The Princess in the Castle
Challenging Serious Game Play for Integrated Policy Analysis and Planning

What are the principles that make societal problems socio-technically complex? And, even more important, how can we support public policymaking in the wake of socio-technical complexity? In *The Princess in the Castle*, the author investigates if, why and how serious games and game-like simulations (SGs) can support integrated policy making and planning, especially in relation to managing rivers and oceans. She argues that 'playful methods' are particularly suited to surround sophisticated analysis with extensive participation.

The book contains many examples and illustrations but centres on: the *Climate Game*, used in a neighbourhood reconstruction project incorporating climate adaptation measures; The *Blokkendoos Planning Kit*, used in the Netherlands' planning project Room for the River for integrated flood management; the *MSP Challenge*, used to further the development of integrated, eco-system based marine spatial planning. The book provides a de- and re-construction of the 'principles of play' that underlying integrated policy analysis. The perceived usefulness of game-like tools in the Dutch and Chinese policy contexts is empirically studied. The author concludes that serious games for policy-making and planning are powerful methods with largely untapped potential. Yet, without *room to play* they can be easily turn into ineffective and expensive toys.

Qiqi Zhou is a researcher at Delft University of Technology, the Netherlands. She is involved in several research projects with Dutch and Chinese universities.

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Next Generation Infrastructures Foundation

Invitation

The princess in the Castle

Challenging Serious Game Play for Integrated Policy Analysis and Planning

You are cordially invited to attend the public defence of my PhD dissertation and the reception afterwards

On Monday, 15 September 2014 at 10:00 hours (sharp) in the Aula of Delft University of Technology, Mekelweg 5, Delft.

Prior to the defence, a short presentation of my research will be given at 9:30.

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The Princess in the Castle

Challenging Serious Game Play for

Integrated Policy Analysis and Planning

Proefschrift

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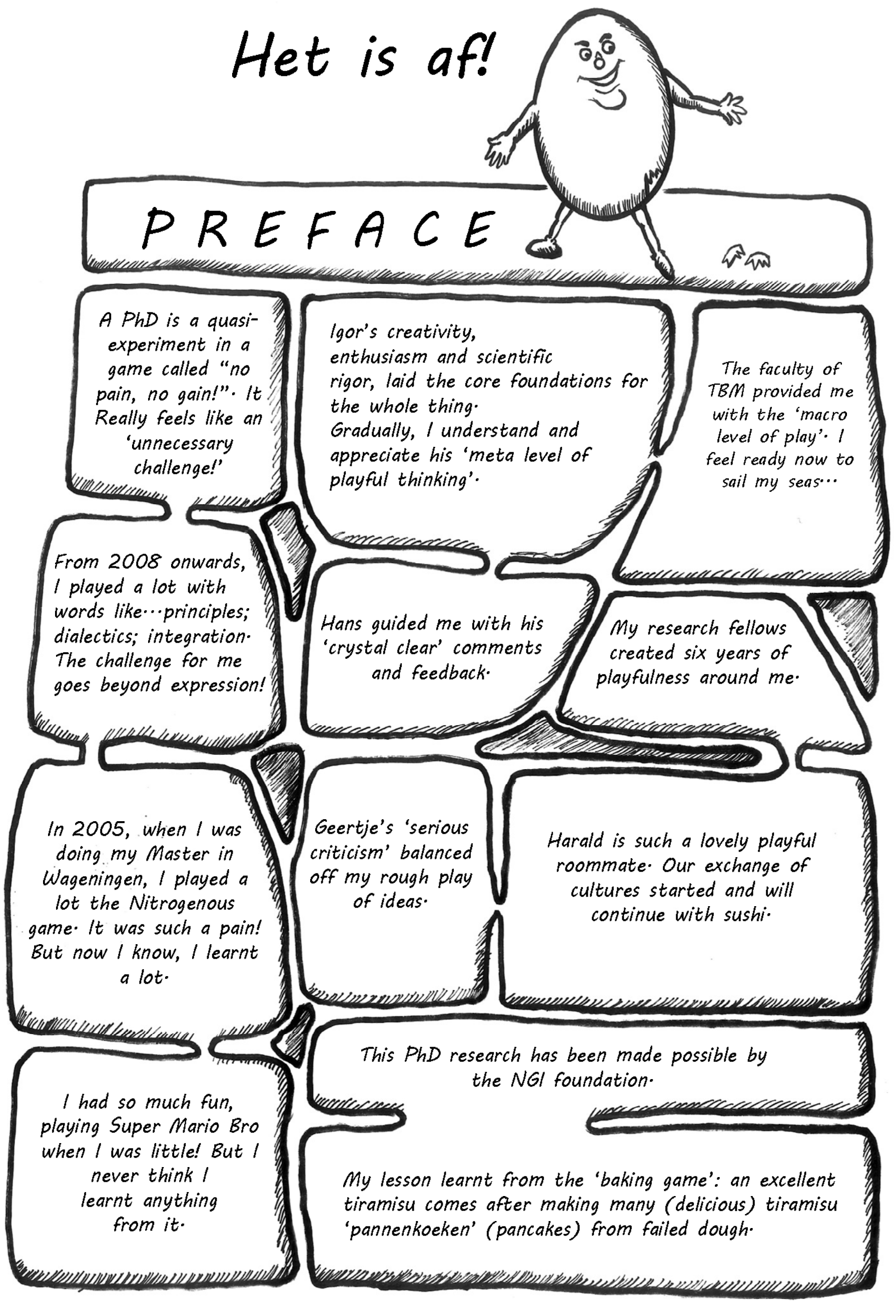
“THANK YOU MARIO!
BUT OUR PRINCESS IS IN ANOTHER CASTLE!”

SUPER MARIO BROS

For Zoe Zhou


Het is af!
PREFACE
A PhD is a quasi-experiment in a game called "no pain, no gain!". It Really feels like an 'unnecessary challenge!'
Igor's creativity, enthusiasm and scientific rigor, laid the core foundations for the whole thing. Gradually, I understand and appreciate his 'meta level of playful thinking'.
The faculty of TBM provided me with the 'macro level of play'. I feel ready now to sail my seas...
From 2008 onwards, I played a lot with words like...principles; dialectics; integration. The challenge for me goes beyond expression!
Hans guided me with his 'crystal clear' comments and feedback.
My research fellows created six years of playfulness around me.
In 2005, when I was doing my Master in Wageningen, I played a lot the Nitrogenous game. It was such a pain! But now I know, I learnt a lot.
Geertje's 'serious criticism' balanced off my rough play of ideas.
Harald is such a lovely playful roommate. Our exchange of cultures started and will continue with sushi.
This PhD research has been made possible by the NGI foundation.
I had so much fun, playing Super Mario Bro when I was little! But I never think I learnt anything from it.
My lesson learnt from the 'baking game': an excellent tiramisu comes after making many (delicious) tiramisu 'pannenkoeken' (pancakes) from failed dough.

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1 Policymaking in the Wake of Complexity

> [.] all the king's horses, and all the king's men, couldn't put Humpty together again. *Nursery rhyme* (unknown author)

1.1 Introduction

1.1.1 Grand challenges

There are many examples that can back the proposition that *socio-technical complexity* (STC)[1] (Byrne, 2001; Holling, 2001; Ropohl, 1999) is at the forefront of public policymaking, and that managing socio-technological complexity is the common denominator among the grand challenges of modern-day society (Briassoulis, 2008; Cagnin, Amanatidou, & Keenan, 2012; Saloranta, 2001; Weick & Sutcliffe, 2007; Winner, 2004). Climate change (The Economist, 2010), the banking crisis (Awrey, 2012; Haldane & May, 2011), internet security issues (Rose & Gordon, 2003), the flooding of urban areas (Beniston, Stoffel, & Hill, 2011), migration (Hugo, 2011), the Arab Spring (Lotan et al., 2011) and the turmoil caused by Project X events[2] are just a few consequences (or manifestations) of socio-technical complexity. In short, STC means that the complexity residing within the *natural-technical-physical* (NTP) realm – for example the technology behind Facebook or Twitter – spirals the complexity residing in the *socio-political* (SP) realm, for instance riots at Project X events, and vice versa. Such spiralling complexity between NTP and SP complexity is prone to give the public policymakers involved persistent and recurrent headaches. That being the case, the diagnosis that grand challenges in society are both socially and technically complex, does not say very much about the 'patient's' condition or prospects, or about effective remedies (if there are any). So, the question should be asked what are the principles that make societal problems socio-technically complex and, even more important, how can we support public policymaking in the wake of socio-technical complexity?

1.1.2 Earth systems

Fortunately, there is growing awareness among scientists and politicians of the importance of understanding complexity and finding new ways to make policy in the wake of it. This awareness may carry different labels; a recent, popular one is 'policymaking 2.0' (Crossover, n.d.). A connection with new media and computer technology is commonly made in these new forms of public policymaking, because things like big data analysis, visual analytics, citizen science, crowd sourcing, e-participation, and new forms of modelling, simulation and gaming (MSG) seem particularly suited to surround sophisticated analysis with extensive participation (Charalabidis, Lampathaki, Misuraca, & Osimo, 2012; European Foresight Platform, 2012; Lampathaki, Charalabidis, & Passas, 2010; Lampathaki & Charalabidis, 2011; Misuraca, Broster, & Centeno, 2010, 2012). I argue in this thesis that many of such innovations are *like game play*, and that a better understanding of games and game play can therefore serve the need for integrated policy analysis and planning. We will pick up this theme extensively further on, but let me first give an example. When the EU, in its Horizon 2020 programme (Kalisz & Aluchna, 2012), called for proposals that could qualify as a Flagship project and could address the identified grand challenges, an international consortium of leading researchers and academics proposed the EU flagship project FuturICT. I quote from the project's website:

> The ultimate goal of the FuturICT project is to understand and manage complex, global, socially interactive systems, with a focus on sustainability and resilience. […] FuturICT will build a Living Earth Platform, a simulation, visualization and participation platform to support decision-making of policy-makers, business people and citizens. (FuturICT, 2013, webpage)

Although FuturICT did not manage to get Flagship status, the current EU initiative on *Global System Science* (GSS) (DG Communications Networks, Content and Technology) gives a similar vision, concretized in the Horizon 2020 call for GSS ("FETPROACT-1-2014," n.d.). We quote:

> Global challenges need fundamentally different policies, more *integrated* across sectors and stronger rooted in *evidence* and broad *societal engagement*. […] GSS will provide scientific evidence highly integrated across different policy sectors […] Collaborative ICT tools will facilitate *stakeholder engagement* in evidence gathering and thereby increase trust in scientific evidence. ("Global Systems Science - European Commission," n.d.) (Emphases by the author).

