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The Three Eras of Environmental Information: the Roles of Experts and the Public

Mordechai (Muki) Haklay

Department of Civil, Environmental and Geomatic Engineering

University College London

Gower St., London WC1E 6BT

United Kingdom

1. Introduction¹

Access to environmental information and its use for environmental decision making are central pillars of environmental democracy. This statement, at first sight, seems natural – almost obvious – to anyone familiar with environmental management and environmental policy. After all, from the US National Environmental Policy Act (NEPA), enacted in 1969 and recognised since as ushering in the modern era of environmental legislation [1], through the declarations of international environmental conferences (from the Stockholm United Nations Conference on the Human Environment in 1972 to Rio+20 in 2012) to a whole host of regulations, reports and academic discussions, environmental information is always described as central to decision making.

¹ The content of this chapter is an update of material that previously appeared in Haklay, M., 2003, Public Access to Environmental Information: Past, Present and Future, *Computers, Environment and Urban Systems*, 27, 163-180; Haklay, M., 2009, The Contradictions of Access to Environmental Information and Public Participation in decision making, Nordic Environmental Social Science 2009, London, 10-12 June

Yet, despite its significance, little attention is paid to the way information is created, consumed and used within environmental decision making. While attention to the technical aspects of environmental information creation or distribution are common, as are the procedural and legal aspects of access to environmental information, they are explored in a disjointed way. As a result, there is a lack of analysis of how environmental information comes into being and by whom, who uses it and to what ends, and what is its direct contribution to decision making processes. Such an analysis is especially important in the context of participatory sensing and active public engagement in the creation of environmental information through citizen science as it allows us to understand the wider policy context in which these activities take place.

In this chapter, the history of environmental information production and use is divided into three eras, based on the identification of who creates the information and who is expected to use it. The first era starts with the emergence of the modern environmental movement at the very end of the 1960s, marked by the introduction of NEPA, and continues to the Earth Summit in Rio 1992 (the United Nations Conference on Environment and Development – UNCED). In this era, environmental information is produced by experts and scientists and is intended to be used by other experts and scientists. The second era runs from the Earth Summit and ends with the Eye on Earth Summit in Abu Dhabi in 2011. This period is marked by the opening up of environmental information to the public while maintaining the paradigm of information production by experts and scientists, as in the first era. The third era, which we are now experiencing, is marked by opening up the information production process, too. Both the production and consumption of environmental information is undertaken by the public, experts and scientists.

In fact, the transitions between each of the eras were evolutionary and not revolutionary. Yet, the different markers (NEPA in 1969, UNCED 1992 and Eye on Earth in 2011) indicate a policy level recognition of a wider change, which usually started well before the specific date of the legislation or declaration. Thus, the experiments in environmental impact assessments – which are the core of NEPA – started in the early 1960s [2]. Despite the temporal gap between early experimentation or professional adoption and the date of the legislation or declarations, it is valuable to identify the point when the practice received official recognition, as this indicates widespread acceptance as the new modus operandi within environmental management and decision making.

As we explore each of the eras, we will look at the legal and regulatory aspects as well as examples of specific environmental information systems that demonstrate the practices at the time. Following the descriptions of the three eras, we explore the reasons for the changes, which are both technological and societal trends, as well as the implication of the new era that is currently emerging. First, we turn to a more detailed description of each of the eras.

1969-1992: Environmental Information by Experts, for Experts

In most accounts, the publication of Rachel Carson's 1962 book *Silent Spring* [3] is considered a turning point for the 20th century environmental movement and the emergence of 'the environment' as a substantial topic on the public agenda [4][5]. Environmental awareness was not invented in the 1960s and what we, today, might call environmental politics predates this era [4]. Yet, the connection between regulatory measures and the collection of information is linked to the early responses to the modern environmental movement. As noted, one of these responses is the USA's NEPA from 1969, which explicitly binds environmental politics and information. The two main implementation vehicles established in it are an annual report on the state of the environment and an environmental impact assessment (EIA); both are information tools. NEPA also makes the connection between environmental information and how it is distributed. When discussing EIA, NEPA states:

All agencies of the federal government shall ...

