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Public access to environmental information - challenges and research directions:

a review of current issues with environmental information provision

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Abstract

Ever since the Environment gained its place in the public agenda, it has been bundled with information and information systems. In the decade that passed since the Rio conference and the establishment of "sustainable development" principle, there is a legislative and practical move to open access to this information to all parties involved in environmental decision making processes. In this chapter, the origins of environmental information and public environmental information systems will be explored and scrutinised. The chapter questions the current state of the art in information provision, and calls for a user-centred approach, which will integrate studies from other disciplines that are relevant to this task. These disciplines include current research in Public Participation GIS (PPGIS), Public Understanding of Science (PUS) and Usability Engineering. The chapter concludes with the connection between environmental modelling and the production of environmental information, and the societal and moral obligation of researchers to create information that is accessible to a wide audience.

Keywords

Environmental Information Systems, EIS, Public participation, Public access.

Introduction

In most accounts, the publication of Rachel Carson's "Silent Spring" (Carson 1962) is considered as the starting point for the modern, late 20th century environmental movement. Indeed, environmental awareness was not invented in the 1960s, and what we today call environmental politics predates this era (Lowenthal 1990). However, the 1960s serve as an established and well-recognised starting point. In this modern environmental movement, information and information systems played an intriguing part. As environmental issues secured their position in national and international agendas, environmental information followed suit. The continual development of computer-supported environmental models and environmental information systems that has started in the late 1960s, happened in a continuously changing social, political and economic environment. One of the more recent and profound changes to

environmental information systems occurred during the 1990s, with the demand to provide public access to environmental information. The vast literature that covers computer use for environmental application - spanning modelling, monitoring, management and so on - seem to give little or no attention to needs and requirements of different user groups and audiences. The current demands to provide wide access to environmental information make this aspect necessary.

This chapter offers a conceptual model for public environmental information systems which is based on critical examination of the current state of the art of environmental information provision and offers some directions for future developments.

A brief history of environmental information

In order to understand the context of public provision of environmental information, the source of such information must be taken into consideration. To that end, a brief sketch of the connection between environmental politics and information will be useful.

The early years

The connection between regulatory measures and collection of information dates to the early responses to the modern environmental movement. One of these milestones is the USA National Environment Policy Act - NEPA (1969). NEPA binds environmental politics and information explicitly. The two main implementation vehicles established in it are an annual report on the state of the environment and environmental impact assessment (EIA), both of which can be interpreted as information tools. NEPA also make the connection between this information and any interested party. When EIA is described, NEPA states that information about the state of the environment must be used by federal agencies and that this information will be made available to all. (U.S. Congress 1970). NEPA goes on and connects information utilisation to the "job specification" for the Council for Environmental Quality (CEQ) members and demands that "each member shall be a person who ... is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds..."(U.S. Congress 1970, Sec. 201). In short, though NEPA sets 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 USA was not the only active country. Other countries went through similar shifts in policy and public awareness in this period. For example, the UK went through several changes during the late 60s. The creation of the Royal Commission on Environmental Pollution (1969) and the Department of the Environment (1970) are the governmental response to these public pressures (McCormick 1995). It is now commonly accepted that this period marks the awakening of environmental awareness throughout the developed world (Hajar 1996; 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 major outcome from the conference was the creation of the United Nation Environmental Programme (UNEP). From its inauguration, UNEP saw the collection of data and information about the environment as its most urgent task

(Wallen 1997), based on the "Earthwatch" principles - the evaluation and review of existing knowledge; creation of new knowledge through research; information gathering through monitoring activities and information exchange (UN 1972, Sec. C). Once the programme started, considerable gaps in data and knowledge have been found, and the task to fill them was handed to the Global Environment Monitoring System (GEMS) unit. By the end of the 1970s, GEMS had created INFOTTERA - the International Environmental Information System - probably the first of its kind.

