B/ordering the Anthropocene:
Inter- and Transdisciplinary Perspectives on Nature-Culture Relations

TRIER UNIVERSITY

Antje Bruns & Rebekka Kanesu (Eds.)

Prof. Dr. Antje Bruns
Chairholder of Governance & Sustainability Lab,
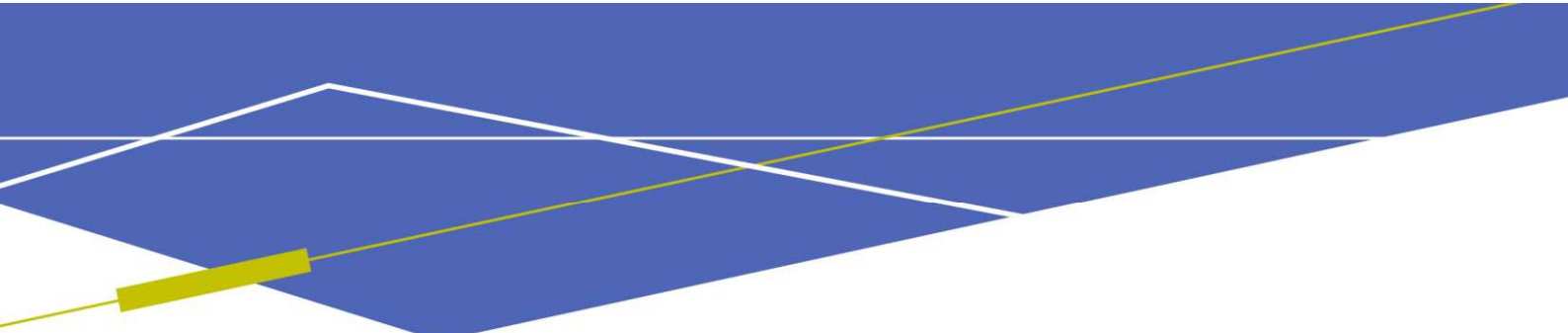Spatial and Environmental Sciences
Trier University

Rebekka Kanesu
PhD candidate at Governance & Sustainability Lab,
Spatial and Environmental Sciences
Trier University

OF BINARIES, BOUNDARIES AND BENEVOLENCE:
Critical interdisciplinarity in natural resources management

Peter P. Mollinga

The 'Cartesian divide' between nature and society is a defining binary in the natural resources management and human development (NRM&HD) field. It creates many hurdles for addressing contemporary complexity in the dynamics of natural resources and development. Science exhibits ongoing boundary creation and boundary guarding – of the tribes and territories we call disciplines. Simultaneously the complexity of societal problems has stimulated experiments with processes of boundary crossing, and the development of methodologies for boundary work, under the banner of inter- and transdisciplinary research. Interdisciplinarity is critical interdisciplinarity, first, when it seeks to transcend divides created through binarism, and, second, when it is self-conscious about paradigmatic location and adopts a scientific approach that allows the investigation of 'politics', including that of research and the researcher. Third, critical interdisciplinarity needs to be struggled for, as interdisciplinarity is not inherently critical, particularly in the present development research policy emphasis on instrumental interdisciplinarity as part of 'benevolent' development discourses. Interdisciplinarity may get depoliticized in sophisticated incarnations of instrumentalism like sustainability science.

Interdisciplinarity, sustainability science, natural resources management, critical science

VON BINARITÄT, GRENZEN UND WOHLWOLLEN. Kritische Interdisziplinarität im Management natürlicher Ressourcen

Die ‚kartesianische Grenzziehung' zwischen Natur und Gesellschaft ist eine entscheidende Binarität im Forschungsfeld des Managements natürlicher Ressourcen und Entwicklung. Es schafft viele Hürden, um der heutigen Komplexität in der Dynamik der natürlichen Ressourcen und damit verbundenen Entwicklungsprozessen zu begegnen. In der Wissenschaft zeigt sich die fortlaufende Grenzgestaltung und Grenzsicherung - der Stämme und Gebiete, die wir Disziplinen nennen. Gleichzeitig hat die Komplexität gesellschaftlicher Probleme Experimente mit Prozessen des Grenzübertritts und die Entwicklung von Methoden für die Grenzarbeit im Rahmen der inter- und transdisziplinären Forschung angeregt. Interdisziplinarität ist kritische Interdisziplinarität, erstens, wenn sie versucht, die durch den Binärismus entstandenen Gräben zu überwinden, und zweitens, wenn sie sich ihrer paradigmatischen Position bewusst ist und einen wissenschaftlichen Ansatz verfolgt, der die Erforschung der ‚Politik' ermöglicht, einschließlich der der Forschung und des Forschers. Drittens muss um kritische Interdisziplinarität gekämpft werden, da Interdisziplinarität nicht von

Natur aus kritisch ist, insbesondere in der gegenwärtigen politischen Ausrichtung der Entwicklungsforschung, die instrumentelle Interdisziplinarität als Teil ‚wohlwollender' Entwicklungsdiskurse hervorhebt. Interdisziplinarität kann in komplexen Verkörperungen des Instrumentalismus, wie der Nachhaltigkeitswissenschaft, entpolitisiert werden.

Interdisziplinarität, Nachhalitgkeitswissenschaft, Management natürlicher Ressourcen, kritische Wissenschaft

DES BINAIRES, DES LIMITES ET DE LA BIENVEILLANCE. Interdisciplinarité critique dans la gestion des ressources naturelles

La ‹fracture cartésienne› entre la nature et la société est une binaire déterminante dans le domaine de recherche de la gestion des ressources naturelles et du développement humain. Elle crée de nombreux obstacles à la prise en compte de la complexité contemporaine dans la dynamique des ressources naturelles et les processus interconnectés du développement. La science fait preuve d'une création et d'une surveillance continues des frontières - des tribus et des territoires que nous appelons les disciplines. Simultanément, la complexité des problèmes sociétaux a stimulé l'expérimentation de processus de franchissement des frontières et le développement de méthodologies de travail aux frontières, sous la bannière de la recherche inter- et transdisciplinaire. L'interdisciplinarité est une interdisciplinarité critique, d'abord lorsqu'elle cherche à transcender les clivages créés par le binarisme et, ensuite, lorsqu'elle est consciente du lieu paradigmatique et adopte une approche scientifique qui permet l'investigation de la ‹politique›, y compris celle de la recherche et du chercheur. Troisièmement, il faut lutter pour une interdisciplinarité critique, car l'interdisciplinarité n'est pas intrinsèquement critique, en particulier dans la politique actuelle de recherche pour le développement qui met l'accent sur l'interdisciplinarité instrumentale dans le cadre de discours ‹bienveillants› sur le développement. L'interdisciplinarité peut se dépolitiser dans des incarnations sophistiquées de l'instrumentalisme comme la science de la durabilité.

Interdisciplinarité, science de la durabilité, gestion des ressources naturelles, science critique

"The modernist dichotomy of nature and society, so deeply ingrained in agri-food studies and orthodox social theory, is disabling – analytically, politically, and ethically." (Goodman, 1999, p. 33)

"…when approaching collaborative work between scientists, forget disciplines; think scientific communities." (Lele and Norgaard, 2005, p. 972)

"(…) without a critical approach (…) interdisciplinary researchers run the risk of colluding with power, reinforcing the status quo, contributing to current problems, and blocking paths to progressive change." (Sumner, 2003, p. 10)

This essay presents a narrative that positions interdisciplinarity as critical scientific practice – in the academic domain that studies the relationship between natural resource management and human development in the global South. Positioning interdisciplinarity as critical is not an original attempt. Klein's (1990) monograph *Interdisciplinarity: History, theory, and practice* distinguishes two 'waves' of interdisciplinarity in recent modern science, which she labels as critical and instrumental interdisciplinarity. The first refers to the emergence of fields like gender studies, development studies, peace studies and environmental studies as part and outcome of progressive social movements focusing on these issues from, say, the 1960s. This is an interdisciplinarity pursuing transformative change of the societal order. The second refers to interdisciplinarity in the sense that organizations like the OECD have promoted it (cf. OECD, 1972; Berger and Duguet, 1982), as a requirement for fixing the increasingly complex problems that surface in the ever more interconnected world that we live in – without questioning the status quo of societal relations.

The two 'critical science' fields that are directly relevant to the focus of this paper, environmental studies and development studies, both emerged as critical fields in Klein's first wave. They have developed instrumental incarnations too. For instance, where political ecology approaches are located on the critical side, ecological modernization as a perspective is located towards the instrumental side[i]. There is critical development studies, inspired by heterodox political economy perspectives (cf. Veltmeyer and Bowles, 2018; Kothari, 2019), and there is the study of development management (cf. Davids et al., 2005). Arguably, instrumental approaches to interdisciplinarity predominate in the current practice of interdisciplinarity[ii].

