Public Environmental Information Systems:

Challenges and Perspectives

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A thesis submitted for the degree of Doctor of Philosophy

Abstract

Ever since "the environment" gained its place in the public agenda, it has been bundled with information and information systems. Today, the claim that "the discussion on the environment should be an informed one" can be considered as almost a truism. While many features of information and data are sources of heated debate (including content, ownership, cost and accessibility), the need for information is never questioned. The area of environmental information systems is becoming more complex due to the current trend of making this information available to the public. This process is based on the assumption that access to environmental information will improve public awareness and participation.

This thesis investigates public access to environmental information, starting with the examination of environmental information and environmental information systems (EIS). This examination demonstrates that the term "environmental information" holds a wide range of meaning, and while it is possible to describe "core environmental information", the full range of environmental information is open for wide interpretation. In regard to environmental information systems, the thesis demonstrates the importance of Geographical Information Systems (GIS) as a major component of most EIS, and the influence of the institutional settings within which they operate on these systems. To better understand the requirements and needs of likely users of environmental information (those with interest in environmental issues and with access to the technology), the thesis contains two empirical studies – a web-based survey of requirements and needs from a public environmental information system for London, and a public participation workshop in which representatives of local interest groups explored the use of GIS for local planning purposes. The analysis of these studies (using the framework of Soft Systems Methodology) leads to the development of conceptual models and criteria set for public access to environmental information. These models and criteria are then compared to existing web-based information systems, a comparison that reveals gaps between the desired system and the current state of the art. The thesis ends with some suggestions about how to improve information systems to improve public access.

The thesis is based upon a wide array of topics, including aspects of Human-Computer Interaction (HCI) in the context of Geographical and Environmental Information Systems (GIS/EIS), Information Systems Design methodologies, Public Participation GIS (PPGIS), Public Understanding of Science (PUS), social aspects of Information and Communication Technologies (ICT) and Philosophy of Technology.

Table of Contents

List of Figures[1]

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[1] Larger colour versions of the figures marked with an asterisk are included in Annex II

List of Tables

F o r w a r d   a n d   A c k n o w l e d g e m e n t s

The study described in these thesis began three years ago with the awkward title: "The Socio-Environmental Implications of Virtual Reality Interface to GIS". Its starting point was the false assumption that, in the context of environmental decision making, the information flow to and from the public are well understood. Hence, all that is left is to use the latest technology (VR and GIS) and explore how it can contribute to this knowledge area.

As a student of Geographical Information Science for many years, and being aware of the extensive research on environmental applications of GIS, I was certain that the usage of environmental information by different users is a well documented and clear issue. I was surprised to realise that this is not the case. One of the first issues that arose was "there is probably nothing special in environmental information and, therefore, there is no need to focus on it - general studies of information systems can provide the needed insights". The thesis that follows argue that this is not the case. Environmental information deserves special attention, and the time is ripe to start scrutinising its uses and applications.

From the outset, I was conscious that a study that tackles public access to environmental information ought to be based on an extensive research programme. Being very aware of my limited resources and the time frame, I have approached this study as a collaborative project where I will be able to receive the details that I need while others that assist me will gain from it too. Therefore, I feel obliged to acknowledge those who helped, and to clarify to which parts they have contributed.

The two empirical studies of this project rely on extensive help. The London Environment Online (LEO) survey was developed with the help of the LEO team (Dr. Kate Heppell and Steve Evans) and the students on the Human Computer Interaction (HCI) course of 1999 at the Computer Science Department under the guidance of Dr. Angela Sasse. Once the extensive results were gathered, I had the daunting task of analysing vast amounts of textual information. I am grateful to Dr. Gail Davis and her students at the Public Understanding of Environmental Change course of 2000 for their enthusiasm in dealing with this data and providing me with their reports. I have stated where my analysis is interwoven with those reports.

The UCL Brownfield Research Network could not have materialised without the active engagement of Dr. Kate Heppell, Dr. Carolyn Harrison, Rebekah Boott, Dr. Judy Clark, Dr. Sue Batty, Alex Aurigi and Jeremy Moreley. The workshop involved over 30 people from CASA, Geomatic Engineering and Geography (Environment and Society Research Unit - ESRU) - all contributed to the success of it.

Abbreviations

CASA	Centre for Advanced Spatial Analysis (UCL)
CATWOE	Clients, Actors, Transformation, Weltanschauung, Owner, Environment (part of SSM terminology)
CEQ	Council on Environmental Quality (US)
CMC	Computer Mediated Communication
COTS	Commercial Of-The-Shelf (standard software)
DETR	Department of Environment, Transport and Regions (UK)
DSS	Decision Support System
EA	Environment Agency (UK)
EC	European Commission
EEA	European Environmental Agency
EIA	Environmental Impact Assessment
EIS	Environmental Information System
EPA	Environment Protection Agency (US)
ESRU	Environment and Society Research Unit (Department of Geography, UCL)
FAQ	Frequently Asked Questions
FoE	Friends of the Earth
GIS	Geographical Information System
GMO	Genetically Modified Organism
GRASS	Geographical Resources Analysis Support System (Open source GIS)
GRID	Global Resource Information Database (part of UNEP)
GUI	Graphical User Interface
HCI	Human-Computer Interaction
ICT	Information and Communication Technology
INFOTERRA	Global environmental information system of UNEP
IRC	Internet Relay Chat
LEO	London Environment Online
NCGIA	National Center for Geographical Information and Analysis
NEIS	National Environmental Information System
NEPA	National Environment Policy Act (US, 1969)
NGO	Non-Governmental Organisation
NIMBY	Not In My Back Yard
NLUD	National Land Use Database (UK wide project)
OECD	Organisation for Economic Co-operation and Development
OS	Ordnance Survey (UK)

PEIS	Public Environmental Information System
PPGIS	Public Participation GIS
PSR	Pressure-State-Response (OECD model for environmental information)
PUS	Public Understanding of Science
RAD	Rapid Application Development
RD	Root Definition (part of SSM terminology)
SDSS	Spatial Decision Support System
SSADM	Structured System Analysis and Design Methodology
SSM	Soft Systems Methodology
SSSI	Sites of Special Scientific Interest
UBRN	UCL Brownfield Research Network
UCD	User Centred Design / Development / Deployment)
UDP	Unitary Development Plan
UN/ECE	United Nations - Economic Commission for Europe
UNEP	United Nations Environmental Programme
WWW	World Wide Web

1 Environment, Environmentalism and Information

In most accounts, the publication of Rachel Carson's "Silent Spring" (Carson 1962) is considered to be the starting point for the modern, late 20th century environmental movement. In fact, what we today call environmental politics predates this era and environmental awareness did not appear on the public agenda in the 1960s. Among events that demonstrate awareness to environmental problems we can find the 1930s American "dust bowl" problem, or even as far back to 1388 when legislation was introduced to control pollutant emissions in England (Lowenthal 1990). However, for any study of current day environmental politics, the 1960s serve as an established and well-recognised starting point. In this modern environmental movement, information and information systems play an intriguing role. As environmental issues secured their position in national and international agendas, environmental information followed suit, albeit in a low key manner. In the years and decades that followed, environmental information, and the computerised systems that store it - Environmental Information Systems (EIS) - continued to evolve and to grow outside the limelight. In recent years, the issue of public access to environmental information is forcing a re-examination and re-evaluation of the connection to, and role of information in, environmental politics.

This thesis aimes to improve our understanding of the role of environmental information, and the need for public access to it. The main issue that will be tackled is the essence of public access to environmental information: making the information more relevant and effective for the core group of its users - those within the general public with an interest in the environment. This thesis tries to unpack and understand the various issues that surround public access to environmental information: the meaning of the term "environmental information", the provision of information, its applications and the requirements and needs of its potential users. Therefore, the starting point for the thesis is a description of the relationship between environmental politics and information. In subsequent paragraphs, a brief sketch of the connection between environmental politics and information will be outlined. Once this connection is explained, the main research questions of the thesis will be explained and the general structure of it will be laid out. This chapter ends with a few general notes about the methodological and structural aspects of this thesis.

1.1   A BRIEF HISTORY OF ENVIRONMENTAL INFORMATION

Once the wheels of the modern environmental movement were set in motion, wide ranging environmental regulations and legislation started to emerge throughout the developed world. By the end of the decade (literally on the last day of 1969), the US congress enacted the National Environment Policy Act (NEPA) - another milestone in the history of environmental politics (McCormick 1995). NEPA binds environmental politics and information explicitly. The two main implementation vehicles established were an annual report on the state of the environment and Environmental Impact Assessment (EIA), both of which can be interpreted as information tools.

The EIA is a "detailed statement by the responsible official" (U.S. Congress 1970, Sec. 102) about impacts of proposed action on the environment. Indeed, NEPA refers to EIA as a decision making tool, but leaves no doubt about the connection between decision making and information. Moreover, sub-sections (G) and (H) of Section 102 deal with environmental information directly:

> "All agencies of the federal government shall …
>
> (G) make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;
>
> (H) initiate and utilize ecological information in the planning and development of resource-oriented projects;"(U.S. Congress 1970, Sec. 102)

The other information tool - the state of the environment report - is described in the section that defines the role of the "Council on Environmental Quality" (CEQ). This report is submitted by the President to the Congress on a yearly basis and is prepared by the CEQ. To be able to compile this report and complete other tasks required of them, the act states that:

> "Each member shall be a person who, as a result of his training, experience, and attainments, is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds…"(U.S. Congress 1970, Sec. 201)

While the role of the council includes:

> "… to gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in title I of this Act, and to compile and submit to the President studies relating to such conditions and trends; "(U.S. Congress 1970, Sec. 202)

In short, though NEPA sets out to deal with national policy to "encourage productive and enjoyable harmony between man and his environment", it implements it through production and use of information.

The early years of the 1970s are seminal in the context of the modern environmental movement, and not just for NEPA. On 22nd April, 1970, "Earth day" formed the largest demonstration in American history (Mowrey and Redmond 1993). It was an active demonstration in which local and national environmental topics were raised by protestors, arguing that they must be tackled by the political system. By the end of this year, the US Environment Protection Agency (EPA) was established.

The United States was not the sole active scene. Other countries went through similar shifts in policy and public awareness during this period. For example, the UK underwent several changes during the late 1960s (though it is possible to interpret them as a part of continuous modern environmental awareness and politics that stems from the second half of the 19th century). The creation of the Royal Commission on Environmental Pollution (1969) and the Department of the Environment (1970) are the governmental responses to increasing public pressures (McCormick 1995). It is commonly accepted that this period marks the awakening of environmental awareness

throughout Western countries (Hajer 1995, McCormick 1995). The major global event that marks this period is the United Nations conference on "The Human Environment" held in Stockholm during June 1972. In the action plan of the conference, information (and exchange of information) is mentioned over 60 times (UN 1972). The action plan calls for knowledge sharing in many activity areas - food production, pollution prevention and more. This is not surprising, given the conference's controversy between the developed and developing countries, which arose from the view that pollution is the outcome of industrial growth and that, by limiting pollution, the industrialised nations try to limit the growth of the developing ones (McCormick 1995).

The major outcome from the conference was the creation of the United Nations Environmental Programme (UNEP). From its inauguration, UNEP saw the collection of data and information about the environment as its most urgent task (Wallen 1997). This is based on the "Earthwatch" principle, established in the Stockholm action plan. "Earthwatch" aims to tackle the following areas:

> "*Evaluation and review*: to provide the basis for identification of the knowledge needed and to determine that the necessary steps be taken.
>
> *Research*: to create new knowledge of the kinds specifically needed to provide guidance in the making of decisions.
>
> *Monitoring*: to gather certain data on specific environmental variables and to evaluate such data in order to determine and predict important environmental conditions and trends.
>
> *Information exchange*: to disseminate knowledge within the scientific and technological communities and to ensure that decision-makers at all levels shall have the benefit of the best knowledge that can be made available in the forms and at the times in which it can be useful" (UN 1972, Sec. C)

Since then, UNEP has been a catalyst and co-ordinator in the field of environmental data collection and exchange. As commonly happens in such situations, considerable gaps have been found in the data and knowledge, and UNEP have focused on filling them - a project that was supervised by the Global Environment Monitoring System (GEMS) unit. By the end of the 1970s, GEMS had created INFOTERRA - the International EIS - probably the first of its kind.

An awareness of environmental problems led the European Community (EC) in 1973 to move, for the first time, beyond strictly economic issues and to establish the EC environmental programme (Briggs 1986). The first programme focused on the issue of pollution prevention, natural resources protection and quality of life and involvement in international initiatives to solve environmental problems. By the second action plan (amended June 1977), research, data collection and information received centre stage, alongside EIA. Some of the directives and regulations that stem from these policies relate directly to data collection and information. For example, in 1979 the EC established a programme for the exchange of information on atmospheric pollution, which focused on data collection methods and aimed to improve the comprehensiveness and compatibility of air pollution data (Briggs 1986).

Environmental politics continued to develop throughout the 1970s. However, the oil crises and the economic recession that followed caused some decline in its importance in the political agenda. Another explanation, offered by Hajer, was the change of focus of environmental discourse and the move toward "ecological modernisation" (1995). According to Hajer, ecological modernisation can be defined as a mode of environmental politics that accepts the existence of environmental problems while at the same time assumes that existing political, economic and social institutions can internalise the care for the environment. Ecological modernisation introduces concepts that makes issues of environmental degradation calculable and by framing environmental problems in a way that combines monetary units with discursive elements derived from the natural sciences, provides a common denominator through which costs and benefits can be taken into account. Secondly, environmental protection is portrayed as a 'positive-sum game' where all parties benefit. By doing so, ecological modernisation opens up opportunities for collective action that demands the co-operation of all elements of society (individuals, firms and countries). Environmental protection thus becomes a management problem. Thirdly, ecological modernisation claims that economic growth and the resolution of environmental problems can be reconciled. "At the core of ecological modernisation is the idea that pollution prevention pays" (Hajer 1995, p. 28) .

During that period (late 1970s and the early 1980s) UNEP and other environmental programmes on the national and supra-national levels continued to evolve. A noted milestone during this period was the publication of "The Global 2000 Report to the President", which was prepared under order from US President Carter, and was published in 1980. *Global 2000* was a comprehensive study of environmental problems in a global context and predictions for the future. One of the recommendations in the subsequent document, entitled "Global Future: Time to Act" was a call to reorganise the United States government and to create a new centre to co-ordinate data gathering and modelling to support policy formulation (McCormick 1995).

The next major shift in environmental politics was marked by the publication of the report "Our Common Future" by the World Commission on Environment and Development (WCED and Brundtland 1987). The report was followed by major activities in the UN, especially in view of the global perspective that the report nurtured. These culminated with the conference on "Environment and Development" held at Rio de Janeiro during June 1992. The main outcome of the conference was Agenda 21 - a global agenda for the 21st century (UN 1992a). The Rio Declaration and Agenda 21 link information and sustainable development. Principle 10 of the declaration reads:

> "Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. *States shall facilitate and encourage public awareness and participation by making information widely available.* Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided." (UN 1992b, Principle 10, emphasis added)

The Declaration mentions environmental information in other places. The need for EIA at the national level is mentioned in principle 17 and the need to share information about transboundary impacts of proposed actions in principle 19. Similarly, Agenda 21 pays special attention to information. In each chapter, a section is dedicated to data collection and information. Moreover, Chapter 40 of the agenda is dedicated to "information and decision making" and its preamble states:

> "In sustainable development, everyone is a user and provider of information considered in the broad sense. That includes data, information, appropriately packaged experience and knowledge. The need for information arises at all levels, from that of senior decision makers at the national and international levels to the grass-roots and individual levels. The following two programme areas need to be implemented to ensure that decisions are based increasingly on sound information:
>
> (a) Bridging the data gap;
>
> (b) Improving information availability. " (UN 1992a, Chapter 40)

Two aspects of this focus on environmental information are noteworthy. Firstly, the Agenda emphasises the role of a special kind of information system: Geographical Information Systems (GIS) and remote sensing systems (mentioned in connection to human settlements, deforestation, agricultural and rural development, ocean protection and fresh water). Both are closely related in their development history and applications (Coppock and Rhind 1991). This is of particular interest, especially when compared with the general reference to "information technologies" or "state-of-the-art data management technologies" that appears in other parts of the Agenda (Chapter 8, for example). Though other types of information systems are mentioned occasionally (such as expert systems), GIS appears time and again in many chapters (but notably not being mentioned when land resources are discussed!).

Secondly, special attention is paid to public access to environmental information. Both the Declaration and Agenda 21 mention it (as the earlier citations demonstrate). Section III of the Agenda, dedicated to "Strengthening the Role of Major Groups", connects the need to integrate women, children and youth, indigenous people, Non Governmental Organisations (NGOs), local authorities, trade unions, business and industry, science and technology, and farmers with access to information:

> "Individuals, groups and organizations should have access to information relevant to environment and development held by national authorities, including information on products and activities that have or are likely to have a significant impact on the environment, and information on environmental protection measures…" (UN 1992a, Chapter 23, sec 23.2)

Current developments in environmental politics are frequently related to Agenda 21 and to the principle of Sustainable Development - "to ensure that {development} meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED and Brundtland 1987, p. 8). In this context, public access to environmental information should be seen as part of a more general principle of public participation in environmental decision making. However, several developments during the 1990s target this issue specifically. On the legal side,

conventions that promulgate public access to environmental information have been developed and signed. These include the European Council Directive 90/313/EEC, "Freedom of Access to Information on the Environment" and the "Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters" (UN/ECE 1998). In the latter, the following statements can be found:

> "..improved access to information and public participation in decision-making enhance the quality and the implementation of decisions, contribute to public awareness of environmental issues, give the public opportunity to express its concerns and enable public authorities to take due account of such concerns..." (p. 2)

Other developments include the creation of purpose-built information systems (many of them are Internet-based) to serve environmental information to the public. These systems will be the centre of attention in this thesis.

Environmental politics and environmental discourse have gone through a profound change between the first era (1960s to early 1970s) and ecological modernisation. Careful reading of "Silent Spring" (Carson 1962) reveals that although Carson is calling for a reduction in the use of chemicals and pesticides in agriculture, the book actually calls for governmental intervention and development of scientific applications and methods (what today we call "organic farming"). The view of scientific environmental management and control is deeply embedded in "Silent Spring", NEPA, the early UNEP programmes and regulations surrounding EIA. This is not the case with "Our Common Future" and subsequent ecological modernisation. In this era, environmental concepts (in the form of "Sustainable Development") should be embedded into all human activities. It is no longer a secluded responsibility of an obscure public agency. This time, at least in principle, the focus is on an inclusionary form of decision making; so much so that "Our Common Future" is urging us to take into consideration the views of non-humans and the following generations (WCED and Brundtland 1987). This principle has implications for environmental information. As was shown, environmental information and data have always been perceived as imperative for environmental decision making. Therefore, to achieve a more inclusive form of decision making, this information must be exposed and shared with all those concerned with the decision. The importance of environmental information has been accepted by NGOs such as Greenpeace and Friends of the Earth (FoE). Both have been championing issues of access to information. This issue also appears in the "Alternative Treaties" that were developed and signed by NGOs during the Rio conference. This aspect of environmental politics and activities will stand at the centre of this thesis and provides the main motivation for close scrutiny of environmental information provision and use.

In the 13 years that have passed since "Our Common Future", environmental problems seem to have held their position in the political agenda. They have moved a long way from their rather sidelined position in the early 1970s. The signs of current public awareness are rife. They include the popular attribution of major natural disasters to global warming; resistance to Genetically Modified Organisms (GMO) and the rise in consumption of organic food; and attention

throughout the mass media with the appointment of special reporters on environmental issues. If these current signs can be used as indicators for the future, then it is likely that we will have to deal with environmental politics well into the 21st century. This will include facing the challenge of providing better public access to environmental information[1].

1.2 QUESTIONING ENVIRONMENTAL INFORMATION

In the previous section, the connection between environmental politics and information (mainly in the form of information systems) was established. It was shown that every major event, convention and discussion acknowledges information. Moreover, it was demonstrated that the circle of potential users[2] of environmental information was extended from the scientific community to policy and decision makers and then on to the public. As most environmental information is stored in computerised information systems, and in accordance with the growing demand for public access to this information, there is a growing need for Publicly accessible Environmental Information Systems (PEIS). As will be examined and extended in the following chapters, current PEIS are based on a set of six assertions:

A. Sound knowledge, reliable information and accurate data are vital for good environmental decision making.

B. In sustainable development/ecological modernisation all stakeholders[3] should take part in decision making processes. A direct result of this is a call for improved public participation in environmental decision making.

C. Environmental information is exceptionally suitable to GIS (or *vice versa*). GIS development is closely related to developments in environmental research, and GIS output is considered superior in understanding and interpreting environmental data.

D. (Based on A and B) To achieve public participation in environmental decision making, the public must gain access to environmental information, data and knowledge.

E. (Based on A and C) GIS use and output is essential for good environmental decision making.

F. (Based on all the others) PEIS should be based on GIS technologies. Such systems are vital for public participation in environmental decision making.

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[1] Of course, future economic changes and shake-ups might change the balance of public and political awareness towards environmental issues and other topics. However, as ecological modernisation strives to integrate environmental issues with the economic and social, it seems likely that even during such disruptions environmental issues will not be disregarded altogether.

[2] As this information is distributed through computerised information systems, it makes sense to use the term "users".

[3] This is a common term in the ecological modernisation literature, used to describe all parties who hold a stake in the decision - i.e. will be impacted by it.

Although it seems that these assertions have a logical flow to them, they represent several conceptual leaps that must be scrutinised. The three basic assertions (A, B & C) grow from different "segments" of environmental politics. The first comes from the institutionalised response to the environmental movement, the second is based on grass-roots pressure and the third emerges in scientific-technical circles. Assertion D is arguably the basis for the grass-roots pressure for access to environmental information and the reason for environmental NGOs to champion "freedom of information" issues. Assertion E can explain the integration of GIS into major environmental conventions (such as Agenda 21) and systems (such as UNEP), and, finally, F explains observations on existing PEIS. F is also important for a certain research theme in Geography - Public Participation GIS (PPGIS). This theme emerged in the second half of the 1990s and attracted attention from many sub-disciplines in current day Geography. PPGIS will be described in more detail in later chapters. Notably, the connection between public participation (B) and GIS (C) is a result of the need for information-based decision-making. Figure 1.1 presents the relationships among the assertions.
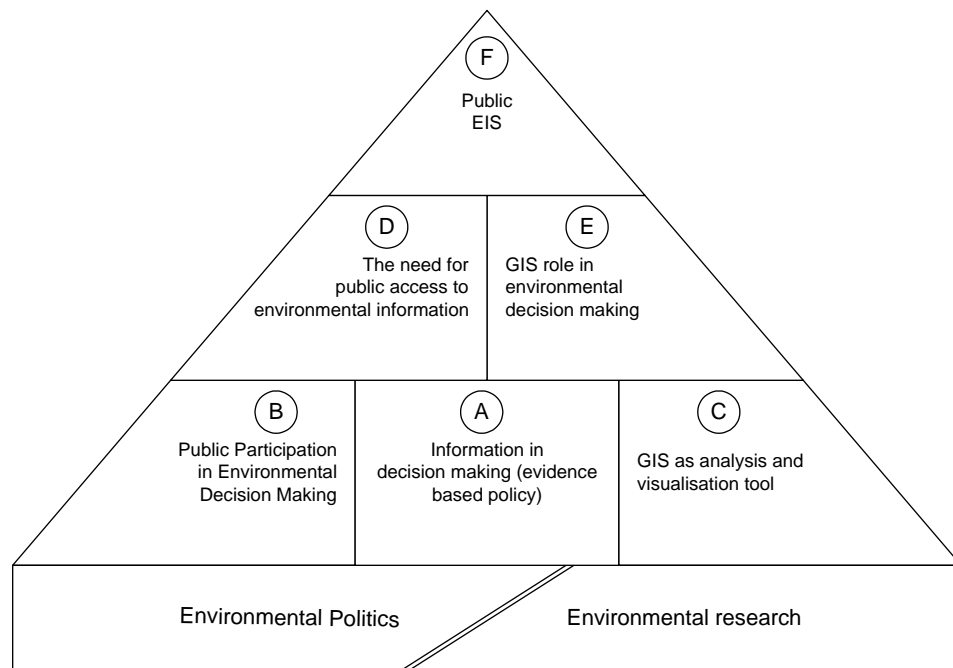
Figure 1.1 - Relationships among assertions

Can we support these assertions with evidence from research and literature? The first three assertions are well established. As shown in the previous section, they appear in texts of international conventions and general literature. Though they can be questioned, there is enough supporting evidence to accept them. Moreover, they are all part of the way we conceptualise and frame environmental politics. Therefore, for this thesis, they will be accepted as 'axioms'. The derived assumptions (D and E) are more problematic. Unquestionably, access to environmental information plays a major role in public disputes. We can trace this back to the first litigation that surrounded the EIA for an oil pipeline in Alaska in 1970 (Mowrey and Redmond 1993). Is it justified to conclude that *any* environmental information is useful to the public? Is this 'public' a

monolithic entity, a set of single-issue interest groups, just a collection of individuals or maybe other forms? What kind of information should we declare as 'environmental'? Any overview of environmental politics (such as Hajer 1995, McCormick 1995) reveals changes in framing, focus, topics and awareness to environmental issues throughout the years. How should public access to environmental information reflect those changes? Finally, what is the relationship between public participation and public access to information? Are they inseparable or should we analyse access to information separately?

The foundations of assertion E are somewhat better. The growth in GIS use must be attributed, at least partially to its use as a decision-support tool. This use stems from many studies that treat GIS as such (and coined the term Spatial Decision Support System - SDSS). These studies are based on real problems to which GIS technology provides useful solutions. Any major book about GIS can attest to this (Longley *et al.* 1999, Maguire *et al.* 1991). This is true for Environmental applications, too (see Goodchild *et al.* 1993, Goodchild *et al.* 1996). How vital, then, is the use of GIS for good environmental decision making? As mentioned earlier, EIA represents a widely used environmental decision support tool. In a survey by João and Fonseca (João 1998, João and Fonseca 1996), it was demonstrated that even though many practitioners know about GIS, it is not used in many cases (for various reasons that will be discussed later). Does this mean that the EIA and the corresponding decision are of a lower quality? Therefore, we can conclude that the value of GIS in environmental decision making is an open question. Examination of existing literature will reveal a lack of knowledge about how much GIS contributes to the final decision.

These basic problems with assertions D and E shake the foundations of assertion F and force us to question it. Therefore, it cannot be argued that the creation of PEIS is a direct, uncomplicated matter. At first sight, assertion F seems plausible: participation in environmental decision making requires access to information. Thus public participation in such processes cannot be done without proper means for access. As most of the information is stored on computers, and - as will be shown - in a GIS form, then it seems sensible to argue that these EIS should be opened to the public. Even if this argument is accepted in principle, it ought to be scrutinised and validated.

This thesis aims to deal with the last three assertions and especially to explore aspects of the final assertion about PEIS. As part of the wider study of environmental information provision, this develops a conceptual model of PEIS. Such a model should help in understanding the audiences for PEIS, the information that such systems should hold and the appropriate delivery mechanisms. Such thorough analysis of PEIS on a conceptual level does not exist but it touches on an interesting aspect of environmental information research. When considering the overwhelming embedding of information into environmental discourse, it can be expected to find analysis and evaluation of information in general, and information systems in particular. Parallel fields (like the study of information systems in general, or GIS) have developed an extensive literature in both academic forms (journals and books) and more popular forms, targeted at professionals who work in the area (trade magazines and how-to books). Surprisingly, this is not the case with EIS. As any search in a

library catalogue or scientific journals index will reveal, a very limited amount of literature deals with EIS directly. Most of it focuses on implementation issues and an extensive body of research on environmental modelling and analysis techniques. There seems to be a major lack of research on usefulness, requirements and broader analysis, which is common in Information Systems research.

Before turning to a description of the thesis' structure and flow, it is important to clarify the meaning of the acronym PEIS. Most EIS are maintained and owned by public authorities, and in this sense they are Public Environmental Information System. This, however, does not entail public access to the information system or that the system was designed for, and aimed at public consumption. For example, if a research centre creates a website to share information with other scientists, then it is, in effect, in the public domain. However, such systems will not be treated as PEIS. PEIS are seen as systems which are in the public domain and for public use. Other systems will fall under the category of EIS.

1.3   THE FRAMEWORK OF THIS THESIS

The previous sections have shown that there are many questions which surround the development and implementation of PEIS. The overarching question – "what is the exact influence of environmental information, as used by the public, on decision making processes?" will be left, largely, unanswered. Indeed, on the backdrop of the lack of conceptualisation of environmental information that was identified above, such a question must be left for the future. Instead, this thesis is set up to answer a more modest problem: what are the design issues for a computerised and Internet-based PEIS which will provide useful information to those with interest in environmental issues? The main rationale behind this question is assumptions about the pervasiveness of the Internet and computerised systems as the main means of information delivery to the public, and that by targeting those with interest in environmental matters, it will be possible to evaluate the quality of current information provision for the "likely users".

It should be stated from the start, that this thesis is based on a specific investigation framework – Soft Systems Methodology (SSM) (Checkland 1984, Checkland 1999, Checkland and Holwell 1998). Although the rationale and explanation for using SSM to tackle such a problem is explained in Chapter 3, it is important to note that this methodology is used here. SSM was developed to tackle problem situations where there is a general feeling of 'uneasiness' or 'ambiguity' towards the problem. Such uneasiness is expressed here towards the development and implementation of PEIS.

The first part of the thesis will investigate the issues of PEIS audiences: who they are, what they expect it and what they do with the information they obtain. Before turning to these questions, however, there is a need to explore the meaning of the object 'environmental information' and to understand what unique topics are associated with it. Then, an examination of EIS is needed to understand the current state of the art. This part of the thesis builds the background information about environmental information, environmental information systems, public access to

environmental information and the needs and requirements of those that are likely to use PEIS – educated members of the middle-classes with interest in environmental issues.

This information will be the basis for the second, analytical part of this thesis which will attempt to create an holistic overview of environmental information issues and their relationship to PEIS and to develop conceptual models of PEIS roles as seen from different perspectives. This analytical section uses SSM tools and techniques to create a clearer presentation and discussion of the issues that the first part revealed. Equipped with these conceptual models, the next step is to compare them to the state of the art in information provision. Based on the lack of critical examination of environmental information issues in general, and PEIS in particular, it is expected that such comparison will reveal some discrepancies in existing systems.

The third and final part of this thesis confronts the challenges revealed in previous parts by rethinking the role of PEIS and exploring appropriate avenues for future developments. It is important to note that the thesis does not aimed to offer a prescriptive solution or a panacea for PEIS. The main aim is to expose the issues surrounding PEIS and to argue that environmental information the role of PEIS in decision making and how they are used by the public deserves special attention and more comprehensive research and development. Therefore, Part III of the thesis serves to offer possible directions that can improve the current state of PEIS.

1.4   THE MAIN FLOW OF THIS THESIS

Due to its integrative nature, the thesis passes through many topics. Therefore, a roadmap to the structure of the thesis might prove useful. In general, the thesis is comprised of three parts. Part I (Chapters 1 to 4) explores the problem situation - the issues that influence PEIS and must be taken into consideration when they are studied. Part II (Chapters 5 and 6) develops the concept of PEIS using systems thinking. Part III (Chapter 7) suggests future directions for improving the problem situation.

The exploration of PEIS started in previous sections with the description of the connection between environmental politics and information and the development of the six assertions. Chapter 2 expands on the six assertions and investigates the grounding to the claims that appeared above. It starts by examining environmental information as the object of investigation and asks if environmental information (especially its public aspects) holds some special properties that justify special attention. After exploring this aspect, the three basic assertions (A, B and C) can be tackled. First, EIS are examined in a developmental and historical approach, with some attention paid to the relationship between them and general computing, including the role of GIS within EIS. Next, the thesis will review aspects of public participation in environmental decision making, as currently presented in the literature and in practice and connects to topics of access to environmental information and the developments in the legalistic framework that supports it. The next section of Chapter 2 puts PEIS in the context of other uses of environmental information and positions the current research vis-à-vis other environmental information utilisation. The final part of the chapter

examines the adequacy of the Internet to serve as the main medium of environmental information dissemination because PEIS should not be seen in isolation, but must be connected to other aspects of the information age.

Chapter 3 describes the methodological structure of this thesis. First, it explains the methodological framework that is used throughout the thesis – Soft Systems Methodology (SSM). SSM is being used here as result of its adequacy and proven record of attacking "wicked problems" - problems that mutate while being solved (Rittel and Webber 1984)[4]. This methodological chapter explores the theoretical grounding for the thesis and explores the current discourse about technology and society, which relates to themes like "The Information Society" and the social implications of Information and Communication Technology (ICT). The following sections begin with a closer look at SSM, explaining its structure and the techniques that are integrated in it. This introduction to the methodology will examine how the different parts of the thesis fit into it, including the introductory chapters. After presenting the framework, the three empirical studies are explained. These are the London Environment Online (LEO) user survey, the UCL Brownfield Research Network (UBRN) workshop and a comparative study of existing PEIS. The LEO survey was designed and carried out to reveal attitudes, requirements and needs from a proposed urban PEIS (in this case, for London). It was implemented through a World Wide Web (WWW) interface, and respondents were recruited through e-mail and leaflets. The UBRN workshop gave an opportunity for a qualitative and detailed examination of interaction with environmental information held in a GIS. During the workshop representatives of local pressure groups explored issues surrounding brownfield sites development through hands-on experience with GIS and a follow up group discussion. The two studies form the basis for the central analytical stage of this thesis. In this stage, conceptual models of PEIS will be developed and explained. These conceptual models are compared with existing PEIS, in order to examine the gaps between these models and the current state of the art with PEIS.

In Chapter 4, the survey and workshop outcomes are examined. They are used to build a "rich picture" of the problem situation, in which the complexity and multiplicity of the environment in which PEIS operate are described. This picture opens Chapter 5 which is the core of the systems thinking stage, where the conceptual models are developed. This stage is based on some techniques developed by SSM users, such as identification of the components of the conceptual model and the description of the essence of the model through "root definitions" - a concise description of the system and its operation. Chapter 6 brings us back to the real world, where the conceptual models are compared and contrasted with four existing PEIS. The first system is that of the Department of Environment Transport and Regions (DETR) air monitoring network system, in which users can access information about air pollution levels. The second is the Environment Agency website and especially its "what's in your backyard?" section. The third system is the Friends of the Earth (FoE)

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[4] The original paper was publish in the early 1970s.

website, with special attention to the "factory watch" section, which enables user interaction with GIS. The last of the PEIS is the commercial "homecheck" system, designed to provide homebuyers with information about environmental conditions in the area where they want to buy a property. All these systems are accessible through the WWW, hence they operate in a public information environment. They also represent three sectors of data providers: the first is operated by a commercial entity (on behalf of the government), the second by a NGO, the third by a government agency and the last by a commercial body privately. Together, Chapters 3 to 6 form the core of the thesis in which major aspects of PEIS will be explored.

The final part of the thesis explores the possibility of improving PEIS. Chapter 7 attacks the problem from the various aspects of information systems design and starts by exploring the design principles that should underlie PEIS. This evaluation considers the state of information technology and the technical means that can help in materialising the principles of PEIS. Intelligent agents, adaptive systems and end user programming will be explored in this part. Another aspect of PEIS, which lies between the technical and social, is the issue of "packaging and delivery" of information. Chapter 8 concludes the thesis, by summarising the main findings and concluding notes.

1.5   SOME NOTES ON THE STRUCTURE AND CONTENT OF THIS THESIS

Before diving into the core of the thesis, there are three important notes about its structure and methodology. The first note is about the lack of definitions for the main objects of this thesis, the second deals with the role of ICT and the Internet, while the third focuses on the general modularity of the thesis and its objectives.

1.5.1   Definitions and the Lack of Them

This thesis grapples with complex (or at least complicated) topics. Environmental information, EIS, PEIS and GIS are all objects that will be discussed in following chapters. In most scholarly studies, the common approach is to define such elements before turning to the discussion. I have chosen not to do so.

The thesis started with a feeling of uneasiness about the way EIS and environmental information are defined and used. As the following chapters demonstrate, it seems that many are pleased with "non definitions" - like the example from NEPA (U.S. Congress 1970) where a requirement for an ability to analyse environmental information is not backed up by an explanation of what this means! Therefore, I have decided to start from a *tabula rasa* and to explore what these objects mean according to their observed characteristics - what kind of things are called EIS, which information is called "environmental" and so on. As the thesis develops, I will present some concepts and discuss the ability to define them. In some cases, I will point to a specific definition while in others I will provide only partial ones.

As for GIS, even though many definitions exist, I would use Chrisman's all-inclusive definition:

"Geographic Information System (GIS) - Organized activity by which people measure and represent geographic phenomena then transform these representations into other forms while interacting with social structures" (Chrisman 1999, p. 175)

During this thesis we will come across GIS that range from the first computerised system - Canada GIS or CGIS (Tomlinson 1970) desktop GIS such as ArcView and WWW-based map servers. Almost no other definition will include all under one roof.

Of course, I run the risk that readers will come to this thesis with a different conception of these objects. This, however, does not seem to be much of a problem as my stated aim is to open up the issues of environmental information to discussion and debate. Thus, other conceptualisations are welcome.

1.5.2 Information and Communication Technology as Major Delivery Medium

Throughout the thesis there is a clear assumption that environmental information will be delivered to the public through the Internet. At the same time, the thesis raises issues of justice and equity of access to ICT. Though this might seem contradictory and even blindness to other modes of delivery, I contend that this is not the case. As will be discussed in Chapter 2, the current literature and regulations assume that ICT is an appropriate medium and will become more so in the near future (OECD 2000a). It is this feature of PEIS that the thesis faces and tries to answer. It is valid to explore other modes of delivery, the role of information intermediaries and so on. Some of these will be explored in various levels of depth in the course of the thesis. The selection of ICT was done knowingly to focus the thesis and to ensure that the suggestions deal with an area that is still open to influence more than other media (such as EIA, which are formalised and closed procedures in many countries).

1.5.3 Modularity and Structure

Although Chapter 3 describes the overall structure of the thesis, it is important to note that it is written in a modular way that provides coherent and autonomous units which fit into its general structure. Therefore, the study of environmental information and EIS in Chapter 2, the LEO survey and UBRN workshop (Chapters 3 and 4) and the evaluation of existing PEIS (Chapters 5 and 6) are all structured as semi-independent units with an internal analysis and structure. Of course, they are connected to one another. For example, the selection of perspectives and criteria in Chapter 5 is closely connected to the findings of Chapter 4. The structure, however, tries to keep them as independent and self contained as possible.

The reader might find the rich pictures at the end of Annex II useful as an aid or road map through the discussion in the following chapters. Although their purpose and concepts are explained in Chapter 2, they are a graphical representation that captures the issues and topics that are at the centre of this thesis.

2 Information, Environment, Environmental Information Systems and the Public

As Chapter 1 briefly charted, environmental discourse is coupled with the ideas of information and knowledge. This coupling further connects environmental politics with information systems and computing. As noted, this connection seems neutral and even natural. However, some questions were raised about the triviality of this connection and its uncritical acceptance. In the current chapter, the issues surrounding environmental information will be expanded. This is needed in the context of this thesis as it is impossible to explore PEIS without a clear understanding of environmental information and environmental information systems (EIS). Therefore, the chapter starts with an investigation into the constitution of environmental information. This section aims to clarify the special attributes of environmental information and its uses. The second section focuses on the technological and organisational settings within which EIS operate. Once environmental information and EIS are clarified, the focus turns to the political and societal background of public access to environmental information in the third section. The three streams are integrated in the fourth section of this chapter. Environmental information concepts, EIS developments and public access provide a context in which different questions and processes can be explored. The range of these will be laid out and the context of the thesis will be explained. The concluding section is dedicated to the delivery medium for PEIS. Increasingly, the Internet and the WWW are considered to be the most important delivery technologies; such a selection has societal implications and some of these are examined.

2.1 ENVIRONMENTAL INFORMATION AS THE OBJECT OF INVESTIGATION

Does environmental information deserve special attention? A review of existing literature shows that such an object exists and is being discussed. Furthermore, this acceptance is not confined to a specific discipline but can be found in many fields - from Information Science to Chemistry, Ecology and Geography. What are the characteristics of environmental information? What attributes distinguish it from other types of information? Is it possible to provide criteria that will help us in defining it? In what follows, some tentative answers are offered.

2.1.1 Defining Environmental Information

Traditionally, legal documents tend to be a good source of definitions for objects or activities. Though clearly open to interpretation (and being interpreted by courts), they provide a good starting point. The following definition is taken from the Aarhus convention (UN/ECE 1998):

> "3. "Environmental information" means any information in written, visual, aural, electronic or any other material form on:

(a) The state of elements of the environment, such as air and atmosphere, water, soil, land, landscape and natural sites, biological diversity and its components, including genetically modified organisms, and the interaction among these elements;

(b) Factors, such as substances, energy, noise and radiation, and activities or measures, including administrative measures, environmental agreements, policies, legislation, plans and programmes, affecting or likely to affect the elements of the environment within the scope of subparagraph (a) above, and cost-benefit and other economic analyses and assumptions used in environmental decision-making;

(c) The state of human health and safety, conditions of human life, cultural sites and built structures, inasmuch as they are or may be affected by the state of the elements of the environment or, through these elements, by the factors, activities or measures referred to in subparagraph (b) above;" (Article 2).

A careful reading of this definition leaves the reader puzzled. If this is the definition of environmental information, then what kind of information is excluded? Are there "conditions of human life" which are not "affected by the state of the elements of the environment"? Is Turner's painting of clouds over Hampstead Heath environmental information (it is visual and it shows a state of the elements of the environment)?

This definition seems deliberately vague - especially when compared with other entities defined in similar documents or even to details of activities that require public participation which are mentioned later in the same convention. For example Annex I provides definitions for objects such as:

"15. Installation for intensive rearing of poultry or pigs with more than:
(a) 40,000 places for poultry;
(b) 2,000 places for production pigs (over 30 kg); or
(c) 750 places for sows"(Annex I - p. 25)

Other documents demonstrate similar vagueness, for example EC directive 90/313/EEC on "Freedom of Access to Environmental Information" states that:

" (a) 'information relating to the environment' shall mean any available information in written, visual, aural or data-base form on the state of water, air, soil, fauna, flora, land and natural sites, and on activities (including those which give rise to nuisances such as noise) or measures adversely affecting, or likely so to affect these, and on activities or measures designed to protect these, including administrative measures and environmental management programmes;" (Article 2, cited in Hallo 1997).

Thus, there is a need to go back to the origins of modern environmental politics to understand how the definition of what is and what is not environmental information became so broad. However, such examination will reveal that the tendency to be as inclusive as possible is not new. Tomlinson (1970) argues that the term 'environment' refers to the whole living space of humanity. Deininger

(1974), provides an example to the problems associated with a clear-cut definition of environmental information in the context of EIS design:

> "Quite often it is not possible to determine *a priori* the user, nor their questions, nor the future problems which may be encountered. Ten years ago a suggestion to include mercury levels in the environment in a data bank would have been treated with a benign neglect[1]…unfortunately there are no simple answers, and perhaps one should concentrate now on the consideration that a system should be as open-ended as possible"(Deininger and World Health Organization. Regional Office for Europe. 1974, p. 4)

The Stockholm Action Plan (UN 1972) and NEPA (U.S. Congress 1970) exhibit the same vagueness and lack of clarity. For example, as the citation in Chapter 1 demonstrates, the members of the CEQ should be "exceptionally well qualified" to deal with environmental trends and information, but NEPA does not provide a clear-cut definition of the nature of such information!

We are, then, left as bemused as when we started. Seemingly, a fixed and precise definition is probably impossible. Furthermore, we are forced to conclude that legislators and professionals throughout the world have chosen vague definitions *deliberately*. As they operate in an administrative and legal environment where such definitions are rife, they must feel comfortable (at least to a considerable extent) without a clear definition. However, the same group accepts the existence of environmental information. Following the same path, I will not try to provide or formulate a definition. A better and more useful strategy to define environmental information is not to provide an holistic and conclusive definition but to examine different facets of this object. In the rest of this section, these facets are examined. Before turning to the specific aspects of environmental information, there is a need to clarify the terminology and to discuss what will be considered as information.

2.1.2   Capta, Data, Information and Knowledge

To describe the basic units that form environmental information, a better terminology is needed. Checkland and Holwell's (1998) definitions of capta, data, information and knowledge are very useful in this context. Their definition starts from observations on reality and the world: there are myriad facts and empirical observations on the world that can be tested or refuted. The facts that can be codified and collected are *data*. However, we do not collect all the possible data (facts) and store them for future reference. The first step in information processing is the selection of those facts that are relevant for us and which we want to collect. Such data will be called *capta* (based on the Latin *capere,* meaning to 'take'). Thus, the basic tokens of environmental information are capta. For example, when an air quality monitoring system is designed, the sensors for specific chemicals are developed in such a way that will ensure their reaction to those chemicals and will translate such observations into numerical form. The level of the chemical in the air is the data, while the sensor's

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[1] It can be noted that anyone suggesting at this time to measure and collect the distribution of GMO, as it might have a major environmental impact, may have been treated in the same way.

reading is the capta. Once capta are collected, it is put in a wider context and viewed as part of larger whole. Meaning is attributed to collections of capta. By doing so, the capta is converted into *information*. Information can have a meaning in a cognitive, spatial or temporal context. The process of information gathering can lead to larger structures of related information with a common meaning. Such collections are usually referred to as *knowledge*. Figure 2.2 presents the process from reality to knowledge.

Suitable words
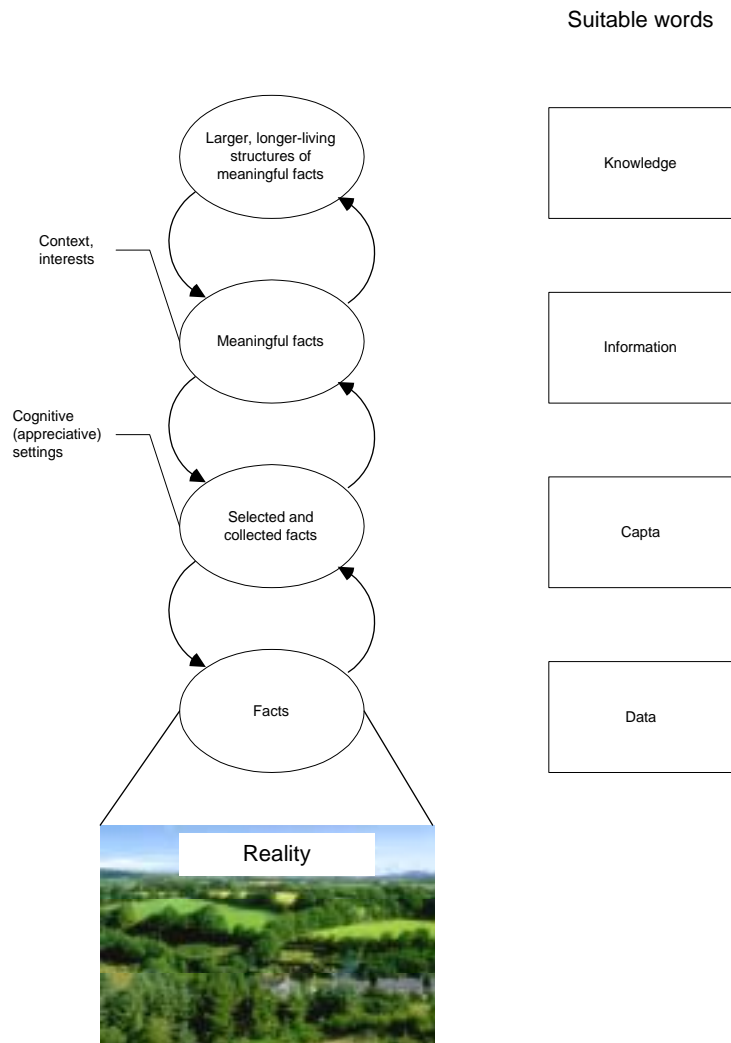
Figure 2.1 - information terminology (after Checkland and Holwell,1998)

To illustrate the relationship, the air monitoring process provides a useful illustration. Air quality is affected by the levels of various chemicals in the atmosphere and there are many facts (data) that relate to the atmosphere. Of all these facts, only few receive any attention - such as the airborne concentration levels of carbon monoxide (CO) measured in Parts Per Million (PPM) during a given period of time, as measured by a sensor X installed in location Y. By defining the exact fact that researchers are interested in, the data was converted to *capta* which can now be collected and stored. The output of the sensor over time is examined and compared to the readings of other sensors from other locations. This collection of CO *capta* has a meaning now - it is the representation of CO levels as measured across locations Y_1 to Y_n during the period T. This collection is *information*

about CO levels. However, we need to collate and analyse more information in order to create a full picture of the CO levels throughout the year - or to obtain *knowledge* about CO levels.

As Brown and Duguid noted recently (2000), it is impossible to store knowledge in machines. Knowledge exists only in the mind of cognitive beings. In that sense, libraries do not hold knowledge, they hold information. The reader converts this information into knowledge by "consuming" an ordered collection of information. Knowledge is very elusive and very hard to package and store. The current "knowledge based" information systems hold packaged information that facilitates the transfer of knowledge, but they do not store knowledge itself. By examining environmental information in the literature (Avouris and Page 1995, Deininger and World Health Organization. Regional Office for Europe. 1974, USEPA 1996) we can see that the range of "objects" or "entities" which belong to environmental information span from capta to highly processed information. A library of research documents on environmental issues will announce that it contains environmental information while the same thing can be said about a magnetic medium that holds output from devices such as the aforementioned CO sensor.

Furthermore, this aspect of environmental information is inherent in environmental problem solving. It is usually impossible to predict future developments, and it is common that future research will shed a new light on existing knowledge and will require a re-examination of existing capta in order to verify it. For example, once scientists from the British Antarctic Survey put forward evidence on the thinning of the stratospheric ozone layer, NASA experts had to re-examine satellite imagery which they had already examined (Benedick 1991). In other words, once the hypothesis of new knowledge was presented, NASA examined their capta, in order to produce further new information, which in turn founded the claims about the "hole in the ozone layer". Thus, the cycle was completed by improving the existing knowledge about this problem. It can be concluded that environmental information is inherently a mix-up of all the forms of stored information: capta, basic information and process information (from which knowledge can be obtained easily). Furthermore, as this thesis focuses on environmental information systems which are based on digital computers, the digital form of capta and information will play a central role. As noted, although Tate Britain (where Turner's paintings are on display) can be regarded as an Environmental Information System, such definition will not help in dealing with the problem at the centre of this thesis: the provision of environmental information to the public, through the Internet.

To avoid confusion throughout the rest of the thesis, unless the differentiation between data and capta is necessary, the term data refers to capta, as it is much more common.

2.1.3 A Fuzzy Definition

The main conclusion that emerges from the review of environmental information definitions above is that environmental information is fuzzily defined. Environmental information does not have clear-cut and crisp boundaries and it is hard to define what is included and excluded. As is true with

other fuzzy boundaries, there are entities that clearly fall inside them, and some that clearly do not. In the case of environmental information, it seems that sub-section A of the Aarhus convention provides the definition for such a set, or in the form that EC directive adopts:

> "Any available information in written, visual, aural or data-base form on the state of water, air, soil, fauna, flora, land and natural site" (Article 2, cited in Hallo 1997)

Even this definition is too broad. For example, information about wild/natural fauna is probably more accepted as part of this definition, while information on agricultural processes which deal with the fauna, soil or water might be classified as commercial information by its owners and they may dispute its classification as environmental information. Furthermore, as various issues gain or lose position on the public agenda, so does the information that relates to them. Deininger's note on mercury levels point to this problem. Open-fire coal burning, though clearly an environmental problem in and around London less then a century ago is no longer an issue and there is no point in collecting data about it today. It is also possible to identify types of information that is clearly outside the boundaries of such a definition. For example, the daily cash transactions of a given shop or supermarket. This type of information is not environmental, though it has some indirect environmental implications. The transition between what is included and what is excluded is understandably wide. The inclusion of man made structures and activities and the interaction between human activities and the environment leaves a wide space for interpretation.

2.1.4 The Core Of Environmental Information: Pressure-State-Response Model

In the context of defining the boundaries of environmental information, there is one conceptual model that must be mentioned - this is the pressure-state-response model of the Organisation for Economic Co-operation and Development (OECD) (OECD 1991), presented in Figure 2.1.
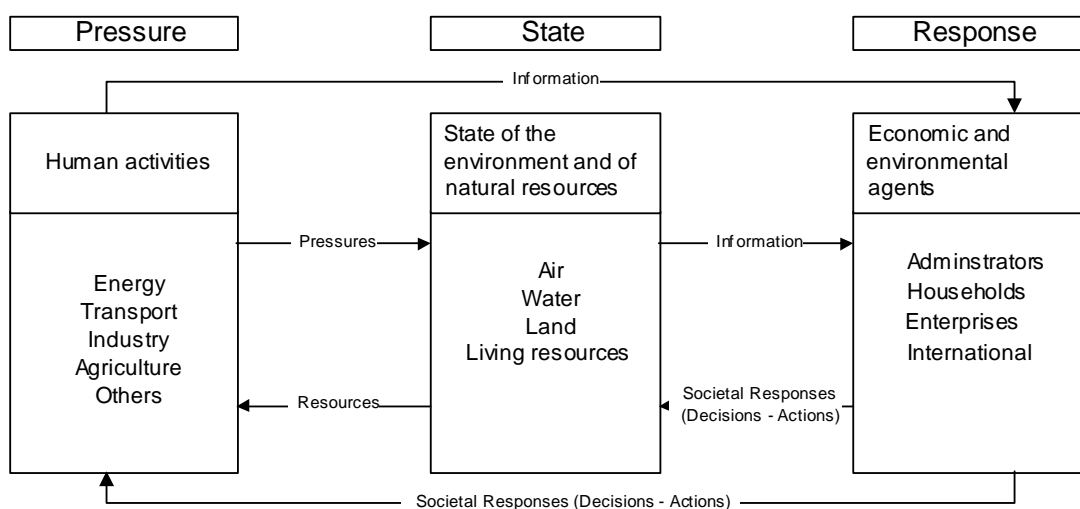
Figure 2.2 - OECD pressure-state-response framework (source: USEPA 1996)

The Pressure-State-Response (PSR) framework does not try to specify the nature of interactions between human activities and the environment, instead it states that human activities exert

pressures on the environment which might cause changes in the state of the environment. The societal response to these changes is through various means that are targeted to prevent, reduce or mitigate the pressures or the damages (USEPA 1996). This framework explains the structure of information gathering actions that were mentioned earlier - EIA, state of the environment reporting or the current activities to collect and collate sustainability indicators (USEPA 1996). Many of the environmental information collection initiatives are based on the PSR framework and information that was collected as part of the two "information flows" in the model - the identification of pressures and the indicators for the state of the environment - will be classified as environmental information undisputedly.

2.1.5 The Spatial Element

The spatial properties of environmental information have been noticed by many. As early as 1970, Tomlinson noted (1970) that:

> "The essential difference between most data and those describing the environment of the surface of the earth is that the latter frequently have a location identifier as part of the data element … throughout the symposium the terms "geographical data" and "environmental data" were used synonymously as were the terms "geographic information system" and "environment information system". (p. 1)

This special character of environmental information did not diminish over the years. The US EPA, for example, is one of the largest federal users of geographically referenced information (USEPA 1996). As the following review of EIS will demonstrate, GIS play a pivotal role in them. Moreover, in some cases the terms GIS and EIS are interchangeable. When the role of GIS in handling environmental information is examined, we can find explanations like the one which argues that GIS are the only technology that offers computerised spatial analysis, and therefore the most adequate for environmental problems, as the latter are inherently spatial (Fedra 1993). However, such an argument should not be taken at face value, as there are other examples that contradict it. In transportation modelling GIS do not have the same role and specialised software tools are widely used[2]. No one would argue that transportation does not have a strong spatial dimension and, yet, it exhibits far less dependence on GIS technology.

Furthermore, a thorough reading of environmental GIS literature (such as Goodchild *et al.* 1993, Goodchild *et al.* 1996) demonstrates the process of integrating GIS with environmental modelling. The transition to GIS centred modelling happened during the 1980s and, slowly but surely, GIS became *the* tool for environmental modelling. As the citations from Tomlinson demonstrate, the connection between environmental studies and GIS can be traced back to the 1960s. In this context, it is worth mentioning the work of Ian McHarg "Design with Nature" (McHarg and

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[2] Most of the leading tools in the field of transportation modelling can interchange information with common GIS packages. However, when their development history is examined, it is clear that the GIS functionality was added to tools that have developed independently.

American Museum of Natural History 1969). McHarg advanced ideas about environmentally sensitive planning while using the overlay technique that later became one of the major analysis techniques in GIS. In the early 1970s, a computerised implementation of his methods was developed (GIS World 1995). Several GIS products have clear environmental origins. One of the leading vendors of GIS software, "Environmental Systems Research Institute" (ESRI), started in 1969 as a consultancy with a focus in using GIS related technologies for environmental planning. As mentioned, the acceptance of GIS as appropriate technology for handling environmental information is recognised in Agenda 21, too (UN 1992a).

The connection between GIS and environmental information can be explained in the following way. Environmental problems are, by their nature, geographical - they deal with the aggregate surroundings that exist in, below and above the face of the earth. When capta is collected during the problem solving process, the locational aspect cannot be discarded and stays important throughout the analysis. Therefore, when "environmental problem solvers" evaluate how they could use computers to help them, they require spatial capabilities. They look for ways to carry out spatial analysis using computers. This feature made the connection between GIS and EIS. This explanation follows a co-evolutionary argument: the spatial aspects of environmental problems have lead problem solvers to develop computational methods that form the basis of GIS. Other problem solvers have identified the value of GIS to their specific problems, deployed it and, by doing so, extended its environmental capabilities while promoting it as a tool for such purposes. Other researchers in the field have learned from their peers' knowledge about the adequacy of GIS to their problems and used it too. It is a case where the match between the tool and the problem domain influences both the tool and the domain.

2.1.6 The Temporal Dimension

The temporal dimension is a further issue that is intrinsic to environmental information. Environmental discourse, debate and politics focus on trends. Environmental research is concerned with temporal processes - and many indicators have a temporal element. Levels of air pollution, noise or water pollution are measured and quantified using time as part of the matrix (Canter 1996). This aspect can be found in the Earthwatch principles that form the basis for UNEP. The Stockholm action plan calls for research and evaluation of environmental trends and processes (McCormick 1995) and time-series and baseline data are essential to environmental modelling (Miller 1996).

A common element in environmental activities - especially research and management - is the creation of long term monitoring programmes. In this context, the "emergency treatment" metaphor was suggested (Eddy 1993) and the environment is compared to a critically ill person in an intensive care unit where vital signs are monitored and measured. The implication of such developments is that environmental information is always used in comparative analysis. The handling of time in environmental information is usually carried out through the creation of a

"datum" or reference data set. Then, the information which is collected, measured or modelled can be compared to this datum, in order to identify trends.

2.1.7 Interconnected and Holistic

Environmental problems are perceived as interconnected and more and more voices call for an holistic approach to their solution. From "Silent Spring" (Carson 1962) to the Gaia hypothesis (Lovelock 1982) and throughout environmental discourse, the idea that various factors and elements operate together and have an ongoing inter-influence seems to be universally accepted (though parties will argue about the nature of the influence). Similarly, the idea of viewing biological activities as an ecological system (ecosystem) is accepted in an axiomatic manner by all parties. While the extent of the damage to various ecosystems is an open debate, the use of this concept as an approach to environmental problem framing is beyond question - as "Our Common Future" clearly demonstrates, by dedicating a chapter to them (WCED and Brundtland 1987). If we explore the origin of the term "ecosystem" we will find that it was invented in the latter part of the 1930s (OED 2000) and, as such, should be seen as part of the 'systems' approach to science in general which emerged at the same time (Checkland 1984). Ecology and environmental studies were among the first adopters of systems concepts. Today, these concepts are tangled with environmental research, debates and politics to the extent that they are inseparable. The implication of this approach to environmental information is far reaching. Although the capta is collected through sensors and other means that are designed to deal with specific data, the process of analysis and translating it to information connect and relate it to other sources of information. Though some analysis may seem to focus on a specific environmental element - like distribution of a specific pollutant - in reality there is no information that stands alone.

2.1.8 Science-Based Data Capture and Analysis

Environmental awareness and politics are inherently science-based. The agenda of environmental politics is driven by the scientific observations and, even though scientific findings are interpreted and debated in the process, they play a pivotal role. Scientific findings and their manipulation played a major role in Carson's arguments (Carson 1962), during the Stockholm and Rio conferences (UN 1972, UN 1992b), in the discussions that lead to "Our Common Future" (WCED and Brundtland 1987) and the Ozone debate (Benedick 1991). In general, environmental data, information and knowledge are traditionally scientific. Most of the data and analysis that is collected and stored is a result of scientific measurements.

However, the process of opening access to the public has changed this aspect quite radically. The acceptance of local knowledge and perceptions as important and valuable inputs to environmental decision making processes - an idea that was introduced during the Rio conference and gained momentum since then - is changing this attribute. Even so, most of the environmental information that is being produced and stored in EIS is scientific information.

2.1.9 Uncertainty and Accuracy

Connected to the previous attribute is the accuracy and uncertainty of environmental information. By their nature, measurement and observations of the environment cannot be done in a controlled laboratory. Furthermore, many limitations exist on the amount of observations that can be collected and analysed. As a result, many environmental models (which are used during the analysis process) have a certain level of uncertainty (Goodchild *et al.* 1993, Goodchild *et al.* 1996, Heuvelink 1998). This inherent uncertainty influences environmental decision making and is sometimes used by stakeholders during debates (Benedick 1991). The problems of accuracy, uncertainty and the propagation of errors throughout information during the analysis process are common in environmental information and are part of any set of it. Of course, errors in the output can be reduced by using reliable and complete data sources. This, naturally, raises the cost of collecting the information and reinforces the need for well documented data sets.

2.1.10 Size and Quantity Matters

The spatial and temporal elements and the need to integrate data sets from various sources explain why environmental information usually comes in large quantities. This aspect is connected to the feeling of "information overload" that has been noted by many: "We have an ocean of data but only drops of information" (Tveitdal 1996) or the feeling of "data rich but information poor" (Jimenez-Beltran 1995, USEPA 1996). During the three decades of environmental information collection, literally billions of dollars have been spent on environmentally related data collection programmes. Over the years, the theme of "bridging the knowledge gap" continuously echoes. Recently, however, the other side of the coin has been mentioned - the problem of getting meaningful information out of the huge amount of environmental capta that is being collected every day. Furthermore, the growing volume of environmental information made it necessary to develop indicators and catalogues of information to describe information - metadata (Chrisman 1994, Goodchild and Gopal 1989, Hicks *et al.* 1999; Laurini 2001) - and the issue of information management is now a significant aspect of any EIS.

2.1.11 Summary

In this section, I have illuminated several intrinsic attributes of environmental information that relate to its context, sources and the way in which it is used. None of the above is special when examined in isolation and other types of information share the same attribute. The combinations among these attributes makes environmental information special. Together, they provide a loose definition for environmental information. The need for a broad and flexible definition explains the selection of vague definitions, which are so common in regard to environmental information.

However, other attributes of environmental information relate to the institutional and organisational settings within which the information is collected and integrated into EIS. These attributes will be examined after the following review of existing EIS.

2.2 ENVIRONMENTAL INFORMATION SYSTEMS

The aim of the following review is to try to understand the reasons for declaring a certain set-up of computerised technology and data sets as an "Environmental Information System". The section starts with some definitions of EIS taken from the literature. These definitions are then scrutinised in the light of existing systems. The review is based on a survey of the use of the term "environmental information system". The main part of the survey was based on the WWW as a "information base", and was verified with computerised literature catalogues (such as GEOBASE).

First, using a dedicated tool for WWW search (WebFerret from FerretSoft, LLC) a large number of Uniform Resource Locators (URLs) that relate to the phrase "environmental information system" have been collected. As this tool enables issuing multi-search engines queries, the results present the combined information from major search engines at the time of the study (October 1998). This search retrieved about 4,500 URLs. The resulting list of URLs was then transferred to a dedicated programme, which fetched each web page and checked for the existence of the string "environmental information system". The filtered list contains 600 URLs. Each page that contained the phrase was marked and was checked manually. By the end of the survey, 56 examples of EISs were found. A similar method was used to extract the occurrence of the phrases "environment/al information" and "informatics" and their context (three words before and after).

From the outset of the survey, it became clear that there is a distinct difference between the use of the singular form (environmental information system), which is used to describe a specific system, and the plural (environmental information systems), which is used to describe the generic type of such systems (in the same way that the term "information systems" is used). Since this section examines the plural (denoted by EISs) in the light of the singular (EIS), I will start with the latter. To avoid confusion, I will not use the plural form when EIS is discussed (even if the sentence refers to a group of specific systems).

2.2.1 Formal and Semi-Formal Definitions for Environmental Information Systems

Before turning to the results, it is worth examining some definitions of EISs. The International Symposium on Environmental Software Systems (ISESS) defines EISs as:

> "Environmental Information Systems is the umbrella term for those systems used for:
> - Monitoring
> - Data storage and access
> - Disaster description and response
> - Environmental Impact Reporting
> - State of the Environment Reporting
> - Planning
> - Simulation modelling and decision making" (Anonymous 2000)

In another section of the web site the organising committee of ISESS 97' declares:

> "Environmental Information Systems (EIS) are an important factor in environmental research, decision support, management and policy. EIS implementations have a number of

requirements which are hard to satisfy, even with the information technology of today. After a period of 10 years of trial and error, of failures and successes, the study of EIS has matured. The subject is still growing, in a multidisciplinary work environment which changes quickly, both in the IT and the environmental sector." (Anonymous 2000)

Another definition is taken from a book titled "Environmental Information Systems" (Gunter 1998)

> "Environmental information systems are concerned with the management of soil, water, air and species in the world around us. This textbook describes a framework for systems based on four phases of data processing: data capture, aggregation, storage, and analysis. The first part of the text concerns the collection of environmental raw data. The second part explains how this raw data is condensed and enriched to extract semantically meaningful entities. How aggregated data is then stored in a file or database is described in the third part of the text. In the final section the available information is prepared for decision support purposes. " (p. 1)

As the following sections will demonstrate, these definitions do not provide a complete description of EISs.

2.2.2   What is an Environmental Information System ?

According to the survey, and in line with the vague definition of environmental information, an appropriate definition of EIS is "a computerised system, that stores environmental information". The term EIS is used to describe a collection of socio-economic indicators; a contact list of consultants or a list of chemicals that are used in the production cycle. It can be a set of data files, or a highly integrated information system; a standalone system, running on a personal computer or a sophisticated system, based on super-computers. It can rely on "proven" technology - such as a database management system running on a mainframe computer; or be based on the latest "hot" technology (such as the early WWW at the first part of the 1990s). Its scale can be as wide as the globe, national, local, or it might not relate to any geographical scale.

The presentation order in this section follows the historical "evolution" of EIS, while categorising groups according to the declared functionality of the system. The most influential family of EIS is presented in Figure 2.3 – systems that were developed by UNEP and its activities. As we shall see later, these systems epitomise the main trends in EIS development.
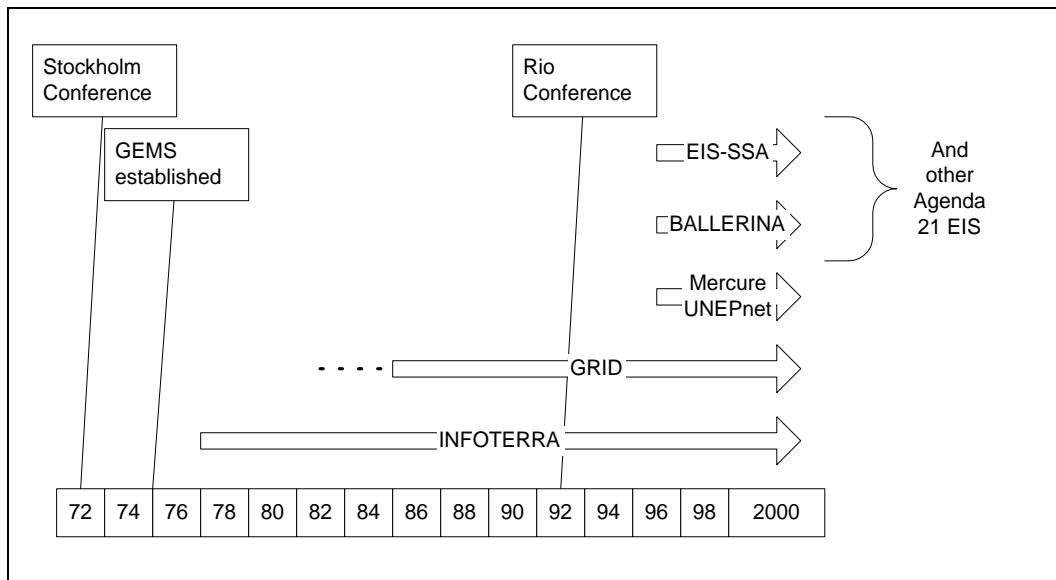
Figure 2.3 - Time Line of UNEP EIS

2.2.2.1 Environmental Information Systems and UNEP/Earthwatch

As mentioned in Chapter 1, the "Earthwatch" concept was on the UNEP agenda from its inception: a mission to evaluate, monitor, research and exchange data and information about the global environment. As time went by, the GEMS unit became the pivotal body within UNEP. GEMS is in charge of collecting, validating, storing and systematising the data from various monitoring programmes at a global scale. To help co-ordinate the sources of environmental information GEMS developed INFOTERRA, which first came on-line in 1977 after 5 years of development. It serves as a repository of contacts and expertise on every aspect of environmental research. The system operates through several regional centres, with National Focal Points (affiliated bodies at the national level that act as INFOTERRA contact points). INFOTERRA was intended for researchers and professionals and was run by the environmental data unit of UNEP which also collected various data and statistics about the environment:

> "...Infoterra is thus responding to an increasing world demand for accurate, quality information on environmental planning, development ... Its achievement has been to reduce wrong decisions on environmental issues made more from ignorance than ill-will." (UNEP 1979, p. 25)[3]

A typical query to INFOTERRA would focus on the "meta" level (exchange of information about information - "Where can I find knowledge/information about air pollution modelling? ") and the system would give answers by providing contact points and references. The next major UNEP EIS is the Global Resource Information Database (GRID). It was conceived around 1981-1983, with a mission to co-ordinate, within a common geographical reference system the numerous data sets

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[3] This was the second year of INFOTERRA operation. The total fund spent on it was $973,136 while the number of queries was about 2,000. Each query cost about $500 in 1979 terms (over $1,200 today).

that GEMS, UNEP and other specialised agencies already had. In the heart of GRID there is a GIS and digital geographical information is the main resource that GRID provides. GRID is based on ARC/INFO GIS - donated by ESRI back in 1983, two years after the package was released.