(G) make available to States, counties, municipalities, institutions, and individuals, advice and **information useful in restoring, maintaining, and enhancing the quality of the environment**; [6, Sec. 102, emphasis added]

NEPA goes on to connect information utilisation in the 'job specification' for members of the Council for Environmental Quality (CEQ), requiring that:

...Each member shall be a person who, as a result of his training, experience, and attainments, is **exceptionally well qualified to analyse and interpret environmental trends and information of all kinds**... [6, Sec. 201, emphasis added]

In short, though it sets out to deal with national policy to 'encourage productive and enjoyable harmony between man and his environment' [6], NEPA implements it through the production and use of information.

The United States was not the sole active scene of political change. Other countries went through similar shifts in policy and public awareness during this period. For example, in the UK the creation of the Royal Commission on Environmental Pollution (1969) and the Department of the Environment (1970) were the governmental response to public pressure [5]. It is now commonly accepted that this period marks an awakening of environmental awareness throughout the developed world that was termed 'environmental revolution' [5][7], evident in the organisation of the United Nations conference on 'The Human Environment' in Stockholm in June 1972. In the action plan of the conference, information and information sharing are mentioned over 60 times [8]. The major outcome from the conference was the creation of the United Nation's Environmental Programme (UNEP). From its inauguration, UNEP saw the collection of data and information about the environment as its most urgent task [9], 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 [8, Sec. C]. Once the programme started, considerable gaps in data and knowledge were

found. The task to fill them was handed to the Global Environment Monitoring System (GEMS) unit. By the end of the 1970s, GEMS had created INFOTERRA (the International Environmental Information System) – probably the first of its kind [9]. INFOTERRA was operated through national focal points and provided the service of locating sources of environmental information through computerised queries [10]. It is important to remember that INFOTERRA was running on mainframe computers, and each query was expensive to run. In addition, UNEP printed the directory of information from INFOTERRA and distributed it to national focal points.

Other notable activities on the international level happened in Europe. In 1973, the European Community (EC) moved, for the first time, beyond strictly economic issues to establish the EC environmental programme [11] – a medium-term plan with declared targets and goals. Though the first programme did not target informational issues directly, by the second action plan (1977) environmental information took centre stage, alongside EIA. Some of the directives and regulations that stem from those 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 improved comprehensiveness and compatibility of such data [11].

Within the first era, another noteworthy development that exemplifies the use of environmental information came again from UNEP. The initiative was termed the Global Resource Information Database (GRID) and was conceived around 1981-1983, with a mission to co-ordinate, within a common geographical reference system, the numerous data sets that GEMS, UNEP and other specialised agencies already had. At the heart of GRID are the concepts and technologies of Geographic Information Systems (GIS). This is how UNEP described GRID:

...Existing technology now makes possible the development within GEMS of the global resource data base (GRID), which will be a data management service within the UN system designed **to convert environmental data into information usable by decision makers** ... The technical feasibility of GRID has been assessed by expert groups... [12, emphasis added]

And a year later:

...GRID technology allows us ... initially to describe, but eventually to understand, and ultimately to predict and manage... GRID is also providing practical introduction to GIS technology for application in the national level ... data transmission rates were very low, and for cost-effective telecommunication between GRID nodes, direct satellite links will clearly have to be established ... UNEP looks forward to the day when GRID data and technology will be routinely and easily available to the entire world community to help sharpen the process of environmental assessment and guide the forces of environmental management [13]

To summarise, in the first era the political response to the growing public concern about environmental issues was to set in place regulations, systems and activities that were created by experts or link experts from different countries. The assumption is that only the experts can create environmental information that is

suitable for decision making. In addition, because the information required specific expertise in interpreting it, an implicit assumption is that only experts will be interested in using it, so only they need access to it.

1992-2011: Environmental Information by Experts, for Experts and the Public

Experts, however, were not the only ones with interest in environmental information, and this was recognised even in the early days. As noted, the legislation for the policy instrument that opened the first era – EIA – required the disclosure of the final document to the public. Awareness to the need for public participation in decision making at the end of the 1960s is also evident in the now famous Ladder of Participation [14] (Figure 1), created by Sherry R. Arnstein, and addressing general urban planning processes. Arnstein identified 3 grouping of processes and actions that can be taken in a participation process. For her, manipulating public opinion through public relations or providing opportunity to complain but without any intention of action cannot be considered as public participation. Next, only informing the public about what is going to happen or providing a short consultation are only tokenism of participation. Only when the public is involved fully in decision making a process can be called participatory. Notice that, in Arnstein's conception, 'informing the public' is fairly down the scale, identifying it as tokenism.

