



UCL

WORKING PAPERS SERIES

Paper 38 - Sept 01

**Conceptual Models of Urban
Environmental Information
Systems - Toward Improved
Information Provision.**

ISSN 1467-1298





Centre for Advanced Spatial Analysis
University College London
1-19 Torrington Place
Gower Street
London WC1E 6BT

[t] +44 (0) 20 7679 1782

[f] +44 (0) 20 7813 2843

[e] casa@ucl.ac.uk

[w] www.casa.ucl.ac.uk

CONCEPTUAL MODELS OF URBAN ENVIRONMENTAL INFORMATION SYSTEMS -
TOWARD IMPROVED INFORMATION PROVISION

Mordechay Haklay

<http://www.casa.ucl.ac.uk/paper38.pdf>

Date: September 2001

ISSN: 1467-1298

© Copyright CASA, UCL.

Introduction

Cities are the hub of European society – for over a millennium, they are the locus of social, political and economic development. As the core of intensive and creative human activity, they are also the place where the environmental externalities that accompany rapid development are most visible. The environmental consequences of urban development have been recognised long ago, as in the case of London, where in 1388 legislation was introduced to control pollutant emissions (Lowenthal, 1990). Similar historical environmental regulations can be demonstrated for many cities in Europe. However, while for most of history those who govern the city (be it the sovereign, city elders or local government) were responsible for the control, mitigation and management of the common environment in the city, the last 30 years are a period of profound change. This is due to the trend toward improved participation in environmental decision making – a more inclusive and open approach to decisions that deal with the city commons. This change did not occur overnight but rather gradually. For example, in the United Kingdom, it was the Town and Country Planning Act of 1947 which introduced public scrutiny to changes in the urban form (Rydin, 1998), or the development of public involvement in environmental impact assessment of urban projects as developed in many countries throughout the developed world during the 1970s and 1980s (Gilpin 1995). These changes accelerate within the last three decades, and especially since the publication of “Our Common Future” (WCED and Brundtland 1987), the acceptance of the “Sustainable Development” principles and the Rio conference. A quiet (mini) revolution happened in Europe not long ago, toward the end of 1998 when the members of the United Nations Economic Commission for Europe (UN/ECE) signed the “Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters” - the Aarhus Convention (UN/ECE 1998). The convention is expected to come into force by the end of 2001, and calls the governments and public authorities to open up access to environmental information as a means to improve public participation in environmental decision making and awareness of environmental issues (UN/ECE, 1998).

However, these declarations on the value and importance of environmental information do not match our level of understanding on the role of environmental information in decision making processes, and especially on the role of information in improving awareness and participation. Therefore, it is useful to take a step back, and to try and evaluate how environmental information and access to it and its use support public involvement in such processes.

This paper is aimed to offer a framework that can assist us in the analytical process of understanding environmental information use. It focuses on public access and assumes that environmental information will be delivered to the public through the Internet. Such assumption is based on the current trend within public authorities is to use Information and Communication Technology (ICT) as a major delivery medium and it seems that it will become more so in the near future (OECD 2000).

The framework which this paper presents, is based on Soft Systems Methodology (SSM) study which unpacked some of the core issues relating to public access and use of environmental information (Haklay, 2001). Although the aim here is not to discuss the merits of SSM, but to focus on the conceptual models, some introduction to the techniques that are used here is needed. Therefore, the following section opens with introduction to SSM and its techniques. The core of the paper is dedicated to the development of conceptual models. After presenting the conceptual models, some conclusions about these models and their applications are drawn.

SOFT SYSTEMS METHODOLOGY

SSM is a problem solving methodology for ill-defined problem situations, which was developed by Checkland and others from the 1970s onward (Checkland 1984). As the name implies, 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 the analysts to perform the 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. For a wider discussion on SSM, the reader is advised to look at Checkland (Checkland 1984, Checkland 1999, Checkland and Scholes 1990) or Patching (1990).

Soft Systems Methodology Process - Mode 1 and 2

The most common representation in the literature of SSM is as a seven-stage process. As we shall see immediately, severe limitations and problems are associated with it. In spite of these, 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’. The stages are:

1. Learning and understanding the problem situation.
2. Expressing the problem situation, usually by using the technique of drawing *rich picture*.
3. Development of *root definitions* that describe what the system is and what it aims to achieve.
4. Development of *conceptual models* - models that describe how the activity for which root definitions have been constructed can be achieved.
5. Comparing the conceptual models with the rich picture while discussing the problem with stakeholders.
6. Discussing changes that are feasible and practical.
7. Implementing the changes.

The seven stages are represented in Figure 1.

During the SSM life-cycle it is possible to repeat and iterate through stages as necessary. An important aspect of the ‘Mode 1’ model is the line that separates the “real world” from the “systems world”. 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.

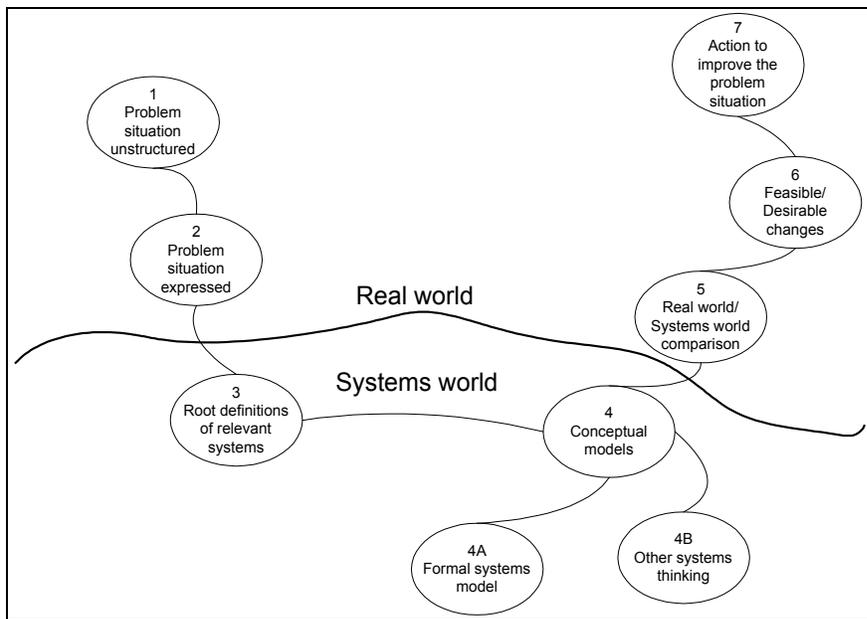


Figure 1 - The SSM Mode 1 process (After Checkland 1984)

However, SSM has 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 (input, output, transformation and control), could be replaced with a refined model that helps to create the conceptual model from the root definition. ‘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 2 represents the current loose model that is being advocated as the “real” SSM.