Rather than seeking to make an original point on critical interdisciplinarity's practice, this essay explores how the criticalness of interdisciplinarity can be thought and maintained in the present time and age, with environmental problems like steadily progressing climate change and developmental challenges like increasing inequality looming large. In this exploration, I draw and reflect on my own experience in interdisciplinary research endeavors.

My narrative on critical interdisciplinarity is presented in three steps and sections.

1) I first look at binaries – notably the 'Cartesian divide' binary, dichotomising nature and society as two different objects. This binary underpins and pervades modern instrumentalism; critically thinking natural resources-development connections requires questioning, and transcending, the nature-society divide.
2) The second port of call is boundaries. I discuss which boundaries need crossing to achieve interdisciplinarity, but also question whether the challenges in collaborative interdisciplinary research are about disciplinary divides and fragmentation to begin with.
3) In the third part, I alight at the Haltestelle of benevolence. Benevolence is the hallmark of mainstream development intervention efforts. I explore three types of approaches to boundary work in NRM&HD research, and discuss the 'sophisticated instrumentalism' that, I argue, sustainability science, as the emergent dominant form of NRM&HD research, is prone to.

Before coming to binaries, boundaries and benevolence, I present, in two sections, the understanding of interdisciplinarity and of criticalness used in this essay. Section 6 concludes.

1. Interdisciplinarity and its contradictions

Klein usefully summarizes what has motivated interest in interdisciplinary academic practice.

> "Educators, researchers, and practitioners, have all turned to interdisciplinary work in order to accomplish a range of objectives:
> - to answer complex questions;
> - to address broad issues;
> - to explore disciplinary and professional relations;
> - to solve problems that are beyond the scope of any one discipline;
> - to achieve unity of knowledge." (Klein, 1990, p. 11)

Sustainability, poverty and inequality, key challenges facing the field of natural resources management and human development (NRM&HD), are such complex questions and broad issues. The relations between sectors, between aca-

demic disciplines, notably those between physical and social sciences, and between research and policy are often seen as problematic and as gaps to bridge. Any concrete natural resources management situation is multidimensional, having physical, technical, and/or ecological aspects as well as cultural, political and economic human aspects, and is thus amenable to and in need of interdisciplinary consideration. The notion of complexity has made headway in both the study of physical systems and of human systems, including the fields of environmental studies and development studies, and is a vehicle for new (modest) attempts at convergence and unity of knowledge. A discussion of interdisciplinarity in the field of NRM&HD may thus well have broader relevance.

Beyond this commonality, interdisciplinarity, as a category as well as a practice, is accompanied by considerable confusion and contradiction (cf. Robinson, 2008). I highlight three contradictory aspects of interdisciplinarity relevant to the purpose of this paper.

First, disciplinarity, the organization of the sciences in (ever more) specific sub-fields, can, in a Marxian perspective be understood as the product of the contradictions that drive capitalist development. In such a perspective disciplinarity is the division of labor in knowledge production that simultaneously enhances productivity and functions to discipline (academic) labor. The introduction of market principles and new public management approaches in university governance are the most recent versions of that logic (cf. Becher and Trowler, 2001). Interdisciplinarity then becomes an instrument for resolving some of the concrete contradictions that capitalism produces – the threats to capitalist accumulation by ecological and social crises. Just like management orchestrates fragmented labor, interdisciplinarity orchestrates fragmented research and innovation. Not surprisingly, the management of research teams is an important element of debates on interdisciplinarity (cf. Fiore, 2008; Nancarrow et al., 2013; Ruecker and Radzikowska, 2008).

There is, obviously, more to interdisciplinarity than this instrumental functionality for the reproduction of capitalism. Academic disciplines, once established become 'academic tribes and territories' – the evocative title of Becher and Trowler's (2001, orig. 1989) book on disciplinarity and interdisciplinarity. Disciplines institutionalize, they become organized and acquire agency, and they develop interests and cultures. This creates a whole series of hurdles for interdisciplinary collaboration – another prominent theme in debates on interdisciplinarity. Disciplinary institutional reproduction happens through the internal processes of socialiszation in disciplines through teaching

curricula, journal publication rankings, career paths, research funding organization, and many other mechanisms.

Second, one particularly contradictory, or perhaps better, paradoxical phenomenon is that research entities (epistemic communities) that emerge as interdisciplinary endeavors, tend to become institutionalized as new disciplines after some time (when they are successful). This has happened to gender studies, to peace studies, to environmental studies, and to development studies, and more recently also for example to science and technology studies (STS)[iii]. A most striking example of this that I was involved in directly, is an effort in the 1980s at Wageningen (Agricultural) University, in the Netherlands. A (student) lobby for the creation of a new professorial chair on 'technology and agrarian development', which was to head a center to bring together the different social and natural science disciplines working on different aspects of development, was transformed into an additional chair without a center (and in the course of time became further boxed in by making it part of a social science disciplinary unit). The element of a center for interdisciplinary collaboration was regarded by almost all disciplines (departments) as a threat to their autonomy, was resisted, and got sacrificed in the university decision-making process[iv].

Sometimes such interdisciplinary centers do get established though. An example is the Center for Development Research (ZEF) at Bonn University, Germany, where I worked from 2004 to 2010. It was newly established in the 1990s after Bonn lost the capital status of unified Germany to Berlin. The new institute was endowed with a strongly worded interdisciplinary mandate. However, disciplinarity crept in through the internal organization of the institute. Its three departments were organized on a disciplinary basis rather than a thematic/issue basis. The latter was reportedly considered when designing the Center, but discarded in favor of a disciplinary organization in the form of a social sciences department, an economics department, and a natural sciences department, each affiliated with a different faculty of the university[v]. The Center thereby internally reproduced the 'normal' problems of disciplinary divides, while having an external profile emphasizing inter- and transdisciplinarity.

Third, yet another contradictory or paradoxical aspect of interdisciplinarity is that the so-called disciplinary gaps or divides are perhaps not primarily about disciplines. Lele and Norgaard (2005) label disciplines as 'academic administrative artefacts' – an institutionalization already referred to above. They argue that e.g. market economic models are used in a wide range of disciplines beyond economics. The use of such models creates a cross-

disciplinary affinity stronger than that with same-discipline colleagues working from, say, a Marxist perspective. Also, the ontological and epistemological premises of a discipline may radically change. In the organization of biology, for example the plant/animal subdivision has given way to a completely different level-based organizing from gene to ecosystem. For successful collaboration between what have been historically called disciplines, Lele and Norgaard (2005, p. 972) argue, epistemological (paradigmatic) alignment may be more significant than the disciplines as such.

Though in my appreciation Lele and Norgaard's 'forget disciplines, think scientific communities' (see opening quote) is an overstatement – disciplinary organization does constitute problems for collaboration as such – their argument does strongly resonate with my own experience at both institute and collaborative research project level. Rather than to the three ZEF departments' disciplinary affiliations, the problems in internal collaboration were in my experience due more to a 'paradigmatic misfit'. Two of the three departments were departments whose science was grounded in positivism; one department was on the critical realist and interpretivist side of the philosophy of science spectrum. The former two collaborated relatively easily; collaboration of each of them with the third department was problematic and prone to misunderstanding and conflict.

At research project level, the fate of social scientists interested in natural resources management is often to be a minority in a natural sciences dominated project. In two such EC funded large interdisciplinary research projects I was involved in, the same 'paradigmatic misfit' played out. In one instance it played out along natural science vs. social science lines (allowing labelling it as a problem between disciplines), but in a second instance it manifested also within the social science within the project, suggesting that, as Lele and Norgaard argue, scientific approach may, indeed, be more decisive than discipline[vi].

Transcending disciplinary divides in research on sustainability and sustainable development is thus not an inherently critical activity. A closer examination of what it means to be critical when practising interdisciplinarity is warranted.

2. Critical: Three senses

Critical is understood in this paper to have the following three senses.

1) The issue of natural resources management for human development (commonly referred to as the issue of sustainability or sustainable development) is of critical importance for a (common) human future.

2) Concrete situations of NRM&HD are investigated using critical theoretical approaches, which are, simply and crudely put, approaches that explicitly analyze the social relations of power that are part of these situations.

3) Scholars critically question the political positioning of research and researchers in their work, that is, are reflective about the situatedness of their knowledge and themselves.

The first sense is the one on which probably most agreement exists – though climate change denial is a counter example. There are, however, considerable differences in view, on what needs to be done about this critically important set of issues. The eco-modernization and political eco-logy perspectives alluded to above take very different views for instance, which resonate with paradigmatic differences in scientific approach [vii]. This first sense provides part of the common justification for interdisciplinarity, in combination with the acknowledgement of the complexity of natural resources management situations[viii].

