The Complexity of Environmental Problems

Chapter 1

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INTRODUCTION

Complexity of environmental problems

Dealing with environmental problems in the context of sustainable development is often a *complex* endeavour because it inherently involves many aspects: different scientific disciplines are needed to interpret the problem and various actors in society play a role in causes and possible solutions. This is even more so when problems are interrelated or have simultaneous impacts at several geographical and time scales.

'Environmental problems' in this course are always 'environmental problems in a context of sustainable development'. For the sake of brevity, we refer to them as 'environmental problems' in the remainder of this course book.

Multiple dimensions of environmental problems

Complex environmental problems typically have *multiple dimensions*. In the case of air pollution, for example, multiple pollutants (e.g. sulphur, nitrogen) are emitted by multiple sources (industry, agriculture, transport), interact with each other and have multiple effects (acidification, eutrophication, smog). Effects can manifest themselves at multiple scales, such as the local (e.g. health effects of fine particulate matter), regional (e.g. atmospheric deposition) or even global scale (e.g. sulphates having a cooling effect on the world's climate).

In the case of climate change, mitigating measures like introducing biofuels in Europe might have negative impacts on biodiversity and food production at the other end of the world. Measures intended to adapt to climate change, such as building stronger dykes, impact on the local ecology and on landscape values. Measures to mitigate air pollution by introducing compulsory air purification filters on animal housing units might have negative social and economic consequences for farmers.

At the same time, environmental problems may have multiple causes which are rooted in our society: demography, consumption patterns, social and behavioural patterns and political settings all play a role. The search for solutions involves multiple actors, while multiple goals often have to be dealt with and multiple stakes and values have to be considered. Environmental researchers and decision makers have to find a way to cope with this *plurality*.

Plurality of environmental problems

Another consequence of this plurality of environmental problems is the fact that conflicting interpretations of 'the problem' may exist in society, and different views on solutions may compete. Furthermore, describing the system at hand or even defining its boundaries is a challenge for environmental researchers and others.

The starting point and basic assumption for this course is that environmental scientists, or in broader terms, environmental professionals, expect to use their expertise to help solve environmental problems in the context of sustainable development. Or, if not to solve the problems, then at least to understand, mitigate or deal with them. This would seem to imply that the aim of this course is to learn how to do this in the most effective way, i.e. how to organize the *process of knowledge production* in such a way that this knowledge can be used as a basis for action?

Knowledge production process

It follows from the above, however, that this is not such a straightforward question as it might seem to be. The question necessarily leads to other questions. Who organizes this process of knowledge generation? Is there just one such process? In practice, is action taken on the basis of knowledge? Which knowledge is relevant? Who should or is able to take action? When is an environmental problem 'solved'? Who decides what the problem is anyway? Does more and 'better' knowledge always lead to 'better' action?

The title of this course, 'Environmental Problems: crossing boundaries between science, policy and society' also invites questions. Where are these boundaries to be found? What is the role of environmental experts at these boundaries? Various actors in different settings contribute to the development of the knowledge needed to solve environmental problems.

Solving environmental problems as a process of interaction between science, policy and society

During this course, you will be invited to think about several of the above questions. The course approaches *solving environmental problems as a process of interaction between science, policy and society*, and it aims to offer insights into the different roles that science, policy and society play in dealing with environmental issues and the way coordination between different roles is achieved. You will learn about the complexity of environmental issues and the various interests, actors and perspectives involved.

Together with the material in the electronic workbook on Studienet, the present chapter familiarizes you with the central themes of this course: the complexity of environmental problems; the relation between science and society; the role of environmental expert organizations and their room for manoeuvre and the role of individual environmental experts. It also sensitizes you to some important challenges in the process of knowledge generation: dealing with plurality, dealing with uncertainty and knowledge integration. The next section introduces an analytical concept that can help assess the complexity of environmental problems. This is the first of the central themes listed above.

LEARNING GOALS
After reading this chapter and completing the assignments in the e-workbook you will be able to:
- mention three challenges when dealing with complex environmental problems: dealing with uncertainty, dealing with plurality, integration of different types of knowledge,
- describe the distinction between structured and unstructured problems and explain why environmental problems often are unstructured problems.

1 The complexity of environmental problems and the science/policy/society interface

1.1 INTRODUCTION

Scientific knowledge can make important contributions to dealing with environmental problems (see chapter 2 for a more detailed discussion). However, there is a fundamental problem here. As mentioned above, many environmental problems (climate change, preventing loss of

biodiversity, genetically modified organisms, urbanization, water management etc.) are of such a complex nature that no definitive answers can be given even with the most sophisticated scientific investigations. The available objective scientific knowledge is insufficient, and scientific knowledge is also characterized by some degree of uncertainty. Scientists are often unable to offer one unanimous definitive analysis and solution for a problem. Hence, decision makers will have to make choices and decisions in conditions of (sometimes huge) uncertainties. Since these decisions can have a large impact on the environment and society, fundamental decisions under conditions of great uncertainty cannot be considered legitimate without involving the relevant actors.