Climate change is an obvious target of complexity science because it is full of uncertainties and controversies about causes, consequences and coping strategies (mitigation and/or adaptation) (Juhola, Driscoll, Mendler de Suarez, & Suarez, 2013; Peake, 2010; Pielke, 2004; The Economist, 2010; Wanek, Mooshammer, Blöchl, Hanreich, & Richter, 2010). Ecological systems – for example, the living earth of FuturICT – are governed by the laws of nature, although we face severe limitations in how much we know about them (i.e. the hand of God). Scientists can be confused or err. What we do know is stored and analysed in databases, GIS systems and simulation models that can simulate complexity through cause–effect and feedback relations. These may give us a glimpse of the future (Pahl-Wostl, Schlumpf, Bussenschutt, Schonborn, & Burse, 2000). But if we decide to negotiate out 'truth' for the sake of 'politics', reality will strike back sooner or later.

At the other end of STC – the world of socio-political complexity – there are enormous interests at stake in the way we, for instance, arrange our future energy provision. The problem in a nutshell is how to exponentially expand our energy resources while preserving our natural resources. Popular opinions about the past, present and future of sustainability diverge, as demonstrated by the rising controversy over shale gas (Arthur, Coughlin, & Bohm, 2010; Booker, 2013; Davis, 2012; Schafft, Borlu, & Glenna, 2013). Because in the world of politics truth is largely constructed, we can 'negotiate out' political problems by making compromises and deals. We can, for instance, decide to manipulate, ignore, buy off or compensate those who suffer the effects of shale gas drilling. Data and knowledge systems are scattered among an almost infinite number of proprietary institutions. Large-scale trends associated with climate change, such as sea-level rise and weather extremes, affect numerous other issues at various geographical and spatial levels and in such sectorial domains as transport, health, housing and water. In 'big problems', everything is connected to everything (Head, 2008).[3]

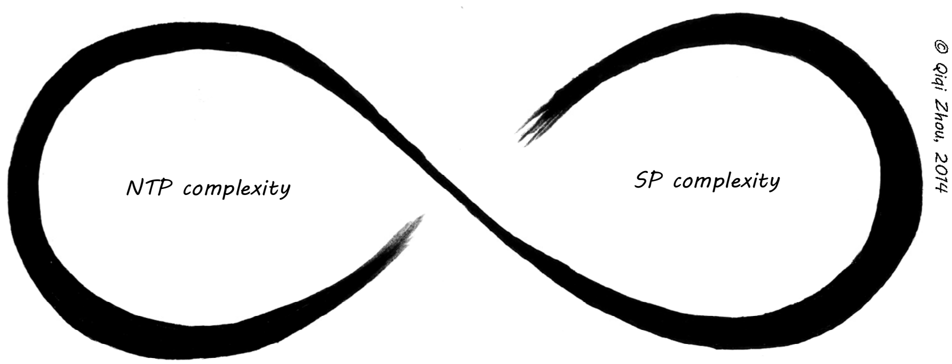
In order to reduce the complexity of big problems, system boundaries need to be drawn; but this gives rise to further fragmentation and compartmentalization into numerous 'silos' of governance and research. To some extent, this silo'ing is unavoidable – it is pragmatic, efficient and legitimate. But it is also a reductionist approach: when the problem becomes too big to handle, we simply break it up into manageable pieces (Nowotny, 2005). Reductionist scientists study isolated relationships between, for instance, natural gas drilling in the northern part of the Netherlands and the occurrence of earthquakes in that area. When they find no scientific proof for such a relationship, the problem for politicians and industry simply and conveniently does not exist, so that there is no need to compensate for damage. Unfortunately, big problems do not stay within the arbitrary boundaries of governance departments and research disciplines. At some point, the frequency of earthquakes and the societal response to them can no longer be ignored. Then, the interdependencies between geology, engineering, energy, safety, economy, welfare, local politics and many more, come to surface, and hit back hard. So, the question is, how and when the various fragments of a big problem, lying scattered on the floor like *Humpty Dumpty*, can be put back together again.

1.2 Socio-technical complexity

1.2.1 An embryonic model

The starting point of this thesis is that inherent causes of complexity in what I call the natural-technical-physical (NTP) realm and the socio-political (SP) realm, spiral into an even higher level of complexity, which I call socio-technical complexity (STC).[4] This is abstractly portrayed in Figure 1.1 – the embryonic stage of a conceptual research model that will further evolve in this thesis. This is the theoretical strand of my research, namely the conceptualization of socio-technical complexity and how game play can serve integrated policy analysis and planning.

Figure 1.1 An embryonic model of socio-technical complexity



Before I come to a well-founded question to guide this thesis and define the empirical study that might give an answer, we need to first explore the root causes of STC and how scientists and policymakers have tried to deal with it.

1.2.2 Characteristics of complex systems

Complexity science has expanded rapidly in recent decades, but its roots and key motifs can be traced back to the very origins of Western philosophy. According to Bertalanffy (1950, 1972) , one of the founding fathers of complexity:

> Aristotle's statement, 'The whole is more than the sum of its parts' is a definition of the basic system problem which is still valid. (Bertalanffy, 1972, p. 407)

The synergetic '*1 + 1* > 2' argument lies at the heart of all branches of systems thinking. It shifts attention from understanding relations between individual elements, to understanding the interaction among elements. This interaction creates behaviour at a higher level of aggregation (i.e. the system) which cannot be explained from the properties of the single elements alone: this is called emergence. Emergence is key to all branches of complex systems theory. There are too many to address here at length;[5] I limit myself to a brief characterization of NTP and SP complexity (Bekebrede, 2010; Lei, Bekebrede, & Nikolic, 2010) and how they spiral into STC:

(1) *Heterogeneous* elements: elements that make up systems can differ greatly. They can be bio-natural, physical or technological elements and artefacts; but they can also be values, beliefs, emotions or abstract concepts, such as sustainability or democracy. Many elements in a system, like fish or water, are tangible, observable and/or quantifiable, at least to some extent and to the best of our knowledge. Others are a construction of the human mind, non-tangible, very difficult to quantify or not quantifiable at all, with present knowledge. In addition, elements and systems can be on different scales and levels – anything from elementary particles, to animals and plants, cars and traffic, metropolitan areas or the climate.

   (a) *The NTP complexity* of systems is very much dependent upon how we define and measure the tangible observable and quantifiable properties of system elements. In other words, they seem more fact-based than value-based. In the example of a river basin, the movement, distribution and quality of water are examples of quantifiable properties of such elements.

   (b) *The SP complexity* of systems, is very much dependent upon how we view, interpret and construct the socio-political behaviour of actors (persons, organizations) through properties like their objectives, visions, values, interests, stakes, opinions, emotions, behaviour and power. These elements are non-quantifiable or semi-quantifiable because they are more value-based than fact-based. In the example of marine waters, the interest of the fishing industry, the power of the oil and gas industry, and the objectives of the EU are examples of non-quantifiable elements in SP complex systems.

   (c) *Interaction between NTP and SP complexity*: Because of the heterogeneity of elements within and between NTP and SP complex systems, we use different languages to understand and represent their complexity; from disciplinary languages in the sciences (chemistry, physics, etc.), to hard and soft modelling languages, to natural languages in politics and journalism, and even art (pictures, movies). The discourses about the complexity of marine waters or rivers are broken up and lie scattered around. When real-world systems, like a sea or river basin, consists of many heterogeneous elements within and between NTP and SP systems, representation of this complexity with one unifying language seems impossible.

(2) *Emergence*: elements in a system are interconnected in such a way that changes in a few elements of the system cause changes in other elements of the system. The cumulative interactions of all changes within the system makes the system behave in a way that cannot be explained from the changes in the single elements alone. There are several principles of complex systems that cause this. First, relations among elements in a system are not linear; small changes in one part of the sys-

tem may cause big changes in other parts of the system and the system as a whole. Secondly, feedback relations cause self-reinforcing or self-mitigating loops within the system. Thirdly, there may be delays before the effects of changes upon elements in other elements or the systems become apparent. Small changes can build up imperceptible pressure within the system, until a tipping point is reached and the system changes suddenly and radically (Gladwell, 2000; Vespignani, 2011). Fourthly, the behaviour of elements and systems may be subject to certain built-in rules or conditions. Many natural species in the ocean, for instance, live only in waters where all conditions in terms of food, protection, temperature, etc. are optimal. The interactions between numerous stable and unambiguous rules of behaviour are cumulative. According to chaos theory, this can lead to repeating patterns of system behaviour. For human beings, an unknown number of the rules that guide socio-political behaviour are intentional and changeable. Human behaviour may be guided by the anticipation of changes that have not yet occurred, in self-fulfilling or self-denying behaviour. Humans may respond to inexplicit and ambiguous rules – such as aesthetics and morality – that lead to stable behavioural patterns that are called culture, policy or institutions. Humans can also reflect upon their own rules of behaviour and change them. Institutions and cultures may become more concerned about the sustainability of the ocean and make legislation to protect it. In sum, and for all the reasons given above, the behaviour of complex systems can become highly erratic, unpredictable and counter-intuitive (Gladwell, 2000).

