Chapter 30

Sustainability Assessment

Joop de Kraker and Marc Dijk

Abstract

Sustainability Assessment (SA) can be defined as "a structured process, dealing with a sustainability issue, using knowledge from various scientific disciplines and/or stakeholders, such that integrated insights are made available to decision makers." How the SA process can best be structured depends on the nature of the problem addressed. Sustainability issues are routinely referred to as complex, wicked, unstructured problems, often without further specification. A closer look at the typologies of wicked and unstructured problems makes it clear that problem structuring is an essential first step in dealing with complex sustainability issues. Important dimensions to address in problem structuring are knowledge uncertainties and normative disagreements concerning the problem and its possible solutions. A participatory and iterative learning approach appears to be the most appropriate way to structure problems. It is from this perspective that we discuss SA approaches developed at ICIS.

1 Introduction

Sustainability Assessment (SA) is increasingly considered an important tool to support decision making on issues of sustainable development. Bond et al. (2012) even spoke of a "dramatic increase in the practice of sustainability assessment in many countries", and observed an exponential growth in the number of papers published on the topic. Looking at the large variety of activities currently labelled as SA, it becomes clear that there is no clear-cut and universally accepted definition of the concept of SA. However, the commonality is that the term "assessment" is used to indicate that (scientific) knowledge is generated with the explicit intention to support policy and decision making for sustainable development. Assessment is therefore distinguished from research by its purpose: to inform policy and decision making, rather than to advance scientific knowledge for its own sake (Hettelingh et al., 2009).

SA can be seen as a marriage between environmental assessment and sustainable development (Gibson 2005). In SA thinking and methodologies, a broad distinction can be made between approaches that developed from the well-established practice of Environmental Impact Assessment (EIA) and approaches rooted in the more academic practice of Integrated Assessment (IA) of complex environmental problems. Both types of approach developed more or less simultaneously and share a focus on comprehensive assessment in the context of public policy and decision making. Thinking at ICIS is rooted in Integrated Assessment, and SA is therefore addressed as a special form of Integrated Assessment, applied to sustainability issues. Following Rotmans' (1998) definition of IA, SA could thus be defined as "a structured process, dealing with a sustainability issue, using knowledge from various scientific disciplines and/or stakeholders, such that integrated insights are made available to decision makers."

The question now is: how can the process of SA best be structured? What are important steps to include and in what order? Our answer is: this depends on the type of problem one is dealing with. The nature of the problem will determine which problem-solving approach is appropriate and which ones are not. Sustainability issues are routinely referred to as complex, wicked, unstructured problems, often without making a distinction between these terms. In this chapter, we first revisit the source publications of these problem typologies and consider the typical problem characteristics, and then discuss how these are addressed in the SA approaches developed at ICIS.

2 Problem types

The "discovery" of wicked problems

In December 1969, at the very end of one of the most turbulent decades in the country's history, the American Association for the Advancement of Science organised a "Panel on the Policy Sciences" in Boston. One of the papers that were presented there has become a classic: "Dilemmas in a general theory of planning." By now the paper has been cited in almost 9,000 scientific publications. Perhaps as a mark of originality, the paper itself contains no more than four references. In this paper, the authors Horst Rittel, professor of design science, and Melvin Webber, professor of urban planning, reflected on societal developments over the past 10 years and introduced the concept of "wicked problems." They observed that the start of the decade was marked by the publication of "Goals for Americans", the report by President Eisenhower's Commission on National Goals, and concluded that despite the initial optimism, goal-finding had turned out to be "an extraordinarily obstinate task" (Rittel & Webber, 1973). During the decade that followed, the supposedly nationally shared goals for the American society were attacked by "the revolt of the blacks, then by the revolt of the students, then by the widespread revolt against the war, and more recently by new consumerism and conservationism." Rittel and Webber concluded that in 1969, America had become a pluralistic society where "there is nothing like the undisputable public good." They then continued to address another development, the increasing connectedness of societal sub-systems into complex, "large networks of systems, such that outputs from one become inputs to others", the consequence being that an intervention at one location in the network generates "waves of repercussions."