> "...Existing technology now makes possible the development within GEMS of the global resource data base (GRID), which will be a data management service within the UN system designed to convert environmental data into information usable by decision makers ... The technical feasibility of GRID has been assessed by expert groups... " (UNEP 1985, p. 43) [4]

> "...GRID technology allows us ... initially to describe, but eventually to understand, and ultimately to predict and manage... GRID is also providing practical introduction to GIS technology for application in the national level ... data transmission rates were very low, and for cost-effective telecommunication between GRID nodes, direct satellite links will clearly have to be established ... UNEP looks forward to the day when GRID data and technology will be routinely and easily available to the entire world community to help sharpen the process of environmental assessment and guide the forces of environmental management" (UNEP 1986, p. 54)

GRID gives an example for the explicit connection between environmental information and GIS data sets. GRID has grown by its own momentum, and became a separate unit (Programme Activity Centre - PAC) of the UNEP in 1991 (Wallen 1997). The next major event in the UNEP EIS story is the Rio Conference 1992 and "Agenda 21". EIS are first mentioned in chapter 12 of Agenda 21, which focuses on desertification:

> "Governments at the appropriate level, with the support of the relevant international and regional organizations, should:

> One. Establish and/or strengthen environmental information systems at the national level;

> Two. Strengthen national, state/provincial and local assessment and ensure cooperation/networking between existing environmental information and monitoring systems, such as Earthwatch and the Sahara and Sahel Observatory;

> Three. Strengthen the capacity of national institutions to analyse environmental data so that ecological change can be monitored and environmental information obtained on a continuing basis at the national level." (Article 12.7)

Chapter 40 of Agenda 21 is dedicated to the role of information in sustainable development, as was discussed earlier. Under the header "activities", Chapter 40 makes an explicit connection between computerised information systems and environmental information:

> "Relevant international organizations should develop practical recommendations for coordinated, harmonized collection and assessment of data at the national and international levels. National and international data and information centres should set up continuous and

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[4] Investment in GRID $2,000,000 US in 1985 prices - partially from donations, most notably by ESRI – ARC/INFO developers.

accurate data-collection systems and make use of *geographic information systems*, expert systems, models and a variety of other techniques for the assessment and analysis of data. These steps will be particularly relevant, as large quantities of data from satellite sources will need to be processed in the future. Developed countries and international organizations, as well as the private sector, should cooperate, in particular with developing countries, upon request, to facilitate their acquiring these technologies and this know-how." (Article 40.9, *Emphasis added*)

and

"Countries, international organizations, ... should exploit various initiatives for electronic links to support information sharing, to provide access to databases and other information sources, to facilitate communication for meeting broader objectives, such as the implementation of Agenda 21, to facilitate intergovernmental negotiations, to monitor conventions and efforts for sustainable development to transmit environmental alerts, and to transfer technical data. These organizations should also facilitate the linkage of different electronic networks and the use of appropriate standards and communication protocols for the transparent interchange of electronic communications. Where necessary, new technology should be developed and its use encouraged to permit participation of those not served at present by existing infrastructure and methods. Mechanisms should also be established to carry out the necessary transfer of information to and from non-electronic systems to ensure the involvement of those not able to participate in this way." (Article 40.25)

With the new agenda and the availability of computer and telecommunication networks, the number of UNEP related systems proliferated. UNEP established an Internet backbone (UNEPnet) and a set of regional systems - such as BALLERINA for the Baltic sea area, EIS-SSA for the Sub Saharan Africa region and others.

Finally, the CORINE (CO-ordinated Information on the European environment) system should be mentioned within this context (Mounsey, 1991). CORINE was not developed by UNEP, although it clearly relates to the principles and methods of GRID. This system was conceived in Europe during the mid 1980s, and was developed till the mid 1990s. It was built as a GIS based database for environmental issues with a specific focus on biotopes, acid deposition and the protection of the environment in the Mediterranean region.

2.2.2.2 Environmental Information Systems and the World Bank

Unlike the rest of the UN system, the World Bank started to assimilate the need for environmental appraisal of projects only during the 1980s[5]. The World Bank has an internal EIS - a database system that contains three components:

- Project Monitoring and Tracking System

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[5] However, current World Bank documents are re-writing history and mentioning that the position of Environmental Advisor was established in 1970. It took the World Bank another 14 years to issue the first significant policy statement about environmental aspects of the bank work ... (The World Bank 1993)

- Country Module with information on protected areas, Environmental Legislation, Environmental and Economic Bibliography, etc.

- Data and Information Management.

This internal system is part of the management information systems of the World Bank. The World Bank is also involved in supporting projects for the development of EIS in the developing countries. The Bank has been focusing on the collection of geographically referenced information, and the promotion of EIS in different regions (such as the aforementioned EIS-SSA).

2.2.2.3 National Environmental Information Systems

As mentioned above, Chapter 12 of Agenda 21 explicitly encourages the creation of National EIS or NEIS (Ballantyne 1995). Yet, NEIS *predates* Agenda 21. The "first NEIS" is also the first GIS - the Canada GIS (CGIS). Developed between 1960 and 1969, CGIS became the main repository of various data sets about the environment. The system was managed as the "Canada Land Data System", which was subsequently replaced with "Environmental Information Systems Division". The system is:

> "…A generalized GIS with a very complete range of functional capabilities to capture, validate, edit, store, manipulate, retrieve and display geographically-based data. Throughout 20 years of operation, an enormous bank of digital data holdings has been captured, now totalling about 10,000 map sheets and encompassing over 200 data coverages (themes)" (The Inter-Agency Committee on Geomatics 1989, p. 1)

Another example of pre-Agenda 21 systems is the Indian ENVIS that stems from INFOTERRA and serves as the National Focal Point for it. ENVIS is somewhat similar to INFOTERRA and serves as a repository and dissemination centre for environmental knowledge in various fields.

Nevertheless, the role of Agenda 21 cannot be undermined. Agenda 21 reinforced the concept of NEIS and was a major influence on the creation of NEIS - especially in developing countries. One example of the influence of Agenda 21 is a project for the development of a framework for NEIS, initiated in 1996 by the Special Interest Group on Environmental Information of the International Federation for Information and Documentation (FID SIG/EI). The project aim is to develop a framework that could assist developing countries in the implementation of NEIS. The elements of this project are a clear specification of the requirements from NEIS - data, management structure, common problems and pitfalls and so on (FID SIG/EI 1996).

2.2.2.4 Sub-national Environmental Information Systems

Sub-national EIS can be found mainly in Western countries where a sub-national governance arrangement exists. In most cases, it is the environmental function within this governance that initiates and manages the EIS. During the survey, examples were found in Portugal (the Alentejo region), Switzerland (with GENIE - EIS for Geneva canton), Spain (Andalucia) and the UK (Cornwall). The most prominent example for a set of sub-national EIS is in Germany - with the system of Umweltinformationssystemen (UIS). Every German state (Lander) has a UIS. These

systems have been developed since the early 1980s, and the environmental authority at the state level runs it. At the core of each UIS we can find GIS, which contains information about various aspects of the environment. They are used to analyse and model the condition of the environment and to manage the environmental resources of the state. The systems are mainly for the use of the environmental professional and researchers, but some are already developing a WWW interface with the aim to provide access to the general public (Gunter 1998).

2.2.2.5 Management Tool for Regional Projects

In many countries, some geographical areas have earned a special importance in their environmental amenities. Due to their special virtues, it is common to find a concerted effort to manage and monitor them. In some cases, these efforts have led to the creation of dedicated EIS for the region. As the jurisdiction over the region is usually divided between more then one authority, an "environmental oriented" body is assigned to create and run the system (the UNEP regional systems, such as BALLERINA, have the same roots: supra-national bodies who can overcome the juridical barriers). In the United States such systems exist in Chesapeake Bay, the US-Mexico border region, the Virginia coast and the Great Lakes region. Other examples are Canada (the Crown of the Continent) and Vietnam (Red River - sponsored by Canada).

The Great Lakes Regional EIS (GLREIS) will serve as an example for these systems. As Figure 2.4 demonstrates, the Great Lakes area falls under the jurisdiction of 5 US states and 2 Canadian provinces. The whole area forms one integrated and interconnected ecosystem. In 1992 the Great Lakes Programme Strategy was launched, with the aim to reduce releases of toxicants into the environment, to protect and restore the habitat, and to protect the ecosystem's living resources. To help the co-ordination between the various bodies and to enable them to share information, the EPA commissioned GLREIS. The system is based on a WWW interface that provides access to data sets - statistics, GIS, documents and WWW links. The system also provides data exploration utilities - such as a tool to create thematic maps based on census data. The system has now (late 2000) been withdrawn and is not accessible any more.

Figure 2.4 - Great Lakes EIS area
(source: GRLEIS - http://epaserver.ciesin.org, accessed Nov 1998)

2.2.2.6 Municipal/Metropolitan Environmental Information Systems

The urban environment has its own set of environmental issues and authorities. Just like their colleagues in the regional and national environmental services, the municipal environmental professionals have created a range of information systems to manage and monitor the environment. Among the reviewed EIS, the municipal systems seem to be the ones that try to contact the wider public by providing "environmental atlases" and "interactive information kiosks". With the growth of the WWW, public access through the Internet to environmental data and information is an inseparable part of these EIS. The Berlin UIS can serve as an example for this type.

The Berlin UIS was developed between 1984 and 1989, as an internal project at the "Berlin Ministry of Urban Development and Environmental Protection". Later, as the "environmental atlas" was developed, it was decided to provide the information to the public through various technical means - from CD-ROM to WWW. Figure 2.5 provides an overview of the main components in the Berlin UIS. As the figure shows, the Berlin UIS has a GIS component which plays a pivotal role. Other components of the systems are technical data banks with statistical information about soil, water, air, climate, biotopes, land use and transportation.

2.2.2.7 An Answer to ISO 14000

Yet another outcome of Agenda 21 is the International Standards Organisation (ISO) "ISO 14000" standard and its EISs. ISO 14000 is a rather unusual member in the ISO standards family. Until the creation of the new "management standards", ISO focused on physical and tangible standards (such as size of containers or the definition of the A4 paper size). ISO 9000 (which focus on quality management) and ISO 14000 can be considered as the response of ISO to the information age and the need for standards in information work. ISO 14000 introduces a range of methods and techniques that can help the organisation in combining the environmental aspects into the general decision making process. The standard is called the "Environmental Management System" (EMS). The standard was developed as ISO's response to the Rio Conference (1992) and provides a framework for the inclusion of the "sustainable development"[6] principles in the management process and was published in the autumn of 1996.

The framework of ISO 14000 (known as ISO 14001) gives the guidelines to the EMS - the organisation should establish environmental policy, identify the environmental aspects of its operation, set targets and objectives, manage a programme to achieve them and set the system for internal and external reporting. Software vendors have seized the new opportunity, and there are several software packages that support EMS, some of which are called EIS. The ISO 14000 EIS is mainly a document management system. They offer a database to store the information, and some means to produce reports.

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[6] The quotes appear in ISO documents and its WWW site.

Online

CD-Rom

Analogue

ENVIRONMENTAL ATLAS

Soil	Water	Air	Climate	Biotopes	Land Use	Noise

Other Applications
- Specialist reports
- Statistics
- Scenarios
- Excerpts from the land register

Cartography
- Draft (Graphics and Text)
- Design
- Print draft

Methods
- Assessment
- Analysis
- Interpretation

Data Processing
- Cutting
- Grinding
- User function
- Valuation matrix/cube

Basic geometrical data 1 : 50,000
- Basic layout
- Residual pollution
- Other thematic maps

Access to 1 : 5,000

Land register of soil contamination (residual pollution)

Land register of soil pollutants (heavy metals)

UIS data land register - data on ground layout: land use, soil, water, climate

Land register of ecological effects of emissions

Long-term ecological surveillance

Central Technical Data Banks

Provision of data or adoption of results

- Protection of nature
- Geology
- Ground water
- Air
- . . .

Other technical data

Interface with decentralised systems

Data exchange with district authorities/Other specialist departments
Pilot project
Link to the district environmental offices

**Data management system / Management network
(General Information System - FIS)**

**Research Project
„Online Access to environmental data via the public network "**

**Public Network Services
(Internet CompuServe DatexJ/BTX)**

Figure 2.5 - Berlin UIS: Main Components (Source: Berlin UIS

http://www.sensut.berlin.de/sensut/umwelt/uisonline/index_e.html, accessed Nov 1998)

2.2.2.8 Environmental Information Systems and Industry

ISO 14000 is not the only reason for the development of industrial EIS. As a response to industrial accidents - such as Bophal (1984) or Chernobyl (1986) - the regulations that control factories and installations that deal with hazardous materials have been tightened (McCormick 1995). The ever-growing demand for reporting and inspection encouraged the operators to create a dedicated computerised system to follow the movement and use of those materials. The term EIS is used for these systems, probably because their reports are sent to the environmental authorities. These systems can range from a database system which stores the inventory of chemicals to a highly integrated system (which includes a GIS component) that helps in risk assessment and quick response in case of emergencies. The latter exists at the Pantex Plant - the main nuclear weapons disassembly facility of the US (Ruan and Maidment 1997).

2.2.3 Typology of Environmental Information Systems

To set some order in what seems to be a "chaos of EIS", it might be beneficial to try to give a typology of EIS. First, it is possible to divide them into two broad groups – systems that store information *about* the environment, and those that store information measured *from* the environment.

The first group includes systems that store and retrieve various types of document and/or information that relates to the environment. INFOTERRA, ISO 14000 or industrial EISs belong to this group. The information does fall under the title environment (e.g. a list of consultants in the field, inventory of potentially hazardous materials or a database of legal references) - hence the "environmental" in the system name.

However, the majority of EISs belong to the second group. It is quite safe to conclude that GIS is the nucleus of these EISs. In some cases, GIS is the only technology that is used. These systems are characterised by data and information that relate directly to the environment. The information is gathered through different means - from satellite imagery to noise probes. The GIS is used as an overarching framework that brings the various data sets into an integrated database. These systems also focus on monitoring, analysing and modelling.

While the first type belongs to the general group of "information systems" (like management information systems, etc.), the second is not exactly dealing with information in the strict sense. Rather, they are environmental data processing systems. These tools are used to collect environmental data and to analyse it - Gunter's definition (1998) captures this aspect clearly. The production of information might be the goal of these systems, but they are not strictly "information systems". It is interesting to note that the same situation exists with GIS. The first GIS were information systems – they relate information to a geographically referenced object. It was prohibitively expensive to store "non-meaningful facts" (i.e. unprocessed data) in them. Today, many GIS are geared toward analysis, and many times they operate on raw data.

This division along the lines of GIS utilisation marks another possible typology for EIS. This can be based on their role as Decision Support Systems (DSS). DSS are computer based systems that help decision makers in evaluating alternatives by supporting the process of organising information and modelling outcomes (Sauter 1997). As such, they can be positioned in a continuum of information systems, presented in Figure 2.6, which categorises information system according to their sophistication and contribution to decision making. The four main types of information systems represented in this figure are Management Information System (MIS) or Transaction Processing System (TPS) – systems that are used to support common business operations such as sales or delivery, then DSS, followed by Executive Information Systems (EIS) – systems that are tailored for strategic analysis and decision support, and finally Expert Systems (ES) – systems which are based on Artificial Intelligence principles and are used to perform tasks and to offer decisions based on their internal logic. The main differences between the systems are their capabilities in tackling ill structured problems and the flexibility of the system. Management information systems are structured to provide predefined reports that are based on the information they collect. They do not provide any analytical capabilities. INFOTERRA and some of the monitoring systems described earlier provide this functionality. They can answer only specific questions. As we move to a more GIS oriented environment, we move up the ladder and into systems that have more analytical capabilities. However, the ways in which those capabilities are deployed position the EISs along the axis.

| Management Information Systems (Transaction processing Systems) | Decision Support Systems | Executive Information Systems | Expert Systems |

Repetitive   **Specialized**
Linear Logic   **Huristics; System**
Regular reports   **make decision**
No support of   **itself; no regular**
decisions   **reports**
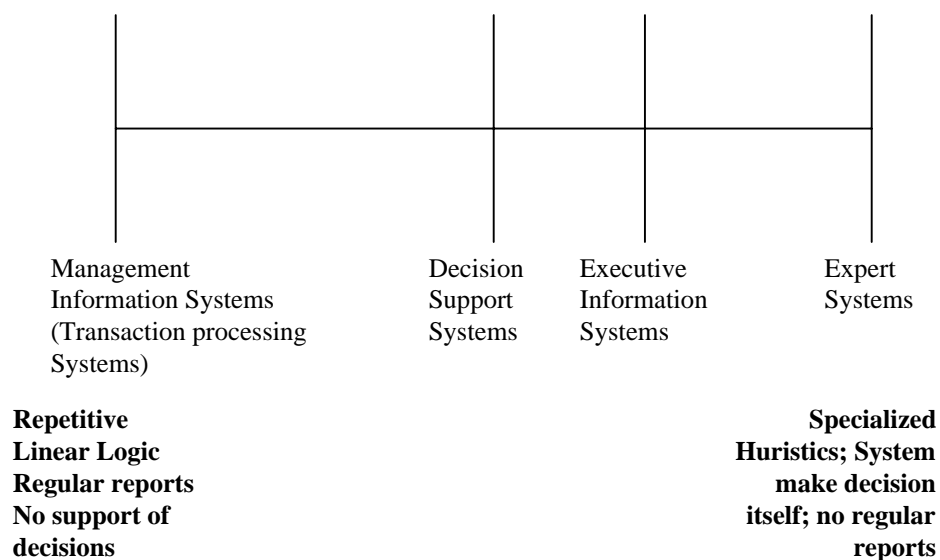
Figure 2.6 - Continuum of information systems products (Source: Sauter 1997, p. 13)

Those systems which rely on GIS technology and build upon DSS principles can be regarded as Spatial Decision Support Systems - SDSS (Densham 1991). The development of environmental modelling within a GIS environment, as will be discussed in section 2.2.4.6, is partially oriented towards the use of their output in environmental decision making processes. There are now reports in the literature on purposely built SDSS for environmental applications (Church *et al.* 2000, Cowen *et al.* 1995, Salt and Dunsmore 2000, Srinivasan and Engel 1994, Wadsworth and Brown 1995) and

their creation and integration is now possible. Many other systems are used to aid professionals and decision makers, though without following the structure and environment of DSS, which enables interaction and explorations of alternatives in real time. For example, the use of GIS during Environmental Impact Assessment (As reported in Fonseca *et al.* 1995, Haklay *et al.* 1998, João 1998) is oriented towards a decision making process. The difference between these uses of EIS and SDSS is their operation - i.e. the analysis is not carried out in real time, and it is not expected that the decision maker will use the GIS themselves. This is probably the most common use of EISs - as a professional tool that is used by professionals to provide the correct information to be used in decision making processes. Early definitions of DSS might include such systems under the DSS framework (Sol 1987) but more recent definitions (Sauter 1997) will exclude them. This is mainly due to the fact that they are not used by the decision makers themselves, but by others.

2.2.4 Operational and Organisational Aspects of Environmental Information

Based on the review and analysis of existing EISs, more facets of environmental information emerge. These relate to the operational and institutional/organisational aspects of EISs. In this section, these aspects will be explained.

2.2.4.1 Public Sector Environment

As noted by Gunter (1998) EIS usually operate in a public sector environment. The reason for this is that the environment is perceived as a public good or a common asset. It is therefore the task of governments and public bodies to preserve and control it. As happens in the current political climate, governments might outsource the actual activity to a private sector entity. Even in such situations, the responsibility for environmental protection and management remains with the public body. It is this property which enables the promulgation of legislative tools to open access to environmental information. After all, if most of environmental information was not in the public domain in the first place, then such tools could not be effective, especially when intellectual property rules are taken into consideration.

2.2.4.2 Lack of Money - the Cost of Environmental Information Systems

ICT is expensive. On top of the costs of hardware and basic software (such as the operating system), software development (custom application development) and maintenance, ICT is becoming obsolete faster then any other product or service. In many cases, system upgrades are not an option – they are mandatory; therefore considerable maintenance costs are a continuous burden. Agenda 21 gives some idea about these costs: the collection of digital geographic information for environmental applications is estimated by GRID at about two billion $US annually. The cost of the systems themselves is 165 million $US annually (and that is just in supporting the UN system and partially helping developing countries!). The situation is aggravated by the tight budgetary constraints of public organisations.

2.2.4.3 Lack of Expertise

Efficient, productive and useful operation of EIS requires a fairly high level of knowledge and skills - ranging from basic knowledge in computer maintenance and programming to knowledge in the specific domain - such as ecology or pollution control. The wide spread use of GIS in EIS expands the set of skills which are needed to operate such systems successfully (including geomatics, cartography, database operation and more (Traynor and Marian 1995)). It is possible to trace this aspect from the early days of GIS/EIS:

> "GIS world: ... you have to work with quite [a] variety of experts in different fields, right?
>
> McHarg: ... the instruction I offered ... was based upon having ... geologists, meteorologists, certainly hydrologists, always a soil scientist, ecologists, limnologists, plus ethnographers, anthropologists and of course computer scientists...."(GIS World 1995, p. 47)

In many cases these requirements make it fairly difficult to recruit, train and retain adequate staff. A common solution to this problem is to recruit a multidisciplinary team to operate the EIS. This aspect complicates the situation further, as it requires the organisation that runs the EIS to retain a diverse team of experts. Operation within the public sector is of special importance, especially when considering the continuous demand for skilled workers in the field of ICT.

2.2.4.4 Scale, Jurisdiction and Environment Information

As the review revealed, EISs deal with different spatial scales. This aspect stems from the spatial nature of environmental information. As a result, different EISs (operated by different bodies) might hold information about the same spatial location. The scale and area covered by any EIS usually relates to the spatial jurisdiction of the organisation that operates it. Of course, many environmental problems do not obey manmade boundaries. Sometimes, the EIS is seen as a way to circumvent the jurisdiction problem:

> "In parallel with its cooperation with external bodies, participation of third countries in the work of the EEA is clearly important since *environmental problems and challenges are not confined by national frontiers.* This has been envisaged from the outset and provisions for their involvement is covered by Article 19 of the Council Regulation setting up the agency. Considerable interest has already been shown by member states of the European Free Trade Association (EFTA) as well as by countries of eastern and central Europe to participate fully in the EEA's programme. *The conclusions of European environment ministers' conferences at Dublin (June 1990), Dobris, (Czechoslovakia) in June 1991 and Lucerne (April 1993), emphasised the importance of integrating environmental information systems throughout Europe.*" (EEA, 1998. *Emphasis added*)

Bearing in mind the obstacles of data sharing within a national framework, the portrayal of EIS as a transboundary panacea is false. An illustration for the lack of data sharing between different jurisdictions exists in the GLREIS map (Figure 2.4). The map does not depict the boundary between the aforementioned two Canadian provinces – Ontario and Quebec. It should not come as a surprise that this map was produced in the US (and it provokes the question about the extent of transboundary collaboration in GLREIS).

2.2.4.5 Information Sharing

Due to the need to integrate varied datasets in the analysis framework, information sharing issues have a special significance when environmental information is discussed. Issues related to information sharing can be divided into two aspects: organisational and technical.

The organisational problems relate to ownership and therefore access, and the willingness to share information - even among experts. Data sets that can be classified as environmental information - even in the strictest sense - are being collected and held by private sector bodies (like geological databases compiled by oil exploration companies). These data sets are usually beyond the reach of any researcher outside those organisations. Even between scientific institutions there is not too much enthusiasm for information sharing. A scientist or group who have spent many years and resources in collecting environmental information usually regard it as their "own" and are reluctant to share it (Porter and Callahan 1994).

Even when organisations agree to share information, there are technical obstacles, including:

File Formats - almost every computer application has its own data structures and file formats. Data sharing is impossible without knowing the full details about the data format (which is not always public knowledge). Furthermore, it is very common that file formats and data structures change with new versions of the application.

Different baselines/content sets - data sets vary in scale, projection, datum and time. Even when the information is accessible, incorporating the data sets into one comprehensive framework is laborious work.

Lack of documentation - if the data sets are not documented properly, it is virtually impossible to assess their value and to integrate them into a coherent set. This topic has received a lot of attention in the last ten years and the documentation of data sets is now termed "metadata" (information about information).

Data volumes - Some data sets tend to be very large (for example, satellite images). With very large data sets, there is a physical problem of sharing data sets - it is difficult technically to transfer the data set between research centres (Mounsey, 1991).

2.2.4.6 Managing information

The management of EISs databases is not a trivial task. During database compilation, the use of multiple sources presents a major issue. Different co-ordinates system, scale, quality and coverage - all are well cited within the GIS literature (Laurini 2001). Furthermore, and as noted before, one of the inherent elements of environmental information is the reliance on time series. This aspect makes EISs more susceptible to problems which are associated with databases management. For example, it is not enough to populate the system with basic data sets, but there is a constant need for updates of data sets, maintenance of consistent time series and so on (Mounsey 1991). They are also very sensitive to problems with data quality – because capta is manipulated throughout the

operations of EIS, error tend to propagate throughout the database (Hauvelink, 1998). In this context, Mounsey account on the creation of CORINE (1991) deserve mentioning, as it provides a candid description of the problems which were discussed here.

2.2.4.7 GIS Related Issues

The extensive use of GIS in EIS brings with it a set of issues that stem from its use. Those issues emerge from capabilities of GIS software and from attributes associated with it.

The first of those is the lack of good quality geographic information, and the cost associated with it. Though it is possible to analyse and display any set of information in GIS in isolation, the common practice is that for presentation purposes the information must be contextualised by adding geographic features such as roads, settlements or coastlines. The analyst needs this information during the analysis process, too. Therefore, the cost and availability of digital geographic information plays a crucial part in the feasibility and creation of EISs. This pose an obstacle in areas of the world where accurate base mapping is not available - a common situation in developing countries (Tveitdal 1996). In areas where such information is available, it is usually costly and that aspect prevents the creation of "grass roots" EISs (Pipes and Maguire 1997). This problem is known in the GIS literature and receives attention in both academic and non-academic publications (for example, Rhind 1996).

Another issue is the weak analytical capabilities in off-the-shelf GIS packages. In many environmental applications, there is a need to create and integrate sophisticated models. However, the current software products lack functionality and can not "keep up" with the innovations in the field of environmental modelling. As a result, the EIS developer must programme the specific models with software development tools that come with the GIS. This, of course, increases the total costs of the EIS even further (João and Fonseca 1996). This problem touches a fundamental aspect of environmental uses of GIS. Inherently, GIS offer several data models which encapsulate a world view and influence analysis. These data models are (following Goodchild 1993):

- *Vector-based*: a view of the world as a collection of objects, made of points, lines and areas. Each object is distinct and can be described by its boundary.
- *Raster-based*: a view of the world as a continuous field; the data stored in the computer represent some sampling of values.
- *Object-oriented*: a view of the world as conceptual objects ("river") that may be made up of other objects.

An interesting aspect of environmental problems is the prevalence of the field view. Many spatial problems in other management areas - utilities, traffic or retail - can use one of the other models without many problems. In environmental problem solving, however, the field view is the most common. It is, therefore, not surprising to find that the raster-based model has gained popularity in environmental modelling and was integrated into software packages that are designed to tackle environmental issues - like GRASS (GRASS Development Team 1999). By its nature, the raster-

based data model requires more computer resources (mainly in storage space) then the other models. This aspect prevented the wide-spread use of GIS for environmental applications until the mid 1990s and the availability of cheap, reliable mass storage.

2.2.4.8 Information and Information Technology "Fetishism"

While exploring information about EISs, it is almost unavoidable to reach the conclusion that (at least in some cases) EISs exhibit "ICT fetishism". Researchers feel that computers are powerful instruments, are "captured" by their capabilities, and want to use this awesome power for their research projects. Sometimes, the reason for the use of computers has nothing to do with the problem solving issue for which the system was built. Evidence that reinforces this "accusation" dates from the beginning of GIS. This is how Ian McHarg describes the first printouts from computers (from a line printer using Xs and Os) :

> "McHarg: {it was} absolutely terrible. I mean there wasn't a left-handed, barbarous, mentally retarded technician who couldn't do better than the best computer. Terrifying. It has come a long way.
>
> GIS World: the analytical process was rather crude, even with early computers, wasn't it?
>
> McHarg: Primitive beyond description..."(GIS World 1995, p. 47)

The question is then: "Why use computers in the first place?" the answer, presumably, is "because it is there". Curiosity is healthy and important when ground breaking research is done - and that is exactly what McHarg is describing. An example of ICT fetishism in EIS comes from UNEP. After two years of operation, INFOTERRA has a database of 6,500 entries and has processed 2,000 queries annually at a cost of about 1,000,000 $US (9.6 per cent of UNEP budget). It can be argued that a card based system, which would be printed on a quarterly basis and distributed all over the world, would be as effective as the early INFOTERRA. To make things worse, the UN Annual Review reports that a hard copy was produced and distributed to the national focal points.   In comparison, GRID costs during the first four years of full operation (1988-1991) were 14,369,862 $US (UNEP 1994) and it is clear that the costs of maintaining EIS have not decreased but rather increased.

To show that this trend is set to continue, the reader is invited to explore recent papers about environmental modelling and GIS. A quick look at Wiesel *et al.* (1996) will reveal a wide use of novel information technology. The paper discusses visualisation component for EIS, and dedicates two (rather short) paragraphs to the content and use of the system while focusing on the technical aspects of connecting different software elements and delivering information on the WWW. Reading the paper three years after it was written, one feels sorry that they did not include information about actual use. Most of the software components that they mentioned are either obsolete (like the early Mosaic web browser) or changed to such an extent that the paper is unhelpful to anyone who wants to establish a similar system.

Should we not appreciate the pioneering efforts of all these people in pushing environmental informatics while using the latest ideas from the field of ICT itself (ENTAG 1997)? The answer is probably no. There is enough evidence of projects that lost the balance between content and medium. The development of innovative models or techniques for the environmental sciences is sometimes replaced by innovative use of immature techniques from the ICT field. It is as if the E in EIS has gone missing or become secondary to the ICT.

2.3   PUBLIC ACCESS TO ENVIRONMENTAL INFORMATION

The previous sections of this chapter explored the intrinsic attributes of environmental information, and then the organisational and operational aspects that the overview of existing EISs revealed. This analysis provides the context for assertion A - the importance of information in environmental decision making - and C - the importance of GIS in the context of environmental information (Figure 1.1). The attributes of environmental information and its uses (as existing EIS demonstrate) support the two assertions. In this section, the context of assertion B - the growing importance of public participation in environmental decision making will be provided.

The principle of public participation and consultation is not new in environmental decision making. As noted in Chapter 1, public participation elements were included in environmental regulations since the early 1970s. Widely cited examples are NEPA and Environmental Impact Assessment (EIA) systems in Europe and elsewhere (Gilpin 1995). In these processes, the common method for consultation is through public meetings in which the project and its environmental impacts are presented and discussed. In some systems (US, Canada and the Netherlands) another meeting is integrated in to the early stages of the process, in order to select and verify the issues that will be investigated in the EIA (Brachya and Marinov 1995). This basic form of public participation is based on a process that is carried out according to experts' judgement (either environmental experts or decision makers) and the interaction and consultation with those outside this closed circle is limited. In Britain, this form of public participation has existed since the 1930s (Gilpin 1995). However, this mode of participation provides only a limited input from the public, while the main part of the decision making is done behind closed doors. Of course, in Western democracies there are means to appeal a decision through the use of the legal or political systems, but these means either circumvent the decision making process or happen after it is completed.

In recent years, this model of participation is changing. This is not unique to environmental matters, and encompasses many aspects of governance in a process of "democratising democracy" (Bloomfield *et al.* 1999). In their general form, the changes and processes that are associated with this process stem from the inadequacy of representative democracy in dealing with the complexity, diversity and rapid change in current society. Manuel Castells (1996, 1997, 1998) offers a broad analysis for this transition and puts it in the context of "the network society" and the information age. According to Castells the growing use of ICT has caused a profound change in Westernised societies:

"At the dawn of the Information Age, a crisis of legitimacy is voiding of meaning and function the institutions of the industrial era. Bypassed by global networks of wealth, power, and information, the modern nation-state has lost much of its sovereignty. By trying to intervene strategically in this global scene the state loses capacity to represent its territorially rooted constituencies. In a world where multilateralism is the rule, the separation between nations and states, between the politics of representation and the politics of intervention disorganizes the political accounting unit on which liberal democracy was built and came to be exercised in the past two centuries."(Castells 1997, p. 354)

This crisis of legitimacy leads to a "crisis of democracy" in these societies. Castells identifies three main trends that deal with this crisis. The first of them is the devolution of power into local government down to a neighbourhood level and the increasing demand for citizen participation. The second is the use of electronic communication to enhance political participation and communication among citizens. This mode of use is now well documented and has been demonstrated in environmental activists groups in the UK (Pickerill 1999). The third trend is the development of "symbolic politics" or the creation of single-issue and mobilisation around "non-political" causes - Humanitarian and Environmental causes serve as good examples and the growing popularity and acceptance of non-governmental organisations (NGOs) such as Amnesty International, Greenpeace, Oxfam and others demonstrates this trend. These groups mobilise around issues and themes that cross traditional political boundaries and provide an alternative arena in which to pursue them.

For our purpose, it suffices to recognise the growing demands for improved citizen participation and involvement in decision making processes. As for environmental decision making processes, the late 1980s and the publication of "our common future" mark the move towards this participatory form. The Rio conference and Agenda 21 reinforce these ideas and call for inclusionary forms of environmental decision making (WCED and Brundtland 1987). Today, environmental issues are used as a test-bed for participatory approaches and principles of inclusions and participation are playing a central role in the debate (see for example Burgess *et al.* 1998). This includes the creation of 'Local Agenda 21' which aimed to bring Agenda 21 principles to the local communities, citizens' juries, issue based forums, 'planning for real' exercises and so on (Bloomfield *et al.* 1999).

This trend impacts environmental information, too: the growing demand to "open up" the environmental information resources and provide access to the general public is one visible result. As was noted in Chapter 1, the Aahrus convention on "Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters" was signed in 1998 (UN/ECE 1998). This convention follows the principles of Rio documents and the European Commission directive 90/313/EEC on "Freedom of Access to Environmental Information" that came into force in 1993. In his analysis of access to environmental information, Hallo (1997) identifies two general rights - "active" and "passive". "Active" provision means information which the authorities must provide to the public at their own initiative. Examples of such provision are

Environmental Impact Statements or information on the potential hazards of an industrial facility for its workers and residents of the surrounding area. "Passive" information refers to the right of the public to obtain information upon request. However, the "active" form is mainly concerned with the traditional modes of public participation. This is quite remote from the inclusionary and participative stance that was described earlier or the stances of the Aahrus convention:

> "2. Each Party shall endeavour to ensure that officials and authorities assist and provide guidance to the public in seeking access to information, in facilitating participation in decision-making and in seeking access to justice in environmental matters.

> 3. Each Party shall promote environmental education and environmental awareness among the public, especially on how to obtain access to information, to participate in decision-making and to obtain access to justice in environmental matters." (UN/ECE 1998, p. 5)

Comparing this stance to Hallo's definitions, it seems that a need to move toward a new mode of information provision has emerged - one that can be termed "hyperactive". In hyperactive information provision, putting the information in the public domain is not enough. The holders of environmental information are called on to be proactive and to promote participation through action. Information provision is seen as a corner stone of such participation, and an integral part of the political process.

In the light of such analysis, there is a need for a better analysis of what participation mean. One of the well cited categories of participation was Arnstein's eight stage participation ladder, which comprises of:

1. Manipulation
2. Therapy
3. Informing
4. Consultation
5. Placation
6. Partnership
7. Delegate power
8. Citizen control

Where stages 1 and 2 can be considered as non-participation, stages 3, 4 and 5 as degrees of tokenism and 6, 7 and 8 are degrees of citizen power. Recently, Carver and his colleagues (1998) adopted a ladder from Weidemann and Femers which holds six stages:

1. Public right to know
2. Informing the public
3. Public right to object
4. Public participation in defining interests, actors and determining agenda
5. Public participation in assessing consequences and recommending solutions
6. Public participation in final decision.

Clearly, level 1 matches Hallo's "passive" while levesl 2 and 3 are "active" provision. My "hyperactive" provision relates to levels 4, 5 and 6. The purpose of provision of information changes in this process from a unidirectional process (from the authority to the public) to a bi-directional one. Therefore, there is a need to consider the aim and content of the information. For example, there is a need to evaluate and capture public opinions and perspectives and to integrate them with the information in the systems. Horita (2000), Kingston and his colleagues (1999, 2000) and other researchers who worked on Public Participation GIS (PPGIS) have developed some systems which demonstrate the capability to extract information from the public. In later chapters I will discuss how such developments can be integrated with PEIS.

2.4   ZOOMING IN ON PUBLIC ENVIRONMENTAL INFORMATION SYSTEMS

The focus of this thesis is on the provision of public access to environmental information. However, selecting environmental information as an object of investigation opens up multiple avenues of research. The aim of the current section is to offer a framework for such studies, and to provide a clear position for this thesis, while presenting areas that are worthy of investigation, but beyond the remit of this thesis. A "commodification" of environmental information provides such a framework. Borrowing from industrial terminology, the metaphors of harvesting, processing, packaging, marketing and consumption will be used. Environmental information (in its strictest sense) is harvested through scientific environmental research, monitoring programmes and data collection activities according to regulation and legislation. Examples for such "harvesting" activities are:

- Earth Observation System (EOS) project of NASA (part of their Earth Science Enterprise), which is mainly based on satellites and remote sensing data capture;

- collection of datum data for EIA: current air pollution levels or a flora survey in the project area;

- collection of air pollution readings across European cities, following the guidelines in an EC directive;

- Chemical Release Inventories (like those in the US and the UK) based on reports from factories on their use of certain chemicals.

Using the definition in Section 2.1.1, it can be argued that these processes focus on the creation of capta - large quantities of factual bits about various environmental factors. While environmental data is the raw material of the production process, the capta represents a first step in the distillation and creation of knowledge about the environment. It is important to note that some of this capta is being collected without a clearly defined process to convert it down the consumption chain. NASA's EOS is an example for this. Some of the capta streaming from satellites is being stored without any processing.

The processing of environmental information turns capta into information. The capta is reorganised, summarised and visualised. In this stage, computerised models are used to fill in the gaps (through extrapolation or interpolation) and GIS is widely used. During such processes capta might be used in isolation from other information (for example, when a remotely sensed image is manipulated) but it is very common to use other information. This is true especially in a GIS environment, where various information sources are being used as a reference for the analysis. It is at this stage that EIS are traditionally used - to collect, organise and analyse environmental capta.

The packaging stage is aimed at creating a common source of information, from which knowledge can be extracted. The packaging forms include:

- Creation of "state of the environment reporting" which is common in OECD countries;

- Environmental impact statements and reports that summarise the main findings of the EIA;

- Environmental atlases and collections of maps and reports;

- Scientific and scholarly papers published in academic journals.

As these examples demonstrate, the packaging is done in accordance with the target audience. The scientific reporting is to enable knowledge transfer to other scientists in the specific field. Environmental impact statements, on the other hand, are written to enable the evaluation of the environmental impacts of the specific activity by decision makers. In many countries around the world, these experts have knowledge in environmental planning, but not necessarily in every domain of environmental science which is used during the analysis.

Finally, various audiences consume environmental information (Centre D'estudis D'informacio Ambiental 1998). They use channels and packages regardless of the originator's intentions. Environmental impact statements can be used to oppose a development even if the contender is not interested in environmental aspects. The media might look for a news item in fresh reports from governmental bodies. The ways in which the media mould the information shapes the knowledge that the audience receives.

In this wider context, there are many aspects that are noteworthy and deserve closer scrutiny. To the best of my knowledge, there have been no studies that try to analyse and provide a complete and holistic framework for the ways in which environmental information is "manufactured". However, this thesis focuses mainly on the packaging and consumption of environmental information. As was discussed earlier, the principle of public access to environmental information is concerned with the provision of access to existing information. Furthermore, one of the aims of this access is to improve the knowledge of the public and, by so doing improve public awareness of environmental problems. As the later chapters of this thesis will demonstrate, this issue cannot be discussed in isolation from collection, distillation and processing - just like any other process, changes in consumption patterns force a re-evaluation of the whole process and reflect on every

stage in the chain. Despite this caveat, it is possible to carry out most of the analysis while focusing on packaging and consumption patterns.

Moreover, the analysis will focus on a specific user group. As was pointed out in the overview, various users of environmental information and knowledge can be identified. Those include scientists in disciplines that deal with environmental research, professionals in statutory bodies in charge of environmental regulation, decision makers who must incorporate environmental aspects into their decisions and so on. From this vast array of users, each with special requirements and needs, this thesis focuses on the specific group that has been titled "public". This group is not homogenous and needs to be unpacked. Nevertheless, this group is distinct enough to require special attention. This attention is timely, as new regulation and changes in society force a re-evaluation of environmental information provision for this group. It is likely that other user groups (scientists, professionals, etc.) enjoy a better provision of information. If the argument about co-evolution between EIS and their immediate users is correct, then it is likely that these users have influenced their working habits and information systems in such ways that support their daily work (though this assertion needs scrutiny). Therefore, it seem appropriate to start the analysis of environmental information needs from the most problematic user group. From the outset it is clear that this group will express a variety of view points and will not have a shared worldview and values which can be assumed, to a certain extent, about other, more formal groups.

2.5   DELIVERING ENVIRONMENTAL INFORMATION TO THE PUBLIC

Thus far, this chapter has moved through the different layers of PEIS. First, environmental information as an autonomous object was examined. At the next stage, the systems that hold such data - EISs - were reviewed and more aspects of environmental information came into light. Then, after explaining the origins of the call for public access, PEIS were positioned in the context of the environmental information "production cycle"[7]. In this final section, I will examine the means by which information is delivered to the public.

Environmental information is packaged in almost every known form of information delivery. Most of those forms involve paper. However, the medium (paper) is used in different ways - in terms of form, it may carry text, maps or photographs. When content and context is considered, that paper can be a short article in a local newspaper, or a scholarly article in an academic journal. Environmental information can be transmitted in other forms - as a radio or TV programme or in a face-to-face meeting during a public consultation.

Though these modes of communication are important and will not be ignored in the course of the thesis, the focus will be on a specific mode of electronic delivery. By that I mean the use of ICT as the means to provide public access. The reason for this focus is the trend toward reliance on ICT as

[7] For analysis of media-based environmental information communication, see Centre d'Estudis d'Informacio Ambiental (1998)

the main medium for public access. This is apparent in the Aahrus convention (UN/ECE 1998) in which Article 5 declares:

> "Each party shall ensure that environmental information progressively becomes available in electronic databases which are easily accessible to the public through public telecommunications networks..."

Furthermore, one medium has gained importance: the Internet in general, and the WWW mechanism and set of protocols in particular. The citation above shows that the convention calls for public provision through the Internet. Making a reference to "Public Telecommunication Networks" in 1998 must mean that. In a recent OECD seminar (held July 2000) on these issues, this link was made explicitly (OECD 2000b).

However, the use of the Internet for public provision of information opens up a host of issues and problems. The implications of ICT on society have gained a lot of ground as a topic of study in social sciences since the 1980s (Dutton 1999).

From this wide and extensive area, a few issues will be raised - those that are most likely to inform and impact PEIS. Those issues include the social inequality of Internet access, the relationship between the "information age" and environmental politics and, finally, the mode of communication that the Internet and WWW entail.

2.5.1   Public Environmental Information Systems and the Digital Divide

The lack of equity of access to ICT or the "digital divide" as it was termed (USDOC/NTIA 1999) is of special concern regarding PEIS. As noted, one of the postulates of sustainable development is the focus on an inclusive mode of decision making. This is also self-evident in the title of the Aahrus convention on "Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters" with its clear connection between access to information and justice (UN/ECE 1998). The prevalence of the Internet means that equity in access is a crucial factor in its suitability to serve as a medium for PEIS.

The series of reports titled "Falling through the net" (USDOC/NTIA 1995, 1998, 1999), published by the US National Telecommunication and Information Administration (NTIA) is probably one of the most reliable sources of statistics about access to the Internet from home. According to this report, households with high incomes ($75,000 and over) are twenty times more likely to have access from home then those in the lowest income bracket. The "digital divide" seems to be growing between income groups. About 26.2% of US households have Internet access, and about 42.1% own a computer. Minority groups, the less-educated, single parents, and young households are less likely to be connected. Geographically, inner city and rural inhabitants are less connected. Another aspect of Internet exclusion is age related. Among the US population only 25.8% of those over 55 own a personal computer and only 14.6% have Internet access.

There are strong reasons to believe that the same patterns repeat in other parts of the world. For example, in Europe the cost of computers and communication are higher than in the US and there is likely to be an even higher tendency toward higher income. For example, recent figures from National Statistics in the UK (published July 2000), show that 25% of households have Internet access from home (Bowman 2000). However, those who are in the second lowest income decile groups have access at around 3%, while 48% of those in the upper group have access from home. In the lowest decile the access level is about 6%, but the report attributes this anomaly to the presence of student households in the survey population (Bowman 2000).

These figures support Castells' conclusion that (Castells 1996 p. 358) "Computer Mediated Communication (CMC) is not a general mode of communication and will not be so in the foreseeable future … it will exclude for a long time the large majority of humankind".

The obstacles that stand between low-income and marginalised communities and the "Online world" include (after Mitchell 1999b):

- *Connection speeds.* Access to the Internet can be made through telephone lines (by using modems), cable TV or dedicated communication lines. The cost of connection is relative to the speed of data transfer. It is, therefore, expected that even in the case where low-income groups gain access to ICT, it will be at the lowest speed.

- *Lack of infrastructure.* In many cases, due to commercial reasons, telecommunication companies exclude low-income areas from their deployment programmes and priorities. This might result in a lack of technical opportunities – for example, the equipment to support high-speed connection might not be installed in such areas. This problem is made worse in rural areas where the economic justification for new and expensive equipment does not exist.

- *Access appliances.* Even with today's dramatic drop in the cost of personal computers, they are still expensive appliances. The price is even higher when their short life expectancy is taken into consideration. A five year old computer will not be supported by the latest modem technology and effectively will exclude its owner from the on-line world. Other access appliances (like web-enabled digital TV) are not much cheaper, and provide limited functionality.

- *The accessibility of software.* Some of the software that is used to perform CMC is getting more and more complex. For example, the first graphical web browser (NCSA Mosaic) had just a few buttons, and though it was very limited, it could be learned in a few minutes. The current generation of browsers, though still relatively accessible, have became rather complex pieces of software that inundate users with many buttons and options and require training and practice.

- *Language.* Most of the tools and information on the Internet, and even the communication itself in ICT, is in English. As many people who belong to marginalised groups do not speak English, this will alienate them even more.

All these aspects should not lead one to the conclusion that the Internet is an inadequate medium; there are several reasons to believe that the excitement about it is justified. First and foremost, Internet use expands very rapidly. According to Nua Internet Survey, the number of users will reach 250 million world wide by the end of 2000 (see Figure 2.7). The growth in developed economies is even faster. The figure cited earlier for the UK shows that this medium has penetrated 25% of households within 5 years (Bowman 2000).

How Many Online Worldwide
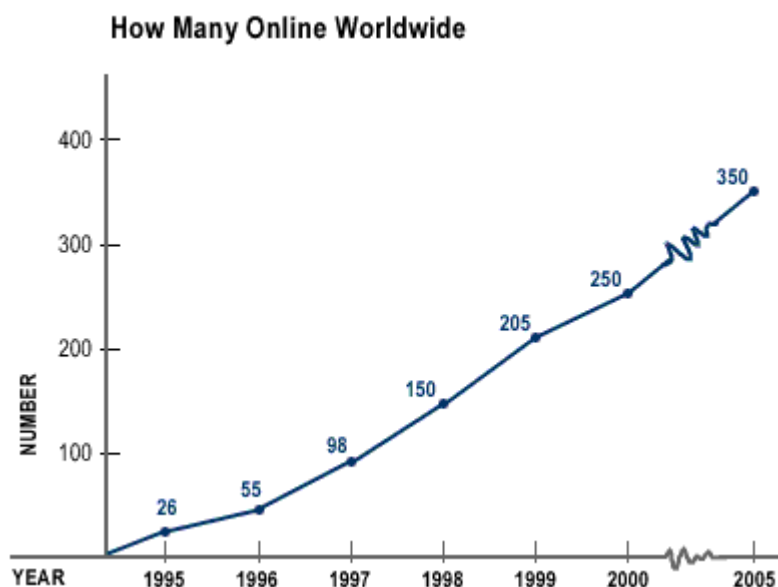
Figure 2.7 - Internet User growth (millions) 1995-2005
(Source: Nua Internet Surveys http://www.nua.ie/surveys/how_many_online/index.html accessed Dec 2000)

Furthermore, it can be argued that awareness that reports like "Falling through the net" demonstrate should be a source of optimism rather than pessimism. The active research held by governments, not only in the US but elsewhere (for example, in the UK see Foley 2000) and inter-governmental organisations (for example, OECD 2000a), signals the concern that governments express towards the "digital divide" and the acceptance of the principle that access to the Internet should be widespread throughout society. Governments and voluntary organisations are also taking active measures to tackle the problem and to provide access to the Internet for disadvantaged groups (Schon *et al.* 1999).

The second reason to prefer this medium is the simple argument that it is the best available. The structure and architecture of the Internet provide a mechanism by which information can be released in the public domain at relatively low cost for both provider and consumer. The Internet enables the consumer to look at the information at anytime and from any location (provided, of course, that the technical means - access appliance and communication - exist in this place). The network of computers and the ability to interact with a remote information system while using a standard tool (the web browser) enables standardised access to information. The rapid growth and the wide ranging societal impact of the Internet are clear evidence of the success of this medium in facilitating access to information and computers (Castells 1996). The experience of accessing

information through ICT is considered and perceived to be inherently democratising and empowering (Dutton 1999).

2.5.2 Environmentalism in the Information Age

As Castells (1997) noted, the development of the environmental movement and politics in recent years can be interpreted as part of the transition to the information age. Castells identifies five types of environmental groups. The first group focuses on the conservation of nature and fights uncontrolled development while raising the values of the wilderness. This is one of the long established environmentalist foci, and includes mainstream groups like the Sierra Club in the US. The second grouping includes those that focus on the quality of their own lives and defence of their own space - this is termed Not In My Back Yard (NIMBY). The third group includes the eco-activists who promote "deep ecology" and ideas of ecotopia. In this group we can find most non-conformists and radical environmentalists. The fourth group focus on sustainability and the need to save the planet (Greenpeace is an example for such an approach). Finally, there are groups who act within the political establishment to promote environmental issues - i.e. green politics.

These groups act differently according to the issues at hand. However, Castells connects the rise of environmental issues to wider societal changes. All these groups have an ambiguous, yet deep connection with science and technology. It sometimes amounts to a revolt of science against science. Environmentalism is inherently based on science. The identification of problems and the development of solutions rely on scientific ideas. Secondly, there is a strong connection with the struggle that is part of the information age - the control over space and time and an emphasis on locality. This aspect is a recurrent theme in many environmental debates. Of course, Castells connects this to the main struggle that he identifies between the space of flows - information, corporation and money networks that act across the whole globe - and the space of places - where actual communities live and manage their livelihood. The space of flows becomes the major space of power and the way power structures interact. The space of places is the main arena for environmental action. As such, environmental politics represents the collision between the two. On the temporal scale, the environmental movement is presenting another collision - while the economic structure moves toward "timeless time", a compactness of time and space so famously identified in Harvey's "The Condition of Postmodernity" (Harvey 1990), the environmental movement is forcing the introduction of another timescale - the following generations, the last ice age and so on. This holistic view represented by environmental politics stands in a sharp contrast with the fragmented and fractured space/time structure of current society. The same holistic framing is used to extend the identity of the human species as just a component of nature.

The environmental movement has also represented the rise of new politics, in which narrow or single-issue groups emerge, and the personal political identity is not homogenous any more but constructed from multiple interests and political agendas. ICT plays an interesting role within this movement. Its ability to communicate messages quickly and easily has been recently used by

various activist groups to co-ordinate grass root groups (or unruly mobs) to plan concerted action during discussions of major, globalisation-related bodies like the World Trade Organisation conference in Seattle at the end of 1999 (Economist 1999).

The democratising values of the Internet, the feeling of uncontrolled, limitless communication have been identified by many environmental groups. This has taken the form of e-mail lists and web sites (O'lear 1997, Pickerill 1999) and it is important to note that both Greenpeace and Friends of the Earth started to use the WWW relatively early. It is clearly part of their campaign strategy, as will be demonstrated in Chapter 6.

2.5.3 Modes of Communication and Information and Communication Technology

As was discussed in Chapter 1, the provision of environmental information to the public should be understood as part of a communicative process which is the centre of ecological modernisation. Due to this aspect of PEIS, there is a need for an analytical framework for the communicative value of the delivery medium. As ICT plays a major role in this thesis, such a framework must relate to its special characters.

As Holwell (1997) noted, Shanon's information theory is, of course, inadequate. As many have noted (starting with Shanon himself), information theory is not about information in its common sense. Information theory is dealing with accurate delivery of some strings of signs regardless of content. Such theory is of major importance to the technology at the basis of PEIS - computer networks, software systems and the Internet - all encapsulating the principles of Shanon's theory. However, information theory does not help in the communication of information in the sense that was described in section 2.1.4.

In the wider social framework of communication of ideas and concepts using technology, McLohan's ideas about the role of the media in modern societies, developed during the early 1960s, cannot be ignored (Castells 1996). However, his theory and a lot of the media studies that followed focus on the mass media. Today, as the media fractures into multiple channels and especially when media like the Internet are discussed, this theory does not provide an adequate framework. One of the reasons for the democratising aspect of the Internet is the low entry barrier of this medium for publication. As such, it is a medium where multiple voices and opinions are being distributed. As Castells notes (1996), the mass media is also fractured through the use of cable and satellite TV, the proliferation of privatised radio stations and so on. Finally, the new media offers interactivity as a major aspect - this is not a uni-directional process anymore, but a process of communication in different forms between the information producer and consumer (Castells 1996). Therefore, we need to focus on ideas that will help in understanding and organising those modes of communication.

Mitchell (1999a) offers such a typology that is especially helpful in relation to ICT. This typology is similar to Shiffer's one (1999), and can be traced back to Schmidt and Rodden's analysis (1996). However, the wording of Mitchell will be used in this section.

This typology is based on the spatial and temporal aspects of communication. Communication between different participants can happen when all participants are at the same place - a mode that will be labelled "presence", or when they are in different locations - so in terms of the communication act they are present remotely or "telepresence". The temporal aspect can be divided into communication that is being made at the same time and requires that all those who communicate are actively engaged in it during that period, such communication will be termed "synchronous"; the other mode of communication is when information is passed over different time frames - an "asynchronous" mode.

By using the two divisions - presence/telepresence and synchronous/asynchronous - we can categorise different communication modes and media into four groups. Traditional communication is mainly focused on three areas: presence/synchronous - face to face talking, or meeting. This is still the richest mode of communication between humans, as many have noted (Brown and Duguid 2000). The telepresence/asynchronous mode was in use for thousands of years. Sending a letter or any written form of communication where the parties are actively engaged in passing messages is an example for this mode. The presence/asynchronous mode exists in formal settings, where the participants are required to get into a specific physical location to exchange messages. Public exhibitions of planning proposals are example for such places, where participants need to arrive at a specific location and then they can communicate by writing objections or support letters.

The introduction of ICT is supporting all modes of communication - but especially the telepresence/synchronous one. Since the introduction of the telegraph in the 19th century, it has become possible to communicate rapidly over long distances (Standage 1998). The development of the telephone and the improved capabilities of telephone-based systems (multi-participants tele-conferencing for example) enhanced these capabilities. However, the introduction of computers and ICT increased the modes and techniques that are available for the various modes of communication.

For example, the most common CMC is based on text communication where the participants "chat" by exchanging short textual messages. This mode of communication creates a whole plethora of unique and new psychological and social issues (Turkle 1984, 1995). Other modes of CMC rely or imitate "off-line" media but their temporal difference makes them distinct and different (for example, the speed in which electronic mail travels across the world compared with regular mail). It is an accelerated modality of communication in all channels.

In table 2.1, I have adapted the Mitchell (1999a) and Shiffer (1999) representation, and provided examples for "traditional media" and ICT. I have focused on interactive forms (therefore, the brochure and leaflet are not included) and give some examples for each. Each cell is divided into

three areas. The top-most provides Mitchell's list of advantages and disadvantages. This is followed by examples for traditional uses of each medium. The last cell provides some ICT examples.

As this table demonstrates - most of the developments in ICT focus on the telepresence aspect. In the following chapters, I shall return to this typology when evaluating the different means for delivery of environmental information.

Table 2.1 - Advantages, Disadvantages and examples for modes of communication (After Mitchell 1999a and Shiffer 1999)

		Synchronous	Asynchronous
Presence		Intense, multimodal - speech, visual…	Limited by storage and playback capabilities
		Immediate feedback	No immediate feedback
		High transportation costs	High transportation costs
		High space costs	High Space costs
		Need for co-ordination between participants, space…	No need for co-ordination
		Need full attention	May allow some division in attention
		Public meeting	Public exhibitions of plans
		Shared use of information systems	Community information kiosks Centrally organised community EIS
Telepresence		Limited by bandwidth and interface capabilities	Limited by storage, bandwidth and interface capabilities
		Immediate feedback	No immediate feedback
		Reduced transportation costs	Reduced transportation costs
		Reduced space costs	Reduced space costs
		Need for co-ordination between participants	No Need for co-ordination between participants
		May allow some division of attention	Allows multiple activities and transactions in parallel
		Telephone / conference calls	Letters, mail communication
		Groupware (video conferencing, chat, IRC) Interactive TV Phone-in radio or TV discussions	E-mail lists Internet discussion groups WWW-based information systems

2.6 SUMMARY

In the course of this chapter, the main aspects of environmental information and EIS have been explored. The following paragraphs recap the main argument that was developed in this chapter.

As the analysis of this thesis demonstrated, Environmental information is an interesting object of investigation. Though it clearly exists, it is impossible to provide a clear cut definition for it. In its core, there is capta collected from the environment, in many cases following the pressure-state-response principle. This capta usually deals with the "state" aspect and monitors the condition of a certain environmental variable. It has a strong spatial and temporal element. By its nature, environmental information is based on the integration of multiple data sources which form an holistic and coherent picture of environmental aspects. Data capture and processing procedures for this capta are likely to be based on scientific principles - but this type of processing forces us to confront the uncertainty and inaccuracy which are intrinsic to it. Environmental capta and information comes in large quantities. They are usually collected and managed by public sector

bodies. This type of operation opens up the opportunity to increase access to this information, but brings with it an array of problems - including the extensive start-up and running costs attached to EIS and the need for qualified and diverse human resources which the public sector might find hard to obtain. The spatial element explains the extensive use of GIS, but brings with it a set of issues associated with its use (on the other hand, it can be argued that the use of environmental information in GIS has brought many issues that GIS researchers and developers used for the development of this technology). Finally, in some cases an excessive use of information technology can be identified - a use that goes beyond the issue of environmental problem solving, and loses track of the problem at hand. Such uses put the technology first and they are beyond the scope of the current analysis.

The environment within which EIS operate has changed considerably in the last decade. Following the general trend in Western society, and the need to foster more inclusive and open decision making processes, statutory bodies that collect and store environmental information are forced to provide public access. Taking into consideration the basic acceptance that environmental decision making should be informed and scientifically based, it should not come as a surprise that information provision is seen as a vital part of an inclusionary form of decision making. Environmental information has many roles in environmental decision making processes - but due to the stark differences in requirements and needs from other, more traditional user groups, it seems appropriate to focus on public aspects of environmental information provision.

As for delivery means, it seems almost unanimously accepted that environmental information should be delivered to the public through ICT, and especially through the Internet and the WWW. There the special properties of these media and their influence on the communication itself must be scrutinised as part of a PEIS study. Using Mitchell's and Shiffer's analysis (Mitchell 1999a, Shiffer 1999) a framework that is based on space and time has been established. Castells' analysis (Castells 1997) hints that this framing is of particular use in trying to understand the collision between the 'space of places' and the 'space of flows': the use of ICT for delivery and discussion of environmental issues – many of them relate to a specific locality and a place.

The next Chapter is provides the methodological and theoretical background for this thesis. In this chapter, the investigation framework is explored and put within the theoretical context of the study. Once these aspects are explained, the chapter will explain the empirical studies that provide evidence for the analytical part of the thesis.

3 Exploring Requirements and Needs from Public Environmental Information Systems

The previous chapters laid out the main issues concerning PEIS. As noted, the content of environmental information systems has increased and changed over the years. This has happened in a constantly changing political, economic and social environment. The special aspects that make environmental information unique, revealed in Chapter 2, raise many questions about the ability to develop comprehensive PEIS - due to the doubts about their content. While Chapter 1 opened up the research question and Chapter 2 provided the background for environmental information, EIS and public access to environmental information, in the current Chapter the thesis framework is explained. The main aim of this chapter is to explore possible research methodologies that are adequate for this thesis research question: the ability to develop PEIS that will meet their users' needs. Put in this way, the research question resembles a requirement for Information Systems. Therefore, it seems natural to explore available Information Systems (IS) development methodologies, methods and techniques. However, such exploration will reveal the shortcoming of these methods. The main argument developed in this chapter is that information systems development is not merely a technical issue but, like any other human activity, the action is influenced, shaped and constrained by theoretical and philosophical frameworks. For this thesis, I have adopted a framework that views technology in general, and information and communication technology (ICT) in particular, as a pivotal force in modern society. I am not considering technology as an autonomous force. Rather, is it an integral part of society, shaping and being shaped by various forces. This view of technology is just one of several possible interpretations. These interpretations and the theoretical framework of the thesis form the core of the current chapter. In the light of this framework, it will be explained why such a stance has special importance when discussing technology that is embedded into politics and society - such as PEIS.

After putting in place the methodological and theoretical framework, the rest of the chapter is dedicated to the methodology and empirical studies that are the major basis for this thesis. This section starts by explaining SSM, followed by the structure and background for the empirical studies - the survey for London Environment Online system, the UCL Brownfield Research Network workshop and the comparative study of existing PEIS. The role of each study within the SSM framework will be explained.

3.1 HOW TO INVESTIGATE PUBLIC ENVIRONMENTAL INFORMATION SYSTEM?

This thesis was set up to explore the issues that must be taken into account when designing a computerised and Internet-based PEIS which will provide information that those with interest in environmental issues will find useful. Although this is a relatively a limited domain of investigation, there are many ways in which an answer to this question can be explored. One of the intuitive ways

is to attack this question from a technical perspective – after all, this question reassembles "user requirements study" which is common in information systems design. Performing such analysis will produce results that can be applied to real systems without much trouble. In a simplistic way, such an investigation framework treats PEIS as a sub-type of EIS which, in turn, are a certain implementation of Information Systems. Hence, in order to develop PEIS, all that is needed is to select and implement one of hundreds of the available information system development techniques, methods and methodologies – many of which have been developed since the 1960s, and more are still being developed.

However, adopting a technical perspective has its limitations – while most of those techniques, methods and methodologies are very useful in developing operational information systems, they (as shall be explained) lead the analyst into a technical tunnel vision which, while useful in focusing attention on database design or interface design, is myopic toward social and political implications of the design. On the other end of the scale, the question can be approached in an ethnographic or cultural manner. Such frameworks are common within Science and Technology Studies (STS) and was proven useful in the study of existing socio-technical domains such as technical systems and sciences (for example Latour, 1996). These frameworks and studies provide important insight into the social construction of technology and explain the social processes that operate within modern societies. However, adopting such framework makes the conclusions of a study hard to implement on specific information system. Between the technical and the social emphasis ends, there is a third option – an investigation framework that supports social and political analysis, while producing results which are useful for information systems design. The advantages of adopting such a framework for this thesis are the ability to integrate the social and political complexities into the design considerations, to clarify the theoretical/philosophical stance of this thesis and to draw on the literature and lessons of both ends. There are, of course, disadvantages. First, while the technical approach enjoys the use of authoritative stance and "objectivity", a middle ground approach must struggle with the complexities of subjectivity and, by so doing, make the whole analysis entrenched within certain analysis of the modern social condition. Second, such a method is open to accusation from both ends – its language and methods might seem too soft and difficult to digest by technically minded readers, while being overly technical for culturally minded ones.

The process of adopting SSM as a research framework for this thesis was based on its adequacy to serve as a middle ground methodology. It is based on somewhat similar analysis to that carried out by Checkland and Holwell's "Information, Systems, and Information Systems" (Checkland and Holwell 1998) in which SSM is used to understand the field of information systems. Other studies that use SSM as a research framework show similar capabilities (Checkland 1999). However, the adoption of a framework is not without cost. It is, after all, impossible to predict the outcome of this thesis if another research strategy was used here. In the following sections, I will describe the rationale and learning process that led to the adoption of SSM for this thesis. This process starts with an overview of the software-engineering/information systems fields as understand their

development and the reasons for the variety of techniques, methods and methodologies. This overview is presented here to explain the reasons for adopting SSM for this thesis.

Before turning to the discussion, there is a need to clarify the differences among methodologies, methods and techniques - these terms play a major role during the discussion of information systems development. Following Checkland (1999) I will differentiate among them in the following way (all defined in the context of this thesis):

> *Technique* is a prescriptive way to perform an action in a meaningful and efficient way. For example, an Entity Relationship Diagram (ERD) - a pictorial representation used in data modelling (Chen 1976) - can serve as an example. It has a clear set of rules, describing how to draw it, and how to convert the results into a database scheme.

> *Method* is a specific approach to conducting an activity. Usually, we will find that a method is using different techniques while conducting the activity.

> *Methodology* is a set of principles that underlie, inform and justify methods. It provides a framework in which methods and techniques are developed and deployed.

As we shall see, the information systems development field is packed with methodologies, methods and techniques. Furthermore, the terms are used interchangeably in the literature without clear distinction. For example, one of the descriptive methods that will be reviewed later - Structured System Analysis and Design Methodology (SSADM) is more of a method than a methodology. It seems that in most cases, little or no attention is paid to methodologies, as practitioners focus on methods and techniques as tools that will help them to accomplish tasks efficiently and effectively.

To avoid confusion, when I refer to all the possible approaches (methodologies, methods and techniques) I will use the term Information Systems Development *Modi Operandi* - or simply *Modi Operandi* where appropriate. This Latin term mean "modes of operation or work" and is used here to describe the possible approaches to design – all of them provide ways to perform different tasks within the design process.

3.1.1 Software Engineering and Information Systems Studies [1]

When the digital computer was invented, in the mid-1940s, and during the first years of their deployment, there was no need for software development methodologies or methods. The arcane task of coding data, running programs and understanding the results was done by highly trained individuals who developed software from start to end (Sasse and Fultun 1997). During the early 1950s, the abilities of digital computers to process numbers efficiently attracted the attention of organisations and individuals who need to perform such tasks on a daily basis. Governmental

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[1] The following section is aimed to provide a brief overview of computer systems development *Modi Operandi*. For a more complete discussion of this broad field, consult (Avison and Fitzgerald 1995) or (Checkland and Holwell 1998).

bodies and corporates alike started to apply computers in "number crunching" applications (Sasse and Fultun 1997).

As their capacity - speed of calculation and data storage - increased, the need for an ordered process of software development became apparent. Engineers, scientists and managers started to realise the immense flexibility of these calculating machines[2], and the requirements from the applications became more and more complicated. This complexity was the main driving force behind the development of computer languages, which enabled a higher level of abstraction. The computer programmer, freed (to a degree) from the need for intimate knowledge of the ins and outs of the computer processor was able to focus on the logic of the program and the task (Shemer 1987).

The continuous development and the gathered experience lead to yet bigger software projects. By the late 1950s, the complexity reached a point that software projects needed to be designed and planned ahead. As a result, methods for developing large computer applications started to emerge. Soon after, the view of computerised applications as "software systems" became pervasive. The concept of systems, and systems analysis - which emerged from the work of the RAND corporation during the second World War - became popular in science and technological projects, and found fertile ground in computer applications (Checkland and Holwell 1998). The continuous development in input and output devices supported the "system" view - these devices are connected ("hooked up") to the central processing machine and form an orchestrated set of machines that work in harmony to perform a computational task. Furthermore, this concert operation is driven by an illusive combination between computer programs - by now pronounced in some English-like text - and those mechanics. A broader view of the computer system, and the task that it performs (like dealing with the process of air flight reservations) lead to the concept of "information system". This term was coined during the first part of the 1960s, and this era also marks the emergence of "information systems" as a field of study that merges Computer Science with Management Science and Operational Research (Adam and Fitzgerald 1995, Checkland and Holwell 1998). The focus on programming languages and program structure continue throughout the 1960s, and toward the end of this decade (in 1968) the term "Software Engineering" was coined, during a symposium held by NATO (Shaw 1996).

During the 1970s, the scope of software design and development expanded. Application developers started to construct *Modi Operandi* that encompass the whole context of the development process (Shemer 1987). One of the new concepts in the field was the idea of software life-cycle (also known as the waterfall model, since each step cascades to the next) consisting of four major stages:

- *Specification* - problem definition, feasibility study, requirement specification and conceptual design.

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[2] Today, it seems, we are taking this flexibility for granted - to the extent that many ignore the limitations of digital computers, and there is a tendency to think that everything is computable.

- *Development* - detailed design, coding and testing

- *Implementation* - acceptance tests and user training

- *Operation and maintenance*

Among these phases, it was identified that requirement specification is the most crucial stage in the system life-cycle (Adam and Fitzgerald 1995, Shemer 1987). As a result, much attention was paid to this stage. Since then, hundreds of methodologies and methods for computer systems analysis and design have been developed. Some even argue that the number of available methods is near a thousand, though such a figure should be treated with a grain of salt (Avison and Fitzgerald 1995). These methods range from a wholly structured process to *ad-hoc* processes. As the original aim was to provide a perspective solution for information systems design, it is not surprising to find that the first attempts focused on 'hard' system thinking and wholly structured *Modi Operandi* (Checkland and Holwell 1998). Such *Modi Operandi* were developed across the world and at least some of them exhibit local cultural emphasis (Fitzgerald 1996). SSADM is an example of this type. This method is now used in many projects in the UK and variants of it are used across the world. It gives the system's developer a complete and prescriptive set of instruction that should be followed to the letter. SSADM covers the whole life-cycle, from the documents that are associated with system initiation to maintenance (Avison and Fitzgerald 1995). *Ad-hoc* development methodologies, on the other hand, can be viewed as the extreme 'soft' side of this scale. As the name implies, no formal guidelines exist or are being used. Somewhere near this extreme we can find methodologies like Rapid Application Development (RAD) - which became popular in recent years (Fitzgerald 1996). This methodology does not provide a step-by-step instructions for system construction. Instead, the methodology provides general guidelines that are adapted to the specific case. Furthermore, it calls for fast deployment and refinement of the software product in an iterative process. The development of new methods and techniques does not seem to slow down and, in fact, even established *Modi Operandi* (like SSADM) are going through cycles of updates and revisions.

The observation that the field does not seem to approach any convergence, and that there are no methods and techniques that can guarantee a successful implementation of information systems was noted by many (Adam and Fitzgerald 1995, Checkland and Holwell 1998, Fitzgerald 1996). Furthermore, a very high percentage of computer-based projects fail to materialise, as the media informs us from time to time (for example, Norton-Taylor 1999). Since computer hardware is considered robust and reliable (and has been so for the last two decades), the culprit lies with software development to the extent that a "Software Crisis" was announced during the 1980s (Shemer 1987). The evidence for the crisis, as Fitzgerald (1996) puts it, are that information systems take too long to develop and exceed the allocated budget while delivering poor products that do not work well. This attribute has sparked many to rethink the software development process and to reconsider the broader aspects of information system development.

In his famous article "No Silver Bullet" (1987) Fredrick Brooks counts the inherent aspects of software development that might explain the difficulties that accompany software projects. These elements include the complexity of software entities and their interactions; the lack of conformity in design and implementation of software entities as different people created them; the changeability of software and the expectation of users to see changes implemented rapidly; and the invisibility of software - it is an intangible product which is hard to visualise. These problems are essential in software projects and have not disappeared. Brooks argued that some breakthrough might improve the situation, though no magical solution is likely to be found.

While Brooks addresses practitioners in the field of Software Engineering, it seems that these problems infest the wider field of Information Systems. As recent as 1998, Checkland and Holwell analysed the field of Information Systems and found "confusion" in the field - there is no agreement between practitioners on core conceptual issues, terms or theories (as common in other scientific fields). Even after 30 years of development, there are no signs of convergence or coherent development of knowledge (Checkland and Holwell 1998). This view echoes Adam and Fitzgerald's conclusions in their call for some unification in the field (Adam and Fitzgerald 1995).

To summarise, in spite of on going efforts to cast the development of computerised systems as rationalised, engineered and controlled activities, they are both illusive and problematic. It will be adequate to define the field of information systems development as "the art, science and technology of making information systems"[3]. Some projects succeed, some fail - as any review of trade magazines will reveal. Therefore, it is wrong to declare that no development was made during the last decades - there is a wide variety of techniques to support software projects, and many are widely used. They facilitate the development of software projects, but do not guarantee success.