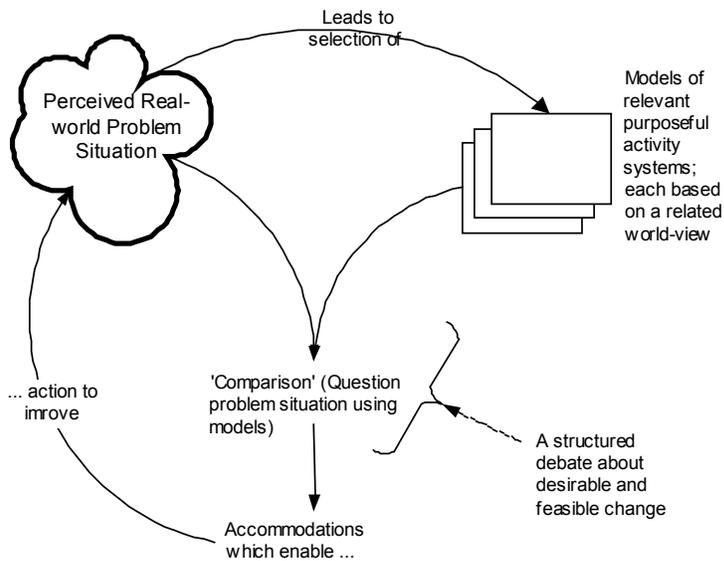


Figure 2 - SSM ‘Mode 2’: inquiring/learning cycle (after Checkland 1999).

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)

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).

Soft Systems Methodology Toolkit

There are several tools and techniques that have been found useful within the SSM framework for understanding and discussing the problem situation. The following paragraphs describe the main techniques used in the current paper. They are described in the order of their use in the process - as portrayed in Figure 1. 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 here are the final outcome of iterations and improvement of initial models.

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). 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). The issues that individuals and groups have expressed about the situation are depicted - usually as “cartoon balloons”.

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 of 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.

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 of 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?). In most cases, elegance is implicit in the structure of the conceptual model.

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.

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.

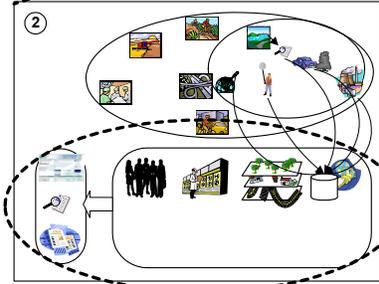
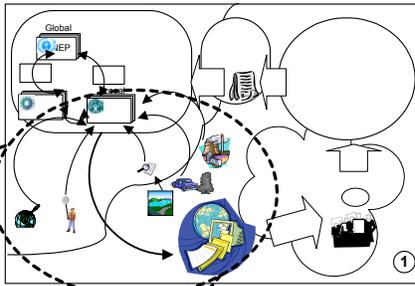
Conceptual models are based on “cloud shaped” objects, each contains a description of a certain activity. The various objects are connected by arrows, representing the relationship and flow of activities. Finally, elements of monitoring and control are added to the model.

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.

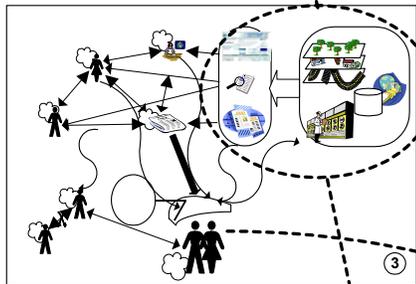
Developing conceptual models for environmental information systems

In the following paragraphs, the main aspects of environmental information and public access to it are examined using the “rich picture” device. In the case of Publicly Accessible Environmental Information Systems (PAEIS), 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 PAEIS. Figure 3 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.

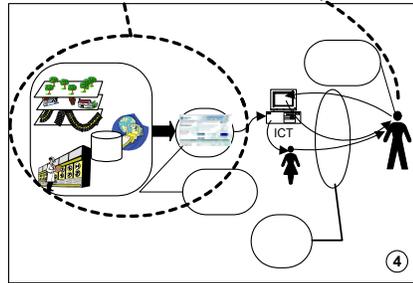


Figure 3 - The four rich pictures and their relationships

The Context of Environmental Information (Picture 1)