(a) *The NTP complexity* of systems commonly views the relations among elements in terms of physical laws, rules (including mathematical rules) or statistical relations. The NTP complexity of systems is manifested in, for instance, feedback (e.g. the erosion of a shore or the degradation of a mangrove forest usually causes more and faster erosion and degradation), non-linearity and tipping points (e.g. water pollution from diffuse sources might have no observable effect until the pollution level reaches a point where some species in the food chain disappear, which makes the ecosystem collapse).

(b) The *SP complexity* of systems, commonly views the relations among system elements in terms of social, political and economic rules. These rules can be informal, like social conventions, or formal, like regulations; but in general these rules are subjective, ambiguous and hard to quantify. In contrast to laws in physics, social rules are subject to intentional change; actors can modify them. The SP complexity of systems is manifested in, for instance, strategic behaviour (whereby human actors behave in response to or anticipation of other actors' behaviours), social behaviour and political systems (which can seem quite stable, until small conflicts and tensions cause the system to collapse, as happened to some financial institutions in the USA and Europe in the last decade).

(c) *Interaction between NTP and SP complexity:* NTP complexity is studied in many, partially overlapping theories, disciplines and methods. Each discipline (e.g. physics, chemistry or computer science) has its own way of clustering elements and relations into subsystems and methods to analyse their complex behaviour. In addition, our capacity to monitor, grasp and communicate about such interaction effects is limited. The more elements and relations we consider, the higher the uncertainty becomes (Aerts, Botzen, van der Veen, Krywkow, & Werners, 2008; Argote, Turner, & Fichman, 1989; Brugnach, Tagg, Keil, de Lange, & Lange, 2007; Funtowicz & Ravetz, 1994; Koppenjan & Klijn, 2004). NTP complexity often induces controversies and disputes among scientists and experts. Is marine life affected by the noise caused by sea floor drilling when we construct an offshore wind farm, or is it not affected? Vice versa, strategies to manage socio-political complexity, influence and drive the understanding of NTP complexity.

(3) *System change: adaptation and learning:* Elements in a system are networked or clustered in subsystems that form complex systems within a complex system. Innovative organizations, for instance, cluster in Silicon Valley, which influences the economy in California, which in turn influences global innovation. The boundaries between elements, subsystem, system and the outside environment of a system are fuzzy and like a membrane, as influences from outside the environment of the system will enter the system. A system is therefore in constant interaction with its environment. Tensions, conflict and incommensurabilities between the system and its environment trigger system change.

(a) *NTP complexity* views tensions between a system and its environment in terms of adaptation of the system, until a new stable state of the NTP system is reached. This adaptation of the system is unintentional and has no moral value. A river or sea is an open system full of dynamics and changes as part of its interaction with the system's environment (Pahl-Wostl, 2006). Changes in climate cause a rise in sea temperature, which may lead to adaptations in the ecosystem, like the relocation of fish or the dying of coral reefs.

(b) *SP complexity* views tensions between a system and its environment in terms of social learning. Learning is intentional social change through which an SP complex system adapts to external pressure. External pressure may come from the fact that the SP system is not effective enough in achieving its goals and objectives, or from the fact that there are conflicts and incommensurabilities with the external environment. Laws and institutions in water management may develop as a result of government decisions to make them more effective and integrated.

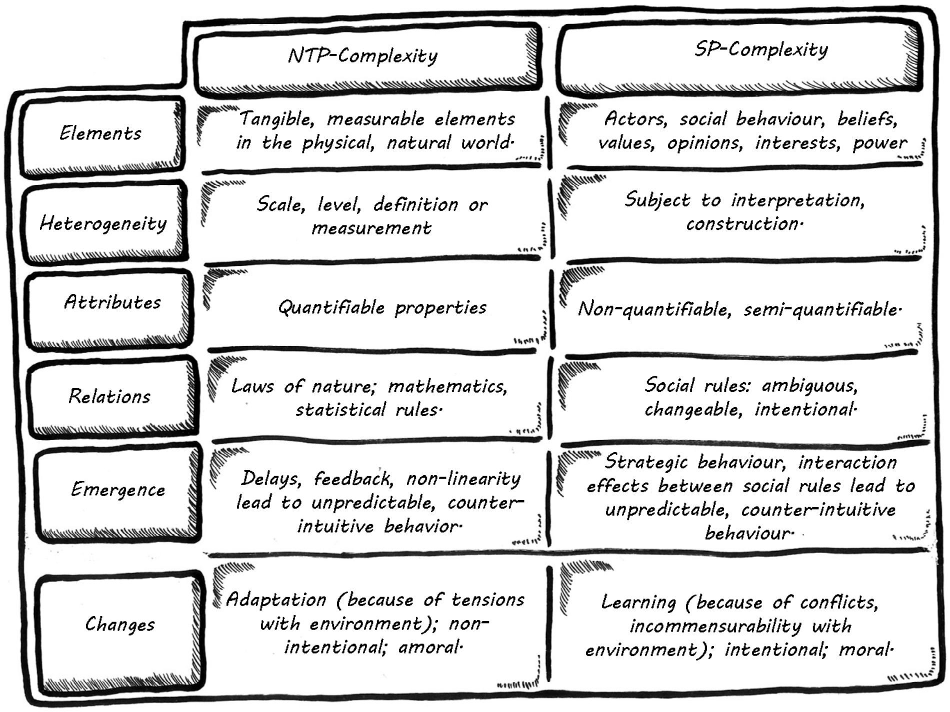
(c) *Interaction* between NTP and SP complexity: changes (adaptations) in the NTP complex system (e.g. climate change and the dying of coral reefs) may be considered socially, politically or economically undesirable within the SP system. This necessitates human intervention in the form of policy and management. Vice versa, human decisions and activities, like fishing and offshore drilling, influence the NTP system and trigger change in the ecosystem. Changes in an SP system can be caused by external events, like a natural disaster; however, bad decisions in the SP system can also cause natural disasters.

I have now briefly characterized the realms of NTP and SP complexity and how they interact. In Chapter 2, I will discuss them more in depth based upon a case. Figure 1.2 summarizes the above.

1.2.3 The complex system as a frame

Despite the characteristics of complex systems mentioned above, a system is not much more than a powerful frame through which we see and understand the world. It is a way of thinking (Checkland, 1999; Forrester, 1994; Meadows, 2002; Senge & Sterman, 1992). It is not reality itself that defines the system or its boundaries, because in that sense Buddhism is right and the universe is a *holistic system*, where everything is one. In the light of the ecological crises, Buddhism has become one of the philosophical and theological roots of alternative and holistic 'earth science' (Cooper & James, 2005; Jenkins, 2002). This is what Buddhism and system thinking have in common: the vision of an alternative, holistic science as an alternative to the traditional, reductionist and formal sciences. It is 'we' who define the system and its boundary. 'We' break the world up into an endless stream of overlapping systems of systems in order to define reality (Nowotny, 2005).

Figure 1.2 The characteristics of NTP and SP complexity



However, unless we take an extremely idealistic viewpoint and consider the universe a figment of our imagination, one system representation may tell us more about reality than another representation of the same system. Natural systems can be represented more or less accurately, more or less validly; technological systems can be represented more or less functionally; political systems can be represented more or less meaningfully or persuasively. And although all of them are by definition flawed (at least, until we grasp the infinite truth), system representations have 'truth claims' that need to be critically examined. Most of what we know and study in the realm of NTP complexity is represented in the formal, reductionist language of the sciences (Aerts et al., 2008; Argote et al., 1989; Brugnach et al., 2007; Funtowicz & Ravetz, 1994; Koppenjan & Klijn, 2004).

The socio-political realm is also complex by itself, even without interference from the realm of NTP complexity. Most of what we know and study in the socio-political realm is subject to the social sciences, as well as to journalism, politics and the arts. Hence, complex systems are rooted in many formal and natural languages that enable us to represent complexity with words, concept graphs, pictures, movies, figures, numbers, logarithms, formulas, etc. These languages enable us to communicate about complexity, which again allows us to take actions, to guide, steer and correct the system (so we hope), etc. Some parts of our world, for instance marine ecosystems (see Chapter 2), lend themselves well to a representation in the formal language of the natural sciences because the interaction between the NTP elements follows some laws of nature, for example the laws of the ocean's food chain. Other parts of the world, for instance public protests about ocean pollution, lend themselves well to a representation in a natural language (e.g. social sciences, journalism, politics) because the elements in this frame of the system are related to the human condition, for example our preferences, interests, beliefs and emotions. The rules of their interaction are informal, fuzzy and ambiguous. Other parts of the world (e.g. the beauty and wonders of the ocean) may surrender themselves only to the languages of the arts in poems like *Sea Drift* (Walt Whitman, 1803), music like the Sea Drift suite by Delius (Delius, 1903), movies such as the *Living Sea* (The Living Sea, n.d.) and paintings such as those by William Turner (Shanes, 2008).

It has been observed that the many languages we use to capture complexity are difficult to integrate. That is why we separate science (physics, mathematics, etc.), social science (sociology, political science), philosophy, pseudo-science (acupuncture), religion, journalism, art, etc. Furthermore, as we have seen, the language of science itself is reductionist because it breaks down into numerous sub-languages in disciplines, communities, schools and theories that tend to focus on isolated relationships between system elements, rather than systems as a whole. In a broad sense, holistic science – or pseudo-science, if one prefers – is an attempt to incorporate into science some of the things that we find difficult to express in a formal language of science, such as feelings, emotions, beauty, intuition, etc. We find examples of holistic science in popular ideas about *mindfulness* in psychology and *Gaia* in ecology. But in a more narrow sense, holistic science is an attempt to consider complexity from the perspective of the whole, which is usually called the system. To avoid confusion, I therefore prefer the word 'synthesis' to 'holism' (see Chapter 3).