Yet, because of the prevailing stance by decision makers and experts that a decision should be based on scientific understanding which is only available to experts, the role of the public was seen as limited. This view was challenged by many, especially with the growth of environmental Non-Governmental Organisations (NGOs) such as Friends of the Earth or Greenpeace, which had access to scientists and bridged the knowledge gap by interpreting environmental information for non-experts. At the same time, these organisations also mobilised their members to have a say in decision making.

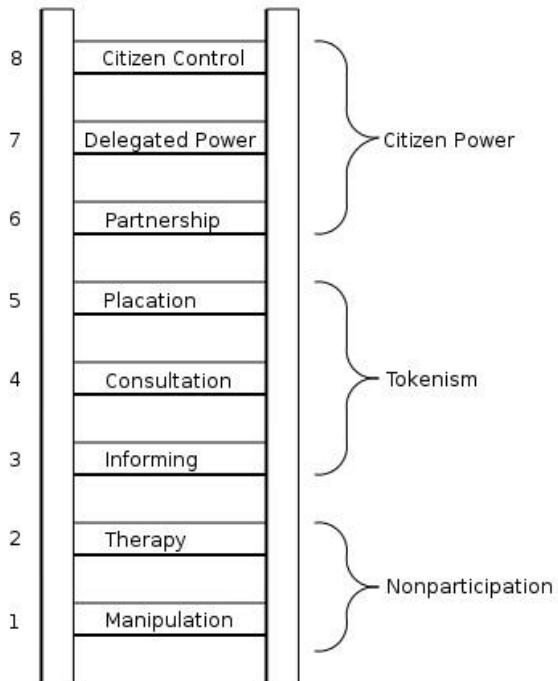


Figure 1. The Ladder of Citizen Participation (Arnstein, 1969)

The changes in participation and access to information accelerated in the late 1980s with the publication of *Our Common Future* [15] and the acceptance of the Sustainable Development principles at the Rio conference in 1992. *Our Common Future* argued that Sustainable Development calls for inclusion of environmental, social, economic and political considerations in decision making, and therefore participation of stakeholders from a wide constituency is necessary [16]. In parallel to the realisation that the public should be involved in environmental decision making, there was growing understanding that access to environmental information should be open to all. As many have noted [17][18][19], the need for environmental information spans a wide range of needs – from the educational role and raising awareness to biodiversity threats, to planning ahead for a day out.

However, to enable citizens to participate fully in environmental decision making processes, access to information has been seen as a necessary element as these processes usually rely on scientific advice and information. In the process that led to the Rio conference, access to environmental information and participation in decision making were inexorably linked. This was the result of an initiative by north-

ern European countries to promote a ‘Charter of Environmental Rights and Obligations’ during the Rio conference, which was supposed to include ‘the right of access of individuals to environmental information, the principle of the participation of citizens in decision making affecting the environment, and the right of access to administrative and judicial proceedings’ [20] (p. 259). The initiative failed, but the Rio Declaration’s Principle 10 is a watered down version, which carries through the spirit of the Charter. It is one of the most significant and far-reaching elements within the declaration:

Environmental issues are best handled with participation of all concerned citizens, at the relevant level. At the national level, **each individual shall have appropriate access to information concerning the environment** that is held by public authorities, including information on hazardous materials and activities in their communities, and the **opportunity to participate in decision-making processes**. States shall **facilitate and encourage public awareness and participation by making information widely available**. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided. [21, emphasis added]

Following the Rio Declaration, work continued on extending Principle 10 and setting out the necessary legal mechanisms to turn it into action. In 1995, the United Nations Economic Commission for Europe (UNECE) in their Environment for Europe Ministerial Conference in Sofia signed the ‘UNECE Guidelines on Access to Environmental Information and Public Participation in Environmental Decision-Making’:

Recalling Principle 10 of the Rio Declaration on Environment and Development which states that: “Environmental issues are best handled with the participation of all concerned citizens, at the relevant level”,

Recognising that **in order to increase awareness of environmental problems and promote effective public participation, access to environmental information should be guaranteed**,

Recognising that public participation contributes to the endeavours of public authorities to protect the environment, and bearing in mind that environmental policy and decision-making should not be restricted to the concerns of authorities,

Recognising that in order to promote effective public participation the public need to be aware of the means and methods of participation in environmental decision-making processes, and in the solving of environmental problems,

Recognising that **public participation can be a source of additional information and scientific and technical knowledge to the decision makers** ... [22, emphasis added]

The change in the understanding of the role of the public and its need for environmental information is noteworthy. The citation shows clear signs of what is termed ‘the information deficit model’[23], which assumes that the public is uninformed about environmental issues and lacks the ability to understand them. The deficit model was (and is) common amongst experts and decision makers, and it is therefore unsurprising that it emerges with respect to public access to environmental information. However, the text also recognises that knowledge does not only reside with experts, and that the public can contribute useful information. These two aspects illustrate the shift that occurred in this era – there was still reluctance to open

up information and participation, mixed with the realisation that time had changed and that access and participation were necessary.