Senses two and three of being 'critical' have clear associations with scientific approach or paradigm. An NRM&HD example of a highly sophisticated but non-critical theoretical contribution is Ostrom's work on common property resources (Ostrom, 1990). Social power is not explicitly conceptualized in her approach. Her 'design principles' and IAD (Institutional Analysis and Development) approach to improving resource management and governance have a clear instrumental ring to them. They have been mobilized for mainstream policy and intervention approaches quite widely. Scientific approaches that do explicitly analyse social relations of power, like those in the broad and diverse field of political ecology, are usually associated with policy and practice of a more transformative kind (see Robbins, 2012 on political ecology; on transformative change see Green, 2016 and Olin Wright, 2010). The distinction should, however, not be made too simple and binary. Assessments of Community Based Natural Resources Management (CBNRM) show that critical political stances do in practice often together with instrumentalist approaches to development and social change, regularly producing contradictory outcomes (cf. Dressler et al., 2010)[ix].

Questioning the positioning of research and researchers, sense three is divided along similar lines. On the more instrumental side discussion on the dynamics of teamwork in interdisciplinarity (Fiore, 2008) and training students for working in sustainability contexts (Jones et al., 2010) are

found. Several contributions in sustainability science reflect on actual (political) roles of researchers in projects aiming at sustainable development (Pohl et al., 2010; Wittmayer and Schäpke, 2014). More radical approaches on the contradictions in the role of researchers in development are Adams (1979) and Breman (1985), while Pulido (2008) tries to answer questions about what it takes to be a scholar activist (also see Borras, 2016). More discussion on positioning is provided in section 5. After these separate introductory explorations of interdisciplinarity and criticalness, I now proceed to the three-step discussion of their combination in the field of NRM&HD.

3. Binaries

The biggest binary in modern science is perhaps that between Nature and Society. It is sometimes called the Cartesian Divide, after René Descartes, the French philosopher of *cogito, ergo sum* (I think, therefore I am). Descartes has been (dis)credited for the separation of mind and body in modern thinking – separation meaning that mind and body are considered to be two different objects. The understanding of society and nature as ontologically separate objects is a variation on the mind/body theme.

Francis Bacon has been (dis)credited for inventing the experimental scientific method based on this – by putting nature 'on the rack', (true) knowledge can be extracted from 'her' bosom, which can then be put to use to the benefit of society, that is, to control and dominate the natural world. The crediting refers to the scientific revolution that ensued, facilitating historically unprecedented productive and other human capacity. The discrediting refers to the problematic sides of the 'science is progress' project, in which the body and nature are treated as machines. Carolyn Merchant (1980) analyzed the perspective first articulated by Descartes and Bacon as a masculine project, in which both nature and women are subjugated:

> "nature cast in the female gender, when stripped of activity and rendered passive, could be dominated by science, technology and capitalist production." (Merchant, 2006, p. 514).

In water studies, my own field, the desire to master nature is evident for instance in the standard phrase of 'the harnessing of rivers', a narrative in which 'no drop shall go waste to the sea', and which is arguably masculine in rhetoric and practice (Zwarteveen, 2008).

There is considerable debate and difference of opinion on how much and what can exactly be attributed to Descartes and Bacon (see Merchant,

2006 for references). It seems quite clear, however, that they have been read, interpreted and enhanced in the way that Merchant proposes[x], and that this has produced 'ecological crises'. These crises have been articulated by environmental movements, since the 1960s particularly, and the environmental problems that modern societies, both communist and capitalist, have produced during the 'great acceleration' (Steffen et al., 2015) have been documented in detail, leading to calls for 'sustainable development', following on from Rachel Carson's 1962 *Silent Spring* and the 1972 *Limits to Growth* report (Meadows et al., 1972)[xi].

Ever since environmental critiques became publicly articulated, critical currents in academia are seeking to reconceptualize the nature-society divide: through the notion of co-evolution, the social construction and production of nature, as political ecology and ecological economics, by applying complex systems thinking to socio-ecological systems, by post-structuralist approaches like Actor-Network-Theory and assemblage thinking, by documenting alternative cosmologies, and in a variety of other ways (for reviews see Braun, 2004 and Stuart, 2016). For Latour (1993), the (ontological) distinction of nature and society is an element of the 'modern Constitution' (see Braun, 2004, pp. 168ff.). In recent Marxist analysis of 'capitalist ecology' (see Moore, 2015) the nature/society binary is seen as definitive of capitalist society, where the anthropocene is actually a capitalocene (Moore, 2016). Bernstein, in review, writes that according to Moore the "Cartesian syndrome (…) is a product of bourgeois thought and its various conceptual revolutions" (Bernstein, 2017, p. 645) and cites Moore as stating that,

> "the notion that social relations (humans without nature) can be analyzed separately from ecological relations (nature without humans) is the ontological counterpoint to the real and concrete separation of the direct producers from the means of production" (Moore, 2015, p. 19).

Carolan (2005) proposes to distinguish between 'nature' (as a discursive construct), nature (the hybrid sphere where the human and non-human co-evolve), and Nature (the material domain of physical processes). This is perhaps a useful demarcation (though only in printed form), but it does not solve the challenge of conceptualizing hybridity in the second, nature sense. Moore's 'web of life' metaphor illustrates the (ongoing) search for a vocabulary that is non-binary, as do hybrid concepts like socionature, social-ecological, sociotechnical and hydrosocial.

As already suggested in the introduction, the dichotomous configuration of nature and society

and the harnessing project produced the specialization, if not taylorization (cf. Braverman, 1974), of scientific practice. Disciplinary specialization is part of the perilous condition of modernity, and one of its causes. Interdisciplinarity is one of the things that must come to the rescue – as an analytical response to address the complexity of NRM&HD issues, which are presenting themselves ever more poignantly. From this perspective, interdisciplinarity is critical practice when it seeks to overcome or transcend binary and dichotomous thinking on NRM&HD. As stated in the quote by Goodman at the start of this paper, binary nature/society thinking is analytically, politically, and ethically disabling: analytically because it does not allow adequate capture of how socioecological systems function (and their problems persist); politically because it juxtaposes 'red' (socio-economic) and 'green' (environmental) issues, policy and activism; ethically because, for example, among other things, it is unable to deal with animal rights (cf. Sanbonmatsu, 2011) and denies alternative cosmologies (cf. Ziegler and Groenfeldt, 2017). I, thus, argue that a characteristic of critical interdisciplinary thinking on NRM&HD is that it questions and attempts to transcend binary thinking, notably as regards nature and society.

4. Boundaries

A binary not yet mentioned is fragmentation/integration. It plays an important role in NRM&HD debates as well as in reflections on (the practice of) interdisciplinarity. An example of the former is the post-1990 policy framework of Integrated Water Resources Management (IWRM) that seeks to address the different challenges in water use, management and governance in a usefully combined manner (GWP, 2000). One of the main fragmentations this policy framework seeks to address is that of sector and institutional fragmentation. This includes the separate dealing with surface water, groundwater, water supply and sanitation and water conservation as separate sub-sectors for instance, and the lack of administrative coordination of the government departments responsible for different types and aspects of water use, management and governance. Another fragmentation, partly related to this, is the existence of different water knowledges, in the form of disciplines or sub-disciplines (irrigation, water supply, erosion & soil and water conservation, and so forth). In the post-1992 Rio de Janeiro Earth Summit surge of global interest in sustainable water management and water governance, a variety of social science disciplines have entered into and/or expanded their work on water issues, including history, human geography, anthropology, political science and several others – adding to disciplinary 'fragmentation' of the field of (social science) water studies. This imagery then informs considerations about interdisciplinarity (and transdisciplinarity): fragmentation creates gaps to bridge and boundaries to cross if more comprehensive analysis of the 'wicked problems' of NRM&HD is required (Balint et al., 2011; Murphy, 2012)[xii].

Such a perspective understands that disciplines, and other institutional entities like government departments and civil society organizations in the policy and societal domains, are prone to 'boundary guarding' (Gieryn, 1983). For a host of reasons these entities tend to behave as tribes defending their territory (Becher and Trowler, 2001)[xiii]. To overcome this, 'boundary crossing' is needed through 'boundary work' – however the boundaries are exactly defined. Boundaries are like borders – meant to protect, to shut off and out, as they are meant to be permeable, a point of passage, a site of traffic and exchange[xiv]. At the boundary interface specific technologies and institutions, upheld by certain contextual arrangements (the 'enabling environment' of policy discourse), are needed to make both the boundary and the boundary crossing productive.

For classifying the challenges in bridging gaps and crossing disciplinary boundaries that I encountered in the practice of interdisciplinarity at ZEF Bonn, I have used Carlile's (2002) threefold classification of syntactic, semantic and pragmatic problems (Mollinga, 2008) – a terminology to get used to, but with, as I hope to show, considerable merit. I understood the different types of 'problems at the boundary' to be the following.