With regard to my research focus, it has been observed that STC is key to some of the challenges of our time, that this socio-technical complexity emerges at the *science–policy interface* (SPI), and that it is important to develop some kind of integrated science to manage some of the grand challenges (Boogerd, Groenewegen, & Hisschemöller, 1997; Edelenbos, Schie, & Gerrits, 2009; Pahl-Wostl et al., 2000; Toth & Hizsnyik, 1998; van Kouwen, Dieperink, Schot, & Wassen, 2007). In other words, the formal and natural languages need some kind of synthesis in order to be able to represent the many faces of complexity. Precisely this argument was put forward, in slightly different words, by Dick Duke in *Gaming: the Future's Language* (Duke, 1974a), where he argued for gaming as a holistic language of complexity. And that is the reason this thesis examines *game play* as method of synthesis.

> The interweaving of problems in this era has forced attention to wider and more complex fields by each decision maker and by staff or research efforts set to aid him. The mode of understanding is one of gestalt appreciation rather than explicit knowledge of bits of data. (Duke, 1974a, p. 43) […] The citizen, policy researcher or other decision-maker must first comprehend the whole – the entirety, the system, the gestalt – before the particulars can be dealt with. (Duke, 1974a, p. 10)

1.2.4 Duality

There is no clear boundary separating an NTP complex system from an SP complex system, or vice versa. They are a *duality*, like yin and yang or the two sides of a coin. The dichotomy is a helpful creation of our mind that uses two or more languages to represent different aspects of the same complexity. The complexity of a river basin for instance, can be represented from the perspective of hydrology, engineering, ecology, etc. Or its complexity can be represented in terms of political actors, strategic behaviour, power, stakes and interests, or emotions. But to understand the river basin system in a truly integrated manner, both aspects need to be adequately represented, because they are highly interwoven. The same applies, mutatis mutandis, to all grand challenges and many policy problems. In urban renewal, for instance:

> […] initiatives are beset by complexity: the existing urban plan, buildings and constructions, green structures, infrastructures, and residents pose conditions for and constraints on renewal. This complexity has several dimensions: there is the complexity of the urban system; the technological complexity of potential solutions; and co-workers and the political complexity stemming from the many actors involved. (Mayer et al., 2005, p. 405)

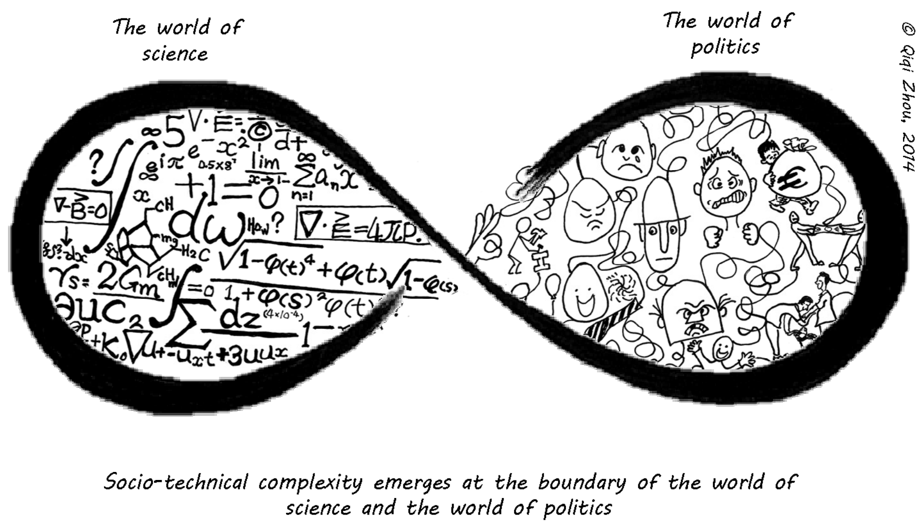
Getting a grip on the duality of NTP and SP complexity is gaining in both importance and urgency. Ecological challenges are pressing, with imminent threats of climate change, sea-level rise, extreme weather, floods and global migrations. The amount of data – big data – that may say something about the complexity of such systems is growing exponentially, mainly due to a revolution in ICT. With ideologies and grand narratives disappearing, science and evidence are the politicians' last resort. Knowledge and data are diffused in numerous networks and communities of practice. Traditional roles in society and economy have become blurred. Consumers are becoming producer–consumers, called pro-sumers. Citizens voluntarily provide data and contribute to citizen science. The strain of social technological complexity is increasing. A lack of evidence and disagreement about values can turn issues into endless debates and controversies (Berkes, Colding, & Folke, 2002; Cunningham & Vanderlei, 2009; Kimmel, 1988; Mitleton-Kelly, 2003; Warren, Franklin, & Streeter, 1998). The two forms of complexity spiral into a higher level of complexity. Here, the system of complex systems follows the law of emergence where 1 + 1 > 2. For urban planning, this has been eloquently described in the following citation:

> First, on the nature of the phenomena handled by planners, it is increasingly recognized that the evolution of the urban development process is an extraordinarily complex and dynamic activity. In simple terms, it involves both physical and social systems; here lies the heart of the problem, namely the simultaneous handling of 'both types' of system as they evolve and interact. On the one hand the physical system is relatively simple to measure and represent as tangible elements are involved. The components of the social system, on the other hand, are not so convenient to handle, as volatile human behaviour is very much involved. (Taylor, 1971, p. 85)

1.2.5 Science versus policy?

Unfortunately, common methods for analysing systems are quite limited in their ability to help us understand volatile human behaviour and its influence on the duality, for example how emotions, values and institutional culture are connected to NTP complexity, and vice versa (Bygstad, Nielsen, & Munkvold, 2010; Emery & Trist, 1960; Herrmann, Loser, & Jahnke, 2007; Laracy, 2007; Mayer, Bekebrede, & van Bilsen, 2010; Ning, 2009; Ottens & Franssen, 2006; Rohatgi & Friedman, 2010; Rouse & Serban, 2011; Trist, 1981; Winner, 2004). There are ways to represent and communicate about NTP complexity – especially through formal modelling – and there are ways to represent and communicate about SP complexity, especially through designing human interaction. But how can we integrate the two without making one ancillary to the other? The ontologies, epistemologies and methodologies developed in the world of science (WoS) and the world of politics (WoP) seem radically different. For integrated policy analysis, it implies that we must come to know how we can create a synthesis between a formal and a natural language, between the formal modelling of complexity on the one hand and political interaction on the other. And in order to do that, we need to know more about what happens at the interface of the WoS and the WoP. In this thesis, I use the term *science-policy interface* (SPI). This is illustrated in Figure 1.3 and will be taken up extensively in Chapter 3.

Figure 1.3 The science–policy interface



1.3 The integration of social and technical complexity

1.3.1 Integrated policymaking

A wide range of proposals, under a plethora of names, have been put forward to approach the socio-technological complexity of systems in an integrated way. In the area of water management, for instance, paradigms of integrated water resource management (IWRM) (Allan, Abdulrahman, & Warren, 2003), integrated flood management (IFM) (van Herk, Zevenbergen, Rijke, & Ashley, 2011), integrated coastal zone management (ICZM) (Massoud, Scrimshaw, & Lester, 2004) and integrated river (basin) management (IRM) (Meigh & Bartlett, 2010) are in vogue. In the area of marine spatial planning, there is talk about integrated, ecosystem-based marine spatial planning (Douvere & Maes, 2010) or integrated maritime spatial planning (Schäafer, 2010). Some proposals for integrated policymaking and its analysis are more theoretical and conceptual – making a strong plea for integrated science (Wilson, 1998), integrated policy appraisal (Russel & Turnpenny, 2009) and integrated assessment (Dowlatabadi, 1995; Turnpenny et al., 2008). Other proposals, like FuturICT (see above), are more instrumental – searching platforms of integrated simulation, visualization and participation for policymakers (Edsall & Larson, 2006; White et al., 2010). It seems logical to look for approaches and methods of integration. When things lie scattered on the ground, we had better collect the pieces and reassemble them. But the scattered parts may not fit together very well, or at all. I will give a few illustrations.

> How are social, political, economic, and institutional issues addressed? The lack of suitable methodologies for understanding the interface between a technical system and the human and organizational it exists within is a stumbling block (Laracy, 2007a, P.19).

One of the solutions that have been proposed as a new form of applied science for public policymaking, especially in climate research and sustainability, is integrated assessment (IA):

> […] an interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines in such a way that the whole cause–effect chain of a problem can be evaluated from a synoptic perspective. (Brouwer, Georgiou & Turner, 2003, p. 174).

According to the United Nations Environmental Program 2009, integrated policymaking needs three capacities:

> *Analytical capacity* is critical for IP (integrated policy) because multidimensional integrated policies tend to face more complexities and uncertainties than single dimensional policies […] *Political support* is critical as integrated policies may represent major changes from the status quo, altering the existing balance of power and interests […] *Administrative capacity* refers to a government's capacity to formulate and carry out policies […] These components form a stylized strategic triangle in a policy environment, each playing an indispensable role in determining the extent of IP's success or failure. (Fritzen et al., 2009).

Conceptual proposals of IA are translated into methods for integrated modelling where knowledge from different disciplinary or sectorial fields are brought together into one scientific model, or where different models – city models, traffic models, water models and environmental models – are interconnected, so that they can communicate with each other and exchange input/output or form a new system:

> Assessments of policies to respond to global climate change, for example, are largely being conducted using integrated assessment models (IAMs). These models attempt to integrate information by linking mathematical representations of difficult components of natural and social systems in a computer model. (Risbey et al., 1996, p369)

Methods for integrated modelling have evolved to a point where we can better simulate the complexity of social systems as well as socio-technical complexity:

> Various models and theories have been developed to provide general and causal explanations of complex socio-natural dynamics (Medema, McIntosh & Jeffrey, 2008, online).

Advancements in integrated complexity models have also significantly increased the models' capacity to deal with uncertainty through, for instance, system dynamics (Bonabeau, 2002; Forrester, 1995, 2007; Lempert, 2002; Spector, 2000; Winz, Brierley, & Trowsdale, 2008) and agent-based models (ABM).