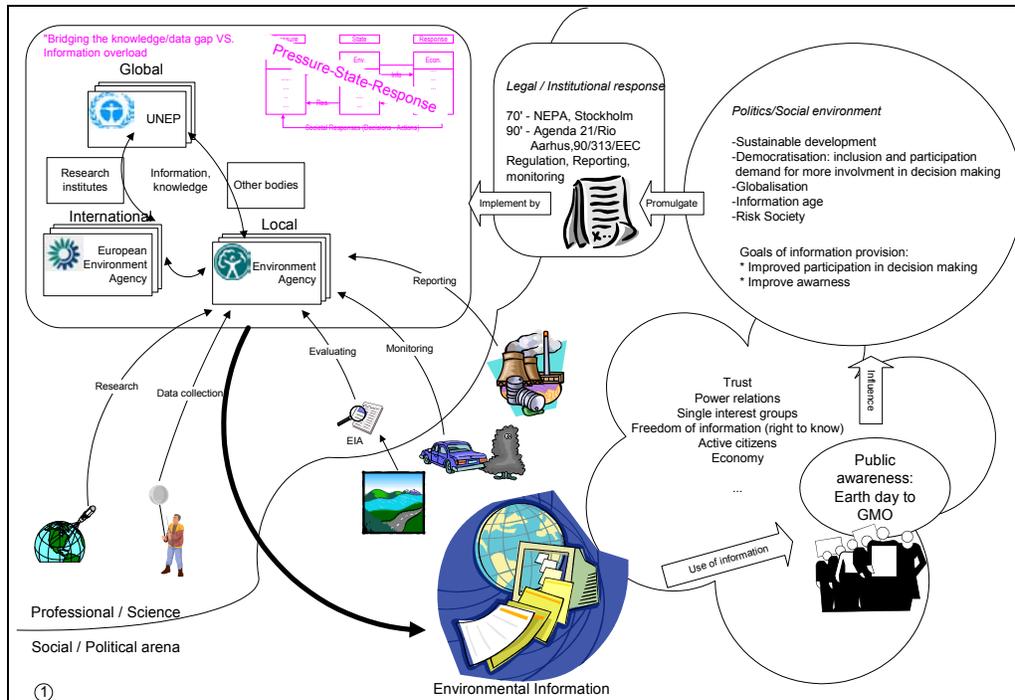


Figure 4 - Picture 1: The context of environmental information

Picture 1 (Figure 4) 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 lead to “Earth Day” is connected to the development of National Environmental Policy Act of 1970 (McCormick 1995); 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 Organism (GMO). 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 PAEIS. 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 become 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 the 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 UN 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 EIA 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.

Environmental Information Systems (Picture 2)

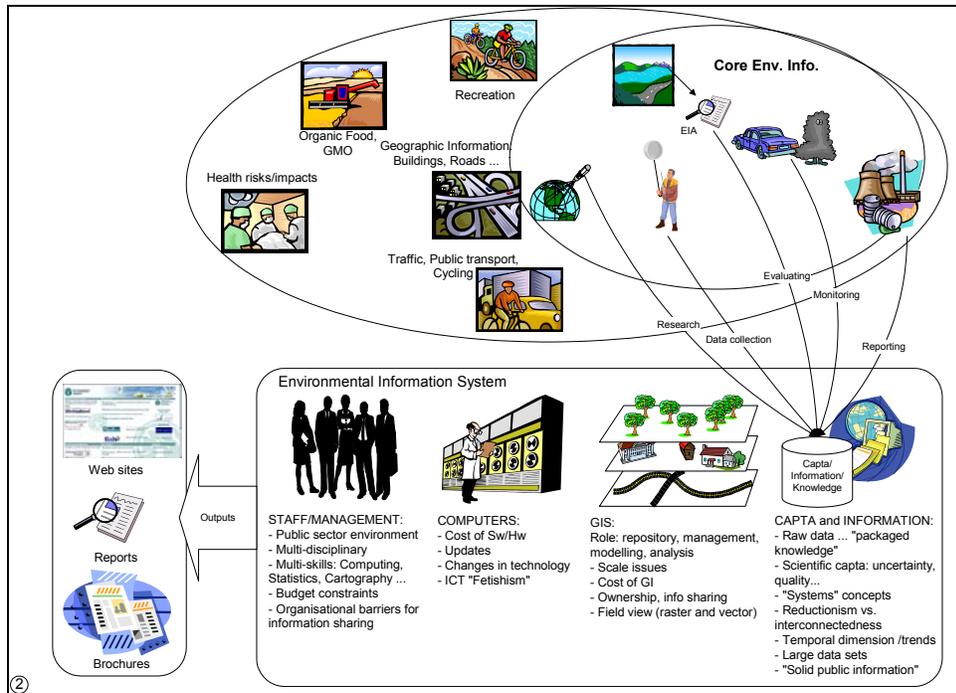


Figure 5- Picture 2: Environmental information system

Picture 2 (Figure 5) examines aspects of environmental information systems (see also Haklay 1999). 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 between them.

The content of EIS is, very often, a mix of raw data side-by-side with detailed explanations that include text and images. Hence, it is a mixture of *capta*¹, information and packaged knowledge. This content comes from scientific *capta - capta* that were 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 these *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 Geographical Information System (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

¹ The concept of *capta* – facts that are actually collected from the real world – was developed by Checkland and Holwell (1998). It is used to differentiate from data – all the facts about the world.

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.

Public Access to Environmental Information (Picture 3)

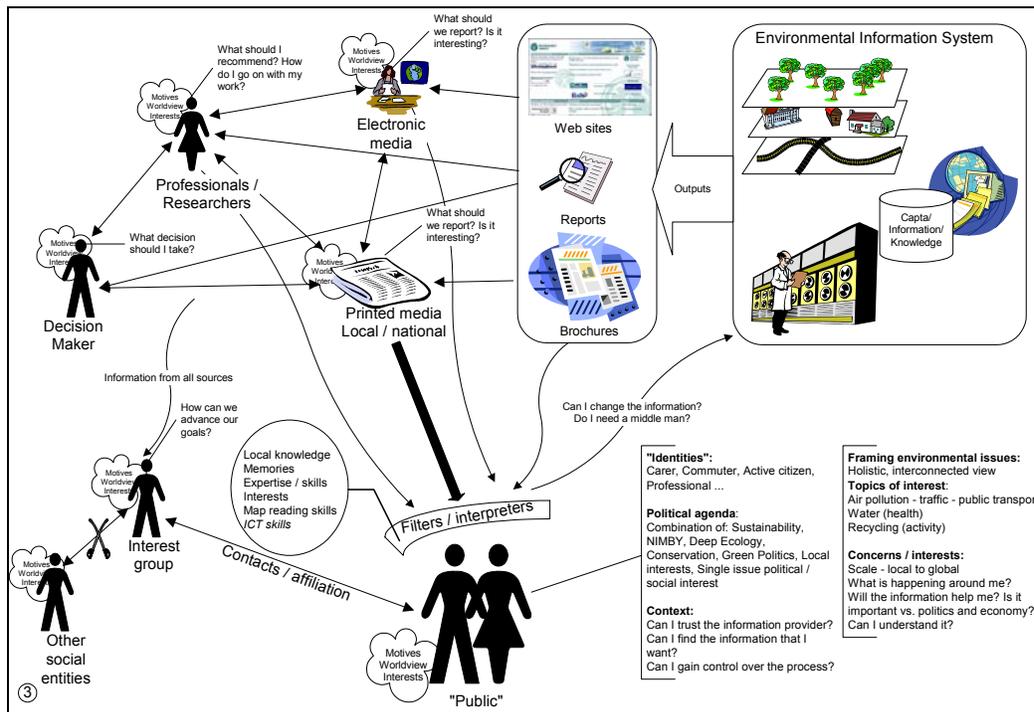


Figure 6 - Picture 3: Public access to environmental information

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. 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 Organisations (NGO) 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 in the UK obtained and published the Chemical Release Inventory database). 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 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”.