The process that started with Principle 10 reached its climax in 1998, when members of the UNECE signed the ‘Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters’ – which is known as the Aarhus Convention (UNECE 1998): one of the most influential environmental agreements in the past 20 years. Here, the preamble reads:

Recognizing also that every person has the right to live in an environment adequate to his or her health and well-being, and the duty, both individually and in association with others, to protect and improve the environment for the benefit of present and future generations,

Considering that, **to be able to assert this right and observe this duty, citizens must have access to information, be entitled to participate in decision-making and have access to justice in environmental matters**, and acknowledging in this regard that citizens may need assistance in order to exercise their rights,

Recognizing that, in the field of the environment, **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 the opportunity to express its concerns and enable public authorities to take due account of such concerns... [24, emphasis added]

The Aarhus Convention was implemented through legislation such as the EU Directive 2003/4/EC on public access to environmental information, and Directive 2003/35/EC on public participation in environmental decision making, as well as in state level regulations – for example in the UK as the Environmental Information Regulations, which came into force in 2005. Activities such as the Access Initiative (<http://www.accessinitiative.org/>) continue the work that started with Principle 10 and examination of its implementation across the world shows that there is still a need for implementation in many countries.

While the legislative framework of the second era was important, the agreements, conventions and regulations lagged behind the practice. This is to be expected as it took 13 years from discussions on Principle 10 to its implementation. The examples that follow demonstrate both the importance of NGOs as intermediaries and the rapid innovations that resulted from the growth of the Internet and the World Wide Web.

The first example is from Friends of the Earth UK (FoE UK), which, in the mid-1990s, had an internal GIS team with outstanding technical capabilities [25]. At the time, information about chemical releases from factories was collected by the governmental body (the Environment Agency) but was not available to the public. A copy of the database was leaked to FoE UK, and was then used to create the campaigning website ‘Factory Watch’ which was launched in 1998 and allowed members of the public to enter their postcode and see which factories were in the vicinity. Moreover, it was possible to explore the pollutants that were reported and see details about their possible health implications (see Figure 2).

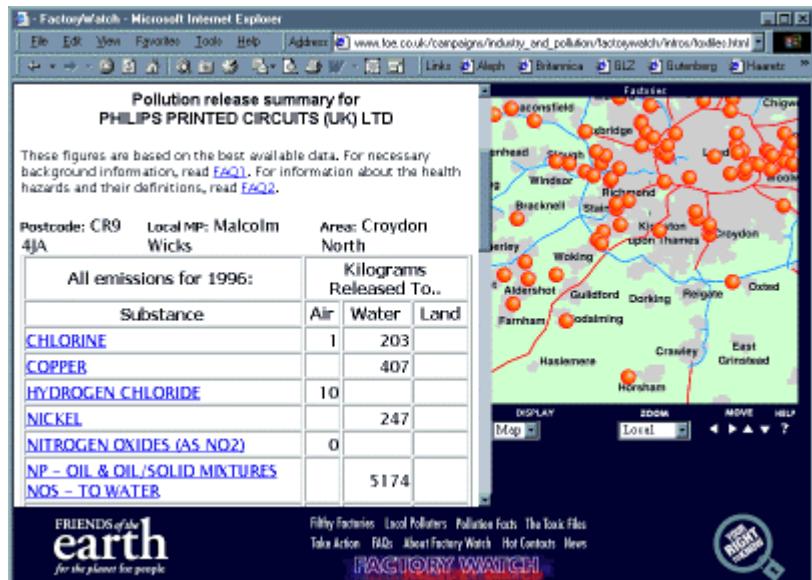


Figure 2. Friends of the Earth (UK) Factory Watch website. Notice the hyperlinks for each pollutant, which provided further information, and the logo at the right-hand side: ‘your right to know’