1) Syntactic problems, or, language and communication problems, including the specificity of meanings in different language domains and thus translatability, modes of expression (e.g. textual or graphical), and discursive strategies and rhetorical styles;
2) Semantic problems, or, differences in approaches and paradigms, that is, theoretical and methodological divergence;
3) Pragmatic problems, or, problems related to incentives and institutions, including academia's funding structure, career structure, and publication and peer review structure. Carlile (2004) develops this further into an 'integrative framework' for managing boundaries, summarized in Figure 1 below.

Figure 1 An Integrated/3-T Framework for Managing Knowledge Across Boundaries
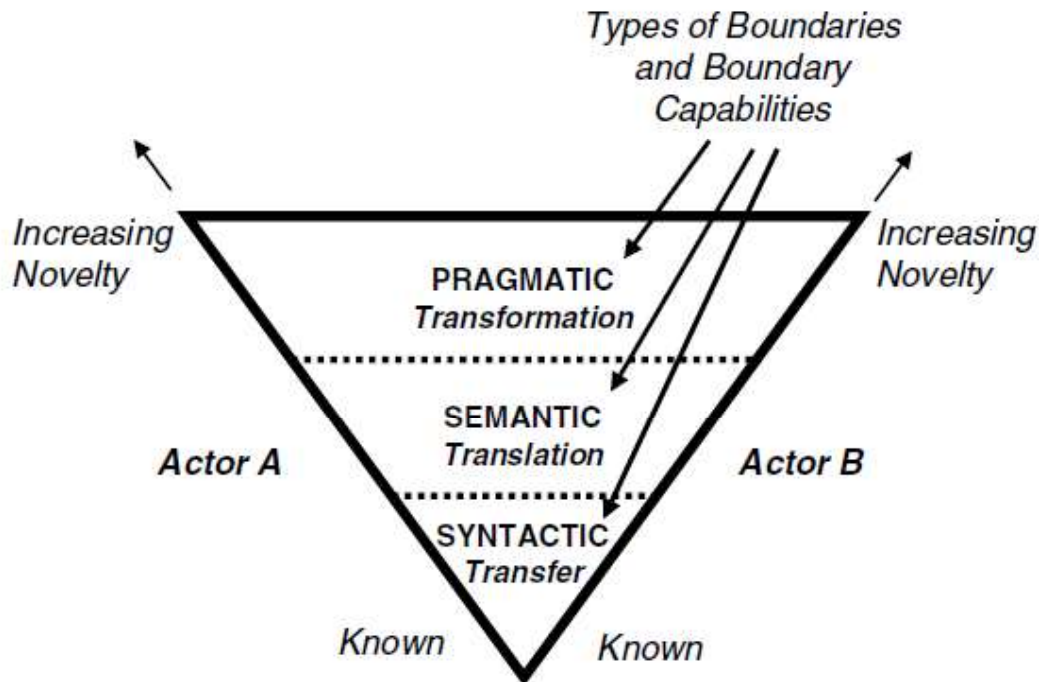

Fig. 1
Source: Carlile, 2004, p. 558

The activities of transferring, translating and transforming represent increasing degrees of complexity in making knowledge travel across boundaries. Transferring is about information processing, a technical exercise for which the right tools need to be used or developed (say, a database for an environmental impact assessment framework in which different contributors can deposit their data for combined processing). It assumes a common lexicon shared by contributors (say, a joint understanding and classification of ecosystem goods and services).

When the problem on which knowledge is to be shared becomes less 'tame' and 'novelty' increases[xv], an interpretive boundary arises and translating becomes the activity. Rather than sharing and pooling information the challenge is to share meanings and to develop mechanisms to deal with discrepancies in meanings attached to the same thing (for example, hydrologists, civil engineers, agronomists and neo-classical economists have understood the notion of 'irrigation efficiency' very differently, and a lot of conceptual and methodological work is required to develop a common framework, while critiques of the neo-

classical concept of efficiency by heterodox economists and other social scientists are even more difficult to reconcile). When novelty moves further into the direction of 'wicked' problems, the process of translation starts to reveal differences in interests and becomes a political boundary. Transforming becomes the activity. When interests conflict, which they tend to do in real-world NRM&HD problems, there are different costs and benefits for different actors and trade-offs that need to be negotiated. These 'costs' include 'knowledge costs', rethinking or even abandoning cherished theories, frameworks and methods, and also include material costs (say, in resolving the problem of unequal water distribution in an irrigation system managing engineers have to abandon their textbook professional knowledge on irrigation scheduling, and irrigators stand to lose or gain access to water).

This movement from a taxonomy of problems to an integrative framework for boundary management allows us to see that the challenges in boundary crossing in inter- and transdisciplinary endeavours are of various type and intensity[xvi]. It also allows us to think about what the most fitting

and effective tools (devices and processes), that is, 'boundary objects' (see Star and Griesemer, 1989), might be to do the work of different types and intensities of boundary crossing. While common standards and a common algorithm for processing data may suffice for addressing certain syntactic problems, the pragmatic/political problem of water allocation, distribution and use in the city of Phoenix, Arizona has led to the establishment of a separate boundary organization, the Decision Center for a Desert City. It operationalizes the boundary work required to achieve a sustainable water use scenario through a whole suite of, in White et al.'s (2008) words, 'boundary ordering devices' (including water briefings, data sharing techniques, models, and a decision theatre) for facilitating interaction and negotiation of a variety of academic research, policy and societal actors (also see Cash, 2001).

Carlile's framework also allows us to put Lele and Norgaard's (2005) 'forget disciplines, think scientific communities' discussed above into perspective. When problems are syntactic in nature, the main challenge may well be the creation of a common framework or calculus to align different disciplinary approaches. Arguably, this challenge is part of any inter- and transdisciplinary endeavor when knowledge production continues to be organized in units that we call and institutionalize as disciplines. As soon as problems move into the direction of the semantic/interpretive and pragmatic/political, as real world NRM&HD (knowledge) problems tend to do, there are additional things at hand and at stake. Alignment and negotiation of paradigms, worldviews and other semantics, as well as the alignment and negotiation of (knowledge and material) interests becomes a requirement. The issue of the 'technical' alignment of disciplinary knowledge may recede to the background as one of several things to be addressed, and perhaps not the most prominent one.

Carlile's framework allows us to think critically about the politics of the boundary work involved in inter- and transdisciplinary research. He observes that there may be a 'mismatch' between type of boundary problem and the devices and processes deployed for addressing them: addressing semantic or pragmatic problems with syntactic tools only is unlikely to work. He also observes that 'powerful actors' may impose their familiar way of doing things, and this may not be helpful because leaving semantic and pragmatic challenges unrecognized (Carlile, 2004, pp. 560-561). This 'mismatch' argument can be taken quite a bit further when we shift from the car industry (Carlile's domain of inquiry) to the domain of this essay, NRM&HD.

In one of the EC funded collaborative projects that I was involved in at ZEF Bonn and referred to above, the project leader in the first meeting of the project consortium, which harbored a variety of natural and social scientists, suggested to develop a list of definitions (a glossary) of the terms and concepts that we were going to use in this project, so that we would all work with the same understandings and definitions. The project focused on hydrological basin management and water governance. One of the concepts was 'institution'. When I questioned the glossary attempt by observing that there are very different understandings of 'institution' available in the academic literature, and that there is enormous variety in concretely existing institutions, and that perhaps the project was more about exploring which understandings would be useful for what analytical and practical purposes rather than close that exploration with a singular definition at the start, I was branded as a nuisance, disloyal to the project, and not interested in its successful implementation. What happened, I would suggest, is that a syntactic device (a glossary) was posited to be sufficient to also address semantic/interpretive and pragmatic/political aspects of the problematic at hand. Whether this arguing away from the semantic/interpretive and pragmatic/political dimensions was by design or by default I do not know. Structurally I have read it as the imposition of a positivist scientific paradigm (at the cost of my own critical realist stance) and as a way and desire to 'keep politics out of the research', as part of an instrumental approach to interdisciplinarity. The way I want to use Carlile's framework in this essay is to suggest that instrumental forms of inter- and (trans)disciplinarity favor syntactic/information-processing approaches and tools and tend to abstract from particularly the pragmatic/political dimensions of NRM&HD problems. In contrast, or so I argue, critical forms, of inter- and (trans)disciplinarity emphasize (and perhaps sometimes too exclusively emphasize) the pragmatic/political dimensions. I label approaches that include semantic/interpretive dimensions but abstract from pragmatic/political ones as forms of 'sophisticated instrumentalism'. In the next section, I discuss approaches to NRM&HD research in terms of Carlile's framework.