For planners dealing with societal problems, these two developments create major difficulties in defining problems and developing solutions. Due to the plurality of society, it is no longer clear what the desired situation looks like and what measures should be taken to achieve this. The complexity of society has made it very difficult to determine the causal structure of a problem and to predict the effects of an intervention. This led the authors to conclude that societal planning problems have become inherently "wicked". They used the term wicked not in a moral sense, but in a sense comparable to "vicious" in "vicious circle". In other words, a "wicked problem" is a problem that is very hard to deal with, a problem "resisting" solution. This contrasts with a "tame problem", which is easily defined within known categories and for which tried and tested solutions or problem-solving procedures are available, even though it may be technically very challenging (Figure 30.1). A large part of Rittel and Webber's paper was dedicated to presenting ten defining properties of wicked problems, which make it indisputably clear that wicked problems are very wicked indeed, and, worse, that nowadays all major societal problems are wicked problems. In summary, wicked problems can be defined and explained in numerous ways, are unique and connected to

other problems, and do not have a single, objectively best, definitive solution or a well-described procedure to find a limited set of potential solutions.

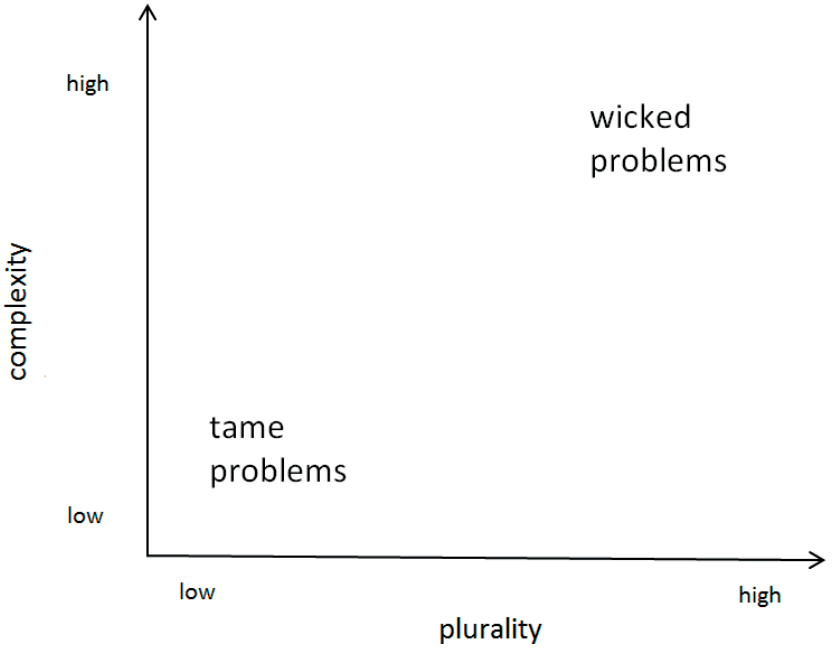

Figure 30.1 Problem types according to Rittel and Webber (1973) as a function of societal plurality and complexity

Obviously, this startling set of properties implies that wicked problems cannot be addressed in the same way as tame problems without running into trouble. If the wicked nature of a problem is ignored, attempts to solve it as a tame problem may result in even more serious problems emerging somewhere else or vehement societal protests against the planned solutions. According to Rittel and Webber, dealing with wicked problems differs from solving tame problems in two major ways. The first concerns a shift in focus from finding the optimal solution to understanding and formulating the problem, the second involves a shift from a linear to an iterative approach. The formulation of a wicked problem *is* the problem. Moreover, defining the problem *is* defining the solution, because every specification of the problem is a specification of the direction in which the solution is to be sought. This means that in the case of wicked problems, a lot of time should be spent on formulating the problem, and that this phase of the problem-solving process must be revisited several times, as the assessment of proposed solutions will lead to a better, more complete understanding of the problem. In this context, the authors concluded that “the famed systems approach” will not work for wicked problems, as it is a linear approach organised into distinct phases, from defining the problem to implementing the

preferred solution. They therefore proposed a "second generation" systems approach, which "should be based on a model of planning as an argumentative process, in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgment, subjected to critical argument."

The paper by Rittel and Webber spurred the development of methods and tools that focus on qualitative systems analysis and problem structuring, often involving multiple stakeholders, rather than on finding the optimal solution (Rosenhead, 2013). Some of the current tools are even based on a discussion-support system developed by Rittel himself in the early 1970s: IBIS, the Issue Based Information System (Conklin, 2003). These problem-structuring methods help to address wicked problems by explicating alternative perspectives and formulations, assisting argumentation, promoting negotiation, and generating mutual and eventually shared understanding. Problem-structuring methods are also known as soft systems approaches, as opposed to hard systems analysis, in the sense that high-tech computer models are replaced by low-tech graphical representations, and algorithms and modellers are replaced by discussions and facilitators, probabilities by possibilities and forecasts by alternative scenarios.