The Factory Watch website was a pioneer in several aspects that are important for the discussion here. First, it demonstrated the ability of NGOs to understand, access and use environmental information in a way that was meaningful to the wider public. Second, it demonstrated the sophistication and skills that were available to NGOs – at the time Factory Watch was designed, there was no ‘out of the box’ web mapping software and, therefore, the creation of an interactive mapping website demonstrated the level of technical know-how that FoE’s GIS team had. Third, Factory Watch demonstrated the power of the Web as a public information delivery medium, with the potential to release significant amounts of environmental information to a wider audience. Finally, Factory Watch need to be seen within the context of pressuring public bodies to release environmental information to the public, which at the time was discussed at the policy level.

A second example, and a later one within this era, are the websites from around 2008 that provide access to Strategic Noise Maps, which appeared across the EU following Directive 2002/49/EC (see also Wenninger, and Jennett et al. elsewhere in this volume). The directive is discussed in detail elsewhere in this book. The directive included a requirement for member states to create maps that assess the level of noise exposure for residents in major agglomerations, as well as those living next to airports, major roads and railways. By the time the directive was enacted, public access to environmental information was seen as the norm, as was the use of the Web as the dissemination medium. An example of one of the first maps released to the public in the UK is provided in Figure 3, for the area of London.

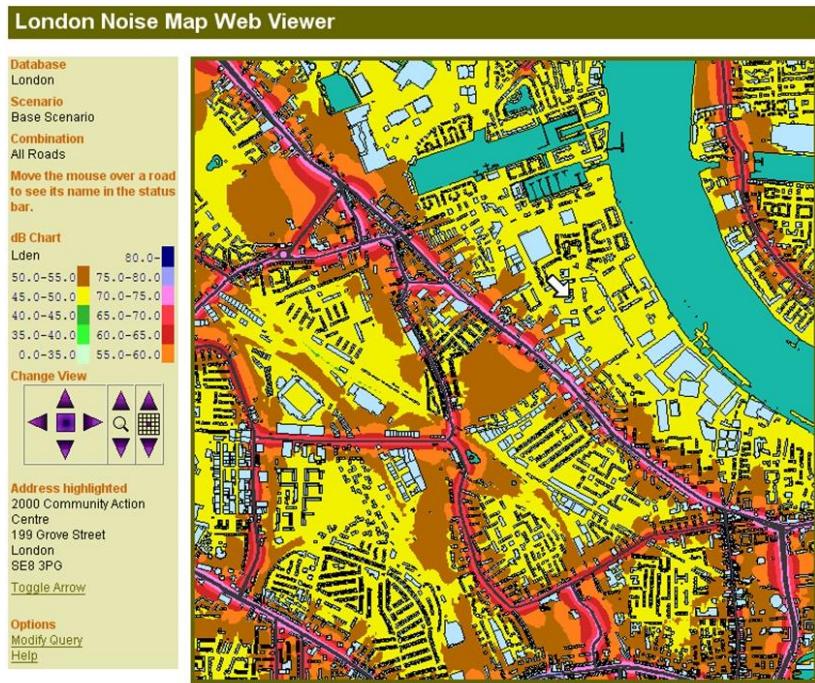


Figure 3. London Noise Map (2008)

The Strategic Noise Maps, such as the one shown above, epitomise the second era. Experts and decision makers decided the details of the modelling process and the visualisation of information. The complex process of assembling very large data sets which included the outline of each building in urban agglomerations, developing sophisticated computerised acoustic models, the production of the results and the development of the maps was all carried out by experts with limited, if any, engagement with the public. The resulting website is littered with jargon – Lden, dB or a reference to a scenario. In addition, the map lacks some basic cartographic elements such as street names or major landmarks, which makes the output difficult to read. Moreover, the details of the modelling approach and the relationships between the maps and the noise that members of the public are exposed to in their daily lives are not explained.

To summarise, during this era several factors played an important role: regulations and legislation such as Aarhus, which mandated the release of environmental information; the rapid development of Web technology, which made it easier to build systems to deliver the information to a wider audience, coupled importantly with increased access to the Web by larger segments of the public (though a significant group, of about a quarter of the European population, remain marginalised even today); and the increased experience within public institutions and civic society organisations in using information to advance public participation in decision making. Because of these, during this era, thousands of websites emerged – some

as simple as a blog with very localised information to a few that were complex, interactive and rich such as the Friends of the Earth website, or with interactive content that could be explored and customised through maps, charts and downloadable information as offered in advanced governmental sites at this time (e.g. the map of European Environment Agency Natura 2000 site, Figure 4). Yet despite all the sophistication, the websites provided access to information that was created mostly by experts, and were controlled by experts.