5. Benevolence

I did not only choose 'benevolence' as a heading because it nicely alliterates with binaries and boundaries. The notion of benevolence brings us to the topic of 'development' and refers to an im-

portant aspect of it. It captures the normative underpinning of (discourses legitimizing) development intervention, a strategic project implemented through policies, programmes and projects, with a 'human development' agenda attached or implied, to make the world a better place, materially and socially. Normative structures of benevolence underpin charity most obviously, but even top-down technocratic approaches to development conceive of their intervention and implementation activities as benevolent acts in the interest of the poor (cf. Li, 2007). The arguably most influential report on sustainable development, *Our Common Future*, the so-called Brundtland report (Brundtland, 1987), is full of claims of benevolence[xvii]. The most recent expressions are the UN's Sustainable Development Goals[xviii].

There may be nothing wrong with benevolent objectives in the abstract, but discourses of this kind obscure the 'violence of development' (Kapadia, 2002; Mowforth, 2014) and the 'tyranny of participation' (Cooke and Kothari, 2001) – to quote two evocative book titles. The 'common' in *Our Common Future* in one stroke obscures the world of difference and social relations of power. Sneddon et al. (2006) summarize critiques of the report as follows.

> "While the broad goals [of the Brundtland report] were widely embraced, critics argued that steps toward their implementation would be thwarted; first, by fundamental contradictions between the renewed call for economic growth in developing countries and enhanced levels of ecological conservation; and, second, by the inattention to power relations among the local-to-global actors and institutions supporting un-sustainable development (…). In retrospect, 18 years later, the critics appear to be more or less correct." (p. 254)

The assumption of 'benevolence' makes invisible the uneven and contradictory effects and impacts that development policy and intervention produce. Duffield puts it, very strongly, as follows in the context of humanitarian aid/assistance.

> "The benevolence with which development cloaks itself – its constant invocation of rights, freedom and the people – conceals a stubborn will to manage and contain disorder rather than resolve it." (Duffield, 2007, p. viii)

Critical perspectives on development have analyzed (claims of) benevolence as forms of paternalism, instrumental egoism and attempts at social control[xix].

In this section, I discuss how different forms of research on NRM&HD express and negotiate the normative structure of benevolence, specifically looking at approaches and strategies to generate interdisciplinary and transdisciplinary knowledge. All interdisciplinary and transdisciplinary

NRM&HD research activities are forms of boundary work and have implicit and/or explicit assumptions and premises on the nature and characteristics of the boundary work they are practicing. I replace Klein's instrumental/critical binary by Carlile's trinity of syntactic, semantic and pragmatic boundary crossing to produce a finer grained mapping of approaches to boundary work in the plurality of NRM&HD research.

5.1 Syntactic/information processing: Agent-based modelling and decision support

Syntactic approaches focus on comprehensive analysis of particular situations using a single conceptual framework, that is, one language to capture all dimensions and components of the complex situation of interest. Some approaches claim to have such a language. A characteristic example of this is agent-based modelling (ABM) of coupled human-natural systems linked with decision support systems (DSS). The ABM approach wants to be able to answer if-then questions, which then form the basis for proposing courses of action. Not only the physical behavior of the ecological/natural resources system is mathematically modelled, but also social behavior and human choice making. For example, for their analysis of domestic water management in the Spanish city of Valladolid Galán et al. (2009)

> "adapt and integrate different social submodels, models of urban dynamics, water consumption, and technological and opinion diffusion, in an agent-based model that is, in turn, linked with a geographic information system. The result is a computational environment that enables simulating and comparing various water demand scenarios." (p. 1)

In such approaches, different calculated /simulated scenarios then form the basis of decision-making, through formalized comparison and optimization or in other ways. "Model-driven DSS use algebraic, decision analytic, financial, simulation, and optimization models to provide decision support" (Power and Sharda, 2007, p. 1044). In the field of NRM&HD such approaches usually involve a combination of positivist forms of mathematical physical systems modelling with neo-institutional economics mathematical modelling of human behavior, for example using game theory (for discussion and examples, see for instance An, 2012; Hare and Deadman, 2004; Matthews et al., 2007).

Most of this work falls in the non-critical and in-

strumental category. It does not model social relations of power and is 'objectivist' in its approach to decision making, that is, subscribes to rational planning perspectives implicitly or explicitly. The 'coupled (human and natural) systems' vocabulary suggests that the nature-society binary is not transcended. A main challenge for (or critique of) these approaches relates to the question whether human agency, behavior and choice making can be adequately modelled/grasped through techniques like agent-based modelling. Those taking critical realist and interpretivist philosophical positions, as against a positivist position, would be (very) sceptical on general, foundational grounds, referring to the multiplicity, fluidity and evolutionary nature of human agency and human society among other things. But also practically, there are reasons for being sceptical: the 'take up' of these approaches seems to have been very limited. A 'within paradigm' assessment of the application of agent-based land-use models states that

> "there is a need to demonstrate that such models are able to solve problems in the real world better than traditional modelling approaches. It is concluded that in terms of decision support, agent-based land-use models are probably more useful as research tools to develop an underlying knowledge base which can then be developed together with end-users into simple rules-of-thumb, rather than as operational decision support tools." (Matthews et al., 2007, p. 1447).

Stephens and Middleton (2002) document the poor uptake of farm-level decision support systems in both developed and developing countries, with one reason for this being that their development is overwhelmingly science-driven rather than user-driven. Borowski and Hare (2007) discuss the limited results of providing model-based tools to water managers for implementing the European Water Framework Directive. There may thus be a high degree of scientists' wishful thinking in the advocacy of such approaches. In contrast, it may be argued that human behavior is increasingly made to operate in this manner by institutionalizing the techniques employed. This limited uptake is perhaps a reason for shifting the ambition of approaches as described from 'decision making' to 'learning'. Examples of this are Barnaud et al. (2010), Berger et al. (2010), and Tubaro and Casilli (2010).

Lastly, caution is required, here as elsewhere, not to succumb to caricaturing and homogenizing the described approaches too much. There are also efforts to insert techniques as referred to into local, participatory decision making (see for instance D'Aquino et al., 2003; Becu et al., 2008; exemplifying semantic approaches as discussed next), there are efforts to develop agent-based models of 'politics, environment and insurgency' (Cioffi-Revilla and Rouleau, 2010) (moving, at

least in thematic orientation, in the direction of the pragmatic approaches discussed below), and discussion of constructivist, as against positivist, approaches to agent-based modelling (LePage et al., 2013).

5.2 Semantic/interpretive: Participatory crafting of usable knowledge

In the field of sustainability science as understood in the USA, there has been a flourishing of innovative contributions on boundary work and boundary management. This literature focuses on "how researchers (scientists, engineers, planners, etc.) interested in promoting sustainable development can increase the likelihood of producing usable knowledge." (Clark et al., 2016b, p. 4570)[xx].

Characteristic of sustainability science is the premise that the alignment of the knowledge of different 'stakeholders' (involved in a particular issue and interested in its solution) is not a trivial matter but requires work. As Cash et al. (2003, p. 8086) put it, for being practically useful, knowledge not only needs to be credible (meaning scientifically sound), but also salient (it has to speak to the concerns of decision makers) and legitimate (the process through which knowledge is produced and who is the carrier of it matters), and there may be trade-offs between these three qualities of knowledge. Pohl and Hirsch-Hadorn (2007) propose that three types of knowledge are necessary for successful transdisciplinary collaboration around a particular issue: system knowledge (how the world works - A), target knowledge (what does the group of stakeholders want to achieve in terms of type or direction of a solution, having an inherent normative component - B), and transformation knowledge (the features of the process that can take the situation from A to B). These three types of knowledge cannot be reduced to each other (as an ABM-DSS type of approach arguably does by combining modelling with an optimization calculus).

Successful development and combination of system, target and transformation knowledge involves active 'boundary work' for "harnessing knowledge to promote action" (Clark et al., 2016a, p. 4615). Boundary work is generally considered to have three features: 1) meaningful participation of all stakeholders in agenda setting and knowledge production; 2) governance arrangements assuring accountability to stakeholders; 3) the production of 'boundary objects' – practical devices and processes that facilitate collaboration at the interface (ibid., p. 4615). Clark et al. (2016a) seek to add to these general principles

contextually specific strategies for organising boundary work, based on a comparative analysis of a set of research projects of the CGIAR (Consultative Group on International Agricultural Research).

There is a growing literature on the techniques of boundary work as transdisciplinary research practice. Key themes are learning (Müller et al., 2005; Schneider and Rist, 2014; Roux et al., 2017), leadership and roles (Pohl, 2005; Pohl et al., 2010), communication (McGreavy et al., 2013), and collaboration (Kumazawa et al., 2017). Central to the sustainability science type of approach is what is called 'participation' in the development studies literature: the involvement of all those who have a stake in solving or transforming a particular problem or issue is not a sufficient, but certainly a necessary condition for a successful contribution to human development. For example, Krueger et al. (2016) summarize as follows in a paper on European water research.