It is noteworthy that the study of computer application development has split into two disciplines. Today, Software Engineering and Information Systems are two distinctive fields of study. The former is now part of computer science, while the latter relates to management science and business administration. As a result, Software Engineering focuses - almost entirely - on the technical aspects of software design, while Information Systems focus on overall design methodologies, methods and techniques. In the following sections, the focus turns to the lessons from information system design since they hold the potential for an analysis and design framework. At the same time, it focuses on specific types of information systems – GIS and EIS – which are the foundation of PEIS.

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[3] As the familiar reader will notice, this definition rephrases the International Cartographic Association's definition of cartography (Cited in Krygier 1995)

3.1.2 System Design *Modi Operandi* and Geographical and Environmental Information Systems

In general, EIS and GIS development lag behind mainstream computer applications - the first attempts to develop GIS appeared only in 1965 (Coppock and Rhind 1991), and being what they are - a by-product of the late 1960s "environmental revolution" - EIS were developed only during the early 1970s (Deininger 1974). In line with other developments of computer systems, these systems started with the applications that could easily be automated (Infoterra and CGIS are good examples for this). Noteworthy is the term that was used for GIS during this period - Automated Mapping (AM) systems - a clear emphasis on the mechanical aspects of computing. By the time that these systems became complicated to the point that a development approach was needed, there was a wide variety of available methodologies, methods and techniques to choose from. It is, therefore, not surprising that most of the *Modi Operandi* used in GIS projects were taken from this array (Reeve and Petch 1999). Only during the late 1980s and the 1990s, some of the methods have been adopted to deal with special aspects of GIS projects. For example, Huxhold and Levinsohn (1995) give a detailed account of GIS project management but, by-and-large, their method is similar to other structured methods and is based on them. However, during the same period (mid 1990s) some researchers in the field of GIS started to look at the lessons from the emerging Human-Computer Interaction studies. This was mainly geared toward task analysis - the process of understanding user interactions with software and adapting the software accordingly (see Medyckyj-Scott and Hearnshaw 1993, Nyerges *et al.* 1995, Rasmussen 1995).

As for the field of EIS (which relies on specific deployment of GIS and other applications (Gunter 1998)), it seems that almost no attention was paid to development *Modi Operandi*. In the most recent book that is dedicated to EIS, Gunter (1998) discusses all the technical aspects of data capture, storage, modelling and decision support but does not discuss any specific development methodology. He does provide techniques and methods to specific aspects of EIS, but not for the overall process. Conferences dedicated to computer use in environmental modelling, while paying some attention to organisational issues, ignore aspects of design and implementation (Goodchild *et al.* 1993, Goodchild *et al.* 1996). Thus, we can conclude that even if EIS designers used development methodologies and methods, they borrowed them from elsewhere.

3.1.3 The Adequacy of System Analysis *Modi Operandi* For This Thesis

The plethora of *Modi Operandi* that have been developed in the last three decades, aim to provide a prescriptive solution that can be used to develop information systems. In order to evaluate the adequacy of these *Modi Operandi* for this thesis, there is a need to understand the context in which they were developed and then determine whether the question at hand exhibits similar properties, and therefore can be answered by using one of them.

The main motivation behind most computerised applications during the 1960s and 1970s was to automate workflow processes that relate to "number crunching" (Landauer 1995). These "Phase

one" applications were conceptually easy to implement, despite some technological problems that mark that era - such as data storage, data structures, algorithms or even interaction with input and output devices. Accounting and inventory applications belong to this category: they operate according to a clear set of rules and focus on arithmetic manipulation. During the 1970s, as the price of computer hardware dropped and the scope of applications increased, "Phase two" applications started to appear. These applications relate to other aspects of work-flow and started to tackle a wide range of activities, many of them office related (white-collar activities). Word processors, spreadsheets and management information systems all belong to this group. Historically, information systems design *Modi Operandi* and the software crisis are associated with these "Phase two" applications, both emerged in the late 1970s and during the 1980s. As most information systems were developed for inter-organisational use, it is not surprising that almost all the *Modi Operandi* deal with this type of application. They aim to evaluate and identify the business process that the information system should support and then to provide an adequate solution for it (Alter 1996). Most of the literature in the field is aimed at organisations that develop information systems internally (See Alter 1996, Avison and Fitzgerald 1995, Reeve and Petch 1999). The pervasive "waterfall model" starts from the assumption that the problem is well defined. According to Checkland and Holwell (1998), most of 'hard' (structured) systems analysis *Modi Operandi* hold a worldview of organisations as goal-seeking entities where information is used to support rational decision making.

In short, the vast majority of structured *Modi Operandi* aim to tackle clear problems (or at least - problems that can be described clearly), and provide a solution that falls inside organisational boundaries. How adequate are 'hard' methods to the issue in question – understanding the requirements and issues that concern potential users of PEIS? The short answer is "not very adequate". There are several reasons to assume that the workflow-structured methods would not suit this type of system.

Firstly and most importantly, PEIS do not operate within organisational boundaries. While most EIS and PEIS are built *by* public sector organisations (Gunter 1998), the user community - by definition - is beyond these organisations' boundaries. Secondly, the user group is vaguely defined. The call for public access to environmental information is tightly connected to the concept of sustainable development (UN 1992a). As result, PEIS must be inclusive and responsive because this principle is at the heart of sustainable development discourse from its inception (WCED and Brundtland 1987). Open access to environmental information is mentioned in tandem with justice and social equality. This poses a specific problem for PEIS designers. The "target audience" is defined in very broad terms, whereas 'hard' design methodologies work with a specific and clearly defined user group. Thirdly, the rationale behind PEIS - the improvement of access to and awareness of information - is neither easy to conceptualise nor to automate. There is no concrete work process that is attached to the task "increasing environmental awareness". Fourthly, as was discussed at length in Chapter 2, the term "environmental information" is ill defined. Fifthly, the

relationships among the various components of PEIS - the changing politics, public opinion, rapid changes in information and communication technologies and environmental knowledge - force the conclusion that PEIS design clearly belongs to a class of "wicked problems" (Rittel and Webber 1984). Conklin and Weil (1997) state that:

> "a wicked problem meets the following criteria:
>
> - The problem is an evolving set of interlocking issues and constraints. Indeed, there is no definitive statement of the problem…
>
> - There are many *stakeholders*-people who care about or have something at stake in how the problem is resolved. This makes the problem solving process fundamentally social. Getting the right answer is not as important as having stakeholders accept whatever solution emerges.
>
> - The constraints on the solution, such as limited resources and political ramifications, change over time. … Operationally, they change because many are generated by the stakeholders, who come and go, change their minds, fail to communicate, or otherwise change the rules by which the problem must be solved.
>
> - Since there is no definitive Problem, there is no definitive Solution. The problem-solving process ends when you run out of time, money, energy, or some other resource, not when some perfect solution emerges. "(Conklin and Weil 1997)

All these factors together lead to the conclusion that the design of PEIS is an ill-structured problem. Therefore, the needed framework must be able to deal with the richness and complexity of such problems; something that 'hard' methodologies cannot do.

3.1.4 Alternative *Modi Operandi* to Public Environmental Information Systems Investigation

Unlike 'hard' *Modi Operandi*, 'soft' ones accept that there are social and human aspects of information systems development and seek to accommodate them. Some *Modi Operandi* provide a soft framework for the development process and assume that the domain and problem descriptions have reached a certain level of clarity. Such a methodology is Rapid Application Development (RAD): it provides a range of methods and techniques to develop an information system in an iterative process. In this process, a prototype is developed, exposed to users, and improved in several cycles according to users' needs and demands. This type of development assumes that we know more or less what type of information the system should deal with, but not *how* it should do it (Reeve and Petch 1999).

Only a few 'soft' methodologies offer a broader view of the information system and its context. One of the widely cited methodologies in this category is Multiview (Wood-Harper and Avison 1990). The main difference between Multiview and 'hard' methodologies is its reliance on SSM (Checkland 1984). Multiview is based on 5 stages as demonstrated in Figure 3.1. SSM plays a major role in the initialisation of the design (or the requirements study) in Multiview. The other stages

follow Human-Computer Interaction principles and, once the information needs have been solved, continue using common design methods. Wood-Harper and Avison emphasise the value of SSM during the design process.
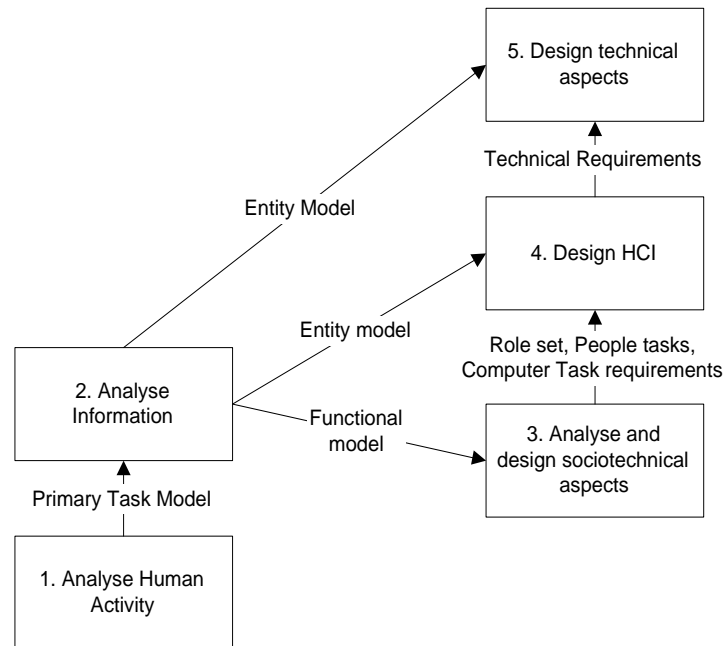
Figure 3.1 - Multiview methodology (after Avison and Wood-Harper, 1990)

However, for the research question of this thesis, there is no need to go beyond the first stages of Multiview and into interface design. Furthermore, the core difference between Multiview and other methodologies is its use of SSM. One explanation for the use of SSM is that it offers an alternative to 'hard' system thinking and opposes the view that we can engineer organisations as if they were goal-seeking systems. In SSM, systems thinking is used during problem solving processes. It uses the idea that human activity can be *understood* using systems terminology and ideas but without claiming that such activity *is* a system. SSM appreciates and accepts the multifaceted character of human activity and tries to integrate broader organisational and social issues in the solutions. Interestingly, the integration of SSM with Information Systems *Modi Operandi* was noted by SSM developers from the one hand, and by Information Systems researchers on the other hand. During the 1980s and 1990s it became clear to the methodology developers (Checkland and Scholes 1990) and to others (Wood-Harper and Avison 1990) that SSM is suitable for information systems development. SSM has also been found by many to be suitable when tackling ill-structured problems (to mention just a few Avison and Fitzgerald 1995, Patching 1990, Reeve and Petch 1999, Sasse and Fultun 1997, Vidgen 1997, Wood-Harper *et al.* 1996). In its current form (Checkland 1999), SSM offers a framework to integrate political and social analysis in the process of information system development. As such, SSM and methodologies that use it are especially useful in the context of PEIS because PEIS are forced to operate within the climate of environmental debate, which is constantly influenced by social and political actions. In summary, SSM seems to be an adequate framework for this thesis - it is geared toward ill-structured problems, has been found useful in an information systems context, and pays attention to political and social issues.

Further support for the adoption of SSM as a framework for this thesis' research question comes from another sub-field of Computer Science which plays a major role in the development of soft *Modi Operandi*. This is the area of Human-Computer-Interaction (HCI or in its American variant CHI) that appeared during the 1970s, as "Man Machine Interaction" and focused on issues of the "User Interface" or those aspects of the computer systems with which the end-users come into contact (like screen layout) (Preece 1995). During the mid 1980s, the "HCI" term was adopted and the field became broader - aiming to tackle all aspects of interaction with computers. The key concept of HCI is "Usability". This term aims to describe how easy a computerised system is to learn and use. HCI is based on multidisciplinary research - it draws on lessons learned in Computer Science, Cognitive Psychology, Social and Organisational Psychology, Ergonomics and Human factors, Linguistics, Artificial Intelligence, Philosophy, Sociology, Anthropology, and Engineering and design (Preece 1995). Each of these fields illuminates a specific aspect of computer operation and use.

HCI has implications for other aspects of information systems. For example, Landauer (1995) used the lack of usability as an explanation for the productivity paradox - the fact that in spite of the continual and growing investment in computerised systems in the workplace, the productivity of the American workforce did not increase (and even decreased in some sectors). Some evidence shows that similar trends can be observed in other western countries. This trend is identified in the period between the early 1970s and the early 1990s[4](Brynjolfsson 1993). Landaur's explanation for this paradox is that a lack of attention to usability when computerising work processes and tasks results in wasted effort and counterproductive software products. Computers do not necessarily improve productivity, they can actually hamper it in applications that deal with more sophisticated manipulation of information rather than clear-cut calculations.

HCI researchers have developed concepts that relate to Information Systems Design. The core concepts that emerge from this effort are the ideas of User Centred Design, Development and Deployment or UCD (Landauer 1995). User Centred Design is a development methodology that put usefulness and usability at the centre of the process and evaluates them empirically (Landauer 1995). When it comes to broad information system design, the UCD literature mentions SSM, Multiview and several other design methodologies and methods (Preece 1995). The UCD concept is important in the context of this thesis, as it chimes with the participative stances in sustainable development principles of participation in decision making. The focus on end user needs and requirements seem especially relevant for information systems that are supposed to improve awareness and participation – otherwise, their intended user will not find them usable!

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[4] It is important to note that recent analysis proves that IT contributes to productivity and investment in information technology pays back (Kolbasuk Mcgee 2000). We should view the 30 years of the productivity paradox as an adjustment period.

It is important to note that, as HCI was developed mainly in the context of organisation and work-related computer applications, "task analysis" became a major component of UCD. Many methods and techniques exist to help in understanding users' work and task practices (Preece 1995). This development was noticed by the GIS research community and task analysis was integrated into GIS development (see the section in Nyerges *et al.* 1995). Task analysis can be useful once the context and what the system does have been clarified.

In summary, SSM emerges as a useful methodology for UCD. Combined with its ability to tackle ill-structured problems and the other aspects reviewed earlier, it seems to be an adequate methodology in the context of the thesis. The experience of other researchers (Checkland and Holwell 1998, Checkland 1999) as well as a short pilot of using SSM for previous research projects (based on Haklay *et al.* 1998) demonstrated that SSM is capable of providing insights into EIS related design tasks (Haklay 1999). Based on this analysis, SSM was deemed adequate and no further testing of research methodologies was carried out. Of course, there might be some better method lurking somewhere, but this can be said on just about every research project.

There is one caveat - though some studies examine applications of SSM with systems that cross organisational boundaries, and examples of User Centred Design in public systems exist (like the telephone system in the Olympic village at Los Angeles during the 1984 Olympics), the problem at hand seems to be different and somewhat more complicated. This is because of the unclear definition of what it contains, who it serves and to what purpose. Still, SSM seems flexible enough to accommodate such issues. However, the adoption of SSM has some consequences. The previous sections concluded that PEIS research (and therefore their design) is, to put it bluntly, a messy business: it is an ill-structured and 'wicked' problem. These inherent attributes that are part of the research problem force us to choose a 'soft' approach. However, while some of the 'hard' methodologies entail a straight-forward and prescriptive implementation, 'soft' methodologies force the user to be more clear about his/her position toward the problem situation. 'Hard' methodologies (implicitly) select, encapsulate and integrate a philosophy[5] and worldview into their methods and tool. Most commonly, this is a positivistic and systemic worldview (Checkland 1984). The user does not need to bother with issues and questions that need to be answered as part of this philosophy: "what is the role of an information system in an organisation?" or "what is an organisation?". There are good reasons for this - most information systems implementers prefer to see the process as engineered and rational[6].

'Soft' methodologies force their users to consider their positions toward the problem situation and to integrate moral and ethical stances in them (Wood-Harper *et al.* 1996). Therefore, philosophy

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[5] Needless to say, we are dealing with philosophy with a small p, though it is always possible to connect it to a broader Philosophy.

[6] It is possible to question how rational and linear engineering projects are in general, as Latour demonstrated (1996), but such a discussion is beyond the current one.

plays a conceptual and contextual role in any investigation that is based on such a methodology. Therefore, I am obliged to clarify the context of the thesis before turning to the details of the methods and techniques of the empirical study. The following section focuses on the theoretical and philosophical framework of this thesis.

3.2   TAKING A STEP BACK: TECHNOLOGICAL SOCIETY

Within this thesis, PEIS will be viewed as a sociotechnicial object. From the main attributes of PEIS that have been reviewed in Chapter 2, there is one which reinforces this view: PEIS must operate within the public domain, where it meets social, economical and political systems. It is a product of multidisciplinary actors - environmental researchers who build the methods to collect, analyse and display the information; environmental professionals who run monitoring systems that produce information; politicians who set out the legislative framework to collect and distribute the information; lawyers; activists and so on. The computer engineers who write the programs and maintain the system hold an important role in EIS. They act as the mediators between the technical know-how and the requirements of those who want to store, process or distribute the information. As a result, PEIS is an object that couples the social and the technical.

The next aspect of PEIS that ought to be considered is its relationships with the broader framework of ICT. PEIS stands in an interesting position regarding ICT. Apart from a limited contribution to GIS, there is enough evidence to claim that EIS did not push the boundaries of ICT but rather followed its developments. Even when considering GIS, it was arguably military, utilities and commercial applications that provided the financial resources behind its development and not environmental applications. This position should be taken into account when considering a framework for PEIS. Is the development of PEIS just influenced by technology? Is the whole legacy that was portrayed in Chapter 2 merely a history of the development of computing and the way in which these developments were accepted and put into use by EIS developers? Or should we view EIS development as a social process that influences technology, reshapes it, and leads it to certain domains and applications?

In other words, when we try to analyse and advance PEIS development, should we accept ICT as a given, autonomous technology or should we see it as a variable and flexible element which is influencing and being influenced by other forces? This is a philosophical question that most of the literature cited in Chapter 2 ignores. It can be explained by the scientific-technical environment in which most EIS were developed. According to these views, the problem was defined in scientific and technical terms: development of a system, based on available means that supports modelling of environmental problems. It is also true that scientific knowledge was always influenced by available techniques and theories. A tacit assumption in the whole science project is that techniques and theories that are adequate today stand up to scrutiny tomorrow and can be changed without regret. As for EIS, the theories and problems that researchers faced came from the environmental domain. Digital computers were just a tool to solve the problem. ICT changes the range of possible building

blocks that can be used while solving the problem in question. Only in a few cases were the consequences of using tool X or Y considered beyond their immediate ability to solve the current problem.

In many cases, the reasons behind using software X, programming language Y or computing environment Z is explained away by accessibility or adequacy to the problem[7]. Indeed, many research papers ignore the computing apparatus altogether and focus on the problem in question. In many instances this approach makes sense, as it is not the specific computer or software that are the essence of the problem solution but the equations and abstractions. Even if the size of the data set or the complexity of the method make this solution impossible without a digital computer (of a certain speed), there is no need to dwell upon this detail - as without doubt future generations of computers will be more powerful. This practice has not gone without notice by critics of GIS use in scientific research; Curry (1998) discusses this issue in detail.

However, once EIS moves out of the scientific environment - a tacit understanding of the role of technology cannot be assumed anymore. There is a need to spell out the assumptions and the worldview on which EIS foundations lie. This is especially true in the case of PEIS, when one of the system roles is to reach out to an audience that is outside the technical and scientific circles. While other users of environmental information, such as decision and policy makers, are likely to share (to an extent) the world view of the professionals in the field and accept that the information is based on scientific principles, we cannot use such an assumption for PEIS.

One area of recent philosophical thought can help in illuminating these issues and provide guidelines to the possible contexts that can be used for PEIS design. This is the area of "philosophy of technology" that relates to science studies. In the following section, the possible *Modi Operandi* of technology in general, and ICT in particular, will be examined. In the light of this examination, the adopted approach will be explained.

3.2.1 Technology and Society

As Feenberg (1999) noted, "the human significance of technology is largely unmapped territory" (p. 1). It became an issue for scholarly studies and discussion only during the final years of the 19th century. Most of the ideas were actually developed during the 20th century. Even the word "technology" gained its current sense only at the beginning of the 20th century (Marx 1999).

Feenberg (1999) identifies four main streams of thought on the essence of technology. The deterministic view was first chronologically, and it follows the ideas of Marx and Darwin. Technological progress supports humanity's march to freedom and happiness. Technology was also

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[7] Noteworthy is the development of GRID, mentioned in Chapter 2. It is one thing to claim that GIS is an adequate tool for environmental monitoring, it is a totally different thing to claim that Arc/Info in its early versions was the right tool.

viewed as neutral as it provides a means to natural progress. Hence, technology is an extension of nature and outside the political realm.

According to Feenberg, By the 1940s and 1950s, another view emerged. The substantive view developed once it became clear that technology has political implications. Though autonomous, technology is not viewed as a neutral force but as a force that embodies specific values. The technologies that we use shape modern life. Thus, it is impossible to separate means from ends. The way we do things determine who and what we are. Heidegger and, more pronouncedly, Jacques Ellul are two of the prominent advocates of the substantive view. This view became especially popular during the 1960s and 1970s, as the results of technological development became apparent. Some prominent voices of the environmental revolution pronounced such a position toward technology.

The same period marks the emergence of a third view that is based on critical theory. In the first years of this theoretical development, Marcuse and Foucault stand out as critics of scientific ideologies and technological determinism. They do not accept the unilinear path of technology, but argue that technological progress is shaped by social control. At the same time (inconsistently) they argue that modern forms of social control and domination are essentially technical. Using Feenberg's terms, this view is "left dystopian" and it is influenced by substantivists.

The critical view of technology is still dominant in the studies of technology. In the last 20 years, the ideas of Kuhn on the nature of scientific projects have gained ground and the critical approach has evolved into constructivism. According to this view, technology must be studied and understood as an integral part of society. Technological projects do not have a single, clear path from inception to production, but multiple routes and directions. The success of any given technology does not lie with superior design or efficiency, but in the social context and support that it receives. The process of creating technological artefacts is socially constructed until a process of "closure" happens, in which the specific technology is fixed. Once closure happens, the technology becomes a "black box" and the social negotiations that accompany its creation are forgotten.

The four main positions are presented in Figure 3.2.

Technology is:	**Autonomous**	**Humanly controlled**
Neutral (Means and Ends are separated)	*Determinism* (Traditional Marxism, Darwinistic explanations)	*Instrumentalism* (Liberal view of technological progress)
Value-laden (Means and Ends cannot be separated)	*Substantivism* (Ellul, Heideggar)	*Critical Theory* ("Left dystopian", constructivism)

Figure 3.2 - Technology and Society: main theoretical frameworks (after Feenberg 1999)

These classes represent "ideal types" of thought, usually associated with a specific writer. As mentioned above, Jacques Ellul stands for the substantive view. In his "Technological Society"[8] (Ellul 1964) he gives a bleak account of the influence of technology on humanity. He views technology as an unstoppable force that is taking over society and impacts every aspect of life. The only solution that he provides is the spiritual transition of humanity.

The instrumentalist view is common today and has a wide range of supporters. For example, in his famous "Being Digital", Nicholas Negroponte (1995) praises the capabilities of digital technologies to improve the quality of life and society in general. It is probably the more common view among ICT enthusiasts (as any occasional reading of "Wired" magazine will reveal).

Finally, in research circles, it is critical theory that is standing at the focus of current debate. An example of current theories is Bruno Latour's and Michael Callon's "Actor-Network Theory". This theory explains technological projects as the process of social activity. In their views, there is a link between individuals and groups that creates technological artefacts and their users. The technological artefacts act as mediators that convey messages between the groups (Latour 1993, Latour 1996).

It is also worth noting that, in practice, many scholars do not subscribe to a specific view but locate themselves somewhere in the continuum between autonomous technology and social constructivism. Mitchell (1999a) addresses this specifically and argues: "Perhaps it is most accurate to say that we make our technologies, then our technologies make us, and so on recursively"(p. 105).

3.2.2 Implications to Information System Design

When comparing the various theories, and the range of design methodologies, it is possible to categorise them according to their world views. Using this categorisation it is clear that 'hard' methodologies of information system design embody instrumentalism. They envisage information systems as tools that need to be deployed in a social context, but this task can be done while using rational and logical analysis tools. It is a view that detaches technology from its social context.

'Soft' methodologies, naturally, choose a position within the box denoted 'critical theory'. SSM, for one, was influenced by Kuhn and Gidden's ideas (See Checkland 1984). However, Checkland (1984) makes an explicit link to Churchman's idea of enquiring systems and Vickers' concept of appreciative systems. The idea of enquiring systems looks at the process of learning as a human activity to design systems that produce knowledge. Science can be viewed as such a system. At its core, it is based on a network of truths, or facts, that are within a consensus of the enquirer community. As the system evolves, the network grows and develops. Though this view stems from 'hard' system thinking, it provides a description of an on-going process of learning, which is

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[8] Interestingly, the American book cover shows an IBM tape-reader, part of the "electronic calculating machines" about which Ellul complains.

essential to the SSM idea of action-research (Checkland 1984, p. 259). Vickers' ideas of appreciative systems are also important to the core of SSM (Checkland 1984). According to this view, human activity cannot be explained or analysed in goal-seeking terms alone but rather as an evolving relationships between various actors and groups:

> "… personal, institutional or cultural activity consist in maintaining desired relationships and eluding undesired ones. The process is cyclic …our previous experiences have created for us certain 'standards' or 'norms', usually tacit... the standards, norms and/or values lead to readinesses to notice only certain features of our situations, they determine what 'facts' are relevant; the facts noticed are evaluated against the norms, a process which both leads to our taking regulatory action and modifies the norms or standards, so that future experiences will be evaluated differently."(Checkland 1984, p. 263)

It is possible, therefore, to conclude that it belong to the constructivist set of methodologies. Rapid Application Development also belong to the same group. In essence, RAD argues that technological artefacts (information systems) cannot be designed in isolation from its users and their context. The cycles of development and adjustment make the object a product of social effort between the producer and the user. Using such an interpretation, it seems plausible that RAD users accept Active Network Theory (at least implicitly).

3.2.3 Choosing a Framework for Public Environmental Information Systems Design

From the discussion above, it is clear that my adoption of SSM as an investigation and design methodology has theoretical implications which, in turn, make it necessary to clarify the theoretical grounding that I am going to use throughout this thesis. My approach to the role of ICT in general, and to their particular implementation for PEIS, is based on critical theory. I will view this technology as humanly controlled and value laden. There are several reasons to adopt this view when dealing with PEIS. I will review them briefly before turning to the specific framing that I adopted.

Experience with ICT over the last few decades, especially the development of the Internet, has demonstrated the forces of the social milieu in shaping technology. The development of virtual communities (Rheingold 1993), or the social practices that are exposed by technologies such as Internet Relay Chat (IRC) (Turkle 1995) are all well documented. Another well-cited example is that of the Mexican Zapatistas who used the Internet as an effective tool in their political activity (Castells 1997, Froehling 1997). Evidence on the ability of society to reshape ICT predates the Internet. The French Minitel, though designed as a phone directory replacement, took off only when it mutated into an interactive communication tool. Moreover, and to the dismay of its designers, it became an important mechanism for sex-related communication (Castells 1996). In short, there is evidence aplenty that an autonomous view of ICT will be inadequate. Moreover, viewing ICT as neutral seems even more ridiculous - especially with its growing role in political and social discourse (one recent example is Marr 2000).

As for the specific framing, there is a need to adopt one approach from the "basket" of critical theories of technology. As demonstrated, this set of theoretical frameworks provides a certain level of freedom in selection of the specific approach. Such a framework can lean more towards substantivism, constructivism or an integrated view. The same conclusion applies to SSM. Despite the connection to Churchman's and Vickers' ideas during the formalisation of the methodology (see Checkland 1984), SSM leaves enough space to select the framework for interpretation of the system under investigation.

Taking into consideration the nature of environmental discourse in the last decade, and the emphasis on democratic processes that are inherent in sustainable development, it seems that the most adequate framework for PEIS is one that opens the opportunities to "democratise technology". Andrew Feenberg, in his "Questioning Technology" (1999) offers such a framework, and it will be used here. Feenberg's starting point is the view that technology creates a de-facto legislative force. This view is based on the political nature of technological development and the interpretation of technology as an outcome of an on-going deliberation of values and social interests. This force comes into effect when technology dictates the food we eat, our work conditions and many other aspects of our livelihood.

This view of technology enables us to make a connection between technology and the movement toward more open and participative democracy, which appears in both political theory and practice during recent years. Participative design, where end users actively influence the development of the final product, is a way to implement these ideas and ideals in technological projects. However, the scale of technological reach - in both geographical terms and social groups - makes such 'populist' *Modi Operandi* problematic. Feenberg suggests a "deep democratisation" that involves the embodiment of social and political demands in technical codes. This can be done by enabling local control where possible (like electronic town halls), but there are also other means. Many technological projects are decided by experts, but the process of selecting the experts can be democratic or at least inclusive, so as to represent a range of opinions.

Getting back to information system design *Modi Operandi*, the 'hard' *Modi Operandi* hold far less 'democratisation potential' than the 'soft'. This is due to their analytical framework that does not involve the users in the process - the whole process can be designed without any contact with those who will use the system eventually. Furthermore, they favour top-down design and enable their users to avoid (if they wish to do so) any ethical or social consideration during the design process.

The 'soft' *Modi Operandi*, especially User Centred Design and SSM hold a better potential. For a start, they force the designers to negotiate and deliberate with users. They are also more accommodating to bottom-up design - since they are based on adaptive solutions that emerge from deliberation. SSM appreciates social and political interests and includes their analysis explicitly. However, while they hold the potential, using these methods does not necessarily entail achieving this "democratisation". Nothing prevents Machiavellian use of any 'soft' methodology, where the deliberation with end users is used to develop a technology that will improve anti-democratic aims.

Moreover, it is possible to learn and use soft methodologies without any consideration of the methodology or the analyst's value system. Many of them are actually being "sold" as value free. Therefore, to fulfil the potential of the 'soft' methods, the integration of participative and democratic principles must be done conscientiously. The principles of public access to environmental information, that make the participative aspects of PEIS explicit, reinforce this need.

To summarise and conclude this theoretical section, the stance in this thesis will be stated. PEIS analysis and design requires an inherent democratic and participative stance. Other *Modi Operandi* may produce technical artefacts that will not fulfil the high principles that are mentioned time and again as the foundation of PEIS - especially when they are viewed as part of 'sustainable development'. Feenberg's ideas and principles, alongside other perspectives on the information age, will be used throughout this thesis to illuminate and focus it on this democratic potential. Indeed, such an approach might seem naïve and ignorant of the political, economical and social pressures that the bodies who actually build PEIS have to confront. These aspects will be tackled later on, so that the "ideal type" of PEIS can be constructed.

3.3 SOFT SYSTEMS METHODOLOGY EXPLAINED[9]

SSM was developed by Peter Checkland, during the early 1970s at the Systems Department of Lancaster University, as a problem solving methodology for ill-defined problem situations. As the name implies, and as was stated earlier, SSM is based on systems concepts - the idea that a problem can be tackled by taking a broad view that tries to understand the different parts and the interactions among them. SSM is a set of guidelines that help analysts to perform analysis, while allowing considerable scope for personal interpretation.

In the following paragraphs, the various aspects of SSM will be explored, starting with the general structure of the methodology. After presenting the overall structure, the main elements and techniques that can be used in SSM are discussed. In the course of the discussion, the jargon and terminology of SSM will be presented.

3.3.1 Soft Systems Methodology Process - Mode 1 and 2

The most common representation of SSM is as a seven-stage process which while severe limitations and problems are associated with it, is useful as an introduction to SSM. It is important to note from the outset that "doing an SSM study" does not require following the stages blindly. Moreover, this structural problem encourages the removal of the model altogether, to avoid misinterpretation (Checkland 1999). This mode of using SSM almost slavishly, in what might seem very much like a 'hard' approach, is termed 'Mode 1'. This process is portrayed in Figure 3.3.

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[9] The sources of for this section are Avison (1995), Patching (1990), Sasse (1997), Finegan (1994) and, of course, Checkland (1984, 1999, 1998, 1990, 1997). References will be mentioned only when it is necessary to associate the concept with the author.
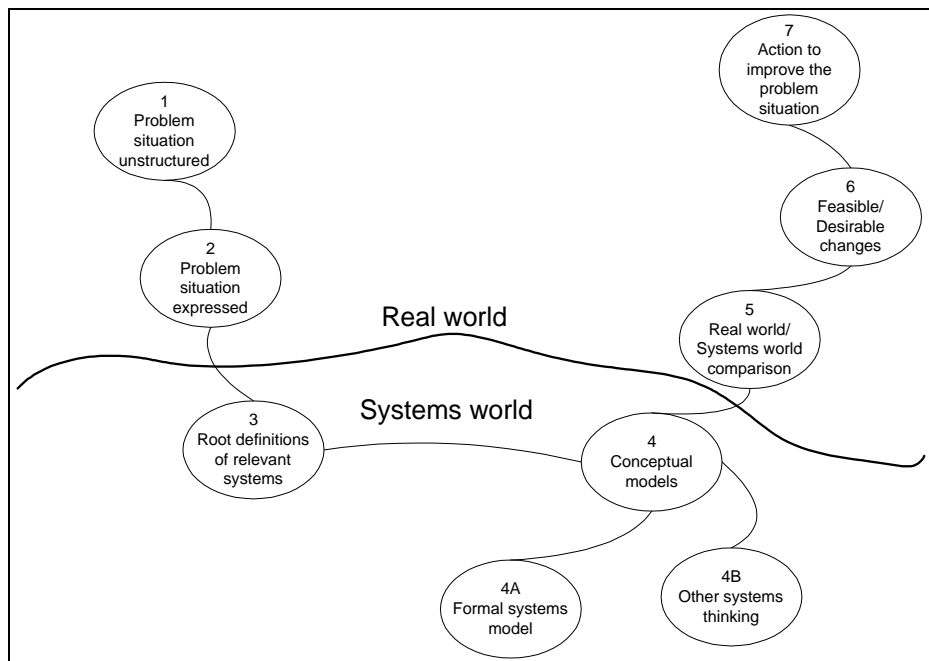
Figure 3.3 - The SSM Mode 1 process (After Checkland 1984)

The stages are:

1. In the first stage, the analyst is learning and understanding the problem situation. The reason for the initiation of the analysis is usually a *general feeling of uneasiness* toward the problem situation from the perspective of the person/body who asked for the analysis (the *problem owner*). The term *problem situation* is used to describe the specific problem and its environment, to convey to the analyst that the investigation should be done with as "open a mind" as possible, and not to limit the investigation. In this stage, the analyst reads background material, performs interviews and other activities that are needed in the learning process.

2. The second stage is to express the problem situation. One common technique that was developed is the *rich picture*. A rich picture is a schematic tool, that helps the analyst to describe the problem situation, and a communication tool with the problem stakeholders. The aim of this deliberation is to ensure that the analyst understands the problem, and to expose differences between stakeholders.

3. In stages three and four the analyst distances herself from the problem situation and analyses it using system thinking. In stage three, the focus is on *root definitions* that describe what the system is and what it aims to achieve. By subscribing to the root definition, the different views of the problem and the expected solution are expressed clearly.

4. The root definitions form the basis for the *conceptual models* - models that describe how the activity for which root definitions have been constructed can be achieved. Based on systems principles, it includes the following elements - input, output, transformation (the processes that transform input to output), control elements and relations among these elements.

5. In stage five, the conceptual models are compared with the rich picture and discussed with the problem stakeholders. Again, those involved in the problem situation should participate and approve the conceptual models that the analyst creates.

6. Stages six and seven focus on the implementation of necessary changes. In stage 6 the analyst and the problem owner deliberate and discuss what changes are feasible and practical. Some changes might be impractical due to political, structural, financial, ethical or other reasons.

7. After clearing out the necessary (and feasible) changes, these changes can be implemented and added to the system.

During the SSM life-cycle it is possible to repeat and iterate through stages as necessary. If, for example, several changes are rendered impractical, the analyst can go back and search for different solutions, by repeating stages three to five.

An important aspect of the 'Mode 1' model is the line that separates the "real world" from the "systems world" (as Figure 3.3 shows). The "real world" is the world where the problem is occurring and human activity takes place. The "systems world" is the analysis context in which the information from the real world is scrutinised and dissected in the problem solving process.

As mentioned, SSM has currently moved away from 'Mode 1'. In particular, it was found that the formal system model in stage 4, with its emphasis on the system elements, could be replaced with a refined model that helps to create the conceptual model from the root definition. The conceptual models still resemble this "formal system model", but do not necessarily follow it.

'Mode 2' is based on internalisation of SSM principles by the analyst to enable a more "natural" flow and interaction between the analyst and the various stakeholders in the problem situation. The analysis itself is richer and adds elements that might be left out in the prescriptive form of 'Mode 1'. Figure 3.4 represents the current loose model that is being advocated as the "real" SSM.

The principles of SSM 'Mode 2' that accompany this schematic model are:

- "[The] real world [is perceived as] the complexity of relationships.

- [These] relationships are explored via models of purposeful activity based on explicit world-views.

- Inquiry structured by questioning perceived situation using the models as a source of questions.

- 'action to improve' based on finding accommodations (versions of the situation which conflicting interests can live with).

- Inquiry in principle never-ending; best conducted with wide range of interested parties; give the process away to people in the situation."(Checkland 1999, p. A9)
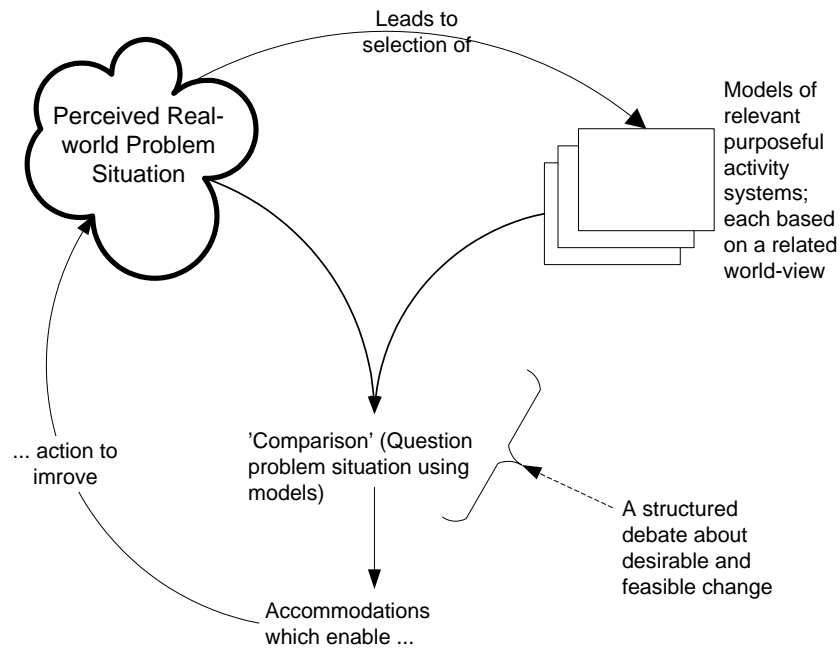
Figure 3.4 - SSM 'Mode 2': inquiring/learning cycle (after Checkland 1999).

To complete the schematic/iconic representation of SSM, another depiction of the main process will be useful. This representation should be seen as a transition from the (what looks like) prescriptive seven-stage model (Figure 3.3) to the inquiring/learning model (Figure 3.4). This description of "the SSM process" shows the general structure and, most importantly, represents the addition of analyses one, two and three. Analysis one focuses on the intervention - identification of a possible 'problem owner' by the 'problem solver'. Analysis two unpacks the social structure of the problem situation, while three focuses on the political setting. By *political* it means understanding the power relationships that constrain and construct the problem situation.

As Figure 3.5 demonstrates, the process is divided into cultural analysis and logic-based (systems based) analysis. The two interact constantly throughout the analysis.

The three rather different models demonstrate the wide range of analyses that SSM accommodates. This range raises a question about the essence of SSM. Like the 'hard' methods, a study that follows 'Mode 1' and uses the prescribed techniques in each stage is easy to recognise. However, SSM moved away from this structure and it can be argued that it fell out of favour due to this prescriptive nature (Checkland 1999, p. A9). What then distinguishes SSM study? What is needed to sustain a claim that SSM is used?
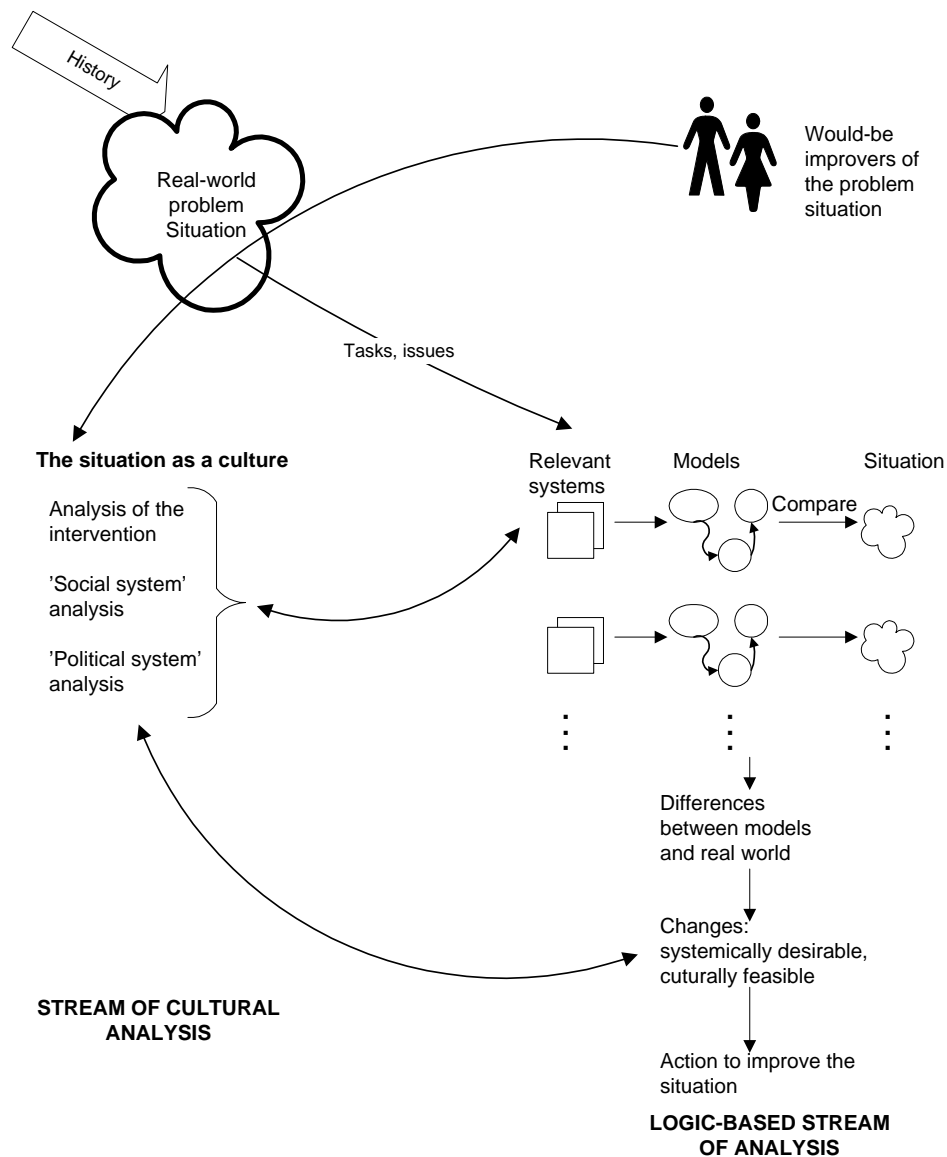
Figure 3.5 - The process of SSM (after Checkland, 1990)

According to Holwell (cited in Checkland 1999, 1997) there are three necessary principles or assumptions or principles:

"You must accept and act according to the assumption that social reality is locally constructed, continuously;

You must use explicit intellectual devices consciously to explore, understand and act in the situation in question; and

You must include in the intellectual devices 'holons' in the form of systems models of purposeful activity built on the basis of declared worldviews.

Then there are the necessary elements of the process. The activity models … are used in a process informed by an understanding of the history of the situation, the cultural, social and political dimensions of it…"(Checkland 1999, p. A35)

In its Mode 1, SSM was used in geographical research (Agnew 1984) and, more recently, it was used in Mode 2 for practical problem solving study in India (Bunch 2000).

3.3.2 Soft Systems Methodology Techniques and Methods

During the development of SSM, some tools and techniques have been found useful in understanding and discussing the problem situation. Some are more common in SSM studies, but none-of them is "mandatory" - as explained earlier. The following paragraphs describe the main techniques used in the current study. They are described in the order of their use in the process - as portrayed in Figure 3.5. It is important to note that the relationships among the different tools are not serial but iterative. Most of the outputs that will be represented in the following chapters are the final outcome of iterations and improvement of initial models, as a description of the whole development process will make the current work non-intelligible. Although Checkland emphasises the importance of hand-drawn diagrams because they express clearly the fuzziness and tentativeness of the models and ideas, I have chosen to implement them using a drawing software package.

3.3.2.1 Rich Picture

The first tool that characterises SSM is the rich picture - a diagrammatic representation of the problem situation. It represents what the human system is "about", and can be considered as a mental map (Avison and Fitzgerald 1995) (though not in the same way that this term is used in Cartography). The rich picture should be self-explanatory and easy to grasp. It is usually used to express the problem situation and to enable discussion about the various points-of-view and world-views that construct it.

The rich picture contains structures - factors that are slow to change, parts of the processes that are carried out within the system, and the connections between these factors (the climate). These connections are represented as arrows or lines with text associated with them. The issues that individuals and groups have expressed about the situation are depicted - usually as "cartoon balloons". There are no strict guidelines about the way to draw rich pictures, but some of the more common elements include:

- Crossed swords - indicators of areas of conflict.

- Eyeballs - indicators of external scrutiny

- Cartoon-like balloons to indicate issues.

- Clipart images of people.

    Also common is the use of a key or *ad-hoc* acronyms to make the picture itself clearer and to avoid cluttered text strings. Figure 3.6 provides an example of a simplified rich picture for a GIS development. In this imaginary situation, an auditor was called in to explore the reasons for delays in project implementation. She discovers that one of the main reasons was disagreement about the software that should be used and a conflict between the project manager and the system manager. The rich picture describes the problem situation.
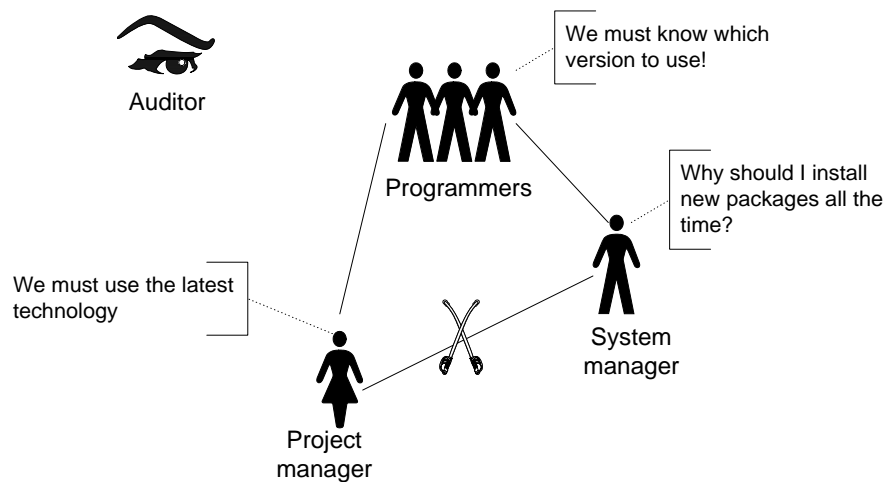
Figure 3.6 – Rich picture

3.3.2.2 Root Definitions

Once the problem situation is understood, a possible model of the activity system can be developed. The main tool that helps in the development of these models is the root definition (RD). A human activity system would usually have more than one RD and, during the analysis, it is expected to offer a range or RDs. Each root definition uses a certain perspective of the system.

The RD should include the following elements (usually referred to using the mnemonic CATWOE):

1. **Clients** - customers (or victims) of the system who benefit from (or are affected by) the output of the system.

2. **Actors** - those who carry activities within the system.

3. **Transformation** - changes that happen within or because of the system.

4. **World view (*Weltanschauung*)** - assumptions made about the system or how the system is perceived from a specific viewpoint. The German word is used to describe the specific point of view that makes the transformation and the system meaningful.

5. **Owner** - those who have control over the system. A common test to identify the owner of a system is to evaluate their capacity to shut it down.

6. **Environment** - the environment within which the system operates and, in turn, influences the system, but the system has no control over.

CATWOE can be viewed as answers to the questions: Whom? (Clients) Who? (Actors) What? (Transformation) Why? (Assumptions and World view) Who is in charge? (Owner) Where? Or what influences the system? (Environment). The CATWOE elements are used as a checklist for the construction of the RD, to ensure that it answers those questions. In practice, the order of analysis starts with T and W, then the E and finally O, A and C - in some order.

In early literature on SSM, some attention was paid to the difference between primary task RDs and issue-based RDs. Primary task RDs are detached and less contentious ("objective") while issue-based RD represent specific viewpoints ("subjective"). However, the difference between the two has eroded as the structure has moved away from 'hard' system thinking.

Another two attributes of RDs are the use of "P-Q-R" structure of the definition, and the focus on the 3 (or 3+2) Es principles when considering the transformation itself. From the experience gathered during practical use of SSM, a general structure of RD has emerged. This structure follows the form "Do P by Q in order to contribute to achieving R", P answers the question "What to do?", Q answers "How to do it?" and R answers "Why do it?". The 3Es are used as a measure of performance of the system - criteria to judge how well the proposed system operates. The 3Es used in many models are Efficacy (do the means work?), Efficiency (amount if output divided by amount of resources used) and Effectiveness (is the transformation meeting the longer term aim?). These 3Es can be extended with another two, where appropriate: Ethicality (is this transformation morally correct?) and Elegance (is this an aesthetically pleasing transformation?). The root definitions can be described as "the root from which the model grew" (Patching 1990) and form the base for the creation of conceptual models.

3.3.2.3 Conceptual Models

The conceptual models (or activity model) are intellectual devices that translate the root definition into diagrammatic form, where the relationships and dependencies of the human-activity-system are presented as a set of interacting elements.

The conceptual models should show the minimum necessary activities that must exist for the described transformations. Therefore, the model is built from the activities (based on the verbs in the RD) and the relations among them. The models should be simple and include five to ten activities. Where needed, the analyst should continue and analyse each activity, in what is known as decomposing.

Conceptual models are based on "cloud shaped" objects, each contains a description of a certain activity. The various objects are connected by arrows, representing the relationship and flow of activities. Finally, elements of monitoring and control are added to the model.

The completed models are distilled views of the activity system according to the specific worldview. They are an important input when structuring a debate to improve the situations.

3.3.2.4 Comparison

The next important element of SSM is the comparison of the conceptual models and the root definitions with the problem situation. The comparison validates the model and gives an answer to the question "do the activities that the models/RDs depict really exist?". It can be viewed as cross-checking the model to ensure that no activity that takes place in reality was missed and is not represented in the model, or that the model depicts an activity that simply does not exist. The

analyst is expected to discuss and deliberate the models and the RDs with the problem owner and other stakeholders.

The comparison in SSM is an on-going process that is part of the iterative nature of the process. It is used to improve and refine the various representations of the situation (rich picture, models, RDs). Practically, the comparison can be done through structured or semi-structured interviews, discussions or with the aid of tools like model-overlay in which a model of the current situation is drawn and then compared with the models.

3.3.3 The Essence of Soft Systems Methodology

The major aspects of SSM can be summarised as follows:

- SSM is a problem solving methodology in a systems context approach. It tries to analyse human activities as systems and develops a solution that will address the whole situation and not just the specific problem. As such, SSM can be described as an holistic and systemic approach.

- SSM is a participatory approach, which tries to involve the problem owners - stakeholders, decision makers, etc. - in the analysis and in finding the solution. SSM forces the analyst to engage with the problem situation in what is known as "action research" - the researcher is immersed in the analysed organisation and keeps a close contact with the problem owners.

- SSM offers guidelines and a set of tools that the analyst can use. However, the analyst can and should align the methodology with the specific context of the problem. SSM encourages the analyst to iterate and repeat stages as much as necessary.

- SSM enables the analyst to incorporate "soft knowledge" and to expose political and cultural conflicts. Moreover, by putting this conflict 'up front', SSM enables a better understanding of the problem situation and the solution constructions.

In the next section, the adaptation of SSM to the context of PEIS design is discussed.

3.4 THE STRUCTURE OF SOFT SYSTEMS METHODOLOGY STUDY OF PUBLIC ENVIRONMENTAL INFORMATION SYSTEMS

As explained in Chapter 1, this thesis starting position is the feeling that the foundations of PEIS (as presented in Figure 1.1) should not be taken for granted in an unquestionable manner. Rather, there is a need to consider the full context of PEIS, take into account the unique aspects of this field - the political and social climate, the changing definitions of environmental problems, etc. Such inquiry can provide the guidelines for PEIS design and, by so doing, offer possible improvements to the current situation. These possible improvements or changes should be scrutinised in the light of the existing context so that their acceptance in the current political, social and organisational climate can be evaluated.

Taking into consideration these general features of the study, the choice between the two modes of SSM is obvious. As discussed, 'Mode 1' is more problem-solving oriented and provides a context for an intervention that is more or less contained and clear while 'Mode 2' is more oriented toward a learning/inquiring process. Thus, 'Mode 2' will be used in this thesis.

The process of intervention in the problem situation started in Chapter 1, with the introduction to the main problems and questions that PEIS present. Chapter 2 explored the history of the problem situation and contains the main elements of analyses one, two and three: the context in which PEIS work; their main stakeholders; and the changing social and political climate within which they operate. Subsequent stages require a closer look at the problem situation and the user group at the focus of this thesis, their context, what they require from environmental information and how they use it. For this purpose, two empirical studies have been conducted. In the first, potential users of an environmental information system for London have been asked to express their opinions and requirements from such a system. This online survey was designed to gather the ideas and wishes of this user group. However, a survey has the shortcoming of being declarative, and though the respondents were given the opportunity to explore existing PEIS, it is likely that most of them answered the questionnaire without any conditioning. To compensate for this aspect, a second study was conducted. Fifteen representatives of local interest groups have been exposed to a prototype for a PEIS (using an off-the-shelf GIS package). During a half-day workshop, participants experienced hands-on interaction with the system. This study provides a more intimate look at some of the aspects of PEIS. The design and background of these studies are described in this chapter, and their results are presented in Chapter 4. The studies and the information gathered on the problem situation form the basis for the prescription of RDs and for the development of activity models, which are the focus of Chapter 5. The next step is to compare the activity models with the current situation in the real world by comparing the models to existing PEIS (Chapter 6). Finally, there is the need to move forward, and to improve the problem situation. Based on this comparison, Chapter 7 explores possible developments that can help in bridging the gap between the activity models and the current situation. Figure 3.7 represents the process of inquiry that is the basis for this thesis

To complete the methodological foundations of this thesis, the following sections focus on the background for the three empirical studies: the LEO survey, the UBRN workshop and the comparative study of existing PEIS.
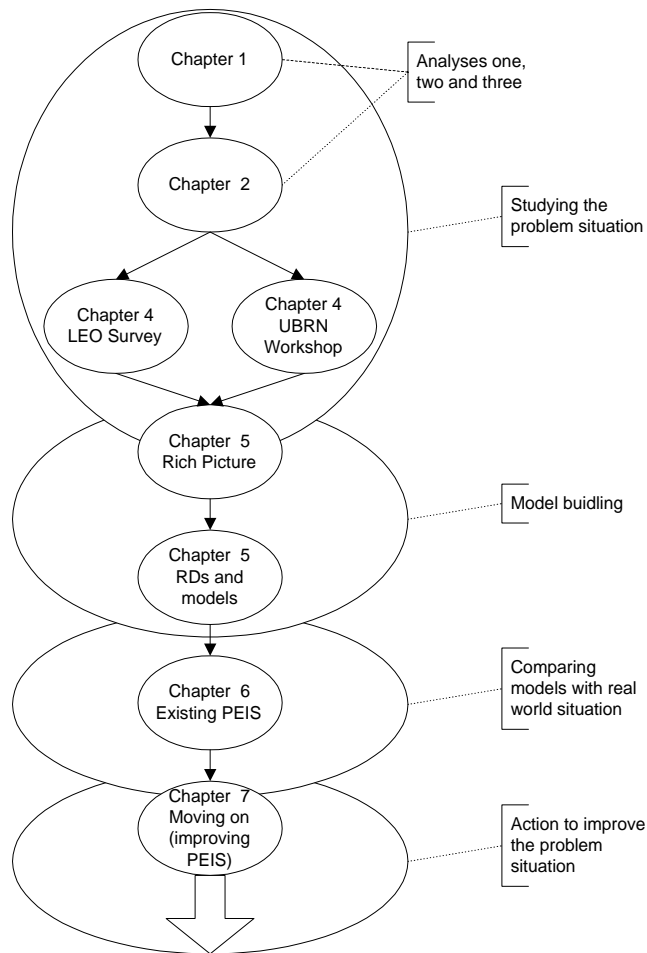
Figure 3.7 - SSM and the structure of this thesis

3.5 LONDON ENVIRONMENT ONLINE (LEO) SURVEY

Within the context of this thesis, the London Environment Online questionnaire is aimed to increase the level of understanding of PEIS audiences, by evaluation of the information that they would like to receive, their current information sources and their opinions about different forms of delivery. As will be explained, the questionnaire used a mix of open and closed questions so it can provide both quantitative and qualitative information which can provide solid empirical evidence for the SSM analysis. As was noted, this thesis focuses on the "interested public" – which are likely to be users of PEIS.

3.5.1 Introduction and Background

An EIS for London has been developed at UCL since 1998. The main parties involved in this project are the Institute of Environmental Policy at the School of Public Policy (then the Jackson Environment Institute) and the Centre for Advanced Spatial Analysis (CASA). The aim of the project is to develop an Internet-based EIS that provides information to a wide audience. In the last months of 1998, some seed funding for a prototype system was granted through the Jackson Environment Institute. The first task and the major aim of the prototype were to implement a

"proof of concept" for the system. As a feasible target, it was decided to base the system on a GIS that delivers environmental information.

During the first months of 1999, the author of this thesis suggested conducting a user requirement study as to improve the project as well as to provide data for his research. While the prototype phase had a clear goal, it was not at all clear what the requirements and needs of general users were. As one of the goals of the system is to have a "public interface", there was a need to understand what this user group expects from such a system.

The study was used by the HCI M.Sc. course students (Computer Science department, UCL) as one of their assignments. The author of this thesis prepared a brief for them, and presented to about 10 groups of students. The various groups conducted a preliminary study. These pilot studies explored different potential user groups (education, media, respiratory disease sufferer, etc.) and came out with a list of topics and some general directions about subjects (e.g. information sources). Another source of information was the US/EPA report "Listening to our customers" which summarised the consultation process by the EPA about needs from environmental information (Princeton Economic Research Inc. 1998).

At the same time, an Internet address (www.leo.ucl.ac.uk) was established and a skeleton website was developed. The questionnaire itself was designed during March 1999 by the author together with LEO team and was evaluated the following month by about 40 targeted reviewers. On the 17th of May, an e-mail message was sent to the list "all-staff@ucl.ac.uk" which includes all the academic and managerial staff in college. This was followed by an e-mail message to "all-postgraduates@ucl.ac.uk" a week later (21st May). To reach other groups, a leaflet was prepared and distributed at the "London Living Festival" (environmental fair, held in Battersea Park on the 30th and 31st of May 1999) and sent to all the libraries in London with Internet access on the 22nd July. At the end of October 1999, when the data files were analysed it was found that just over 1,100 visitors accessed the website and about 385 answered the questionnaire.

3.5.2 User Requirement Studies and Web based Surveys

User requirement studies are part of the User Centred Design framework. UCD calls for a thorough evaluation of user perspectives on the specific information system in question (Preece 1995). The methods for such studies are based on techniques that were developed in social science and brought to HCI.

In task-oriented studies, a common recommendation is to follow (shadow) users during their routine tasks. Other anthropological techniques are also common - such as documentation in the form of photographs, popular culture artefacts and the like (Laurel 2000). When it comes to public systems, especially those that are based on the WWW, questionnaires and telephone surveys have become commonly used tools. Therefore, a UCD study for PEIS can rely on survey techniques that are common in social science studies.

There is, however, a need to take into account the special properties of Computer Mediated Communication. First and foremost, as was discussed in Chapter 2, it is still an exclusive mode of communication. The skills, equipment, and software needed for using the Internet are creating an entry barrier. The current population that has access to the Internet can be generalised as those with above-average income, well educated and mainly urban. Therefore, any survey that is based on the WWW as the questionnaire medium is structurally biased and, at least for now, cannot be considered as a means to sample the views of the wider public.

This bias, once recognised, does not invalidate a survey for the purpose of this study. As noted, it is assumed that more and more PEIS will be available over the Internet. Therefore, this bias in sampling would be a cause of concern if the aim were to approach the whole public as possible users. However, as other research projects deal with general awareness among the public (for example Bristow 1996, Witherspoon 1994, Witherspoon and Martin 1992) it was felt that such investigation is beyond the remit of the current study.

The second attribute of WWW-based questionnaires is their reliance on certain types of computer applications. The available Graphical User Interface (GUI) elements constrain the design process. On the other hand, the wide use of the same technology enables the development of good knowledge on its usability aspects (Nielsen 1999). These studies helped in shaping the design of the questionnaire.

3.5.3 LEO Website and the Questionnaire

The opportunity to evaluate questions came during the HCI students' study; the LEO team and a selected group of respondents - including colleagues in the Environment and Society Research Unit (ESRU) in the Department of Geography, UCL - helped refine the questionnaire and the underlying software and website design. The structure of the LEO web site was built around several pages with basic information about different potential audiences for environmental information. One page (LEO and you) includes some external links to existing web-based systems that provide access to environmental information. The survey page is linked to a script (Form Processor) that handles the three parts of the survey. The same script handles the feedback form in which respondents were able to leave contact details in case that they would like to learn about the development of the system. Once the questionnaire was completed, the script generated a page with an option to complete the feedback form, or continue browsing the site. The feedback form was not accessible through other parts of the site. The main navigation through the site was based on link sets, based on images of buttons. Each button was a link to the appropriate page. The website was designed as a "closed" system, where the user is directed toward the questionnaire by several visual "cues". It was possible to access it directly from the home page; the main navigation bar contained a special button that lead to it and the textual information on the website encouraged the reader to answer it. Other pages contained links to the questionnaire.

Figure 3.8 demonstrates two pages from the website – the main page and the information about educational uses of LEO. The main web site was designed by Mr Stephen Evans, and the author of this thesis focused on the technical management of the website, questionnaire design, advise and instructions about website content and implementation of the script.
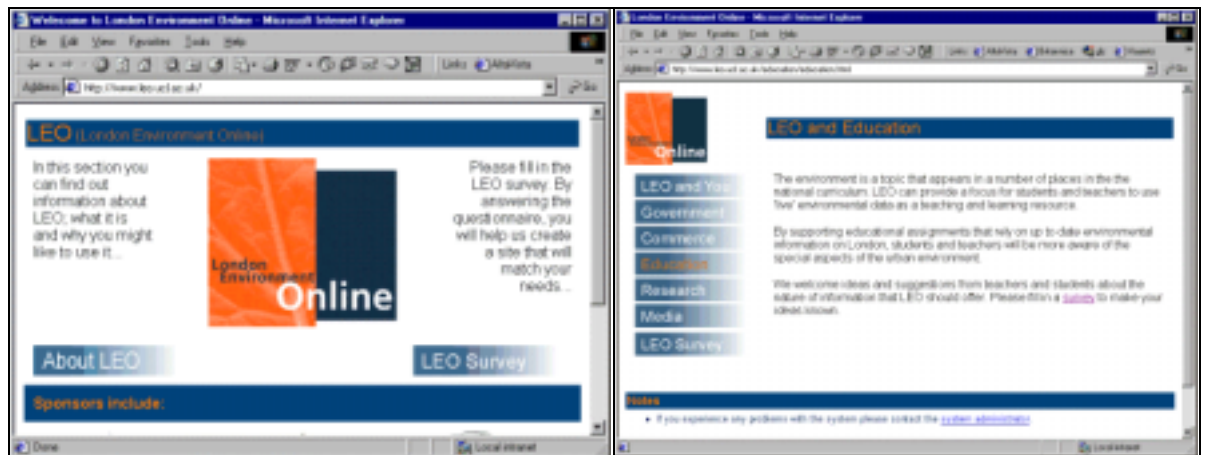
Figure 3.8 - Sample LEO pages

The questionnaire was designed as a set of three HTML forms, in which the respondent has a mix of closed questions and open ones. The three parts of the questionnaire focused on six issues (See Annex I):

- Part one focused on types of information, the importance of it and the frequency of updates for the various issues.

- Part two focused on opinions about the content of environmental information systems and about current use of information sources and perceived advantages and disadvantages of Internet based EIS.

- Part three focused on demography – gender, age, occupation, and Internet use patterns.

After completing the questionnaire, an opportunity was given to complete a feedback form – with details such as name, address and e-mail. The feedback database is disconnected from the main questionnaire database, to ensure privacy. A statement on the feedback form conveyed this information to the respondents.

The program that operated the questionnaire (the Form Processor script) was configured to enable the respondent to submit the questionnaire with any amount of information that she felt was adequate. Furthermore, the configuration did not include any conditions on the information that she should provide. Although it is possible to "force" the user to fill in details, it was envisaged that this might cause antagonism and would not improve the reliability of the answer as the respondent might choose a random response to "convince" the computer that the appropriate section was filled.

3.6 UCL BROWNFIELD RESEARCH NETWORK

While the London Environment Online survey provided declarative information from the likely users of PEIS, it does not provide enough information about the outcomes of actual interaction with such system. As noted in previous chapters, GIS is an important building block in many EIS and it can be expected that it will be integrated into PEIS. Therefore, the observation and analysis of interaction between PEIS audiences and a demonstration system can provide more insights into elements of PEIS which are more practical than declarative. The role of the UCL Brownfield Research network is to support the survey by focusing on GIS and by revealing the aspects that emerge from real interaction with a PEIS.

3.6.1 Introduction and Background

The Jackson Environment Institute in partnership with the Environment Agency have funded a project, 'London's Brownfield Resource' which has produced a GIS on the brownfield resource in London for a pilot area: the Wandle Valley. Initially, the goals were defined through interviews with local and central government officials, representatives of the Environment Agency and others. These one-to-one interviews were augmented by views and ideas about brownfield development that came from a seminar series in UCL, held during 1999 and focusing on wide range of issues. These include definitions of and criteria for brownfield sites, the information required by the various stakeholders, the role of public participation and so on. The seminar participants came from a wide variety of backgrounds – including policy makers, officials, representatives of the commercial sector and academics (including the author of this thesis).

The key points raised at the seminars included suggestions for broadening the objectives so that more interests would be accommodated. Ideas included to study either the potential or the capacity of the Wandle Valley for brownfield development and to look strategically at environmental protection issues. During all seminars, the issue of information needs and GIS integration appeared repeatedly. Many participants felt that integration of GIS with a public access medium (the Internet) would be very useful. Data availability was an important issue and it was suggested that improved availability/accessibility to information on the system might benefit the public. Participants also voiced concern about the creation of a system designed with the objective of only aiding developers in their search for sites to suit their own purpose. Many participants also wanted to see contextual as well as site-specific information. By including environmental or policy-based text on the system users would be able to view brownfield development as one component in the regeneration program of a whole area. Regular updating of the system was also raised.

During the first period of the system development, an opportunity for testing its use for public participation purposes emerged. This was carried out with a grant from the UCL Graduate school, which helped in establishing a network of experts with knowledge in planning, geomatics, GIS, public participation and inclusionary processes and environmental research. The author of this thesis was involved in the research proposal for this network, and was involved in all its activities.

One of the original aims of the network (among others) was to provide data that will be used in this thesis. As a result the research objectives of the workshop were broad-ranging and reflect the wide interests of the group. The research questions that the group hoped that the workshop would address includes issues of the communicative role of GIS and the ways in which novice users with existing agendas approach the system. A full list of research questions can be found in the UBRN report (Aurigi *et al.* 1999).

The UBRN workshop was designed with the following additional criteria in mind:

- The participants were to be "active citizens" with an interest in the planning system and some active role in a local or regional group. Furthermore, they should have an interest in brownfield development.

- There was no assumption to be made about computing literacy or experience with GIS. In order to evaluate the usefulness of GIS, it was agreed that a "mixed bag" of skills would give a better overview of the potential.

- The workshop should run as a half-day seminar either in the evening or at the weekend so that it would be possible to have a continuous session during which the GIS could be introduced and discussed.

- A Commercial Off The Shelf (COTS) desktop GIS package would be used in the workshop as it is likely that such packages will become more accessible to the general public.

3.6.2 Data Collection

The data sets used in the workshop (and in the GIS brownfield project) came from many diverse sources in both digital and analogue formats. Table 3.1 summarises the data sets that were used to compile the system database.

The data sets categorised as **green/natural environment** data in Table 3.1 were chosen to show how environmentally and culturally sensitive areas could influence the brownfield redevelopment process. The data acquired from the London Ecological Unit (LEU) was included in this data grouping because it was thought its use might show how development of some of the brownfield sites might be inhibited by environmental concerns. Flood plains were included to show how easily GIS can be used to 'layer' information. As a result the brownfield sites with a potential risk of flooding can quickly be identified, as explained in the following sections.

The **infrastructure** datasets in Table 3.1 were chosen as they provided a good backdrop over which to view other datasets. Ordnance Survey (OS) Meridian data was also chosen so that the road system could be used to carry out network analysis. Main public transport nodes - railway and underground - were digitised using London maps.

The **socio-economic** data was included in the project to show which areas could already be over populated despite there being brownfield sites suitable for redevelopment. The shopping area data

was included so network analysis could be carried out to establish which brownfield sites were within each shopping centres service area.

The **brownfield** data shown in Table 3.1 that was derived from Unitary Development Plan (UDP) maps was used because it was the most recently available. Originally, data collected for the National Land-use Database (NLUD) was to be used until its lack of availability and its difficulty for integration with GIS was discovered. Instead, older data was digitised from the UDP maps and a sample of NLUD point data for Sutton was used in comparison. The Wandle Valley Regeneration Partnership (WVRP) brownfield site data was used as a direct result of the iterative development process. The nine sites were deemed of high importance to the partnership.

Together, the datasets represent a cross section of the issues that influence brownfield site development, with an emphasis on the integration of environmental data sets with socio-economic and infrastructure datasets.

Table 3.1 - **Data used in the brownfield GIS**

Name	Source	Description
Green/Natural environment Data		
Sites of Special Scientific Interest (SSSI's)	Environment Agency	Areas that have been designated by English Nature as being of outstanding value for their flora, fauna or geology under the Wildlife and Countryside Act 1981.
Metropolitan Open Land	Environment Agency	Areas within the built-up area that are a significant environmental resource to London.
Rivers	Environment Agency	This includes the Thames, Wandle and Beverley Brook rivers.
River Floodplains	Environment Agency	The limits of the floodplain are defined by the peak water level caused by rainfall of a 1 in 100 year return period so such a storm has a 1% chance of occurring in any particular year. The Environment Agency has a statutory responsibility for all flood defence matters concerning main rivers under the Water Resources Act (1991).
Sites of Metropolitan Importance	London Ecology Unit	These sites have the highest priority for protection and contain the best examples of London's habitats alongside rare species or assemblages of species or sites that have particular significance within large areas of heavily built-up London.
Sites of Local Importance	London Ecology Unit	These are sites of particular value to nearby residents or schools and are particularly important in areas otherwise deficient in nearby wildlife sites.
Sites of Borough Importance (I & II)	London Ecology Unit	These sites are important in a borough-wide view but have been split into two sub-categories on the basis of their quality. Damage to any of these sites would result in a significant loss to the borough.
River Thames	Ordnance survey	This file was produced from the Ordnance Survey Meridian data.
Archaeological Priority Zones	Environment Agency	These are areas known to be of archaeological importance because of past finds, excavations or historical evidence.
Infrastructure Data		
Meridian Data	Ordnance Survey	The Meridian dataset was used to show motorways, A roads, B roads and minor roads and mainline railway lines.
Landline Data	Ordnance Survey	This dataset was experimented with as a source of detailed local information.