Other notable activities in the international scene happened in Europe. In 1973, the European Community (EC) moved, for the first time, beyond strictly economic issues and established the EC environmental programme (Briggs 1986). Though the first programme did not target informational issues directly, the second action plan (amended June 1977), research, data collection and information received centre stage. 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, focusing on data collection methods and improve comprehensiveness and compatibility of such data (Briggs 1986).

Environmental information and sustainable development

Although informational activities continue to evolve in the period that followed, for this review it is appropriate to fast-forward to the late 1980s, and the publication of "Our Common Future" (World Commission on Environment and Development and Brundtland 1987) and the subsequent UN activities. These culminated with the conference on "Environment and Development" held at Rio de Janeiro during June 1992. The Rio declaration and Agenda 21 link information to the principle of 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, ... and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available..." (UN 1992b, Principle 10). The declaration mentions environmental information in other places (EIA at the national level is mentioned in principle 17 and information sharing about transboundary impacts in principle 19).

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 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. ..." (UN 1992a)

Noteworthy are two aspects of this focus on environmental information. Firstly, the Agenda emphasises the role of special kinds of information systems. These are Geographical Information Systems (GIS) and remote sensing systems (mentioned in connection to human settlements, deforestation, agricultural and rural development, ocean protection and fresh water). This is of particular interest, especially when compared with the general reference to "information technologies" or "state-of-the-art data management technologies" that appear in other parts (Chapter 8, for example). Though other types of information systems are mentioned here and there (such as expert system), GIS appears time and again in many chapters (while 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 mentions 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 (UN 1992a, Chapter 23)

Current developments in environmental politics are frequently related to Agenda 21 and to the principle of Sustainable Development in what is now known as "ecological modernisation" (Hajar 1996). In the context of ecological modernisation, 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 purposely built information systems to serve environmental information to the public. These systems will be the focal point in the following sections.

Opening access to environmental information

Environmental politics and environmental discourse have gone through a profound change between the first era (1960s to early 1970s) and ecological modernisation. The view of scientific environmental management and control is deeply embedded in "Silent Spring", NEPA, early UNEP programmes and other regulations surrounding environmental issues. This is not the case with "Our Common Future" and the subsequent ecological modernisation. In this era, environmental concepts should be embedded into all human activities. It is no more a secluded responsibility of an obscured public agency. This time, at least in principle, the focus is on an inclusionary form of decision making. This principle has implications on environmental

information. As was shown, environmental information and data have been always perceived as imperative for environmental decision making. Therefore, it must be exposed and shared with all those concerned in formulating and implementing the decision.

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 70s. The signs for current public awareness are rife. 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.

Questioning environmental information

As most of environmental information is stored in computerised information systems, and with accordance to the growing demand for public access to this information, there is a growing need for Publicly accessible Environmental Information Systems (PEIS). Review of current EIS and PEIS (Haklay 1999) will reveal a set of six assertions that seem to underlie current initiatives:

- A. Sound knowledge, reliable information and accurate data are vital for good environmental decision making.
- B. In sustainable development / ecological modernisation all stakeholders should take part in the 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 development 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) Public environmental information systems should be based on GIS technologies. Such systems are vital for public participation in environmental decision making.