> In statistical forecasting models equations are developed *ex post*, i.e. following observation, such that the model output matches available historical data as closely as possible […] In contrast, system dynamics models are *causal* mathematical models. The underlying premise is that the structure of a system gives rise to its observable and thus predictable behaviour. […] This is followed by *ex ante* projection where future system states are replicated from this model. The difference between *ex post* forecasting and *ex ante* projection implies that uncertainties with regards for future changes in system structure can be more easily addressed as there is better understanding of system structure in the first place (Winz, Brierley & Trowsdale, 2009, p. 1304)
>
> The first tentative efforts at 'simulating societies' using agent-based models were made in the early 1990s. Since then, there has been an explosive growth in the application of agent-based modelling in the social sciences, with applications in nearly the whole suite of disciplines, including economics, sociology, geography, political science, anthropology, linguistics and even social history (Dam, Nikolic & Lukszo, 2013, foreword).

Within the WoP, we see a corresponding development, especially in natural resource (water, ecosystem) management and spatial planning. I will give a few, non-exclusive examples. Integrated water resource management (IWRM) is a popular concept often used as scientific guideline for the holistic approach to water management and public policymaking. The need to integrate social and technical elements is expressed in the following explanation of integrated water management:[6]

> Technical systems are perceived as part of the human component. Technologies are embedded in a network of social routines that link technologies to their function to achieve the overall management objectives. This area of research has not yet received sufficient attention since often technical systems have been studied and developed in isolation from their social context. Such negligence may lead to failures in the introduction of new technologies in water management when the influence of cultural factors and social relationships prevails. One needs to better understand the interdependence and co-evolutionary development of manage-

> ment objectives and paradigms, environmental characteristics, technologies and social routines (Pahl-Wostl, 2007, p. 50).

On a wider scale, integration is needed not only within the water system, but also between the water system and many other subsystems of planning. In many European countries, and especially in the Netherlands, water management and spatial planning have become highly interconnected in spatial planning (Healey, Khakee, Motte, & Needham, 1999; X. Wang, 2001; Woltjer & Al, 2005, 2007).

> The spatial relationships between land uses and river-water quality measured with biological, water chemistry, and habitat indicators were analysed […] The study exhibits the importance of integrating water-quality management and land-use planning. Planners and policy-makers at different levels should bring stakeholders together, based on the understanding of land–water relationship in a watershed, to prevent pollution from happening and to plan for a sustainable future (Wang, 2001, p.25).

> Dutch water management currently is in a position of fundamental change and renewal. As a consequence of factors such as climate change, continuous land subsidence, urbanization pressures, and a lacking natural resilience of the water system to absorb water surpluses and shortages, the emphases has shifted from technical measures such as heightening dikes and enlarging drainage capacities towards allowing water to take more space. Since the late 1990s, water management has been modified from an approach of 'keeping it out' towards 'fitting it in'. As a consequence, 'water management' and 'spatial planning' are associated more closely, especially at the regional level of scale (Woltjer & Al, 2005, p.1).

1.3.2 Integration of science and policy

So far, we have seen that integrated approaches in science and politics expand their formal modelling efforts simply by incorporating *more* subsystems. In other words, the models become more comprehensive, incorporating more data and more variables from more domains. Transport models traditionally focussed on traffic flows, but have now started to incorporate noise models, emission models, spatial models, etc. Another way of integration is when models start to incorporate socio-political complexity, because as we have seen the language to represent socio-political complexity is different. The incorporation of socio-political complexity in formal modelling can be done in several ways.

First, socio-political systems can be modelled 'as if' they were NTP systems. Thus, social subjects become formal objects. Real values become formal preferences or stakes; social rules are formalized into formal rules as far as the modeller can, etc. Much of the work known under the heading of 'social simulation' takes this approach, because it applies computational methods to study issues in the social sciences. One of its founders, Robert Axelrod, has presented social simulation as a third way of doing science, a kind of synthesis of the deductive and inductive approaches. Through social simulation – for instance, with agent-based modelling – one can generate data that can be analysed inductively, but the data come from a rigorously specified set of rules rather than from direct measurement of the real world. Thus, simulating a phenomenon is akin to generating it – constructing artificial societies (Axelrod, 1997a, 1997b).

A second solution is to surround the representation of complexity through the formal language of science with a natural language; in other words, computer models surrounded with some kind of human interaction, like in interactive simulations or group model building.

Taking one step further, the formal language of science itself is turned into a natural language when science itself is merely seen as a social construction, not much different from and not holding more truth than other social practices. The practice of knowledge construction, data collection or science at large becomes a democratic, participatory process. The recent upswing in citizen science, crowd sourcing, etc. is a clear example. Such 'new air' of science can be seen in, for instance, the theory of 'post-normal' science. Funtowicz and Ravetz (1994) argued that when 'normal' science is no longer capable of dealing with the emerged complexity, a post-normal science is needed:

> We call it 'post-normal' to indicate that the puzzle-solving exercises of normal science (in the Kuhn'ian sense), which were so successfully extended from the laboratory of core science to the conquest of nature through applied science, are no longer appropriate for the solution of global environmental problems (Funtowicz & Ravetz, 1994, p. 1884).

Moreover, they explained why modelling alone cannot serve socio-technological complexity:

> The epistemological sort of uncertainty has become familiar to experts even where computer methods dominate the problem-solving strategy. They were already accustomed to technical uncertainty, in the 'errors' of the data inputs, and to methodological uncertainty in the response of methods to the input. But increasingly, experts are becoming aware of the insoluble questions of what, if anything, their models have to do with the real world outside, since their outputs are generally untestable. … it cannot be treated by standard mathematical or computational techniques. … such problems have been neglected because there has seemed to be no systematic solution to them […] (Funtowicz & Ravetz, 1994, p. 1884).

Based on these arguments, post-normal science suggests participatory approaches that go 'far beyond the traditional community of science' (Funtowicz & Ravetz, 1994). Along similar lines, proposals for trans-disciplinarily science, citizen science, participatory integrated assessment (PIA) or participatory policy analysis (PPA) have been adopted, developed and applied to integrated public policymaking (Coenen, Huitema, & O'Toole Jr, 1998; Fritzen et al., 2009; Hisschemöller, 2005; Mayer, 1997; Mermet, 1991; Toth & Hizsnyik, 1998; van Asselt & Rijkens-Klomp, 2002; van de Kerkhof, 2004). Participatory approaches aim to involve external communities – such as policymakers, experts from various disciplines and social stakeholders – in a dialogue or negotiation as a form of co-production of knowledge. To a certain extent, the practice of participatory analysis blurs the boundary between the scientific and the political worlds. It is argued, however, that integration in complex policymaking is much more than providing 'the right science' as input. The political agenda and the strategic behaviour of using power and influence need to be addressed much more than is currently the case in the study of socio-technological issues.

1.4 Study design

1.4.1 Finding the princess in the castle

> Thank you Mario! But our Princess is in another Castle!
> Super Mario Bros

It is now time to wrap up this chapter by presenting the study design. I will start by explaining the topic of this thesis through the above citation. This popular quotation from the classic video game Super Mario Bros, to which the book title refers, hints that finding the right model for socio-technological integration is a difficult mission with uncertain outcomes. We are like Super Mario trying to find our princess (social–technological integration) in one of the many castles of integrated science and public policymaking. As the main title of this thesis, it also expresses the essentiality of what we are looking for – the more gender-neutral prince(ss) – as a metaphor for the significance of socio-technological integration. We have a clue in which castle we may find her, namely the castle of game play. The metaphor also gives us some indications as how to approach the challenge:

(1) What will the princess look like?
(2) Is there a princess in more than one castle?
(3) Is 'my' princess the same as 'your' princess?
(4) Etc.

The main title furthermore expresses the importance and fun of the quest itself. Perhaps the princess will turn out to be less attractive than we imagined, but the journey itself will be very worthwhile. The subtitle of the thesis – 'challenging game play for integrated policy analysis and planning' – also has several meanings. It refers not only to 'game play that is challenging', but also to 'critically examining game play'.

1.4.2 Objectives and relevance

The objective of this research is to create a conceptual understanding of socio-technical complexity and integration in a context of policy analysis and planning. Both complexity and integration are reflected at the interface of the world of science (WoS) and the world of politics (WoP). Figure 1.4 presents the conceptual model of this research: at the *science–policy interface* (SPI) we want to investigate whether and, if so, how integration can be served by game play. The relevance of the research is derived from the observation that STC is at the forefront of political decision-making, and that managing STC is the common denominator among the grand challenges of modern-day society. As a consequence, actors in the WoS and the WoP are now trying to construct methods for the integrated analysis and management of STC. I believe that such integrated methods are becoming like *game play* and that understanding how we play with artefacts like models, simulations and games is relevant to integrated policy analysis and planning.

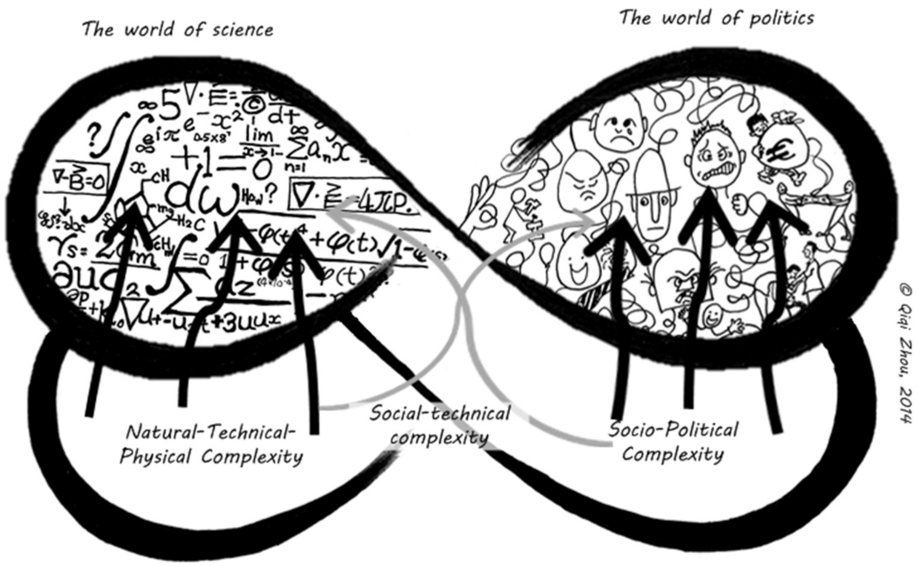
1.4.3 Focus of the research

The focus of the research can best be defined as the role and value of games/gaming for integrated policy analysis and planning. Hence, it is necessary to briefly say something about 1) policy games, that is, what they are and the state of knowledge in the literature; 2) the relation between games and public policymaking; and 3) the research and evaluation of games in general and for public policymaking in particular.