Overland and Underground Stations	Own	Identifying a six-figure grid reference for each station from a 1:20,000 street atlas collected this data.
Socio/Economic Data		
Population per Enumeration District	Manchester Information & Associated Services (MIMAS)	Socio-economic data was provided through MIMAS
Main Shopping Areas	Unitary Development Plans (UDP's)	These are centres providing a range of facilities for the local population including shops, employment, social and community facilities, transport services, leisure and entertainment.
Brownfield Site Data		
Brownfield sites.	UDP's	These are areas designated by each of the four boroughs for redevelopment and range from vacant land to empty shop units.
Wandle Valley Regeneration Partnership (WVRP) Brownfield Sites.	WVRP	WVRP provided comprehensive information on nine key development sites in the Wandle Valley Strategic Employment Corridor. This data was in an analogue format and was digitised onto the system using ARC/INFO GIS. The sites are: - Cane Hill Park, Croydon - Former CMA site in Morden Road - Springfield Hospital, Tooting - Plough Lane Football Ground, Wimbledon - Beddington/Purley Way Cluster - Former Beddington Tip Site, Beddington Lane - Site North of Goat Road - Beddington Farmlands - Anchor Business Centre, Beddington Lane
National Land Use Database (NLUD) Brownfield Sites.	LB Sutton	This data was supplied so it could be compared to the Brownfield polygons digitised from the UDP maps.

3.6.2.1 Textual Data Collection and Multimedia

To make the information held in the system more extensive and complete, web pages were designed using DreamWeaver software (Macromedia Inc. 1998) to provide information on brownfield sites, ex-brownfield sites, rivers and areas of nature conservation. Hotlinks were established from many polygon data themes as direct links to the web browser so that further information, such as Environment Agency pages, planning registers and local activity groups' pages on the Internet could be easily and quickly accessed. The Environment Agency's pages' links deal with regulations and the agency responsibility areas. As Wandsworth Council provides public access to the planning register, applications that relate to specific brownfield sites were identified, and each page contained information that would help the user to identify the application in the Wandsworth website. Some brownfield sites also had web pages set up by local independent groups. Links to these pages were also included in the system web pages connected to each brownfield polygon (the best example is Battersea Power Station). Finally, pictures were taken with a digital camera for various sites and included on the system web pages[10].

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[10] Ms Rebekah Boott created the database and the web pages, and the author assisted her in advice and some technical help.

3.6.3 Recruitment: Composition of the Group

The workshop was not simply a means of exploring various questions relating to public participation and GIS (including the research questions of this thesis); it was also intended that those who participated would learn something about GIS and its uses in planning and other contexts. Thus, in publicising the workshop and issuing invitations, the research group looked primarily to recruit people associated with community and other voluntary groups based in Wandsworth.

First, activists would be likely to have a greater interest in learning more about GIS technology and perhaps be aware of its increasing use. Second, participation was limited to members of voluntary groups because of the interest in investigating their particular perspective. Voluntary groups are likely to be affected by the increasing use of GIS by, for example, local councils, but have not been involved in setting up such systems. In addition, as recruitment proceeded it became evident that the relationship between many local groups and the statutory sector (in particular the local authority) was characterised by a certain amount of mistrust, and that it would not be appropriate to invite, say, local councillors as representatives of members of the public. Finally, it was important that participants had some knowledge of the geography and environment of Wandsworth, as otherwise it would have been difficult for them to relate to the GIS and they would be unable to bring local knowledge to the workshop.

A second criterion for participation concerned computer skills and that participants represented the spectrum of such skills from complete novices to experienced email and Internet users, as this would expose issues of accessing and using the technology. A group of 15 people were recruited from a variety of local groups and encompassed the range of computer skills.

3.6.4 Recruitment Methodology

Participants were recruited using the 'snowball method'. This was done by contacting a few groups already known to members of the network and as each contact was made that person was asked if she knew of any other group or person who might be interested. Initial contact was mostly made by telephone, although some participants were recruited through attending a local meeting. The project was explained and if an interest was shown that person was sent a one-page outline explaining the project, an agenda for the workshop, and a GIS screenshot. A follow-up telephone call was made a week to a fortnight later to confirm, or not, that person's interest in attending. Finally, each participant was called again in the week prior to the workshop to confirm her attendance.

Most of those contacted showed an interest in the project. The two main reasons for declining the invitation to attend were a prior commitment or reservations about the technology. Reservations were expressed in terms of both 'mistrust of computers' and the view that 'this isn't relevant to me'. In some cases reservations were overcome but in other cases the contact could not be persuaded.

3.6.5 The Workshop: Organisation and Running

The workshop was divided into four parts:

(i) Introduction:

An introduction to the aims of the project, in general, and the workshop in particular formally opened the workshop. The diversity of skills and backgrounds of the UBRN team and their varying technical expertise was highlighted, along with the aims of the selection process for workshop participants. The team decided that to allow the participants to engage in the technology, some brief introduction would be needed to show both the capabilities of the software and the range of information and associated data types stored in the system.

The complexity of GIS jargon is well documented and known (Traynor and Marian 1995). To avoid antagonism and disengagement, the introduction was prepared so that it was as free from jargon as possible. The aim here was principally to give an overview of the richness of information in the system while more subtly demonstrating basic geographic information system abilities such as layering of information, data browsing and data querying. This technical introduction was limited to a 15 minute overview in an attempt to stimulate interest without saturating the participants with detail.

Site-specific information presented in the overview included basic Ordnance Survey medium-scale mapping, post-code centres, Battersea Power Station as an example brownfield development site with linked WWW-based documents, and, finally, brownfield sites in relation to flood plains as development restrictions.

(ii) Hands-on session

During this session, the participants divided into small groups of three people each so that they might each have an opportunity to use the GIS. Each group was supported by a 'GIS expert' (i.e. a person familiar with the software and the datasets) who could help with any inquiries about using the package; and an observer/moderator who kept tabs on the tasks that needed to be achieved during the session, facilitated the discussion and recorded basic information on the progress of the discussion.

To record the session, tape recorders were used and to capture the operations within the computer system, Lotus ScreenCam software was used (Lotus Development Corporation 1996). ScreenCam captured all the operations on the computer screen down to the movements of the mouse cursor, while recording the discussion on a synchronised audio track. By using a small computer microphone and the software, it was possible to record the session in a non-intrusive manner.

During the hands-on sessions, large (19" and 21") monitors were used. The main limiting factor in the use of monitors, namely the number of people that can watch it simultaneously, was alleviated by using notebook computers with the capability both to display the image on their built-in screen while also displaying it on an external monitor. The experts were briefed that although some

demonstration might be needed on their part to initiate interaction by the participants, the principal aim was as soon as practical to have the participants themselves either using the system directly or else at least guiding the tasks performed by the expert.

Lunch Break - After the hands-on session there was a short lunch break of approximately 30 minutes during which time the participants were free to mingle and discuss the morning's proceedings and their experiences amongst themselves, or to ask any further questions of the UBRN team before the group discussion session in the afternoon.

(iii) Discussion

The participants formed medium-size groups by combining previous hands-on groups. The purpose was to discuss their experiences from the hands-on session, to evaluate the use of GIS for their purposes and to identify the potential of these tools for public participation.

The two groups each had an expert on-hand to answer technical questions or provide any further demonstration that was felt necessary, and a moderator to facilitate the discussion. During the lunch break, the observers for each small group had summarised the topics of conversation in their groups on flip-chart sheets and these were pinned to the walls in the discussion sessions to provide possible points for discussion.

(iv) Conclusion

This was a final ten minute session with all the participants to close the workshop and to gain some feedback about the whole experience. This was followed by a final tea break during which the participants were asked to complete the debriefing questionnaire.

3.6.6 Context: Public Participation GIS

Beyond the immediate methodological aspects, which were based on the vast experience of the academics participating in the network, the UBRN workshop was influenced by and designed with regard to current developments in PPGIS research. PPGIS is relevant in the context of this thesis, as result of the integration of GIS into many EIS, and through the assumption that PEIS are important for improved participation in decision making. Indeed, many applications of PPGIS aim to deal with social justice, urban planning or other research questions. Nevertheless, they are helpful in providing insights into the role of GIS within PEIS.

In the last decade, there has been a growing interest in the societal uses, and social implications of GIS. There are multitudes of origins to this interest. Most notably among them is the growth of GIS critique from within the circles of human geography (epitomised by the publication of the influential "Ground Truth" (Pickles 1995)) and two research initiatives by the US National Centre

for Geographic Information and Analysis (NCGIA) – Initiative 17: Collaborative Spatial Decision Making (Densham *et al.* 1995) and Initiative 19: GIS and Society (Harris and Weiner 1996)[11].

Although it is impossible to compress all the arguments in this debate to a paragraph, it is still possible to note those that are relevant for the purpose of this thesis. In short, the GIS critique and self-examination raised awareness of the potential of GIS to impact society in far reaching ways. Due to its spatial nature, GIS is a very powerful tool in the hands of the technological and economic elite (Pickles 1995). GIS is used to control and influence the livelihood of the less powerful segments of society without being accountable, transparent, or even accessible to those affected by it. The image of the panopticon is common in this context.

To counterbalance this power relationship, a call for public oriented GIS emerged. During one of the meetings of NCGIA's Initiative 19, the concept of PPGIS was suggested and accepted (Schroeder 1997). It did not take long for the acronym to be adopted and PPGIS is now well recognised and used extensively in the literature (as the recent proceedings of the GISOC 99' conference demonstrate).

Reviewing the PPGIS literature reveals two research streams – technical and process oriented. The technical focuses on the development of tools and techniques for PPGIS. These include issues of data capture, representation, user interface, and so on. Process-oriented research is usually done in some form of "action research", whereby the researcher is involved in the process and reports usually give accounts of participant-observers. In terms of literature, the latter is substantive and seems to reach some general model. It can be argued that this model is clearly participative and inclusionary by nature.

In a South African case study that deals with land reforms, Harris *et al.* (1995) give an example of integration of local knowledge into GIS. In this study, local knowledge was captured through discussion groups. Issues of history, ownership and the value of the land (in terms of soil quality) were raised and then transformed to a thematic map in a GIS database.

In a neighbourhood planning project in Chicago (Al-Kodmany 1998), a workshop was held with representatives of the community. The ground rules of the project were: (1) Speak only for yourself. (2) Don't criticise an idea. (3) Don't focus on solutions but alternatives. In this project, GIS visualisation was used in conjunction with "on the spot" drawings by an artist, who helped to animate ideas and concepts that were suggested during the workshop.

In another case, collaborative agricultural planning in Ecuador is supported by GIS. The local knowledge was integrated into a database of a national project (Alspach 1999). The GIS was used to visualise, aspects of the project for discussion, and to integrate the local perspective into project plans.

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[11] For a review of the origins and background, the interested reader is referred to (Schroeder 1997) and (Chrisman 1999a)

Harris and Wiener (1996) suggest the following assertions as the fundamentals of successful PPGIS implementations:

- Agency driven, but not top-down nor privileged toward conventional expert knowledge

- Local knowledge is valuable and expert

- Broaden access base to spatial information technology and data

- Incorporate socially differentiated multiple realities of landscape

- Integrate GIS and multimedia

- Explore the potential for more democratic spatial decision making through greater community participation

- Assume that spatial decision making is conflict ridden and embedded in local politics
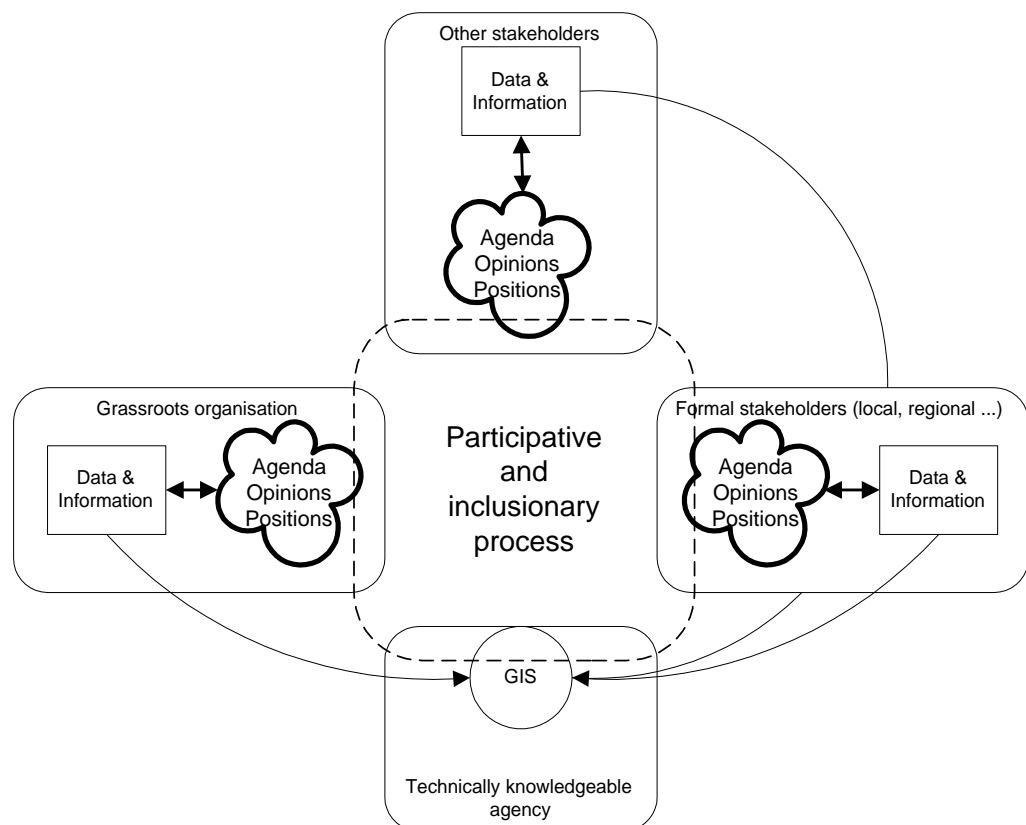
Figure 3.9 - PPGIS as part of a general participative process

Combining this definition with the aspects of participation (Healey 1997) can help in describing a model of PPGIS (Figure 3.9). The emphasis is on the process, and the GIS is seen as data repository and, using Nicholas Negroponte's words "tools to think with for the world at large" (Bennahum 1995). The "agency" is bringing the know-how and the expertise in building and using the GIS database. The GIS database will incorporate multimedia aspects. The database is based not

just on local knowledge and data. In many cases, the initial database is based on local, regional or national records (for example Elwood 1999, Ghose 1999, Kyem 1999 – and many others). By doing so, the views and positions of these bodies are integrated implicitly. Other case studies (for example Al-Kodmany 1998) deal specifically with a process where those stakeholders took part. The GIS is used as a hub for information that is otherwise beyond the reach of grassroots organisations or individuals.

Every stakeholder is using its agenda and perception to select and shape the data and information that will be used in the process of spatial decision making. By integrating them all into one database, comparisons between them can be drawn and discrepancies can be found. An inherent requirement from the agency is to act as fair moderator and custodian of the databases. It is possible to envisage cases where each stakeholder is using its GIS outside the process, and brings the results to the discussion table. In such cases, the ability to "think with GIS" is reduced dramatically. It is worth emphasising the importance of such use, as many have noted that GIS visualisation can be of great value to understanding and solving spatial problems (Krygier 1998).

In the technical stream, there is a clear trend to explore the Internet as the main delivery mechanism (Craig 1998, Talen 1999). Research projects range from radioactive waste site selection (Carver and Openshaw 1995), public participation in planning a village in England (Carver *et al.* 1998) to neighbourhood planning in inner city areas in Buffalo (Krygier 1998). All those examples focus on the development of a GIS interface embedded in a web browser. The user can explore the information on the site and then provide his own input, relating this input to a specific geographic location. Participation is achieved by using the computer as a communication facility and leaving a text note that relates to a specific location[12].

This focus seems to be encouraged by the notion of the Internet as a public information utility that opens up access to information on equal terms, anytime and from anywhere. This approach fits with cyber-utopian views of the role of the Internet in our world. As discussed previously, these views are not universally received and agreed upon. This issue will be discussed at length in later chapters.

3.7 COMPARATIVE STUDY

While the two studies discussed in previous sections form the first phase of the SSM study, the comparative study belongs to the third phase. This stage aims to evaluate the validity of the conceptual models, which are based on the first phase. These models give a set of requirements and goals that can be compared with existing PEIS. The conceptual models will be constructed according to several worldviews. The first of these is the "official" definition of PEIS, as conventions and international agreements define. Other worldviews are far more subjective, and

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[12] See also the recent review in Laurini (2001)

will be based on user groups and views that the first part will reveal. The various worldviews and models will be developed in Chapter 5 and will be used to develop the comparison criteria.

The four PEIS that have been selected are the FoE website (with a special attention to the Chemical Release Inventory), the Environment Agency (EA) website (with special attention to the "What's in my backyard?" section), the DETR air quality monitoring website and Catalytic Data's "Homecheck" website. Before turning to a short description of each site, the reasons for selecting Internet-based PEIS in general, and these sites in particular will be explained.

Firstly, As Chapter 2 demonstrated, the assumption that public telecommunication networks will serve as the main medium for PEIS is now commonplace and even taken for granted. As the awareness of the Internet as a publicly accessible information network increases, it seems obvious that it can be used to mediate the distribution of environmental information to whomever wishes to access it. Even though the hype over the Internet has changed its tone, and instead of "information superhighway" we hear more about its economic capabilities - as the term e-commerce implies - the aspects of information provision and access did not diminish. As the pervasiveness of the Internet is only expected to increase in the future, it is safe to predict that future PEIS will be based on it. Therefore, evaluating existing websites is appropriate for our analysis.

Secondly, all three sites operates in the United Kingdom, and contain information about the London area. This is significant, because it ensures that the study compares like with like. The empirical studies of the first phase are based on the population that resides in London. Therefore, comparing their conceptual models with American websites (like the Environment Protection Agency website) might be inappropriate and lead to misleading conclusions that should be attributed to cultural and societal differences between the location of the study and the system.

Thirdly, all sites contain elements of interactive mapping. These elements will be used in the comparative study. As was discussed in previous chapters, GIS is a major element in EIS and it is likely that it will be integrated in PEIS. Therefore, existing PEIS that use GIS were selected.

Fourthly, the sites provide examples of systems that were built in three different organisational settings and give an opportunity to compare and contrast the organisational *Modi Operandi* that are encapsulated in each system.

FoE Chemical Release Inventory (CRI) is one of the first examples of Internet-based PEIS that use GIS. It also pioneers Internet-GIS. The system was built in 1997 by FoE, and is based on the Chemical Release Inventory of 1996 that they have aquired. The system enables users to locate polluting factories in their area, and is part of FoE's campaign on the "Right to Know" in which they promote the principle of public access to environmental information. This site is run by a proactive NGO, which aims to promote public awareness toward environmental issues by using aggressive public relations strategies.

Environment Agency "What's in my backyard?" site is the EA "response" to the FoE call, and contains information from the CRI for the years 1996 onwards. It was released during 1999, and it is part of

the EA approach to public outreach. It is based on GIS mapping and provides maps of local areas with information on elements that fall in the EA's responsibilities - CRI and Water quality. The site is run by the EA which is a governmental professional body, with a remit to implement environmental policies, management and control.

DETR Air Quality Monitoring Network site touches another aspect of environmental information. It provides a gateway to information about air quality across the United Kingdom. The site is run by a commercial company, on behalf of a government department. The information in it is collected across the UK, including a set of 60 monitoring stations around London. The collection of this data dates back to the 1970s, and it now being done under EC-led legislation.

Catalytic Data's site is an example of private PEIS. The site provides access to environmental information across the UK, and is aimed at homebuyers who want to check a property before buying it. It provides a gateway to information about air quality across the United Kingdom. The site is run by a commercial company and relies on multiple sources.

3.8 SUMMARY

In this chapter the methodology of this thesis was explained and developed. The research framework, SSM, was adopted for this thesis as it provides a middle ground approach that can be use as the foundation for information system design. As was demonstrated in the case of Multiview, SSM provides just the first step – the elucidation of needs, requirements and context of information systems users. The next steps of the design include database design, selection of appropriate data sources, integration of databases, interface design and so on. These steps will not be developed within this thesis, though some references and principles for them will be mentioned later.

The second aim of this chapter was to clarify the theoretical stance toward PEIS – especially the use of critical theory-based analysis which views them as socio-technical artefacts which shape and are shaped through social interactions. The approach that this thesis adopts is based on Feenberg's (1999) ideas about the democratising potential of technology.

Based on these foundations, the chapter moved on to explain SSM and the empirical studies that will provide input for the analysis (London Environment Online survey and UCL Brownfield Research Network) and, after the development of the conceptual studies in Chapter 5, comparison with existing PEIS. In the next chapter, the results of the two major empirical studies are presented.

4 The Scope of Public Environmental Information Systems

4.1 OVERVIEW

As Chapter 3 charted, the SSM study which frames this thesis is now in its first stage - the process of learning the "problem situation". The general issues concerning environmental information have been laid out and explained; they were then used to evaluate the development of EIS in general, and PEIS in particular. In SSM terminology, this analysis explores the political and social systems that influence PEIS. The review in Chapter 2 exposed a top-down approach to the principles of PEIS. This approach is apparent in calls for information provision and the legislative framework that supports them. As Hallo's review (1997) discusses, the direction of the flow is *from* public authorities *to* the public. This aspect leads to an important question: what do those who are expected to consume this information want? What are their expectations of PEIS? To answer these questions, and to better understand the problem situation, two empirical studies have been carried out. The context and methods used were explained in the previous chapter; this chapter focuses on an analysis of the results.

The chapter opens with the London Environment Online (LEO) survey. The purpose of the survey is to understand the level of general interest in environmental issues and the expressed needs for, and requirements of, Internet-based PEIS. As explained in Chapter 3, the survey's recruitment strategy was designed to capture the group of likely users of such systems: educated, middle class members of the public with an interest in environmental issues. The survey explored the "informational behaviour" of those users as it can provide important hints to the ways in which environmental information is understood and consumed.

The second part of the chapter focuses on a more contextual and qualitative study - the UCL Brownfield Research Network workshop. The workshop was designed to complement the survey by focusing on the interaction between potential users of PEIS and GIS. This is of special significance with regard to PEIS, as GIS is an important element within common EIS and, therefore, is expected to play a major role in PEIS. The workshop provided an opportunity to evaluate the perceptions of activists, some with very limited computer and Internet literacy.

Both studies exposed some important facets of environmental information. First and foremost, they demonstrate that the "public" must not be perceived as a monolithic entity. Furthermore, though generalised categories of social groups (such as those offered by Castellls (1997)) are undoubtedly useful to understand the broader picture, on the individual level there is much more diverse scenery where an individual relates to multiple issues using "multiple identities". This issue is important for PEIS, as they try to deliver information to the individual level and, therefore, need

to appreciate different audience groups. Second, the studies exposed the diversity in perceptions of what the term "environmental information" means. Both studies exposed the variety of topics and scales that are used when the concept of "the environment" is connected to specific bits of information. Third, the studies provide hints to the ways in which information is used. Environmental information consumption is not always connected to action: it also provides a general knowledge of the surroundings. Using these insights, and the full analysis of these studies, the two threads are linked at the end of this chapter and the ground is set for the development of the "rich picture" in Chapter 5.

4.2   LONDON ENVIRONMENT ONLINE SURVEY

4.2.1   Overview

As noted, the survey aimed to expose and evaluate the requirements and needs of likely users of PEIS. The questions were selected to provide information about what issues are of interest to this group, to explore their preferences when consuming environmental information, and to provide some insight into current patterns of information sources and use.

After the launch of the survey, its website ran for about six months. At the end of October 1999, the data files were analysed. In total, just over 1,100 visitors accessed the website and about 385 answered the questionnaire. By the time the report (Haklay 2000) was published on the LEO website (July 2000), another 30 responses were registered in the data files. These responses came from respondents that found the website through search engines or collected a leaflet from a local library. This group was not integrated into the analysis as it does not demonstrate a significant change from the main body of respondents. As was described in Chapter 3, the questionnaire combines qualitative and quantitative questions (see Annex I). The qualitative section of the survey proved successful and yielded about 40,000 words of textual information. This information provides a rich contextual picture of respondents' views and opinions about environmental information. The use of the WWW as the survey medium, combined with the abilities of the web-server software to log every interaction and the information that the respondents submitted, provided a rich source for quantitative analysis. Together, the two streams enabled the depiction of the audience of PEIS.

The analysis is divided into three main sections. First, the statistics from the web-server are analysed. This information helps to describe access patterns to the website, temporal aspects of access and some observations about the locations of respondents when they answered the survey. Second, the quantitative results of the survey are portrayed, followed by a discussion of the qualitative responses. The section ends with a discussion of the survey outputs and some tentative conclusions are drawn[1].

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[1] For a full description of the LEO survey, the reader can refer to the report (Haklay 2000)

4.2.2 Web-Server Analysis

The Web-server log file provides rich information about the survey and can help in constructing the context of the respondents. The following analysis is based on statistics generated from the access log of the LEO web-server. Part of this was done using "SurfReport" software (Netrics.Com 1999). An access log is a list of all the requests for individual files from a website. These files include the HTML files and their embedded graphic images and any other associated files that were transmitted. The access log contains information about the computer that accessed the site, time of access (up to the second), the file that was accessed, and details about the transaction (for example, that the file was successfully transferred to the client and the number of bytes transferred). In the following section, some of the main statistics from the log server analysis are presented.

Over the entire period of the survey (from 17th April until the end of October, 1999) the website performed 21,817 transactions. 1,107 unique computers accessed the site; an under-estimate of the number of people who browsed the site. This is for two reasons: first, in some cases more than one person uses a given computer and, second, in some computer network settings, the traffic to and from the Internet is channelled through a specific computer (known as a proxy server). In such settings, multiple accesses will be recorded under the same IP address. For the same reasons, the number of visits - 1,591 - can be viewed as a better (under)estimate of "eyes" which viewed the site.

The number of responses to the questionnaire was about 385, and in some cases the person who viewed the questionnaire simply browsed through it without filling-in or submitting any information. Another aspect of WWW based surveys are technical glitches – at least nine respondents experienced problems with the software that prevented them from completing the questionnaire. In addition, a respondent can stop answering the questionnaire at any stage and leave. Therefore, the number of complete responses declines towards the second and third parts of the survey (about 30 questionnaires were partially filled). Finally, 171 respondents expressed an interest to learn more about future developments of LEO.

In summary, the analysis of the log file provides a general profile of the people who answered the questionnaire. It is most likely that the survey was answered by someone living in the United Kingdom during the first half of the working day in the second half of May 1999. After receiving the e-mail message about the site, the website was accessed. By following the hyperlinks directly from the front page or after accessing the "about" page, the survey page was opened. The next phase took about 15 minutes in which the three parts of the survey were filled-in and sent back to the server. In about half of the cases, the feedback form was completed (an indicator of interest in the development of LEO). After completing the questionnaire, the respondent left the site.

4.2.3 Survey Results

4.2.3.1 Demography – Who Answered the Questionnaire?

4.2.3.1.1 Gender and Age

Among the respondents, 45.81% identified themselves as females, 50% as males, and 4.19% preferred not to answer. The distribution across age groups is displayed in Table 4.1

<div align="center">

Table 4.1 – Age groups and gender

Age group	N/A	F	M	Total
N/A	1.12%	0.28%	0.28%	1.68%
14-16		0.28%		0.28%
17-18		0.28%		0.28%
19-24	1.12%	9.80%	7.28%	18.21%
25-29	0.56%	14.29%	14.01%	28.85%
30-34	0.56%	7.00%	9.52%	17.09%
35-39	0.28%	4.20%	8.96%	13.45%
40-44		2.52%	3.36%	5.88%
45-49		3.92%	2.80%	6.72%
50-54		1.96%	0.84%	2.80%
55-59	0.56%	0.56%	1.40%	2.52%
60-64		0.28%	1.40%	1.68%
65+		0.28%	0.28%	0.56%
Total	4.20%	45.66%	50.14%	100.00%

</div>

Most respondents are aged 19-39 with a balanced distribution of gender. Figure 4.1 portrays the distribution of age groups and gender.
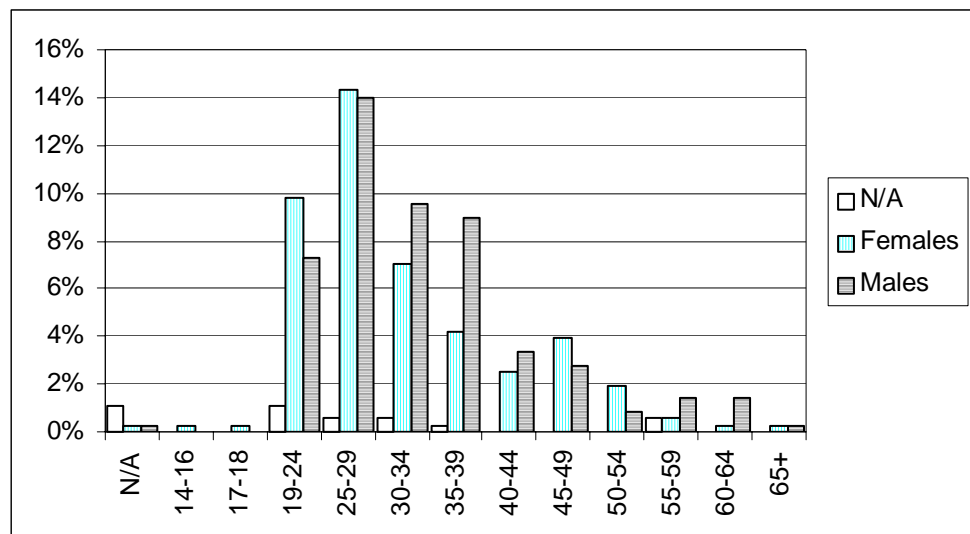
Figure 4.1 – Age groups and gender among LEO Survey respondents

4.2.3.1.2 Occupation

The occupations of the respondents fall into several groups:

- University/research occupations (lecturers, researchers, scientists);

- Professional occupations (IT professionals, administrators, consultants); and

- Students (mainly postgraduate/research students)

Considering the initial audience of the e-mail message, combined with the fact that the other media did not provide more responses, this should not come as a surprise. However, it should be emphasised that the survey responses did not come exclusively from an academic audience.

4.2.3.1.3 Geographical Distribution

The following figures present the geographical distribution of the survey respondents.

Apart from four overseas responses, all the responses came from people who live or work in London. Naturally, there are more responses from inner London, and less from the neighbouring counties. The population of the survey was not concentrated in any specific area and, by and large, it is distributed across the area.
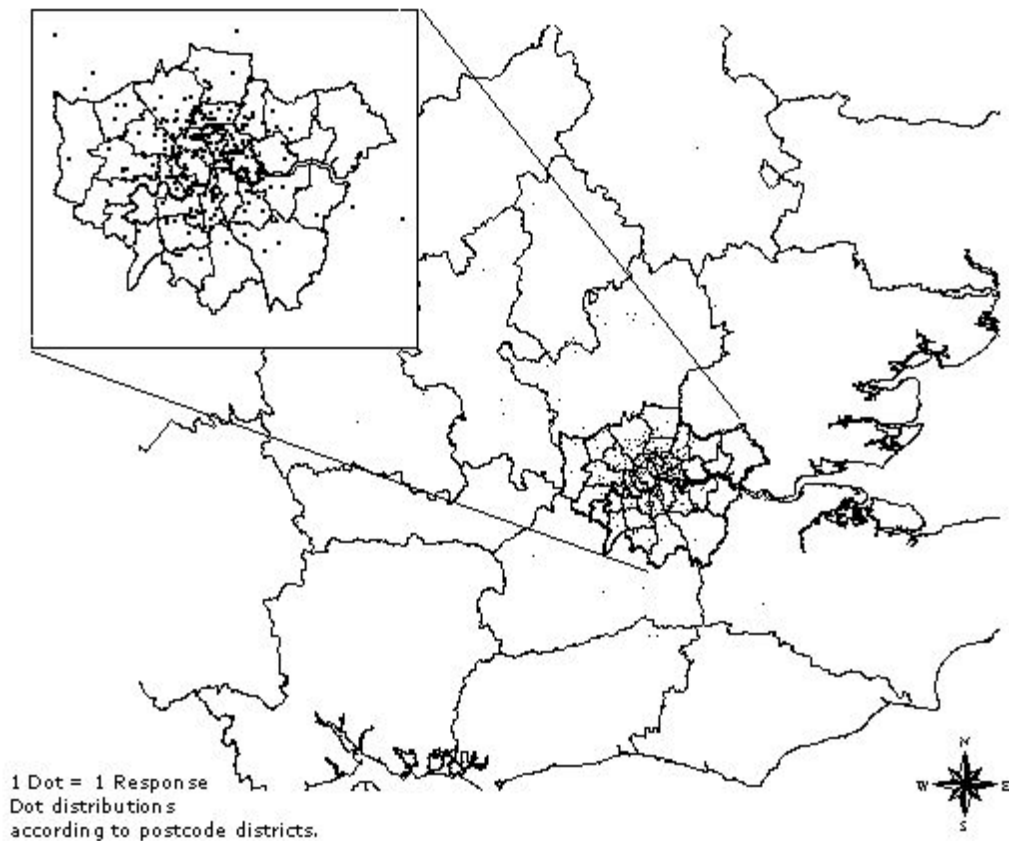
Figure 4.2 – Geographical distribution of respondents

4.2.3.2 Environmental Issues

The first section of the questionnaire focuses on interest in environmental issues, reasons for this interest, frequency of update of the data in the system, and an option to mention issues that are missing from the list in the questionnaire. Table 4.2 describes the levels of interest in the environmental issues that were included in the survey. The number of valid answers differs across the topics, as some respondents preferred to mark topics that they are mostly interested in and left

other topics unchecked. It is possible to assume that such action is equivalent to selecting "Not interested". An indicator of such a connection exists in the correlation between the number of valid answers and the interest ranking. However, these samples were removed from the analysis which focused on unequivocal selections.

The interest index, and the ranking that is based upon it, were calculated as a weighted index in the form:

Interest index = ((count "very interested") * 3 + (count "interested") * 2 + (count "possibly interested") *1) / N (Valid answers)

This positive measurement does not account for the selection of "not interested". Therefore, the selection of "not interested" affects the calculation of percentage, but not the index. The index can be seen as a measurement of general interest and takes a value between 0 and 3, where 0 denotes "no interest" and 3 "very interested".

Table 4.2 – Interest in environmental issues

	Very interested	Interested	Possibly Interested	Not Interested	Valid answers	Interest index	Interest ranking
Public Transport	76.78%	17.41%	3.69%	2.11%	379	2.69	1
Air Quality	63.85%	29.82%	6.07%	0.26%	379	2.57	2
Traffic	55.67%	29.82%	11.87%	2.64%	379	2.39	3
Water Quality	45.33%	40.00%	13.33%	1.33%	375	2.29	4
Recycling / Waste management	41.38%	40.58%	15.38%	2.65%	377	2.21	5
Environmental Health Risks	39.10%	35.90%	22.34%	2.66%	376	2.11	6
Noise Pollution	34.75%	33.42%	25.99%	5.84%	377	1.97	7
Biodiversity / Ecology	30.50%	34.75%	30.50%	4.24%	377	1.92	8
Land Use / Planning	27.49%	34.23%	32.35%	5.93%	371	1.83	9
Contaminated Land	26.20%	35.29%	32.62%	5.88%	374	1.82	10
Environmental Regulations	16.89%	35.92%	37.27%	9.92%	373	1.60	11
Environmental Campaigns	17.43%	28.95%	44.77%	8.85%	373	1.55	12

It is noteworthy that only a few people expressed "no interest" in air quality and, at least in that sense, air quality is the issue in which most respondents will admit to having some interest. As for updates, a similar picture emerges. The update index is calculated in a similar way to the interest index in the form:

Update index =

((count "hour") * 1 + (count "day") * 2 + (count "week") * 3 + (count "month") * 4) / N (valid answers)

This formula yields a result between 0 and 4, and the values indicate the preferred frequency of update for each topic.

Table 4.3 – Update rates for environmental issues

	Hourly	Daily	Weekly	Monthly	Valid answers	Update index	Updates ranking
Air Quality	34.49%	52.94%	7.49%	5.08%	374	1.83	1
Public Transport	41.35%	24.59%	20.81%	13.24%	370	2.06	2
Traffic	33.61%	25.96%	23.22%	17.21%	366	2.24	3
Noise Pollution	12.57%	35.47%	29.89%	22.07%	358	2.61	4
Water Quality	3.40%	33.14%	40.51%	22.95%	353	2.83	5
Environmental Health Risks	7.14%	26.57%	33.43%	32.86%	350	2.92	6
Environmental Campaigns	0.60%	11.11%	38.74%	49.55%	333	3.37	7
Recycling / Waste management	0.86%	5.17%	37.07%	56.90%	348	3.50	8
Biodiversity / Ecology	0.87%	5.78%	33.53%	59.83%	346	3.52	9
Contaminated Land	1.47%	4.69%	25.81%	68.04%	341	3.60	10
Land Use / Planning	0.00%	5.19%	28.53%	66.28%	347	3.61	11
Environmental Regulations	0.58%	4.37%	21.57%	73.47%	343	3.68	12

Figure 4.3 shows the environmental issues and their related update index. As the table demonstrates, the number of respondents who choose not to note their preferences varies across issues. Some have used the text boxes to indicate that many of the issues do not fall neatly into categories like "weekly update" but need to be updated whenever new information is available. One of the more interesting responses read:

> "The frequency of the information depends entirely on the nature of the problem, including regional differences. I would rather that something was done about these things than putting resources into giving information to the converted" (Respondent 64)[2].

It is also noteworthy that those issues that received high scores in the interest index received attention in the update scale, too.

Most respondents gave detailed answers to the reasons behind their interests (see 4.2.6.3). About two fifths of the respondents noted that there are some issues that are missing from the list. Broadly speaking, these issues can be grouped into 14 headings. Table 4.4 lists the topics and the

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[2] Each response to the survey was assigned a unique identifier, which is used in this section.

number of respondents who mentioned them in their responses. Naturally, some topics fall into more then one category, and they are represented in the categories that are most relevant to them.
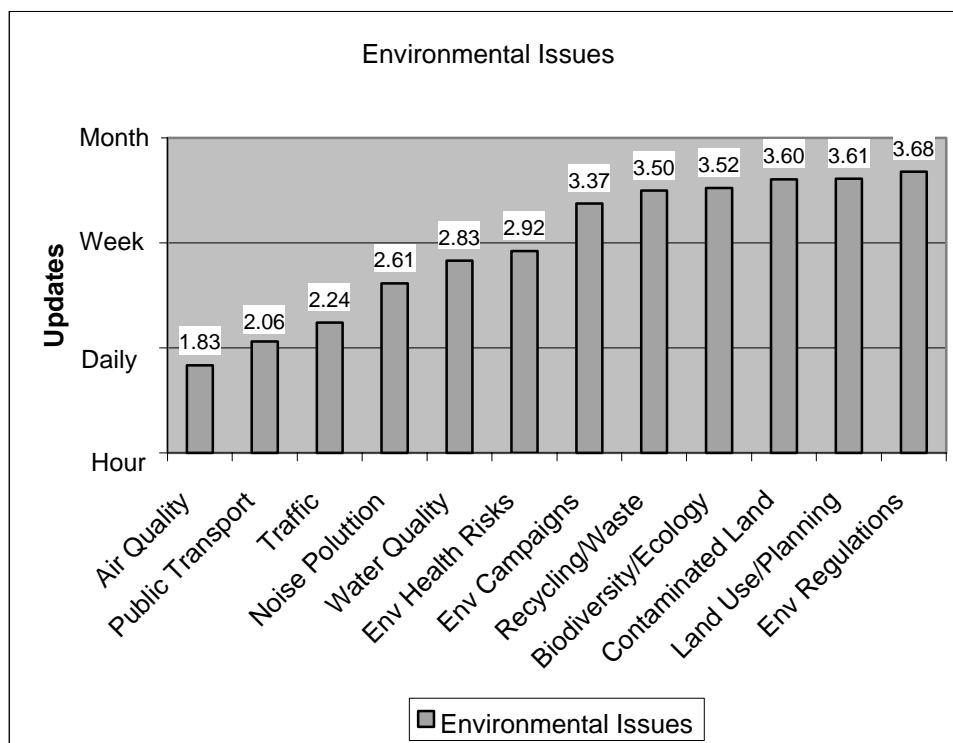
Figure 4.3 - Preferred update rates for environmental issues

Table 4.4 – Issues that are missing from the questionnaire

Topic	Issues	Count
Transport	Cycling & cycle paths; alternative transport means (including cycling and waterways); heavy traffic (lorries and trucks); parked cars and problems related to them, private car washing; regulations discouraging road traffic; transport infrastructure / road building; air traffic	24
Built environment, Planning	Urban renewal; eco-design of building (energy consumption, materials etc.); environmental building regulations; housing; pedestrianisation; population density pressures and human load on the environment; strategic environmental planning and practice for London; work environment (office, stress etc.); urban design for safety and accessibility; historic environment (listed buildings, archaeology etc.)	19
Food and food production	Genetically Modified Organisms (GMO technology); organic food ("pure food"); agriculture practice: intensive farming, livestock practice	18
Green Spaces, parks, ecological habitats	Green spaces (parks, recreational areas); the relation between built environment and natural conservation; protection of greenfield sites under threat; conservation of wild life and natural habitat	16

Topic	Issues	Count
"Urban" waste	Litter (in the streets and public transport system); dog fouling and pet control; smell /odour pollution	15
Atmospheric issues	Climate / meteorological information; tropospheric Ozone; pollen /allergens counts; tobacco smoke; UV levels; light pollution	14
Political issues	Political accountability; citizen influence and action; national and European policy; environmental reports from governmental authorities; strategic planning / shaping the Greater London Authority	13
"Big" environmental issues	Global issues; climate change / global warming; globalisation; sustainable development; sustainable economic development; third world debt	12
Waste	Environmental discharge; toxic waste and transportation of it nuclear waste transportation and handling; sea pollution by waste delivered from London; oil and other residuals from private car washing	10
Business related issues	Corporate pollution (including nuclear); environmental accountability of businesses; sustainable business practice	10
Water issues	The Thames and London's waterways and rivers; aquatic life system ; water conservation	9
Energy	Electricity and its impact on the environment; energy consumption and energy from alternative sources	7
Health issues	Environmental health statistics and epidemiological information; lead poisoning; tobacco smoke	5
Other issues	Light pollution; natural hazards; human ecology; comparison with other cities; coverage of environmental issues in the media; art and culture; environmental education; ecological vandalism; anti social behaviour of neighbours ; employment / volunteering opportunities	11

While the selection of topics in the questionnaire was based on typical urban environmental issues, those that were raised in Table 4.4 span the whole range of the environmental debate and environmental politics. However, the table demonstrates the construction of environmental issues by the respondents and the way that they perceived the role of EIS for London.

4.2.3.3 Types of Interactions

The second part of the questionnaire started with two sets of opinion questions. The first set focuses on the content of the site (Table 4.5). The second set focuses on the delivery mechanism or preferred interfaces with LEO (Table 4.6). The selection of content and interfaces showed a trend towards access to processed information. Interfaces that involved activity from the end user - participation in on-line discussion forums, confrontation with raw data, or development of reports – were less favoured.

Table **4.5** – Opinions about the content of LEO

	Strongly agree	Agree in some cases	Strongly disagree	No opinion	Valid answers
Contact details of environmental organisations	68.31%	25.77%		5.32%	357
Option to contact someone in person about environmental issues	33.05%	51.82%	0.56%	14.57%	357
Learning about regulations and policy	40.62%	42.86%	2.24%	14.29%	357
Having an on-line discussion forum	25.29%	41.97%	3.94%	28.17%	355
Information about local environmental issues	59.89%	33.33%	0.56%	6.21%	354
Information about the relationship between the environment and health	57.87%	34.27%	0.56%	7.30%	356

Table **4.6** – Opinions about the LEO interface

	Strongly agree	Agree in some cases	Strongly disagree	No opinion	Valid answers
Presentation of environmental issues with text and illustrations	78.87%	20.00%		1.13%	355
Presentation of environmental issues with maps	77.97%	20.34%		1.69%	354
Access to "raw" data	33.71%	50.00%	2.53%	13.76%	356
Ability to run on line analysis	25.35%	35.77%	6.20%	32.68%	355
Ability to create customised reports	21.19%	31.64%	7.91%	39.27%	354
Ability to receive customised report via e-mail	25.56%	33.99%	10.67%	29.78%	356

4.2.3.4 Sources of Environmental Information

Table 4.7 presents the sources of information that the respondents currently use to retrieve environmental information. As this was a multiple-choice question, the percentage is calculated for the number of respondents who answered this question.

Table 4.7 – Sources of information

Rank	Source	Percentage
	Never seek	17.89%
1	National newspaper	61.29%
2	TV / Radio	48.68%
3	Local newspaper	48.09%
4	Internet	43.40%
5	Environmental organisations	34.60%
6	Magazines	25.81%
7	Governmental reports	18.48%
8	Environmental professionals	15.84%
9	Regulatory bodies	12.90%
10	Legislation	9.68%
11	CD ROM	2.93%
	Valid answers	341

It is important to note that the question stated "do you ever seek information" and that respondents perceive it as the active pursuit of information. It is interesting to note that 17.89% stated that they do not seek environmental information. Among those who seek information, there are a number of common combinations. The top ten combinations are presented in Table 4.8. They account for approximately 37% of those who seek information.

Table 4.8 – Popular combinations of information sources

National newspapers	TV / Radio	Local newspapers	Internet	Environmental organisations	Magazines	Percentage
X	X	X				7.1%
X	X	X	X	X	X	5.0%
X	X					3.9%
		X				3.6%
X	X	X			X	3.6%
X	X	X	X			3.6%
X		X				3.2%
X						2.5%
	X	X				2.1%
X	X					2.1%

As tables 4.7 and 4.8 demonstrate, the main sources of information are still "old media" and the role of electronic sources is limited.

4.2.3.5 Access to the Internet and Patterns of Access

The final part of the questionnaire focused on patterns of access to the Internet and the locations for access. Table 4.9 presents the frequency of access to the Internet of survey respondents

Table 4.9 – Frequency of Internet access

Rank	Frequency	Percentage
1	Daily	69.03%
2	Several times a week	24.15%
3	Once a week	4.55%
4	Fortnightly	0.85%
5	Monthly	0.85%
6	Rarely	0.57%
	Valid answers	352

It is noteworthy that a very high percentage (just over 69%) of the respondents have access to the Internet on a daily basis. This high-level of connected-ness is reinforced by the pattern of places from which the access originates. Table 4.10 presents patterns of access. As this was a multiple-choice question, the percentage is calculated for the number of respondents who answered this question.

Table 4.10 - Place of access to the Internet

Rank	Place	Percentage
1	Work	63.56%
2	University	43.50%
3	Home	41.24%
4	Library	5.37%
5	School	0.85%
6	Cybercafe	0.85%
7	Other	0.28%
	Valid answers	352

To explore this information one step further, it is worth examining the five most popular combinations of access. Together, they account for almost 85% of total responses. The most popular combinations were:

Table 4.11 – Five most popular combinations of Internet access place

Work	University	Home	Percentage
X			32.20%
X		X	16.95%
	X		16.95%
	X	X	12.71%
X	X		5.93%

It is clear that those who answer have the capacity to operate a web browser and interact with a website. Therefore, every answer can be considered as proof of computer literacy and WWW literacy.

4.2.3.6 Text Answers

The survey contained three areas in which the respondents could provide detailed textual information. The first one followed the question on environmental issues and focused on the reasons for interest in specific topics. The second free form question followed the section on information that the respondents sought. The third question tries to elicit the advantages and disadvantages of an Internet-based information system.

In general, the web-browser interface seems to be very helpful in teasing out detailed responses. Unlike paper-based questionnaires where space for each answer is limited, the text area grows to accommodate any amount of text. It does that seamlessly and enables very intuitive writing. It can be argued that as there is a high level of "Internet literacy" among the respondents, many of them feel at ease with expressing their ideas on the computer screen (similar to identified characteristics of e-mail writing (Suler 1998)). Some answers extended over more than 300 words. However, even these answers carry the marks of intuitive writing in one stream (i.e. no editing is apparent, nor any spelling or grammar checking).

4.2.3.6.1 Reasons for Interest in Environmental Issues[3]

When asked about the reasons for their interest in the environmental issues that they selected, the respondents expressed various viewpoints. The answers were rich and articulate. It was possible to recognise several identities that were used to construct the viewpoints. These positions or perspectives can be broadly divided into four groups:

1.   Individuals who care for themselves and their family;
2.   Commuters who need to commute in to London on a daily basis (be it by public transport, car or bicycle);
3.   Members of the public who want to be active in their community; and, finally,
4.   Professionals who use the information as part of their job.

The individuals' perspective focused on issues of care - concerns about health and quality of life. These concerns are on a personal level and for one's family. Some respondents mention direct connections to health:

> "I have a personal reason for the interest in air quality. As a hayfever sufferer I am more likely to have flair ups during poor air quality days…" (Respondent 131)

Others express more general concerns:

> "Firstly because of how these issues affect me/my family. Health and wellbeing of all is at risk…" (Respondent 7)

The commuters' perspective deals with the daily chore of travel through London's busy traffic. Inside this perspective three viewpoints can be identified. These include a public transport user:

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[3] This section is partially based on C. Ohm Andersen report.

> "Being a frequent user of public transport and a pedestrian, I am upset by the quantity of traffic in our capital. This affects us all, through noise, air pollution, time it takes to travel and aesthetics. I do believe that if public transport was improved/ cheaper /quicker then the number of people who feel the need to use private vehicles would drop…" (Respondent 37)

The next is that of a cyclist:

> "Rather selfish reasons I'm afraid - transport and air related issues because they affect me directly (I cycle a lot)" (Respondent 28)

And, finally, as a private car commuter. Interestingly, as the car is denounced as a major cause of environmental problems, these views are expressed in a somewhat apologetic manner:

> "…I do drive but would prefer a decent public transport scheme." (Respondent 7)

The third identity group consists of community-oriented members of the public. It focuses on issues of activity and involvement in the political process. Many respondents mention the connection between environmental interests and life in London. This connection was expressed as a reason for interest in environmental information:

> "I am interested in these issues because they affect me and many other people who live/work in London." (Respondent 283)

Or

> "They are the issues which I feel are most relevant to 'normal' citizens, and which, if changed or improved, could make a huge impact on our environment, such as improvement / reduction in price of public transport and the provision of better recycling facilities…" (Respondent 313)

A more explicit citizenship identity is expressed when some political action can be taken. Issues of planning, recycling or environmental campaigns directly connect the environment to a sense of political action:

> "I am, in theory, interested in all environmental issues; but most interested in those which I feel I can either make a difference to or affect my personal day to day life the most" (Respondent 338)

The fourth and final identity is the professional stance; this deals with occupation and the information that is needed to carry out daily tasks effectively and efficiently:

> "Professional interest in environmental management…" (Respondent 127)

It is important to note that these identities are not expressed in solitude. Many answers "combine" several identities:

> "I am a Londoner and have a child I enjoy urban life, but do not want be sickly as a result of it, or risk my child's future health. …
> Air Quality - London is brilliant after a big storm. Better quality air is both desirable and achieveable…

> Traffic/Public transport - traffic levels are madness. What every metropolis needs is infrastructure, particularly transport.
>
> Recycling/waste management - a sensible way to reduce the impact of human life. I recycle all organic matter. I wish it was not so hard to recycle paper, glass, etc. I live in … and info on Council and local facilities would be helpful….
>
> Enviro regulations - let's have more sensible ones, that alert people to make a choice, such as food labelling
>
> Enviro campaigns - I'm grateful that other people participate in them. Another of the many things I can't find time for…" (Respondent 205)

It seems that respondents connect different issues to various aspects of their daily life. However, it is impossible to identify an unambiguous connection between a specific topic and certain identity (i.e. it is inaccurate to claim that air pollution is just a health concern).

As demonstrated in the citations above, the respondents express views that connect various issues into an holistic account of the environment (though in the following example the respondent finds the culprit):

> "I *HATE* the level of car use in London; it poisons the air, creates interminable noise and doesn't actually solve transport problems effectively. So "traffic" as it is the source of the others!" (Respondent 290)

4.2.3.6.2 Uses of Environmental Information[4]

As mentioned above, the wording of the question about information use clearly played an important role in constructing the answer - especially the use of the verb "seek" which implies an activity. This can explain the high level of "never seek" responses. One respondent wrote: "I don't go out my way to seek information but am always interested if I do come across it…". Some of those who seek information connect gathering it to an action or activity. Examples include:

- Traffic information before car a journey.

- Air pollution and weather to decide whether to cycle to work or not. This information seems to be important to sufferers of respiratory diseases, too.

- Recycling centres to which to take recyclable waste.

- Food safety issues for decisions about shopping.

- Planning issues for protest if necessary.

- Knowledge about possible campaigns in which it is possible to take action.

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[4] This section is partially based on S. Herrera report.

However, the responses that connect information to action are the minority and, many of those who give an example for such a connection, interleave it with other uses that do not exhibit the same properties.

Far more important is the use of information simply to inform. In what may sound a truism, it seems that the importance of environmental information is due to its environmental (here it is the sense of the surrounding things, conditions, or influences that act on a person) value. The environmental information is needed for possible future action, political stances and generally "to know what is going on" (as respondents 122 and 301 wrote). An interesting aspect of this activity is the perceived obstacles that respondents feel stand between them and information. Respondents perceived the process of information search and gathering as costly (direct costs, time and knowledge). Some responses express this literally:

> "I have contacted [the local] council to find about recycling facilities in the area, regulations on burning garden waste and cycle routes. They were friendly and willing to help, but it took a lot of time to get the information I wanted…" (Respondent 281)

Or

> "Noise pollution levels (where? – bloody difficult). Traffic levels (where? Through my experience on my bike!)…" (Respondent 216)

A related problem is the lack of empowerment that respondents feel toward environmental activity. Though not expressed directly by respondents, it is possible to suggest that this general feeling of disempowerment toward the political and economic system reduces the amount of effort that individuals who are interested in environmental issues are willing to put into information search.

4.2.3.6.3 Perception of Internet-Based Environmental Information System[5]

The question in the survey that relates to environmental information access through the Internet asked respondents to describe the advantages and disadvantages of this medium, as they perceived it. Respondents' answers seemed to relate to general concepts about the Internet and not to the specific topic of environmental information delivery. As most respondents have convenient access to the Internet (see 4.2.3.5) they see it as an immediate medium. It is available anytime and directly from the user desktop. It is seen as a medium that holds the promise (or ability) to deliver the exact piece of information faster and more easily than other forms (such as books). This feeling of immediacy was expressed in various forms by many. Another concept that is common among respondents is the view that the Internet is capable of providing current information, instantly. As the computer screen does not reveal the date of the information, respondents felt that system designers should put in the effort to keep the information up-to-date, and also to state explicitly the date of this information. The Internet is also perceived as a tool with the potential to provide more

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[5] This section is partially based on A. Garfunkel and T. Bowden reports.

details about topics than other media. The balance between the richness of sources and information overload was noted by some.

On the downside, respondents are aware that Internet access is not equal among all social groups and that:

> "… It is very often overlooked that the vast majority of people DO NOT even have access to a computer, let alone the Internet." (Respondent 148)

The aspect of the Internet as an environment in which the costs of publication are very low and, therefore, almost anyone can publish information is seen as a cause of concern. The reader of information obtained from it must be "on guard" and suspicious of it. The respondents view credibility as a major cause of concern. The question of credibility was addressed towards the LEO site itself:

> "WHEN YOU FIRST GET INTO THE SITE YOU GIVE NO INDICATION AS TO WHO YOU ARE, WHY YOU ARE, WHO YOU ARE SPONSORED BY - this IS ESSENTIAL if you are to have ANY credibility. You might be any load of nutcases,or a commerical company seeking free information from the unsuspecting public, but as you have been sent through authorised UCL channels I know you are not - but the general public won't if you go public # # YOU MUST PUT YOUR DISCLAIMER ABOUT KEEPING E-MAIL ADDRESSES AND PERSONAL DATA SEPARATELY FROM THE SURVEY RESULT AT THE BEGINNING AND NOT AT THE END OF THE SURVEY!!!!!!!!!!!!!!!!!!!."(Respondent 40)

Technical aspects of Internet use were also mentioned. The speed of access to information is considered as important, and aspects such as using images (which slow down the loading of web pages) or the design of the site - easy navigation, search engine and other aspects that relate to the technology behind the website were raised. Another request from respondents is to enable interaction (though not by many, see 4.2.3.3) and the ability to adapt their site to their personal preferences and needs.

4.2.4 Discussion

The main goal of the survey within the context of this thesis is to establish a better knowledge base about the needs and requirements of "would be" users of PEIS. First and foremost, there is a need to verify that the survey managed to recruit the right group, and that its results are relevant to the main thrust of this thesis. Based on this verification, it is possible to analyse the most substantial findings of the survey: access to the Internet and its use for environmental information gathering, interest and awareness of environmental issues and evaluation of the information needs in light of existing patterns of information sources.

4.2.4.1 The Survey Population

As discussed earlier, the survey population was defined as those with Internet access and an interest in environmental information[6]. It was not intended to be a representative sample from the general population. The question that must be asked is did the survey collect responses from the most likely users of public environmental information systems? It will be argued that the answer is "yes". To assert this claim, two aspects must be demonstrated and supported. These aspects are:

- Access and literacy in using public information utilities - i.e. the Internet.

- Interest in and awareness of environmental issues.

Other issues like geographic distribution, age and gender have been discussed in section 4.2.3.1 and will not be repeated here.

4.2.4.1.1 Access to Public Information Utilities and Literacy in Using it.

Recent statistics (from CommerceNet/Nielsen Media Research, dated September 1999 (Commercenet/Nielsen Media Research 1999)) estimate the percentage of Internet users in the UK at about 21% of total population. Among them, only 44% have access to the Internet on a daily basis (or in other words, just 10% of the total population). It is, therefore, safe to conclude that the level of connection to the Internet among survey respondents is impressive (compare these figures with those in section 4.2.3.5). Even though there aren't any figures about Internet access among London's population, it is reasonable to assume that it is higher than the overall UK figures (due to more opportunities - such as more places to access the Internet, etc.). Even when considering this, the respondents' population can be considered "Internet savvy". It is also self-evident that they all possess a level of "Internet literacy" that enables them to use e-mail and a web browser. The textual answers also carry the hallmarks of Internet literacy and comfort. Many felt comfortable with expressing their opinions and wrote long (and personal) answers. Some answers carry the "e-mail equivalent" to raising one's voice - writing a few words, or a whole sentence in block capitals. Others include "colloquial writing" such as the shorthand "v. good" or "nope".

4.2.4.1.2 Interest and Awareness of Environmental Issues

The last multiple-choice question in the survey focused on the level of concern at the state of London's environment. 61.36% of the respondents chose the option "I am very concerned", and the majority of the rest (36.93%) choose "I am slightly concerned". The options of "not concerned" and "do not know" were selected by 3 respondents each. This is the strongest indicator

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[6] In the early stages, the possibility of a complementary paper-based questionnaire, which would target a random sample of the general population, was discussed. However, lack of funding prevented this from going ahead. Nevertheless, there is information about the public's attitudes to environmental issues that relate to the survey's findings (for example, Bristow 1996).

of the level of interest in the environment (apart from the fact that each respondent dedicated, on average, 15 minutes of her time to answer the survey). Moreover, 83 of the respondents are active in environmental pressure groups (about 23.3 %). The survey deliberately avoided questions about socio-economic status (apart from the proxy of profession and postcode). The reason for this is the abundance of general studies that can give guidelines to the profile of the respondents. Since the mid 1970s, many theories have been suggested that correlate environmental awareness to high level of education and, by so doing, relate this awareness to middle-class socio-economic status (one of the most commonly cited works in this context is Inglehart 1977).

Examining UK case studies (Witherspoon 1994, Witherspoon and Martin 1992) reveals that, in general, the population of south east England is more aware of pollution and global issues. Level of education does not seem to have an impact on awareness of local environmental issues, as it does with global issues. According to these analyses, the connection between education and environmental awareness is related to political awareness which explains interest and a will to act. They have identified that "at the moment the most environmentally-aware and active … are the educated members of the middle-class …" (Witherspoon and Martin 1992 p. 22). It was also found that those with scientific knowledge display above average levels of concern toward the general environment and for self and family (Witherspoon 1994). As we have seen, both aspects appeared in the survey responses. Also noteworthy is that the same report noted that just 6% of the population belong to an environmental pressure group (Witherspoon 1994). This profile of respondents as educated members of the middle-class is reinforced when access to the Internet is considered. As discussed in Chapter 2, access to the Internet is strongly connected to income and education.

To conclude, the information provided by LEO survey respondents, and the supporting evidence presented here, backs the claim that the survey has captured the most likely audience for environmental information systems. They are well educated, better off than the average population, exhibit literacy and ease with the use of the Internet and are more active in environmental issues then the average population. Therefore, any conclusion drawn from the survey can give us a good approximation for future needs from public environmental information systems, at least in the short to medium term (up to five years). This is a common time frame discussed for information systems design and development.

4.2.4.2 What are the Information Needs?

The survey has shown that information needs relate mainly to respondents' day-to-day activities, with a mix of livelihood issues, quality of life, and health issues. No doubt, the survey respondents accept the concept of interconnectedness between environmental elements and issues. The connections between public transport, air quality, traffic and noise were mentioned several times. Traffic in all its forms is a major issue that comes up time and again throughout the survey. The necessity to move around London for work, shopping, or leisure is seen as unavoidable. Transportation is the most important issue that emerges from the whole survey.

Air quality, water quality, health risks and noise are all connected to one's personal fitness and of vital importance to the respondent's family. Notably, apart for some reference to society as a whole ("it's important to us all") the main focus in on the individualistic level. Despite the environmental rhetoric on future generations and care for all species, they are not expressed as a major issue of interest or concern. Interestingly, the fourth topic relates to the possibility to act. Recycling is expressed as a basic and easy method to "do something" and improve the state of the environment. This finding corresponds with those of Witherspoon, six years ago (1994). The updated scale on the various issues was designed to tap into the question "how often would you like to receive information about these issues?" and to help in differentiating them. Here, the combination of health issues and transport issues is even more potent. Clearly, most of the respondents do not see a value in receiving environmental information every hour, as the highest frequency leans toward the daily value (2) more than towards hourly updates (see Figure 4.5).

Although most of the respondents were satisfied with the list of environmental topics in the survey (which, as mentioned, was refined through the pilot phases), a look at Table 4.4 reveals some interesting points. The survey stated clearly that LEO is an environmental information system for London (i.e. a defined location, which happens to be highly urbanised). This statement did not prevent respondents from mentioning and connecting their answers to broader environmental issues and problems, some of them at the global scale. Despite the impression that this list produces, it is important to stress that the local level is the most important to the respondents. Many mentioned the specific locality in which they live or work. As reviewed earlier, the respondent's identity as persons who live and work in London has an important role in their interest in environmental information. On all these issues, the overall request is for provision of information, and less for manipulation of data. Put simply, though the respondents clearly know how to manipulate and navigate through a website, they prefer to receive processed information. They would like to receive information about environmental organisations, to learn about local environmental issues and health related issues and to view the information in an attractive visual form. There is less preference to access raw data, to perform on-line analysis, to participate in a discussion forum or to receive reports automatically. The reasons for this can be explained in the light of current patterns of information sources; as discussed in the next section.

4.2.4.3 *What are the Current Sources of Environmental Information?*

One of the most interesting outcomes of the survey is the relationship between old and new media sources. As was discussed earlier, most of the respondents exhibit high levels of Internet literacy. There are currently many rich and extensive sites with environmental information. These include those that are run by governmental agencies, NGOs, or Multinational Corporations. Some of these sites will be examined thoroughly in Chapter 6. In the UK, the Environment Agency is one of the best examples of a governmental WWW-based information system. Another example is of an information system maintained by a NGO; the FoE (UK) site provides information about the organisation and holds several interactive databases about Sites of Special Scientific Interest (SSSI)

and the chemical release inventory. Finally, it is worth mentioning the sites of corporations like Monsanto, which provide information about their activities. This is important, especially as they are in the "line of fire" in environmental debates like the discussion around GMO[7]. In short, there is an abundance of environmental information on the Internet - from raw data broadcast directly from monitoring stations, to politically charged statements and manifests by specific interest groups.

In spite of the state of the art in Internet-based environmental information, the percentage of respondents who use the Internet to find environmental information (48.68%) is significantly lower than those with frequent access to it (69.03%)! On the other hand, "traditional media" - TV, radio and newspapers - are the most important and commonly used sources of information. National newspapers are, by far, the commonest source of information. Taking into account the landscape of national newspapers in the UK and their tendency to cover environmental issues (Neale 1999) it can be concluded that it is mainly the broadsheet newspapers (such as "*The Guardian*", "*The Independent*", or "*The Times*") which are used as a source. The lesser importance of radio and TV can also be attributed to their lack of coverage of environmental issues, as one of the respondents mentioned. These findings are similar to Europe-wide findings (Centre D'estudis D'informacio Ambiental 1998).

As a fifth of the respondents are members of environmental NGOs, it is not surprising to find that such organisations are used as a source of information. However, it is noteworthy that the percentage of respondents that receive information from NGOs is higher then those who declare that they are active in such organisations. Hence, we must conclude that they have received information from these NGOs through a secondary source (be it post, brochure or other means). There is a relatively limited use of official sources of information (governmental reports, consultation with professionals, regulatory bodies and legislation). Possible reasons for this can be distrust of such bodies, which has been recorded and documented (Eden 1996, Neale 1999), or simply due to difficulties in accessing and obtaining information from these sources.

Finally, an important aspect of information sources is that in most cases not one source was used independently. Table 4.8 reveals that newspapers (local and national) are the only sources of information that are used in isolation. The other sources are used to support or to enhance the picture of the issue in question. Naturally, the distrust of the Internet as a reliable source of information reduces the likelihood of using it as the sole source.

4.2.4.4 Why is Environmental Information Needed?

When examining the analysis of sources of information (see section 4.2.3.4) and the textual information about environmental information and the Internet (Sections 4.2.3.6.2 and 4.2.3.6.3) a

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[7] For a focused analysis on the relationship between web sites and the use of the Internet for environmental debate see (Rogers 1998)

very interesting picture emerges. Usually, information and information systems are seen in conjunction to an activity (Alter 1996). This aspect of environmental information consumption can be identified in the survey. Respondents state that they need information about traffic and public transport to plan their daily journeys, or need information about air quality to use preventive medication. The best connection between information and action is exhibited in recycling. Respondents have clearly indicated that they want to obtain information about recycling in their area as this is an environmental issue that can be tackled through a personal action and where information can help. An interesting example exists on the Brent Council website where maps that depict the nearest location of recycling centres can be obtained by residents of the borough. Statistics and details about the extent to which this system is used by local residents are not available. However, the answers about sources of information and the textual answers reveal another aspect. This side of consumption is connected with the need "to know what's going on". This is a service that broad spectrum media (TV, radio and general newspapers) have focused on for a long time. An information system, on the other hand, is viewed as a "narrow band" vehicle, which although capable of providing detailed information about a specific topic, cannot compete with "traditional media" on the general provision of news. In a way, it is possible to envisage the role of LEO as an in-depth extension of general media, which provides more detailed information about topics that have been raised by the former.

4.2.4.5 Using the Internet as a Delivery Medium

As was mentioned in Chapter 2, there is a clear trend toward publication of environmental information via the Internet. Noteworthy is the fact that many of the respondents felt that this lack of equity (the "digital divide") is important in the context of LEO. It is also fascinating to observe that respondents see the issues that relate to the "how" (the technical nuts and bolts of Internet-based environmental information) with the "what" (content and presentation). The respondents recommended that information be presented in a simple and jargon-free manner, but connected this aspect to the way in which the information is laid out on the site. By and large, the respondents' preferences follow findings of many WWW usability studies (See Nielsen 1999, Rosenfeld and Morville 1998). This aspect holds an important lesson for the designers of Internet-based PEIS: the "user experience" with the website, as far as common elements are concerned (navigation, search, look and feel) should follow established designs and conventions.

4.2.5 Summary

The survey provided an opportunity to query and reveal the concepts and needs of the most likely users of environmental information. The most important findings of this survey are summarised here, as they will serve the core analysis of this thesis in the next chapter. Though it cannot be claimed that Internet access is ubiquitous to the whole population or that environmental awareness encompasses society as a whole, the survey gave a snapshot of those who are interested in environmental issues and have access to the Internet. This group is not a monolithic body and,

even at the individual level, there is no single identity or affiliation that will give an unequivocal definition of their needs and requirements from such a system. As individuals, they relate to various issues - the need to get to work on time and to get through the city traffic (either by car or public transport) on a daily basis. As parents they care about environmental health risks that threaten them and their family. Those who work on environmental issues as part of their profession are concerned with obtaining high-quality data and information that will enable them to carry out their job efficiently and effectively.

These multiple identities and roles make the issue of information provision more complex. Each type of audience has specific needs and requirements. The frustration and dis-empowerment of respondents may hint at a certain failure in the current provision of environmental information. For some reason, the partial provision of environmental information that newspapers, TV and radio have mastered was not transferred successfully to information systems. This is probably one of the major challenges that the new era of public access to environmental information poses to systems designers.

Furthermore, the various audiences for environmental information seem to perceive it in an holistic manner, as a set of interconnected issues. This interconnectedness makes the task of information gathering more difficult. Respondents would like to enjoy the capabilities of the Internet to pull together a myriad of resources and provide a "one stop shop" for information needs. This information provision should not just focus on action related issues (like planning, recycling or campaigns) but also to provide a context for environmental issues. The "need to know" element seems to be pivotal in the need for environmental information. This aspect of the system should be carried out in a manner akin to newspapers.

4.3   UCL BROWNFIELD RESEARCH NETWORK WORKSHOP

4.3.1   Overview

As mentioned in Chapter 3, the UBRN Workshop sessions were recorded using Lotus ScreenCam (Lotus Development Corporation 1996) and, in some groups, tape-recorders. The ScreenCam movie captures the computer screen and the movement of the cursor over it. Microphones were attached to each computer, so that synchronised audio accompanies the movie. As small size microphones were used, the recording was non-intrusive when compared with the option of installing a video camera in each room (though every "expert" was asked to explain and notify the participants that ScreenCam was being used). Of course, it is almost certain that after a few minutes participants' attention turned to the task at hand - experimenting with the GIS - and the recording was ignored altogether. At the end of the "hands-on" session, which lasted about 90 minutes, the recording was stopped. ScreenCam was used again to back up to tape-recording during the group discussions. These sessions lasted about 45 minutes.

Within this thesis, the aim of the workshop is to support the more general findings of the LEO survey in two ways. First, the workshop used GIS-based environmental information and, as was explained earlier, GIS plays a pivotal role within EIS and, therefore, is expected to be central in PEIS. Second, the workshop observations provide information about the actual interaction with EIS, while the survey is mostly declarative. Together, the workshop and the survey provide background information for the analysis of PEIS. It is important to note that although the whole workshop was part of interdisciplinarian activity, the following analysis was conducted for the purpose of this thesis, to extract those elements which will contribute to PEIS.

4.3.2 "Experiencing" GIS

The "hands on" session provided the participants an opportunity to experience and experiment with a GIS. Previous experiences and knowledge, computer literacy and personal interests influenced preconceptions about the system, the information it contains and the ways it can be used. Table 4.12 lists the five groups and their members, providing the necessary background to understand and interpret the interactions that took place during these sessions. The names have changed to provide anonymity for the participants. The name and background of the GIS expert is also displayed in this table, as they played a role in the guidance of the process. As the observers/facilitator influenced the discussion in at least three groups, their details are added, too.