Web-based PAEIS (Picture 4)

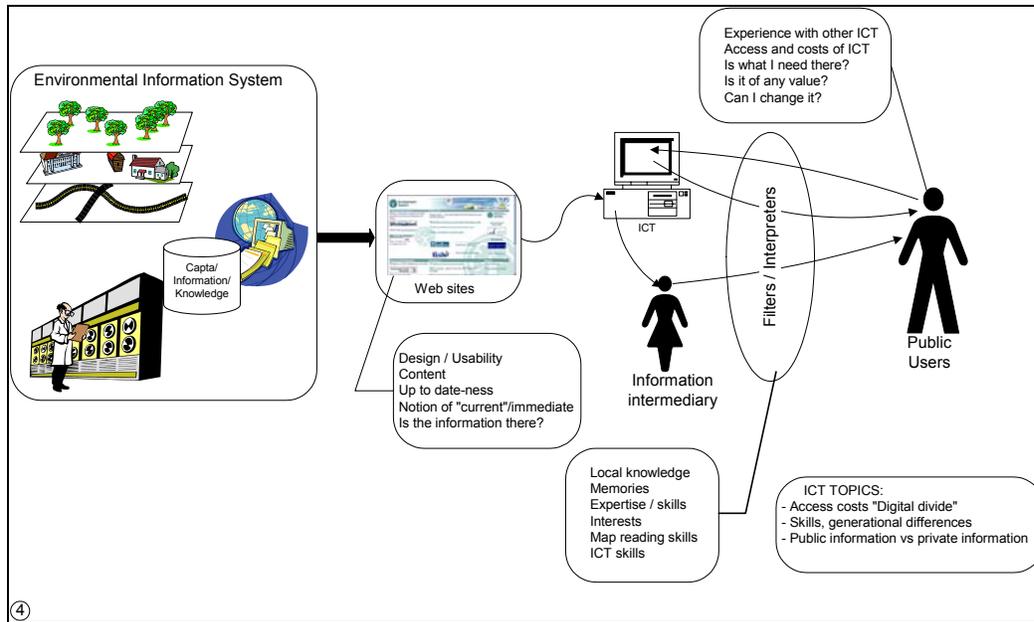


Figure 7 - Picture 4: Web-based PAEIS

Picture 4 (Figure 7) extends Picture 3 by focusing on specific aspects of web-based PAEIS. 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 interactivenss: the ability to change and update the information stored in them. At least some of the expectations from web-based PAEIS 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.

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 PAEIS. 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).

All the models are subjective and tentative and other models (and points of view) are possible. However, the models that are developed here represent the major positions that were identified in the literature and in Haklay (2001). The main reason for developing some generalised models is to suggest the range of possible models that can be used as basis for 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 PAEIS”, but rather put PAEIS 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 PAEIS.
2. Special interest groups (NGOs) model - these groups are pivotal in the activities that lead to PAEIS use. This is a generalised model for “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 PAEIS, 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, PAEIS 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 PAEIS 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 to which PAEIS should respond by providing appropriate information. There are other possible models and those are examined briefly at the end of this section.

The Aarhus Model

The Aarhus convention was used throughout this study 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 PAEIS 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.

<i>Clients</i>	Public
<i>Actors</i>	Public authority, public officials, NGOs, public
<i>Transformation</i>	Public involvement in environmental decision making → participation in decision making improved Public awareness to environmental problems → awareness improved
<i>Weltanschauung</i>	Sustainable development, belief in the importance of access to information and involvement in decision making
<i>Owner</i>	Public authority
<i>Environment</i>	The operation of government and public bodies, the economy, political and planning systems

Table 1 - CATWOE for Aarhus model

Based on the CATWOE elements identified in Table 1, we can describe the root definition in the following way:

“PAEIS 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 and NGOs through public telecommunication networks in order to improve participation in decision making and to improve awareness to environmental matters”.

A conceptual model that describes the process is portrayed in Figure 8. The model is described as a set of activities that are set around the purposeful activity that was described in the transformation above. Four measures of performance (the 3 E’s +Ethicality) are described at the bottom of the model. In this case there is a need to consider the ethical values from which this RD was written – a set of beliefs that documents like the Aarhus convention implicitly assumes.