1.4.3.1 State of knowledge

The historic roots of games for research, policy and planning go back to the 1950s, which saw the emergence of the decision sciences: operations research, system analysis and policy analysis (DeLeon, 1988; House & Shull, 1991; Mayer, 2009; Mirowski, 2002; Miser & Quade, 1985). It is difficult to delineate the field because policy games bear a plethora of names: operational gaming, free-form gaming, scientific gaming, simulation gaming, policy exercises, serious games, social impact games, games for change, gamification and more. Preferred notions and definitions change over time (see Table 1.1). In Chapter 3, I will discuss the issue of defining policy games in more detail by looking at four different frames. For the moment, though, a rough clarification and delineation suffices (see Table 1.1).

Figure 1.4 Conceptual research model



There is an extensive body of literature on the science and craft of policy games and there are various ways to structure this body of literature:

(1) *Policy process*: the sort of policy games that are used, and how are they used, in different stages of the policy process, like agenda setting, policy formulation, decision making and implementation (Backus & Amlin, 2005; Barreteau, Le Page, & Perez, 2007; de Man, 1983; Geurts, Duke, & Vermeulen, 2007; Hoysala, Murthy, Palavalli, Subrahmanian, & Meijer, 2013; John, 2003; B Lankford, Sokile, & Yawson, 2004; Ryan, 2000)
(2) *Policy analytical function*: closely related to the above, whether games support different modes of inquiry in the policymaking process, like problem structuring, evaluation, forecasting, etc. (Bremson, 2012; Green, 2005; Mastik, Scalzo, Termeer, & In 't Veld, 1995; Roelofs, 2000).
(3) *Policy theories*: the views on games for policy, which depend upon the different theories on public policymaking (van Daalen, Bots, Bekebrede, & Mayer, 2004).
(4) *Policy domains*: the games or types of games that play a role in different policy domains, like land use and natural resource management (Castella, Trung, & Boissau, 2005; Ducrot, Bueno, Barban, & Reydon, 2010; Dumrongrojwatthana, Le Page, Gajaseni, & Trébuil, 2011; Bruce Lankford & Watson, 2007; Vieira Pak & Castillo Brieva, 2010), railway policy (Meijer, Mayer, van Luipen, & Weitenberg,

2011; Meijer, 2012), roads and transport policy (Altamirano, 2010; Duffhues, Mayer, Nefs, & Vliet, 2014), energy policy (Bremson, 2009; Chappin, 2011; de Man, 1983; Hoysala et al., 2013; Kuit, 2002) and healthcare policy (Bekker, 2007).

(5) *Design and use of policy games*: The models and recommendations for the design, implementation, use and debriefing of policy games (Bergeron, n.d.; Bots & van Daalen, 2007; Duke, 1980; Ellington, Addinall, & Percival, 1982; Geurts et al., 2007; Klabbers, 2003; Wenzler, 1997).

(6) *Policy impact*: Whether policy gaming has an impact on the policymaking, and how we know that (de Caluwé, Geurts, & Kleinlugtenbelt, 2012; Geurts et al., 2007; Mayer, Bekebrede, et al., 2013).

Table 1.1 Definitions

Concept	Definition, description	References
Business war gaming	'[…] a business war game is a role-playing simulation of a dynamic business situation. […] A business war game is usually prefaced by extensive research on the industry in which the war game is supposed to take place.'	Gilad & Stitzer, 2008; Kurtz, 2003; Oriesek & Schwarz, 2008; Schwarz, 2009; Werbach & Hunter, 2012
Experimental games/gaming	'[…] games with a scenario from a discipline such as economics or political science where the game is presented in the context of some particular activity, even though the same hypothesis might be tested.'	Colman, 1982; Pruitt & Kimmel, 1977; Shubik, 2002
Free-form game/gaming	'A scenario-based game in which opposing teams of human participants are confronted with a generally realistic situation or problem and work out responses both to the situation and to moves made by their opponents.'	deLeon, 1981; Jones, 1985; Shubik & Brewer, 1972; Shubik, 2009
Games for change	'[…] the use of digital games to advance organizational mission and societal change.'	Diffuse sources ('Games for Change.,' n.d.)
Gamification	'[…] the use of game thinking and game mechanics in a non-game context in order to engage users and solve problems.'	Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011; Deterding, 2011
Operational gaming	'A simulation in which decision making is performed by one or more real decision makers.'	Feldt, 1966; Thomas & Deemer, 1957
Policy exercise	'[…] a deliberate procedure in which goals and objectives are systematically clarified and strategic alternatives are invented and evaluated in terms of the values at stake. The exercise is a preparatory activity for effective participation in official decision processes; its outcomes are not official deci-	Brewer, 1986

	sions.'	
Policy games	'[…] safe environments to test strategies in advance, and can help decision-makers to create several possible futures. The players build the future conditions of the system step by step by moving from the current reality to a new vision. In the debriefings, participants 'look back' from those futures'.	(Geurts et al., 2007)
Scientific gaming	'[…] a pre-simulation research strategy that generates information to permit improvement of the game itself; the investigator is moved toward full-fledged simulation through increasing accuracy in specifying the parameters and variables that characterize the system of interest.'	Raser, 1969
Serious game	'[…] the general use of games and game technologies for purposes beyond entertainment'.	Sawyer, 2007
Serious play	'[…] improvising with the unanticipated in ways that create new value. Any tools, technologies, techniques, or toys that let people improve how they play seriously with uncertainty is guaranteed to improve the quality of innovation.' (p. 2)	Schrage, 2000
Simulation	'[…] a conscious endeavour to reproduce the central characteristics of a system in order to understand, experiment with and/or predict the behaviour of that system'.	(Duke, 1974a, 1980)
War game	'Military simulations, also known informally as war games, are simulations in which theories of warfare can be tested and refined without the need for actual hostilities. Many professional analysts object to the term war games as this is generally taken to be referring to a civilian hobby, thus the preference for the term simulation.'	Brewer & Shubik, 1979

In Chapter 5, I will give examples to illustrate the different types of practices of models, simulations and games (MSGs), and elaborate the meaning of game play for interactive and integrated policy analysis.

1.4.3.2 Policy and games

The relation between games and public policymaking can be viewed in two ways: in a conceptual and in an instrumental way. Conceptually, we can look at public policymaking 'as if' it were 'a game'. Looking through the frame of a game, we then see players, stakes, rules, strategies, moves, challenges, winning and losing, etc. in the policy process. We can then use these aspects of a game to analyse public policymaking (ex ante or ex post) and advise policymakers on how better to play their game. Instrumentally, we can design and use the technique of policy gaming as an intervention to deliberately learn about and change public policymaking. In this case, the game is not a metaphor, but a tool in the analyst's toolbox. However, the conceptual and the instrumental way of using games for policy analysis are intricately related. How we frame public policymaking matters for the way we intervene in it. Game play can be instrumentally useful for policy analysis only when public policymaking itself is thoroughly understood in terms of 'game play': can the public policymaking problem at hand be framed in terms of a game, and if so, what kind of game is it? Only then can a policy game potentially impact real-world public policymaking. It now becomes even more important to understand game play both conceptually and instrumentally. What is 'game play' in a context of public policymaking? In Chapter 5, I will view game play as a set of principles, some of which are conditional, a *sine qua non*. These principles of game play can be applied to understand, design and evaluate policy games.

1.4.3.3 Learning, transfer, impact and more

One of the key challenges in the literature on serious game research is validation of learning, and learning transfer: do players (either pupils, students, policymakers or managers) learn from playing games and do they take this learning outside the game? If they do, we are able to make claims about the *learning efficacy* of serious games. Of course, this is a generic question that can be broken up into specific variants. And from the question we can derive appropriate methods of research, for instance through experimental or quasi-experimental design (Mayer, Bekebrede, et al., 2013; Mayer, Bekebrede, Warmelink, & Zhou, 2014). Operationalized research models and hypotheses can be derived from specific learning theories, combined with subject matter and competency models. Some researchers prefer more open learning research approaches in which the objectives and achievements of gaming emerge as they go along. In a nutshell, this is the common approach in serious game research. It is valuable research but mainly addresses learning from games at the micro level, namely individual or small group learning, most often in a context of formal learning (education, training).

The evaluation of game-based learning in policy analysis needs conceptual frameworks that can support the analysis of serious games in a public policymaking context. Shubik (1975) pointed out that the bureaucratic nature of policymaking makes the understanding of the environment of operational gaming far more important than detailed information about individual learning. When it comes to studying games in a context of policy analysis, the individual learning of policymakers matters only if the individual learning transcends on to an organizational, institutional, network or political level. In other words, the evaluation of individual learning needs to be transferred to a higher level. For policy analysis, the essential role of game play is to take the learning to the system or organizational level, otherwise we can only regard game play as a form of training, and not a tool that has a role in real-world policymaking.