Table 4.12 - "Hands on" session groups

Name, Age, Education (highest)	Occupation	Interests and affiliations	Computer literacy
Group 1			
Deborah, 55-64, Further education	Retired	Background in cartography, involved in amenity society	Has almost no experience with computers.
Rose, 25-34, Graduate	Administrator	Local resident	Experienced with computer use, e-mail and the WWW, but has no experience with GIS
Anna, 25-34, Postgraduate	Lecturer	Interest in contaminated land and ex local resident	Experienced with computer use, e-mail and the WWW, but has no experience with GIS
Expert: Rebekah	Research Assistant	In charge of the project, holds a postgraduate degree in GIS	
Facilitator: Simon	Postgraduate student	Research interests not related to the specific project	
Group 2			
Barry, 45-54, Postgraduate	Artist	Has been involved in community planning for 25 years. Involved in pressure groups; residents association	Experienced with computer use, e-mail and the WWW, but has no experience with GIS

Name, Age, Education (highest)	Occupation	Interests and affiliations	Computer literacy
Kevin, 35-44, Postgraduate	Freelance architect	Interest in development pressures along river front; community interface with planners and accessibility of planning system. Involved in pressure group and amenity society	Experienced with computer use, e-mail and the WWW, but has no experience with GIS
Malcolm, 55-64, O-level	Retired	Active in rambling and walking and special interest groups. Interested in computerisation of rights of way records	Experienced with computer use and e-mail, novice with the WWW and has no experience with GIS
Expert: Steve	Research Assistant	In charge of the LEO project, holds a postgraduate degree in GIS	
Facilitator: Sue	Lecturer	Research areas include participation in planning	
Group 3			
Felicity, 45-54, Postgraduate	Unemployed	Interest in open space and environmental issues, active in amenity societies	Experienced with computer use, e-mail and the WWW, but has little experience with GIS in the past
Carol, 45-54, A-level	Administration Director	Interest in local traffic and library planning and active in residents association	Experienced with computer use and e-mail, novice with the WWW and has no experience with GIS
Elaine, 45-54, Postgraduate	Lecturer	Interest in the role of amenity societies and active in amenity society	Experienced with computer use and e-mail, novice with the WWW and has no experience with GIS
Expert: Colin	Postgraduate student	Studies toward MSc in GIS	
Facilitator: Alex	Researcher/ Lecturer	Research areas include participation in planning and use of PPGIS	
Group 4			
Bill, 45-54, Postgraduate	Volunteer community/ environmental projects	Interest in participatory processes in land use and development. Active in pressure groups and special interest group	Has very little experience with computer use of any kind
Martin, 45-54, Graduate	self-employed community planner	Interest in community and participatory planning; community development/regeneration. Active in pressure groups and amenity societies	Has very little experience with computer use of any kind
Paul, 55-64, Postgraduate	Architect	Interest in the role of property industry in planning process; local community involvement in planning. Active in residents association and special interest group	Has very little experience with computer use and e-mail
Expert: Muki	Postgraduate student		
Facilitator: Judy	Researcher/ Lecturer	Research areas include participation in planning	

Name, Age, Education (highest)	Occupation	Interests and affiliations	Computer literacy
Group 5			
James, 55-64, O-level	Freelance , environmental consultant	Interest in planning in relation to cyclists and pedestrians. Involved in amenity society and special interest group	Experienced with computer use and e-mail, novice with the WWW and has no experience with GIS
Tim, 55-64, Postgraduate	Retired	Interest in planning especially property development and development control. Active in amenity society	Has very little experience with computer use of any kind
Expert: Jeremy	Lecturer	Teaches GIS at postgraduate level	
Facilitator: Charlotte	Postgraduate student	Research interests not related to the specific project	

As the table shows, the various groups represent a wide range of computer skills, gender and level of activism. The division along gender lines was based on previous experience in participatory processes. The observers/facilitators were instructed to follow the interactions and to make sure that the participants focus on the use of the GIS as other issues can be raised during discussion time.

A list of possible activities with the GIS was provided to participants to suggest a structure for the session. The analysis of the recording reveals some similarities between the groups and the ways in which they used the GIS and the issues that this use raised. These issues can be grouped into several themes. First, in all groups the interaction with the software was not continuous and the discussion moved into new areas that emerge from GIS use or the information that was displayed on the screen. Such discussions continued for up to five minutes, at which someone (not necessarily the facilitator or the expert) would refocus it on the GIS. Secondly, participants provided a vivid demonstration for the value of local knowledge and familiarity with the locality in providing an interpretation context for the information on the screen. Furthermore, this local knowledge is framed with personal interests and activities. Thirdly, in all groups, difficulties relating to software use and operation were demonstrated at least once. Though all experts were accustomed with the GIS, problems had arisen. Naturally, such events lead to discussion of the use of computers and the level of skills needed to operate them. A related issue is the nature of geographical data sets. Questions about accuracy, ownership and meaning where raised. Interestingly, in almost all the groups, the experts could not provide information about the origin, content or availability of information. This aspect exposes the way in which some data sets are used unquestioningly, even by expert users. Fourthly, though the system's database was clearly oriented toward environmental issues, none of the discussants raised "environmental issues" per se - they have been seen as part of a more complex framing that included wide ranging concerns and interests. Finally, participants exposed their feelings and reflected on their experience with the GIS and its ability to integrate various data sets.

During the discussions that followed the lunch break, participants were asked to reflect about their fresh experience, and to discuss ways in which the GIS can be used in their contexts. Overall, the themes that emerge from these discussions are similar to those from the hands-on session. In terms of participation, the broader groups were divided along gender lines, so group A (females) was made of group 1 and 3, while group B (males) includes group 2, 4 and 5. The discussion was facilitated by experienced facilitators and a "GIS expert" attended to answer any technical questions. In the following sections the various theme are expanded, with examples from the various groups.

4.3.2.1 Local Knowledge as an interpretive filter

The interaction with the GIS required a reliance on local knowledge - even for the purpose of location and identification of sites. The main reason for this is the use of the Meridian data set. This data set contains information about the road network in vector format, with an emphasis on the topology of the network, rather than an accurate geometrical layout of roads and junctions. Furthermore, this data set does not include detailed street names but rather road numbers. As a result, it provides a familiar, yet generalised context for identification of places when viewed at small scale (1:50,000, for example, its native scale) but becomes more abstract when zoomed in - especially below 1:10,000 scale. Figure 4.4 demonstrates this aspect of the data set.

Figure 4.4 - A snapshot of a map (scale: about 1:15,000) as was displayed during the workshop

This aspect requires participants to point to locations on the map and identify them. As the software zoomed in into a small area, the map becomes quite abstract and as one participant (Rose) stated: "… that mean absolutely zero". Deborah: "Unless you know exactly where you are…Is it actually possible to put street names on?". (Group 1 - 8 min). This experience was important for the participants in this group, and it was mentioned during the group discussion, when solutions were suggested, such as the use of street mapping in familiar form.

In many cases, the operation of zooming in led to a discussion about specific memories of events in the area. The participants mentioned changes in the built environment, such as the location of a hospital which is not there anymore, or a train accident which occurred in a specific location. However, these memories are not always just about major events, or such changes, but also contain information about day to day activities – such as getting to the local shopping centre, the type of shops in it and its surroundings. Further evidence for the importance of local knowledge came from a facilitator, who did not live in the area, when she observed the discussion: "I wouldn't have a clue where this was" (Group 5 - 59 min). Local knowledge was used beyond identification of locations on the map. In some cases, discussants use their local knowledge to interpret and understand the information:

> Group 2 - 40 min. Kevin mentions an interesting aspect that he sees in the information "The thing with this system is that people are going to see things looking with their own filters, as it were". Kevin then explains that he "has a theory about Battersea power station" which should be seen as a new urban centre, and not just a separate leisure centre, but it is not recognised as such a centre. The integration of population density and other information is demonstrating the diversity of activities in this area, and reinforces his "theory".

The use of local knowledge culminates when participants start to add information to the map. The most striking example for this happens in Group 4, which represents the participants with minimal computer skills. Toward the end of the hands-on session, they have been offered the opportunity to add information. Bill suggests adding information about community facilities, like playgrounds. During the process, the participants discuss the location and characteristics of playgrounds - equipment, use (for example, a playground for disabled children) and so on. Interestingly, the participants ask to delete the information afterward, as they are not certain about the accuracy:

> Group 4 - 90 min. Paul "that sort of level of information that you might get from say a governmental publication which you hope obviously it's been. … it's interesting this business of the playgrounds comes up. …Clearly we haven't put as many as we ought to, to be able to make a complete picture…" then he asks "…where would you go for verification?" and Bill answers "you'd have to go to the people who are locally involved". Martin notes "what you've got on here, until we got to what we just did - you can quite easily from actually relatively few documents - even the population density - but what we were just about to do, i.e. play areas and if we were to look at shops at a more local level than that, you wouldn't. For local use, and also the written information it is increasingly apparent to me that local input is needed into this system" Bill completes "Because that is where the knowledge is…it's the level of detail and local knowledge and local interest … shops, play areas and whole range of things which requires local groups and individuals to be able to access this. And I don't know if that is allowed. Quite apart from the question about if they have the technical skills … I don't know if that is allowed".

However, participants were aware of possible differences between local groups and, therefore, the potential of GIS as a shared environment to present and express others' views. Some participants had previous experiences in collaboration with other activity groups. In some cases, conflicts can

arise from the wants of different groups. In such cases, a repository of information where the different groups can explore and discuss the issues that concern each one of them is seen as a useful development.

In summary, throughout the workshop, issues which stem from local knowledge was used throughout the session to understand and read the map; it influenced the interpretation of information, as was demonstrated by those who started to use the system to enter information.

4.3.2.2 Information that Participants Would Like to See

The issue of information that participants would like to see integrated into the system, gives another perspective on their knowledge and the ways in which they "filter" information. The most common request for information that was missing from the system is the issue of bus routes, this was raised in all groups throughout the hands-on session and the discussion groups. A typical example is:

> Group 5 - 77 min. The group looks at the service area maps. Tim suggests adding bus routes "buses are an interesting concept. Because of the intended growth of public transport it would make a big difference to do that, because everything is historically based around motorcars, understandably, and the train lines are in and if you put the tube lines in and the bus lines in. That would give people a realisation that there are other options for transport rather than getting in the car". To which James adds "The real pain is actually office buildings particularly because people won't travel very far either from the tube or the railway. Buses don't seem to make much difference".

Alternative transport issues - by foot or cycles were mentioned. Of course, having representatives of the ramblers association (which promotes hiking) and the cycling campaign provided a motivation for such discussion. The discussion of alternative transport modes was not secluded to these activists and others also discussed it. Traffic surveys were seen as an important data source that should be integrated in the system. Other traffic/transport problems that were raised include parking, the relation between building density and traffic and also traffic generated within the borough and passing through traffic and the potential of the Thames for public transport. This was also connected to the broader context:

> Group B - 41 min. After bus routes were mentioned, Malcolm states "the government want to have integrated transport, you want to see what all the methods are, so you would want that the information be available. To see what links are missing" and someone continues "to shops, to hospitals and so on".

Another topic that was mentioned is the locations and features of local amenities. Local and personal knowledge about uses of spaces was demonstrated by participants. Some were interested in information about sport activities, other in local services (library, doctor's surgery or cinema) or:

> Group 4 - 89 min. Martin "Now, I think that at the local level … this is the level of detail that people know and are interested". Bill suggests more data sets "And then sort of shopping and day centres" and Martin moves on "Crèche, nurseries, access to the riverside".

Naturally, issues relating to planning applications were raised. Some of them relate directly to spatial information (details about location of contaminated land) and some to related issues, which are aspatial (like dates of meetings). For example, it was suggested that information about planning inquiries or meetings be distributed to interested parties according to their postcode, or to see a more holistic perspective that demonstrates the inter-influence among different planning programmes. As the discussion surrounded the topic of brownfields, an interest in contamination was expressed:

> Group B - 42 min. Martin: "Contaminated land, that would be useful". Caroline explains that it's "very very difficult to obtain" and mentions the issues that were raised during the seminars. Barry then recalls a meeting about the Imperial Wharf where "someone who used to work for BP could actually remember the oil spillage that actually has blighted part of the site and only later was discovered by the developer and BP having actually sealed off the spillage because it was too difficult at that time to extract"… Paul explains "part of the problem of public information again. Central government tried to force local authorities to keep a contamination register. The system broke down simply because by identifying a contamination site, the site became completely undevelopable".

Not surprisingly, the value of local input and connection to local activity groups received participants' attention. Some of the participants were already involved in development of Websites that expressed their group position toward the proposed development. One of the clear statements about local information was raised during the first session:

> Group 4 - 43 min. Bill raises the issue of local input "so really at the local level it would need sort of developing a local database …" and Martin continues "Now that raises a hugely important question about the local groups. It is the ability of the local groups to put in their own data, local data, truly local data into the system. They would need somehow to be able to access the mechanics of this to put in what they know about a specific area" and he provides an example about birds nesting in a specific site where the local group knew about it and insist on integrating this information into the planning process.

Noteworthy is the request to integrate historical mapping in the system, as past uses of site might be useful when considering current developments.

4.3.2.3 Difficulties with Software - Complexity

As stated, all groups experienced various difficulties associated with software. Group 1 experienced such difficulties when they tried to view a planning document on the Wandsworth planning website. The participants viewed the web page presented in Figure 4.5. The website provides full access to the planning register, which stores every document that is related to a planning application or decision as a scanned image in TIFF format. The system enables search for planning applications and then presents a document page from which each image can be downloaded. Unfortunately, TIFF format was not recognised by web browsers at the time of the workshop, and therefore requires specialised software. As Figure 4.5 shows, the page provides downloading instructions for the needed software.
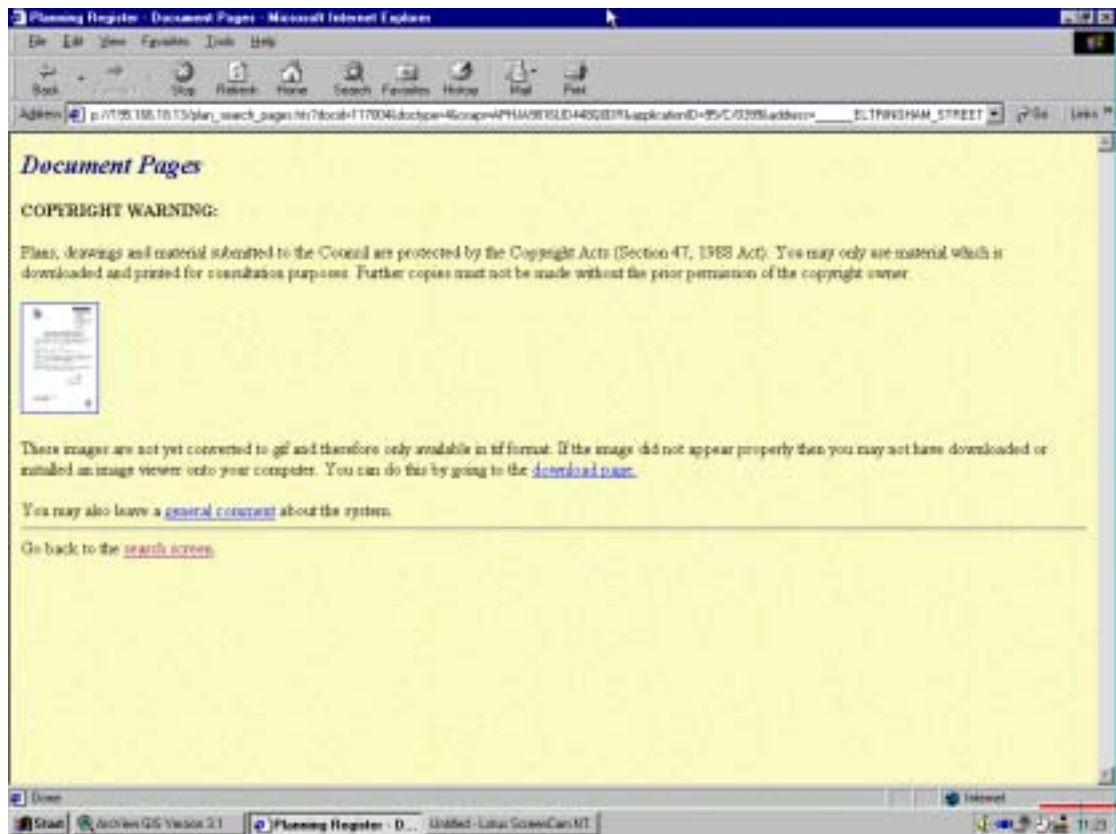
Figure 4.5 - Wandsworth planning website

As the following examples demonstrate, while the participants noticed the "Copyright Warning", they completely missed the instructions for the viewing software at the bottom of the page. Among the 25 people involved in the workshop, not one comment about these instructions has been recorded. However, it is Group 1 who demonstrate the problem most vividly:

> Group 1 - 18 min. Rebekah (the expert) "That is where it starts to be really confusing". A dialog box appears on the screen. Deborah: (in confused/questioning tone - reading from the screen) "Chosen to download file from this location … what would you like to do with this file? (Laugh) put it away …". Rebekah: "yes … you can see there is two choices, so you don't want the second one". Anna: "So we'll open it, shall we?". Rebekah explains how to open the file, and Deborah follows. The computer opens a list of available applications and asks the user to pick the application that can open TIFF files. Rebekah (in irony): "Wandsworth website is really user friendly as you can see…I don't know even which software we want to use but I bet it is one I haven't got". Deborah: "All that just to find an application about school… (Ironic laugh). Rebekah (explains): "this is because the way they set it up, you actually need some specific software to be able to read the pages that they have scanned in". The list of available software on that computer finally appears and by selecting the wrong program the screen presents some gibberish in a window. Rebekah: "Sorry, but that is as far as you can get looking at the information from Wandsworth website"…

However, this problem arises in the last stage of information consumption - the attempt to view the file itself. Other groups experienced problems at an earlier stage of access - during the search. As the search engine in Wandsworth council website was not configured to deal with misspelled street

names, an attempt to find a specific application according to its address, failed. However, and as expected, it was the novice users - those who have little or no experience with computers and GIS - which provide the most vivid examples for the difficulties that are associated with the use of software:

> Group 4 - 4 min. Bill is struggling to control the mouse, and asks questions about it. Paul "The things about computers is that they were designed by geeks and not normal people, they're people like Bill Gates, he's not of our planet and so I mean it's just over complicated". (4 minutes later) Bill wants to see the study area. Muki instructs him to use the button marked "Zoom to Active theme". Martin comments "no one that I know of would understand 'zoom to active theme'" A few minutes later Martin is guided to double-click in order to edit theme visualisation: "...I've got to say, double click the symbol to edit it again hardly means anything to me. I wouldn't know, I mean I'm giving you the impression of somebody that would be using this, trying to use it… I actually personally would not understand that. I know what double click means and I know symbol because it says it's a symbol but what does "to edit it" means?" They later discuss issues like how to know if a single or double click is needed and other terminology like Mitre, Butt, Area Fill, Pan, etc. Bill "If we're having difficulties, and we're thinking about people in the communities that will have problems even with the "themes" that we're talking about" and Martin continues "Many can hardly speak English, let's put it like that, or even read English. After going through the process of changing the symbology of a layer, Martin comments "I'm absolutely convinced that most people wouldn't have got through to this point! Absolutely convinced … they wouldn't have understood the language, they wouldn't have understood what you did there…".

4.3.2.4 Skills Needed to Operate the Computer and the GIS

While the problems associated with software were apparent only on a few occasions, many participants voiced their views about the skill level that is needed to operate GIS successfully. Furthermore, one of the groups provided an actual example for the needed abilities. Toward the end of the session in Group 1, Rebekah, the expert, left the room. The participants continue to use the system and explore its database. After a while, they try to make the boundary of Wandsworth borough visible. They turn it on, but it is a filled polygon, which obscures all the other layers. They want to display it with the road overlaid on top of it. The recording shows them trying to switch layers on and off and, after a few experiments, they all join up (including the facilitator, Simon) to recall how to control the transparency of layers. The efforts continue for about five minutes until they solve it. During the discussion, they reflect on this:

> Group A - 9 min. Deborah explains "I am very comfortable with maps as a cartographer but completely uncomfortable with computers - haven't touched them before - and I did find it actually, I was told that I was quite good but I felt a complete idiot. It's the first time I touched a mouse, haven't used one before, I didn't even know that you have to move it around … if I would left on my own, I would be completely lost, I'm quite sure". Anna notes "I think that it requires an extraordinary high level of computer literacy. Really really high". Jeremy asks if that is an impression from the specific system. Anna answers "It's partially presentation. For

example, we got into a bit of trouble when we got the Wandsworth boundary and we couldn't work out how to see it. Now Simon came with ingenious solution but I would never thought about that. The actual movement to move things up the legend so to highlight different data. So that requires quite a lot. I mean the conceptual thinking and computer familiarity and we were unable to read any of the decisions notices or the applications on the Wandsworth website and that mean that you need to have the ability to understand what is going wrong, i.e. you don't have the right kind of software and then ring them up and ask what kind of software do I need? Is it shareware? Is it freeware? Where can I get it from? And then to be able to download it from the web. So I think it requires enormous amount of computer literacy". Other participants agree. Carol then mentions that another problem is "knowing what we need to know". Judy asks her to expend on this, and she explains "Well, I wouldn't have thought about a lot of points, I wouldn't go on the [Wandsworth] site, I wouldn't know about it, I wouldn't go through half an hour screens…"

Another example came from group 4, where those with limited computer skills experienced the interaction with GIS in particular, but for some of them it was a first experience with computers in general:

Group 4 - 28 min. After spending about 20 minutes struggling with the jargon in order to change the appearance of the layer, Paul notes "I was just going to make a general remark about this. … I'm fascinated being in a situation where I find two people who have used these machines less then I have. I'm actually now converted in the sense that I think this is absolutely marvellous. But it's very interesting hearing you talk about it and yes, it is a pain and you're quite right if we're talking, and I had actually almost prejudged that you would almost have to have somebody with a degree of expertise to get this far. I mean, I couldn't get this far without him [Muki] here and I know something about computers. But I have sympathy - I know more than I think you two do, but it's not enough yet. It suddenly occurred to me that, you know". Martin asks if others in local groups would be able to get over the obstacles, and Paul suggests that if they had a "child in the house" it would help. Martin agrees that a young person would be "up to scratch with all". Then Martin asks "…the generality of people - I mean is this for … the general public or is this frankly active citizens and activists?".

However, this was not an exception and other groups discussed skill issues. For example, group 3 discussed the process of developing a GIS. In particular, participants were interested in gaining information about "How much effort is it to create your own GIS?" (Elaine, 61 min). The participants seem to be aware of the costs of geographic information and the need to buy software and expertise. As a partial solution, some participants offer that several activity groups should join forces in the development of a GIS. Another important set of skills that is considered a pre-requisite for interaction with GIS, is the ability to read maps. This was noticed in one of the groups:

Group 2 - 87 min. Barry discusses the ability of 3D models integrated into planning. "This is got its limitations. … people reading maps I mean when you kind of used to do it, then you can understand the map. But not actually everybody understand maps - flat map. They can't actually visualise these lines to rivers and railway line with little ticks on them. A lot of people, I

think, cannot actually relate to it at all ... you think they can with all the A-Z maps, finding their way around London and stuff like that but I'm sure there are people who would only recognise a picture of Battersea power station rather than rectangle with four circles on it which would be the map of it". Steve then suggests the use of aerial photography to be integrated. Barry agrees but argues that he wants to see it at ground level in 3D.

4.3.2.5 Internet Access - Cost, Boundary, Skills

Another element is associated with the costs and skills needed to access the Internet. Though computer literacy is needed, participants have raised special concerns regarding this medium. The first of these is the skills and costs needed for access. Participants raised the issue that not every potential user owns a computer, and that the use of an Internet-based system is "limited to certain socio-economic groups and ages" (Felicity, group 3, 32 min). As a remedy, it was suggested that in a public library the librarian or operator will assist those who have difficulties in accessing and using the system. Furthermore, as Internet and computer use tend to exclude those from disadvantaged backgrounds, it might alienate the exact part of the population that already feels excluded and alienated. However, participants felt that as more and more will learn computer skills during their education, they will "filter through the system" in the next few years. A related issue is the cost of Internet connection, and the feeling that interaction with GIS-based systems can be a lengthy process:

> Group B - 35 min. After Martin requests "what-if" capabilities, Tim explains that he wouldn't want to see such a thing on-line over the Internet "simply because it's so slow on the computer and it will cost me more money to watch it. While this thing takes ages to come physically on the computer and are very very slow and not very effective. … I have to pay for my time of connection unlike you here where it's free. …If you are on the telephone on the Internet for two hours it costs you a lot of money". Barry comments "I think that that is going to change, it's definitely going to change" to which Tim replies "I don't think it will, because the telephone companies might not make money out of it". Barry comments that people are interested in information about themselves "So if you put an aerial photograph of London and you can actually put in your home address and it comes up, it can actually get people to be involved in that particular programme. … it is reality where this thing is a map that I don't understand too much. The initial reaction of people wanting to see their personalised bits as an inroad into this kind of programme".

Another aspect of the Internet is the expectation that public information will become available through it. Of course, this raises the aspects of ease of use and accessibility. Some participants felt that local authorities "ought" to release environmental information through libraries and the Internet. Other participants mentioned the advantages of such information release:

> Group 5 - 102 min. James provides some final impressions from the system. "Very very useful. It's intriguing, I think that from my point of view with the cycling campaign it got a certain potential and if the cycle network can be superimposed into it, it will be very very interesting indeed - and if I can get it on the net! So I can sit at home and work with it. That will be

fantastic, to be able to sit at home and work with it over the net. And if you can download it, better still, the whole thing and just keep it at home there is probably so much data".

The hands-on session provided several cases in which participants couldn't tell the ownership of a site, and found it difficult to identify a "boundary" - which pages belong to whom. This was especially true as they moved from the local pages to external sites by following links. Questions of the sort "who's site is it?" or "is this is all on the Internet?" appeared in the course of the discussion. Participants were also aware of the speed of access and the issue of bandwidth. Those who experienced with Internet access over a slow modem from home, were especially impressed with the speed of access and comment on it. Finally, participants expressed their views on the communicative potential of the Internet:

> Group 3 - 78 min. Felicity, after listening to Alex explains the need to control information and possibilities for entering information "So, in fact, people like us need not just use the system we could create, provide information as well…Two way process".

4.3.2.6 Ownership and Cost of the Information and the System

Participants were quite aware of the cost and other complexities involved in setting up an information system. These concerns can be divided into three groupings - those that are connected to the direct costs of obtaining the information; the cost of the software and the hardware; and, finally, issues that stem from ownership of the system and the information. First, the following example demonstrates concerns with data and information costs. Some participants were aware of the costs of Ordnance Survey paper maps, and inferred that digital information should be as expensive and as difficult to obtain. However, such costs were viewed as part of the total costs of the system - and hence the costs of using it. Participants were interested in the direct costs of the software. They raised questions about the operation of the system and the implication of its funding:

> Group 1 - 57 min. Elaine: "Who is funding all this? Is it going to be a government, overall, out of our taxes, linking presumably this website in the libraries ... I know that they want to put computers in the libraries and almost get rid of the books … I'm just wondering at what point are we going to pay? Shall we pay to you every time we use it?" She continues "it goes back to the amount of information that you can get out of it, some people spend quite a lot of money on research …".

However, the discussion moved beyond the point of just costs and into the ownership of information, its value and the willingness of organisations to open information. Some participants felt that for commercial reasons, information about contaminated land is kept away from the public. An intrinsic issue of PEIS management relates to the trust of activity groups in the local authority who run and maintain the system. Some commented that "a lot of local groups are very suspicious of the borough, they don't trust local authorities to put everything on their information sheets and anyway lots of local groups know things that local authorities doesn't know - for example about a particular bird, a particular plant" (Martin, group 4, 46 min). A possible solution

that was mentioned earlier is to leave the data entry and management of local information to activity groups, while providing them with adequate training and tools. However, this solution is not simple and depends on the ownership of the information on the system

> Group 4 - 69 min. Martin asks "Can you for example, I mean I don't know because I've never actually done this but can you for example if you've, forgive the language here because I don't even know what I'm saying, but can you for example access somebody's website and change it yourself?" Muki replies "If you got permission to change it". Martin "Ah! You have to get their permission to change it". … Martin "what I'm really asking and I don't have the language to ask this so forgive me, but is a website personal property, legal property?" Muki explains that it is legal property and that there are laws regarding it that have emerged now.

Interestingly, the participants exposed contradicting views about trust in the local authority and its ability to run an information system. While, as was mentioned earlier, some felt that local groups could not trust the local authority, other felt that this is possible:

> Group 5 - 37 min. James "In the sheet you sent us you mentioned how this information might be distributed and made available to the public, in fact because the planning applications and so on go onto the internet I think I would be perfectly happy if this information was available to the council and then to the public because one of the strengths of Wandsworth is that they are very good in being helpful to the public". Tim "Excellent, yes I agree with you".

Finally, the value of free information was questioned. It was felt that in an age when information is viewed as commodity, a commercial value is attached to it. Some thought that free information is inherently valueless. The following two examples, demonstrate the view of one of the participants on free information:

> Group 5 - 55 min. James "Oh, yes, sure. I mean with something like planning it is fine because there is a very clearly defined area between public and private information and all the public information is there and that is fine and therefore the web is extremely valuable. Where the web is a tremendous waste of time is if you want to find out information about other organisations whatever it may be, they will only put information on the web that is of no real intellectual value because obviously anything that is of real value to them would be stolen from the web so it is a very, very useless tool if you want detailed information about things because inevitably the more detailed interesting information isn't there …something like the planning website is worth searching because it had got good solid public information but there are an awful lot of others that are a complete waste of time".

> Group B - 37 min. James "one of the problems with overload information that on the Internet generally it's public information on the public domain and it's free information and it's not very valuable because anybody who got valuable information don't put it there because … that's the fundamental difficulty or problem with the use of the Internet, or all of these systems. You go on the Internet and you look for 2-wheel, small-wheels bicycles you get 10,000 references and since I know quite a lot about them, none of them got any information that I need - because it's all public information which is very uninteresting. The person who is developing small bicycles with square wheels which will be the world's most amazing thing

isn't there. Because he doesn't want people to know about it. And that's fundamentally what's the problem is. Therefore, I think it's fine for planning applications. All planning information are public information but the information everybody wants is the private information which is not there. So the whole thing is perhaps a real waste of time".

4.3.2.7 Accuracy and Currency

The issues of accuracy and currency of the information were noted by participants. Naturally, participants have spotted visible spatial errors - or what seem to be errors. Such a case happened with the postcodes layer, where some postcodes were located in the area designated as the river. Other errors are due to omissions in the data set, the date on which the data were collected or their content. In one group, the omission of a large supermarket (where some of the participants and facilitator were doing their daily shopping) was noted. Another type of error was the selection of the analysis area:

> Group 5 - 74 min. Tim is looking at the map of service areas of tube stations but something is missing: "…an interesting feature that you have got here. What you have done is you restricted, quite rightly, the information to Wandsworth but the fact of the matter is that a large section of the area here is out of reach of 1 Km of Putney Bridge tube station … so you need to revise that because you can walk across the bridge and all of that area will become within 1 Km of Putney Bridge tube. So you missed out on that".

The related issue of currency, and the ability to obtain updated information, received participants' attention. In one of the group the issue of updates to the system was raised, and participants interrogate the GIS expert on the procedures that will be used to update the system. Other, more general comments about validity of data sets were raised, too:

> Group B - 27 min. Tim "most people are involved in one way or another in objecting or commenting schemes… the biggest problem that I find is to get the latest bit of information down from the UDP. In other words if the UDP make an assertion about traffic, I really need the information, whether for instance Old York road is over used or its still got capacity … and that sort of information like traffic survey is the most useful. At the moment it is all in different places and its very, very difficult to actually find supporting information you need". Martin talks about various scenarios in traffic planning, like blocking a road or other changes "that must be possible to build into this. And I always thought in public halls where I've been doing things 'if only I had such model to illuminate on the side wall' and then when people can say 'Oh, I want this closed or one-way' what would happen then?". Barry mentions for example, the simulation of 10 Million visitors to Battersea power station site, and Martin explains that such simulations exist but systems should have the ability to incorporate them.

4.3.2.8 Interaction with GIS

The interaction with GIS - the use of an interactive, computer-based mapping environment - provokes a range of responses from participants. Summarising some of these feelings, Paul suggested at one point "Can you show us more tricks?" (Group 4 - 75 min.). For some participants, previous experiences with computers, GIS and mapping are used and recalled. Deborah, who had

some previous experience with paper-based cartography noted "…It's a great advance, 'cause when I was drawing maps, 30-40 years ago, to get something like that you had to draw one sheet and then put it on top of another sheet, you couldn't just click buttons" (Group 1, 78 min.). Felicity who used GIS a few years ago (probably with a command line-based interface) comments "this is much friendlier than I expected …(laughing) I might want to take it home with me!"(Group 3, 13 min). Even people with no previous experience with GIS commented about the ease of access to the information:

> Group B -33 min. Paul: "One aspect of this is that it may not get people involved immediately. But people who are interested and are involved - I mean after this I begin to seriously re-examine how I get information and the more the merrier but Martin might have a point on that". Martin states "I think that there is such a thing as information overload, but I think that if I had the choice, and I wanted to get more people engaged, I would be moving from information which is practically one dimensional, to what-if type engagement. I personally have a bit of techno-fear and I would need a huge glossary to get through what Muki showed me this morning, but I think that even me could get to grips with it, and anyway future generations definitely will. But you could get endless amounts of information from all of this, and you can get completely overloaded so it is something different that you need from that. I think that what-if might be a good entry into it".

Others use the immediate experience to offer uses of GIS. One of the more fascinating comments was offered by Kevin:

> Group 2 - 52 min. Kevin "the other thing that is probably important, is [the ability of GIS] to combine dissimilar things, things that you think are previously unrelated, and it seems to be the real power of the thing". Malcolm notes that using too many data sets will "overwhelm the screen". Kevin suggests that information will be on the web with the ability to integrate and combine with diverse information from other sources.

The interactiveness and the ability "the good thing about GIS it that is a draws picture very quickly, and it can also give you the planning scheme" (Claire Group 3, 31 min) was also noted. There was also a sense of playfulness or enjoyable experience:

> Group 4 - 47 min. Paul "Three things occur to me: one, I think it's incredibly exciting … I love the sort of display effect of it and one thing occurs that Martin does have the access and he's a professional, I get as much information as I can from what I… what I like about this is at least it's tempting me to go and find the books, if not actually to verify what I find on here. I mean I've seen information and things … and the relationships to various things, these colours which has excited me enormously about things that I didn't know and need now to know … but I need to go to somebody like Martin perhaps for guidance as to which book or which direct government planning guide did the information come from or what's the relevance of it and that's still another area I think that, you know, one does need professionals". Paul then asks for links to "people you can talk to".

Others, had some expectations from the system. In one case a participant drew a list of expected outcomes and was pleased to announce that the interaction with a GIS fulfilled most of his expectations. Participants used the discussion groups as an opportunity to reflect on GIS use. For some it provokes thoughts about the relationships between different aspects of the planning process and was helpful as a one-stop shop for various data sets which are usually difficult to obtain.:

> Group B - 22 min. Paul "I thought it was a very exciting presentation and I enjoyed the first presentation as well and I felt strongly, having given many presentations to the community group, I wish I had the competence to use this tool for two reasons. One, it offered, it engendered in my view an enormous amount of discussion and things that I have not considered" He used the example of walking distance from transport nodes - "we were looking at Putney, it was incredibly revealing. That sort of information, I can't think of anywhere else that you can possibly get it. The speed of access to this sort of information - I found it absolutely fascinating". Caroline suggests "there is a creativity about this, that otherwise you wouldn't encounter" Paul replies "Absolutely".

The final comment about GIS use is more thoughtful and cautious:

> Group B - 8 min. Martin "I think it's useful. It could be more useful amongst out of London boroughs where the bulk of the population are technically confident. In the inner London boroughs that I work in, it's seriously disadvantaged communities and housing estates, I think that there are simpler and more easy processes like Planning For Real which are more engaging and which will do the same job in an equally powerful if not more powerful way". Kevin asks about the ability to use the GIS in conjunction with Planning For Real. Martin answers "for example, the bulk of the information can be obtained from the UDP much more simply. The sort of stuff that is really taking your point … that's really local, needs local people to put it in. And we were concerned slightly about who controls the information, and so on". He continues "the other serious point that I would like to make is that this is just on the periphery. Information is important, certainly. But property development, which is what this is all about is a process involving really huge things like: land ownership, land valuation, the property market, the politics of planning and development. None of which this thing could really and seriously engender". Someone comments "it's above all money" and Martin concludes "that's what I mean". … "It might seduce you to think: oh, it's a sensitive site of nature conservation and couldn't possibly be developed. Nothing could be further from the truth".

4.3.2.9 Information Integration

As the previous section demonstrated, one of the strongest features of GIS as an exploratory environment is its ability to integrate quickly and easily different data sets. The hands-on sessions provided various examples of this element. Participants noted that the integration of layers within a GIS environment created an information rich environment or "the picture is getting quite good … you don't realise what is going on in the area" (Rose, Group 1, 72 min). The two following examples provide an indication of the integration capabilities of GIS:

Group 4 - 35 min. Nature conservation areas are integrated with metropolitan open land. Martin notes "You see, that's so important to see that … now you can see that quite a huge amount of the metropolitan open land is not nature conservation and there's just little bits which are both".

Group B - 18 min. Kevin talks about the ability to integrate different issues. He explains how GIS can be used to integrate environmental impacts of transportation and that "it triggers things off".

Others, more accustomed to the planning process, and the documents involved in it, were critical about the value of the information held in the system and claimed that most of it is available in the form of the UDP documents. Participants have noted the cartographical difficulties that are associated with the integration of multiple data sets:

Group B - 15 min. Tim "…the actual maps themselves. I think that they were quite lacking particularly in the graphics, at the time… I was interested in the actual maps and the ways in which the layers fall upon each other and the interaction between the layers. … we defined the boundary of Wandsworth much more heavily in the map that we had - because you couldn't read it or see it. … There were all sorts of points of that type of thing that are important. I think that it needs an awful lot of work doing on it with essential user groups of various kinds to improve the graphics and make it less cluttered. ... I think that it is that kind of thing that needs to be really looked at to make it simpler and clearer so that people that look at the maps can recognise the places and recognise segments of the map quickly and more easily… There must be other layers that can be put in, of local information of various kinds that would be very beneficial to people".

Another feature of GIS as an interactive mapping environment is the ability to view information of different scales. As was noted earlier, this can cause problems. In other cases, participants used this capability because it provides an overview of the whole borough and the ability to compare the status of different areas. Finally, participants identified the value of easy access to information and the ability of GIS to serve as a "one stop shop" for information:

Group A. - 27 min. After discussing the idea of accessing information and using it as a shared resource, Carol comments "How do you ensure that that's become the base for everybody? … that everybody, all different organisations do actually use this so when you want the software and the information integrated from all different sides it is there and they do use it and that is their base for the information.

4.3.2.10   Understanding and Interpreting Information

The hands-on sessions and the discussion exposed various problems with the interpretation of information displayed. The basic information that the GIS interface provides includes the name of the layer and the spatial objects that belong to it. This is not always self-explanatory:

Group 1 - 75 min. Rose: "Sites of Special Scientific interest - does that mean that they are dodgy or that they are archaeological?"

Other issues that were raised by participants include the definition of brownfield sites, and the connection between such a definition and land contamination. Several groups encountered problems interpreting the information while observing the population density layer. The reason for this difficulty stems mainly from the way in which the layer was named. The calculation of population density was carried out by dividing the number of inhabitants by the area of the census enumeration district. The results were in the ranges of 0.0002 to 0.029. These numbers express the number of inhabitants per square meter. However, the layer was tagged as "population per enumeration district". During the discussion this issue received special attention:

> Group 1 - 22 min. Rose: "Lets go to population… oh wow". Anna: "Oh that's good, what's this?". Rebekah explains population density as calculated per enumeration district. Rose: "OKay, what does this numbers mean?" Rebekah: "That's just the density, person per enumeration district". Rose: "OKay, so how would I translate that to numbers". Rebekah: "The darkest is the most dense so."… Rose: "So I say .029 people living there?". Rebekah (laughing) "No" (general laughter). Rebekah "It's just to give a rough idea about the density and not the actual number…so it just gives you the density across the borough. "

Another group provides a hint to the proper way in which the population density information ought to be presented and calculated:

> Group 5 - 5 min. James looks at the population density map and explains his interest in this information. "One of the big arguments from Wandsworth society is over density because they have got rather loose wording in the UDP about density, 172/100 inhabitants per hectare is the figure they use which on all the river sites which are probably the most contentious things in Wandsworth, the densities permitted have gone up to 450-500 and it has been very difficult statistically to combat or draw comparisons with any other borough". Jeremy explains the problems with using census data which becomes increasingly outdated. Tim continues "The starting figure that the councils use is that they have a demand on them in the UDP for I think 10,750 houses to be built on all Brownfield sites and to monitor that is almost impossible for an outside organisation".

The availability of textual information through web pages that are associated with various locations on the map proved to be useful. The participants found the contact details especially interesting. In one case, an activist noted that the person who is mentioned as the contact name for the developer has shown up at the focus group about the site, presenting himself as a design director. The value of information and its potential use during public meetings receives participants' attention. Participants envisage a more proactive use of GIS – as in the suggestion that local activity groups should collaborate and integrate their information, before and while approaching the local authority. The experience of interpretation was mentioned during the group discussion:

> Group B - 30 min. James "It is interesting, it does make you … I was intrigued, if you would like to share your views about the railway stations and the tube stations - it does give you sort of a new dimension about how you think about the places in which you live and perhaps it will encourage people, of all kinds, to rethink about their environment and where they are and what

they do and how they can do it. Because that's what this sort of layered map begins to reveal in a more thematic way than the old traditional printed map. … The printed map is very, very good and I don't think it's a bad idea at all, but this made me think 'hang on, it is very interesting about where you can get to/from Wandsworth by using public transport' which makes people realise, made me realise that perhaps we should encourage more people to think about their transport options and therefore lead to less pollution, less congestion and so on. When they'll realise that they can actually go by something other than car. … and this kind of layered approach can make people rethink a little bit what their options may be".

4.3.2.11 Future Developments

The use of the GIS during the hands-on sessions provoked ideas about future uses of it. Some of these ideas have been exposed in previous sections. Participants suggested how a similar system could be used in "real world" settings.

> Group 5 - 19 min. Tim notes "I think that one of the future applications in the next four or five years is going to be to use this thing in public enquiries. There've been a lot of these in Wandsworth over the last four of five years and the great difficulty is actually producing maps on scale where everybody can [understand]". Jeremy asks if he sees it being used during the enquiry or as a preparation tool before. Tim explains that with the big screen projection that was demonstrated earlier, he doesn't see a reason why it shouldn't be used. James then explains "the problem with public enquires, is that we had a big public enquiry about the shared use of paths on Wandsworth Common and Tooting Common for bicycles and pedestrians if you remember, (went on for far far too long) … if we had been using maps of this sort I think there was so much contention between the parties that you would probably spend a lot of time fooling about: zooming in and zooming out and looking at things and not gaining that much extra information over and above the argument that was going on. I just think that is it going to be a great time waster in a public enquiry? Because who's going to operate the mouse, where do we move the map to and from. I got huge power now because I got the mouse in my hand, and you [Jeremy] got the second most power because you tell me what to do and you [Tim] has the least power. So in public enquiry terms that will be a very, very difficult kind of thing to operate - especially in an atmosphere that start with a contention between two different view". Tim adds "you could do it with your evidence in chief but it would be very difficult to be cross examined on it actually". James adds that as preparatory tool where the stakeholders use it to produce acetates that show their position will be a good thing - but without the opportunity to manoeuvre it. "Because once you start manoeuvring it, you are into real problems in relation to the politics of enquiries and people operating in enquiries… quite a lot of them do go at that sort of lines where people get there - because that is what public enquiry is about which is a good thing, I'm not against public opinion in that sense. This would be a terrific complication to an enquiry, I have to say". And Tim agrees "It would be impossible to handle cross examination with having to get examples on the screen each time to answer specific question". James adds "but I do think the information content within it is valuable. I think that that sort of, the concept of bringing the layers of information together I like very much".

Others stretched their imagination, and projected from their knowledge about computer capabilities. In Group 3, Elaine suggests to extend the capabilities by enabling users to add information by pointing to the screen and creating links and, in Group 2, Barry suggested the use of GIS in a way similar to "planning for real" in which users can add textual information about various locations on the map. Other, more sophisticated options were suggested during the group discussions:

> Group A - 37 min. Final comments - Rose explains that they would like to see scenarios, like the impact of putting in a one-way-system and follow that through "if a brownfield site was developed what the knock-on effect would be?" Jeremy mentions the idea of integrating viewshed analysis that was raised during the hands-on session to identify the buildings that block the view to the river. Rose explains that such capabilities will be useful to a local action group because they can argue "no, that couldn't work because X,Y,Z but how about this" and there by improving their voice over in the decision.

4.3.3 Discussion

After presenting the main themes that emerged from the workshop, there is a need to discuss their implications for the core issues of this thesis. In the following sections, the themes that emerged from the workshop are discussed within the context of similar projects (especially from the field of Public Participation GIS – PPGIS). The PPGIS literature provides more examples in which members of the public and activists in local interest groups interacted with GIS. As such, the PPGIS literature can assist in generalising and augmenting the findings of the workshop. This is needed within this thesis, when the outcomes of the workshop are used to depict a general picture of requirements and needs from PEIS.

4.3.3.1 Local Knowledge

The workshop demonstrated the importance of local knowledge and its influence on the way information is interpreted. Local memories, familiarity with specific areas and characteristics of local amenities - all were used by the participants during the discussion. Similar observations have been recorded widely in the PPGIS literature. Even the earliest papers that are dedicated to participatory GIS specifically (Harris *et al.* 1995) make an explicit connection with local knowledge by articulating this knowledge and transferring it into a layer in the GIS database. Other projects show similar activities to collect and integrate local knowledge (Alspach 1999).

This discourse is not unique to PPGIS. In fact, earlier discussions about participatory and inclusionary planning - from which the term "public participation" originates and was borrowed to form the PPGIS acronym (Obermeyer 1998) - have addressed these issues since the late 1980s (Tewdwr-Jones and Thomas 1998). Tewdwr-Jones and Thomas describe the use of the Planning for Real (PFR) method during the planning process of a sensitive area (Brecon Beacons National Park) in which a 3D model is constructed with the involvement of local residents, who use the process as an opportunity to express their opinions and put forward their interests. Later in the

process, participants put notes on option cards. This type of participatory planning was mentioned during the UBRN workshop by one of the participants. Kingston *et al.* (2000) provide an example of a web-based application that follows similar principles and was run in tandem with a Planning For Real exercise (Kingston 1998, Kingston *et al.* 1999, Kingston *et al.* 2000). Connected to these developments in participatory planning are the research projects that are most related to the UBRN workshop - those that have been carried out by Harrison and Burgess at the same period (Burgess *et al.* 1988a, Burgess *et al.* 1988b, Harrison *et al.* 1998). The common theme in these projects is the use of small groups to discuss environmental values and positions toward the environment - the local and the global - in such settings.

Using this background, and with an attempt to avoid redundancy, it is worth focusing on those elements that stem directly from GIS use. Local knowledge has a strong influence on map reading. This is strongly associated with the scale of the map and the area that is displayed on the screen. In zoom levels that fall below 1:10,000 there is a need for detailed spatial information to aid orientation. The use of skeletal street maps that become even less clear once zoomed in, forced participants to rely heavily on their knowledge and to project their "mental maps" on the generalised objects presented on the screen. This knowledge serves as a "filter" that, when combined with user perceptions and interests shapes the way the map is read and understood. The general shapes of shopping areas provided such an example - James, with his interest in cycling, could show the convoluted route to a specialised shop in the borough while Martin was aware of the cost of shopping at different stores, and the range of retailers in a specific area. This means that knowledge and interests form a filter that prioritises information - the information that participants would like to see, combinations between layers that are of interest to them and information that they would like to add.

An interesting aspect that emerges during the workshop is the interest and enthusiasm of participants in adding information to the system. Though the role of information in the decision-making process was questioned, even the strongest critic (Martin) admitted that the addition of local information is the most valuable exercise. There is a notion that by putting information in a shared environment, which is public, the information becomes more valuable. Adding information to a public system is a statement. By doing so, participants felt that their voices and opinions might receive some attention and can be integrated in the agenda. It is also viewed as a means to enable local groups to mobilise and concentrate their attention. As Carol describes it, this mode of use can be termed "proactive".

The workshop correlates with the findings in the PPGIS literature. As others have noted (Harris *et al.* 1995) the integration of local knowledge into a GIS is not a solved problem. It is more than entering textual messages that are attached to a location (Kingston *et al.* 2000). It might be that some combination of more complex arenas for argumentation (such those proposed by Horita 1998) offer a better solution. From the workshop it is clear that textual and contextual information are valuable.

4.3.3.2 Information - Accurate and Accessible

The use of GIS and the manipulation of geographical information raised many issues relating to participants' views about information itself. Broadly, the issues can be divided into errors and organisational/institutional. Following Burrough (1986), it is possible to identify 5 types of error with spatial information: currency (up to date-ness), completeness (area covered), consistency, accessibility (format, copyright and cost) and accuracy and precision (positional and attribute accuracy). Participants provided examples of, and noted, four of those types of errors (as consistency was not raised). However, the discussion of GIS within a social setting raised issues of power and trust, which are more organisational and institutional issues than relating directly to the nature of the information.

Participants were interested in the date of the information. The problem of dating GIS data sets, which has been long recognised by GIS researchers and users (Chrisman 1994) and leads to the development of standards, is seemingly more acute with lay users. The GIS does not provide any information that "gives away" details about updates and currency. Participants were also interested in knowing the rate of updates, where those updates come from and who provides the information. Naturally, this issue is strongly associated with trust and reliance on the information. In at least one case (with the analysis of the 1 km service area from tube stations), participants identified a completeness error. As traffic and transportation is a major concern that impinges on a lot of perceptions and interests about the locality and the environment (as the first part of this chapter demonstrated), this error was connected to the broader question of inter-area influence. Most of the problems that are associated with traffic in Wandsworth do not originate from within the borough, but are external. Participants were also interested in the spatial coverage of various data sets and questioned this aspect.

While consistency (at least in the way Burrough defines) did not receive any attention, the issues that fall under the accessibility category were considered very important. While in the GIS literature it has become relatively rare to read complaints about obstacles that are associated with file formats, interaction with a multimedia environment, where the end user faces multiple file types (image, text, video, GIS…), raises some obstacles for non-expert users. Wandsworth's website provided such an example. At a basic level, the site seems to provide the software to read the scanned documents. However, downloading and installing this software might prove too complicated for many. Furthermore, the design of the web page detracts from the reader finding the details that will assist him in this operation. The issue of copyrights and costs received similar attention. The participants seem to accept that the Ordnance Survey do not provide mapping information for free, while professionals and activists complain about it bitterly (Pipes and Maguire 1997). It seems natural that a map is a commercial commodity that cannot be redistributed without prearranged agreements. Participants were aware of the complexities involved in collecting and digitising geographical information and the skills needed (this is not surprising when considering previous experience and knowledge in mapping and architecture). However, access to funds for software and data was raised

as a major obstacle that inhibits the use of GIS within local groups. In this context it is important to note that success stories of local groups appear in the literature (Ghose 1999) though arguably there was a need for skills transfer and active engagement of professionals in such a process. Accuracy and precision was another area that participants noticed and noted. Spatial errors were identified, as well as attribute errors. The participants were active in marking errors when they identified them and felt that "they have the knowledge" to verify and validate the results. Again, following Ghose (1999), the workshop demonstrated that the local community have a much richer knowledge about their environment and, therefore, feel that they can provide a better validation. However, some of the issues about information move away from Burrough's typology and relate to the institutional context within which the information system operates and the power relations or struggle that is part of the activity of the local community, the local authority and other stakeholders.

The first of those issues is trust. Participants voiced different opinions about the level of trust between public bodies and local communities: some felt that in the particular case the local authority represents an enlightened one, open to the public, while others felt that many local groups simply do not trust them. The level of trust has a direct influence on the interpretation of information. The best example was provided by the discussion on contaminated land records. The feeling that this is valuable information with far reaching economic consequences means that there is an inherent suspicion of the body who holds and presents it. Participants voiced concern that "censorship" of information can harm political or commercial interest. When provoked, they preferred a system that is open for all and that serves as a public arena where all sides can expose their views. The need for a trusty facilitator for such a system (to avoid clutter and to keep it manageable) was raised too. Trust was connected to ownership of information and information systems. Participants wanted to learn about the ownership of the specific system they were using, and the information they explored.

A linked issue is the value of public information. At least one participant (James) offered the view that public information is problematic, as it is inherently valueless. If a value is attached to the information, then it will not be available to the general public. Other participants were interested in public information and wanted to find ways to access it. A very important aspect of public information was revealed during the workshop. Though most of the participants were "active citizens", only one (Martin) knew about the sources of the information that he observed, pointed to the documents it originated from and claimed that it is easier to obtain information from those documents. Others were surprised and intrigued by the information they saw. This aspect exposed an important issue about public information - most people do not know where to find and obtain specific information about their own locality. The ability to access public information in an integrated form, which is based on the locality was, therefore, beneficial. This provides another advantage of GIS: it reinforces the sense of location and enables the connection of "seemingly unrelated information" to a specific place.

Furthermore, this integration of information into a computer-based information system has an interesting effect. Unlike static documents (such as the UDP) where the answer for the question "will I find information about the old Queen Mary's hospital" can be answered unequivocally, the computerised environment provides a "black box" effect. In at least two cases, the participants searched for information; when they failed they did not declare "the information is not there" but "maybe it is not there". It might be there, but you simply don't know how to get it. This is a well known aspect of information systems as Landuar (1995) and others have noted. Another aspect of computer-based information is the ability to mutate representations and to organise it differently "with a press of a button". The idea that the information that is "hiding inside the computer" can be presented in different ways was raised by participants and "GIS experts" alike. Such an occasion was the display of mass-transport service areas which lead to questions about bus routes. In at least one group, this was followed by ideas of frequency of service in different stations and the level of service that various geographical areas receive. Accessibility of information is another issue noted by participants. While some praised the openness of Wandsworth, and the effort that they have made in putting planning information on the web, it became clear that the scanned documents are not really accessible. Putting aside the problems with viewing the documents, it is practically impossible for a home user to download a multi-page document from the system while staying on-line using a modem. Finally, noteworthy is the issue of information overload and the problems associated with finding accurate and relevant pieces of information. Kevin provided the best sound bite: "It's just like the BBC website, they got three-quarters of a million web pages, who does that? Why?"

4.3.3.3 Interactive Mapping and Exloratory GIS

The design goals of the brownfield GIS (see section 3.6.1) described a tool that goes beyond a mere data repository and provides some SDSS capabilities. However, as the system was developed using a standard GIS package, without any dedicated effort to build into it the capabilities that are expected from an SDSS (for example, those suggested by Densham 1991) it is wrong to define the system as an SDSS. Furthermore, though all the analytical capabilities of a modern GIS package were accessible to the experts, they were not used in the course of the workshop. Some of the data layers (particularly the service area analysis and the flood plain model) demonstrated these capabilities though not in real time. Therefore, it is accurate to describe the system as an "exploratory GIS" or a "Discussion Support System". A similar concept was offered by Jankowski and Stasik (1997). Such a system enables users to explore the characteristics, options and alternatives of a specific problem domain. To do so, the system integrates some SDSS capabilities - a collection of relevant data sets and the capabilities to run analytical models. Such a system is then used in the course of a discussion or deliberation, and serves as a visualisation arena around which the participants can express their views and opinions. This mode of use is akin to the Nicholas Negroponte concept of "tools to think with for the world at large" (Bennahum 1995). The focus in this application of GIS is not necessary on its geodetic or analytic capabilities (although they do play

a major role), but rather on the visual and contextual exploration of the problem situation and issues connected to it. This mode of use relies heavily on GIS capabilities to work "at the speed of discussion" (as one of the participants described it) and the ability of the expert user to understand, facilitate and perform the analysis on the spot using the full toolbox of GIS capabilities. Recent changes in the field of GIS have enabled such applications. Traditionally, data collection and collation is considered one of the most complex and expensive tasks that relate to the creation of a GIS (Huxhold and Levinsohn 1995). However, this situation is rapidly changing - at least for certain types of applications and activities[8]. The availability of digital data sets and the ability of commercial software to integrate them easily was predicted in the early 1990s by Batty (1993) and it can be argued that we have entered this era of easier and faster collation of data-sets.

Another aspect is the increasing capabilities of desktop GIS and, in particular, the integration of multimedia with GIS. This started during the mid 1990s (Craglia and Raper 1995). Soon after, GIS vendors started to integrate multimedia capabilities into their products. However, such integration was somewhat awkward and the multimedia functionality was usually limited. The introduction of the WWW as a medium that is inherently multimedia-based followed soon after and changed the way in which multimedia is distributed and organised. It is important to note that environmental applications of multimedia GIS have used the precursor of the web environment - the acclaimed HyperCard (Fonseca *et al.* 1995, Shiffer 1995). However, the web browser which is now part of any operating system makes the task of integrating multimedia into applications far easier. In some cases, the whole GIS application is integrated into the web browser, for example, Kingston *et al.* (2000) discussed an application that is more akin to traditional GIS, while others (Brown 1999, Doyle *et al.* 1998) discussed the potential of integrating other multimedia forms with web-based GIS. In the case of the brownfield GIS, the capabilities of the web browser and the WWW were used to integrate multimedia and information held in remote servers to augment the capabilities of the basic software package, without "struggling" with the limited multimedia capabilities of the specific software.

The workshop provided insights into "exploratory GIS". In all groups, the changes in scale in the GIS environment - the seemingly ubiquitous operations of zooming and panning - clearly changed the direction and content of the discussion. Such operations focused attention on specific areas and, as a result, provoked different responses, associations and ideas from participants. While the GIS database is seemingly "objective", the responses are clearly subjective. For example, the attention of participants on buses and bus routes is not surprising, when considering the importance of this mode of public transport in south London. A likely hypothesis is that if a workshop had focused on one of the northern boroughs of London, where the underground is the

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[8] Also for certain organisational settings. It is important to remember that the brownfield GIS was developed inside a university and research group that have already collated massive amounts of digital geographical information.

main public transport, buses would not receive such a priority. Scale was a connected issue, as participants turned from the general pattern of accessibility to the specific locations of bus stations they use. Furthermore, the workshop exposed the relationship between scale and personal interests and objectives. For the activists who are interested in cycling, the area of the local borough is but a part of the network that criss-crosses London. For those who are interested in local planning, the borough boundary is the appropriate scale, while for the Gargoyle Wharf activity group the surroundings of this specific site form the area of interest.

The participants also exposed the importance of interactivity including the ability to change and manipulate visualisation, juxtaposition of various data themes and the speed with which such operations happen. Connected to it is the sense of playfulness of computer use and the sense of exploration that this activity conveys. Noteworthy is the association with computer games (SimCity), 3D visualisation environments (Active Worlds) and participants' requests for what-if scenarios. The need for integration of near real-time models that are common to planning activities (for example traffic or air pollution) is, therefore, not surprising. However, participants noticed the other side of the coin - the danger of playing with the technology and the information without reaching any conclusive decision. The discussion in Group B concluded that the use of full-fledged GIS during public enquiries may prove too risky and may result in complicating the problem situation instead of improving it.

4.3.3.4 Skills

The use of relatively unchanged desktop GIS exposed the difficulties that are associated with commercial GIS use, even in advanced, GUI-based environments. There is no doubt that the use of GUI is improving the accessibility of computers (Preece 1995): even novice users which were exposed to computers and GIS for the very first time have managed to use it for basic operations. This can be attributed to the GUI, as such a short session with a command line-based GIS would not get very far. However, participants, even those with extensive computer experience, felt that the product they are facing is complicated and sophisticated and requires a long learning curve. On the other hand, the operations that they were asked to perform with the GIS were quite sophisticated and, in practice, will require the full capabilities of a GIS package. These include overlay analysis, sophisticated symbology, network analysis and so on. The complexities involved in GIS use were identified a while ago (Davies and Medyckyj-Scott 1996, Traynor and Marian 1995). They include the relations with multiple domain knowledge (database, drawing, cartography and so on) and the workshop has demonstrated that these features are still embedded in modern, GUI-based GIS. While such systems provide a productive and relatively easy to use environment for a professional, it is almost impenetrable for occasional users. As was noted, local activity groups find it difficult to obtain and maintain skills within them - especially with the voluntary basis on which they operate.

Intriguingly, participants have expressed the common opinion that computers will become more accessible for younger generations. A counter argument can be raised about the need to maintain computing skills. It is easy to imagine the complexities that face someone who has not been using

computers on a regular basis for a long while (two or more years) as was exemplified by one of the participants. However, it must be assumed that the "techno-fear" that Martin has noted will not be as prominent as with someone without any experience. If something is known about computers it is their alien ways of operating and as Paul noted: "they were designed by geeks and not normal people, they're people like Bill Gates, he's not of our planet…". The skill required from a GIS operator or user go beyond computer literacy. An almost implicit (and trivial) assumption is the expectation that the user can read and interpret maps. More often than not, GIS maps are abstract and require some manipulation in order to annotate them. The need for rapid changes of scale requires change in annotation detail, character size and so on. Though automatic solutions for this are available, they are not common in basic commercial packages. Even if these capabilities are available to occasional users, map reading might be a scarce skill within disadvantaged communities. Participants have noted this major shortcoming and suggested the use of more accessible forms of spatial information, such as 3D models or aerial photography.

Finally, there is a problem that is more general than map reading - the accessibility of English-based information in an inner city environment where some of the communities do not speak it. The use of information systems, computers or maps requires language skills that disadvantaged communities do not posses. This is a general problem with information systems and computers that receives attention not just in the local context, but also in the global one (Wresch 1996). This issue receives more and more attention (Shneiderman 2000). Even so, it is expected that it will remain problematic in areas which do not receive the resources and attention of commercial activities.

4.3.3.5 Exclusion

Stemming from the issues that were raised earlier is the problem of exclusion. Participants felt that the use of computer-based information systems would exclude certain segments of the population. Groups that were particularly mentioned were low income groups, the elderly and disadvantaged communities. The participants were especially aware of the cost involved in connecting to the Internet and maintaining the connection. Clearly, metered access is a source of concern and prevents extensive use. Participants were also concerned with the time that it takes to perform operations on an Internet-based system.

4.3.4 Summary

The UBRN workshop illuminated various aspects of the use of environmental information by active citizens. A few aspects deserve special attention in the broader context of the research and will be examined here. First, the participants discussed "pure" environmental issues (such as air pollution) only rarely. These issues were connected to other aspect of local life - transport, parking, shopping and so on. The specific interests, knowledge and points of view are used as filters that influence the information in which the individual is interested, and the ways a user reads and understands information. Second, the workshop provided another explanation for the importance

of GIS for visualisation and interpretation of environmental information, especially in a lay user context. The comment about GIS ability to integrate "seemingly unrelated issues" is of special interest. Of course, in geographical terms, those issues are anything but unrelated - they all relate to the same area! The GIS provides a certain bridge between the issue-based, reductionist view of the world that is used to manage the environment by authorities and other modern entities, and the place-based knowledge of local communities. This is a toll bridge in the sense that it requires the ability to read and understand maps, and the ability to operate computers. Third, the workshop raised the importance of trust, ownership and power relationships that are attached to information and influence the way in which it is consumed and interpreted. Participants raised concern about the ability of politically driven bodies (local authorities) to provide information openly and completely. Such bodies will have to build trust and prove that they do not hide or manipulate the information they provide to the public. However, the Internet seems to be an appropriate medium for the delivery of "solid public information", given that it is provided by a trustworthy body. Fourth, participants demonstrated the difficulties that a lay audience has to confront while trying to obtain information. Though the participants were active citizens and familiar with the local context, some of them did not know where to obtain the needed information. Finally, the communicative aspect of information provision should be noted. This includes the action of entering information to the system, leaving comments on a website or engaging in a communication process by using contact names, telephones and other communication means.

4.4   COMBINING THE EMPIRICAL STUDIES

In the course of this chapter, the issues surrounding public access to environmental information have been explored and examined through empirical studies. In this section, the main aspects that emerged from both studies are summarised. Firstly, users of PEIS are anything but a monolithic entity. They are made up of various groups with multiple interests. Even within a single user group, it is possible to identify different perspectives and interests according to life style, actions and activities. The survey demonstrated the multiple identities that are used when information is accessed. During the workshop, even though participants were recruited through local activity groups, they have not used this "group" identity all the time. Interest in various environmental issues were expressed from personal perspectives and only rarely was a group's identity ("We, in the cycling campaign…") raised. These interests operate on different time scales - information that a commuter is interested in is needed daily while action related to house location is needed only once in a while. The survey is particularly revealing in this sense (Table 4.3 and Figure 4.3). This fragmentation of perspectives and identities leads to different "filters" for environmental information. The workshop showed that local knowledge and memories are added to pronounced interests and make these filters even more personal. Secondly, the studies demonstrated that these users have a personal definition of what constitutes environmental information. This is not surprising, when considering the confusion that Chapter 2 explored. In the survey, the most vivid demonstration is Table 4.4 - respondents mentioned issues like "light pollution", "art and culture"

and "Globalisation" as topics that are relevant for EIS for London! The workshop participants demonstrate a similar range of topics - sports activities or nurseries were mentioned as elements that are relevant for the system. Another aspect was attention to current topics. During the survey, the issue of food, which received a lot of attention in the media at the time of the survey, was noted by respondents, too (Table 4.4). Scale makes the concept of environmental information even fuzzier. During the survey, respondents addressed issues that range from the very local to the global. This was also apparent during the workshop, where some were interested in a specific site, others had interests that correspond with the borough boundary, and a further group were interested in a London-wide scale. Thirdly, both studies exposed two types of information consumption - action related and general. Action related information is gathered to perform a specific action. Such action can be simple - finding and using a recycling centre - or complex, as in opposing a proposed development. This type of information use can be translated into a defined task and an information system can support it relatively easily. The second type of information use seems to be at least as common. This general pattern of consumption can be labelled as the need to know "what's going on". Such information does not necessarily lead to specific action, and is probably used to build a picture of the world in which one lives. Although this type of information is provided by the media, providing it through an information system is rather a difficult task. Fourthly, the users of environmental information prefer interpreted and rich information. They are less interested in the raw data and want to see text and illustrations that explain environmental issues. During the workshop, it was shown that there is an urge to learn more about information sources and their meaning. A connected issue is trust: the content, representation, currency of information and ownership of the data and information systems all influence the trustworthiness of environmental information. Two other issues are the costs of information and the skills needed to obtain and use it. Fifthly, environmental issues are perceived with a strong local and place-based perspective. They are treated as an interconnected web of topics and issues - an holistic view that is somewhat reminiscent of the concepts of regional geography. This holistic view and strong local interest provides another explanation for the advantages of maps and GIS interfaces for the delivery of environmental information. GIS provide a platform to integrate various themes using the spatial element and, by so doing, connect "seemingly disconnected things". Finally, when considering a delivery mechanism for PEIS, the Internet is generally accepted as an appropriate medium. Both studies show enthusiasm toward the possibility of accessing and using systems over the Internet; however, such use cannot be made uncritically and there is a need to tackle the social exclusion that might result. Another worry is the cost of such service, as the costs of metered access put a price on the information. Personal skills are another issue and the need to establish some public facilities (like libraries or town halls) as access locations was raised. In the next chapter, the findings of the empirical studies, and the supporting literature that was used to support them (such as the information about general public attitude to environmental problems, or the PPGIS literature), will be used to develop a comprehensive picture of the PEIS arena through the use of SSM tools. By so doing, the thesis moves to the core "system thinking phase" of the study.

# 5 Conceptual Models of Public Environmental Information System

5.1 OVERVIEW

The current chapter brings together the political, social and organisational aspects of access to environmental information. This synthesis provides a coherent picture that summarises the findings of the thesis, explains the connections among the various streams and develops conceptual models of PEIS. Within the main theme of this thesis – development of a coherent conceptual model of PEIS that can be used to improve the delivery of environmental information to the public – this chapter serves as the main analytical part where the findings of the thesis are synthesized and developed. As is noted throughout, Soft Systems Methodology (SSM) is the framework for this thesis. In this chapter, this framework becomes explicit through the use of SSM tools: the rich picture, root definitions and conceptual models are all developed here. Towards the latter part of this chapter, the question of a universal conceptual model - a model that provides a general description for PEIS - is raised. Though such a model is possible, it is of questionable value. Instead, a generalised model of production and consumption of environmental information is offered. Finally, and in order to set the ground for the next chapter, criteria for evaluating existing PEIS are developed. These criteria are based on the conceptual models and other findings of the thesis. Larger, colour versions of the main figures in this chapter are included in Annex II.

5.2 UNDERSTANDING PEIS

In the following paragraphs, the arguments and insights of the thesis are examined using the "rich picture" device. As was noted in section 3.3.2.1, a rich picture is a graphical representation of a problem situation and is intended to represent complex relationships in human activity systems. Graphics and pictures provide an excellent medium for examination of the situation in an holistic way, while depicting the multiple interacting relationships among groups and individuals (Checkland 1999). In the case of PEIS, the description of the situation comprises of four sub-pictures. This separation makes the pictures more comprehensible and easy to read. The first picture expresses the position of environmental information in the broader context of environmental politics. In the second picture, the focus turns to environmental information systems - the information that they hold and the factors that influence their operation. The third picture provides the context for public access to environmental information and its use, while the final picture provides a closer look at WWW-based PEIS. Figure 5.1 depicts the relationships among the pictures.

Picture 1: General overview of environmental information and its use.
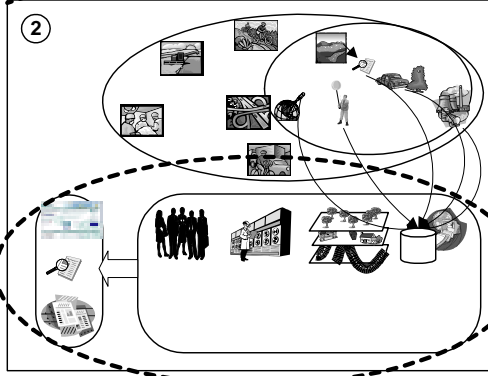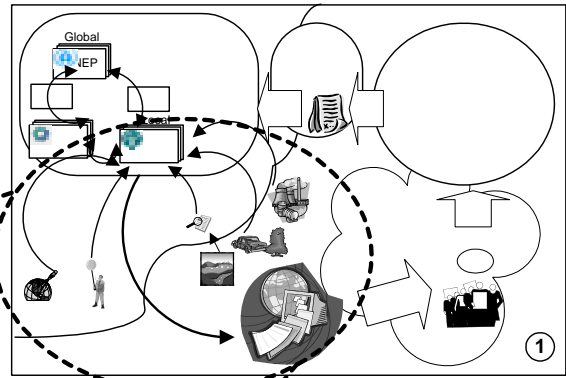
Picture 2: Focus on environmental information systems and the information they contain.
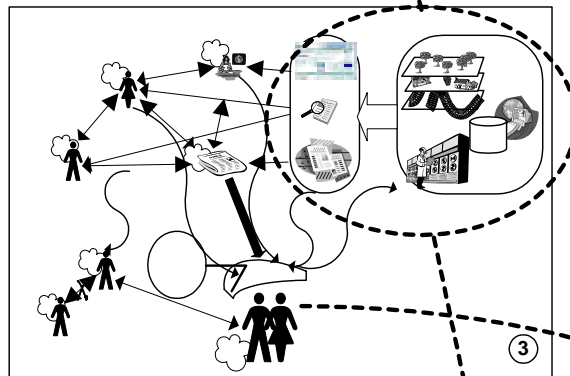
Picture 3: Public access to environmental information and distribution channels.