> "Participation in water research and governance is typically motivated normatively (people have a right to influence matters that affect them), substantively (bringing diverse perspectives and knowledges together leads to better evidence and policies) or instrumentally (participation leads to greater acceptance of policies and outcomes)." (p. 378)

Sustainability science's boundary work is prone to the same limitations and critiques as the development literature has identified for participation more broadly (cf. Cooke and Kothari, 2001; Hickey and Mohan, 2005). Siew et al. (2016) for example provide a detailed description of practical efforts at enhancing participation of scientists and practitioners in integrative efforts at improving natural resources management through self-conscious boundary work in four transdisciplinary research projects in China, Vietnam and the Philippines. The paper describes many of the recurring challenges reported in the literature on university-based consortia with European leading partners working in the global South. The paper's observations strongly resonate with my own experience of the challenges in such projects in Uzbekistan (Hornidge et al., 2011) and India. A primary focus of scientists on disciplinary research, different kinds of hierarchies that hinder open 'horizontal' collaboration, and a variety of communication and translation problems, are among the main challenges. Rather than further discussing these challenges as such, I want to suggest that such analyses of the challenges in boundary work in transdisciplinary research projects illustrate a defaulting to 'getting the process right'[xxi], away from the substantive and political challenges that this type of projects and mode of doing research pose.

In Siew et al. (2016), all recommendations derived from the evaluation of the four projects are focused on their internal research process, rather than on the contextual and strategic positioning of the projects, notwithstanding the authors' observation, in passing, that in all projects "local political conditions restricted the set of stakeholders that could be involved in the research processes" (p. 813). Brandt et al. (2013) in their review of transdisciplinary research in sustainability science conclude that very few projects achieve empowerment, on a scale of increasing stakeholder involvement intensity of information – consultation – collaboration - empowerment. They observe that the link between academic researchers and practitioners is often not strengthened, while the transdisciplinary research was exactly meant for that. Chilisa (2017) discusses how transdisciplinary sustainability science can (or rather should) be 'decolonized', and democratic scientific inquiry achieved, through an analysis of the relationship between academic and indigenous and local knowledge based on southern African examples[xxii]. Marshall et al. (2018) assess that in the sustainability science literature "[e]ngagement with the wider system appears to be limited to the function of supporting solution-oriented knowledge production" (p. 2). Their suggestion that instrumentalism prevails thus rings true.

This suggests that structural changes may be required rather than, or in addition to, individualized (research) projects – which are the dominant form of scientific practice in sustainability science. Bold general statements are made on this in sustainability science, but in concrete terms of 'what to do' the approach stays within instrumentalist boundaries.

Cash et al. (2003) call for a "'new contract' for science and engineering (..) to be seen as a truly radical contract, not just for individual studies or projects, but for whole professional careers" (p. 8090). Clark et al. (2016b) want "[r]esearchers seeking to craft usable knowledge (...) to accept the political character of their work" as science "may impinge on power structures", and possibly "forsak[e] research that academic colleagues would judge to be at the cutting edge of the field in favour of more mundane or practical work." (p. 4573) However, when it comes to practically dealing with social relations of power, these need to be 'managed' – in participatory development mode[xxiii].

> "Efforts linking knowledge with action are more likely to be successful when they manage to 'level the playing field' to generate hybrid, cocreated knowledge and deal with the often large (and largely hidden) asymmetries of power felt by stakeholders." (proposition 7 in Kristjanson et al., 2009, p. 5052)

Marshall et al.'s (2018) own approach seeks to address "structural injustices in knowledge systems" (p. 1) by adding a transformative space making (TSM) orientation to the cocreation of solution-oriented knowledge in TDR (transdisciplinary development research). In the 'TDR as TSM' approach, knowledge production is meant to serve as a catalyst for system transformation. However, like in sustainability science, hope is invested in the capacity of the development industry to accept and support approaches that address the 'politics of structural injustice'.

> "Finally, we argue that development research funding and commissioning agencies should pay attention to the mechanisms of TSM, alongside more recognized aspects of the planning, monitoring, and evaluation of TDR initiatives, in order to provide appropriate support for enhanced impact." (p. 1)

Development research and its funders thus remain the frame of reference of Marshall et al.'s (2018) discussion (for similar positionings and reflection on these, see Van Kerkhoff and Lebel, 2006; Wiek et al., 2012; Krueger et al., 2016; Schmidt and Pröpper, 2017), suggesting the disciplining force of research funding[xxiv].

I conclude that notwithstanding observations and calls emphasizing the politics of knowledge and social transformation, the sustainability science literature on boundary work as transdisciplinary practice remains predominantly focused on 'getting the (project) process right'. Politics and power tend to disappear to the background both with respect to the context in which projects function, and as regards internal relations in projects. Sustainability science should therefore, in my assessment, be considered as a sophisticated form of instrumentalism rather than a critical form of transdisciplinary development research.

5.3 Pragmatic/political: Activist research for transformative change

When the point of departure of syntactic/information processing approaches is the pursuit of new scientific knowledge, and the point of departure of semantic/interpretive approaches the pursuit of sustainability, then the point of departure of the third, pragmatic/political approaches is the pursuit of structural societal transformation. Not surprisingly therefore, little of the research discussed in this section self-identifies as inter/transdisciplinary research on NRM&HD, let alone sustainability science. United under this third heading are research activities that self-identify as (participatory) action research and activist research that addresses natural resources

management issues to a smaller or larger extent. To a large extent, this research is institutionally located in social movements and civil society organizations outside the academic system.

Choudry (2013) argues that social movement networks are significant sites of knowledge production through 'activist research'.

> "[R]esearchers located outside of universities are often referred to as project workers, community activists or consultants, 'anything but 'researchers'. They search and record, they select and interpret, they organize and re-present, they make claims on the basis of what they assemble. This is research' (Smith 1999:17)." (Choudry, 2014a, p. 477)

Hale (2001) describes activist research as having the following features[xxv]. It:

> "a) helps us better to understand the root causes of inequality, oppression, violence and related conditions of human suffering; b) is carried out, at each phase from conception through dissemination, in direct cooperation with an organized collective of people who themselves are subject to these conditions; c) is used, together with the people in question, to formulate strategies for transforming these conditions and to achieve the power necessary to make these strategies effective." (p. 13)

Activist research takes sides, and researches and acts from that standpoint, rather than projecting an 'involvement of all stakeholders' model for the research process with a facilitating role for researchers, as sustainability science tends to do. In similar vein, Pulido (2008, p. 342) defines 'organic praxis' (citing Gilmore, 1993, p. 71) as "talk-plus-walk: it is [the] organization and promotion of ideas and bargaining in the political arena", which connects the scholar "to oppositional action beyond that of writing for academic audiences". Hale (2006) counterposes (within anthropology) activist research and 'cultural critique', and approvingly summarizes Tsing (2005) as arguing that in cultural critique "efforts at theory building (..) have degenerated into unmoored conversations among smart, critical, disaffected, and largely ineffectual intellectuals" (Hale 2006, p. 104).

> "Cultural critique, and the approach to ethnography it has spawned, is politically positioned, with primary (or even exclusive) commitments to the institutional space from which it emanates. Activist research, in contrast, affirms dual political commitments from the start. Activist anthropologists attempt to be loyal both to the space of critical scholarly production and to the principles and practices of people who struggle outside the academic setting." (ibid.)

Based on (his involvement in) indigenous land rights movements in Central America, Hale argues the academic case for activist research by linking "the practice of activist research with key moments of theoretical innovation", and

"asking whether the dual commitment to a political struggle and intellectual work on these issues has in fact yielded new and challenging ideas that later achieved a central place within academia" (Hale, 2006, p. 108)

One possible answer to this question can be found in the field of political ecology. Martinez-Alier et al. (2014) document grassroots concepts for sustainability as generated and formulated by what the authors call Environmental Justice Organizations. There is a whole series of concepts, for each of which the origins in social movements and social activism are traced: environmental justice (and specifications of that like climate justice, water justice, food justice, transport justice, and others), ecological debt, biopiracy, food sovereignty, land grabbing, extractivism, and others. Together these have produced a 'political ecology from the bottom up' (ibid., p. 21). The concepts have generated substantial academic research programmes, but stem from outside universities and research institutes (ibid., p. 36). This is, indeed, how political ecology understands itself – not just as an academic research and teaching programme, but as an epistemic community with a particular style of speaking, writing and acting in the world (cf. Heynen and van Sant, 2016; Temper et al., 2016; Osborne, 2017; Batterbury, 2018)[xxvi].

Like the first two clusters of research, this third one also faces several challenges. Given the focus on critical interdisciplinarity of this essay, I discuss three types of challenges, related to 1) the process of knowledge generation, 2) how the interconnection between the ecological and the human is understood, and 3) the separation of bias and objectivity in research.