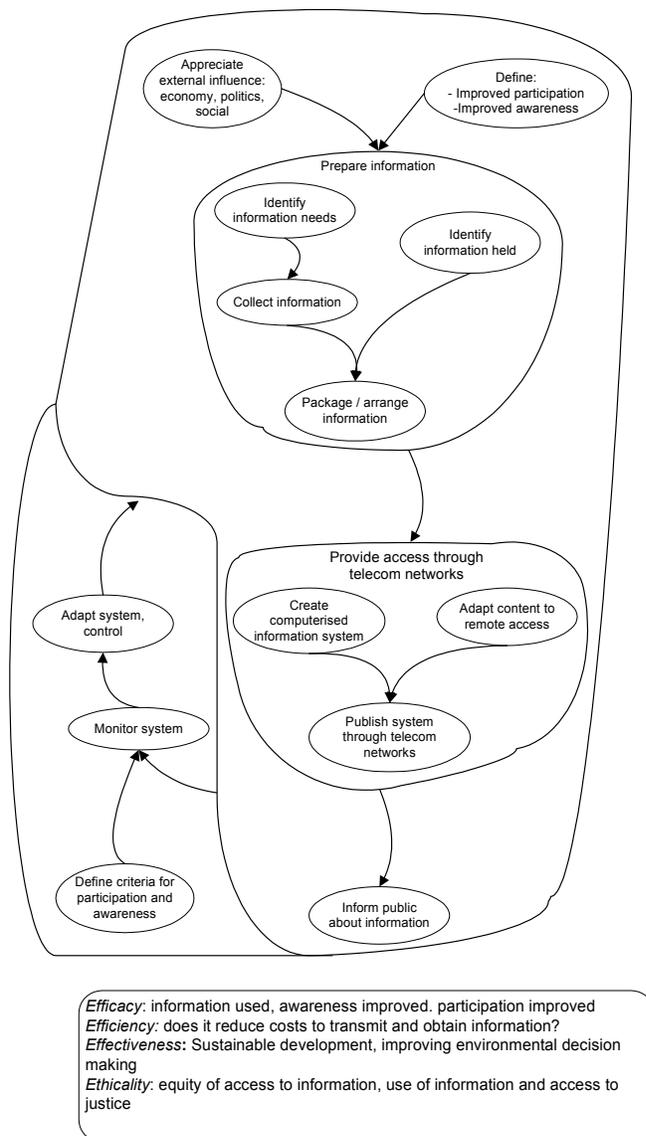


Figure 8 - Aarhus conceptual model

Special Interest Groups (NGOs) Model

Special interest groups (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”, is 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 PAEIS. 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.

<i>Clients</i>	Public, NGO activists
<i>Actors</i>	Public authorities, NGOs, public, political actors
<i>Transformation</i>	Need for information that will promote the goals and objectives of the NGO → need met
<i>Weltanschauung</i>	Advancing the special interest
<i>Owner</i>	Public authority
<i>Environment</i>	The operation of government and public bodies, the economy, political and planning systems

Table 2 - CATWOE for interest group model

Based on the CATWOE elements identified in Table 2, we can describe the root definition in the following way:

“PAEIS is a public authority run information system, operated within the current economic, social and political systems that provides 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 PAEIS). This model is described in Figure 9.

It must be noted that 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. As in the previous case, there is a need for consideration of the ethical dimension as

many NGOs present a strong world view in which the ethical dimension is important, and therefore it must be taken into account when a model is constructed.

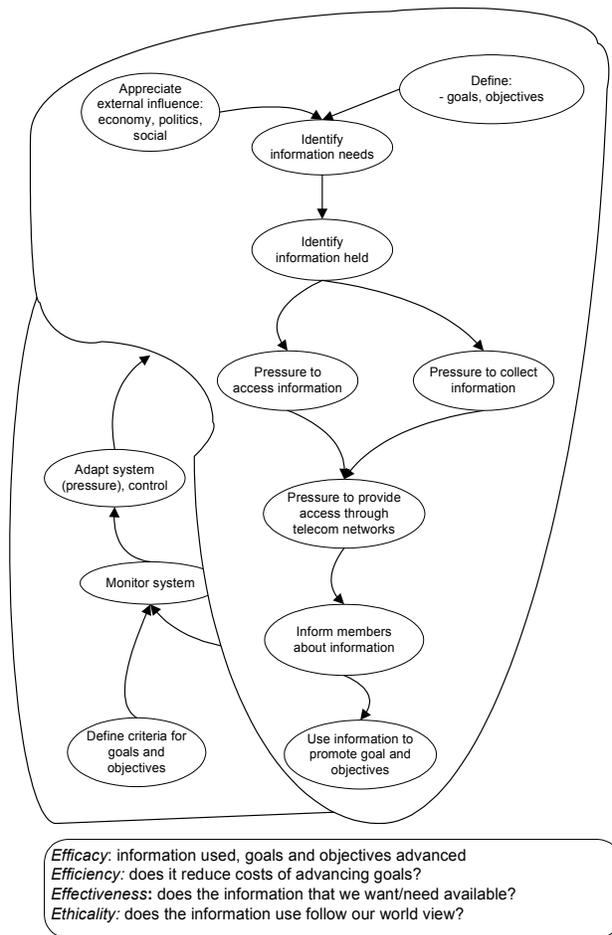


Figure 9 - NGOs conceptual model

Media Model

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 study, and the interested reader is referred to Anderson (1997) as a good departure point. 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 PAEIS. To enable generalisation, the term “readers” is a reference to various users of the media. Hence it should be read as readers/listeners/viewers.

<i>Clients</i>	Media readers
<i>Actors</i>	Media, public authority, officials, journalists
<i>Transformation</i>	Need for interesting news articles → need met
<i>Weltanschauung</i>	Improve readership of the media. Also depends on the media. Can be: promote sales, advanced political goals, provide a comprehensive public service.
<i>Owner</i>	Public authority
<i>Environment</i>	The media market, the interests of media readership

Table 3 - CATWOE for media model

Based on the CATWOE elements identified in Table 3, we can describe the root definition in the following way:

“PAEIS 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 10. In this case, the ethical dimension is stemming from the practice of the media.

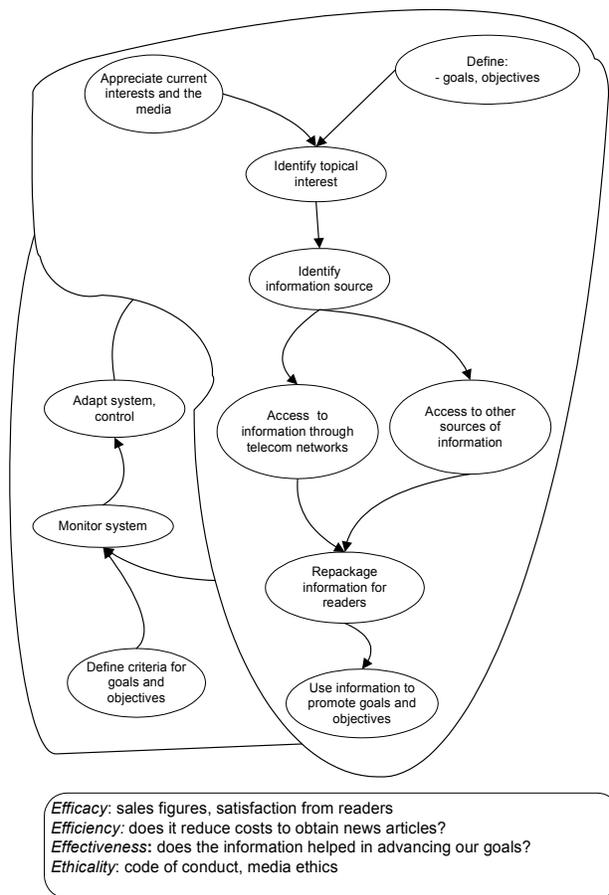


Figure 10 - Media conceptual model

Professional / Environmental Authority Model

The professionals that work within environmental public authorities produce and prepare the information for PAEIS. 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 study and the generalised model will suffice.