The "discovery" of unstructured problems

In our introduction, as in many publications, sustainability issues were referred to as "wicked", "unstructured" problems, suggesting that both terms are synonymous. However, this is not the case, although both problem typologies (tame/wicked, structured/unstructured) are rooted in the growing complexity and diversity of society. The concept of unstructured problems was developed, long after Rittel and Webber's publication, by the Dutch political scientists Matthijs Hisschemöller and Rob Hoppe in their paper on "Coping with intractable controversies: The case for problem structuring in policy design and analysis" (1995). As the title suggests, the authors were interested in the phenomenon of "intractable controversies", a term derived from Schön and Rein's work on "frame reflection" (1994) and referring to a situation of political deadlock over a controversial policy issue. Based on studies of the siting of hazardous facilities, Hisschemöller and Hoppe argued that intractable policy controversies arise when policy makers treat unstructured problems as if they were structured. To make this case, the authors first defined four types of policy problems, a policy problem being a "gap between the existing and a normatively valued situation that is to be bridged by government action." Their problem typology is defined by two dimensions: the degree of consensus about relevant norms and values concerning the goals or ends, and the degree of consensus about relevant kinds of knowledge concerning the solution or means (Figure 30.2). In other words, in case of widespread discomfort with the status quo, is there agreement about the desired situation as well as agreement about the way to get there? Presented in this way, the "(dis)agreement on ends versus (dis)agreement on means" typology of unstructured problems is clearly distinct from the "plurality

versus complexity" typology of wicked problems. Yet, they are closely interrelated, which, combined with the far from consistent and often confusing terminology used by Hisschemöller and Hoppe, is probably why both typologies have often been perceived as one and the same. Lack of consensus about ends or means is directly associated with the plurality of values and interests in today's society, whereas disagreement and uncertainty about the kinds of knowledge that are relevant to the solution of a problem will at least in part be caused by the growing complexity of problems.

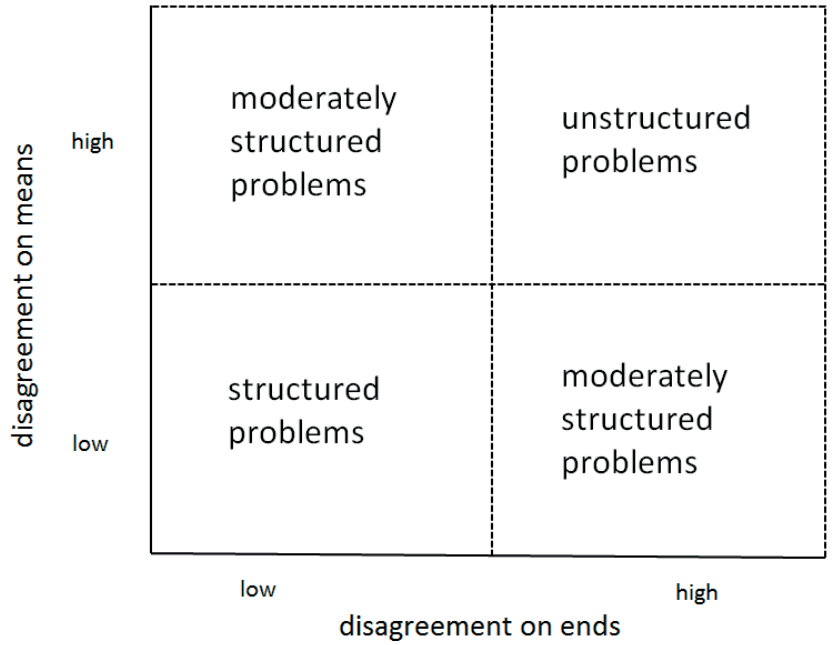

Figure 30.2 Problem types according to Hisschemöller and Hoppe (1995) as a function of disagreement on ends (values) and means (knowledge, expertise)

As mentioned above, their typology of policy problems was not a goal in itself for Hisschemöller and Hoppe, but a means to understand how intractable controversies arise and how they could be coped with. As the authors observed, decision and policy makers prefer to deal with structured problems, problem situations in which there is no debate about the goals and for which standardised procedures and clearly defined expert knowledge can be invoked. In such situations, it is possible to move straight from problem recognition to resolution, which saves a lot of time and trouble. As a consequence, policy makers tend to see structured problems even where the problems are of an unstructured nature. Consciously or unconsciously, they "structure" these problems by predefining the relevant values and expertise and by excluding stakeholders with diverging views. When these stakeholders start to protest and fight for a place at the table for their values or expertise, the controversy is born, and it will

be intractable as long as the policy makers try to deal with it as an already structured problem.