Knowledge generation: One question asked in the literature on activist research is whether it has a specific method. Viewpoints differ, partly because of different understandings of 'method', but clearly, the methods of (participatory) action research are central to discussions on activist research. Typical features are long-term engagements of academic researchers with social movements (questioning the project mode of regular academic research), collective modes of knowledge generation (against the individualism of academia), and a 'radical' form of participation in participatory action research. Activist research seeks to change the 'everyday material relations of the research process' (Hale, 2006, p. 103) and is suspicious of the notions and practices of 'participation' that tend to prevail in mainstream research and that makes academic researchers shy away from the fact that "[a]ctivist research involves commitments that are not accountable to arbitration, evaluation, or regulation from within

academia" (ibid., p. 105). Notwithstanding activist research's strong and clear principles, operationalizing participatory action research remains a considerable challenge as the 'dual commitment' demands continuous negotiation and mediation[xxvii].

The ecological and the human: There is little doubt that activist research on NRM&HD adopts an overall conception of the ecological-human connection as a (hybrid and complex) single system. The field of political ecology is grounded on this very idea. This holistic perspective expresses in the cosmovisions that normatively frame it (from the standpoint of marginalized groups – environmentalism of the poor/dis-possessed; Martinez Alier, 2003), and in the analytical popularity of the category of 'metabolism', particularly in urban studies, which captures both the interconnected and cyclical/recursive nature of socioecological systems (Heynen et al., 2006; Newell and Cousins, 2015). Alternative designs of these connections and metabolisms exist in the form of concrete, often local, initiatives and practices (as for instance in agroecological practices of farming advocated by La Via Campesina, see Val et al., 2019).

Most of the 'grassroots concepts' listed by Martinez-Alier et al. (2014) as referred above are social relations concepts, capturing rights, justice and related matters. Very few, if any, theorize the ecology-humanity connection beyond a general, abstract level.

> "EJOs often draw upon concepts coming from the sustainability sciences, for instance they know, use and sometimes criticize the ecological footprint, the HANPP (…), 'peak-oil' and EROI, material flow analysis, the Environmental Kuznets Curve, life-cycle analysis, ecological terms of trade, cost-benefit analysis and multi-criteria assessment, resilience, valuation of ecosystem services…." (p. 50)

Whether these 'master's tools' can bring down the 'master's house' would seem to be a question (cf. Kloppenburg, 2010).

Bias and objectivity in research: Fox (2006) formulates the following methodological dilemma for activist researchers.

> "On the one hand, we are biased, in the sense of having strong sympathies or preferences for the way we want the story to end. On the other hand, it is not going to help movements to assess past strategies and plan new ones if we just tell them what we want to hear or already know. This means that it's worth trying to disentangle objectivity from bias - two ideas that are often conflated - in order to provide an objective analysis about what worked and what did not." (Fox, 2006, p. 33)

But Fox also observes that "we know that sympathetic scholars often wait decades before daring to call mistakes mistakes" (ibid., p. 34). Identification with a social movement requires

identification with, or at least accepting, the 'strategic essentialisms' that it adopts in the messy and harsh reality of everyday politics and struggle. The pitfalls from an academic perspective are, first, keeping silent (as Fox indicates), that is

compromising academic integrity, and second, strategic essentialisms translating into analytical reductionisms (Baviskar, 2003; Mollinga, 2010b), leading to partial, if not apologetic, analysis.

	System knowledge	Target knowledge	Transformation knowledge
Syntactic/ information processing *ABM-DSS*	Integrative mathematical system modelling and methodological individualism. Social relations of power absent as system component or dimension.	Primarily focused on (academic) knowledge generation. Priority setting/decision making externalized to non-academic actors. Sustainable development objectives formulated in the most general terms.	Rational planning
Semantic/ interpretive *Sustainability science*	Socioecological systems analysis and modelling. Complexity theory. Policy analysis. Dedicated reflective interest in inter- and transdisciplinarity. Social theory usually not explicit on social relations of power.	Primarily focused on sustainability and sustainable development. Objectives articulated in 'benevolent' terms (prevalence of 'visioning'), looking for 'within system' solutions.	Participation, boundary work
Pragmatic/ political *Activist research*	Explicit analytical focus on social relations of power in concrete struggles/issues. Focus on 'grassroots concepts' and 'bottom up' theorising. Holistic understanding of hybrid and complex ecological-human systems through metaphors like 'metabolism'. Borrowing of a diversity of analytical tools.	Explicit and specific social transformation objectives articulated in terms of (in)equality/winners and losers and justice/rights. Explicit and partisan political theory.	Theories of (political) change

5.4 Situated knowledges

My summary characterization of the three clusters of approaches is given in the table 1 below. This table suggests that for the degree of instrumentalism/criticalness of inter/ transdisciplinary research on NRM&HD institutional location and accountability decisively matter.

The syntactic/information processing ABM-DSS type of research discussed above is mostly firmly located in the academy, though with policy-re-

lated research funding sources. It is the most instrumentalist of the three types in that it sees a direct link from scientific analysis to decision making, and represents a modernist, rational planning view of development. In academia, the 'push' for dedicated problem solving (in the sense of real-world problems) is often less obvious and pertinent than that of solving intellectual puzzles. Policy research funders have in several ways tried to make interdisciplinarity compulsory by making it a conditionality of research funding, but with

mixed results (Pohl, 2005). As Fox (2006, p. 29) poignantly states:

> "In the social sciences, the well-oiled mainstream research apparatus and its associated media 'punditocracy' are staffed by literally thousands of PhDs whose livelihoods depend on thinking inside the box."

The semantic/interpretive sustainability science approaches are strongly located in global research institutes supported by global and national policy funding on environment and development. Sustainability science thus often adopts the language of mainstream development paradigms and its recurrent 'visioning' exercises – 'participation' being an example of that. Sustainability science is under constant pressure to assume or profess that 'getting the process right', the process being the 'boundary work' required, can solve the substantive challenges of 'sustainable development'. Sustainability science thus easily depoliticizes itself. This positioning I label as 'sophisticated instrumentalism'. Sophisticated because it makes use of many critical insights, but instrumentalist because it chooses to focus on 'within system' innovation through 'getting the process right'.

The pragmatic/political third cluster of research approaches, takes issue with the very notion of 'sustainable development', and 'participation', and proposes activist, transformative approaches to research that change the material relations of knowledge production. Its location is mostly outside regular academia, policy and research funding circles. It exists as a much less consolidated practice accountable to myriad social and political movements, though political ecology and environmental justice movements may be an emerging consolidation. Activist research faces the challenge that it "is compromised – but also enriched – by opting to position itself squarely amid the tension between utopian ideals and practical politics." (Hale, 2006, p. 100)

As Fox (2006, p. 31) reminds us "[t]hinking of how our institutional locations influence agendas is a reminder of the meanings of the term 'discipline'". Though my description of locations has a clear element of simplification, what is safe to conclude is that all three clusters of approaches should be understood as 'situated knowledges' in the sense of Haraway (1991). The ideals-practice challenge described for activist research arguably exists in all forms of science, as all are situated knowledges, even when their positioning may be implicit. This credits activist research for at least addressing political positioning explicitly, but that, of course, does not resolve the challenge.

6. Conclusion

In the three preceding sections on binaries, boundaries and benevolence, I have made three points on inter/transdisciplinary research on natural resources management and human development. Together they form the main message of the paper.

1) Scientific and political practice suggest that binary thinking is difficult to avoid but can be very treacherous. The 'Cartesian divide' between nature and society is the primary binary in the NRM&HD field and creates many hurdles for addressing contemporary complexity in the dynamics of natural resources and development. Interdisciplinarity must come to the rescue to address complex problems; it is critical interdisciplinarity when it seeks to transcend divides created through nature-society binarism.

2) In science, as elsewhere, a lot of boundary creation and boundary guarding is taking place – of the tribes and territories we call disciplines. Simultaneously the complexity of societal problems has stimulated the emergence of experiments with and reflection on processes of boundary crossing and boundary work. However, the problem may not primarily be located in 'disciplines' but in 'paradigms'. Interdisciplinarity is critical when it is self-conscious about paradigmatic location and adopts a scientific approach that allows the investigation of 'politics', including that of the research and the researcher.

3) Inter- and transdisciplinary research are not inherently critical; their critical moment needs to be preserved and struggled for, particularly in the present development research policy emphasis on instrumental interdisciplinarity. Interdisciplinarity may get 'depoliticized' in sophisticated incarnations of instrumentalism like sustainability science.