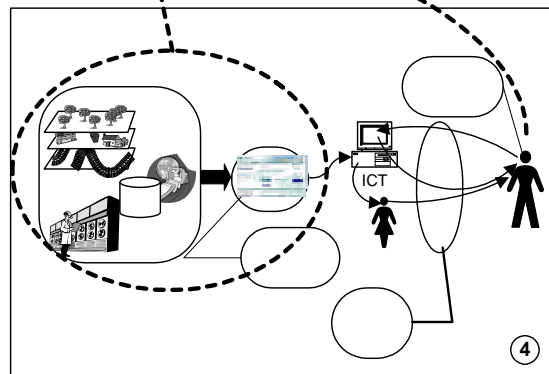Picture 4: Public access to environmental information systems.

Figure 5.1 - The four rich pictures and their relationships (see colour version in Annex II)

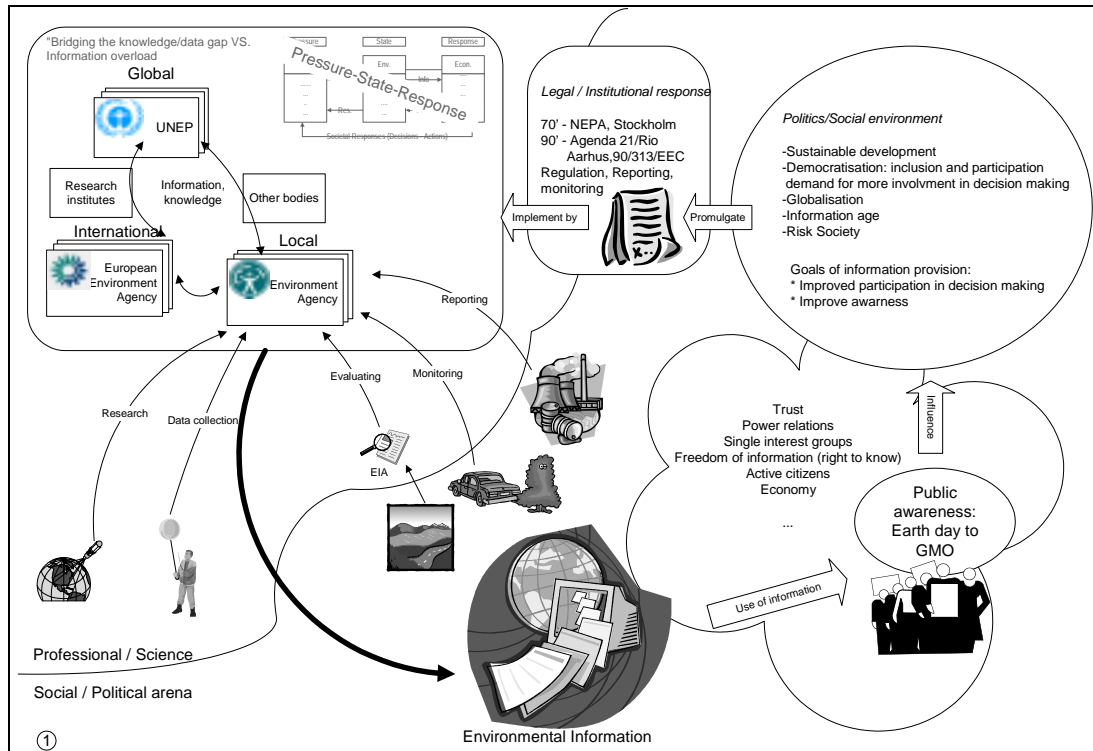### 5.2.1 The Context of Environmental Information (Picture 1)

Figure 5.2 - Picture 1: The context of environmental information (see colour version in Annex II)

Picture 1 (Figure 5.2) depicts the societal and political context surrounding the production and consumption of environmental information. The knowledge and information gathered on environmental conditions become public knowledge and awareness. Throughout the history of the environmental movement, there are examples aplenty of topics that gain a place in the public agenda and subsequently influence the political one. The activity that led to "Earth Day" is connected to the development of environmental laws; many others issues derive from it - including acid rain, the hole in the Ozone Layer and, at the time of writing, global warming and the use of Genetically Modified Organisms. The social and political atmosphere influences the modes of action. Hence, some of the issues that form the background for environmental activism are presented. These include the activities of a single interest group, the notion of active/inactive citizens and several other issues. This list is by no mean exhaustive, but is intended to raise some of the issues that are most frequently mentioned in the context of environmental politics.

This social atmosphere and action, in turn, lead to changes in the political arena. Several factors or trends have influenced the political and social environment in the last few decades. These trends, or influencing concepts, are listed in the upper right "bubble". Of the various "buzz words" that describe current transitions in the social sphere, I have listed those that are most relevant to PEIS. These include:

- the concept of "sustainable development" as a framework to integrate environmental considerations with economical development;

- the move to "modernise democracy" and a more participatory and inclusive mode of decision making;

- the economic transition to globalisation and the interaction between local (governments) and global (corporate) entities;

- the notion that Western society is entering the "information age" and that information and knowledge are crucial elements of the economy. The most prominent sign of this is the rapid growth of the Internet in the second half of the 1990s; and

- the growing notion of a "risk society" that provides a possible explanation for the precautionary principle which has became commonplace in environmental discourse.

This wide range of societal and political concepts forms the background for current developments and trends in the provision of environmental information to the public.

The two main declarative goals behind information provision are also presented. As was demonstrated in previous chapters, information provision should improve participation in decision making and improve awareness. These concepts appear in documents that are the outcome of political and social activity. In terms of long lasting influences, it is possible to view the legal documents that have been promulgated as an institutional response to social pressures. These responses are presented in the next "bubble". A sample of major conventions, agreements or acts is presented. These include mandatory reporting and evaluation, creation of specialised programmes for monitoring environmental conditions, research and so on. To implement these outputs, various bodies were created. These bodies exist on all scales - from the global (with the likes of United Nations Environmental Programme -UNEP), through the international (the European Environment Agency – EEA - serves as example for those) to the local level. Of course, there are more and more bodies as we move down the hierarchy. Though the Environment Agency is used as an example of local bodies, it must be noted that this level includes local authorities' environmental officers and even site-specific environmental officers. However, these specialised bodies are not the only entities involved in the production of environmental information. Research institutes of all sorts play a pivotal role in developing environmental knowledge. Such research bodies include NASA, with its earth observation activities, and the British Antarctic Survey that was pivotal to the Ozone debate. Other bodies that are involved in the creation of environmental information include, among others, private consultants (for example, Environmental Impact Assessment specialists) and companies that specialise in the development of monitoring devices or in running monitoring systems. These various bodies are engaged in continuous interactions and transfers of knowledge and information. Such transfers are by no means ideal or optimal. The two main concepts that influence the operation of these bodies, are the Pressure-State-Response framework and the growing notion of information overload, side-by-side with the urge for more data. The ways in which these bodies obtain environmental information is described in the lower half of the picture. The information is collected through:

- mandatory reporting (as with polluting chemicals and the Chemical Release Inventory);

- monitoring programmes - for example, the cross EC air quality monitoring network;

- evaluation of environmental conditions, such as Environmental Impact Assessments or "state of the environment" reports;

- data collection that is part of research activities - meteorological or ecological observation; and

- finally, research projects are another source of environmental information, though not always complete and comprehensive (as many projects focus on specific study areas).

The information that these bodies produce is getting back to the social/political arena (see Picture 3). The final element of Picture 1 presents the separation between the professional and scientific environment, within which the environmental information is produced, and the social/political one. This separation is, of course, artificial in the sense that the bodies that create and collect environmental information do not exist outside the social and political realm and do not operate in an objective way.

5.2.2 Environmental Information Systems (Picture 2)
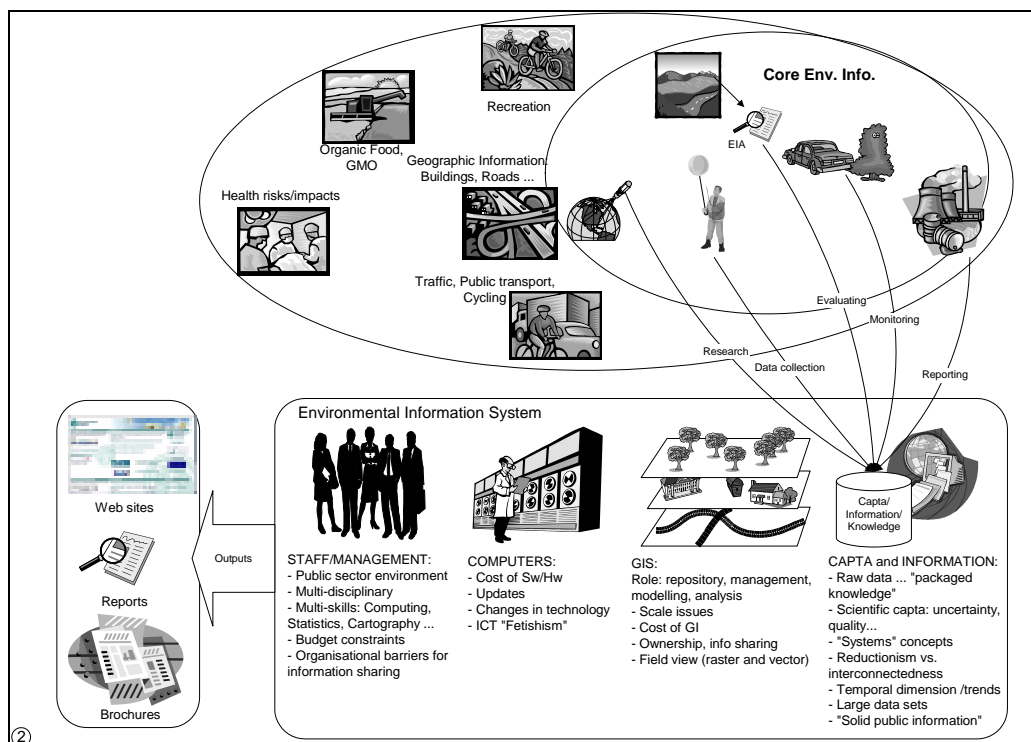
Figure 5.3- Picture 2: Environmental information system (see colour version in Annex II)

Picture 2 (Figure 5.3) examines aspects of environmental information systems (most of them are discussed at length in Chapter 2). The picture comprises of three parts - the input to the system, running and operating EIS, and its outputs. The elements of environmental information that were presented and discussed in the previous picture can be termed "core environmental information" - they form the traditional content of EIS. However, this core is surrounded by a wide range of

topics that are considered by some to be environmental information, but not by others. This includes Geographic Information (especially in digital format) about the built and natural environment; information about public transport, traffic and alternative transport means; information about recreational activities; health related information or information about food production and content. Of course, these topics represent part of the range of topics and it is likely that there are other aspects which are considered as environmental by some.

The main part of the picture deals with EIS aspects, grouped into four categories. However, these four categories should be seen as facets of the same object, and there are links among them. The content of EIS is, very often, a mix of raw data side-by-side with detailed explanations that include text and images (the next chapter provides examples). Hence, it is a mixture of capta, information and packaged knowledge. This content comes from scientific capta - capta that was collected using scientific methods. This element makes it necessary to deal with uncertainty, quality, accuracy and predictability and their propagation into information subsequently derived from this capta. Another element that is relatively common in environmental research is the "systems" concept and the view of the various factors as interconnected and influencing one another. At the same time, the use of environmental science, with its multiple disciplines, encourages a reductionist view of information. As a result, air pollution information is separated from water pollution capta or ecosystem capta. Another element of the data is its temporal dimension and the emphasis on trends. This, and the use of spatial information, lead to the need to confront large data sets.

The spatial element of environmental information promotes the use of GIS as a pivotal tool in EIS that serves many roles. Historically, GIS started as a repository for environmental information. It then evolved into a management tool with modelling and analysis capabilities added or connected to it later. These developments reinforce the role of GIS within EIS and introduce several topics in EIS. First, there is a need to address scale issues, from the definition of the study area to decisions on data collection. Geographic information is notoriously expensive and it adds to the overall costs of EIS (Rhind 1996). The field view (the analysis of phenomena as continua across space) that is common in environmental science makes the raster data model important for EIS. Finally, the need for integration of multiple data sets makes information sharing and institutional co-operation an important issue in EIS. There are technical barriers to integration (such as file formats) alongside organisational ones.

Capta and information are stored in digital computers. The use of ICT brings with it several specific issues. The continual updates and changes in technology combine with the costs of software and hardware (which despite increases in their functionality and capacity, do not drop dramatically over time) to make it expensive and difficult to maintain an operative EIS. There is also a continual need to follow changes in technology and to adopt existing systems to these changes. Such changes include the move from central, mainframe computers to distributed computing and from text-based terminals to the multimedia environment of the WWW. The use of

computers and recent technology is sometimes attractive enough to become an end in itself, what has been termed "ICT fetishism".

EIS are usually found in the public sector. This imposes budget constraints that influence data collection, information sharing and the ability to hire and maintain highly qualified personnel. This problem is aggravated by the multi-disciplinary nature of environmental problem solving. The range of skills that are required for operating EIS encompasses computing, statistics, cartography and knowledge from the appropriate domain disciplines. EIS are used to produce a wide range of outputs. These include reports for decision-makers, brochures for general use, websites, press releases and other outputs. It is important to note that the current "working assumption", as expressed in the Aarhus convention and similar documents, is that environmental information will be mainly stored in computerised systems.

5.2.3 Public Access to Environmental Information (Picture 3)
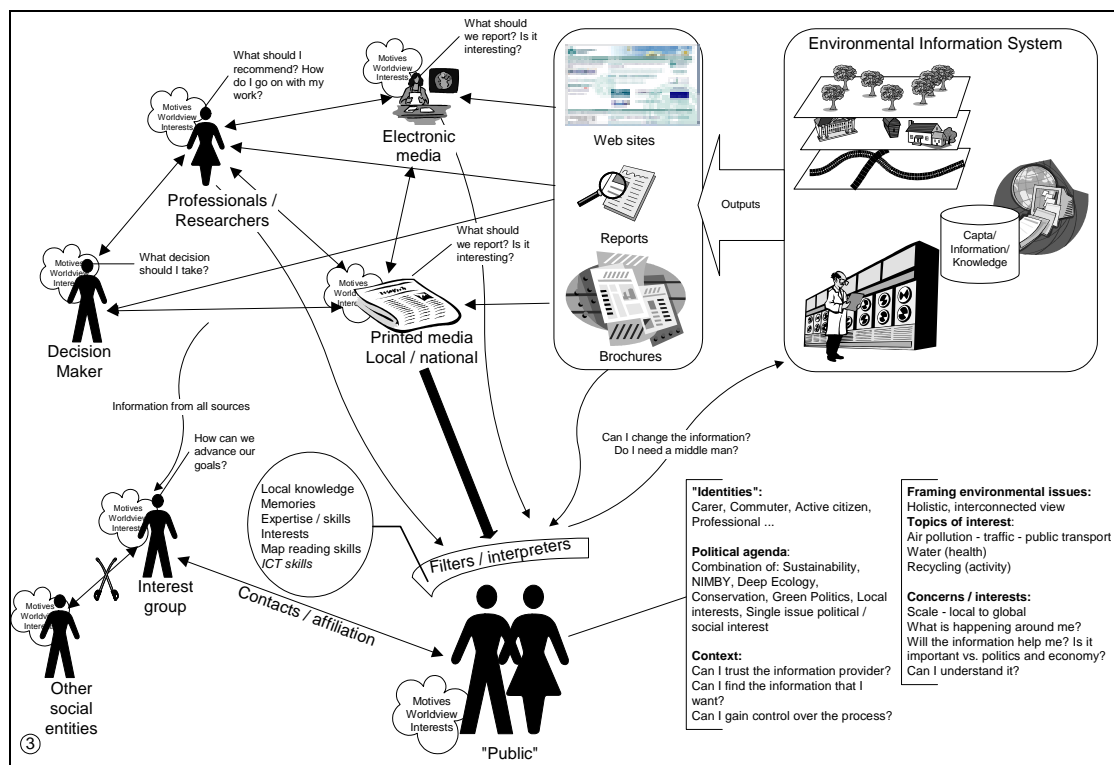
Figure 5.4 - Picture 3: Public access to environmental information (see colour version in Annex II)

The information that is released from EIS in various forms reaches several "user groups" that are effectively "information brokers" from the point of view of public users. Five "typical" users are identified in the picture. The first two are electronic and print media. They use environmental information in their "news" gathering and select information and packages to reflect their perceptions of their audiences' interests and concerns. Two other user groups are professionals, or researchers, and decision-makers. Professionals can obtain information as part of their job - for example, when an official is scrutinising an EIA. Sometime, information is produced and used by other researchers or professionals. The brownfield GIS (see section 4.2) serves as an example. It

was developed by researchers who reported to a professional environmental body (the Environment Agency). Decision-makers might use information that was prepared for use during the decision-making process, or ask for specific information. The fifth type of user group consists of the various interest groups - it can be a national environmental Non-Governmental Organisation such as "Friends of the Earth" (FoE) or a local community group. Finally, any information that is publicly available can be accessible by any member of the public. It is important to note that even though the producers of information sometimes package it with a specific user group in mind (such as a scientific report prepared for "internal use"), it does not mean that the information will be used by the designated users or that other users will not pick it up. Furthermore, the packaging of information in a specific way does not guarantee that it will be interpreted and reproduced in the way that the information creator intended. The various groups transfer information amongst them: a professional might receive a report and pass it on to a journalist, who will publish it; and an interest group might come across an opportunity to obtain environmental information and publish it (as happened when FoE obtained and published the Chemical Release Inventory). Of all these sources, printed media is the major source for a "general public user".

The public user receives information from all these sources, but uses a set of filters or interpreters in the process. The main filters that have been identified include knowledge (with the special importance of local, or place-based knowledge and memories), expertise and skills. Two crucial skills are map reading and the ability to use ICT. Interests and concerns form another set of filters; these are expanded in the lower right part of the picture where six groups are identified. Different "identities" are used toward environmental information. These identities are used in relation to a topic, life history and condition. The London Environment Online survey identified the identities of carer, commuter, active citizen and professional. However, it is reasonable to assume that other identities exist.

The framing of environmental problems is in an holistic and interconnected manner. Environmental concerns include issues that are local (some can be classified as "Not In My Back Yard" - NIMBY) to interest in global issues such as global warming or biodiversity. The survey textual responses demonstrated that topics of interest relate to different aspects of everyday life. Transport and traffic are part of daily activity (work, school run, etc.) but also a source of air pollution which is, in turn, a source of health concerns. Water quality is also part of health concerns. There are other interests that relate to the ability "to do your bit" for the environment - such as recycling. Finally, there is general interest in knowing "what is going on".

Five types of environmental activities were identified by Castells (1997) that form the grounding for concepts and political action that influence the interpretation of information. It can be assumed that a personal position toward a specific environmental issue combines different positions. The political action is carried through single-issue political or social interest groups. The alliances, contacts and affiliations between interest groups of an individual can change between topics, too.

Finally, the use of environmental information must be seen in the broader context of social and political activities. The decision to search for information is based on perceptions about the value of information (will this information help me in achieving my goals?), the likelihood of finding it, trust in the information provider, the ability to understand and use the information once it is found and the weight of the information and its relevance to the social, economic and political process (such as is the case with environmental information in planning applications).

The involvement of individuals in interest groups provides them information obtained by other members of the group. Such groups are usually formed to advance a specific set of social and political goals. Naturally, there are other social/political/economic entities with which such groups are debating and might be in conflict. Each group can collate and use environmental information according to its own "filters".

5.2.4 Web-based PEIS (Picture 4)
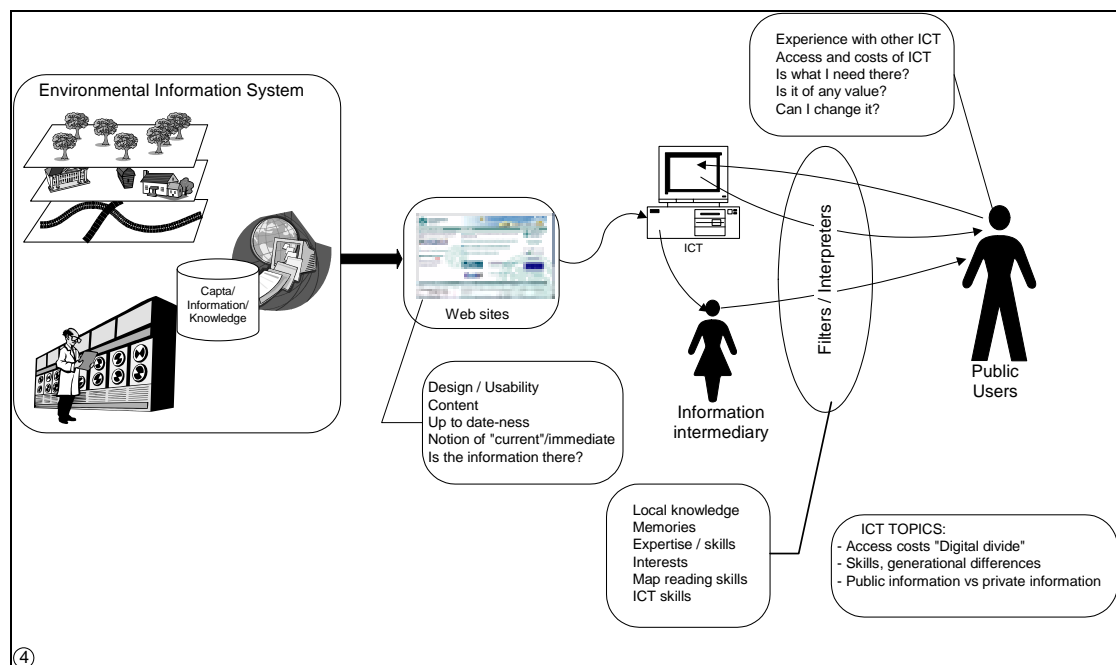
Figure 5.5 - Picture 4: Web-based PEIS (see colour version in Annex II)

Picture 4 (Figure 5.5) extends Picture 3 by focusing on specific aspects of web-based PEIS. The use of ICT adds to the set of skills that are required from anyone who may want to access the information. Experience with other websites or information systems influences the ways in which the user perceives the information on the specific systems. The use of computerised EIS by end-users who are not experts raises issues of usability and design of system interfaces. Another aspect of such exposure is the need to adapt the content of the system and its representations to users' needs. Noteworthy is the message of "currency" and up-to-date-ness that such systems convey to their users. A related issue is the "black box" nature of computerised information systems, as many times it is not clear if the information exists in the system or not. From the user point of view, the skills and costs of ICT make it sometimes necessary to use "information intermediaries" to

overcome technical difficulty. Such middlemen can be librarians or even a teenage daughter with ICT skills.

Modern computers convey a message of interactiveness: the ability to change and update the information stored in them. At least some of the expectations from web-based PEIS is to enable end users to change system content and add to it. By doing so, the system is turning from an information repository to a communication medium.

A few other topics that are general to ICT are presented in the lower right corner - the discussion about the "digital divide", the generational difference and its influence on skills, the costs and accessibility of public and private information and the ability to access them through the WWW.

5.3   DEVELOPING CONCEPTUAL MODELS

The series of "rich pictures" that the previous section explored are intended to summarise the essence of the arguments that were developed in the course of the previous chapters. They prepare the ground for the development of conceptual models of PEIS. It is worth remembering that in SSM models do

> "not purport to be representations of anything in the real situation. They are accounts of concepts of pure purposeful activity, based on declared world-views, which can be used to stimulate cogent questions in debate about the real situation and the desirable changes to it. They are thus not models *of…* anything; they are models *relevant to debate* about the situation perceived as problematical. They are simply devices to stimulate, feed and structure that debate" (Checkland 1999, p. A21).

The following models are developed using the devices that were developed as part of SSM. First, the CATWOE elements are identified. Using these, root definitions are developed and explained. The root definitions form the basis of the models.

All the models are subjective and tentative. They present my understanding and analysis of the situation. Other models (and points of view) are possible. However, I have tried to represent the major positions that were identified in the thesis so far and to ensure that they resonate views that were expressed in the existing literature. Some of the models are generalised in the sense that they describe a type of model that can be developed. When I have done so, I have stated that and pointed to the directions in which sub-models can deviate from the generalised type. The main reason for choosing to do so is an attempt to suggest the range of possible models to enable comparison and discussion. None of the models is "right" (i.e. other models may exist), though they are "correct" in the sense that they represent a stated approach to information provision and access. As it will become clear, the models do not provide direct answers to the question "what is the conceptual model of PEIS", but rather put PEIS in the context of purposeful human activity.

In the following sections, seven models will be developed:

1. The Aarhus model - a model that follows the declarative stances on environmental information provision and may be seen as the institutional model of PEIS.

2. Special interest groups (NGOs) model - these groups are pivotal in the activities that lead to PEIS use. This is a generalised model for an "archetypical" NGO.

3. Media model - the media are the key conduit in the delivery of environmental information to the public. As such, the perspectives of this group are important when considering PEIS, even if they are not the immediate intended users.

4. Professional/environmental authority model - this perspective describes a model as seen by those who provide information on a daily basis. The point of view that was selected is of the professionals that provide the information.

5. Interested citizen (NIMBY) model - while the special interest group model represents the position of those who are active within them, PEIS is aimed to provide a wider range of aims and objectives. The NIMBY position, though usually regarded rather negatively in the literature and practice, should be considered a legitimate worldview for PEIS use.

6. Interested citizen (active) model - although many active citizens choose to channel their activities through NGOs, it was deemed appropriate to develop a model of the individual perspective because it provides an opportunity to expose local issues.

7. Interested citizen (general interest) model - as the survey and the workshop showed, interest in environmental information relates to the notion of "knowing what's going on". This model addresses this need.

Together, the models cover the scope of the main purposeful activities that have been identified in this thesis and to which PEIS should respond by providing appropriate information. There are other possible models and those are examined briefly at the end of this section.

It is important to note that all the models have been developed with a focus on the issue of public access, assuming that the political and professional bodies accept the Rio and Aarhus principles of information provision and public participation. The reason for adopting such a naïve approach to the political system is to demonstrate that even in situations where the political and social power structures do not operate to block access to environmental information, there are complex issues that must be confronted if effective and efficient PEIS are to be developed.

5.3.1 The Aarhus Model

The Aarhus convention on public access to environmental information was used throughout this thesis as a recent reference to the emerging statutory obligation for public access to environmental information. Therefore, the "official" root definition - a model that presents the declarative stance of public authorities toward PEIS can be named after the Aarhus convention. However, the model

is not based on the Aarhus declaration alone. Other sources, like Agenda 21 and the Rio declaration provide views that fall in line with the views expressed in the Aarhus convention.

Table 5.1 - CATWOE for Aarhus model

Clients	Public
Actors	Public authority, public officials, NGOs, public
Transformation	Public involvement in environmental decision making → participation in decision making improved Public awareness to environmental problems → awareness improved
Weltanschauung	Sustainable development, belief in the importance of access to information and involvement in decision making
Owner	Public authority
Environment	The operation of government and public bodies, the economy, political and planning systems

Based on the CATWOE elements identified in Table 5.1, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the current economic, social and political systems that provide access to environmental information to the public and NGOs through public telecommunication networks in order to improve participation in decision making and to improve awareness of environmental matters".

A conceptual model that describes the process is portrayed in Figure 5.6. The model is described as a set of activities that are set around the purposeful activity that was described in the transformation above. The 4 measures of performance (the 3 E's +1) are described at the bottom of the model. The importance of the Ethicality within this model originates from the justice and equality principles which appear throughout documents such as the Aarhus convention or Agenda 21. Due to this, there is a need to integrate a measure of ethicality and to monitor it throughout the operation of the system.
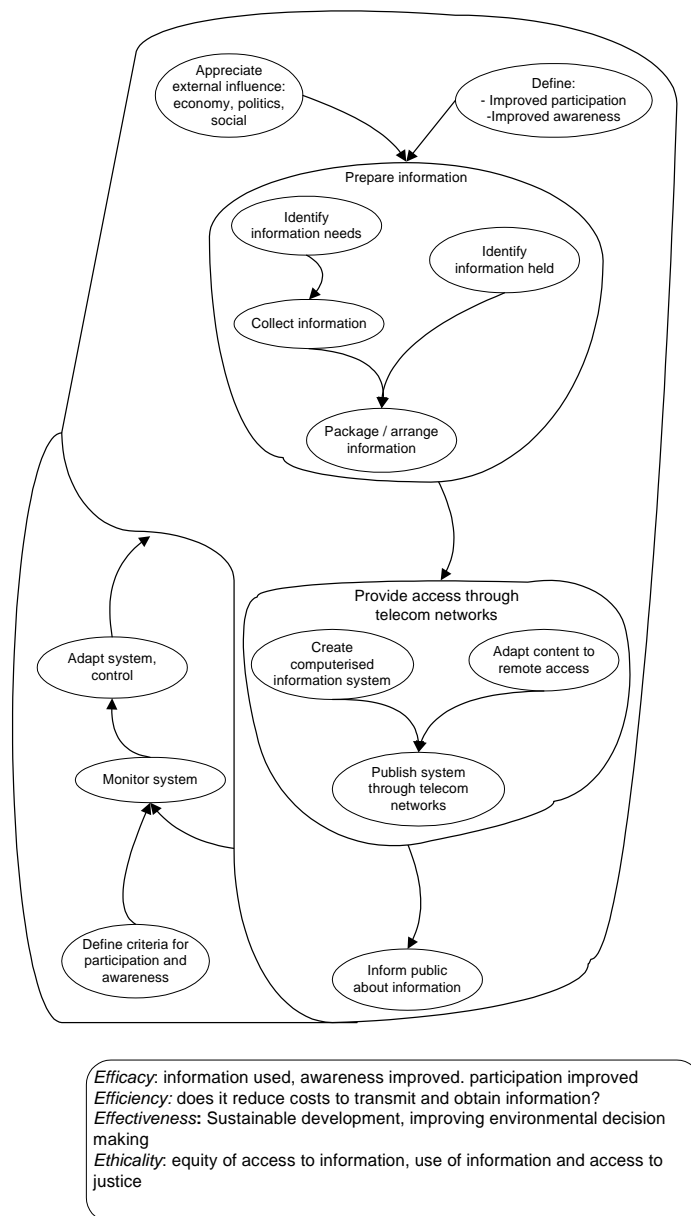
Figure 5.6 - Aarhus conceptual model

5.3.2 Special Interest Groups and NGOs Model

Special interest groups and NGOs hold an important position within the structure of environmental information provision and consumption. The activities of these groups, especially as champions of "the right to know", are important in the context of public access to environmental information. Indeed, the Aarhus convention appreciates their role and, since the Rio conference, their legitimacy is growing and they are more commonly accepted as stakeholders in environmental discussions.

The following model suggests a generalised "NGO view" on PEIS. It is important to note that this generalisation accepts that NGOs are different, and it is very likely that the "Wandsworth cycling campaign" will have a different agenda from "Greenpeace". NGOs can differ in the mode of operation, philosophy and the importance of environmental matters in their range of interest.

However, in all NGOs it is possible to identify some common characteristics that are used here to formulate their view. First, it is expected that an NGO will have a relatively narrow set of goals and objectives and a special interest. Second, it is expected that an NGO will operate by exerting political pressure to advance its goals. For the sake of argument, even violent demonstrations will be considered as political pressure.

Table 5.2 - CATWOE for special interest group and NGOs model

Clients	Public, NGO activists
Actors	Public authorities, NGOs, public, political actors
Transformation	Need for information that will promote the goals and objectives of the NGO → need met
Weltanschauung	Advancing the special interest
Owner	Public authority
Environment	The operation of government and public bodies, the economy, political and planning systems

Based on the CATWOE elements identified in Table 5.2, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the current economic, social and political systems that provide access to appropriate and relevant environmental information to the public and NGOs through public telecommunication networks in such way that will help in advancing and promoting the goals and objectives of the interest group".

The conceptual model that emerges from this definition is a proactive model (as, most commonly, an NGO will anticipate that the public authority will run the PEIS). This model is described in Figure 5.7. In this model, the Ethicality of the system is measured. The reason for this is that many NGOs hold a certain worldview, and the use of information should be seem within this worldview.

As Chapter 6 will demonstrate, sometimes an NGO will operate its own information system. Even in such cases, however, the argument that an NGO promotes is that it is actually the responsibility of the public authority to do so, and the NGO is publishing the information so as to fill a void and to demonstrate the incompetence of the public authority.
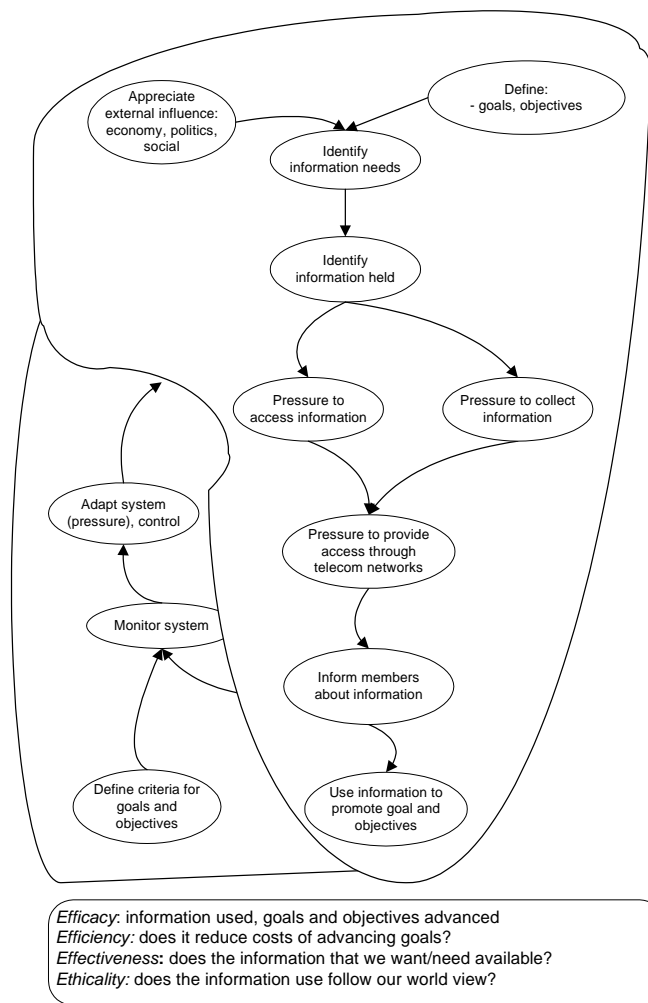
Figure 5.7 - NGOs conceptual model

5.3.3 Media Model

As the survey demonstrated, the media (either in electronic or printed means) are a major channel through which environmental information is delivered to the public. The following generalised perspective assumes that the media operate within a competitive business environment where the news articles (content) are the main commodity that is used to "sell" the product. The goal of media bodies can be described as either improving the sales of their products, promoting social or political objectives of their producers or providing a public service. Of course, a full discussion about the media's relationship with environmental information is beyond the scope of this thesis. However, in terms of purposeful human activity, the interaction of reporters and journalists with environmental information providers can be described as an activity to locate, extract and broadcast information and topics that will interest the audience of the specific media. This generalised description enables the development of a root definition and a model for connecting the media and PEIS. To enable generalisation, the term "readers" is a reference to various users of the media. Hence it should be read as readers/listeners/viewers.

Table 5.3 - CATWOE for media model

Clients	Media readers
Actors	Media, public authority, officials, journalists
Transformation	Need for interesting news articles → need met
Weltanschauung	Improve readership of the media. Also depends on the media. Can be: promote sales, advanced political goals, provide a comprehensive public service.
Owner	Public authority
Environment	The media market, the interests of media readership

Based on the CATWOE elements identified in Table 5.3, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the current social environment that provides access to appropriate and relevant environmental information to the public and the media through public telecommunication networks in such a way that will help in identifying and extracting interesting news articles". The model is described in Figure 5.8. In this model, the ethicality is measured due to the common use of ethics as a measure of performance and scrutiny of media organisations.
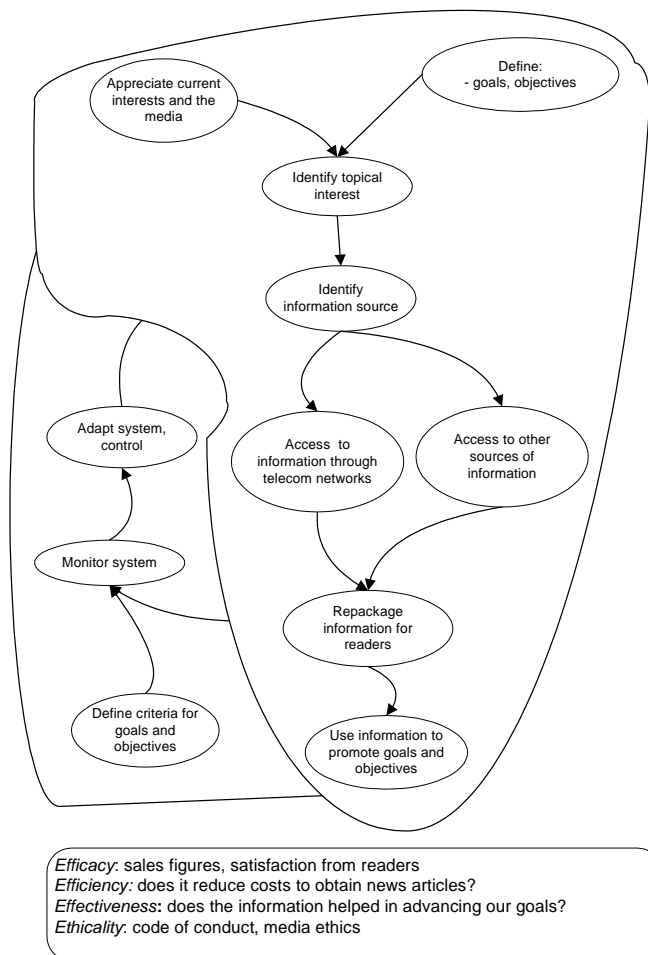

Figure 5.8 - Media conceptual model

5.3.4 Professional / Environmental Authority Model

The professionals that work within environmental public authorities produce and prepare the information for PEIS. For the following model, a perspective of "enlightened" public authority - one that wants to promote public use of environmental information - is taken. However, it is assumed that the motivation for delivering environmental information stems from the regulatory and administrative pressure to do so. This is done so as to avoid the need to state the position of the professional vis-à-vis public access. It should be stressed that there are many possible positions, ranging from those that believe that the public needs to be educated before they can understand the information, to those who promote total transparency. Again, such exploration is largely beyond this thesis and the generalised model will suffice.

Table 5.4 - CATWOE for professional / environmental authority model

Clients	Public
Actors	Public, public authority
Transformation	Need to provide access to environmental information → need met
Weltanschauung	Regulatory framework that promotes public access to environmental information
Owner	Public authority
Environment	The practice of the authority, scientific environmental management

Based on the CATWOE elements identified in Table 5.4, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the practice of the authority that provides access to environmental information to the public through public telecommunication networks in order to comply with regulations and guidelines that stipulate such access".

The conceptual model is described in Figure 5.9. In this model, ethicality is measured due to the common practice of public bodies to develop code of conduct and to promote their "mission statement" and "customer charter" in various forms. Within such a regime, public bodies continuously scrutinise their own activities and practices to ensure that they follow the established codes.
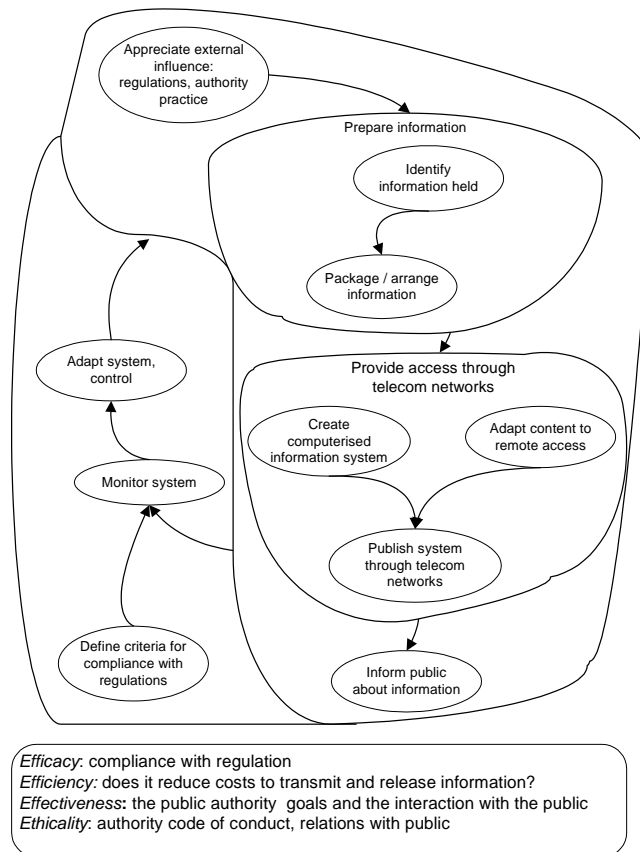
Figure 5.9 - Environmental authority conceptual model

5.3.5 Interested Citizen (NIMBY) Model

The declared users of PEIS can come from a broad spectrum of positions and interests. Though the concept of NIMBY is usually considered in a negative sense (Wolsink 1994), it must be taken into account as a legitimate use of PEIS. A member of the public may want to use environmental information to oppose an unwanted development in her locality, and an ideal PEIS should enable such use.

Table 5.5 - CATWOE for NIMBY model

Clients	Public
Actors	Public, public authority, developers
Transformation	Need to find information to oppose a development project → need met
Weltanschauung	NIMBY
Owner	Public authority
Environment	The planning system, power relationship between developer, public authorities and those who oppose the development

Based on the CATWOE elements identified in Table 5.5, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the practice of the authority that provides access to environmental information to the public through public telecommunication networks in order to enable access to information that will support opposing unwanted development".

The conceptual model is described in Figure 5.10. As noted earlier about the rich picture, this model of environmental information use depends on the appreciation of the "value" of environmental information in the process of opposing the development. In some situations, the user might decide that it would not carry any weight, and would not even start the process of obtaining the information. In this model, ethicality is not evaluated as a measure of performance. This does not mean that NIMBY practice is unethical, but rather that ethical measure is not relevant for this model. The reason for this is that this model promotes a goal directed operation of the PEIS with a clearly defined purposeful activity for which the ethical context (whichever it is) has been set *a prioi*.
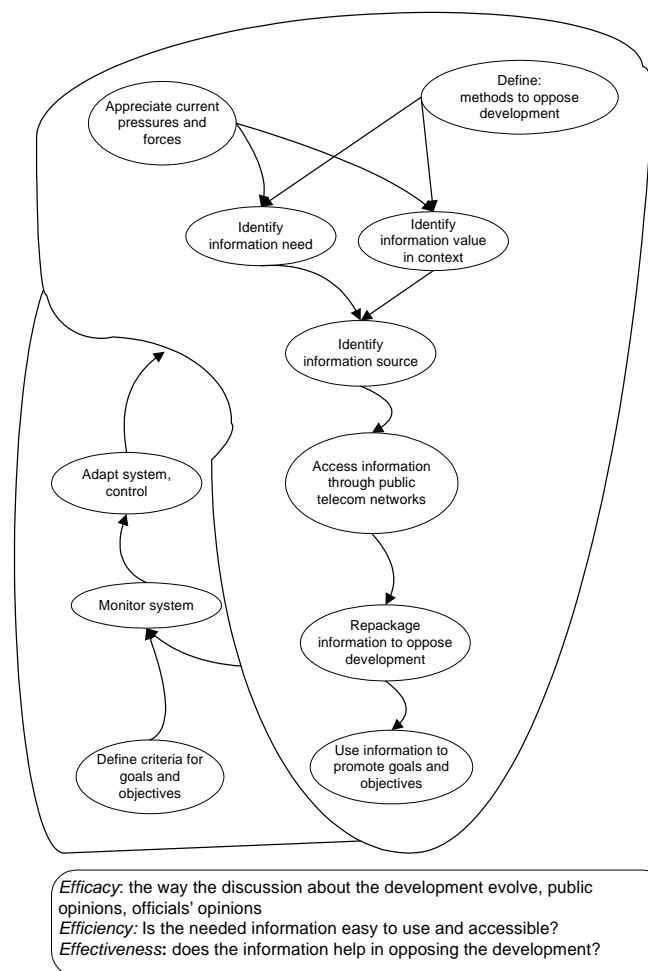
Figure 5.10 - NIMBY conceptual model

5.3.6 Interested Citizen (Active) Model

Though somewhat similar to the special interest groups (NGOs) model, there is value in developing and describing a conceptual model of an active citizen. Though many will use the NGO channel to advance their goals and interests, the local knowledge and emphasis differentiates this perspective from the general one.

Table 5.6 - CATWOE for active citizen model

Clients	Public, activists
Actors	Public authorities, public, NGO
Transformation	Need for information that promotes and support local activities →need met

Weltanschauung	Advancing the special interest in the locality
Owner	Public authority
Environment	The activities is the local area (development, retail …), the political system in operation (local authority) , economy

Based on the CATWOE elements identified in Table 5.6, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the current economic, social and political system that provides access to appropriate and relevant local environmental information to the public through public telecommunication networks in such way that will help advancing and promoting the goals and objectives of the local interest group".

The conceptual model is described in Figure 5.11. Unlike the model for the interest group, the active citizen model does not necessarily entail proactive action to release information. At the local level, connection with other actors plays an important role, as the workshop and survey demonstrated. Therefore, the pressure to collect information is presented as a dashed line, as it is less likely to exist. Proactive demands for access are more common and the more likely path. For the same reason, ethicality is not considered as a measure of operation – the active citizen model is more purposeful then the one of the group.
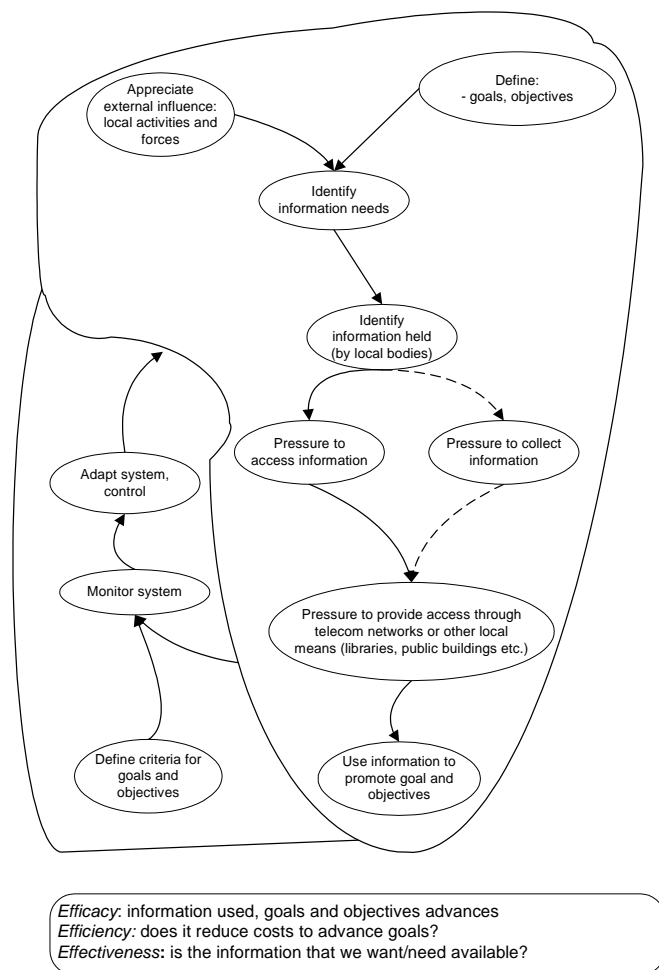

Figure 5.11 - Active citizen conceptual model

5.3.7 Interested Citizen (General Interest) Model

Two models of "members of the public" have been developed. These models focus on a purposeful activity that is easy to define - promoting local interests or opposing unwanted development. However, the survey has identified another use of environmental information. A third model provides the "passive" perspective of information consumption. Here, the purposeful activity is the gathering of information about the locality and beyond, in order to "know what is going on". This general information consumption seems problematic at first sight, but it actually provides the complementary element to the "need to improve public awareness" in the Aarhus model. The current model focuses on self education and the process of a "need to improve self awareness".

Table 5.7 - CATWOE for general interest model

Clients	Public
Actors	Public, public authority
Transformation	Need to know what is happening → need met
Weltanschauung	General information consumption, interaction with the world
Owner	Public authority
Environment	The activities in the area, other issues and interests

Based on the CATWOE elements identified in Table 5.7, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the current information provision atmosphere (including media, personal and local knowledge) that provides access to environmental information to the public through public telecommunication networks in order to provide information that will extend public knowledge about the local and global environment".

Figure 5.12 presents the conceptual model. The measures that are used here do not include ethicality due to the nature of the activity. From the point of view of the interested citizen, the information is used to construct views and opinions on the situation. Although ethical considerations and worldviews are clearly important when such a thing occurs, this is not part of the considerations that are in operation toward the system itself.
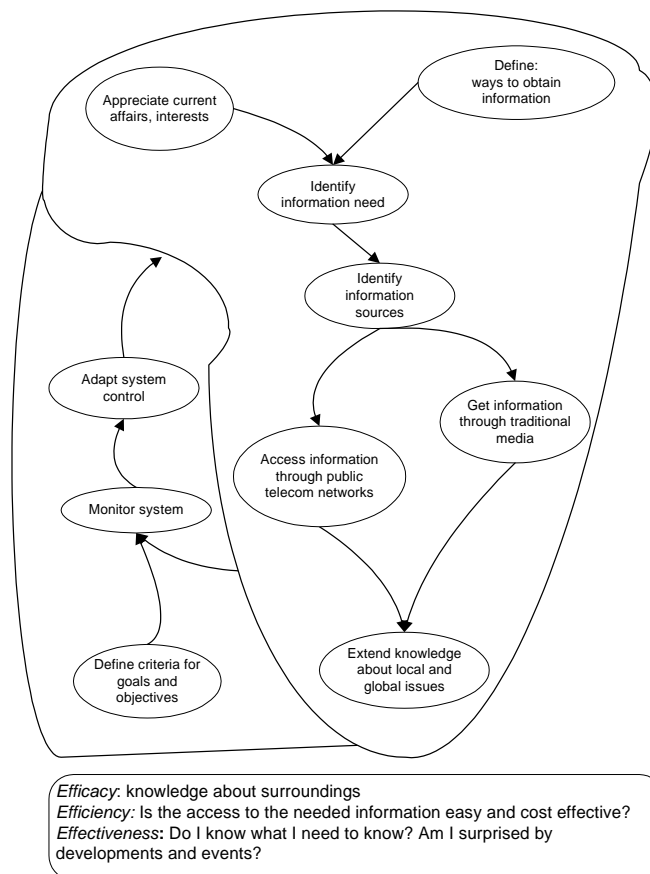
Figure 5.12 - General interest conceptual model

5.3.8 Other Possible Models

The seven models that have been developed provide a range of perspectives on PEIS. They provide models for the main forces that were identified and presented in the rich picture (in particular, Picture 3). As the thesis focuses on PEIS from a user-centred perspective, more attention is paid to the declared users (the general public) and, therefore, conceptual models were developed to represents those users.

However, it is naïve to assume that these perspectives are the only valid ones. Other possible points of view about PEIS include:

- The information intermediary perspective (see rich picture 4);

- The technical and scientific staff who are involved in the collection and analysis of environmental information but not with its delivery to the public;

- Politicians and government officials that are involved in other aspects of governance, for whom the release of environmental information might be a source of problems for initiatives or actions that they want to advance; and

- Developers, corporation officials and employees who are interested in advancing their plans.

Furthermore, as noted, it is possible to elaborate and construct different conceptual models for different NGOs, media and professionals - according to their scale, interests and modes of action. However, to keep the thesis focused and manageable, the selected models provide the main range of opinions and perspectives.

5.4 IS THERE A UNIVERSAL CONCEPTUAL MODEL?

The simple answer to the question "Is it possible to develop a universal conceptual model for PEIS?" is no. As was reviewed throughout this thesis, the use of environmental information depends on the context: the area and place for which the information is needed, the activity for which the information is required, the interests and positions of the information user and so on. As such use might happen in a conflict situation, such a model ought to deal with opposing perceptions of the problem situation. For example, while the developer of a NIMBY project may favour PEIS that does not provide access to information that can potentially stop the development, the citizens that oppose it want the exact opposite. The fact that environmental politics exist points to the complexity of arguments and to the fact that the meaning of "environmental", and the solutions to environmental problems, is a contested issue where different actors view the problem and the solution differently. Therefore, their "filters" toward environmental information and, subsequently, toward PEIS must be different and are likely to be incommensurable.

In spite of this inability to devise a universal model, it is possible to combine the different models and create a generalised model that appreciates the opposing views and concepts of the different actors. This model is by its nature generalised and idealised.

Table 5.8 - CATWOE for general PEIS model

Clients	Public, media, NGOs, developers, political parties, professionals
Actors	NGOs, media, political actors, professional , public authority
Transformation	Need to find relevant environmental information → need met
Weltanschauung	Current interest, activities and concerns
Owner	Public authority
Environment	The general social, political and economical activities

Based on the CATWOE elements identified in Table 5.8, we can describe the root definition in the following way:

"PEIS is a public authority run information system, operated within the current economic, social and political system that provides access to environmental information to the public, NGOs, media and other users through public telecommunication networks in order to improve access to and use of environmental information by different social actors".

Figure 5.13 presents the conceptual model, which is constructed by a combination of the various models. In the centre of this model is the public authority view that includes collection and dissemination of environmental information; the other area of the model focuses on the purposeful activity of information consumption by a generalised user (who has a certain activity for which he wants the information).
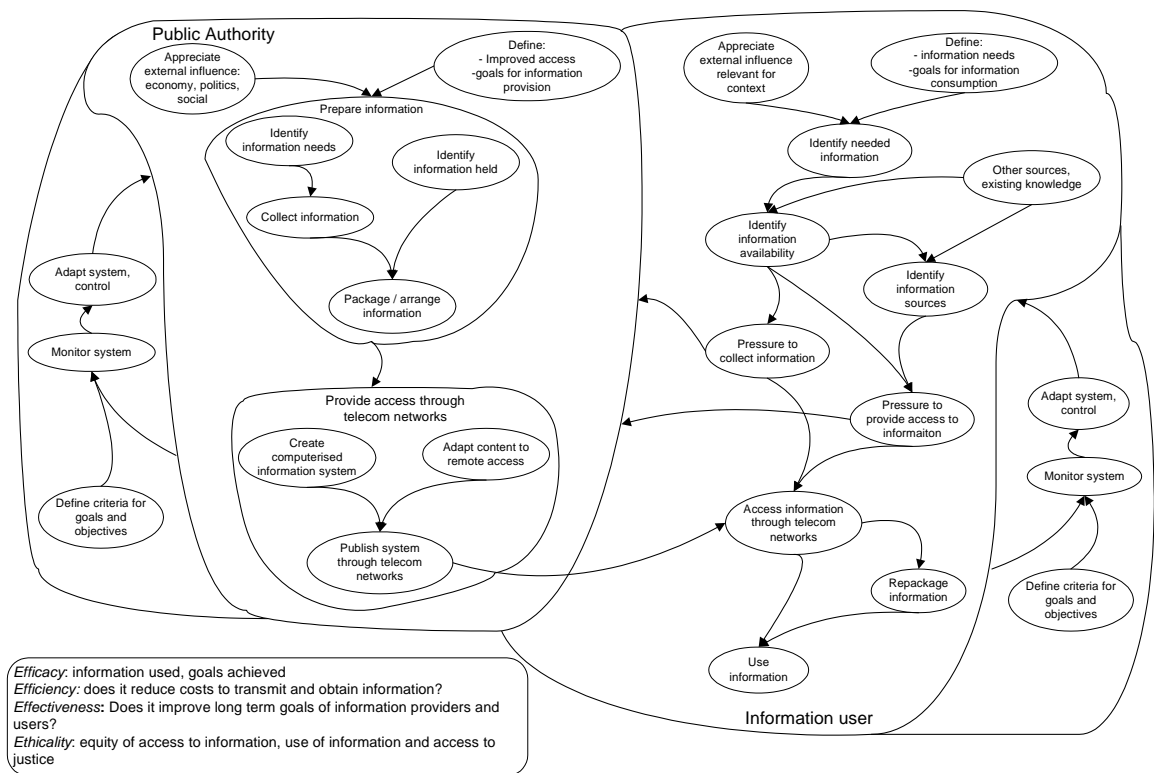
Figure 5.13 - General PEIS conceptual model[1]

5.5 DEVELOPING CRITERIA FOR COMPARISON

In the next chapter, the conceptual models that were developed will be compared to existing PEIS that are currently (Autumn 2000) accessible over the Internet. The different systems will be compared to the models in the following way. Each system is an operational example of PEIS. As such, it represents the outcome of information collection, organisation and dissemination activities by its maintainers. Therefore, it is possible to compare the system and the messages it conveys with each of the conceptual models and to evaluate how well the system meets the requirements and needs of the perspective from which the model was constructed.

However, there are other measures that have been exposed by the empirical studies. They can be used to form criteria that will be used in the comparison stage. As we have seen, a PEIS should respond to the following requirements:

1. The existence of multiple audience groups requires that a PEIS can respond to different needs. Does the system provide different routes for different users? One of the most commonly identified user groups in existing PEIS is students and teachers. Does the system provide service for these users? This is of special importance when the "improving awareness" stance is taken into account.

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[1] See larger version in Annex II

2. The need for interpreted and contextualised information. Does the system provide explanations about the information? What kinds of explanations are provided? What is the level of the text - is it scientific or is it aimed at a lay user?

3. Does the system support an holistic view of environmental problems? Does the system provide the user the ability to combine and contrast different and "unrelated" data sets?

4. Taking into account the importance of local knowledge and place-based information seeking patterns, does the system provide mechanisms for place-based search? What kinds of maps does the system provide?

5. Users want to have interactive capabilities in an information system: the ability to add their own information and use it for communication purposes. What kinds of communication does the system provide?

6. Does the system convey a clear message about currency and details of updates, accuracy and other attributes of the data and information?

5.6 SUMMARY

In the course of this chapter, conceptual models for PEIS were developed as well as sets of criteria. Together, they provide a comparison "tool set" for existing PEIS. Using the framework of SSM, this chapter has focused on systems thinking and described the human activity systems that are relevant for the thesis. These model deals with the various elements and views that are relevant for PEIS and that could help in scrutinising existing systems. Following the process of a SSM study (see Figures 3.3 and 3.4), the next stage in the thesis is to move back into the real problem situation and compare the models with it. This comparison is orientated toward identification of gaps in current practice and to evaluate whether the current provision of information matches the needs of the identified users. The next chapter focuses on this comparison.

6 Evaluating the State of the Art in Public Environmental Information Systems

6.1 OVERVIEW

Once conceptual models have been developed, they can be used as tools to evaluate existing PEIS. Of course, the models that have been described in the last chapter were constructed in relation to existing PEIS (including those that will be reviewed here). Hence, the comparison of the models to the PEIS might seem tautological; it is, therefore, appropriate to clarify the aim of this chapter and its structure.

As was discussed in Chapter 3 (especially sections 3.3.2.4, 3.4 and 3.7), the current thesis is using 'mode 2' SSM in a "sense making" process. The aim of the models is to crystallise possible positions toward the problem and to help us understand the complexities of the situation (Checkland 1999). The outcomes of Chapter 5 provide us with two sets of tools for this comparison: the conceptual models and the six criteria. The main question to be answered during the comparison with the conceptual models is "does the system answer the needs that this model describes?" The answer will give a better understanding of the operation of the system and its adequacy from the pertinent point of view.

This chapter contains four case studies, all based on active, web-based PEIS. Furthermore, because they are all UK-based and contain information about the London area, they can be compared to models and criteria that were developed on the basis of London-focused studies (Chapter 4). The comparison comprises of four sections, each dedicated to existing PEIS. In each section, a short introduction presents the system and its content. The following section focuses on the interactive, place-based component of the system that is used for the comparison. Based on this introduction, the comparison with the conceptual models is developed, followed by the criteria. The chapter concludes with a synthesis of the case studies and an evaluation of where existing PEIS comply with the conceptual models and an identification of their main shortcomings.

Before turning to the cases themselves, there is an important methodological note. The following discussion focuses on the systems as they were at the time of the evaluation (November 2000). A full examination of their background and history is deliberately omitted, as it is irrelevant for the current thesis: the focus is on the system "as is" and, therefore, any background that is not provided through the system will not be considered.

6.2   THE UK AIR QUALITY INFORMATION ARCHIVE[1]

Figure 6.1 - The UK National Air Quality Information Archive home page

The UK air quality information archive (http://www.aeat.co.uk/airqual) stores information which originated from the air quality monitoring network of the UK Department of Transport, Environment and Regions (DETR). The site is run and maintained by AEA Technology Environment (a division of AEA Technology, PLC) a company that focuses on

> "…providing solutions that help improve environmental performance. From strategic advice through to specific skills and services, the environment is our business.
>
> Our expertise covers the breadth of environmental concerns - land, air quality, water, energy, waste management and transport - and includes risk assessment, contamination, incidents, planning, monitoring, due diligence, programme management, remediation and software." (AEA Technology Environment, 2000).

The website does not provide any information about itself (there is no "about this site" link) although some information is provided under the Frequently Asked Questions (FAQ) link. Noteworthy is the use of the acronym on the button[2] as it might be unfamiliar to novice users (see

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[1] All the images in this section where taken from the AEAT website (AEA Technology Environment, 2000).

[2] All the images of web-sites in this chapter have been captured at a screen resolution of 800x600 and using Microsoft Internet Explorer, as this represents the most common resolution and browser combination, each accounting for about 54% and 58% of popular usage, respectively (Rowan 2000). Colour versions of Figures marked with an asterisk can be found in Annex II.

figure 6.1). The FAQ contains information about air quality issues. The link "what's on this site" leads to a search facility for the site, but does not provide more information about the site itself.

The main "public access" part of the site is dedicated to forecasts and bulletins. Following two more links (to select a forecast presentation and a region from a map of the UK), the system displays a chart (Figure 6.2)
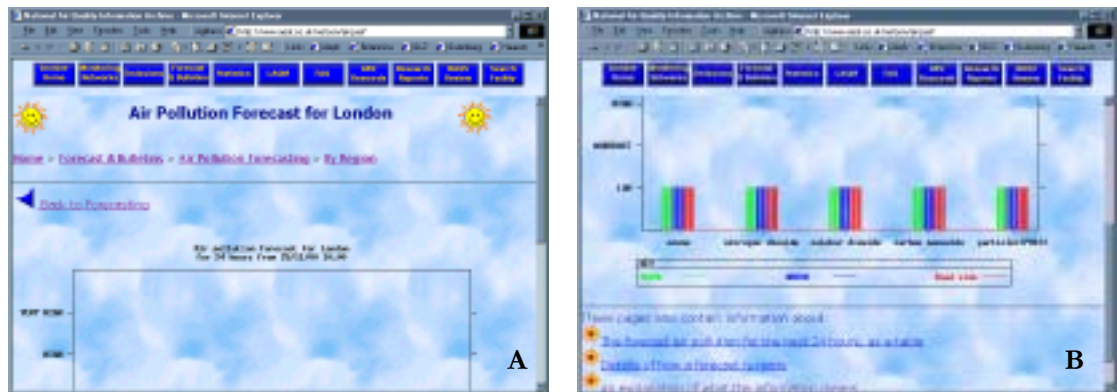
Figure 6.2 - Air pollution forecast chart, the two images show the scrolled page **(*)**

When the user scrolls the page all the way down, there is a link to "explanation of what the information means" (the same link exists on all the pages leading to the chart). This link leads to a table with similar information and explanations of the modelling techniques. Another link from the main "forecast & bulletin" page leads to a table that allows the user to choose between seven pollutants: benzene, 1,3-butadiene, Ozone, Nitric Oxide, Nitrogen Dioxide, Sulphur Dioxide, Carbon Monoxide and Particles (PM_{10}). The link leads to a table that provides a description (such as "below standard" and the measured value). Other links provide access to charts that summarise the last week for a specific pollutant, for a specific site, or a combination of pollutants and sites.

Another part of the site provides access to information on the monitoring network. In this section, there is a short explanation of the monitoring network with details on the automatic and non-automatic monitoring network stations. Figure 6.3 shows the information about one of the sites (London Bridge Place). The page contains a photograph, map and text about the pollutants that are monitored and other characteristics of the site.
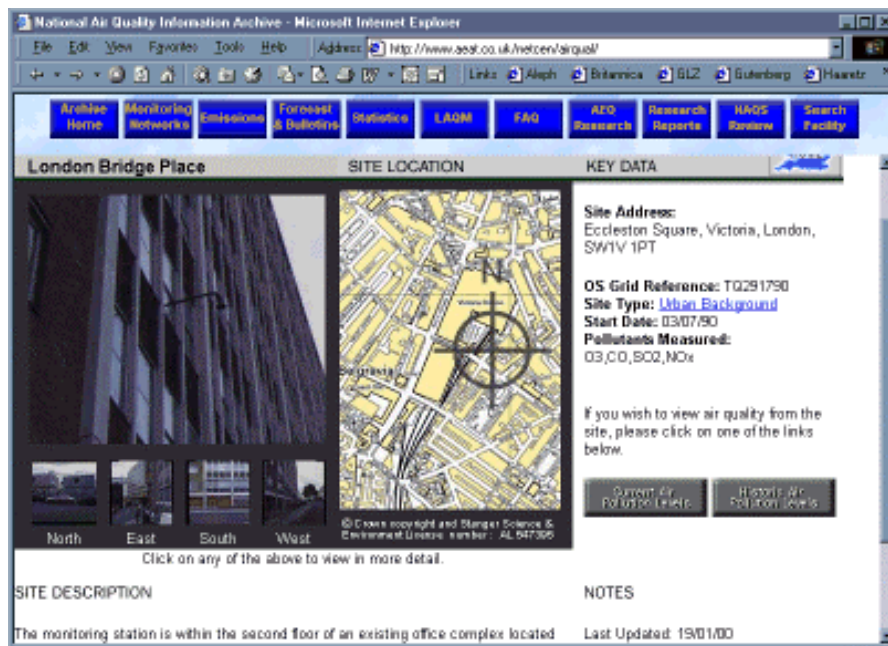
Figure 6.3 - London Bridge Place information page

The grey button "historic air pollution levels" leads to a page where the user can choose from a table of pollutants that are measured at that site, during a given year. Once a year and a pollutant type are selected, the user is presented with the table in Figure 6.4.

Figure 6.4 - Ozone information for London Bridge Place for 1999

Though each page contains information about a pollutant for a given site in a particular year, it needs to be manipulated heavily in order to be useful for analysis. Finally, the site contains reports about air quality in the UK, including the official DETR annual report.

6.2.1 Comparing With the Models

Table 6.1 - comparison of the Air Quality Monitoring Network site with the conceptual models

Model	*Comparison*
Aarhus	The FAQ page suggests four motivations for monitoring: research, interest, policy and statutory regulations (EU Directives). In reality, the directive is the main motivation behind the monitoring network. The information is presented in several ways (charts, text and raw data) though direct linkage among all these representations is not always clear. As for the 3E's+1, it is not clear how much the information is used and for what purpose. Currently the hit rate is about 9,000 files/day. It is also unclear how much the site contributes to environmental decision making and to sustainable development. Though the site provides some accessible information, in both content and design, the site seems to target professionals and requires the user to know what she is after. It is confusing to use, and requires regular use in order to understand its navigational scheme.
NGOs	The site does not seem to target pressure group uses - it does not provide contextual information about different pollutants and their health impacts. It requires a sophisticated NGO with "in house" scientific (or more accurately, air quality science) capabilities in order to use it. As such, it provides information but requires the NGO to cover a lot of ground before it can achieve any of the 3E's+1
Media	The site does not include press releases and, though it contains reports, they are not intended for use by the media. The rest of the data on the site require scientific knowledge that the media are unlikely to hold.
Environmental authority	The site seems to follow this model more than any other. The information is collected and distributed to follow regulations, and it is likely that it reduces the cost of transmitting such information. The system also meets the 3E's+1 requirements: it provides the DETR an easy way to release the information which is collected according to regulations. The use of the WWW probably makes it more efficient for professional users to access needed information for their daily work. The added public information seems to be part of the general system, and not a specialised part of it.
NIMBY	The site does not seem to comply with this model, as the distribution of monitoring stations is arbitrary and, if the disputed location happens to be away from any existing station, there is no way to associate the site with the data in the system. This is especially true in consideration of the problems associated with extrapolating pollutant dispersal in urban areas.
Active citizen	Similar to the NIMBY and NGOs, the site does not comply with this model.
General Interest	The site is problematic for this model, too. The heavy use of jargon, the lack of contextual information and the confusing structure probably makes it difficult to use. The only part of the site that might comply with this model is the forecast information, which is generalised and uses specific pollutants which may (or may not) be relevant for the user.
General model	The system complies with this model, though it is not clear how relevant the information is. As noted, the information is difficult to obtain, and even professional users need to reorganise it to make it useful.

As Table 6.1 demonstrates, this is a problematic PEIS (if a PEIS at all). Apart from the forecast charts, which seem blank at first sight for most users (as noted, most still use relatively low screen resolutions), the site does not contain information to help users understand what the information is, why it is collected and its potential applications.

6.2.2 Criteria Evaluation

Table 6.2 - comparison of the Air Quality Monitoring Network site with criteria

Criterion	Evaluation
Does the system accommodate different user groups?	The system provides one interface, there is no differentiation among different user groups, it is aimed at all users - from occasional users to frequent ones.
What kind of information does the system provide for educational purposes?	The site does not provide any content for educational purposes.
What kind of contextual information does the system provide? What level of detail is there and what is the target audience?	The contextual information is scattered throughout the site, and is usually found by clicking on links. The information itself is very laconic and not very informative. No information about health issues or sources of pollutants is provided on the site. It is unclear who is in the target audience. The site tries to satisfy all users using a single interface.
Does the system support the holistic view of environmental problems?	No, the system provides information about air quality monitoring without any context or related information.
Does the system provide a place-based search facility? What kinds of maps does the system provide?	No, the system provides information for regions through lists and clickable maps. The locational scheme is based only on the locations of the monitoring stations and no other localities. The maps on the site are either generalised for the whole country or very localised (near the monitoring station). On another part of the site, there are interactive maps to explore the outputs of models of pollutant dispersal for a generalised period (yearly averages).
What kinds of communication does the system provides?	The only type of communication on the system is an e-mail address which appears on most pages. There is no indication of what happens to these messages.
Does the system provide clear details on currency, updates and the value of its information?	Yes, the information that the system provides contains details on the currency of the information - the time when major pages were updated, dates included in graphs, in tables and other information sources throughout the site.

Table 6.2 shows that the air quality monitoring network system falls short of most of the criteria for a PEIS. Though the site states that it is a comprehensive source for air quality information, it seems that its uses as a PEIS are limited.