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

Table 4 - CATWOE for professional / researcher model

Based on the CATWOE elements identified in Table 4, we can describe the root definition in the following way:

“PAEIS 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 11. The ethical dimension of this model is based on the code of conduct and the “organisational culture” of public authorities.

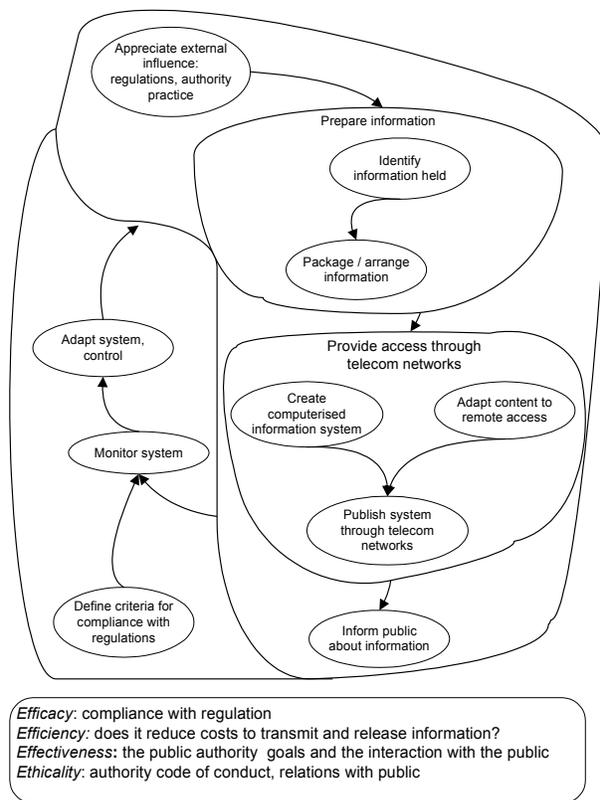


Figure 11 - Environmental authority conceptual model

Interested Citizen (NIMBY) Model

The declared users of PAEIS 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 PAEIS. A member of the public may want to use environmental information to oppose an unwanted development in her locality, and an ideal PAEIS should enable such use.

<i>Clients</i>	Public
<i>Actors</i>	Public, public authority, developers
<i>Transformation</i>	Need to find information to oppose a development project → need met
<i>Weltanschauung</i>	NIMBY
<i>Owner</i>	Public authority
<i>Environment</i>	The planning system, power relationship between developer, public authorities and those who oppose the development

Table 5 - CATWOE for NIMBY model

Based on the CATWOE elements identified in Table 5, we can describe the root definition in the following way:

“PAEIS 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 12. 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.

Although the ethical dimension can be discussed here, it does not impact the model (but the way in which the interested citizen exploits the information)

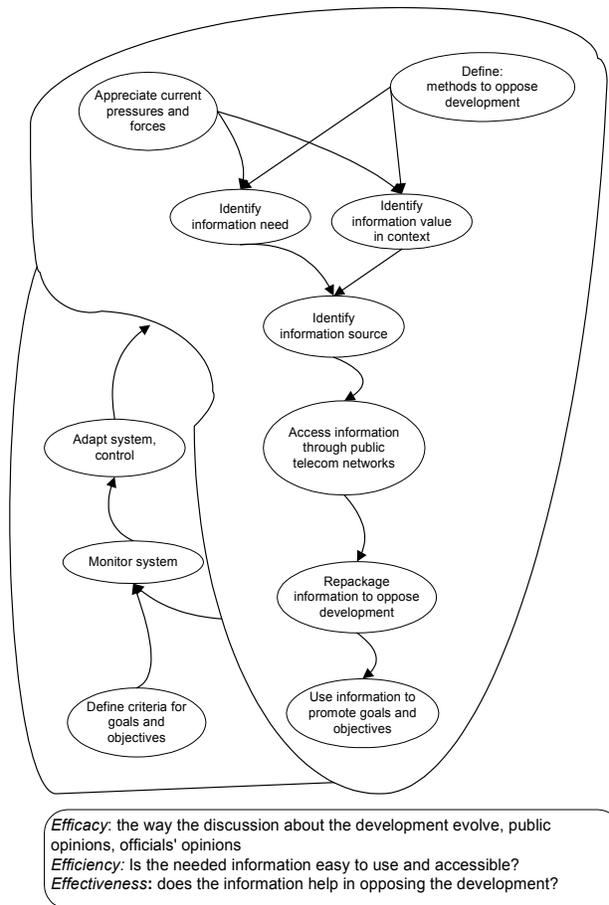


Figure 12 - NIMBY conceptual model

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.

<i>Clients</i>	Public, activists
<i>Actors</i>	Public authorities, public, NGO
<i>Transformation</i>	Need for information that promotes and support local activities →need met
<i>Weltanschauung</i>	Advancing the special interest in the locality
<i>Owner</i>	Public authority
<i>Environment</i>	The activities is the local area (development, retail ...), the political system in operation (local authority) , economy

Table 6 - CATWOE for active citizen model

Based on the CATWOE elements identified in Table 6, we can describe the root definition in the following way:

“PAEIS 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 13. 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. Like the NIMBY model, the ethical considerations are implicit rather than explicit.

