4

Mediated or Institutionalized Modelling

CHAPTER OUTLINE

4.1. Introduction: Why Do We Need Mediated Modelling?

The following questions arise as result of the proposed modelling procedure (Figure 2.2):

- How is it possible to consider the many different aspects of an environmental problem including natural science aspects such as geology, zoology, botany, and chemistry as well as the economic and social aspects?
- The answer to this question is to implement a very wide spectrum of expertise in the modelling team, but it gives rise to the next question: How do you ensure good cooperation from team members when they represent many different disciplines and have many different opinions and "languages"?
- How is it possible to consider *all* relevant ecosystem properties at the same time?
- How is it possible to integrate these insights?
- How can we ensure that all important stakeholders are included in the modelling process?
- How is it possible to integrate impacts and knowledge at different scales?

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- How is it possible to understand the very root of the problems and their sources and have this understanding reflected in the modelling and the final model result?
- How is it possible to build the best consensus among the different opinions and disciplines?

Institutionalized or mediated modelling (IMM) can address these questions. The main idea of IMM is to represent without exception *all* stakeholders, policymakers, managers, and scientists with knowledge and ideas about the problem, the system, and possible solutions for the modelling procedure. The model is developed as a result of integrated brainstorming where all ideas, opinions, disciplines, and knowledge are represented. For the development of most mediated models, depending on the complexity of the problem and the system, several days of intense interaction among participants are required to reach a satisfactory basis for model development. The advantages of IMM (partly taken from van den Belt, 2004) are that the:

1. Level of shared understanding increases;
2. Consensus is built about the structure of a complex problem for a complex system, because all interests are represented in the stepwise model development;
3. Result of the modelling process, the model, serves as a tool to disseminate the insights gained by the modelling procedure;
4. Effectiveness of the decision making is increased, because the mediated model makes it possible for policymakers and the stakeholders to see the consequences of the action plans over longer time scales;
5. Team building is developed parallel to the model development;
6. Process is emphasized over the product;
7. State-of-the-art knowledge is captured, organized, and synthesized.

When a team develops a mediated model "groupiness" is increased because:

1. Individual members perceive clearly that they are a part of the group.
2. Members become oriented toward a common goal.
3. Interaction between group members takes place.
4. Interdependence is realized and acknowledged.
5. A structure of roles/status and norms is built.

4.2. The Institutionalized Modelling Process

The first step in the development of an institutionalized model is to invite representatives for *all* possible groups and stakeholders that have an interest in the focal problem to a brainstorming workshop focused on model development. This could include green organizations, social organizations, policymakers, managers, ecologists, engineers, economists, sociologists, and so on. It is crucial that *all* groups with a well-founded interest in the problem or in the (eco)system are represented. All scientific disciplines associated with the problem and all knowledge bases must also have a voice.

The *first* stage of the workshop is to introduce the objectives; namely to develop a model that can be used as a common reference for all the participating groups, and to understand and hopefully, on a long-term basis, to solve a well-defined problem of common interest. The advantages and disadvantages of modelling, particularly mediated modelling, are presented at this stage, together with the basic ideas behind the system. The various teams participating in the brainstorming must introduce themselves and clearly present their interest in solving the problem, as well as give an overview of their knowledge about the problem.

An IMM is coordinated by the following individuals:

- Facilitator that prepares the meeting and guides the discussion;
- Mediator that plays the role of the facilitator during group meetings;
- Modeller that tries stepwise to conclude the discussion in the form of a model; the model is changed currently to follow stepwise the conclusions made as a result of the discussion and group meetings.

The *second* stage of the workshop focuses on a clear definition of the problem and the scale in terms of spatial system boundaries, time horizon, and time step. The problem can eventually be defined by an ecological risk assessment (ERA), but under all circumstances it will include these crucial questions:

- What has caused the problem or problem complex?
- What are the impacts of the problem?
- If the problem complex consists of several problems, then how are these problems interrelated?

The geographical boundaries are usually already determined by the stakeholders. The time horizon and time step will inevitably lead the participants to focus on some questions, while other aspects are ignored.

The focus can be designed to be narrow or wider in its inclusiveness of economic and social problems, often determined by the roots of the problems. The focus will be very clear as a result of the three crucial questions listed above.

An envisioning exercise attempts to describe the future the participants want and the future that they would settle for. This vision should not be considered a static picture; it has to be redefined over time. Finally, a survey of what we know about the system and the problem is presented, including a list of data and observations.

During the *third* stage of the workshop, a qualitative model is built. The modeller is translating the discussion into state variables, processes, and forcing functions. Simultaneously, he is explaining the meaning of these modelling components, and what it means when the model presents a relationship between forcing functions and state variables. The possibilities for changing the forcing functions and making simulations accordingly will inevitably become a part of the debate in this phase of the model development. It may be beneficial to break up into smaller groups to discuss submodels. Causalities, interacting processes, or possible change of forcing functions should be discussed as well.