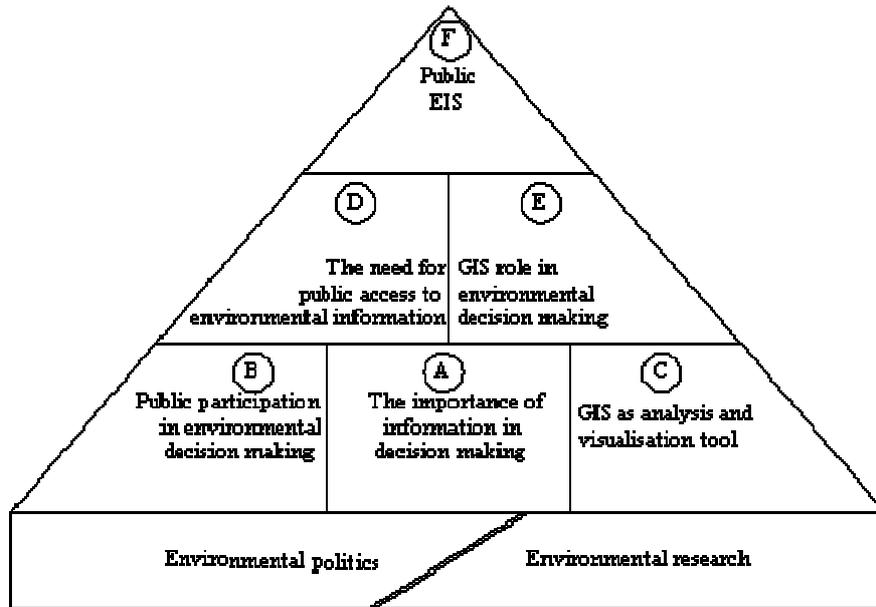


Figure 1. Public Environmental Information Systems assertions

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 activities (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. Notably, the connection between public participation (B) and GIS (C) is a result of the need for information-based decision-making. What is the basis for the logical flow? Can we support these assertions with evidence and research?

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 our discussion they will be accepted as "axioms".

The derived assumptions are more problematic. Unquestionably, access to environmental information plays a major role in public disputes. This can be traced back to the first litigation that surrounded the EIA for an oil-pipe line in Alaska in 1970 (Mowrey and Redmond 1993). Does it mean that any environmental information

is useful to the public? What view of "public" should we accept: the public as a monolithic entity or as a set of single-issue interest groups or other forms? What kind of information should we declare as "environmental"? Any overview of environmental politics (such as Hajar 1996; McCormick 1995) reveal 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 the access to information separately?

The foundations of the next assertion are better. The growth in GIS use in the last decade 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 or 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 and others 1999; Maguire and others 1991). This is true for Environmental applications, too (See Goodchild and others 1993; Goodchild and others 1996). How vital 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 (due to cost, expertise and other factors). Can we claim that the EIA and the corresponding decision are of a lower quality? 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 use 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. In what follows, I aim to deal with them, and especially to explore aspects of the final assertion about PEIS. The main aim is to develop a conceptual model of PEIS that should help in understanding the audiences of PEIS, the information that such systems should hold and the appropriate delivery mechanisms.

Such analysis of PEIS in a conceptual level touches on an interesting aspect of environmental information research. When considering the overwhelming embedding of information into the environmental discourse, we would expect 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 extensive literature in both academic forms (journals and books) and more popular forms, targeted to professionals who work in the area (trade magazines and how-to books). Surprisingly, this is not the case with Environmental Information Systems and very limited amount of literature deals with EIS directly. Most of it focuses on implementation issues, especially when compared to the extensive body of research that exists 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.

Public perspectives on environmental information and current practice

In order to gain a better knowledge on public perspectives on environmental information, a purposely-designed study was conducted. The study adopted a bottom-up approach, i.e. that PEIS should be based on the requirements and needs of the public. These requirements have been gauged through two empirical studies, the London Environment Online (LEO) user survey and the UCL Brownfield research network (UBRN) workshop. The 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 GIS. This was done during a workshop, in which representatives of local pressure groups explored issues surrounding Brownfield site development. The workshop included hands-on experience with GIS and a follow up discussion.

The analysis of the study results demonstrated that the view of the public as a monolithic body (which many existing public EIS implicitly manifest) is inadequate and should be replaced with the realisation of a multiple audience perspective. Users of environmental information do not align to a single perspective, but have "multiple identities" which are used accordingly in different contexts and mindsets. For example, a researcher that is interested in air pollution levels for her daily work, may be interested in local planning applications and their impact when she is at home. Although this statement might seem trivial, examination of existing public EIS show that this multiplicity is not reflected in the design of these systems. Most systems provide a single contact point or interface through which access can be carried out, and do not provide customised access to various audiences. Even the US Environment Protection Agency (EPA) web site, that stands out as an example for Public EIS that provides specialised sections for several targeted groups (such as researchers, business), does not implement this division throughout the system. The information architecture of the site conveys the message that the sections targeted at specific audiences are separate from the main system, and contain information that is of particular interest to this audience. The majority of the system does not differentiate between groups.