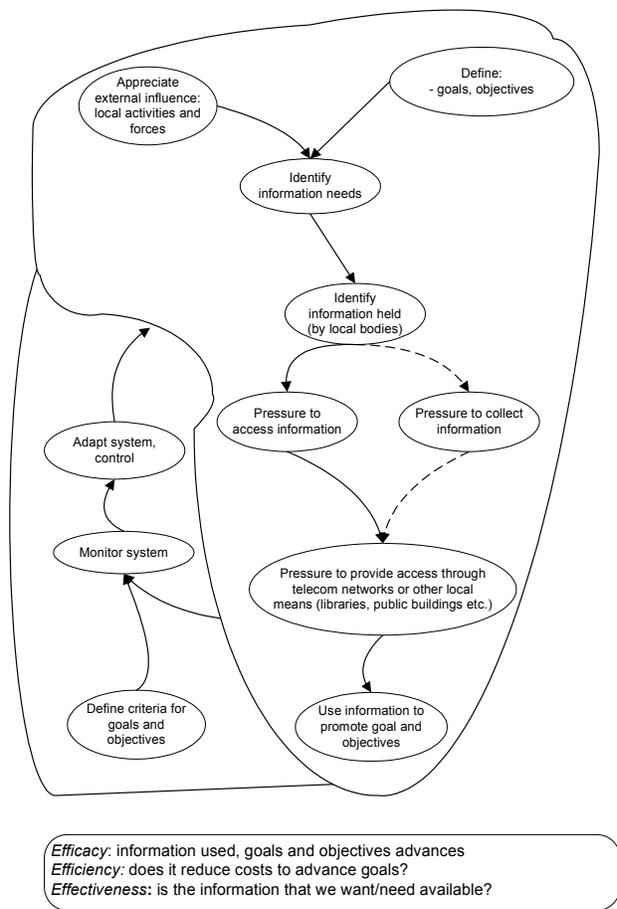


Figure 13 - Active citizen conceptual model

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 seem 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”.

<i>Clients</i>	Public
<i>Actors</i>	Public, public authority
<i>Transformation</i>	Need to know what is happening → need met
<i>Weltanschauung</i>	General information consumption, interaction with the world
<i>Owner</i>	Public authority
<i>Environment</i>	The activities in the area, other issues and interests

Table 7 - CATWOE for general interest model

Based on the CATWOE elements identified in Table 7, we can describe the root definition in the following way:

“PAEIS 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 14 presents the conceptual model, which just like the other individualistic models do not assume any implicit ethical stance.

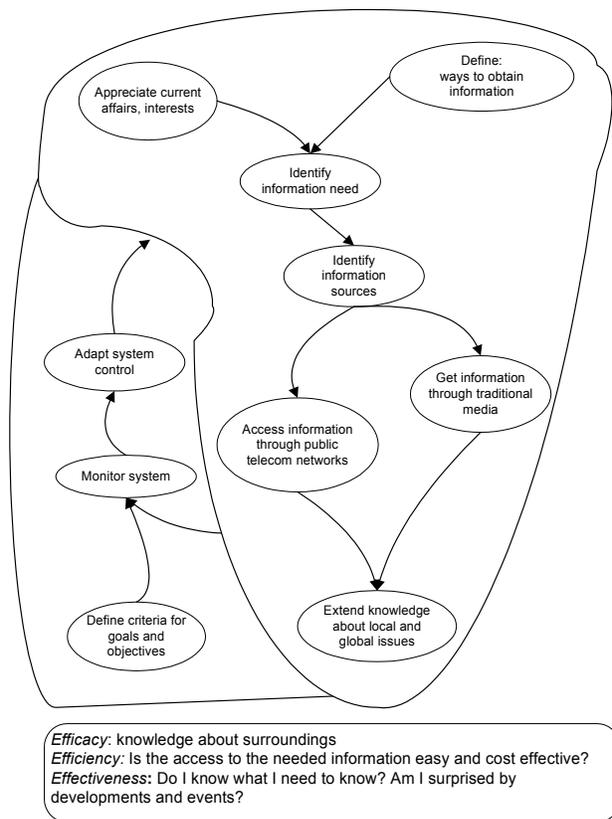


Figure 14 - General interest conceptual model

Other Possible Models

The seven models that have been developed provide a range of perspectives on PAEIS. They provide models for the main forces that were identified and presented in the rich picture (in particular, Picture 3). As this paper focuses on PAEIS from a user centred perspective, more attention is paid to the declared users (the general public) and, therefore, conceptual models were developed to represent those users.

However, it is naïve to assume that these perspectives are the only valid ones. Other possible points of view about PAEIS 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 paper focused and manageable, the selected models provide the main range of opinions and perspectives.

IS THERE A UNIVERSAL CONCEPTUAL MODEL?

The simple answer to the question “Is it possible to develop a universal conceptual model for PAEIS?” is no. As was reviewed throughout this study, 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 PAEIS 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 PAEIS 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.

<i>Clients</i>	Public, media, NGOs, developers, political parties, professionals
<i>Actors</i>	NGOs, media, political actors, professional , public authority
<i>Transformation</i>	Need to find relevant environmental information → need met
<i>Weltanschauung</i>	Current interest, activities and concerns
<i>Owner</i>	Public authority
<i>Environment</i>	The general social, political and economical activities

Table 8 - CATWOE for general PAEIS model

Based on the CATWOE elements identified in Table 8, we can describe the root definition in the following way:

“PAEIS 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 15 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).