Fortunately, there may be a way to deal with unstructured policy problems without ending up in an intractable controversy. In their paper, Hisschemöller and Hoppe presented the so-called "learning" strategy for structuring unstructured problems. In this strategy, a group of stakeholders is gathered, as diverse as the problem requires, who are allowed to introduce as much diverging knowledge and information about the problem as possible. In rounds of debate, the participants become aware of the many aspects of the problem by argument and counter-argument. This interaction enables them to reframe their conception of the problem, and renders them capable of developing new perspectives on the problem and discover new opportunities to solve it. The new views of the participating policy makers incorporate elements from stakeholders' diverging views which were first excluded.

3 Addressing wicked and unstructured sustainability problems

From IA to ISA

ICIS was founded in 1998 as an institute devoted to "integrated assessment" (IA). Founding father Jan Rotmans described IA as "a structured process of dealing with complex issues, using knowledge from various scientific disciplines and/or stakeholders, such that integrated insights are made available to decision makers" (Rotmans, 1998). One might expect that in this context there would be a strong interest in the problem typologies discussed above, and in particular in the methods and tools proposed to address wicked and unstructured problems. However, Rotmans' seminal paper "Methods for IA: The challenges and opportunities ahead" (1998), only mentioned "complex problems", without further definition. Yet, eight years later, in what can be seen as an update of the 1998 paper, Rotmans (2006) referred to wicked problems when explaining the kind of issues addressed by so-called "integrated sustainability assessment" (ISA): "We call these problems persistent problems, an even higher grade of complex problems than what Rittel and Webber called wicked problems." The author did not explain what makes persistent problems even more complex than wicked problems, but it may have to do with the scale of the issues addressed. Whereas Rittel and Webber, focusing on urban planning, mentioned the location of a freeway and street criminality as examples of wicked problems, Rotmans sought to address the unsustainable structure of entire international sectors, such as agriculture and the energy system.

Interestingly, Rotmans devoted much attention to the enormous complexity of persistent problems, involving many stakeholders and being surrounded by structural uncertainties and the corresponding tremendous challenge in correcting these "system

failures." In contrast, the dimension of plurality, which is key in both wicked and unstructured problem types, was only briefly referred to in his lengthy paper when discussing the next generation of ISA tools, stating that these should be interactive, "realising that multiple stakeholders perceive a problem from different perspectives."

Nevertheless, the development from IA to ISA is characterised by the same elements as the proposals by Rittel and Webber and Hisschemöller and Hoppe for dealing with wicked and unstructured problems. These concern: a shift from a linear to an iterative, cyclical process; a shift from a focus on integration of scientific disciplines to inclusion of stakeholder knowledge and perspectives; and a new, strong emphasis on learning. Moreover, in contrast to previously institutionalised EIA types of sustainability assessment, ISA devotes considerable attention to problem structuring. The ISA approach consists of a cycle of four phases (scoping, envisioning, experimenting and learning) and should be conducted as a participatory process including scientists, policy makers and societal stakeholders. The phase of scoping involves defining and contextualising the problem, and is followed by the phase of envisioning, which aims to arrive at shared understanding and common goals. These two phases can be seen as problem structuring. In the experimentation phase, potential solutions are tested and in the learning phase, the preceding phases are evaluated and lessons are drawn. Depending on the outcome, a new cycle of scoping, envisioning, experimenting and learning could start, in which the problem definition and goals may be redefined and new solutions can be tested, and so forth. ISA can thus be seen as a continuous, progressive, multi-stakeholder process of learning about a sustainability problem and about ways to address it. A more elaborate presentation and discussion of ISA can be found in Chapter 31 of this book.