Notes

i For more elaborate classification and mapping see Hopwood et al. (2005) and Storm (2009).

ii This is certainly, and unsurprisingly, the case in the corporate sector, where interdisciplinarity is explicitly about 'problem fixing'. It is also the case in for instance the European Commission funded research programmes on natural resources management, and the Global Challenges Research Fund (GCRF) in the UK. In the international development sector, the imperative of 'research impact' illustrates this dominance.

iii Additionally, the ongoing expansion of disciplinary specialization mostly happens by combining components of 'parent' disciplines (economic anthropology, ethnobotany, molecular biology, etc.), which then may or may not get institutionalized as disciplines. This is Robinson's 'first temperament' of interdisciplinarity, academically focused on intellectual puzzles, which he calls 'discipline-based interdisciplinarity' (Robinson, 2008, p. 71). What I suggest here is that also Robinson's 'second temperament' of 'issue-driven interdisciplinarity', which is "driven primarily by a desire to engage with issue[s] in the non-academic world" (ibid.) is equally prone to disciplinary institutionalization, with possible loss of critical edge in the process. My focus is to distinguish between instrumental and critical interdisciplinarity within Robinson's 'issue-driven interdisciplinarity'.

iv Lele and Kurien (2011, p. 228) argue that there has been an academic 'takeover' of the interdisciplinarity of environmental studies by (sub-)displines, fragmenting, compartmentalizing and voluntarily ghettoizing 'ID space'.

v The full names of the departments are Political and Cultural Change, Economic and Technological Change, and Ecology and Natural Resources Management (www.zef.de).

vi Such problems are also documented in the literature on interdisciplinarity; see Simon and Goode (1989) for an early paper.

vii I choose the formulation of 'resonate' deliberately as there are no simple 1:1 relationships between scientific approach and position on policy intervention/social change. For discussion in a more general context, see for instance Burawoy (2005).

viii For instance: "Due to the emergence of phenomena such as global climate change and unprecedented fires, floods, and pest outbreaks (…), it has become increasingly clear that enlightenment ideologies that separate nature and society cannot adequately explain the complicated interactions that shape our world (…). To address a growing number of environmental issues, interdisciplinary research is needed that bridges the ideological and intellectual divide between nature and society (…)." (Stuart, 2016, p. 118).

ix A more detailed account would look at: a) is 'social power' explicitly conceptualized or not; b) how is 'power' conceived; c) which strategy for societal change is adopted? Such detailed discussion is beyond the scope of this essay. I thank Sharad Lele for inducing me to

point out the limitations of my binary instrumental/critical shorthand.

x For an interesting view, and partly a counter-argument, see Hacking (2005). On the mind/body divide, see for instance Handelman (2007) and Swan (2005).

xi The desiccation of the Aral Sea for enhancing cotton production is the iconic environmental failure of the Soviet Union (Obertreis, 2017; on the history of Soviet and post-Soviet environmentalism, see Coumel and Elie, 2013).

xii Wicked problems are problems that are both ontologically and societally complex (Mollinga, 2010a), as phenomena/systems behave in non-linear fashion, have no fixed set of alternative solutions, and require negotiation/interaction among 'stakeholders' for framing and addressing them, providing the basic grounding for transdisciplinary research approaches. For the original statement see Ritter and Webber (1974).

xiii Recent work on boundaries in this sense includes Swedlow (2007, 2017) and Singleton and Lidskog (2018). For illustration of the tribal and territorial behaviour of disciplines, see the interesting analysis of 'degradation rituals' in science in Thérèse and Martin (2015).

xiv This essay is not about, or grounded in, border studies as such but uses concepts similar to concepts used in the field of border studies. I leave it to border studies scholars to assess whether this similarity is more than semantic overlap. I understand border zones as complex objects, like natural resources management situations, inhabited by multiple actors with multiple relations in a structured configuration composed of both material/physical/technical and human/social components. The question of (critical) interdisciplinarity would seem relevant to both.

xv "'Novelty' refers to a situation where all is not known to address a particular problem, and innovation (through sharing and collaboration) is required. Novelty underscores the participatory and relational nature of what an actor needs to share and to assess when all is not known. Further, unlike uncertainty, novelty doesn't allow us to take for granted that what is new is easily recognized as something unknown. Actors are susceptible to misrecognizing what is novel as something that is already known (i.e., competency traps (…)) or discarding what is novel as irrelevant (…). (…) [T]his tendency [has been referred to] as the 'curse of knowledge', which recognizes the difficulty that actors have in abandoning previous knowledge (i.e., knowledge is 'at stake'). These issues highlight the challenges that actors face in identifying what is of consequence when novel circumstances arise (…)." (Carlile, 2004, p. 557).

xvi While interdisciplinarity can be conceived of as a practice happening fully within the academic domain, transdisciplinarity is 'interdisciplinarity with stakeholders'. It involves societal actor groups in research for addressing concrete societal problems, including joint problem framing. Boundary crossing challenges grow through the presence of multiple types of actors and knowledge

(see Pohl and Hirsch Hadorn, 2007 for transdicipli-narity's 'design principles').

xvii For instance, where the concept of sustainable development is discussed (para. 4): "The essential needs of vast numbers of people in developing countries for food, clothing, shelter, jobs - are not being met, and beyond their basic needs these people have legitimate aspirations for an improved quality of life. A world in which poverty and inequity are endemic will always be prone to ecological and other crises. Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life".

*xviii*https://sustainabledevelopment.un.org/post2015/transformingourworld "This Agenda is a plan of action for people, planet and prosperity. It also seeks to strengthen universal peace in larger freedom. We recognise that eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development. All countries and all stakeholders, acting in collaborative partnership, will implement this plan. We are resolved to free the human race from the tyranny of poverty and want and to heal and secure our planet."

xix For a varied set of perspectives on benevolence and social power, see Banner (1973), Chan et al. (2013), Cook (2012), Domanski (1997) and Leung and Nann (1995).

xx I consider the work of Harvard-based William Clark, David Cash and collaborators as the most relevant example of sustainability science thinking for the purposes of this paper as it explicitly relates to collaborative research experiences in the global South. Much of the European literature on sustainability science/transdisciplinary research is based on European/OECD experiences, though with an increasing presence of experiences in the global South.

xxi The 'getting the process right' phrase originates, for me, from Uphoff (1986).

xxii On power and knowledge in interdisciplinary environmental research, see MacMynowski (2007) and Gardner (2013).

xxiii For general discussion of participation as a 'fix', see Cornwall and Brock (2005) and Gaventa (2016).

xxiv Marshall et al's (2018) paper is a paper for the IDS STEPS Centre. The Pathways to Sustainability programme led by the STEPS Centre at IDS (Institute of Development Studies), Sussex, UK (https://steps-centre.org/) has consistently and enduringly produced critical analyses of collaborative and transdisciplinary NRM&HD research (see Scoones, 2016 for a general positioning). For IDS' continuing effort to insert critical insight into 'mainstream' development thinking, and as an illustration of 'living the paradox', see Leach et al. (2018).

xxv To date, the most comprehensive collection of scholarly papers on activist research is Hale (2008). Also see Casas-Cortés (2009) and Choudry (2015). For a discussion of 'common obstacles and useful tools', see Flood et al. (2013). On issues of validation, peer review and the importance of scientific credibility, see for instance Choudry (2014b).

xxvi Not all political ecology understands itself like this, there are conventional academic forms of it too, and perhaps increasingly so, and it is probably not only political ecology that picks up 'grassroots concepts'. I do think it is fair to say that political ecology stands out as quite distinct in this respect.

xxvii On the lure of collaboration and participation in the context of neoliberal conservation and the green economy, see Adams (2017). Fox (2006) is an engaging introduction to the challenges of activist research. Action research is a slippery category; Fox (2006) classifies it into conservative, centrist, liberal and alternative (or critical) action research. Wittmayer and Schäpke's (2014) paper is at the interface of sustainability science and action research, aiming to mobilize insights on researcher position and role in action research for sustainability science.

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ADDRESS

Peter P. Mollinga, Professor of Development Studies, SOAS University of London, Thornhaugh Street, Russell Square, London WC1H 0XG, UK, pm35@soas.ac.uk

BIOGRAPHICAL NOTE

PETER P. MOLLINGA, Professor of Development Studies. My research interests are: 1) water and development; 2) the dynamics of agriculture and environmental resources management; 3) interdisciplinarity in efforts at 'integrated' natural resources management and governance; with geographical focus Asia, particularly South Asia and Central Asia. Trained as an irrigation engineer at Wageningen University, the Netherlands, from where I did my PhD on the political economy of irrigation water management in South India. My Habilitation in Development Sociology was completed at the University of Bonn, Germany in 2009. Professor of Development Studies at SOAS University of London since 2010. Presently coordinator of an EU H2020 research project on agriculture and migration ('Leaving something behind' - Migration governance and agricultural & rural change in 'home' communities: comparative experience from Europe, Asia and Africa) (2019-2022), and researching, together with Indian colleagues, the 'uses and meanings of water' in the State of Gujarat, India downstream of the Sardar Sarovar dam.