Challenges for the environmental professional:
1) dealing with uncertainties
2) dealing with a plurality of perspectives
3) integrate different types of knowledge

It follows from the above that important challenges to the environmental professional include (1) dealing with *uncertainties*, (2) dealing with a *plurality of perspectives* and (3) finding ways to *integrate different types* of knowledge. None of these are straightforward and no standard recipes exist.

All environmental professionals have to deal with the complex aspects of environmental problems and environmental decision making, though the degree to which this is the case will vary. As an environmental expert, sometimes you may of course have to deal with problems which are not very complex. This depends very much on the institution where you work, on your position and on the tasks you have to perform (see also Tasks 3 and 4).

Depending on the complexity of a problem, different types of knowledge and 'modes of knowledge production' will be appropriate (see also Task 2). Below, we introduce a way to distinguish between problems according to their complexity.

1.2 CONSENSUS ON VALUES AND ON CERTAINTY OF KNOWLEDGE? STRUCTURED AND UNSTRUCTURED PROBLEMS

Structured and unstructured policy problems

Some environmental problems are more complex than others. One way of classifying different kinds of problems is by distinguishing between 'structured'and 'unstructured' policy problems (Hisschemöller & Hoppe, 1996). See Figure 1.1. The role of scientists also differs for each of the different problem types.

This typology is based on the idea that there can be a greater or smaller degree of certainty with regard to the knowledge that is relevant to understand the problem, and a greater or smaller degree of consensus on the goals and values at stake.

Based on the level of agreement on goals and values, and the degree of uncertainty in the knowledge, one can distinguish the following types of problems:

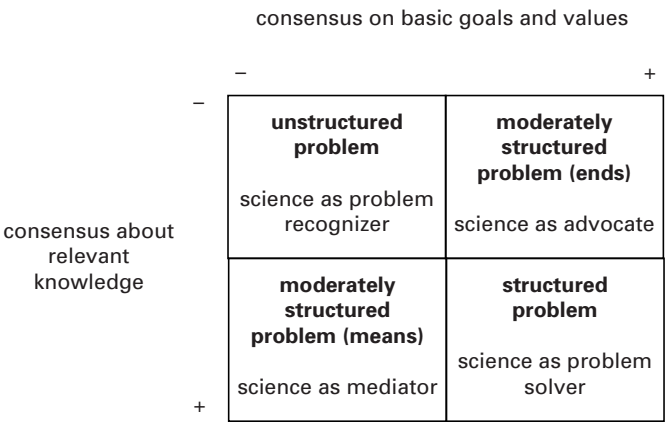

FIGURE 1.1 Four types of policy problems with associated roles for scientific advice
(Source: Hisschemöller and Hoppe, 1996; Hisschemöller et al., 2001)

A problem is considered '*structured*' when agreement is assumed to exist on society's norms and values regarding the problem and on the kind of knowledge used to reach a solution.

At the other extreme, a problem is considered to be '*unstructured*' when there is an acknowledged clash of values regarding the problem and disagreement on the scientific knowledge that should be used to solve it. These kinds of problems are also referred to as 'wicked problems' (Rittel & Webber, 1973), or 'ill-defined problems' (Dunn, 1994). Actors disagree not only on the solution but also on the nature of the problem, because the problems are multi-faceted, ambiguous and interrelated.

The environmental field is characterized by problems of all types. Climate change and biodiversity loss, and especially the broader problem of 'sustainability', reside in the class of unstructured problems. Some of the more locally confined problems, such as noise pollution, belong to the class of structured problems. Air pollution and health problems can often be considered to be situated somewhere in-between. According to the Hisschemöller and Hoppe (1996) typology, such 'in-between' problems can be called 'moderately structured', with either consent on the values and goals ('ends') that pertain to the problem, or consent on knowledge and the possible solutions ('means').

It should be mentioned here that these distinctions are merely a theoretical tool that can help us understand problems, and that a specific problem cannot simply be assigned to one of the quadrants, partly for the very reason why different perspectives on the problem exist and why people are likely to disagree on its nature. However, (a) the type of knowledge production process to be used will vary with the type of problem under consideration, while (b) the knowledge production process itself is likely to alter the nature of the issue. (cf. Hage et al., 2010)

Unstructured problems deserve special attention when it comes to designing the knowledge production process.

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