The evaluation of games and game play at the organizational or system level, however, is still little understood. This is a result not so much of the lack of empirical applications or case descriptions (as we have seen, there are numerous cases), as of the limited conceptualization of why it is being done at all and why it matters.[7] What the impact of using games and game play is on the real-world policy process is a legitimate question. Policy gaming's impact on or relevance to public policymaking is very hard to establish and very difficult to prove, because games are not machines that throw out clear answers to policymakers' questions. However, that is why we can use it to deal with complex policy problems, and why we regard public policymaking as a game in which changes simply continue and the consequences are non-linear. This is how game play can be seen to contribute to policy-oriented learning.

Now, within the stream of events in public policymaking, playing a game with policymakers may not be much more than the 'flapping of a butterfly's wing';[8] but can it cause a hurricane at some future time? This question leads us to consider the role that MSGs have in public policymaking, and how this role is framed by the modellers and policymakers themselves. That, in essence, is the focus of my research: the role of games and game play in a context of public policymaking, and why they matter.

1.4.4 Overarching question

The overarching question that guides this thesis is:

> What is the role and usefulness of serious game play for integrated policy analysis and planning?

This question will be broken down into specific variants in the following chapters to address the specific focus in the theoretical discussion and empirical case study. These various research questions will be formulated at the beginning of each chapter (see also Figure 1.7).

1.4.5 Locus of research

To illustrate and validate the theoretical strand, I have selected two empirical domains: integrated water management (IWM) and integrated marine spatial planning (MSP). Together they are the *locus* of my research and constitute the empirical storyline. The reason for selecting these two cases is that I believe that socio-technological integration can be most vividly witnessed in areas where ecosystems, infrastructure planning and spatial planning interface with each other. In these areas, the need for long-term, integrated policymaking is most urgent, even though it may not be very clear what integrated policymaking means and how it can be done.

In water management, there is an on-going paradigm shift from engineering-driven solutions (more, higher and stronger levees) to solutions where nature, technology and human aspects are in balance. Integrated water management (IWM) advocates cross-disciplinary, cross-sectional and ecologically sustainable spatial planning in which the effects of climate change are anticipated. In highly developed, flood-prone countries like the Netherlands, IWM is fairly well established. Due to global environmental changes, flooding is becoming a major problem in other parts of the world too, where there is much less expertise in water management.

China, where I was born in 1974, is one of the countries to which the Netherlands disseminates and exports the principles and methods of IWM, along with many of the tools to realize it. This gave me, as a researcher interested in socio-technical integration, an excellent opportunity to study how IWM is framed and operationalized in different policy and planning regimes, namely those of the Netherlands and China. Knowing both the Dutch and Chinese cultures very well, I assumed that on both sides there would be a lot of confusion about such notions as integrated water management, participation, models, simulations and games. Furthermore, I could investigate how SPI operates in the Netherlands and China and how MSG plays a role at this interface (if any).

Computer models have a long and well-established tradition in water management. With the paradigm shift to IWM, the models also change: they become increasingly integrated in the sense that all kinds of planning areas are incorporated into planning models, and that some models become more interactive and human-centred. In a number of cases in the Netherlands and elsewhere, the models have been turned into games, in which the NTP system is represented in a virtual manner, and/or simulated in an integrated model; but at the same time human interaction is designed with the use of game principles. I will use two examples as cases: the *Blokkendoos* (Dutch for a 'box of building bricks' for children) – a planning kit developed and used in a project called Room for the River – and the *Climate Game*, which was originally developed and used in 2004 as part of the Living with Water innovation project, and is now used in policy analysis and planning projects such as the planning of Rotterdam Feijenoord reconstruction in 2013.

A similar paradigm shift towards integration is happening in marine spatial planning (MSP) – basically, spatial planning at sea (see Chapter 2). The difference from IWM, however, is that MSP is much more recent and much less developed. It is an area of complex, integrated planning that is on the rise. In Chapter 2, I will discuss why MSP is an extremely complex system. In 2011, we were requested to develop an MSP game: the *MSP Challenge 2011*. The game was subsequently played in November 2011 in the Marine Aquarium in Lisbon with 68 international policymakers and scientists working in the field. Then in a master class on MSP in the Dutch town of Leeuwarden on October, 31, 2012. A third experiment was held with 60 marine spatial planners from the Nordic countries in Reykjavik, Iceland, in November 2013. The field experiments gave me ample opportunity to study integrated policymaking and gaming in action. The results will be discussed in Chapter 7.

1.4.6 Research approach

The research of serious games for any kind of purpose or in any field of application is multidisciplinary by nature. Games are too multifaceted to be understood by one single discipline; they are both technical artefacts and works of art. They involve psychology, didactics, group dynamics and communication; they can be about any kind of subject matter, and the variety of learning objectives is endless. And they are played and used in dynamic organizational and/or political contexts. Although many of these aspects are less relevant in the context of my research, I will apply a *multi-method approach* at *multiple levels* in order to study games in the complex nature of public policymaking. Multi-method approach means that I alternate and combine qualitative methods (interviews, documents) with semi-quantitative research methods, such as questionnaires and the Q methodology. Some scholars would call it *triangulation* (see Figure 1.5). For the theoretical chapters, my research method is evident: I searched, read and interpreted the databases for relevant literature. The multiple methods used in the empirical line are:

(1) *Pilot studies:* two case studies based on the Blokkendoos planning kit (BPK) and the Climate Game (CG), with data gathered from open interviews, observations, documents, etc.
(2) *Structured interviews* with policymakers and modellers in China and the Netherlands using Q methodology.
(3) *Game-based quasi-experiment*: the design, organization, facilitation and evaluation of a policy game around marine spatial planning (MSP) played in November 2011 in Lisbon with 68 stakeholders. Data collection methods in the experiment included questionnaires, observations and in-game data logging.

Since I used several data collection methods, I have chosen to present the justification of methods for data collection and analysis in the chapters where it is appropriate and needed. For multiple levels I combine research at the macro and the micro level. For the theoretical study, it means that SPI is discussed as the macro-level problem and the mechanisms of policy games as the micro level. In the empirical storyline, I investigate how modellers and policy-makers frame the role of models, simulations and games for integrated policy analysis; and how and to what extent game play with a selected group of policy-makers leads to integrated policy. By and large, this research is very much case-driven, but case studies are used in multiple ways: as qualitative illustrations of theoretical and conceptual arguments at a macro or meso level, and also to collect empirical data at a micro level.

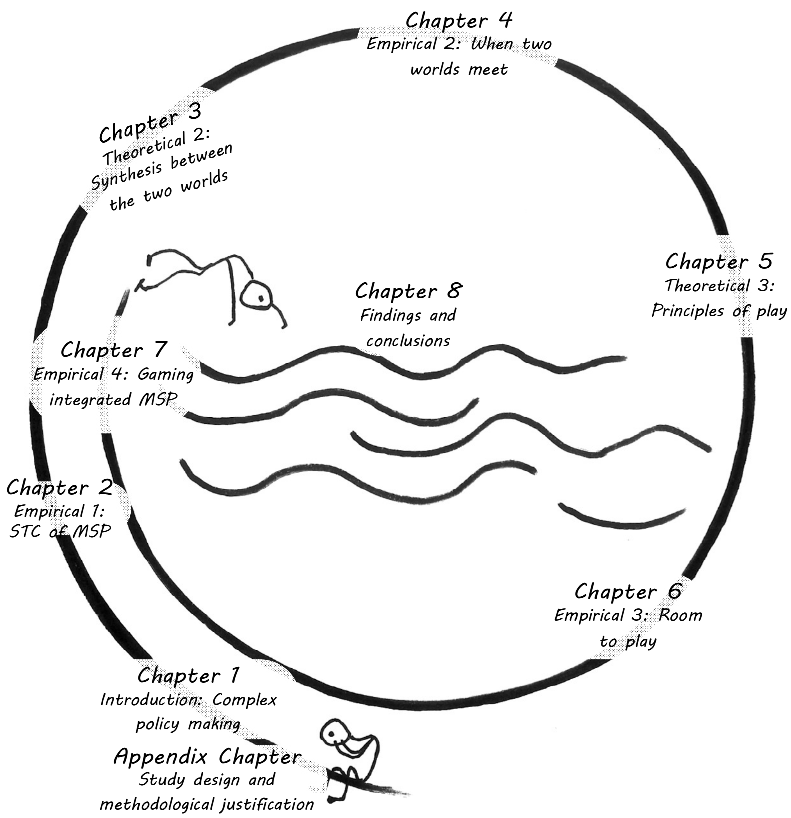
Figure 1.5 Multiple methods

Source: based on Patton (1990)

1.5 Outline

To create a mutually reinforcing effect between the theoretical and empirical parts of my research, I have chosen to interweave the theoretical and empirical chapters. In other words, I am not presenting a number of theoretical chapters and then a few empirical chapters, but alternating theoretical and empirical chapters. The advantage is that more abstract discussions can immediately be enriched and illustrated with data and cases. To avoid interruptions in the storyline, I have also decided to present the research design and methodology justifications in a chapter in the appendix. The spiralling structure of eight chapters is illustrated in Figure 1.6.

Figure 1.6 Spiralling structure



In *Chapter 1*, I formulated the problem, the main research question and the locus and the focus of this study: the conceptualization of socio-technical complexity and how game play can serve integrated policy analysis and planning. I have selected two empirical domains: integrated water management (IWM) and integrated marine spatial planning (MSP). A general study design was provided above. Methodological justifications are in the appendix. The theoretical and empirical chapters that follow, have specific questions derived from the main question. Figure 1.7 provides an overview of chapters and questions.