From ISA to SA

On paper, ISA is the perfect approach to deal with wicked, unstructured sustainability problems, but practical examples are hard to find. The main reasons for this gap between theory and practice are the lack of readily applicable ISA tools and methods and the mismatch between the open-ended cyclical nature of ISA and the linear, time-bound and resource-limited setting of projects and more formal, institutionalised applications. This means that teaching ISA as the way to conduct sustainability assessment is not a good idea if you want your students to acquire competences useful for sustainability practitioners. In that case, they would require tried and tested methods and tools and an assessment approach that is applicable in their future job situations. In ICIS' Master of Sustainability Science & Policy programme, we have combined theory and real-life applications of sustainability assessment methodology to force ourselves to develop an approach to SA that could be successfully implemented in the context of an externally commissioned four-week Sustainability Assessment Project. The continued interaction between theory and application has resulted in an approach

that is – compared to ISA – more linear, more focused on initiating than achieving transformation, and targeted at smaller spatial scales. What has remained are the four phases of the assessment process, now with generic labels following De Ridder et al. (2007), an emphasis on problem structuring and learning, and – perhaps even more so than in ISA – attention for the plurality of stakeholder perspectives. Table 30.1 gives an overview of the methods that have proved to be useful in a wide range of student-conducted SA projects, for each phase.

Conceptually guiding this SA methodology is a problem typology based on a combination of Rittel and Webber (1973) and Hisschemöller and Hoppe (1995). In this typology, problems are characterised along two dimensions: disagreement on values and uncertainty in knowledge. Values and knowledge apply to both the problem and the solution. Problems characterised by high levels of normative disagreement between stakeholders and uncertainty in the knowledge about the nature of the problem and how to solve it, are called "unstructured problems", to indicate that problem structuring is required before known problem-handling or decision-making procedures can be applied. SA is then conceived as primarily a problem-structuring approach, aiming to explicate and reduce normative disagreement and knowledge uncertainty, to the extent that the problem becomes (politically) manageable[59] (Figure 30.3). This requires a balancing act in both dimensions, as the history of SA shows that assessments often focus on either reducing knowledge uncertainty, e.g. by applying complex quantitative computer models, or on reducing normative disagreement, e.g. by organising stakeholder dialogues (Dijk et al., 2016). This results in problems that are only half-structured, and, as indicated above, treating such problems as if they were structured may lead to even greater problems. In our approach to SA, we try to achieve a balance in problem structuring by alternating the use of analytical methods aiming to reduce uncertainty and participatory methods aiming to include stakeholder perspectives, or, ideally, by integrating both types of methods, i.e., applying analytical methods in a participatory and more qualitative manner (e.g., De Kraker et al., 2011). Clients who commissioned student SA projects from ICIS have valued the approach in particular for three aspects, which are usually new to them: the explication of stakeholder perspectives, the integration of knowledge from a variety of disciplines and the exploration of long-term developments and associated uncertainties.

[59] "Uncertainty cannot always be reduced and consensus cannot always be reached; the problem analysis process should at least result in acknowledging and understanding the uncertainty and the dissent." (De Ridder et al., 2007)

Table 30.1 Methods used in Sustainability Assessment projects, for each assessment phase

Phase	Methods	Usefulness
Defining the problem	Systems analysis and modelling, qualitative	+++
	Stakeholder/actor analysis	+++
	Participatory methods*	+++
	Scenario analysis	+
Identifying possible solutions	Participatory methods*	++
	Systems analysis and modelling, qualitative	++
	Brainstorming methods**	++
	Scenario analysis	+
Assessing possible solutions	Multi-criteria analysis ***	+++
	Scenario analysis	+++
	Participatory methods*	++
	Systems analysis and modelling, quantitative	+
Monitoring, evaluation & learning	Group reflection	+++
	Participatory methods*	+

* Methods to explicate stakeholder perspectives on the problem, possible solutions and assessment process, e.g. through group discussions, interviews or questionnaires

** Methods using creative group processes to identify possible solutions, e.g., through brainstorming, brainwriting, brainsketching or mind mapping

*** Comparative assessment methods such as Life Cycle Analysis and Cost-Benefit Analysis may be applied to feed the Multi-Criteria Analysis