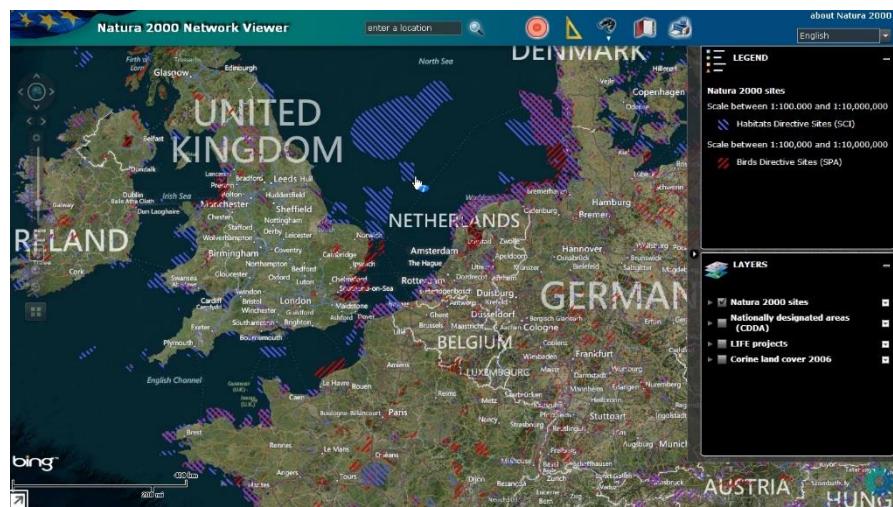


Figure 4. The European Environment Agency Natura 2000 site

2011 onwards: Environmental Information by Experts and the Public, for Experts and the Public

The last stage in the opening up of environmental information to the public is the increased acceptance of citizens, NGOs and other intermediaries as producers of information. One of the first indications of the change came in a talk given by Prof. Jacqueline McGlade, the then Executive Director of the European Environment Agency (EEA), during an international conference to mark a decade since the signing of the Aarhus Convention in 2008. In the speech, she announced the creation of a Global Citizens Observatory for Environmental Change, starting with provision of information about water quality, combined with citizens' observations. She noted that:

Often the best information comes from those who are closest to it, and it is important we harness this local knowledge if we are to tackle climate change adequately... people are encouraged to give their own opinion on the quality of the beach and water, to supplement the official information.[26, emphasis added]

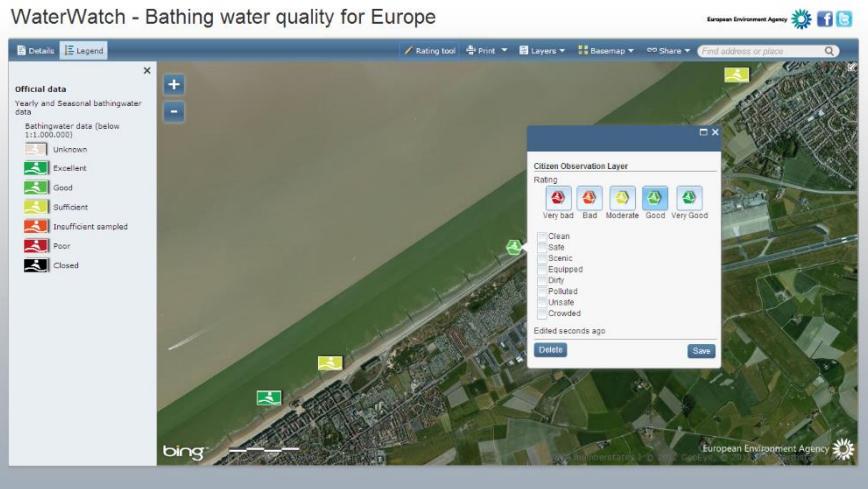


Figure 5. The European Environment Agency WaterWatch site, allowing citizens to provide a rating of water quality based on personal observations

Thereafter, the EEA acted as a catalyst for the increased use of environmental information provided by the public and for increasing the awareness to it among decision makers. The official acceptance of the public as producers of information and not mere consumers is slower. In the preparatory process of the Rio+20 conference (held in Rio de Janeiro in 2012) UNESCO proposed to include the following statement:

The contributions of science, including the natural sciences, social sciences and engineering, to sustainable development are deep and multifaceted. **Communities need to collectively address common pressing challenges facing our society**, such as food security, climate change, natural disaster risk reduction, biodiversity loss, access to clean water, management of terrestrial and marine resources, energy security, and affordable and effective health care. In addition, science and technology and innovation (STI) serve as a major engine for social and economic growth, generating entirely new industries, products, and services and creating jobs for our youth. Science and engineering contribute not only to understanding our world but to acting for change to the benefit of society. To move forward it is clear that a new compact between science and society is needed, one that more effectively promotes dialogue among scientists, policy-makers and society at large [27].

The rationale associated with this statement mentions environmental information that is generated by the public – known as citizen science – explicitly. In the final version of the conference declaration the suggested text from UNESCO is not included, and the move beyond Principle 10 is more nuanced:

We underscore that **broad public participation and access to information and judicial and administrative proceedings are essential to the promotion of sustainable development. Sustainable development requires the meaningful involvement and active participation** of regional, national and subnational legislatures and judiciaries, and all major groups: women, children and youth, indigenous peoples, non-governmental organizations, local authorities, workers and trade unions, business and industry, the

scientific and technological community, and farmers, as well as other stakeholders, including local communities, volunteer groups and foundations, migrants and families, as well as older persons and persons with disabilities. In this regard, we agree to work more closely with the major groups and other stakeholders, and **encourage their active participation, as appropriate, in processes that contribute to decision-making, planning and implementation of policies and programmes** for sustainable development at all levels [28, item 43, emphasis added]

Within the process that led to the Rio+20 conference, the Eye on Earth Summit (held in Abu Dhabi in 2011) provides a clearer indication to the change in environmental information production. The summit focused on environmental information and the sharing of it and included examples of environmental information collection by the public. Examples of citizen science included educational initiatives in the US as well as indigenous knowledge sharing in the Amazon. The final declaration discussed the role of stakeholders in creating and sharing information:

...the objectives of our collaboration are **to foster collaboration among communities, relevant networks, systems, institutions and technology providers on the integration of economic, environmental and social information in a shared information system for the advancement of sustainable development** by taking advantage of the rapid development of information and communication technologies and by strengthening capacity building and technology support to developing countries and countries with economies in transition [29]

While what the declaration means by ‘communities’ is open to interpretation, there is a clear extension of the canvas in recognising the roles of many actors in the creation, dissemination and use of environmental information. The statements in the declaration were strengthened two years later, during the first meeting of the Eye on Earth network in Dublin, in which the final statement explicitly states that the parties:

Decided to continue to collaborate through the Eye on Earth Network, to promote, support and improve access to data and information for sustainable development and, where appropriate, by participating in special initiatives, collaborating on related technical developments, **establishing citizen science as an important source of knowledge within the diversity of knowledge communities**, building capacities across the network and convening meetings to achieve this goal [30]

The Dublin statement needs to be recognised for what it is – the meeting was not a core environmental negotiation meeting with actionable obligations or even a strong international statement. Yet, this is the first example of official recognition of citizen science as a source of environmental information. It is left to be seen how citizen science will become recognised within international and national legislation, and we can expect the process to follow the activities that occur on the ground, to which we now turn.

There is, of course, irony in the fact that it took nearly half a century to open environmental information creation to the public, due to two aspects. First, as noted, it was the public’s pressure that started the modern environmental movement, and this was based on growing public awareness of environmental problems through books and the media that provided environmental information. Second, and more

importantly, many of the data sources that were used by scientists to provide input in environmental decision making were created by citizen scientists. Biological observations and meteorological records are the results of the efforts of many volunteers –in some cases this was a sustained effort over many decades and even centuries [31]. Moreover, the funding for the organisation that maintained and coordinated the data collection activities came from the demand for the data for environmental decision making. However, the source of the data was marginalised or even ignored and, until recently, only the analysis of the data and its scrutiny by experts gave it authority and respectability.

In addition to these long-standing citizen science activities, a new form of environmental citizen science emerged at the end of the 1990s and the beginning of the 200s. An example of this is the Global Community Monitor, an organisation that, since 1998, has developed a method to allow communities to monitor air quality near polluting factories [32]. The sampling is done by members of the affected community using widely available plastic buckets and bags followed by analysis in an air quality laboratory. Finally, the community is provided with guidance on how to understand the results. This activity is termed ‘Bucket Brigade’ and is used across the world in environmental justice campaigns.