6.3   FRIENDS OF THE EARTH FACTORY WATCH[3]
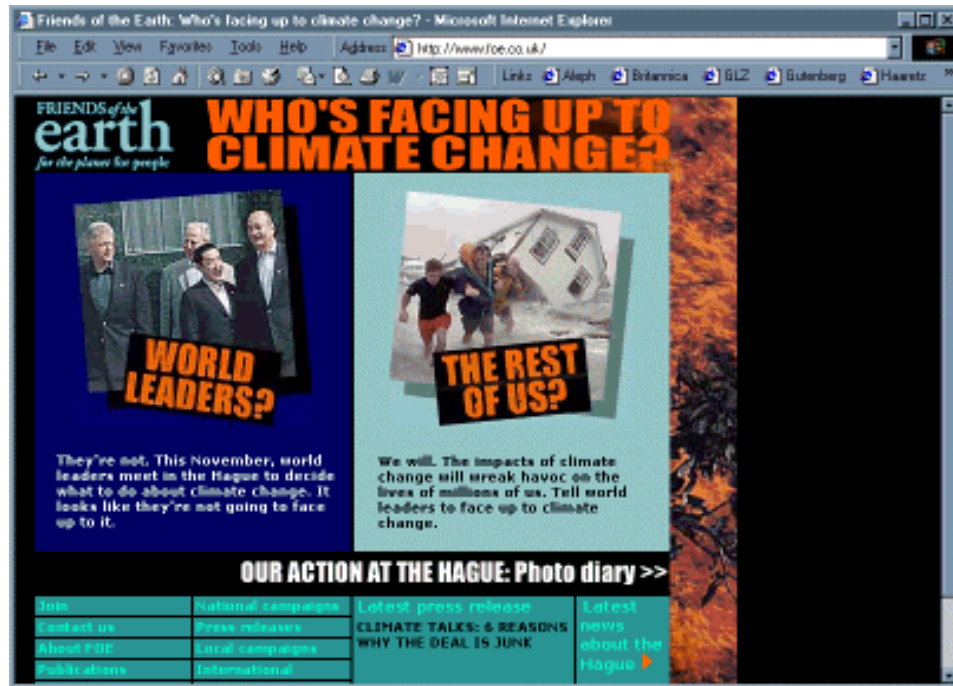
Figure 6.5 - Friends of the Earth UK home page

The Friends of the Earth website (http://www.foe.co.uk/) provides the web presence for this well established environmental NGO. Figure 6.5 shows the home page of the organisation, which presents information about the Hague discussions on climate change, the main international campaign at the time of the evaluation. FoE was established in the USA in 1969, and has operated in the UK since 1970. From its inception, it has been a federation of autonomous environmental NGOs across the world (McCormick 1995). In the UK, the organisation is considered to be one of the leading environmental NGOs (together with Greenpeace). It operates in a multi-scale campaigning scheme, with international, national and local campaigns on various issues. The website provides information about the range of campaigns that the organisation promotes, press releases, publications and an invitation to join it.

For the purpose of evaluation, the thesis focused on one of the FoE campaigns that the website promotes. This is the section "Factory watch" (http://www.foe.co.uk/factorywatch/). Its home page is presented in Figure 6.6

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[3] All the images in this section were taken from the FoE website (FoE,2000) (a new version of the site with a new layout was released on 29 November 2000. Though this version changes the layout, the functionality is very similar)
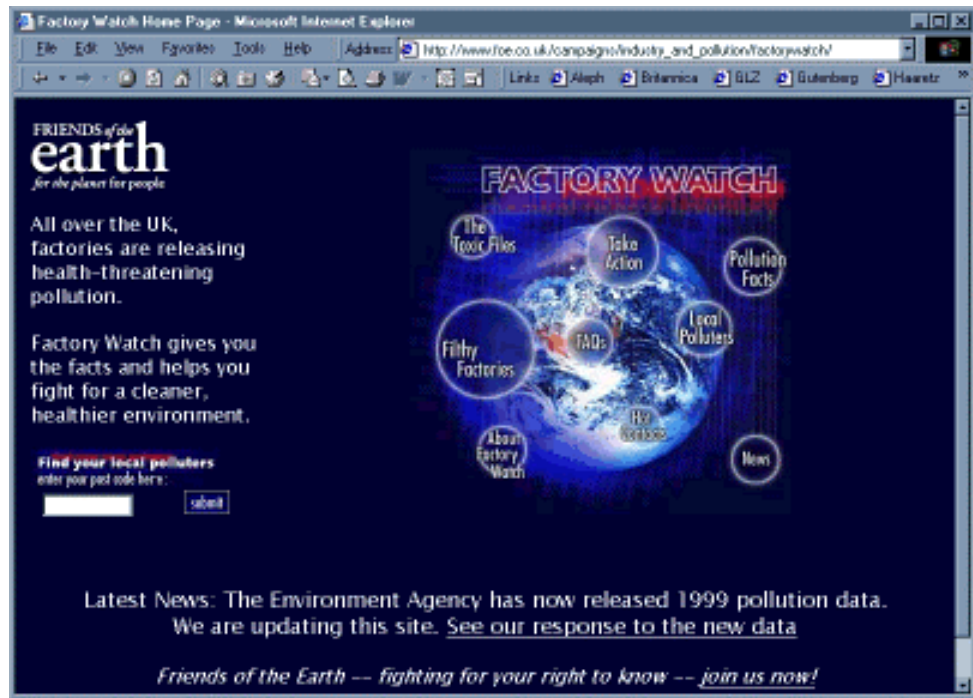
Figure 6.6 - FoE factory watch home page

The home page makes a direct link between access to information, "the right to know", and action ("help you fight for a cleaner, healthier environment"). Different links provide access to different segments of the site and a text box invites the user to enter her postcode to get a customised map for her location. It is important to note that this site was established in 1997 (using 1996 emissions data) and some parts do not work anymore. This is indicative of the high requirements needed to maintain PEIS continuously. On 29th November, 2000, a week after the evaluation, FoE re-released the system after an overhaul of the interface although most of the functionality of the new version is similar to the system that was evaluated. The site provides information about polluting factories across the UK, general information about its content (including a FAQ page, linked using the acronym alone) and an interactive section.

Figure 6.7 shows the main layout of the interactive mapping component. Figure 6.7A shows the generalised UK map that is presented when the link "the toxic files" is selected, while Figure 6.7B shows the layout once a localised map is selected and a specific factory (marked by a red dot) is chosen. Information about the specific factory appears in the left frame.
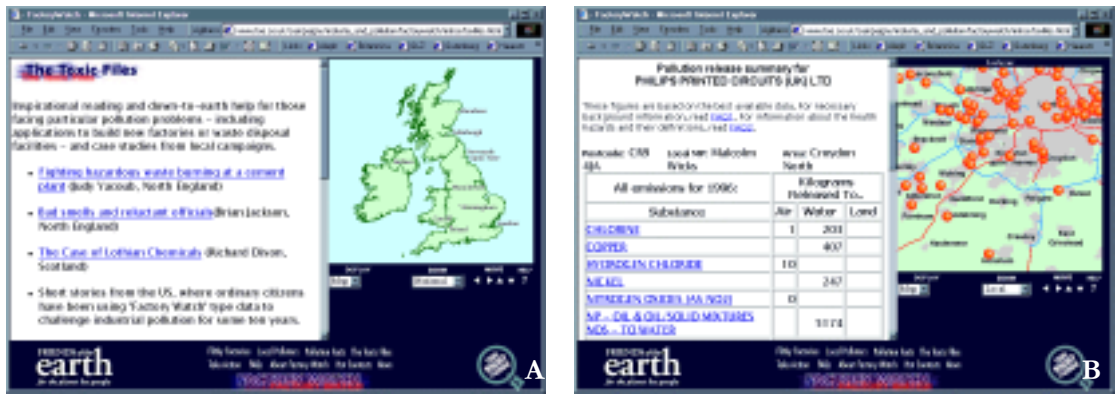
Figure 6.7 - Interactive mapping in FoE Factory Watch (*)

When the first local factory is selected, a pop-up window appears which provides information on pollutants. The window contains information that instructs the user on how to operate the system:

"This is a second browser window which will show you information about the chemicals if you click on a chemical name in Factory Watch. Please iconise this window or leave it open. This window can be minimised (iconised) or put behind the main browser window using {ALT+TAB}…" (Factory watch website)

Once a pollutant is selected from the main window (see Figure 6.7B), the pop up window brings information from the US-based "Scorecard" website (www.scorecard.org). This information includes human health hazards, hazard ranking, profile of environmental releases, waste generation and more. The main map page allows customisation of the information, such as adding a comparison with legal pollution limits, selection of a different year and so on. The link "take action" provides a page with information about possible activities, including sending a letter to the local MP (template provided), requesting a postcard pack addressed to government ministers and opportunities to join local FoE campaigns.

6.3.1 Comparing With the Models

Table 6.3 - Comparison of the FoE Factory Watch site with the conceptual models

Model	*Comparison*
Aarhus	FoE Factory Watch is directed to improving awareness, and provides a clear link to "participation" in the sense of direct action and democratic activity. Of course, the aims, goals and world view of FoE are the main driving forces behind the system and its content (see NGOs model). The database of chemical releases used in the system is from the Environment Agency (see section 6.4) and, therefore, this system can be considered as an NGO/environmental authority co-operation.
	In terms of the 3Es+1, the system provides a gateway to improve awareness and use of the Chemical Releases Inventory (CRI) database. For the users, such a system reduces the costs of obtaining information about their locality. The system can be considered as an improvement on the ethical aspects of PEIS, especially when considering FoE's potential role as information intermediaries.

NGOs	Factory Watch can be considered an embodiment of the NGO model, but with a significant difference. While the model shows the NGO as a force that puts pressure on the public authority to provide access to information, here the NGO goes one step further and repackages the information to suit its goals and objectives. It is noteworthy, that even though the Environment Agency now provides similar information on their own website, FoE did not update their site to provide "deep linking" (a link to internal pages on another site) to it. This is also true of the revised version, which was developed after the Environment Agency released their system. FoE do, however, use deep linking to the Scorecard site (links between NGOs). The system answers the 3E's+1 that are described in the model, as the whole system is controlled and operated by FoE. It provides them a means to promote their goals and objectives and to rearrange environmental information in the way that best serves them and their activists. The use of the Internet reduces the cost of preparing and distributing such information, too.
Media	Following the operational stance of FoE, and their traditional contact with the media, the system provides an area for news. Furthermore, the main site dedicates a section to press releases. This activity was noticed when the Environment Agency published their site - as it was the FoE press release that sparked media interest and practically forced the Environment Agency website to publish their system before their scheduled release date.
Environmental authority	The system "over"-complies with the environmental authority model. The information is collected following regulations about environmental emissions, and is stored in the Environment Agency computers. The fact that FoE received and released Environment Agency information should be considered impressive. The existence of the FoE site forced the Environment Agency to develop their own system (See section 6.4)
NIMBY	As for the NIMBY model, the system provides only partial information. The maps on the site are coarse and do not provide enough details on the local level (see Figure 6.7). On the positive side, the ability to locate major polluters using postcodes, and getting information about how to use the information (including warnings about accuracy) can be helpful in the process. The direct link with action can also be considered helpful. In summary, the information on the site can help a NIMBY objector to oppose proposed development of a factory nearby, based on the operator's performance history.
Active citizen	The system complies with the active citizen model, though the generalised maps can present an obstacle (like the NIMBY one). Interestingly, the system focuses on the national level in both presentation and suggestions for action, and does not provide links to local councils or local bodies (apart from the local FoE group). As such, it does not answer all the needs of this model. Similarly to the NIMBY user, the active citizen can use the information on the site to promote objectives and local activities.
General Interest	The system does not comply too well with the general interest model. It provides access to the CRI alone, and while the maps on the site provide information about polluting factories (and their impacts), they do not connect to other local issues. Therefore, if the "general interest" user wants information on factories and manages to find the system, she might be satisfied. However, this fragmented access to different aspects of the environment (another section on the site provides information on Sites of Special Scientific Interest - SSSI) does not make the process of finding and obtaining general information either cost effective or easy.

General model	The system seems to comply with the general model given that we appreciate the interaction between the public authority and NGO in this case. It can be argued that the public authority used (or was forced to use) the NGO as a pilot project for their own system. The interaction between the two bodies exemplifies an opportunity for synergistic advantages between different actors in a way that brings benefits to both.

As Table 6.3 demonstrates, the FoE Factory Watch system compares well with the conceptual models and provides information to various interest groups, even though it focuses on a single environmental issue. As Porritt (2000) noted, this is part of the internalisation process of environmental NGOs, where they have adopted the reductionist view of environmental problems. The system provides a comprehensive database about chemical releases ranging from raw data to interpretation and a call for action. Of course, the world view of FoE clearly influences the structure, content and presentation of information.

6.3.2 Criteria Evaluation

Table 6.4 - Comparison of the FoE Factory Watch website with criteria

Criterion	*Evaluation*
Does the system accommodate different user groups?	The system provides one gateway, but appreciates the needs of different users (such as the media). However, one interface design is used throughout the system and there is no differentiation of audience groups.
What kind of information does the system provide for educational purposes?	While the main FoE site provides a specialised section for youth and education, the Factory Watch section does not appreciate or deal with this user group (though it is easy to imagine assignments that can use it).
What kind of contextual information does the system provide? What level of detail is there and what is the target audience?	The contextual information on the system is rich and uses hyperlinks to provide more contexts. Noteworthy is the external links to Scorecard. These links use the abilities of the Internet to connect to other NGOs and to leverage systems by sharing resources. The information that is specific to the UK (legal limits on emissions) is provided locally, as to make up for the missing elements of Scorecard. The instructions on the system are clear and, as noted, the system provides instructions for the use of pop-up windows, (a non-standard feature of the system when it was released). The new version does not require any pop-ups.
Does the system support the holistic view of environmental problems?	No, the system focuses on one environmental aspect - emissions from factories. No link is made to other pollutants (like the air quality monitoring system) or even to the other localised information on the FoE server (SSSI information).
Does the system provide a place-based search facility? What kind of maps does the system provide?	Yes; though at the time of evaluation this facility did not work. The new version provides quick access to textual information or maps by using postcodes as the search key. Furthermore, the generalised maps (relatively small scale) make it difficult to identify and locate the factory. The use of large symbols does not assist in this task. The system requires relatively high levels of map reading skills.

What kinds of communication does the system provide?	The system does not provide any means of communication among users or between users and their local authority. The system provides instruction in communication in a subscribed way: contact local MP, local FoE chapter or the national office. The site in general focuses on one-way communication and provides some e-mail addresses and telephone numbers, but not for communication among users.
Does the system provide clear details on currency, updates and the value of its information?	The system provides details on the currency of the emissions data, and some details about the dates of the information pages. However, it is clear that some of the pages have not been updated for a while - but they do not contain any information about the date of the last update.

Though the FoE Factory Watch compares favourably with the conceptual model, it does not meet many of the criteria as Table 6.4 shows. Its main shortcomings are the lack of communication, the reductionist view of the environmental problem at hand, and the needs of different user groups.

Another element that is apparent when using the system is the number of broken links (links that lead to error messages from the web server) and sections which do not operate in the expected way. This might be a result of the "age" of the system (over 3 years). Naturally, the new and improved version works well. This shows that FoE are pleased with the operation of this system and that they are willing to invest in maintaining it.

6.4   THE ENVIRONMENT AGENCY "WHAT'S IN YOUR BACKYARD? "[4]
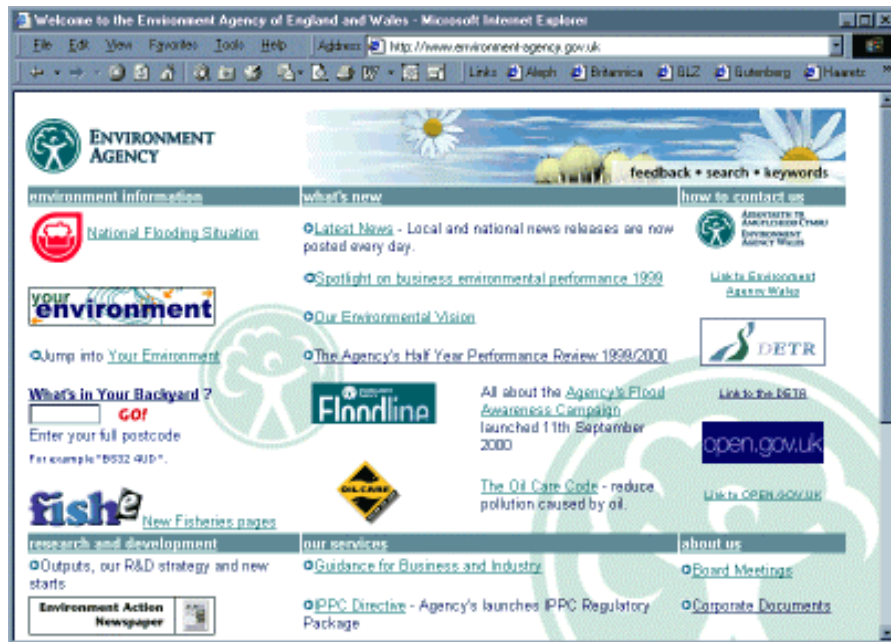
Figure 6.8 - The Environment Agency home page

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[4] All the images in this section were taken from the Environment Agency (2000)

The Environment Agency for England and Wales, created in 1996, is the professional body for environmental protection in these countries. It is in charge of water quality, pollution monitoring, waste, contaminated land, flood control and warning and several other issues.

The website of the Environment Agency provides information about the agency and its work, as well as access to specific information about issues under its control (such as fisheries). One of the sections on the site is place-based and it will be the focus of the following evaluation. It is accessible from the front page in two ways (Figure 6.8), either through a link titled "what's in your backyard?" or through a text box where the user can type her postcode and access a map of her locality immediately. The link leads to the page presented in Figure 6.9. From this page the user can access a mapping facility and explore any specific site though a process of zooming-in using the map. The second option on the page enables the user to home in on a specific location by using postcode, place name or national grid reference. The third option provides a gateway to textual information on specific topics and other options to let the user download data, register for notification of changes and find details about the provided data sets.

It is likely that users bypass this gateway page, as the front page (Fig. 6.8) invites them to type in their postcode and move to the mapping facility immediately.
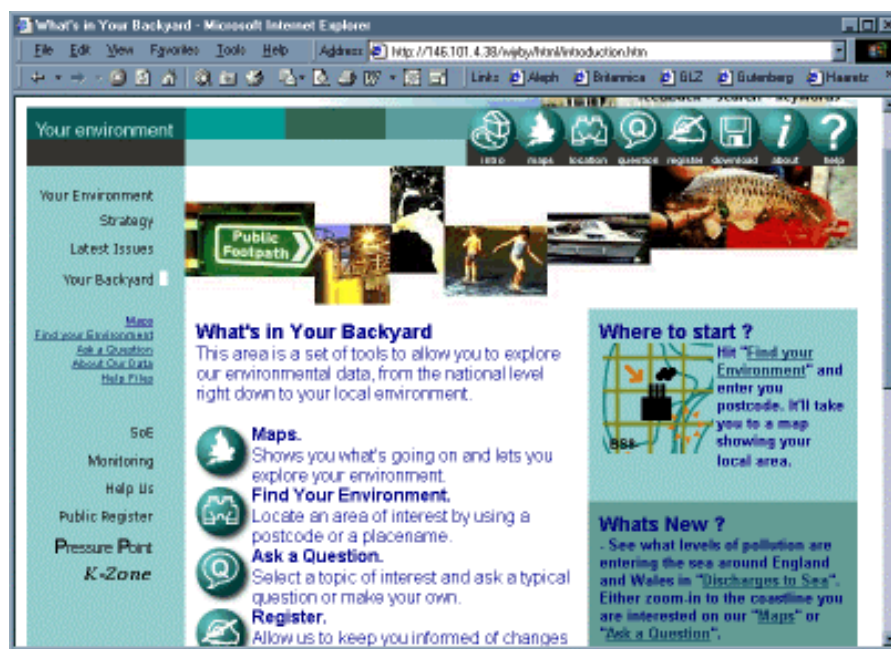
Figure 6.9 - What in your backyard page on the Environment Agency website

The mapping facility provides an interface to a multi-layered GIS database. Figure 6.10 presents the interaction capabilities of this section - from identifying a factory to finding information about it. Interaction with the mapping facility starts with a medium zoom level (1:93,750). The Internet-GIS facility provides the functionality to zoom in, zoom out, pan and identify an object on the map (6.10A). When Microsoft's Internet Explorer browser is used, selecting a function is carried out by clicking on an icon that turns to red, whilst in the Netscape Navigator browser, this is done by clicking on a radio button (6.10E). On the right area of the map the possible layers are displayed.

They include: pollution inventory, bathing water, river quality, environment agency offices, groundwater protection zones and discharges to sea. The legend is also a gateway to information - clicking on one of the symbols on the legends provides a hyperlink to a page that explains the contents of that layer. The user can hide a layer by clicking on a check box. A special column with radio buttons selects the "query layer". The map is displayed at the centre of the screen in a 300X300 pixels area. When the user scrolls the page a bit, she can select from one of five possible zoom levels. A short explanation tells the user "Select tool above, check the Query Layer (next to the Data Layers) and click the map. More Help?" where the *more help* text provides a hyperlink to a page with instructions on how to use the site.

From the medium scale zoom level, the user can zoom further (6.10B) and view localised information at a scale of 1:18,750. As in the previous map, common OS maps are used. In the example, three locations of factories that are registered in the pollution inventory can be seen.
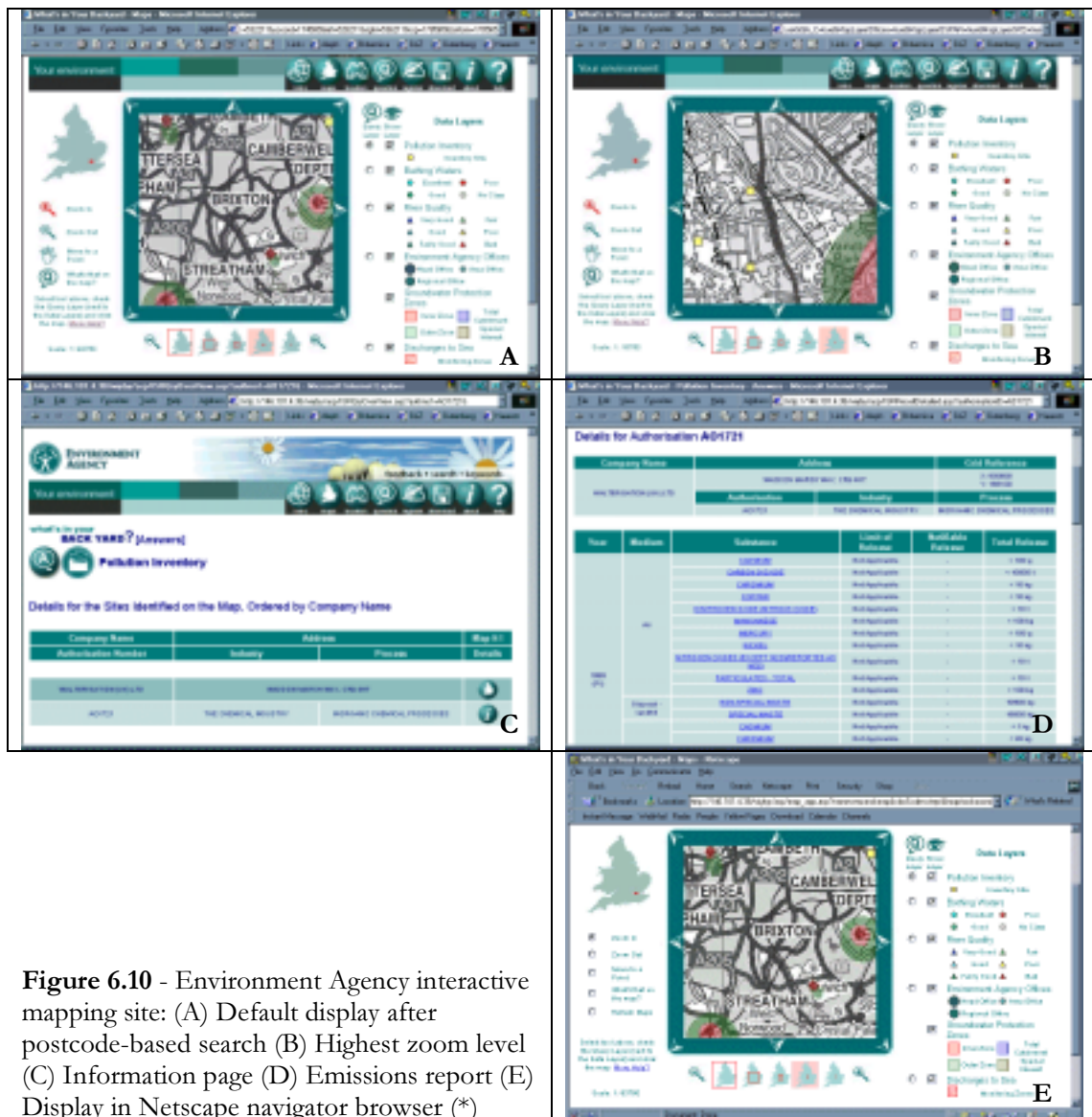
Figure 6.10 - Environment Agency interactive mapping site: (A) Default display after postcode-based search (B) Highest zoom level (C) Information page (D) Emissions report (E) Display in Netscape navigator browser (*)

The next stage is to find information about a specific site. The user needs to verify that the "pollution inventory" layer is the query layer, then change the selected of tool to "What's that on the map?" and click on one of the locations. This leads to a list of factories in that location (6.10C) and a click on the information button (the icon with the "i" on it) leads to a report on the factory (6.10D). The report contains information about medium (air, landfill, sewer), substance, limit on release, notifiable release and total release broken down by year and source (pollution inventory or the chemical releases inventory). Many of the substances are hyperlinks that lead to information: what each is, where it can be found in the environment, how it is used in industrial processes, how much was released in 1999, and a link to a page dedicated to health impacts. This page is interesting as it deals with the question "Will the chemicals in the Pollution Inventory affect my health?" with the answer "This question is not easy to answer using the information in the Pollution Inventory alone", provides seven points about causes of health issues, and then links to other sites that might contain such information, including the FoE one.

Other layers also provide links to relevant information. The river quality layer provides links to simplified charts that give the grade of water quality from bad to very good for each year, and another link leads to a detailed table of water quality. The bathing water index provides similar information about bathing places, and the discharge to sea provides a table with measures of substance discharges. The system also contains a section in which queries can be constructed through a text-based interface (such as the selection of a place name from a list) and results are displayed in tables and maps.

It is important to note that the system exhibits some serious usability problems. In a short experiment with the system, it demonstrates a confusing, non-standard and hard to understand interface. The map screen (6.10A/E) is saturated, provides a very small area for the map (about 20% of the screen area at 800X600 resolution) and even experienced GIS users fail to understand how to get information on a specific site when using the system. The main issues with the interface are:

- On standard resolution monitors, the series of zoom levels is hidden when the page is loaded and, even when visible, users fail to understand what it means.

- The use of colour-changing icons instead of radio buttons confuses many users and prevents them from selecting the "what's on the map?" tool.

- The connection between the legend and its associated information exists only when the user clicks on a symbol - a very small object on the screen - and the text labels are not hyperlinked.

- The scale of the maps is meaningless and does not help the user to orientate themselves. This is exacerbated by the small area of the map which covers 1/2 mile by 1/2 mile.

- The interface uses GIS jargon and unclear labels throughout. This adds to the difficulties of understanding the meaning of the information itself.

These and other issues are major impediments even for experienced GIS users. It can be expected that novice users will find it even more difficult to use.

6.4.1 Comparing With the Models

Table 6.5 - Comparison of the Environment Agency "what's in your backyard?" site with the conceptual models

Model	*Comparison*
Aarhus	The system provides a good example of the Aarhus model. It is run by an environmental authority that prepares information and releases it to the public. It can be claimed that the connection with the FoE site, and the provision of exact information that FoE desired, is an indicator of the awareness of the Environment Agency to public demands. It even complies with the last holon, as the Environment Agency issued a special press release to inform the public about the system. As for the 3E's + 1, no information is given on the Environment Agency website to indicate the uses of information and its impact. The Environment Agency is exploring these issues as a recent R&D project about Local Outreach demonstrates (Clark *et al.* 2000). It probably reduces the costs of publishing these databases for the Environment Agency. As for Effectiveness, this is a long term goal. It can be argued that by putting this information on the web, the Agency improves the equity of access as it provides it to anyone without the need for intermediaries (see section 6.5)
NGOs	The system provides a good example for the NGO model. The activities of FoE and the creation of the Factory Watch website paved the way for the Environment Agency system. The bi-directional link between the systems is indicative of this linkage. A visit to the FoE website shows that FoE uses the Environment Agency system to extract information about polluting factories and compile press releases that follow up on this issue. The system also answers the 3E's + 1 criteria from the NGO perspective: it helps them to promote their goals and as the Environment Agency runs the system, it reduces the cost of maintaining and updating the Factory Watch system, though it's clear that FoE see their system as important enough to update, too.
Media	The system does not comply very well with the media model. It is aimed at the individual user and her locality. Though the Environment Agency website has a section with press releases, and some of them mention the system, the site is not "geared up" to provide such information. A possible use of the system is by local journalists who can "dig out" information about a local polluter. Otherwise, the system is not intended for use by this group.
Environmental authority	The system complies well with this model. Through its development (it started with the pollution inventory alone) it exhibits an ongoing process by the Environment Agency to provide information through the Internet to the public. Furthermore, it is used to integrate different data sets that the Environment Agency holds. All the data sets on the systems were collected by the Environment Agency as part of their statutory obligations. The obligation to release this data set (as a result of the Aarhus process) is not yet in place. Therefore, the Environment Agency can be considered as anticipating regulatory actions and preparing for them. The system complies with the 3E's + 1, especially in view of their commitment for "close and responsive" relationships with the public.

NIMBY	The pollution inventory section provides an example for possible NIMBY use. A user can find information about a factory in her local area and the pollutants it releases. Though the site does not provide any direct connection to action, the user can employ links to environmental NGOs to explore the issues further and, by doing so, develop her opposition to the project. The place-based mechanism can help such action by helping the user to zoom in directly to the locality that she is interested in. The use of the term "backyard" in the site name is also noteworthy.
	The main impediment to this use is the major usability problems with the system. In its current form, it is more likely to alienate the user than to provide her with information. Furthermore, the Environment Agency attaches a disclaimer to the information: "You are entirely responsible for the consequences of any use of the Data and Third Party Data and accept that the Agency shall not under any circumstances be liable to you for any physical damage to or loss of your tangible property …."
	Apart from these problems, the system can help such a user in achieving her goals.
Active citizen	The system compares well with this model too. The Environment Agency is releasing information on their own initiative and provides it to any interested party. The ability to customise the map is also important as it enables the user to create an integrative picture of the information for her own use.
	The usability problems are relevant to this user too. However, as such users may access the system more often, the integration of all the information into a unified gateway must be considered advantageous.
	The system also complies with the 3E's of this model, as it provides easy access to the Environment Agency data sets. Furthermore, the ability to download information from the system for future use is also important, as it provides the activist with the capabilities to use the information without continuous connection to the Internet.
General Interest	The system complies with this model. It provides a gateway to the information held by the Environment Agency about the locality in one place. Therefore, a user can access this section and find it relatively easily.
	Again, the usability problems are a major impediment. The site is complex to operate and understand, and the same issues that were mentioned regarding the NIMBY model, are even more relevant for this one. Therefore, we need to conclude that the system holds the potential to facilitate such usage of the system, but if and only if the usability for occasional users is improved.
General model	As expected, the system complies with this model too. The examples that have been discussed so far, and especially FoE usage of the system, demonstrate the applicability of the model for this system.
	The system also complies with the 3E's + 1 as described in the model.

The Environment Agency's "what's in your backyard?" is probably one of the best practice examples for PEIS. It is relatively new, and the fact that the Environment Agency continuously updates its underlying data sets shows the seriousness with which they handle it.

The equity and justice are, of course, connected to the "digital divide" issues. If we are willing to consider public gateways, such as libraries and Internet cafés, and the lack of any registration or charging mechanism on the site, then it is a very good example of the Aarhus model.

6.4.2 Criteria Evaluation

Table 6.6 - Comparison of the Environment Agency "what's in your backyard?" site with criteria

Criterion	Evaluation
Does the system accommodate different user groups?	No, the system does not provide different entry points for different users, the whole section is constructed in a single way and all users are forced to use it as is.
What kind of information does the system provide for educational purposes?	Similar to FoE's approach, the main Environment Agency site provides a specialised section for youth and education (K-zone). The localised information does not appreciate or deal with this user group.
What kind of contextual information does the system provide? What level of detail is there and what is the target audience?	The site provides explanations of the various data sets (even if they are hard to find sometimes). The level of explanation is simplified, though it does provide details such as chemical formulae. However, it is sometimes unclear who the target audience is from the writers' perspective. For example, the CO description reads: "Carbon monoxide is an inorganic compound that is of low solubility in water and highly volatile. It is a colourless, odourless gas at room temperature."
Does the system support the holistic view of environmental problems?	Yes. The system shows all the information that the Environment Agency holds (or is ready to release) in one place, and it is possible to query the different aspects of this data set.
Does the system provide a place-based search facility? What kinds of maps does the system provide?	Yes. The system provides multiple methods for locational searching, using grid references, place names or postcodes. The maps that the system provides are detailed and are based on OS road maps that can be expected to be familiar for users. However, the non-standard scale may confuse some users and the small size of the map makes them less usable than they could be.
What kinds of communication does the system provide?	The system provides limited communication: e-mail addresses of people in the agency at the bottom of some of the pages. This is not hyperlinked, resulting in the user needing to copy and paste the e-mail address. Another option of communication is the ability of users to register and receive e-mail messages when the information on the site is updated. This communication is especially relevant for frequent users.
Does the system provide clear details on currency, updates and the value of its information?	The system provides details about currency, updates and value of the information - but not throughout the interface (and most notably not on the map). The ability to explore temporal information exists only in subsequent pages and requires the user to follow several links in order to obtain it.

The Environment Agency's "what's in your backyard?" compares favourably with the set of criteria, too. Its main shortcoming is in its lack of communication and the problematic language it uses in the explanations. These aspects, when put together with the usability problem, make it a rather less than ideal PEIS than it looks at first sight. In its current form, it holds the potential to alienate users through the maps or texts rather than improve awareness and participation. Considering this situation, if the Environment Agency adds more data sets to the system it risks making the system even less usable. For example, the "sea discharges" layer is displayed even when the user zooms into London!

As many have noted (Nielsen 1999), issues with usability and information architecture can be solved with relatively low investment. Thus, the system still holds the potential of becoming an exemplary PEIS. The current awareness within the Agency is an encouraging sign.

6.5 CATALYTIC DATA "HOMECHECK.CO.UK"[5]

Figure 6.11 - Homecheck.co.uk home page

Homecheck.co.uk is an Internet-based service which is operated and maintained by the company "Catalytic Data" that specialises in property and environmental information publishing. The site is targeted at homebuyers and enables them to type in the postcode of a proposed property and receive a basic report about various local environmental issues. The aim of the site is to attract clients to the fee-based services of Homecheck, which include specialised reports for experts and other services for property professionals.

The site provides a single service, where the user puts the postcode of the property in the text box at the centre of the screen (see Figure 6.11) and, after a short while, receives a lengthy report that stretches over nine screens (or five pages in its printed form). The Report is presented in Figure 6.12.

The report opens with a map of the area (the system uses an external Internet mapping site to provide this map). This is followed by 10 sections: flood risk, subsidence risk, radon risk, coal mining, landslip risk, landfill sites, waste sites, contaminated sites, air quality and pollution risk. Each section comprises of a simplified chart which indicates the level of concern (seven levels from high to low) and a textual explanation.

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[5] All the images in this section were taken from the Homecheck website (Catalytic Data, 2000)
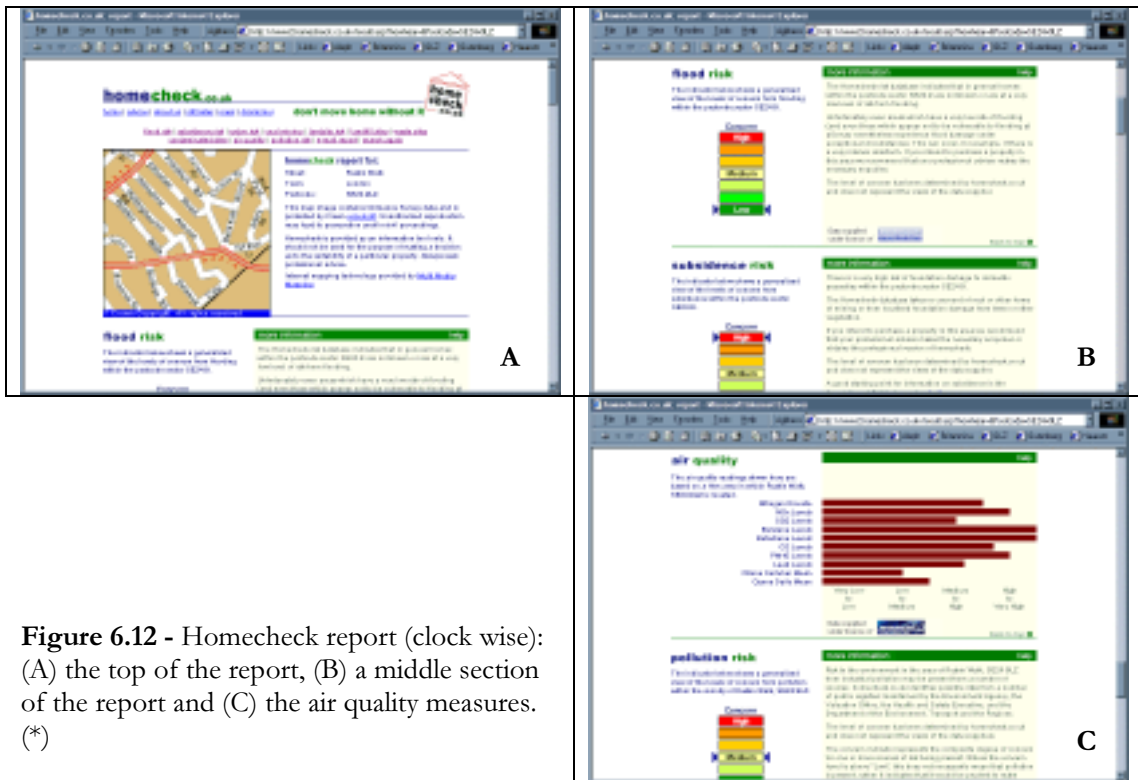
Figure 6.12 - Homecheck report (clock wise): (A) the top of the report, (B) a middle section of the report and (C) the air quality measures. (*)

Each section contains a short explanation of the specific risk at that locality and, if the user presses on the "help" link on the section, a pop-up window provides more information about the way the specific environmental topic was calculated or modelled. In many cases where the risk is high, the site uses the text "If you intend to purchase a property in this area we recommend that your professional adviser makes the necessary enquiries or obtains the professional version of Homecheck."

Finally, at the bottom of the report, the site invites the user to submit the report to his property expert. The e-mail that the site sends is displayed in Figure 6.13.

```
From: {Client name}
To: {Consultant name}
Subject: A Homecheck Report from {Client}
Date: Mon, 27 Nov 2000 09:25:15 -0000

Email from Home check

The following link shows an environmental report for a property I'm
interested in.  Please have a look:

Http://www.homecheck.co.uk/result.asp?t=EC&Postcode=SE249LZ

If your e-mail program supports linked text, you should be able to
simply click on the URL to view the report. If that doesn't work, copy
and paste the above URL into your Web browser.

Alternatively, why not visit http://www.homecheck.co.uk for more
details.
```

Figure 6.13 - e-mail sent from Homecheck to users' property expert

6.5.1 Comparing With the Models

Homecheck is very different from the other PEIS that were examined in this chapter. The aim of Homecheck is to generate revenue for its owners through the professional reporting system. However, it provides an opportunity for users to collect information about their locality, although not for the direct purpose that the site owners intended. It also provides a gateway to public environmental information (like air quality information) and, therefore, it is worth evaluating its role as a commercial information intermediary in the process of distributing environmental information.

Table 6.7 - Comparison of the "Homecheck.co.uk" site with conceptual models

Model	*Comparison*
Aarhus	Homecheck is dealing with a process of arranging and distributing information through a telecom network. Therefore, only part of the model can be applied to it. A more interesting comparison is with the 3E's + 1. The site does hold the potential to improve awareness of environmental problems, through the connection to the property market and the importance of such information for homebuyers. However, it is not clear how much it can improve participation. In the current political climate of public-private partnership, it is possible to justify the use of private body to distribute information, as this reduces the costs for the public bodies (but not necessarily to the public). This leads, however, to a reduction in the amount of information that is released on the site. Homecheck, of course, does not make any statement about sustainable development of environmental decision making - nor does it intend to deal with it. The issue of equity and justice is also relevant here. Homecheck deals with current Internet usage and, therefore, it holds the potential (at least in theory) to exacerbate the connection between social and environmental injustice.
NGOs	The NGO model is irrelevant to Homecheck. However, a skilful user can "hack" the system and reverse engineer some of it content. By doing so, she of course breaks the terms and conditions for site usage - but such information can be used to develop campaigns. Carrying out such "hactivism" is likely to happen when an NGO member has the competence to carry out such an action. It can be assumed that it will be a rather militant NGO that will perform such a deed. Another line of activity can be carried out by forcing the data providers of the site to provide it to the NGO and to use the existence of Homecheck during a campaign to release such information.
Media	The site holds no relevance to the media, as it is not aimed at them but at the homebuyers and those who are involved in the property market. Similarly to the Environment Agency system, there is a possible use of the system by local journalists who can "dig out" information about some local issues.

Environmental authority	In a similar way to the Aarhus model, the system might demonstrate the ability of a public authority to use commercial entities to repackage and deliver their information. Noteworthy is the use of the air quality information and other data sets which involve quite extensive interpolation of the model and simplification of its content. Even though the system uses the Environment Agency pollution inventory, it does not provide any link to the system described in section 6.4. This issue of transparency makes the effectiveness of the relation with the public (the third E) somewhat problematic - there is a chance that the user will feel that the agency is providing information only through the commercial channel.
NIMBY	Though not intended for this purpose, the system can be relevant for the NIMBY model. In such a situation, the user can find information held in the system about the location of a proposed development and use it in the process of opposing it. Such use might be somewhat problematic, but it is conceivable that a NIMBYer will buy the professional report to back up his opposition. Therefore, as a one-stop shop for environmental information, the site might be useful for this model.
Active citizen	In a similar way to the NIMBY model, a local activist might find the system useful for his goals and objectives. The system can provide a one-stop shop for environmental information and help in developing ideas about local issues with which the activist wants to deal. Furthermore, the report provides the source of the various data sets that the activist can explore and use for local campaigns.
General Interest	The site provides a good example of the local interest model. Like the previous two models, the ability to explore a range of environmental issues with a simplified and easy to comprehend presentation is probably beneficial for such use. Furthermore, the strong link to property value is probably a good anchor for the general interest user. This strong link is also a cause of concern. The site uses some sweeping assumptions and very generalised models. As this system holds the strongest potential for impact on a wide range of users, it might give them wrong impressions about the nature and content of environmental issues.
General model	The system does not comply well with the generalised model, though it deals with a very limited section of it. This is the result of the specific aim of the system and its clear target audience.

As can be expected, the Homecheck system does not provide a good example for PEIS. Arguably, it was never intended to become one. The comparison raises some intriguing issues about the consequences of the use of such a system and its impacts on social and environmental justice. It also provides examples of possible uses that differ from its original design and the intentions of its owners. This issue is explored in detail in the next chapter.

6.5.2 Criteria Evaluation

Table 6.8 - Comparison of the "Homecheck" site with criteria

Criterion	*Evaluation*
Does the system accommodate different user groups?	No. The system assumes one possible use - a homebuyer who wants to consider the environmental information that exists around a possible property. Of all the systems reviewed in this chapter, this system has the clearest and most targeted user group.

What kind of information does the system provide for educational purposes?	None. The system is not intended for educational uses. However, it is possible to envisage educational uses of the system, as the locational information and its simplified presentation might be suitable as a starting point for discussions on environmental issues.
What kind of contextual information does the system provide? What level of detail is there and what is the target audience?	The contextual information is brief and laconic. Not surprisingly, it contains a lot of messages about the need to consult experts and to use the full service of the company through its professional reports. The text itself is well written to explain environmental issues to an average, well-educated person - the likely homebuyer that the site owners want to attract.
Does the system support the holistic view of environmental problems?	The system supports the holistic view of environmental problems by showing a range of topics and issues that relate to the same specific point. This picture is, however, fragmented by the narrow scope of the locality. There is no way to explore adjacent areas unless the user knows in advance the spatial distribution of postcodes.
Does the system provide a place-based search facility? What kinds of maps does the system provide?	The system operates through a place-based facility. It homes in on information using the postcode. However, this is the only locational attribute that the system holds. As noted earlier, this system demonstrates the narrowness of a very localised place-based scheme. The only map that the system provides is a local street map that does not show any of the environmental factors that are described in the chart. Due to the narrowness of the locality and the nature of extrapolation from national data sets, it can be assumed that the provision of layers on a map will not make the information any more meaningful.
What kinds of communication does the system provide?	The system provides communication between users only through the e-mail facility that was described earlier. It provides an opportunity to contact the system maintainers and, finally, the option to purchase the more sophisticated reports.
Does the system provide clear details on currency, updates and the value of its information?	The system does not provide very accurate details about the data sets or accuracy of the models that are used to derive the local information from (sometimes) national scale models. This is probably the most acute problem with this system. Some partial details are displayed in the help section, but these details are not enough to evaluate the quality of the information.

The evaluation of criteria against the Homecheck system demonstrates how much this system does not comply with the concepts of PEIS developed earlier. On the other hand, some aspects of it are an exceptional example of a clear and easy to understand presentation of environmental problems (though the alarmist and extensive use of the term "risk" must be noted). It might be the case that the commercial incentives made the system owners more aware of the importance of easy to understand and accessible information. At the same time, the commercial incentives force them to present the information as something that will benefit the user only if he consults a professional before making any decision.

Homecheck also raises issues of access to information and the role of public and private players. Homecheck is an example of a very useful application of environmental information. Yet at the

same time, the system demonstrates the problems caused by reliance on private sector activity as the main channel for releasing environmental information to the public.

6.6 IDENTIFYING THE GAP

Table 6.9 provides a summary of the findings of the four case studies, in a short form. In table 6.9 the four systems are compared to the conceptual models, noting the level in which each model fits each system. In the second part of the table, the five criteria are compared with the finding of this chapter.

Table 6.9 – Summary table for the case studeis

	UK Air Quality information archive	FoE Factory watch	Environment agency	Homecheck
Type of ownership	Governmental (operated by commercial)	Governmental (operated by governmental)	Non Governmental Organisation	Commercial
Model comparison				
Aarhus	Low	Moderate	High	Low
NGOs	No	High	High	Not relevant/ theoretical
Media	No	High	No	No
Environmental Authority	High	High	High	Low / moderate
NIMBY	No	Moderate/Low	Moderate/High	Moderate
Active citizen	No	High	High	Moderate
General Interest	No	Low	High	High
General model	Moderate	High	High	Low
Criteria				
Accommodate different user groups?	No	No	No	No
Educational content?	No	No	No	No
Contextual information	Fragmented	High	Moderate / complex	Brief/laconic
Holistic view?	No	No	Yes	Yes
Place based search? Maps?	No search, limited maps	Place-based search, limited maps	Place-based search, maps	Place-based, limited maps
Communication?	One way	One way, limited	One way, limited	One way
Currency, update?	Yes	Yes	Yes	Limited

The evaluation of the case studies enables the re-examination of the state of the art in provision of environmental information to the public, and to compare this to the requirements and expectations of their potential users. The four cases show that there is a wide variety of ways to present environmental information. The various systems (and others that exist for the UK and in other countries) demonstrate that the Internet and the WWW can be used as a good delivery mechanism for environmental information. The case studies demonstrate that various players can use this medium - an environmental authority, an NGO, a private company that acts on behalf of a governmental department and a private company for commercial purposes - all systems use the WWW mechanism to disseminate environmental information. Of course, each system defines its audience differently but, nevertheless, any user who can access the WWW can access these systems. They require different levels of expertise from their users and, as noted, some of them hold the potential to obfuscate environmental topics rather than educate and help a wider audience to comprehend them.

The comparison with the conceptual models helped in identifying some issues with various potential users. Some systems, like the air quality monitoring network, though very rich at first sight, actually hold a very limited value for occasional users and fail to deliver the information in a usable format. Others, like the Environment Agency, FoE or Homecheck, are more geared toward this (generalised) user group and hold a better potential to accommodate their needs. This aspect means that PEIS deserve special attention and the attachment of a limited public area to existing professional systems will not always be beneficial.

The systems show innovations in presentation, and it is likely that any designer of future PEIS will have a wide range of systems and possible solutions to explore and to "borrow" ideas from. Other significant systems that are noteworthy include the U.S. Scorecard (which is linked to the FoE site) and the U.S. EPA systems. In the review in this chapter, examples of easy to comprehend graphs and charts were demonstrated by the Environment Agency system and Homecheck. The Environment Agency site demonstrates that scale-based evaluation (such as Bad-Poor-Medium-Good-Very Good) can be linked up to more detailed information. This is a transparent, yet easy to comprehend, presentation.

Another issue that the comparison revealed is that of updates and accuracy. Not surprisingly, the air quality monitoring network site, which is the one that is geared toward professionals or scientists more than for other users, also holds more details about updates (down to the date of which an information page was updated). There is no reason why the other systems should not contain such vital information.

The picture, however, is not perfect. The evaluation exposed some of the shortcomings in existing PEIS. The three clearest shortcomings are the fragmented view of environmental issues, the need for clear and easy to understand content and the lack of communication.

All the systems provide a fragmented view of environmental topics, and follow the reductionist and segmented view of professionals and researchers. It is not surprising to find the same view on the FoE site: this environmental NGO has internalised the same reductionist view of the professionals in order "to be taken seriously" (Porritt 2000). It is still surprising that the information on SSSI on the site is totally disconnected from the Factory Watch section. Thus, the two sites that seem to be more integrative (the Environment Agency and Homecheck), have their own problems. The Environment Agency focuses overly on their own data (and notably the map contain a layer with locations of Environment Agency offices) and does not connect this data to other data sets, while the Homecheck system focuses on such a specific locality and issue (property) that the information is not very useful for other uses.

A related issue is the ability to comprehend the information appropriately, and to understand the range of possible uses of the system by various users. As noted, none of the systems show that there are potentially different groups of users. One size fits all, it seems, or one application can serve all. The lack of examples of educational purposes of the systems, though not too hard to imagine or design, makes the system less familiar to a wider range of users and does not help to improve awareness of environmental issues in one's own locality. As noted, none of the systems exhibits an understanding that such a thing can be achieved. Furthermore, the sophistication of the information, and the unclear targeting of readers' groups and languages' can make the system less accessible to a wide range of users. It can be considered an impediment to reach into disadvantaged groups because the difficulties of use can further alienate environmental information. The FoE and Environment Agency exhibit another aspect of presentation and its difficulties. Due to lack of financial resources, FoE could not obtain detailed OS maps at a large scale (Pipes and Maguire 1997). The result is seen in the screen shots from their site and the Environment Agency site (both show the same geographical area - Fig. 6.7B and 6.10B). The FoE map is so generalised and the symbology is so large, that the map is abstract and problematic for a reader without high level map reading skills. The Environment Agency map is more detailed and, if a better layout was used and a bigger portion of the map was displayed, it would be easier to understand as most visitors to London can understand the A-to-Z maps.

A lack of communication facilities is apparent in all four systems. While the FoE SSSI section provides a limited capability for users to enter text messages that relate to a specific site, the Factory Watch does not have such capabilities. All the systems focus on information provision and leave communication as a side issue which is not an integral part of their design and implementation. The inability of users to communicate between themselves using the system should be considered an impediment. It is somewhat weird that the FoE site does not contain a strong communication facility that supports communication among local activists to facilitate mobilisation. The other systems have a much stronger "top-down" design, look and feel and therefore it is not surprising to find that they lack communication facilities.

The evaluations provide some insights into the need for a place-based search facility and the issues that relate to it. The FoE site demonstrates that such facilities must be linked up to proper scale maps; the Environment Agency shows that even if such detailed mapping is used, there is a need to consider the use of limited screen resources carefully; and Homecheck demonstrates that a too specific place-based mechanism might render the information almost placeless.

6.7 Summary

In this chapter, existing PEIS have been reviewed and evaluated. The current state of the art in commercial, NGO and Governmental systems were used to demonstrate that there is a wide gap between the requirements from PEIS, and the resulting systems. In the next chapter, these shortcomings will be examined and some ideas about future developments of PEIS will be developed.

7 Improving Public Environmental Information Systems - a Proposal

7.1 OVERVIEW

The comparison of the conceptual models with existing PEIS has revealed a gap between what is expected from such systems and what they provide. In the course of the current chapter, some possible directions for future developments of PEIS will be developed and suggested. Although these suggestions are based on the literature that has been reviewed in earlier parts of this thesis, they are inherently subjective, personal and somewhat speculative.

The ideas and directions suggested here are all *possible* directions. My intention is to explore knowledge areas that can be applied in future research and development of PEIS. Even though the following sections deal with various elements of information systems, I will not make any claims for "magic bullet" solutions. In previous chapters, the problem of "technological fetishism" – the use of information technology as an end instead of means - was noted. In such cases, the technical advances replace the broader goals of the system, and it would be a mistake to put what follows on offer as a technical fix to a problem that cannot be reduced to questions about information systems design and implementation alone. What I am aiming for is to demonstrate that by synthesising existing knowledge it is possible to develop PEIS that will be "near the mark", more so than the current state of the art.

The chapter opens with a short summary of the "wish list" from PEIS. This wish list summarises the requirements of and expectations for PEIS. This is followed with an exploration of the theoretical framework for such a system. In this section, I will demonstrate how ideas about democratising technology can be used to create "philosophically grounded" information systems. In light of the criticism raised in Chapter 3, of implicit philosophy which is integrated in information system design approaches, this seems necessary. Furthermore, I will endeavour to claim that such grounding is required for PEIS more than for other systems. The following sections move into the practicalities of such hypothetical systems. Three aspects of PEIS design are examined in detail. Firstly, the functionality of PEIS - the various parts that constitute PEIS and the ways in which they can be integrated. Secondly, the ways in which the information is "packaged" (in other words - the presentation and content of PEIS) will be explored. Finally, I will describe aspects of interface and wider access to ICT.

7.2 PEIS WISH LIST

Building on the literature and the findings of the empirical studies, it is possible to construct a "wish list"- a detailed account of expectations from PEIS. Such a list describes all the qualities and

functionality that are expected from a full-fledged PEIS, according to the findings of the thesis and the literature. In particular, the wish list is based on:

- EU directive 90/313/EEC - "Freedom of Access to Information on the Environment" (1990),

- Agenda 21 (mainly Chapter 40) (UN 1992a),

- Hallo interpretation of public access to environmental information (Hallo 1997),

- Princton Economic Research report on the EPA Customer Survey (Princton Economic Research Inc. 1998),

- Aarhus convention (UN/ECE 1998),

- OECD seminar on public access to environmental information (OECD 2000b), and

- the empirical studies that were described in Chapter 4.

It is important to note again, that the position that I adopt throughout this thesis toward the attitude of politicians regarding public participation and provision of information is the one that the documents above adopted. Namely, I assume that the political system views public participation as a positive action and that it is willing to release information, in order to improve such action. This is knowingly a naïve position, but it is taken as to demonstrate that even if we assume such political support toward PEIS, there are major challenges that must be overcome if a *real* PEIS is to be developed.

The wish list is divided into 5 sections: aims, technology, content, presentation and functionality. This division is based on the following model of information systems (Figure 7.1). The information system is designed to accomplish certain *aims*. To accomplish them, a specific technological apparatus is assembled. Three aspects of this apparatus are identified: *content* - the attributes that relate to the information stored within the system, the *functionality* that the system provides and *presentation* - the ways in which this information is represented to the end-user. Of those aspects, content and presentation are sometimes inseparable. Therefore, a special section is dedicated to these boundary issues. When a *user* uses an information system, there are certain *filters* which are being used. They influence the ways in which information is perceived and understood and, although many of them exist in the mind, they are represented in the figure as mediating the user's experience with the system.
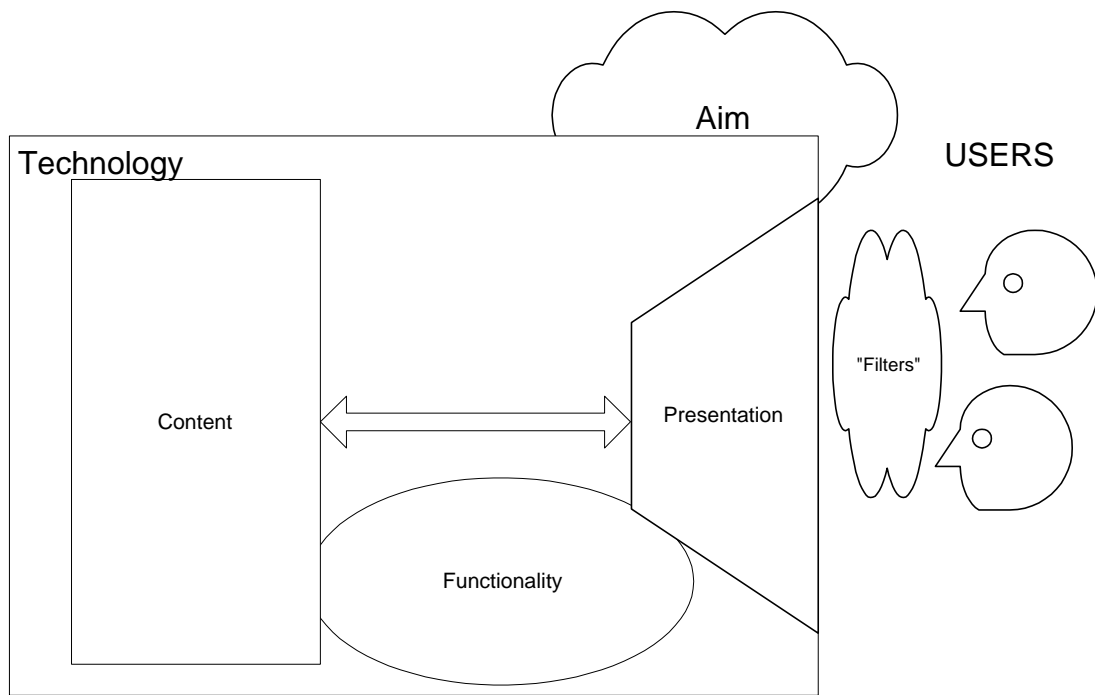
Figure 7.1 - Conceptual division of information systems elements

The aims of PEIS include improvement of awareness to environmental problems, environmental protection, public participation, equality and justice; transparency and accountability of public authorities; and opening up the possibility for the public to communicate concerns and for public authorities to take these concerns into account. *The technical expectations* are that the system will be Internet-based and utilise geographic information technology (or GIS in the broadest sense of the term). Furthermore, it is expected that it will be based on the WWW and will be integrated into it. The two main *functions* of PEIS should be information provision and communication. The system must enable the display of information in a multitude of forms (see section 7.2.4). It should also provide end-users with the capability to add information - either spatial or aspatial. The system should support different types of communication. These include the ability of end-users to locate and contact experts but also to get in touch with others in their locality. Though advanced ICT can be part of this communication scheme, the system should support other modes of communication (like details about office location and operation hours). This communicative aspect can be seen as part of a shared exploration and deliberation, as well as mobilisation.

For both purposes, the system must be adaptive - as there are many uses and many attitudes, and one size won't fit all. Finally, the system should confront a wide range of computer literacy and skills. This includes support for information intermediaries who act on behalf of other users.

The next element of PEIS in this model of information systems is the *presentations*. When presenting environmental information, it needs to be presented in an understandable, non-technical manner. The information should be presented in different, often apparently redundant, formats that are vital for comprehension. The use of maps is noteworthy in this context, although there is a need for more easily comprehended representations (such as aerial photographs and Virtual Reality or 3D

models) for those with limited map reading skills. In general, it means that information should be presented in a simplified way.

Next, *the content* needs to be based on scientific information sources. It should have details about other sources of information and act as a "clearinghouse" or "gateway" for those sources. This capability should go beyond the basic metadata repositories (which focus on cataloguing sources of information) and provide methods to streamline the combined process of finding and obtaining information. It should also provide the capability to integrate various sources and combine multiple study areas; and to store and retrieve information entered by end-users.

Finally, several topics relate to both presentation and media. Information must be presented in its context: in a way that will enable the interconnection of various topics in an holistic manner. This requires an appropriate organisation and presentation. A place-based organisation scheme seems to offer this and should be one of the favoured options. Content should relate to topical issues and provide more details about the likely interests of users (which are driven by the general media). Connections to traditional media such as radio, TV and local and national newspapers should be integrated through direct electronic means - as in the case where media sources have websites - but also in other ways that will expand the information provided by such sources. Content must be trustworthy and authoritative. Trustworthiness and authoritativeness can be improved by ensuring that information is accurate, up-to-date and comprehensive. These three elements should be conveyed in the presentation too. Finally, the content and presentation should accommodate the variety of audience groups and should be "tailored" to the target audience.

7.3   DEVELOPING THEORETICAL GROUNDING FOR PEIS

7.3.1   The Need for Theoretical Grounding

The above "wish list" touches ideas that are beyond the technical realm. The basic claim for "improved participation" can be interpreted in a minimalistic way. This means that blocking access to information makes participation practically impossible. Thus, providing access to information improves public participation. This interpretation does not seem far from the legal approach to "passive" and "active" information provision (Hallo,1997; OECD, 2000b). Such provision, however, does not hold the potential for "improved awareness", as it is based on the public's need to be active in the process of information consumption - whereas "improved awareness" seems to imply a certain passivity on the public side. Furthermore, the claims of improved justice and equality, as well as the communicative process of passing information to and from the public and the transparency of public authorities, all imply a much deeper sense of democratisation than in the legalistic "passive" or "active" forms.

To achieve such ends, these concepts must be embedded into PEIS in a way that consciously connects general aims with specific implementations. A good example of that is the claim for communication. If a dual communication channel is deemed necessary, do we need to spare a

thought about the way it is implemented or can we sustain claims such as "any bulletin board system - where different users can log on and post messages in a shared space - will do"? I am arguing that if we wish to achieve the aims of PEIS, we need to demonstrate the connection between the theory of technology - and especially its integration in democratic processes - and the specific utilisation of this technology. This is needed to provide a framework against which the implementation can be compared and evaluated.

As was noted in Chapter 3, such explicit connection between theory and practice is not common in information system design. Information systems design approaches are not "value free" because they present a specific world-view, which is systemic, and sees organisations as goal-seeking entities. The ethical aspects of information systems design are rarely explored (Wood-Harper *et al.* 1996). In this light, the connection that will be made in the following sections might seem a little strange - though it can be argued that the real question ought to be "why isn't such analysis carried out more often?"

My aim in the following sections is to explore the meaning of PEIS, and to offer the framework for their development. After doing so, it will be possible to deal in turn with each of the elements of PEIS and to show how the theoretical framework links to specific sets of tools or methods.

7.3.2 Is a Democratic Information System Possible?

What does it mean to have an information system that improves public participation, equality, justice and transparency? What is the role of information systems in processes that are inherently social and political?

An obvious observation is that such information systems are not expected to *automate* the above processes (such a ludicrous idea must be considered, as this is the main rationale for creating information systems in general) but to *support* and *enable* them. Furthermore, the *communicative* capabilities of computers play a major role in the ways their potential contribution is conceptualised and understood, and enhance their (traditional) information provision capabilities. Thus, here is an opportunity to explore the full capabilities of recent computer-based systems, as the (relatively) new acronym, ICT, implies.

There is a need to provide sustainable grounding for claims that a certain information system can support democratic processes. To this end, I will rely on Andrew Feenberg's ideas in "Questioning Technology" (Feenberg 1999) and I adopt the critical theory position toward the ability of society to influence and use technology. Before turning to a short description of Feenberg's conceptualisation, it is important to note a major difference between the current discussion, and Feenberg's broader one. The difference stems from the two possible meanings of the term "democratising technology". Feenberg's focus is on the use of democratic processes to create, formulate and influence technological domains. My focus is on the meaning of technology that can sustain democratising claims - that by constructing and using this technology, we improve the public sphere in a democratic way. These two ways are not disconnected, as it is likely that

technology that was not created along the first concept will find it hard to sustain the second. It can be argued that the shortcomings of existing PEIS stem from their top-down, exclusionary design.

Feenberg's approach sees technology as a social construct (hence it can be categorised as part of the social constructivism stream). The vital part in controlling technology is the process of design - where it is possible to negotiate and discuss the nature of a technical artefact before its closure. Wider participation in design and control over technological objects offers the opportunity to integrate a wider range of social positions into the technical code and, therefore, provide opportunities for democratisation. Such participation can be done intentionally, or through the actions of citizens as they react in certain ways to a technological system and force it to change (consumer boycotts can be considered one such action). This mode of interaction offers the integration of "participants' interests" into the design process. Deep democratisation, in Feenberg's terms, involves the embodiment of "participants' interests" (social, political and so on) into technical code. The reason for this is the real barriers for entry in technocracy - especially the need for lengthy specialisation and knowledge building. He suggests that combining this alteration of technical codes with electoral control over technological institutions is a means of achieving "deep democratisation" of technology (Feenberg 1999). Feenberg notes that his concern is with "the survival of agency in technocratic societies and, more particularly, the ability of modern men and women to act as agents in the technical sphere from which technocracy draws its force" (Feenberg 2000)

Using these concepts, it is possible to advance the construction of information systems. More specifically, to "pick from the toolbox" those elements that can support democratic processes. Such systems can be developed in a collaborative manner and support claims of equality. The possibility of building a "democratic information system" is examined in the next section.

7.3.3   Systems That Are Built To Be Hacked

To achieve the PEIS aims that were described earlier, I offer the concept of "systems that are built to be hacked". At the root of these system is the concept of participation and collaboration between those who design the system and those who use it. Thus, the concept of "hacking" will be connected to democratic principles.

As Feenberg (1999), Castells (1996) and others have noted, one of the fascinating aspects of ICT is their elasticity - the ability of users to change systems "from within" or "hack" the system to suit their needs. This is an inherent aspect of computer-based systems, as they are programmable and can be changed by replacing the coded set of instruction that cause their operations. The most commonly cited example is the alteration of the French Minitel from database query system into communication system (Castells 1996, Feenberg 1999). This hacking can be traced back to the early days of e-mail, which was implemented by computer scientists by converting networks that were designed to facilitate data transmission into a human communication medium (Dutton 1999). Although these two examples are widely cited, they are far from anecdotal and unique - they are

practically the standard in computer use. In their contribution to a discussion about the social implications of information systems both Grudin (1999) and Hearst (1999) provide ample examples of the unexpected consequences of information system implementation and use. One of the more striking examples relates to the (now ubiquitous) hypertext link between documents, the essence of the WWW. In early scholarly discussions, it was suggested that any linkage between two documents ought to be bi-directional to facilitate navigation - as soon as a link is established between document A and document B, the computer system links document B to A, automatically. However, once the WWW was conceived, the idea of automatic completion of the second direction (from the linked document to the linking one) must be rejected. Imagine the case where "hactivists" choose to bring a website to its knees simply by linking to it. This short sightedness of early researchers is the direct result of their feeling of control over systems. In a well-controlled and closed hyperlinked system, the bi-directional linkage is extremely powerful. In information systems that have to confront the public domain, with its social and political complications and where human agents operate and influence the system, the same concept is outright useless. A much more common type of hacking can be seen in many shops. In many cases, the cash-register software is designed to handle cash transactions in the purchase process. This does not prevent shop assistants from using the same system in a mock transaction to verify the cost of an item. Many experiences of hacking of that sort are going unnoticed. The HCI literature turns our attention to these experiences as Landauer does throughout his book (1995). Outside the HCI literature, however, these activities are not widely noted.

When we try to conceptualise the emerging pattern from all those cases, three themes emerge. These are the importance of hacking - the process of using a computer system not along its original specification, "meaning hacking" - using existing systems in new ways that change their meaning (without influencing their functionality) and the fluidity of technical closures in the realm of computing. Hacking is the most visible of these three. In all cases where hacking occurs, the engineers who created the systems were either ignorant of social implications or were unable to foresee them (i.e. they failed to conceptualise the social implications). This leads to hacking of a system by its users in order to adapt it to their specific needs.

Secondly, we can identify "meaning hacking". Feenberg (1999) offers an insight into such interaction. In his account of ALS (Amyotrophic Lateral Sclerosis) patients and caregivers use of a Bulletin Board System (BBS) to exchange information and to provide mutual support, he provides a description of a group of people who are introduced to an existing computer system - Prodigy - and utilise it for their specific ends. The users did not change the essence of the system: the way it operates, the way users log into it or the way they submitted messages. For these people, the history that led to the creation of Prodigy, BBS and CMC is of no importance; what they have done is to adopt the technical environment Prodigy provides to suit their social/personal context and meaning. In this sense, the concept of BBS went through a certain level of closure where its functionality is taken as given. This does not prevent the use of the same "container" for a very

wide range of human activities. Any examination of the global Usenet BBS (which supports thousands of discussion groups) will show that at any given moment it is used to exchange information about technical problems, share local knowledge, look for romance, transfer sexually explicit video material and so on. Though the technical protocol that forms the basis for Usenet went through technical closure years ago (Kantor and Lapsley 1986), it is hard to claim that the system as a whole stabilised in its meaning or content. The lesson from such observation is that CMC/ICT systems can stay flexible for a long time after technical closure occur.

A third observation on the nature of ICT development concerns the inherently transitory nature of closures. Though some very basic standards in computing endure through time, in general, standards are in a constant state of flux. The all too common "version number" attached to computing standards is indicative of the continual changes that they undergo. Unlike other technologies, where closure happened within a limited period of time, here we stand in front of a complex technological realm where many closures (where major vendors agree on a common standard) occur and, after a short period, they are dumped altogether (as in the case with punched cards), mutate (as happened to mainframe computers) or constantly change and adapt to new innovations. This observation seems to hold true for over five decades and, if current predictions are correct, the flux will continue for at least another decade.

The concept of "systems that are built to be hacked" is based on these three observations. The starting point for such systems is to accept that computer systems are likely to be "hacked" by users. Instead of resisting this, or assuming arrogantly that it is possible to predict all future uses, a system should be engineered to make it easier for users to change and adapt it. To that end, it will be engineered as open-ended, flexible and transparent. The user of such a system is active in the process of shaping the essence of the system and its content. Such a system should support the two forms of hacking that were identified above - meaning hacking and functional hacking. To support meaning hacking, the system should provide rich means of communication among users. This communication should not be limited to BBS or distinctive areas of the system that focus on communication. Rather, communication among users can happen when a user reorganises information on the system in a novel way and adds textual information to it that explains why this presentation is meaningful for her. If the system supports the easy integration of different perspectives and enables other users to find these representations while providing opportunities for direct communication, it is akin to public debate where the various parties present their positions and open them up for discussion.

Beyond meaning hacking, the system should facilitate more concrete hacking - i.e. to identify the vast array of possible uses of the information stored in it and provide various means to organise, manipulate and process it, without presumptions about the ways in which it will be used. Some tasks can be codified and supported by a basic template. For example, presenting the information that the system holds for a specific locality for the "need to know" user can be codified in such a way. However, such templates should not be closed, and the system must support users who want

to add or remove information from specific presentations to suit their goals. However, the most important aspect of "systems that are built to be hacked" cannot be encapsulated in computer code. This is the mindset of designers and operators. More then anything else, the idea behind these systems is a close collaboration with the users. Those who create such systems must accept the principles of collaboration - to listen and understand what the users want to do with the information and continuously to scrutinise the usage patterns of information. By moving towards this model of collaboration between system designers and users, I believe that users will feel a stronger sense of ownership over the system while the transparency and openness will improve trust. As was noted before, this is based on the general principle of user-centred design, although arguably pushing it further to collaborative design, which is human-centred. A call for such approach can be found in Moggridge (1997) who argues that information system design does not incorporate aspects that are important from humanistic and feministic perspectives. She mentions three aspects specifically - the need to move toward collaborative inquiry, to integrate feministic ideas - especially to provide opportunities to raise "women's ways of knowing, communicating, researching and working" (p. 53) and human-centred system development.

Using the same division of Figure 7.1, I will outline the different aspects and components that can be used to materialise the concepts of "systems that are built to be hacked". Before doing so, there is a need to appreciate those closures that I will take as given. My aim in the following discussion, therefore, is to suggest that in the current computing environment, the wish list can be implemented through a careful and appropriate selection of tools that are based on currently available technologies.

7.4   THE THINGS WE CANNOT CHANGE …

There are several elements of a PEIS "computing environment" that seem to be universally accepted: it constrains the range of tools that can be deployed in their development; and some of the elements have already reached technical closure and are treated as "Black boxes" that cannot be changed. Other elements are still in a state of negotiation and open, at least to a degree, to intervention in their design.