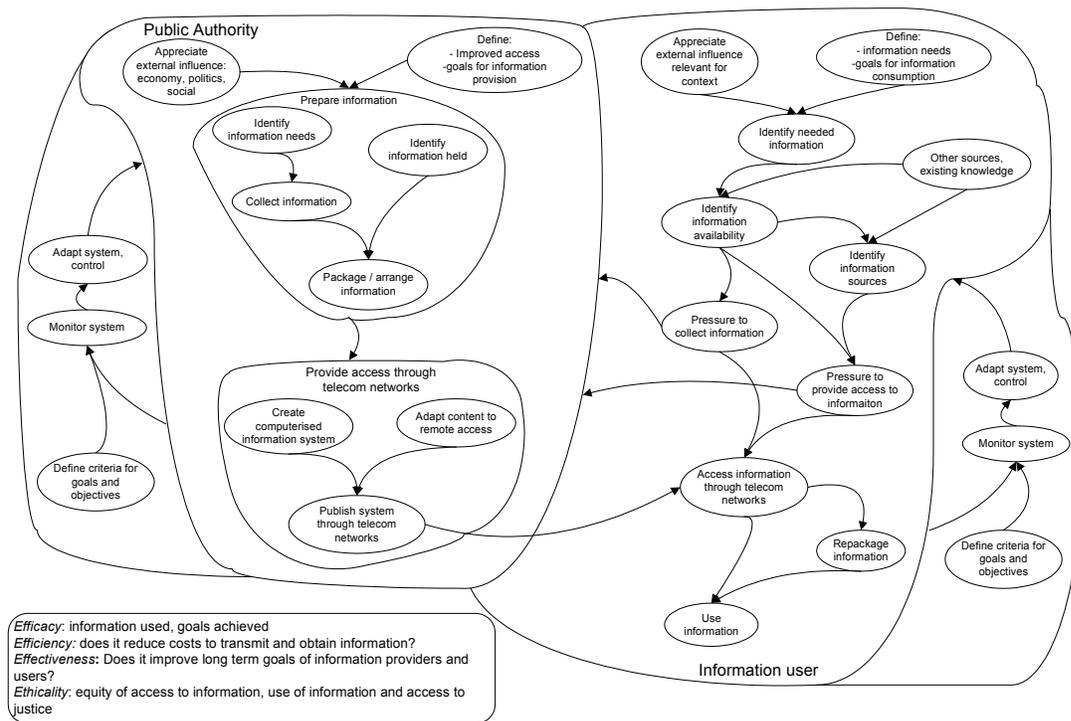


Figure 15 - General PAEIS conceptual model

CONCLUSIONS

The previous sections focused on the development of representative models of the issues which surround environmental information provision and use. Once constructed, they can assist in the discussion on the future of environmental information systems. For example, the rich picture(s) point to several issues that must be taken into account in the development of such systems. Especially, they should be used as a background for re-evaluation of environmental information and its use in decision making process. The overview that the picture provide is detailed enough to point to major issues (such as the life cycle of environmental information, or the multiple users of the information), many of them are under-researched and ill-understood.

The conceptual models can serve another, more concrete target. As noted, such models have been found useful when comparing the actual problem situation and evaluation of the needs of various points of view with it. Such evaluation can be done by comparing the models with existing environmental information systems (Haklay, 2001) but more importantly when new systems are designed and new directions for development are researched. In such situation, the opportunities horizon is wide and the designers can evaluate their proposed solutions with the models and ask: “will the proposed development satisfy the need of this point of view?”. The model can also assist in evaluation of the responses to a specific system by groups that are different from the aimed users. For example, the models of interested citizens can be used to evaluate how they will use a system that was developed for professionals.

In any case, the main aim of the conceptual framework that was presented here is to nurture a more extensive discussion on the way we use environmental information systems, and to assist us in developing better PAEIS.

This brings us back to the point where this paper open. The city is not just a locus of environmental problem – it is also the place where the public is most active and engaged. It is therefore the urban environmental information systems that will be impacted by the changes in regulation which are likely to arrive soon, as result of the Aarhus convention. It is the role of researchers and practitioners to improve these systems as to fulfil the concepts which impinge the Aarhus convention – better access to information integrated with better participation in decision making process, and, hopefully, better decisions.

REFERENCES

- Agnew, C. T. (1984) Checkland's Soft Systems Approach - a Methodology for Geographers?, *Area*, **16**(2), pp. 167-174.
- Anderson, A. (1997) *Media, Culture and the Environment*, U.C.L. Press, London.
- Avison, D. E. and Fitzgerald, G. (1995) *Information Systems Development: Methodologies, Techniques, and Tools*, McGraw-Hill, New York, NY.
- Bunch, M. J. (2000) An Adaptive Ecosystem Approach to Rehabilitation and Management of the Cooum River Environmental System in Chennai, India, PhD Thesis, University of Waterloo, Waterloo, Canada, pp. 422.
- Castells, M. (1997) *The Power of Identity*, Blackwell, Cambridge, MA.
- Checkland, P. (1984) *Systems Thinking, Systems Practice*, John Wiley & Sons, Chichester, UK.
- Checkland, P. (1999) *Soft Systems Methodology : a 30-year Retrospective*, John Wiley & Sons, Chichester, UK.
- Checkland, P. and Holwell, S. (1998) *Information, Systems and Information System -Making Sense of the Field*, John Wiley & Sons, Chichester, UK.
- Checkland, P. and Scholes, J. (1990) *Soft Systems Methodology in Action*, John Wiley & Sons, Chichester.

- Gilpin, A. (1995) *Environmental impact assessment (EIA): Cutting Edge for the Twenty-First Century*, Cambridge University Press, Cambridge, MA.
- Haklay, M. (1999) From Environmental Information Systems to Environmental Informatics - Evolution and Meaning Centre for Advanced Spatial Analysis, UCL, London, pp. 27.
- Haklay, M. (2001) *Public Environmental Information Systems: Challenges and Perspectives* Ph.D. thesis, Department of Geography, University of London, London, pp. 292.
- Lowenthal, D. (1990) Awareness of Human Impacts: Changing Attitudes and Emphases, In *The Earth as Transformed by Human Action : Global and Regional Changes in the Biosphere Over the Past 300 Years*, (Ed. Turner, B. L.), Cambridge University Press with Clark University, Cambridge, MA, pp. 121-135.
- McCormick, J. (1995) *The Global Environment Movement*, John Wiley & Sons, Chichester, UK.
- OECD (2000) *Information Technology Outlook 2000*, Organisation for Economic Co-operation and Development, Paris, France.
- Patching, D. (1990) *Practical Soft Systems Analysis*, Pitman, London, UK.
- Rhind, D. (1996) Economic, Legal, and Public Policy Issues Influencing the Creation, Accessibility, and Use of GIS Databases, *Transactions in GIS*, **1**(1), pp. 3-12.
- Rydin, Y. (1998) *Urban and Environmental Planning in the UK*, Macmillan Press, Houndmills, Basingstoke, Hampshire.
- UN/ECE (1998) *Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters*, ECE Committee on Environmental Policy, Aarhus, Finland, 28 pp.
- Wolsink, M. (1994) Entanglement of Interests and Motives: Assumptions Behind the NIMBY-Theory on Facility Siting, *Urban Studies*, **31**(6), pp. 851-866.
- WCED and Brundtland, G. H. (1987) *Our Common Future*, Oxford University Press, Oxford, UK.