Another example of the new capabilities that are provided to citizens to contribute environmental information in novel ways is provided by the range of applications that are available on smartphones. The applications allow participants to use the sensors in their phones to collect and share observations about the environment. This can be sensing vibrations or noise level, as well as annotating and contextualising the observations. Many of these applications are described and explored in other chapters of this book (see Part I).

Drivers of Change and Implications

As we have seen, over the past 50 years a remarkable transformation in relation to environmental information has happened: from the stance of not only should production of environmental information be done by experts, but they should also be responsible for interpreting it reliably, to the acceptance that both the process of production and use of environmental information is open to the public. Throughout the period, experts continued to have the main role within environmental decision making processes – from advising the US President in the CEQ to summarising the latest science for the Intergovernmental Panel on Climate Change (IPCC) – but the relationship between the experts and the public has changed. To understand this change and to explain the three eras, we briefly look at the societal, political and technical changes that enabled them. What follows is an attempt to pinpoint the main factors that explain this transition.

The societal transition, which includes the rise of a more networked society identified by Castells [33] and others, is central to the shift. Of particular importance is that the increasing level of education and access to higher education, rising to almost half of the 17-30 cohort in the UK in 2012, has been an ongoing trend since the

1960s when only 5% participated [34]. Therefore, while in the first era the general public needed the experts to make sense of scientific information, the situation changed rapidly to a situation where many members of the public had the skills to do so themselves. In addition, the growth of interest in environmental issues, and especially the exponential growth in the amount and ease of access to environmental knowledge in the form of academic articles, governmental reports and educational material, allowed more people than ever before to understand the underlying scientific issues that are the basis of environmental decision making, and therefore the demand to participate in them increased.

On the political side, especially in environmental decision making and the discourse of environmental democracy, there was a growth in acceptance that decision making cannot be made in a top-down manner alone. The declarations about the importance of allowing democratic interventions in environmental decision making led to the opening up of the process. The environmental area is one of the first that officially accepted the role of civil society organisations to act as representatives of interests – some of them of non-human (e.g. organisations that focus on the protection of birds or wildlife). Because environmental decision making is so reliant on environmental information, this political transition meant that access to information was a necessary prerequisite of effective participation. Later on, the recognition that indigenous and traditional knowledge should be taken into account when a decision is made meant that the door was opened to public creation of environmental information.

Finally, both enabling and enabled by the social and political changes, technology not only transformed the availability of environmental information, but also the amount of information and the ability to process it. A good example are geographical information systems (GIS), which are core to the collection, organisation, analysis and visualisation of environmental information. The beginning of the first era coincided with the establishment of one of the earliest GIS companies – the Environmental Systems Research Institute (now known as Esri) – while, by the beginning of the third era, the ability to deliver detailed maps to a mobile device became ubiquitous in many parts of the world. Many other digital technologies – from the ability to network and deliver data, to satellite technology and to the World Wide Web – are critical trends that explain the evolution of public access and public creation of environmental information.

Finally, we consider the implication of the last era we are entering into. The opening up of environmental information in both creation and application, and the advent of expectations that access to information will be provided free of charge, changes the nature of environmental decision making. Without falling into utopian traps, it is clear that the ability of members of the public to create their own environmental data sets or to analyse existing data sets means that we will see different arguments emerging about environmental issues. Because the public can carry out citizen science activities as well as analysing existing and newly created data sets, official data sets will come under scrutiny and be compared to locally produced information. The role of the expert will also be challenged – the expert will not be

able to claim that, because they are ‘exceptionally well-qualified in analysing environmental trends and information’, they have the last word. We can expect calls for more nuanced analysis, explanations that discuss uncertainties and complexities, and even technical discussions about analysis methodologies that explore the limits of expertise. At the same time, there will be plenty of roles for the experts as those who can provide synthesis and interpretations, as they are still likely to be the only members of the public with the luxury of dedicating all their time to the topic in question.

In a way, the journey from 1969 to today can be seen as an increasing democratisation of environmental decision making, in the sense of increasing equal participation within decision making processes. While inequalities within society in terms of education, access to technology or participation in democratic process cannot be ignored, and there is a significant distance to go for fuller democratic participation, we can now see how environmental information acted in its own way as a democratic catalyst.

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