A second valuable finding from the analysis is that in many contexts these audiences perceive environmental information in a holistic view. As many have noted, environmental politics integrate multiple contrasting views, which usually transcend disciplinarian boundaries (Hajar 1996, Benedick 1991, Latour 1993) - for example, the ozone problem is not just a problem of reaction between molecules in the stratosphere but connecting issue of humans, economics, agriculture, manufacturing and developing countries. It is therefore not surprising to discover that environmental information is seen as part of a whole and users expect to see a cumulative picture of the environment. The elements from which this picture will be constructed as different and relate to the specific position of the individual user. Therefore, a keen cyclist would like to see public cycle paths integrated into PEIS, whereas an activist who approaches environmental issue with a strong social conviction would like to see deprivation indices as part of it. Furthermore, many users are interested in

environmental information as part of their general information consumption (in a similar way to news consumption through "old" media). Therefore, there is a need to present environmental information in ways that are adequate to such a viewpoint - the information should relate to current concerns or for the current "topic de jour" and provide a rich information that will support such needs.

Due to their developmental history, existing EIS tend to present environmental information in thematic and issue-based ways. Air pollution information is presented in isolation from other information, chemical releases in an inventory form and so on. When considering the organisational structure within which these systems operate, it is understandable that such systems evolve. As a result, most existing public EIS do not accommodate the need to integrate multiple data sets and contrast them.

Thirdly, in light of the holistic view of environmental information, it should not be surprising that maps and GIS are perceived as essential components of public EIS. The participants of the two studies expressed their interest in mapping based visualisation of environmental information. In the same way that other studies have noted (Fedra 1993; João 1998), GIS has the capabilities in integrating various datasets and visualising their juxtapositions. Moreover, it was demonstrated that basic concepts of spatial analysis (such as overlay) seem natural even to novice users of such systems, once exposed to it. The interesting aspect that came out from the workshop, is the use of GIS in an exploratory way, in which the participants use the tool to explore various aspects of the situation and to evaluate how various environmental components influence and interact.

Fourthly, the studies demonstrated the public interest in processed information, such as the output of environmental models (e.g. flood plain models). There was far less interest in access to "raw data" than to interpreted information. These findings concur with those of the user requirement study of the EPA (Princeton Economic Research Inc. 1998) in which various user groups expressed interest in interpreted information. The interest of an asthmatic user is not in the current level of ground Ozone, but rather "am I going to suffer an attack today", which requires some processing of the original information. Interestingly, in spite of current claims of distrust in science, it seems that for many aspects of environmental politics, the outputs of models are more significant than access to raw or unprocessed data.

Finally, and not surprisingly when considering the studies population, there was a notion that the Internet is a good and adequate medium for information delivery. However, this aspect was not accepted uncritically, and environmental issues were connected to social equity ones. Participants voiced their concern about the exclusiveness of this medium. These concerns have been studied empirically in what is now known as the "Digital Divide" (USDOC/NTIA 1995; USDOC/NTIA 1998; USDOC/NTIA 1999). Therefore, EIS designers and maintainers should take care when they claim that public outreach can be achieved by providing an Internet access to the information. This access should be a part of a wider outreach strategy which deals with the societal aspects of information and communication technologies (ICT).

Moving forward

As the analysis above demonstrated, there is a considerable gap between the conceptual model that would-be user of environmental information hold and the current state-of-the-art in this environmental provision. This gap is of special concern, as in the studies that have been conducted and those that have been reviewed, the participants were drawn from groups that already expressed interest in environmental issues. As the introduction vividly demonstrated, the principle of access to environmental information is directly connected to the goal of improved public awareness to environmental issues and improved participation in environmental decision making. Therefore, the failure to furnish the needs of those who are already aware force us to question the likelihood of achieving the wider aim. By realising that the issue of public access to environmental information should not be examined from infocentric perspective but from a rich and contextual social and political one, some remedies can be offered.