The *fourth* stage of the workshop focuses on the quantitative model. The quantitative process description requires an extensive discussion among the participants. It is crucial that the quantitative description of processes adheres to the known ecosystem dynamics. Another topic, open for the discussion at this stage, is the use of indicators. Which indicators best express the system quality and can be used in the follow-up phase when the model results are implemented to pursue the best possible environmental strategy? Jørgensen et al. (2005, 2010) provided a good overview of possible indicators.

When the quantitative model is prepared, the observations are compared to the model simulations and the possibilities for calibrations are discussed. In some cases, it may be beneficial to close the workshop and leave the calibration and validation to a modelling team and re-open the workshop when the calibration and validation are ready. This is recommended when the calibration and validation are very time-consuming because the model is very complex or because the number of observations is high.

The *fifth* stage of the workshop encompasses the testing of various selected scenarios and their conclusions. The simulated scenarios are made after the calibration and validation and may be carried out after the workshop has been reconvened. The model is foreseen to be adaptive, because if the basic conditions for the model have been changed (we are living in a dynamic world), the model should be changed correspondingly. A follow-up workshop should be agreed upon during this stage.

The follow-up workshop, perhaps one to three years after the first workshop, should adjust the model according to the observed "mistakes" by the model and the changing basic conditions. To what extent the previous conclusions should be changed also needs to be discussed.

During the follow-up workshop it is recommended to examine whether the IMM has been a success or failure. This can be determined by answering the following questions (see van den Belt, 2004):

1. Did the participants establish or reach common goals?
2. Did the participants contribute their knowledge and creative thinking toward innovative solutions?
3. Is the model considered a common reference for the participants?
4. Does the model use a common language when the different aspects are discussed?
5. Is the model expressing all the different opinions and knowledge of the stakeholders?
6. Has a cooperative climate emerged?
7. Have all participants accepted the model as an acceptable learning tool?
8. Is there an increased sense of interdependence among the participants?

4.3. When Do You Apply Institutionalized or Mediated Modelling (IMM)?

All of the models presented in this book could, in principle, be developed as non-institutionalized models, but they still require a workshop as a part of the modelling procedure. Not all models need to be developed as IMMs; for example, if they focus on a less complex problem that only touches on a few aspects. When the problem is complex and many different interests, interactions, and aspects are integrated within the problem, it is strongly recommended to use an IMM. Examples where institutionalized modelling is almost mandatory include: water quality or ecosystem models of important lakes, rivers, coastal areas, lagoons, bays, landscapes, wetlands, recreational areas (national parks, sanctuaries) and so on, where many problems have many sources and there are many conflicting interests. The previously listed ecosystems all have different applications that may be in conflict; for instance, a lake, which is often used simultaneously for recreation, production of drinking water, fisheries, and to ensure recycling of important elements. The cost of wastewater treatment is increasing with increasing water quality of the treated water, but the required water quality is not necessarily the same for each application. The willingness to pay for a better water quality is therefore dependent on the use of the lake, which could lead to conflicts.

Institutionalized models applied to ecosystem management can conclude in an environmental management policy and cost strategies. The model conclusions should be accepted by the population and all interest groups, because they have participated in the process, the simulations, and the conclusions and understand the details and basis for the conclusions.

There are many examples of noninstitutionalized models that have failed without a workshop. It is difficult to collect all the knowledge about the problem and the system, the roots of the problems, and all of the different interests in solving the problems without representation from the different groups. It can also be difficult to understand all of the different aspects of the core problem without a brainstorming session. Complex problems are like icebergs, only 10% is visible.

Most of the crucial problems humans face are very complex. Consider the difference between the problem of climate changes due to global warming and the problem of putting the first human on the moon. The global warming problem interferes with an enormously wide spectrum of other problems involving agriculture, industries, developing versus developed countries, sufficient drinking water of an acceptable quality to all citizens, poverty, and so on. The realization of human lunar exploration was entirely a question about very advanced technology with a much narrower spectrum of interdisciplinary issues.

Using IMM is recommended for all complex problems and modellers are encouraged to use this method for their environmental planning problems, which may often be the most complex problem they have. van den Belt (2004) gave several examples where IMM actually resulted in a good planning strategy for a complex problem. The most illustrative case studies are typical environmental management problems such as:

- Watershed management in Wisconsin
- Planning of Banff National Park
- Coastal zone management

Problems

1. Give examples of problems where the development of IMM would be a good solution.
List the stakeholders interested in the problem. Which group would you invite to a brainstorming meeting? Which type of model do you expect will be developed?

2. Who would be interested in an IMM focusing on the wildlife in a national park, which has enormous income value for a district due to tourism? The wildlife is damaging the surrounding agriculture and negatively impacting the quality of the drinking water in a lake close to the national park.