Taking into account the limited resources that are available to address environmental issues in general, and especially PEIS, the following analysis assumes that PEIS design can utilise existing technological solutions, but it is unrealistic to call for development of totally new technologies. The elements that need to be considered here are: the nature of ICT devices, the Internet, the WWW and its applications and the likelihood of access patterns. Firstly, it is likely, that for the short and medium time scale, we will continue to rely on digital computers and their applications to access information sources. The actual access device, however, will not necessarily be a personal computer (Gens 1998). In his review of Universal Usability, Ben Shneiderman (2000) notes the technical variety that future systems ought to accommodate. This includes issues such as:

- processor speed - from slow and limited hand-held computing processors to top of the range workstations;

- screen size - from the small screen of Wireless Application Protocol (WAP) cellular phones to high definition 21" monitors;

- input and output devices - keyboard, speech recognition, text to audio devices, telephony; and

- software - a wide variety of operating systems and applications (such as different browsers).

Of course, the use of different devices means that the "user experience" (the state of mind, his/her environmental conditions) is inherently different. Access to information from a workstation located in the living room, during the evening hours is totally different from access to information through a mobile phone while driving. This aspect should be taken into account in design.

Secondly, the Internet and the WWW as a major delivery medium will continue to develop in its current form. That means that even though technological advances will appear over coming years, the basic structure will remain very similar. Therefore, the distributed, loosely-coupled network of websites will remain. This technical domain is based on protocols such as HyperText Transfer Protocol (HTTP 1.1) or HyperText Markup Language (HTML 4.0) which are largely settled. In reality, current WWW protocols create a "dual speed web": on the one hand, they enable non-experts to create and maintain information sites while, on the other, they provide the capability for more technically knowledgeable users to control the layout by using Cascading Style Sheets (CSS level 1) or, for those who want to develop sophisticated applications, to use the eXtensible Markup Language (XML 1.0). By doing so, the Internet provides a "layered" technical environment where actors with different technical capabilities and goals can present their information. This environment is not a totally level playing field in the sense that it is possible to tell a well designed, professionally crafted website from that created by a novice. It is level in the sense that all these actors can use it to publish information. Another aspect of the Internet is the speed of access to information. In this domain we are likely to see a variation similar to the one identified in access devices, with some users relying on telephone-based modems with limited transfer capability (56Kbps) and those who will have faster access (100Mbps and more) (Shneiderman 2000).

Thirdly, and as was discussed in length in the course of Chapter 2, the "digital divide" will not disappear rapidly. It is reasonable to expect a similar trend to other technologies (like the telephone or TV) with a significant slow down after rapid diffusion into wealthier sectors of society. The current political awareness of the problem may be a source for optimism, since it may result in action by governments to increase access.

7.5 … AND THOSE WE CAN

Once the "environment" - the stable elements which are taken as given for PEIS development have been identified, attention can turn to implementing the wish list. Following the structure of the wish list (and Figure 7.1), it is possible to offer elements that will meet the requirements outlined so far.

7.5.1 Systems' Functionality

PEIS should serve two main functions - information provision and communication (section 7.2.3). The two functions must be integrated throughout the system and not separated into distinctive segments: the information provided by the system must be connected to the communicative processes for which it is used. This will also enable users to perform "meaning hacking" as this type of action is inherently based on communication among users. Examples of such implementations already exist, and provide a basis to work from. One such example is CRANE, developed by Horita (2000). Using an argumentation framework, Horita describes an environment that provides multiple perspectives on community conflict about proposed development. The computerised system provides access to spatial information, strategic options and a designated discussion area to develop arguments for and against each option in a structured way. In this implementation, Horita included visual cues in the strategic mapping window to show how the discussion develops (see Figure 7.2). The method he proposed provides a computerised way to structure the discussion and to link the various information elements in a unified framework. A more basic form of connection between geographical information and communication is offered by other researchers (Kingston *et al.* 2000, Krygier 1998, see also review in Laurini 2001) where end-users can point to a geographical object and write a message about it. This can be seen in "real world" sites like the FoE system which deals with sites of special scientific interest and provides similar functionality (Chapter 6).
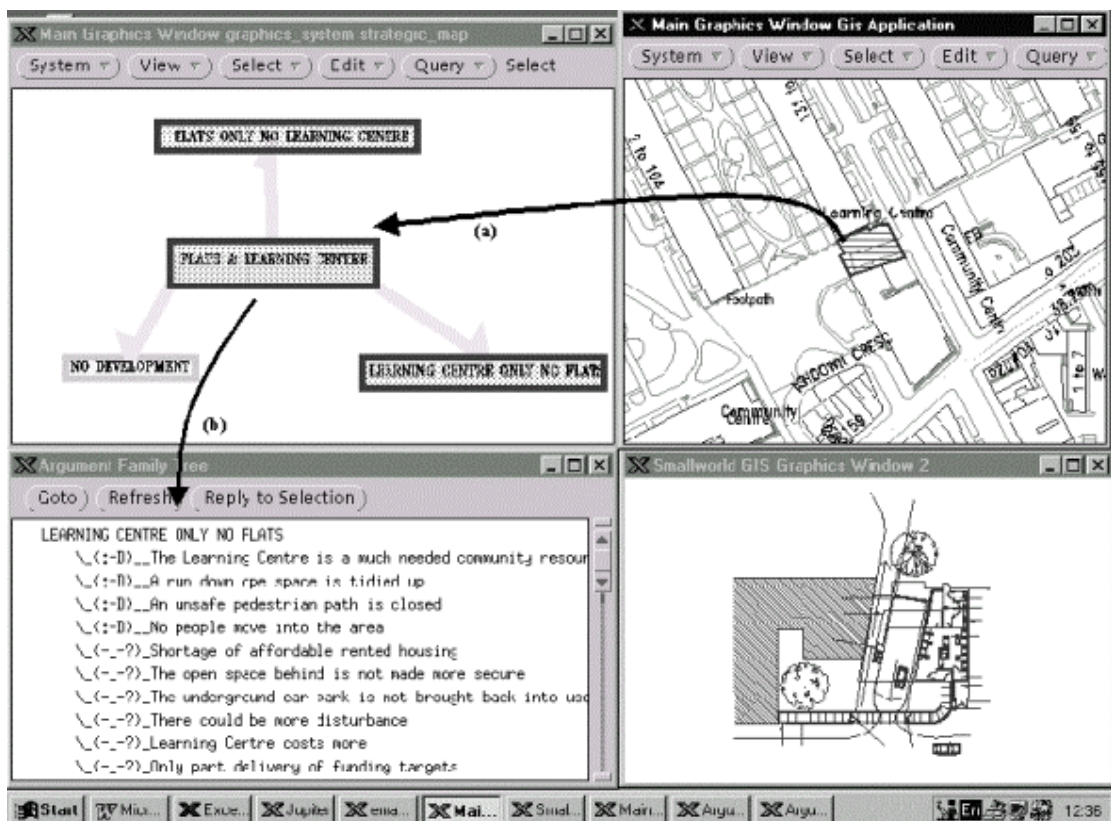

Figure 7.2 - Link between the geographical, strategic and argumentative representations: (a) spatial objects relevant to a scenario can be highlighted via the editor of the scenario; (b) this in turn updates the argument tree (source: Horita 2000)

These systems are far from providing a complete and comprehensive solution for tight coupling of information and communication; they have some serious usability and accessibility shortcomings, as we shall see later. They are, however, a starting point that can be used to develop upon.

The extent to which information and communication can be coupled can be seen on the slashdot website (www.slashdot.com). This is an information system that was designed to provide a medium for computer nerds to share the latest news and ideas. On this site, every information item is open to discussion on a bulletin board that appears on the same web page. At the same time, the site demonstrates the problems of such an approach. Issues that interest many (such as the latest developments in Microsoft's antitrust trial) spark many responses. Such discussions are impossible to follow as the bulletin board gets cluttered and its communicative role diminishes. Such communicative schemes can be supported by intelligent systems that are based on Artificial Intelligent research, for example, the "Risk Agora" system which aimed to support deliberation (Mcburney and Parsons 2000).

End-users need to adapt systems to their own needs, and to be able to restructure information presented in new ways that are meaningful for them. This is not as radical a concept as it may seem, and examples for such applications in the WWW context already exist. The ability of users to adapt web-based systems to their own needs has been termed "Personalisation" and has received much attention recently (Riecken 2000). As Reicken states "personalization is about building customer loyalty by meaningful one-to-one relationships; by understanding the needs of each individual and helping satisfy a goal that efficiently and knowledgeably addresses each individual's need in a given context. To extend this point, it is about the mapping and satisfying of a user's/customer's goal in a specific context with a service's/business' goal in its respective context. Clearly, this is a difficult problem" (p. 27). Due to this wide applicability of personalisation, and the importance of loyalty in the commercial arena of the web, this attention leads to research and development programmes that cover issues ranging from software engineering to usability and interface design. This is a fruitful area to draw upon and to select lessons that are appropriate for PEIS implementation. When selecting from the "personalisation toolbox" we need to be conscious of the adequacy of the various techniques and tools for PEIS. For example, the integration of communication should be carried into the parts that are created by end-users - to keep the principal that the system is a deliberative arena, where interpretations and presentations are open to discussion by all parties. Users should be able to create personalised pages that serve their personal needs (such as information that is relevant to their locality and interest) but also to create personalised pages for public display. This enables local activity groups to put forward presentations that reflect their interests. Furthermore, methods that provide just top-down personalisation are not adequate. Such a system is Amazon.com's collaborative filtering where your "book recommendations" are based on Amazon's database analysis of your profile (what you have bought thus far) with others who hold similar profiles. The user has no opportunity to control the process, or to know how it was carried out. As mentioned above, if we want to follow principles of collaborative design of PEIS as

technical objects, we need to keep them as transparent as possible. This means that collaborative filtering can be used only if the way it computes is transparent to the user (i.e. a full explanation of the algorithm is provided in plain English) and the user can alter its parameters to suit her needs.

Furthermore, the ability to change the site should go beyond the personalisation of content that is common in web portals, such as Yahoo!, where users can adapt the content of the system (Manber *et al.* 2000). This functionality is, of course, needed for PEIS - as users will need to rearrange the information in the system in to a form that suits their interpretation. However, there is also a need to enable users to enter their own information into the system. Again, this does not represent a technical hurdle - some operating examples for such functionality already exist. One of the best examples is Frontier by UserLand.com: Frontier is a web content management system that provides an environment for a browser-based content system (Manila). This means that the same software that is used to view the system can be used to edit its content. Frontier separates form from content by allowing users who want just to enter textual information to focus on the content while providing HTML templates to store it. At the same time, Frontier provides the tools to change templates easily. Examples of Manila/Frontier sites are available at the free web hosting service www.EditThisPage.com and provide good examples of the flexibility that this system offers.

7.5.2 Presentation of environmental information

The need for multiple representational forms - graphs, charts, maps and text should not cause any difficulties. Examples of multiple representations exist in some systems. One such example, reviewed in Chapter 6, is the UK Homecheck system (www.homecheck.co.uk) which provides a map, simplified charts (using a range of low-medium-high) and textual information on one page. Another example is the USA Scorecard (www.scorecard.org) which provides a gateway to various environmental databases and presents them using maps, charts and text. Scorecard is especially noted in this context as it also utilises hyperlinks extensively to connect various themes and topics. This can be improved even further through interactive highlighting of topics in various windows - i.e. providing links between similar objects in their various representations in what is termed "brushing" (Monmonier 1989). Such direct links between different representations are not common in existing systems and seem to be useful. This capability can be integrated with personalised pages, in which the objects that the user chooses to integrate on her page will be automatically linked by the system.

As was noted in section 7.2.4, comprehensible representations - such as familiarised maps (for example, the London A-to-Z) and aerial photography - should be used as the background for environmental information. The use of 3D models and Virtual Reality representation should be used where appropriate, but their use for PEIS is uncharted territory that requires more research.

7.5.3 Content

PEIS need to integrate scientific information with other sources (including the information that users have entered). Furthermore, this information spans the range from raw data to journalistic reports. The identified need for holistic views of the available information means that there is a need to associate these ranges of information "objects" in a common framework that will make them accessible. Such integration of various information objects is possible technically through the use of "metadata" (Chrisman 1994). This form of information "dictionary" is now commonplace within the professional community. For geographical information (and by implication environmental information) there are national metadata standards which enforce the format and content. In their "raw" format, these metadata dictionaries are more likely to alienate lay and occasional users than to assist them in the process of acquiring information. Furthermore, the need to integrate different types of information sources forces us to conclude that any single standard would not do. However, this is an area where research can help by identifying an appropriate metadata scheme (the keywords that should be used, the categories etc.) and developing appropriate systems that will facilitate the search activities of non-technical users. Current research on Internet search engines and Internet portals can be used as a basis for a universally accessible information location method. Furthermore, and as was noted already, geography might prove to be one of the most useful ways to arrange environmental information. The use of a familiar geographical reference (postcode) is very common as a method to "zoom" to data sets that relate to that location. Scorecard and the EPA websites use similar methods. Future research can explore the options to integrate place-based search techniques with text-based search and category browsing (similar to Yahoo!). Scorecard provides an example of such an organisational scheme. It uses environmental issues (topics) and geography to "home in" on specific sets of information.

The need to integrate and juxtapose different data sets can be considered part of the personalisation capabilities mentioned above. One such technological development that is currently underway is the Open GIS Consortium (OGC) Web Mapping Testbed project (Open GIS Consortium 1999). In this project, the consortium members developed the foundation for a distributed mapping scheme where specialised software uses multiple data sources and integrates them before delivery. The project aim is to develop interoperability between various web-mapping servers in ways that will enable the creation of new, integrated maps by rearranging existing sources. Though this is a technical development, it opens up the possibility of developing appropriate integrating components that will facilitate the creation of customised maps by end-users. Another on-going development that needs to be mentioned here is the development of the Aurora partnership (www.aurorapartnership.org). This is a US based partnership incorporating federal, state and local government and private bodies. This public/private collaboration aims "to stimulate the development and applications of decision support tools, services and systems for natural resource and environmental management. It seeks to address the needs of policy makers, land and resource managers, and county and community leaders" (Aurora Partnership 1998). Aurora adopts an

holistic approach to application developments and tries to connect software vendors, data producers and users. As such, and especially in light of its emphasis on environmental issues, it can be an adequate platform for development and testing of PEIS components.

7.5.4 Content / Presentation

The need for scientific information that complies with standards of accuracy and will be current and comprehensive on the one hand, while being accessible and understandable presents a serious problem. In a sense, the information itself, its language and presentation are all part of the "technical code" that requires specialisation and knowledge gathering. Therefore, it presents a major barrier for PEIS users. To deal with this issue, there is a need for an approach that tackles content and presentation simultaneously. There are two fields of study that can be used as a basis for future developments: Public Understanding of Science (PUS) and Human Computer Interaction (HCI). PUS is an active research field which has received attention within science circles in the last decade - as the Royal Society's report "To Know Science is To Love It?" demonstrates (COPUS 1995b). The activities in this field include action to improve the understanding of science among the public, as well as academic research that tries to extend our understanding about the ways in which science and technology is perceived by the public (Irwin 1999). One of the challenges that PUS research advocates is to move away from the "deficit model" (Gregory and Miller 1998, SPSG 1998). Simply stated, the "deficit model" is the common notion that the main problem with public understanding of science boils down to lack of knowledge on the public side (hence a "deficit"). Therefore, by improving education and providing more information to the public, this deficit can be filled and the public will understand science. This simplistic model is challenged with the observation that public relations to science and technology are far more complex. This includes issues of trust, risk assessment, different world views and so on. It can be argued that the Aahrus convention exhibits some signs of the deficit model - especially in the connection that it makes between access to information and improved awareness (UN/ECE 1998). It will be wrong, however, to claim that it promotes only a top-down approach of education, as it provides a space for NGOs to be active in the dissemination of information.

PUS research, in both forms, provides us with methods and tools to shape environmental information into an accessible form. Furthermore, the research programmes in PUS tackle a wide range of audiences - from school children to people who live in the vicinity of a polluting factory (SPSG 1998). Noteworthy is the observation that environmental awareness and perceptions are one of the issues that received attention in this research field (for example, Eden 1996). PUS experts, and lessons learned in PUS research, can be used to shape the presentation of various environmental topics, to select the language and explanations of those topics and so on. It is important to note that some EIS researchers have already remarked on the issue of presenting environmental information to the public (Hoppen *et al.* 1996). PUS alone, however, does not provide the full set of tools that are needed for PEIS. Reliance on computing environments for the delivery of information and interaction can present a major obstacle for potential users (Landauer

1995). The lessons learned in HCI studies, especially those that relate to the design and implementation of web-based systems (such as Nielsen 1999), provide a way forward. HCI research can help in designing system interfaces that will make operations like finding information or reorganising information easy for users with limited computing knowledge. The use of the HCI approach to the design of PEIS holds another advantage, which bounds neatly with the theoretical approach that was described earlier. As was mentioned in Chapter 3, HCI researchers advocate the use of the UCD approach to the design and implementation of information systems (Preece 1995). UCD is an inherently participatory approach - it requires a continuous interaction between system designers and implementers and their proposed users. Of course, web-based interaction presents new types of problems and raises many issues. Among them, it is worth noting Nielsen's "first rule" of Internet user experience which states "Users spend most of their time on *other* sites" and, therefore, they carry habits and conventions from other interactions (Nielsen 1999). For example, Nielsen mentions the aspect of the number of links on a web page. Although researchers thought that high number of links on a page is inappropriate, it became the *de-facto* standard in successful websites (through decisions of site designers) and was proven as a useful feature (Nielsen 1999). Therefore, other sites should follow this convention and provide a rich array of links. Figure 7.3 presents two versions of the EPA web-sites. The recent design (launched May 2000) shows how this trend was integrated in a PEIS.

Figure 7.3 - The EPA home page: (A) the previous design (B) the design since May 2000

Noteworthy is the larger amount of information on the front page (in the current design there are 3 screens of news and links) and the increased number of direct links. This is an example of updated PEIS which follows "Nielsen's rule". In general, existing PEIS demonstrate diversion from convention. The situation is exacerbated by the GIS components which are problematic even outside the web context (Traynor and Marian 1995). It is wrong, however, to claim that there are no activities to improve the situation, including the development of systems that will enable users to reprogramme GIS functionality easily (Traynor 1998, Traynor and Williams 1997) as well as activities to evaluate public use of GIS (Nyerges and Jankowski 1998). This range of research projects can be used as the starting point for future developments.

As noted earlier, current efforts in Public Participation GIS projects over the Internet - such as those described by Kingston *et al.* (2000) - seem to miss the opportunity to improve usability because they carry the interface of traditional GIS. Such efforts make claim for improved access by

removing functionality from the GIS. By doing so, they limit the abilities of system users and decrease its usefulness. For example, in one case, they provide an opportunity for users to add their own textual information by pointing to the map, and entering information. The information the system collects is not organised in any way and, to view the comment, any other user needs to point and click on a point on the map. As noted, CRANE's offers a much more structured information representation (Horita 2000). CRANE shortcoming is in its obscure interface and unfamiliar working environment. Horita noted this point and mentions the development of a similar system, but through the use of a Java application.

Not surprisingly, researchers in both areas - PUS and HCI - advocate the use of their knowledge as a way to improve the trustworthiness of information systems. Clearly, combining information like "last update day", logos and appropriate text can improve the authoritativeness of the system. HCI and PUS can also serve as useful fields for another aspect of future PEIS design - the need to accommodate a variety of users with changing "identities". One possible approach is to identify "audience groups" and to tailor information directly to their needs. Figure 7.4 presents such an approach that was part of the previous design of the EPA website.

Figure 7.4- EPA website point of entry for audience groups

These entrance points still exist in the new design, through a link in the sidebar of the front page. Though it is possible to envisage the existence of special needs for specific audience groups, the analysis of multiple identities within PEIS users calls such compartmentalisation into question. This design not only forces a user to consider "what hat she wears" when she enters the site, it is also likely that different design will be applied to different sections of the system (as indeed happens in the EPA site). A much better approach, it seems, is to enable the mixing of identities as part of the personalisation capabilities of the system. That way, the user can "pick and mix" those information components that are relevant to her.

Finally, the need to link to existing and popular information sources can be used as leverage for future PEIS. The emerging XML standards make the integration of syndicated news sources a more feasible task for system implementers. This development makes it possible for one information system to explore other systems automatically, to extract information from them and to present it again. By implementing such mechanisms in conjunction with news sources (most of them already have "web presence") it is possible to keep information on the site fresh and current. A careful and well-thought out information agent can be used to connect this information with the information

maintained within the PEIS. For this purpose, collaborative filtering might be useful. Imagine a case where a news article is turning people's attention to air quality at a certain locality. In response, users of the PEIS are more likely to look for information about the locality and the topic. These actions can be identified by an information agent, that can re-arrange a hot-list on the front page of the system. By doing so, the agent makes the information that is likely to be relevant for new visitors more accessible, hence improving their feeling that the information they want is accessible.

7.5.5   Other Issues in PEIS design

There are several aspects that tie together various aspects of the wish list, but do not fit any of the previous sections. These are the potential to adapt the system to user interests, the need for continuous communication between the system maintainer and their users and the need to encourage information intermediaries. The aforementioned personalisation can be used to improve the tailoring of information to user needs. When the topic "air quality" is examined, one can consider various interests - from practical advice to asthma sufferers to an explanation of the chemical reactions that are linked to various pollutants. The option to provide users with extensive information that covers everything in this range should be discouraged. Firstly, it might make the information confusing and lengthy - and as it is clear that the web is not an appropriate medium for reading (Nielsen 1999), such things alienate users. By making it difficult for them to find what they want. Secondly, it makes the maintenance of the PEIS a problematic task: the writers of the information need to be capable of producing high-quality text that covers such a range of topics. A better approach, therefore, is to break down the information into "digestible chunks" that are connected through an extensive network of hyperlinks. This approach, however, might create a problem for those who are using the system extensively and have preferences about the topics that they prefer to see. Extensive use of hyperlinks means that they need to "drill down" heavily in order to find the information objects in which they are interested. By using appropriate personalisation, it is possible to make a "personal profile" of interests and, by doing so, provide the user with the information that he is interested in quickly and easily.

The second aspect that is general is the need for continuous monitoring and maintenance. As PUS researchers noted, reflexivity on outreach events is an important part of the process that can help improve future activities (COPUS 1995a). As expected, similar observations exist among UCD advocates (Preece 1995). Furthermore, and as was demonstrated in the analysis in Chapter 4, the type of interaction with websites provides rich sources of quantitative information that can be analysed in order to understand the way the system is used. Such analysis can help maintainers continuously to improve the system. This action however, can be used as part of collaborative efforts and discourse between those who maintain the system and those who use it. It is possible to envisage a *modus operandi* where the system maintainers do the analysis, consider possible improvements and then present them to the users, and implement those changes that are preferred by the users. In this way, the evolving PEIS will be based on on-going collaboration. This continuous monitoring and improvement activity is important in light of the state of constant flux

of environmental topics and their role in the public agenda. Issues rise and fall sometimes unexpectedly and PEIS need to react to such changes by providing appropriate information.

Furthermore, changes to the system should not be initiated just by the system maintainers. In a real collaborative interaction, the needed functionality and content will be decided through on-going interaction with PEIS users, who can suggest improvements to the maintainers. The system maintainers should encourage such proactiveness, as it will increase users' feelings of ownership.

Finally, there is a need for a practical and realistic evaluation of the potential users of PEIS. Though various groups of direct users have been identified earlier in this discussion, there is a specialised group of users that should receive attention during design and maintenance. These are the information intermediaries - people that have better access to ICT (due to skills or access to high-speed communication) and the ability to help others in accessing the system. By doing so, they become "information intermediaries" for a local activity group or neighbours. Though efforts should be made to assist individual occasional users, the information intermediaries are far more important for two reasons - they are likely to use the system more often and they provide a gateway to a wider group of people. It is important to note that making the system useful for frequent users does not mean that its ease of use for infrequent users should be reduced (Raskin 2000). In short, it is possible to create a system that will accommodate infrequent users while providing the needed functionality for advanced users who are more familiar with the system. Information intermediaries can help in tackling another problem area that was raised earlier - the problems associated with the "digital divide". Though it is unrealistic to expect universal Internet access in the near future, it is possible to envisage the activities of committed individuals and groups in an effort to gain access to and use information sources. As noted earlier, the awareness of governments to the "digital divide" and the creation of specialised units within the government (such as the Social Exclusion Unit in the UK) can be seen as signs that governments are interested in tackling this problem. These bodies seem to be good candidates for the role of information intermediaries.

7.6   THE ROLE OF PEIS IN DELIBERATION

In Chapter 2, a conceptual model for different communication means was offered, based on space and time (section 2.5.3). In this section, the proposal for PEIS that was described above will be positioned in the context of other communicative means. This is especially important as, throughout this chapter, the importance of the communicative element in PEIS and the tight coupling of information with communication were emphasised. The conceptual model of communication divided the possible modes into four groups: synchronous/presence, synchronous/telepresence, asynchronous/presence and asynchronous/telepresence. As was noted, ICT improves the ability to perform operations remotely, and is especially strong in providing synchronous/telepresence capabilities. Therefore, PEIS designers should focus on those modes where the systems' impact will be most apparent. PEIS should be perceived as part of this communicative model and not as a replacement for other modes. This is true for CMC in general,

as others have noted (Brown and Duguid 2000). A suggestion for such use was offered during the UBRN workshop - personalised pages, or pages that contain information about a specific locality may contain details of public meetings and encourage users to participate in such events. This way, the telepresence/asynchronous system supports a presence/synchronous activity. A connection in the other direction is also possible: participants in a local group can meet and decide about an issue that they want to raise and than build an information set on the PEIS to present this issue to the wider community. PEIS can also serve as an extension for a discussion that started off line. For example, a local authority can post the transcripts of a planning meeting, and facilitate an on line discussion in either a synchronous or asynchronous way.

The most important aspect of this positioning is for system designers. What they ought to remember is that their system does not operate in a void and must be considered in the context of social and political activity. As an exploratory and deliberative platform, it should be tightly coupled with the context of its users. It should support and facilitate the various information and communication activities that they would like to perform, and must be aware of the interests and needs of these users.

Finally, the issue of scale must be confronted. In a PEIS that deals with a locality, all modes of communication are applicable. As we move up scale, the ability of ICT to support social interaction is becoming more important, due to the impracticality of other modes. For example, a national PEIS that deals with some issue that deserves wide deliberation (i.e. GMO) provides a possible space for such discussion. Such systems, however, face many problems; because they are likely to attract more participants in discussion, facilitating discussions and organisation of many viewpoints is a major issue. Furthermore, as the PEIS becomes more relevant to the discussion (as was mentioned, other modes are impractical), several issues should be treated seriously: the equality of access and inclusiveness, information intermediaries and so on.

7.7 SUMMARY

In the course of this Chapter, suggestions for the improvement of future PEIS were examined and developed. Using the wish list that was presented above, it is possible to see how the concept of "systems that are built to be hacked" is implemented in the context of PEIS and provides a partial solution to the problems that were raised in previous chapters.

7.7.1 Aims of ideal PEIS

The use of place-based organisation, and the close contact with public interest that ongoing communication with participants facilitates, can promote environmental issues. Similarly to the workshop, such organisation of information can help users in seeing "seemingly disconnected issues" in a common framework. The openness of the system - the emphasis on ongoing bi-directional and transparent communication between PEIS maintainers and their user community - should help to improve trust and accountability. The use of opinions and ideas expressed by users

and a close integration of "on-line" and "off-line" communication can improve participation in decision making, too.

7.7.2 Technical Aspects in PEIS Design

The Internet and the WWW are the most *public* telecommunication networks. They provide an appropriate arena for development of PEIS due to the (relatively) low entry costs for the information provider and consumer. Furthermore, lessons that are learnt in commercial information systems can be used to improve the usability of PEIS, while also reducing the technical difficulties that they present to users. The use of GIS technology is important for PEIS, providing place-based information and supporting multiple representations of issues. This is an area that deserves much more research as it holds some major usability issues in addition to map reading skills.

7.7.3 Required Functionality

PEIS can integrate communication and information provision seamlessly. There are already examples to such capabilities, though there is a lot to be done. The main issue for PEIS is this integration, which opens up the possibility of "meaning hacking" or construction of a statement or representation that matches the user world view. Communication is provided among users and between users and system maintainers. It is also imperative that PEIS will be used to support and augment other communication modes - such as providing information about times and locations of meetings that match user interests and locality. Another important functionality is the ability to adapt the system. This can be done by drawing upon lessons from personalisation of websites. Personalisation carries with it the ability to communicate, and takes two different forms. The first focuses on adapting the system to personal needs and interests, while the second provide an opportunity to construct representations that will be displayed to other users of the PEIS.

Another way to make the system more adaptive is by using software agents that implement methods such as collaborative filtering in which the computer logs the actions of many users and, by doing so, build a database of preferred connections among a set of topics. The use of such agents should be considered carefully and their method of operation must be disclosed to the user, if they wish to learn about them. Finally, the system should let users add information. This information can be spatial and aspatial. It is likely that more users will find it easier to add aspatial information. The most important aspect of this function is the ability to present this information to others, and to create a shared database of this information.

7.7.4 Presentation, Content and Content/Presentation

PEIS should support multiple representations of any environmental information. These representations should be meaningful and easy to read by a wide range of users. By using lessons from PUS, and carefully studying patterns of use of existing PEIS, the content and presentation of future PEIS can be improved.

The elements that were mentioned in the wish lists - maps, 3D models, aerial photographs, access and integration of various data sets - all can benefit from a careful scrutiny that will improve the usefulness of the system in both content and presentation.

7.7.5   Organisational Aspects of Implementation

In summary, if it is possible to improve PEIS, the question that remains is the likelihood of implementation of systems that follow the approach described here. A full-fledged PEIS of the type suggested here is still more of a vision than an up-and-coming implementation. As the examples that were drawn upon demonstrate, there are systems that exhibit some of the functionality that was reviewed, though not to the extent advocated. The political "bravery" that is required from public authorities (the main maintainers of PEIS) is too far beyond their current practice. Therefore, the ideal that was described here is feasible technically but not politically. This is another issue that future research will need to tackle - how to convince public authorities that approaches that are similar to those described here, should be implemented in practice.

8 Conclusions

8.1 SUMMARY OF THE RESEARCH AND ITS FINDINGS

This thesis aimed to improve our understanding of environmental information and its uses by the public. Throughout the thesis, the research was aimed at understanding what type of information those that are interested in environmental issues would like to get, what is the current state of the art in information provision, and what can be done to improve public access to environmental information. As a multidisciplinary study, it has touched many knowledge areas in its course. Therefore, it seems appropriate to provide a quick review of the arguments that have been developed in the various chapters, before turning to overall evaluations and general conclusions.

The investigation started with the notion that environmental information is an under-researched area that deserves a closer look. Several aspects of environmental information stand out: the connection with GIS, the importance of providing public access to this information and its value to decision making. These aspects were used to develop the Public Environmental Information Systems (PEIS) assertions, starting with three foundations: (A) the perceived importance of information in environmental decision making; (B) the growing demand for public participation in environmental decision making; and (C) the importance of GIS as an analysis and visualisation tool for environmental information (Figure 1.1). This forms the basis for the main research question: what do users need and require from PEIS, and how should designers respond to them if we want systems that will improve public awareness and participation?

In Chapter 2, the content and meaning of environmental information, Environmental Information Systems (EIS) and PEIS were explored. A study of existing EIS which was conducted for this thesis revealed that environmental information is a fuzzily defined object, with a core that often relates to the pressure-state-response model (and the capta focuses on the state), it mixes *capta* and information - from raw sensor readings to summary reports, it has strong spatial and temporal elements, it is interconnected and deals with topics in an holistic way, it is mainly scientific and, therefore, issues of uncertainty, accuracy and currency are important. Finally, environmental information tends to be available in large quantities and its users grapple with information overload while finding more and more knowledge gaps.

The study revealed several facets of these systems. Most of the systems include a GIS component and focus on collecting and organising measures from the environment - they are environmental capta processing systems. Different systems show capabilities of Spatial Decision Support Systems or, at least, are used during various decision making processes. They usually operate within a public sector environment and, therefore, face problems that stem from lack of resources (both money and expertise). EIS can be found at many spatial scales and it is not surprising to find a connection between scale and jurisdiction. Information sharing is another important issue, especially in view of

the interconnected and holistic aspects of the information. The extensive use of GIS brings with it a host of topical problems: costs, special expertise, data formats and so on. Finally, the issue of "IT fetishism" must be noted, as some cases show signs that the interest in using the latest technology overshadows the goal of improving the state of the environment.

The issue of public access to environmental information gained popularity in the last decade, though it is possible to trace this trend back throughout the history of environmental politics. Current discussion focuses on the delivery of environmental information to the public via open telecommunication networks (the Internet) and on the role of such delivery in improving awareness and public participation in decision making processes. Therefore, the issue of the "digital divide" is important in this context; it is vital to increase access to ICT to a wider segment of society, if we wish to meet these goals while using these means.

Chapter 3 developed the thesis' framework. The aim of this chapter is to explain the selection of SSM as a research framework, and to position it vis-à-vis PEIS development methodologies. It was argued that PEIS design is a wicked problem (a problem that mutates while the solution is being developed). Almost any aspect of the system - content, functionality and use - it hard to define and pinpoint in a crisp way. Due to this nature of PEIS, the case for a User Centred Design approach that uses Soft Systems Methodology was made. Apart from the practical considerations, the use of UCD and SSM was backed by a theoretical framework that explains the role of ICT and technology in society and the need for a collaborative approach to PEIS design.

Chapter 4 focuses on two empirical studies - the London Environment Online survey and the UCL Brownfield Research Network workshop. The analysis of these studies from a PEIS perspective was integrated into the design of these studies and was conducted for this thesis specifically. The first provides general insights into public use of environmental information while the second provides more contextual information. Both studies explored the needs and requirements of those that are already interested in environmental issues. The survey highlighted the following aspects: the need to identify different audience groups and multiple identities that individuals use when they approach environmental information; the importance of integrative and holistic approaches to environmental information; the importance of traditional media (newspapers, TV and radio in particular) as sources of environmental information; the broad and fuzzy definition of environmental information content and its various uses - from action related to general interest and the need for rich and interpreted information. The workshop highlighted more aspects: the importance of the place-based approach for integration and representation of information; the difficulties associated with ICT use and the need for information intermediaries; problems of information ownership and trust; issues of understanding and interpreting information; the role of local knowledge in this process and the need to use systems in a communicative way, especially to enable users to add information to them. It was suggested that GIS has a role as a shared exploratory environment in which different users can collaborate in exploring local issues.

The empirical studies and the analysis in Chapters 1 and 2 were brought into a common framework in Chapter 5. The development of the rich picture (comprised, for clarity, of four sections) provided a way to integrate the findings of the first part of the research. After summarising the findings in this form, it was possible to continue with the development of conceptual models for seven perspectives on PEIS: Aarhus, NGOs, media, Environmental authority, NIMBY, active citizen and general interest. The first model represents the declarative stance in international conventions on public access to environmental information. The next three approach it from an institutional perspective, while the last three focus on individualistic perspectives. A generalised model was developed on the basis of these models. Finally, a criteria set was developed to enable the comparison of existing systems with the requirements and needs that the empirical studies exposed.

The models and criteria were then compared with four existing PEIS in Chapter 6. The comparison with the DETR air quality monitoring network system, the Environment Agency website, FoE Factory Watch and Homecheck demonstrated the gap that exists between the needs and requirements of would be users of PEIS and the current state of the art. The main gaps are: the lack of integrative information; the lack of communication facilities and the ability to manipulate the information in the system; problems with "information architecture" which is only partially place-based; and the lack of contextual and understandable information.

Chapter 7 concludes the thesis by developing some suggestions to improve the situation through the design process. This was done through examination of the theoretical framework that should be used for PEIS, and a suggestion for "systems that are built to be hacked". Such systems should enable the user to add information, alter representations and use the system as a public arena for exploration and communication. These systems are not intended to replace other communicative means and social and political activities. They are intended to facilitate these activities and to ensure that the available information is put to good use.

As stated, the thesis touches many fields of knowledge, alternating and sometimes leaping among them. Therefore a quick summary of the fields and their influence might prove useful when the research is evaluated as a whole. As Table 8.1 demonstrates, the thesis continuously combined the different areas, drawing on their insights while connecting them to the issue of PEIS.

8.2 THESIS CONTEXT

The starting point of the research was a general feeling of uneasiness toward public access to environmental information. As the research progressed, it became clearer that many questions surround the foundations of public environmental information systems. The concept of environmental information itself is problematic and, as a result, it should not come as a surprise that environmental information systems and public access to environmental information are not clearly defined issues, with crisp definitions and concepts.

	Chapter 1	**Chapter 2**	**Chapter 3**	**Chapter 4**	**Chapter 5**	**Chapter 6**	**Chapter 7**
History of environmental politics and information	Connection between the environmental movement and information	The development of environmental information systems			General rich picture and its context. Selection of perspectives for the conceptual models		
Geographical Information Systems (GIS)		The spatial element in environmental information and the connection between GIS and EIS	Design methodologies for GIS	Question in the survey and the UBRN workshop	Rich picture and the need to provide place-based information	Analysis of Internet GIS in existing PEIS	The role of place-based information as an organisation scheme for PEIS
Public Participation GIS (PPGIS)			Design of UBRN workshop	Implementation and analysis of the UBRN workshop			The role of GIS in future PEIS
Information systems design approaches			Design of EIS, GIS and PEIS				Analysis of appropriate design of future PEIS
Soft Systems Methodology	Analysis 1 and 2 (social and political)	Analysis 1 and 2 continues.	Introduction to SSM. The general structure of the study and the way SSM is used for it	Empirical studies to obtain more information about the problem situation	Core system-thinking phase. CATWOE, root definitions and conceptual models	Comparison of the conceptual models with the state of the art in information provision	Suggestions to improve the problem situation
Human Computer Interaction (HCI) and Usability Engineering			Possible design approaches for EIS, GIS and PEIS, User-Centred Design, connection with SSM	Design of the LEO survey and problems identified with GIS use during the UBRN workshop		Analysis of Internet websites and their usability issues for novice users	Design of systems to enable end-user programming and ease of access
Public Understanding of Science (PUS)				Design of the LEO survey and the UBRN workshop. Analysis of survey and workshop results		Analysis of content of information provided on various systems	Content development for future PEIS

	Chapter 1	**Chapter 2**	**Chapter 3**	**Chapter 4**	**Chapter 5**	**Chapter 6**	**Chapter 7**
Participatory and inclusionary approaches	The connection between public access to environmental information and improved participation	The sources of public access to environmental information	Theoretical framework for PEIS design, use of participatory design approaches. Design of UBRN workshop	Implementation and analysis of UBRN workshop	Development of models and criteria	Evaluation of communication capabilities of existing PEIS, ethical / environmental justice evaluation	Development of collaborative systems, continuous collaboration with users.
The information age/ the digital divide		Analysis of environmentalism in the information age and the digital divide	Implications for PEIS design	Awareness of equity in the survey and workshop	Rich picture (4) role of information intermediaries, NGOs conceptual model.	Identifying intended users for various systems	Development of future PEIS and access provision. Role of information intermediaries
Philosophy of technology			Appropriate design methodologies for PEIS				Theoretical backing for "systems that are built to be hacked"

Table 8.1 - Knowledge areas and thesis chapters

From its outset, the research focuses on the issue of public access to environmental information, while keeping in mind that the role of information in environmental decision making in general is an uncharted territory. This issue has implications for the research conclusions. The whole analysis was carried out with this specific use of environmental information at its centre. For example, further investigation may reveal that the DETR's Air Quality Monitoring Network system is invaluable for researchers and environmental professionals, and the critical evaluation of its operation in Chapter 6 is not justified. This, of course, might be true - though such claims do not reduce the problems of this system as a PEIS.

In this final section, the conclusions of the thesis as a whole are presented. First, the methodological conclusions are drawn, followed by broader and more conceptual ones.

8.3   METHODOLOGICAL CONCLUSIONS

The research yields some observations about methods that were used in the thesis. As a whole, the research demonstrated that SSM is useful as an investigation scheme for sense making exercises. It provided a framework for the thesis without constraining the exact tools used in empirical studies. Chapter 5 is practically the only part of the thesis where the use of SSM techniques is overt, though other parts are closely related to SSM concepts (like the analysis of different social structures as human activity systems). It must be noted that the idea of SSM as an appropriate framework for social sciences studies was offered by Checkland himself (1984, 1999) and the study of information systems in "Information, Systems and information systems" (Checkland and Holwell 1998) is an example of such a study. The case with PEIS is, however, somewhat different from those described by Checkland. While the field of information systems in general has received a lot of attention, this thesis tackles a field that has not received the attention needed during its development. The thesis demonstrated that SSM is useful in such cases, too.

The use of a carefully designed Web survey, which went through comprehensive testing, proved to be an important tool for ICT research. Though the use of Web-based surveys is commonplace now, a full analysis of web logs as an integral part of the results is still a rarity. The thesis demonstrates that such analysis can help in understanding the respondents' contextual situation when they've answered the questionnaire. The mix of closed and open questions and the targeting of Internet savvy respondents is another interesting aspect of the thesis. The amount of time spent and the intuitive nature of the answers given demonstrate that respondents were enthusiastic about the topic and wanted to express their opinion. The textual responses in particular show the hallmarks of CMC as a different mode of communication from traditional questionnaires.

Finally, the thesis has "borrowed back" techniques from HCI studies. As Chapter 2 noted, HCI researchers borrowed research methodologies from social sciences and particularly from anthropology and cognitive sciences (Preece 1995). The UBRN workshop (especially the use of ScreenCam) and the design of the LEO survey website demonstrate that it is possible to integrate refined HCI methodologies into more traditional social science research which uses them beyond

their immediate goal (i.e. the improvement of software interfaces). Of course, the connection between GIS and HCI is crucial and researchers have been integrating the two areas for at least a decade (Medyckyj-Scott and Hearnshaw 1993, Nyerges *et al.* 1995, Traynor and Marian 1995). In this thesis, this integration was taken a step further and was used to support contextual and qualitative research.

8.4   CONCEPTUAL CONCLUSIONS

The thesis contributes to the debate on public access to environmental information in several ways. First, it demonstrates that there is no monolithic "public". Consequently, any simplistic definition of user groups and, as a result, the creation of either too-specific or too-general PEIS will not meet expectations. The recognition of multiple interest groups is by no means unique to this thesis and, as was mentioned earlier, Castells has identified multiple groups inside environmental politics (Castells 1997). What is new here is the dissonance between the current state of the art in information provision and this understanding of multiple perspectives, which are used in the process of consuming and using the information. The stance of direct access to information means that it is inappropriate to rely on information intermediaries, and that PEIS designers need to take into account the composition of the "public" that uses the information. It is important to note that the intermediaries (like NGOs) are not eliminated altogether, and recent conventions appreciate their role (OECD 2000). Even so, it means that PEIS designers must accommodate multiple users with a wide range of computer literacy, environmental information literacy and familiarity with the specific topic.

Secondly, by examining environmental information as the object of investigation, it is possible to gain some new insights into this element of environmental politics, which manages to stay out of the limelight for most of the time. The thesis demonstrates that though such an object exists and it is possible to provide some definitions for its core, it has very wide margins. Furthermore, it is a moving target that mutates constantly as new issues wax and old ones wane. Every user defines it differently - according to her personal perceptions, positions toward the issues at hand, memories and knowledge. These fuzzy aspects of environmental information make the creation of PEIS that will satisfy the wishes and needs of everyone a hard and unlikely task. Appreciation of this aspect, and a realisation that different users need different sets of information to satisfy their requirements, may be a useful part of the design of better PEIS.

Thirdly, by focusing on the essence of access to environmental information the thesis exposes the connection between PEIS and democratic principles as expressed in legal documents. As is discussed throughout the thesis, they promote strong democratic concepts - participation in decision making, justice, equity and so on. Creating information systems that can sustain such claims is not an easy task. It is a serious challenge that the research and practice community must be aware of and face directly as they move on into more sophisticated and elaborate PEIS. The thesis demonstrates that it is possible to relate the concepts that underpin public access to environmental

information to a certain technical configuration of ICT. The essence of the argument in Chapter 7 is that the problem goes beyond the technical difficulties of establishing universally accessible information systems (a difficult task by itself) and requires special attention throughout the design and implementation cycle. The aim of Chapter 7 is not to provide a prescriptive design for PEIS, but to show that it is possible to connect a theoretical position toward technology with PEIS implementation. It is possible to imagine other stances toward technology and, therefore, other systems. Whichever theoretical ground the system designer chooses, PEIS is an area where such clarity is needed.

Fourthly, and as a result of all the aspects that were raised in the previous paragraphs, a simplistic connection between environmental information and participation in decision making (assertions A, B and D) seem to be problematic. Within the public sphere, the assumption that information contributes to a rational mode of decision making does not hold. As was mentioned during the UBRN workshop - information is just part of the picture. Those who use information appreciate that it is not always the most important element and that other aspects (like the property market) are often many times more influential on the final decision. This influences the amount of effort that individuals put into finding and obtaining information. This question goes beyond PEIS and some of its possible consequences are quite alarming. If the value of environmental information to decision making is unclear, maybe it is the case that many monitoring programmes do not contribute to decision making at all and, therefore, these projects and the information that is collected through them are simply another example of wasted resources? Can we rearrange data collection and monitoring programmes in a way that will benefit the research community, decision makers and the public at the same time? Is such a thing possible?

The thesis does not deal with these questions, though they hang above it. Clearly, much more research is needed to find and suggest answers. At the moment, the tentative answer is that EIS offer very limited support to occasional users in their decision making process. Another observation is that one of the "information tools" that is mentioned in Chapter 1 - EIA - has gone through many changes and received a lot of attention in the last three decades (Canter 1996, Gilpin 1995). This close scrutiny helped to refine the process and its outcomes and made it more relevant to a wide range of stakeholders. Hence, it is likely that continuous scrutiny of environmental information, EIS and PEIS will help in creating well tuned systems and also in keeping them up to date and relevant.

8.5 FUTURE RESEARCH

As is stated throughout this thesis, there is a lack of understanding and analysis of environmental information provision and use. Although the amount of environmental *capta* is increasing at an exponential rate, it is not clear how much such investment contributes to environmental decision making. This thesis demonstrates that a clear gap exists between the providers of environmental information and their users, as far as public environmental information is concerned. However, this

is all but a small part of the full arena. This thesis assumes a very benign regime as an assumed background – a regime where the public authorities collect and distribute information; where the political will for public participation in environmental decision making and access to information (as manifested in the Aarhus convention) exists and where the public is interested in environmental information and wants to get involved in decision making processes. All these assumptions do not stand the scrutiny of real world situations, as is also demonstrated in this thesis. When it comes to development projects where the political will is strong (such as a major development project in Wandsworth – see chapter 4), there is a disincentive to the political system to release information. In many cases in environmental politics, the situation is one of a struggle among different actors and information is an important 'weapon' in the arsenal. In such a situation, access to information is highly contested, and it is wrong to assume a benign relationship. As is discussed in Chapter 5, the relationship of the various actors: professionals, media, decision makers, developers etc, are highly complex, too. Each of these actors holds a different agenda and, again, information is a tool in this structure. Therefore, future research should continue to unpack the relationships between the different actors and their impact on information delivery. A clear output of this thesis is an emphasis on the impact and relevance of the media as an information conduit.

A second area of research that is coming out of this thesis is the need to explore further the needed information in a context that is beyond London and England. Are the needs of the public in rural areas different from those in London? Do they use different sources of information? Further afield, there is a need to explore cross cultural implications. Is the situation in other countries similar to the one that was described here? Is the situation in other countries better or worse, inasmuch as public provision of environmental information is concerned? Can we establish best practice guidelines?

Finally, on the technical front, the concepts that were developed in Chapter 7 must be put the test. If indeed a dedicated public environmental information system is needed, it is possible to conceive research projects that are aimed at evaluating the possible technologies that are relevant for successful PEIS.

8.6   THIS THESIS IN A WIDER CONTEXT (AND FINALLY …)

The thesis contributes to general developments in the field of Geography, too. Since the "Quantitative revolution" in Geography in the 1960s, and the backlash of the "Humanistic revolution" since the 1970s, it seems that the academic discipline of Geography is divided into two camps - especially in relation to research in human geography[1]. According to Pickles (1999) the core of the debate can be found in the relationship between GIS research and social theorists. As GIS (and the use of computing in general) was perceived to be a manifestation of a positivist and

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[1] For a recent analysis of the discourse throughout the 1990s, see Schuurman (2000)

reductionist world view, those who supported the hermeneutic or critical world view, and believed that Geographical research should move away from an empiricist model of investigation, questioned the value of GIS research as academic inquiry, and some even hoped that GIS "will go away" (Johnston 1999, Pickles 1999). The debate reached its peak at the beginning of the 1990s, when GIS became a widely accepted tool for businesses, law and order bodies and other governmental authorities. In this discourse, two groups can be identified. On the one hand there are "GIS advocates", those who put forward the endless possibilities of using GIS for the better good of society as a whole - to improve the management and use of scarce resources, to improve our understanding of the world and to improve decision making practice (Goodchild 1995). They also emphasise the importance of GIS for the discipline of Geography. Some went as far as offering it as the ultimate overarching concept for Geography, powerful enough to put together all the pieces of Geography's humpty-dumpty (Openshaw 1991). On the other hand, "GIS opponents" emphasise its uses as a military technology for surveillance and the negative societal implications of the technology (Curry 1998, Pickles 1995, Taylor and Overton 1991). A very good example for such debate is the exchange between Openshaw and Taylor (Openshaw 1991, Openshaw 1992, Openshaw 1996, Pickles 1999, Taylor and Overton 1991). In the last few years, a more diverse picture is emerging from various projects which try to tackle these questions from an empirical perspective, rather than a highly theorised one.

With the development of the discourse, some calls for more integrative GIS research were heard (Curry 1998, Johnston 1999). In a way, they echo earlier calls by GIS proponents to use GIS as "simultaneously the telescope, the microscope, the computer, and the Xerox machine of regional analysis and synthesis" (Abler 1988, p. 137) - a versatile tool that can assist different research frameworks.

This framework is exactly the reason for the use of qualitative and quantitative research methods in this thesis. Furthermore, the societal implications of ICT and social theory are integrated into it seamlessly. My aim is to demonstrate that, when all is considered, this division is to incommensurable worldviews does not prevent co-operation and cross fertilisation. By borrowing insights and expertise from both pacts - for example, by using experienced facilitators for the UBRN workshop while at the same time using GIS experts to operate the system - it is possible to create a synergetic thesis that enjoys the benefits of both sides of the debate. This aspect of the research is put in place knowingly, to demonstrate the possibility of such integration.

In an era that promotes multidisciplinary research as the proper approach to academic investigation, and in which the world outside academia is learning to appreciate such synergies, it seems particularly poor that a discipline like Geography - which is inherently multidisciplinary - keeps the delineation between the opposing camps instead of obliterating them. It is my hope that more studies of this kind will appear in the years to come and will prove that although it is possible to interpret the empirical results differently (according to one's world view and beliefs) it is possible to share knowledge and experience in Geography's practice.

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A N N E X   I

The LEO survey consists of three sections. These sections are presented here as screen captures, at a resolution of 800X600 (See Chapter 6). This representation is close to the user's experience when she filled in the survey.

First Section

Environmental Regulations	○	○	○	○
Environmental Campaigns	○	○	○	○

For those issues that you have expressed an interest in, please could you tell us why you are interested? Please also note, which of the issues is the most important to you.

Are there any other environmental issues of interest to you that we have left out from the above list? If so, please tell us about those environmental issues that you feel we should have included.

If information on those issues that you have expressed an interest in was available on London Environment Online, how frequently do you think the information should be updated?

	Hourly	Daily	Weekly	Monthly
Air Quality	○	○	○	○
Noise Pollution	○	○	○	○
Traffic (eg. Private Vehicles)	○	○	○	○
Public Transport	○	○	○	○
Biodiversity/Ecology	○	○	○	○

If information on those issues that you have expressed an interest in was available on London Environment Online, how frequently do you think the information should be updated?

	Hourly	Daily	Weekly	Monthly
Air Quality	○	○	○	○
Noise Pollution	○	○	○	○
Traffic (eg. Private Vehicles)	○	○	○	○
Public Transport	○	○	○	○
Biodiversity/Ecology	○	○	○	○
Land Use/Planning	○	○	○	○
Recycling/Waste Management	○	○	○	○
Water Quality	○	○	○	○
Contaminated Land	○	○	○	○
Environmental Health Risks	○	○	○	○
Environmental Regulations	○	○	○	○
Environmental Campaigns	○	○	○	○

To submit Section 1 and continue to Section 2, press this button [Submit]

Second Section

LEO (London Environment Online) - Survey

Section 2 (of 3) - Environmental Issues and 'London Environment Online' (LEO)

We would like to know what you think an Internet site about London's environment should look like and the information that it should contain. To help us, please could you comment on the following statements.

	I strongly agree	I would agree in some cases	I strongly disagree	I have no opinion on this
I would like the contact details of environmental organisations to be available on LEO	○	○	○	○
I would like the option to contact someone in person about the environmental issues presented in LEO	○	○	○	○
I would like to learn more about environmental regulations and policy through my use of LEO	○	○	○	○
I would like LEO to contain an on-line discussion forum for environmental issues	○	○	○	○
I would like to learn more about environmental issues in my local area through LEO.	○	○	○	○
I would like to learn more about the				

	I strongly agree	I would agree in some cases	I strongly disagree	I have no opinion on this
I would like LEO to contain an on-line discussion forum for environmental issues	○	○	○	○
I would like to learn more about environmental issues in my local area through LEO.	○	○	○	○
I would like to learn more about the relationship between the environment and my health through the use of LEO	○	○	○	○

We would like to know how you would like environmental issues to be presented in London Environment Online (LEO). To help us, please could you comment on the following statements.

	I strongly agree	I would agree in some cases	I strongly disagree	I have no opinion on this
Environmental issues on LEO should be clearly explained using text and illustrations	○	○	○	○
LEO should contain maps so that environmental issues and data can be located	○	○	○	○
LEO should provide access to 'raw' environmental data collected for London	○	○	○	○
I would like to be able to analyse environmental data for London using LEO	○	○	○	○
I would like to create customised reports				

	I strongly agree	I would agree in some cases	I strongly disagree	I have no opinion on this
environmental issues and data can be located	○	○	○	○
LEO should provide access to 'raw' environmental data collected for London	○	○	○	○
I would like to be able to analyse environmental data for London using LEO	○	○	○	○
I would like to create customised reports for my own needs using environmental datasets about London	○	○	○	○
I would like to be able to receive a customised report to my e-mail account	○	○	○	○

Do you ever actively seek information on London's environmental issues? If so, could you tell us how you seek this information? Please tick as many boxes as you like

☐ I never seek information   ☐ CD-ROM   ☐ Internet
☐ Governmental reports   ☐ Legislation   ☐ TV/Radio
☐ Local newspaper   ☐ National newspaper   ☐ Magazines
☐ Regulatory bodies   ☐ Environmental professionals ☐ Environmental organisations

Please give an example of the types of information that you seek and why, and also where you find it.

Please give an example of the types of information that you seek and why, and also where you find it

Do you see any advantages/disadvantages in obtaining environmental information over the Internet (compared to other forms). Please tell us what those advantages/disadvantages might be?

Do you have any comments, suggestions or thoughts that you think we should consider when designing London Environment Online?

To submit Section 2 and continue to Section 3, press this button

Third Section

Section 3 (of 3) - Personal information

To help us classify your answers and relate them to other answers to the questionnaire, we would like to ask you several personal questions

Gender   ○ Male   ○ Female

Age group   ○ Under 11   ○ 11-13   ○ 14-16
              ○ 17-18   ○ 19-24   ○ 25-29
              ○ 30-34   ○ 35-39   ○ 40-44
              ○ 45-49   ○ 50-54   ○ 55-59
              ○ 60-64   ○ 65 and over

Occupation

County or Borough in which you live

The first part of your postcode (e.g. SW17)

How frequently you use the Internet?
○ Daily   ○ Once a week   ○ Several times a week
○ fortnightly   ○ Monthly   ○ Rarely

Where do you access the Internet from?
□ Home   □ Work   □ School
□ University   □ Library   □ Cybercafe
□ Other (please describe)

Do you consider yourself to be concerned about London's environment?
○ I am very concerned   ○ I am slightly concerned
○ I am not concerned   ○ I do not know

Are you a member of any environmental organisation / Pressure group?

□ Yes, I'm a member of environmental group / organisation

If so, Which?

Finally, how did you learned about this site?

- 266 -

ANNEX II

"Bridging the knowledge/data gap VS. Information overload

Pressure-State-Response

Pressure	State	Response
	Env.	Econ.
......		
...	Info	
...		
...	Res.	...

Societal Responses (Decisions - Actions)

Global

UNEP

Research institutes

Information, knowledge

Other bodies

International

Local

European Environment Agency

Environment Agency

Legal / Institutional response

70' - NEPA, Stockholm
90' - Agenda 21/Rio
Aarhus,90/313/EEC
Regulation, Reporting, monitoring

Implement by

Promulgate

Politics/Social environment

-Sustainable development
-Democratisation: inclusion and participation
 demand for more involvment in decision making
-Globalisation
-Information age
-Risk Society

Goals of information provision:
 * Improved participation in decision making
 * Improve awarness

Reporting

Evaluating

Monitoring

Research

Data collection

EIA

Influence

Trust
Power relations
Single interest groups
Freedom of information (right to know)
Active citizens
Economy

...

Public awareness: Earth day to GMO

Professional / Science

Social / Political arena

Use of information

Environmental Information

①

Core Env. Info.

Recreation

Organic Food, GMO

Geographic Information: Buildings, Roads ...

Health risks/impacts

EIA

Traffic, Public transport, Cycling

Evaluating

Monitoring

Research

Data collection

Reporting

Web sites

Outputs

Reports

Brochures

Environmental Information System

STAFF/MANAGEMENT:
- Public sector environment
- Multi-disciplinary
- Multi-skills: Computing, Statistics, Cartography ...
- Budget constraints
- Organisational barriers for information sharing

COMPUTERS:
- Cost of Sw/Hw
- Updates
- Changes in technology
- ICT "Fetishism"

GIS:
Role: repository, management, modelling, analysis
- Scale issues
- Cost of GI
- Ownership, info sharing
- Field view (raster and vector)

Capta/ Information/ Knowledge

CAPTA and INFORMATION:
- Raw data ... "packaged knowledge"
- Scientific capta: uncertainty, quality...
- "Systems" concepts
- Reductionism vs. interconnectedness
- Temporal dimension /trends
- Large data sets
- "Solid public information"

②

Environmental Information System

What should we report? Is it interesting?

Motives Worldview Interests

What should I recommend? How do I go on with my work?

Motives Worldview Interests

Electronic media

Web sites

Reports

Brochures

Outputs

Capta/ Information/ Knowledge

Professionals / Researchers

What decision should I take?

Motives Worldview Interests

Decision Maker

What should we report? Is it interesting?

Motives World Inter...

Printed media Local / national

Can I change the information? Do I need a middle man?

Information from all sources

How can we advance our goals?

Motives Worldview Interests

Local knowledge
Memories
Expertise / skills
Interests
Map reading skills
ICT skills

Filters / interpreters

Interest group

Motives World Inter...

Contacts / affiliation

Other social entities

③

Motives Worldview Interests

"Public"

"Identities":
Carer, Commuter, Active citizen, Professional ...

Political agenda:
Combination of: Sustainability, NIMBY, Deep Ecology, Conservation, Green Politics, Local interests, Single issue political / social interest

Context:
Can I trust the information provider?
Can I find the information that I want?
Can I gain control over the process?

Framing environmental issues:
Holistic, interconnected view
Topics of interest:
Air pollution - traffic - public transport
Water (health)
Recycling (activity)

Concerns / interests:
Scale - local to global
What is happening around me?
Will the information help me? Is it important vs. politics and economy?
Can I understand it?

Environmental Information System

Capta/
Information/
Knowledge

Web sites

ICT

Experience with other ICT
Access and costs of ICT
Is what I need there?
Is it of any value?
Can I change it?

Filters / Interpreters

Public
Users

Information
intermediary

Design / Usability
Content
Up to date-ness
Notion of "current"/immediate
Is the information there?

Local knowledge
Memories
Expertise / skills
Interests
Map reading skills
ICT skills

ICT TOPICS:
- Access costs "Digital divide"
- Skills, generational differences
- Public information vs private information

④

Public Authority

Appreciate external influence: economy, politics, social

Define:
- Improved access
-goals for information provision

Prepare information

Identify information needs

Identify information held

Collect information

Package / arrange information

Adapt system, control

Monitor system

Define criteria for goals and objectives

Provide access through telecom networks

Create computerised information system

Adapt content to remote access

Publish system through telecom networks

Appreciate external influence relevant for context

Define:
- information needs
-goals for information consumption

Identify needed information

Other sources, existing knowledge

Identify information availability

Identify information sources

Pressure to collect information

Pressure to provide access to informaiton

Access information through telecom networks

Repackage information

Use information

Adapt system, control

Monitor system

Define criteria for goals and objectives

Information user

Efficacy: information used, goals achieved
Efficiency: does it reduce costs to transmit and obtain information?
*Effectiveness***:** Does it improve long term goals of information providers and users?
Ethicality: equity of access to information, use of information and access to justice
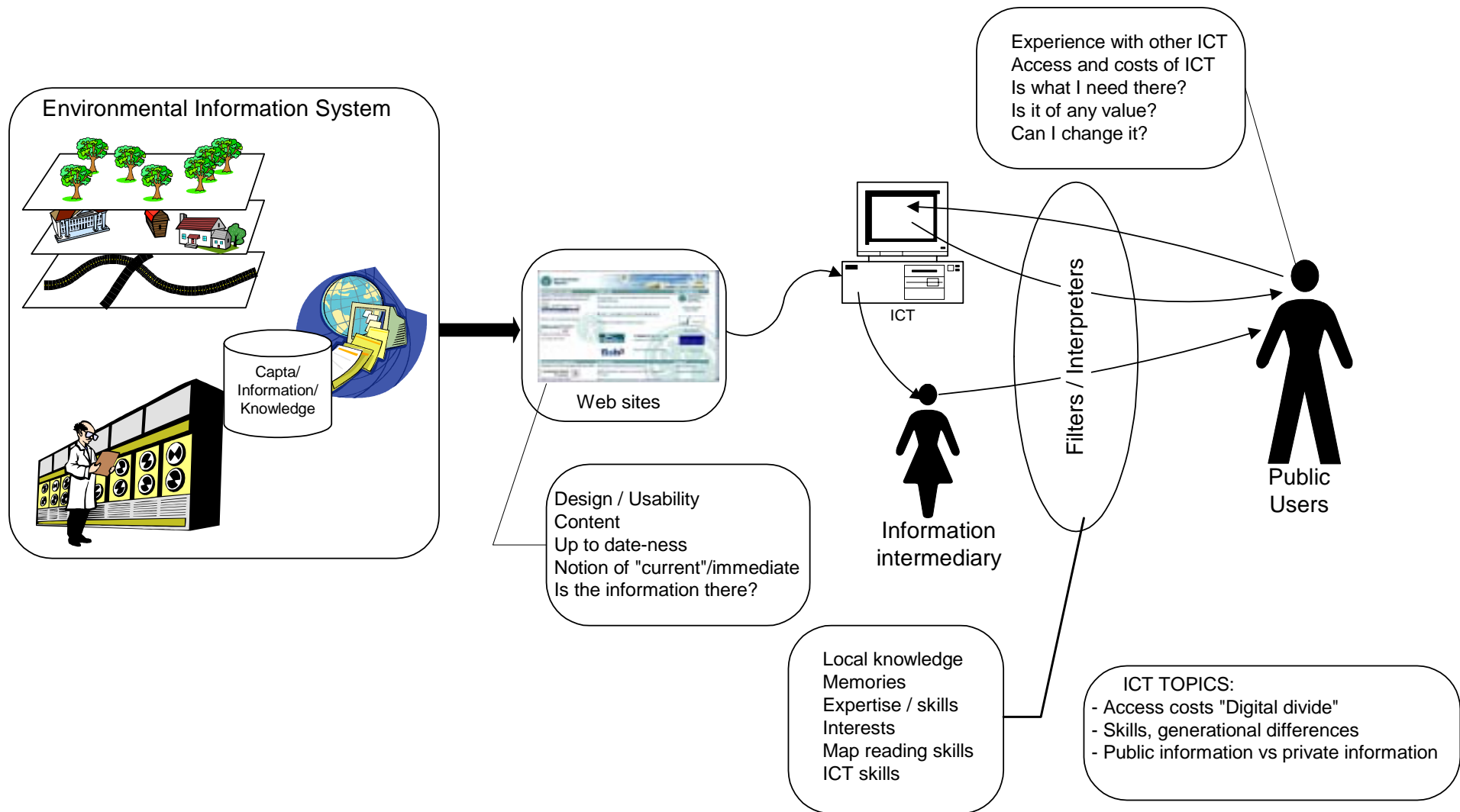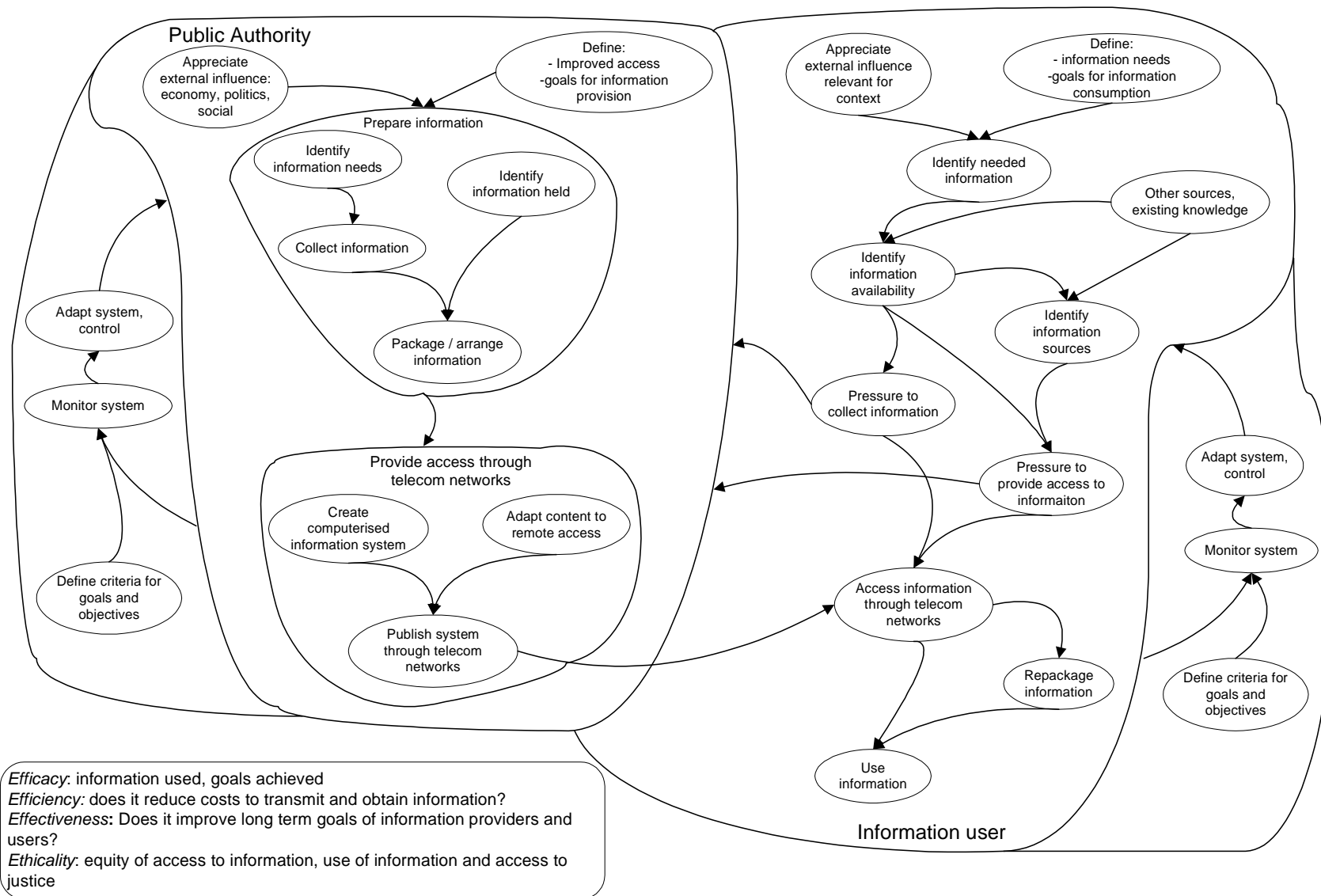
Figure 6.2 - Air pollution forecast chart, the two images show the scrolled page

Figure 6.7 - Interactive mapping in FoE Factory Watch

Figure 6.10 - Environment Agency interactive mapping site: (A) Default display after postcode based search (B) Highest zoom level (C) Information page (D) Emissions report (E) Display in Netscape navigator browser
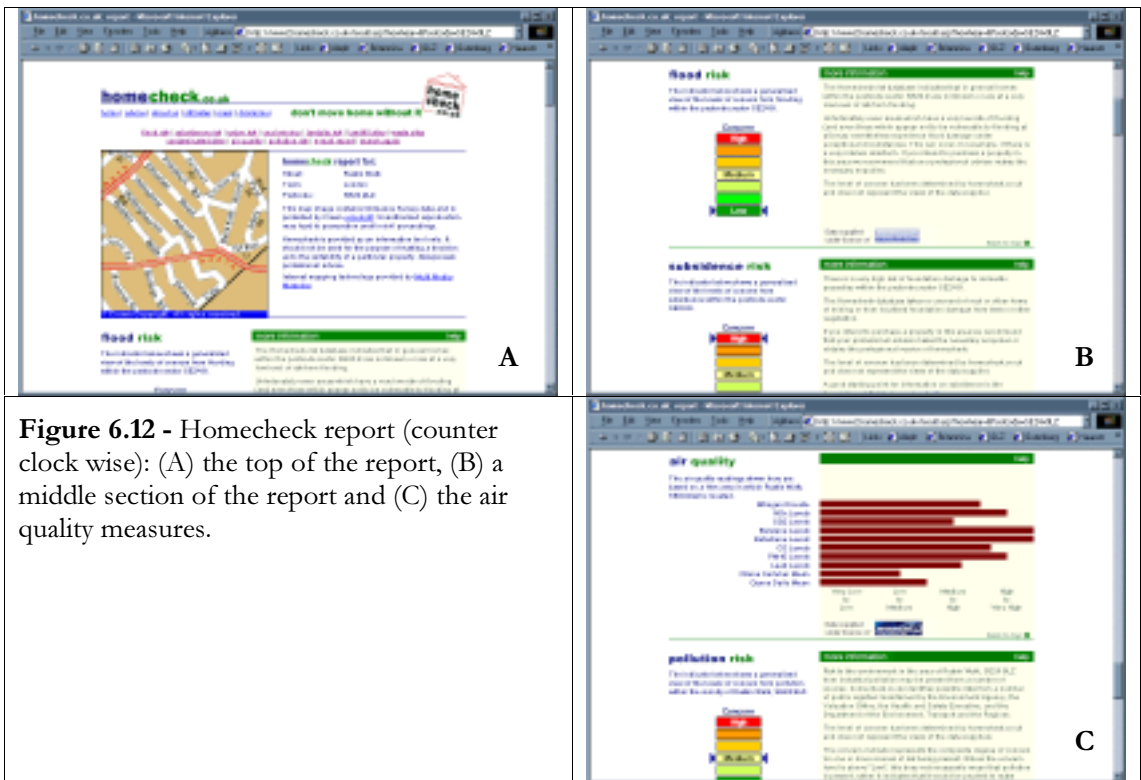
Figure 6.12 - Homecheck report (counter clock wise): (A) the top of the report, (B) a middle section of the report and (C) the air quality measures.