First and foremost, PEIS are inherently different from EIS that have been designed and built for professional use. In many cases, the public interface is being conceived in the same way in which professional documents are published, without customisation. PEIS need a special attention from inception to maintenance. They need to be designed specifically for this non-trivial user group, and to take into account the multiplicity of needs and views.

Secondly, while a shared worldview can be assumed when EIS are being constructed in professional settings, such assumption cannot be made about PEIS. In professional settings, and when information is shared among environmental professionals, it can be assumed that they share a scientific worldview, know how to evaluate the quality of the information and to assess it. Once the information is released into the public domain, this assumption cannot stand must be replaced with the opposite view. In other words, in PEIS the starting point is that a shared worldview does not exist and cannot be assumed. The conceptual framework of each user is unique and relates to the task that she is trying to achieve by using the system - it might be checking the environmental quality of a new place to which she considers moving to, or just browsing a as result of a passing interest. Furthermore, her level of knowledge and belief in scientific information is unknown. An inadequate approach - either by "dumbing down" the system, or using a vocabulary and terminology that is too sophisticated - will alienate users. As happen with information resources, it will be a mistake to choose a mediocre solution that satisfys no one.

The different levels of expertise, needs, background knowledge and social environment should force EIS designers to the conclusion that the "one size fits all" rule cannot be applied to EIS. There is a need to develop systems for the experts, another for the decision makers and yet another for the wider public. Luckily, computers are flexible enough and the technology can support the provision of different views to different users. Of course, the different views should share the underling data sources. On the technical front technologies such as intelligent agents, collaborative filtering and such can help in the development of appropriate PEIS.

Though the aspects that have been reviewed pose a formidable challenge to PEIS designers, current knowledge in various fields can be deployed and used to inform the development of them. The areas in question are: development of different views to different users, the use of bottom-up approach to public access, and the use of lessons from usability studies and public understanding of science studies.

The design of user interface and the technical aspects of storage and retrieval of environmental information can be based on the current knowledge from the field of Human Computer Interaction and usability studies (Landauer 1995; Preece 1995). Too many existing PEIS do not use any recommendation from this useful study area. Even in the relatively new medium of the WWW there are more than enough recommendation for User Centred Design and deployment (Nielsen 1999). However, While usability studies may prove helpful in the technical bits and bolts of PEIS design, the content might yet be problematic to the occasional consumer. Here, the knowledge in Public Understanding of Science (PUS) research can help. The research into PUS provide examples and lessons about the appropriate way to provide scientific information to the wider public (COPUS 1995; Eden 1996; Hoppen and others 1996). It might also prove useful in understanding issues like risk evaluation by the public, trust, proper feedback mechanisms and more.

Conclusion

This chapter focuses on the problem side of PEIS more on the solution side, as it was felt that this issue should receive attention from the research community. The characteristics and problem of PEIS, as described in this chapter must be understood by GIS practitioners since they force a certain degree of reflexivity during model creation and use. The reason for this is that GIS, models and the subsequent information that is generated through them - all fall under the definition of "environmental information". Thus, they have the potential to be exposed to a more informal and less knowledgeable audience. Therefore, the researchers and professionals have another obligation - on top of the scientific and academic one - which is moral and social. This obligation is to provide the result in a form that is adequate to the use of general users and can portray vividly issue of uncertainty and accuracy. This is by no mean an easy task, but the current legislative developments leave no other option.

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End notes

1. One such information oriented activity is the recommendations in the subsequent document to "Global 2000 Report to the President" titled "Global Future: Time to Act" that called for reorganisation of the United States government and the creation of a new centre for co-ordination of data gathering and modelling to support policy formulation (McCormick 1995).

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