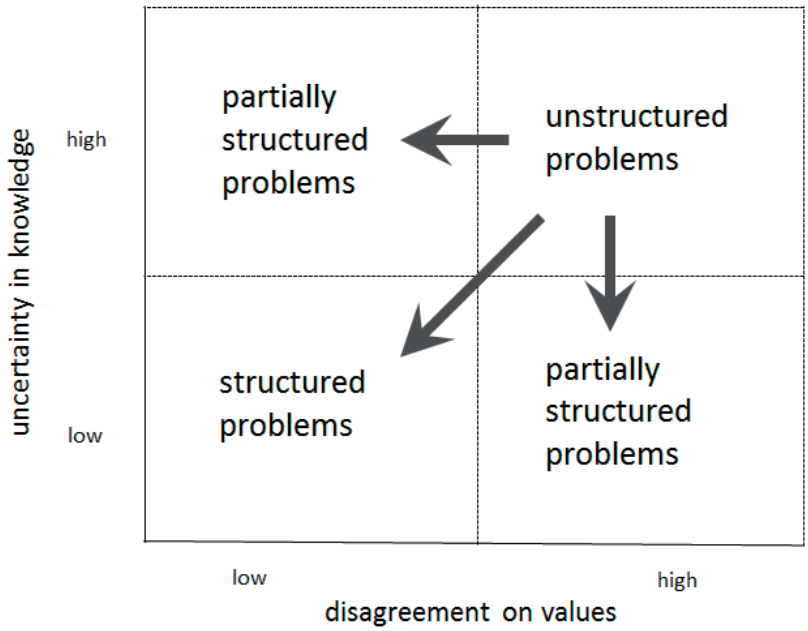

Figure 30.3 Problem types as a function of normative disagreement and knowledge uncertainty, and three ways of problem structuring (arrows)

4 Conclusion

The work on problem types by Rittel and Webber (1973) and Hisschemöller and Hoppe (1995) has made it clear that problem structuring is an essential first step in dealing with complex sustainability issues. Important dimensions to address in problem structuring are knowledge uncertainties and normative disagreements concerning the problem and its possible solutions. A participatory and iterative learning approach appears to be the most appropriate way to structure problems. ISA, an approach to sustainability assessment developed at ICIS in the early 2000s, integrates these elements but is hard to implement in practice. A more pragmatic approach to SA, taught in ICIS' Master of Sustainability Science and Policy programme, has proved to be practical and particularly effective as a method to structure problems, but in this respect also to be in need of follow-up towards policy and decision making. Opportunities for further development of the SA methodology may therefore lie in connecting our current approach to SA with other methodologies which provide a framework for the necessary follow-up, and also to allow more space for learning. Promising in this regard has been a recent experience, in which students conducted a Sustainability Assessment Project as a first step in a transdisciplinary action research project, which combined small-scale experimentation and learning. In fact, this "blend" captures the essence of the ISA approach.

References

Bond, A., Morrison-Saunders, A., Pope, J. (2012). Sustainability assessment: the state of the art. *Impact Assessment and Project Appraisal* 30 (1), 53–62.

Conklin, J. (2006). Wicked problems and social complexity. In *Dialogue mapping: Building shared understanding of wicked problems*. John Wiley & Sons, pp. 3-40.

De Kraker, J., Kroeze, C., Kirschner, P. (2011). Computer models as social learning tools in participatory integrated assessment. *International Journal of Agricultural Sustainability*, 9, 297-309.

De Ridder, W., J. Turnpenny, M. Nilsson, A. von Raggamby (2007). A framework for tool selection and use in integrated assessment for sustainable development. *Journal of Environmental Assessment Policy and Management*, 9, 423–441.

Dijk, M., de Kraker, J., van Lente, H., van Zeijl-Rozema, A., Beumer, C., Beemsterboer, S., Valkering, P. (2016). Sustainability assessment as problem structuring: three generic ways. *Sustainability Science* (in press)

Gibson, R. (2005) Sustainability Assessment – criteria and processes, Earthscan, London

Hettelingh, J.P., de Vries, B.J., Hordijk, L. (2009). Integrated assessment. In *Principles of environmental sciences*. Springer Netherlands, pp. 385-420.

Hisschemöller, M., Hoppe, R. (1995). Coping with intractable controversies: the case for problem structuring in policy design and analysis. *Knowledge and Policy*, 8(4), 40-60.

Rittel, H.W.J., Webber, M.M. (1973). Dilemmas in a general theory of planning. *Policy Sciences,* 4,155-169.

Rosenhead, J. (2013). Problem structuring methods. In *Encyclopedia of operations research and management science* (3rd ed.). New York; London: Springer Verlag, pp. 1162–1172.

Rotmans, J. (1998). Methods for IA: the challenges and opportunities ahead. *Environmental Modeling & Assessment*, 3, 155-179.

Rotmans, J. (2006). Tools for integrated sustainability assessment: a two-track approach. *Integrated Assessment*, 6(4), 35-57.

Schön, D.A., Rein, M. (1994). *Frame reflection. Towards the resolution of intractable policy controversies*. New York: Basic Books.