waar zijn taken onder andere betrekking hebben (gehad) op veldbiologisch, beleidsontwerpend en algemeen-milieukundig onderzoek, en zijn onderwijs zich met name richt op mens en milieu in Noord-Kameroen en Noord-Filippijnen.