Figure 1.7 The four parts of the story and their topics

Four parts of the story and the topics of each part		
The big problem and needs of integration	Ch. 1 Policy making in the Wake of Complexity	Why do we need integrated policy analysis and serious game play as integrated method?
	Ch. 2 Complexity of Marine Spatial Planning	What do we know about the complexity and integration of socio-technical systems in marine spatial planning?
Finding synthesis between the different worlds	Ch. 3 Finding the Synthesis between Two Worlds	What are the discourses of socio-technical integration and how do they relate to integrated methods?
	Ch. 4 When Two Worlds meet	What are the roles of modelling simulation and gaming in different types of integrated policy making?
Integrated policy analysis as serious game play	Ch. 5 Principles of Play	What are the principles of serious game play and how do they make integrated policy analysis become like game-play?
	Ch. 6 Room to Play	How are the principles of game play applied and what are the usefulness of them for integrated policy analysis?
A taste of pudding itself!	Ch. 7 Gaming integrated MSP	How do integrated policy analysis and planning happen in game play? And what do we learn from the gaming experiment?

In *Chapter 2* (The Complexity of Marine Spatial Planning), I demonstrate how the embryonic model of STC (Figure 1.1) can be used to analyse the complexity of marine spatial planning (MSP) and, vice versa, how the analysis of MSP can show the relevance of the question and enrich the abstract model. In short, I argue that the two forms of complexity should be viewed as being in a dialectic relation, namely as thesis and antithesis. Integrated policy analysis is the finding of a synthesis between two worlds. The story of MSP will then pause, and continue in Chapter 7, with a game-based experiment for integrated, ecosystem-based MSP.

In *Chapter 3* (Finding a Synthesis between Two Worlds), I pick up the theoretical strand. The search for synthesis takes place at the interface of science and policy. This does not yet explain why the WoS and the WoP are like thesis and antithesis, and how synthesis can be created between these two worlds. In order to conceptualize these two questions, I examine where the tensions at the *science–policy interface* (SPI) come from. I then present three strategies for socio-technical integration: balance, inclusion and synthesis. My supposition is that all three forms of integrated policy analysis can become 'like game play'. Synthesis, however, is the form where serious game play truly emerges: 1) the representation of NTP complexity as in a formal game, for example as game theory, computer simulation and agent-based models; 2) the representation of SP complexity as in participatory play, role play, etc.; and 3) the representation of STC as in serious game play.

In *Chapter 4* (When Two Worlds Meet…), different types and levels of integrated policy analysis are discussed on the basis of integrated water management (IWM) in China and the Netherlands. I investigate more closely how SPI operates in these two countries, and what role models, simulations and games (MSGs) plays in integrated policymaking. I present the results of structured interviews with policymakers, model experts and scientists on IWM and MSG in the Netherlands and China. I then discuss and analyse cross-boundary interactions at the SPI: what happens when Dutch experts advise Chinese policymakers on integrated water management and MSG?

I continue the theoretical strand in *Chapter 5* (Principles of Play and How They Serve Policy Analysis). I discuss the philosophy behind serious games and simulation games (both abbreviated as SGs) for policymaking. I show what integrated methods and approaches have emerged, and why and how these integrated methods become like game play. I do this by deconstructing the principles of game play and demonstrate how they serve integrated policy analysis.

In *Chapter 6* (Room to Play), I analyse two pilot studies of policy games: the Blokkendoos planning kit (BPK) and the Climate Game (CG). I discuss to what extent the principles of game play determined the design, use and impact of these two game-like cases for integrated water management.

In *Chapter 7* (Gaming Integrated Marine Spatial Planning) I discuss the design and results of a game-based, quasi-experiment for integrated marine spatial planning: the MSP Challenge. This serious game was designed by the Delft gaming centre and played with MSP experts and practitioners from various countries. In this detailed case study, the process and outcome of integrated policy analysis are analysed by applying pre-game, in-game and post-game questionnaires, and logged game data.

In *Chapter 8*, I review the partial answers in each chapter, consider the implications and answer the main research question.

2 The Complexity of Marine Spatial Planning

> For most of history, man has had to fight nature to survive; in this century he is beginning to realize that, in order to survive, he must protect it. *Jacques-Yves Cousteau,* (French Explorer, 1910-1997).

2.1 Introduction

Before we continue the *theoretical strand* of this thesis – i.e., the conceptualization of socio-technical complexity (STC) and how game-play can serve integrated policy analysis and planning – I want to introduce my first case about *Integrated, Ecosystem-based, Marine Spatial Planning*.[9] This case gives empirical foundations to the concepts introduced in Chapter 1; the conceptualization of which continues in the following chapters. With the case, I mainly want to demonstrate how the analysis and embryonic model of STC (figure 1.3) can be used to analyse the complexity of *marine spatial planning* (MSP); and *vice versa* how the analysis of MSP can show the relevance of the question and enrich the abstract model. The question that drives this chapter is:

> What constitutes the socio-technical complexity of MSP and how can it be represented into a synthetic model that could serve as a starting point for integrated policymaking and game-play?

I will start with introducing the rising importance of MSP as it is emerging on the political and scientific agendas. I will then describe its STC, followed by an analysis of how STC is at the heart of the *science-policy interface* (SPI). Then I will pause the story on MSP. It will continue in Chapter 7 with the design, playing and analysis of the *Marine Spatial Planning game* in Lisbon (2011), Leeuwarden (2012) and Reykjavik (2013).

2.2 The rising importance of marine spatial planning

2.2.1 EU policy

Marine ecosystems around the globe are increasingly being affected by human activities such as fisheries, shipping, offshore petroleum developments, wind farms, recreation, tourism and more (see Figure 2.1, the *pressure* arrow). Whilst the necessity and urgency to regulate and plan competing marine spatial claims is growing, the planning and regulation of these claims seems to be more difficult than on land, amongst other reasons because of insufficient data and knowledge on how ecosystems are affected, the international dimension of marine ecosystems and the limited number as well as short time frame of existing formal MSP initiatives (Gee, Kannen, & Heinrichs, 2011; HELCOM, 2010; Kannen, 2012; Mayer et al., 2012). Due to this, experience with MSP is limited and practices are yet poorly validated (Agardy, di Sciara, & Christie, 2011; Curtin & Prellezo, 2010; Douvere & Ehler, 2009; Flannery & Ó Cinnéide, 2012; Jay, Ellis, & Kidd, 2012; Mahon, Fanning, & Mcconney, 2009; Murawski, 2007; Plasman, 2008).

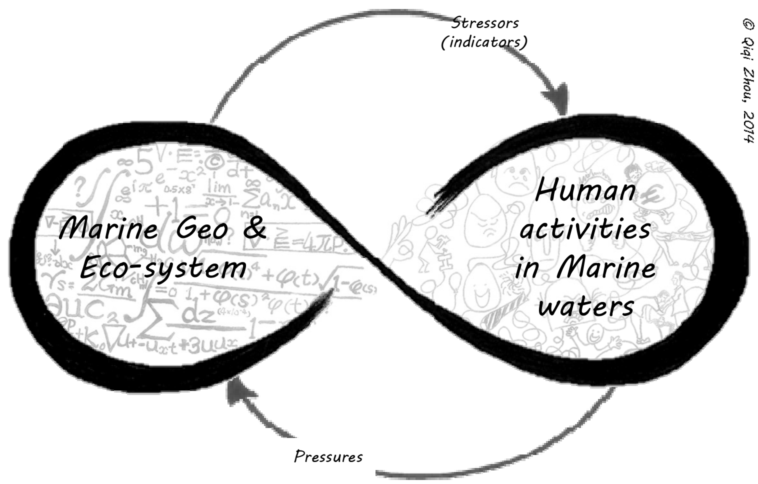
However, awareness for the need of MSP is rising. In 2008, the European commission published its 'Roadmap for maritime spatial planning: Achieving Common Principles in the EU' (Commission of the European Community, 2008), followed by a 2010 Communication 'Maritime Spatial Planning in the EU — Achievements and Future Development' (Commission of the European Community, 2011), which paved the way for a European directive. Under the EU marine strategy framework directive (MSFD), member states are required to make an initial ecological assessment of their waters in respect of each marine region or sub region and then define measures, including MSP, to achieve 'good environmental status'. Moreover, the much broader EU Integrated Maritime Policy is actively promoting an integrated MSP framework that is science-based, includes stakeholder involvement and utilizes marine data collected for various different reasons – 'collect once, use many times' (Commission of the European Community, 2011, 2013; Ehler & Douvere, 2009). This data-collection about the state of marine waters is indicated in Figure 2.1 as the *stressor / indicator* arrow. In this fashion, we recognize the STC of the problems that MSP addresses in Figure 2.1.

2.2.2 National and regional pilots

A number of MSP activities currently exist, in stages ranging from early beginnings and pilot projects to well-established statutory systems. Germany, for example, has spatial plans in place for both its North Sea and Baltic Sea EEZs. The Netherlands has developed a '2009-2015 Policy Document on the North Sea', which analyses spatial developments and formulates policy-related targets (Ministerie van Verkeer en Waterstaat, 2009). Norway has established a series of integrated management plans, starting with the Barents Sea in 2006 (Olsen et al., 2007) – this was revised in 2011 – and followed by the Norwegian Sea in 2009 (Ottersen, Olsen, van der Meeren, Dommasnes, & Loeng, 2011). It is now developing a plan for the North Sea, due for release in 2013. The EU roadmap (Commission of the European Community, 2008) lists MSP activities in several member states (Flannery & Ó Cinnéide, 2012). HELCOM is using Plan Bothnia as a pilot for MSP (Backer, 2011; Heinrichs & Gee, 2011). As part of the EU-funded INTERREG project BaltSeaPlan, detailed drafts of maritime spatial plans taking into account analyses of national maritime strategies and scenarios are under development for several demonstration areas in the Baltic Sea: the Pomeranian

Bight, the western Gulf of Gdańsk, Middle Bank, the Danish Straits, Hiiumaa and Saaremaa, Pärnu Bay and the western coast of Latvia (Gee et al., 2011).

Figure 2.1 Pressures and stressors



2.2.3 MSP Studies

Analyses of MSP cases published in the academic literature cover, amongst other places, Greece (Beriatos & Papgeorgiou, 2011) Portugal (Calado et al., 2010), Malta (Deidun, Borg, & Micallef, 2011), Belgium (Douvere, Maes, Vanhulle, & Schrijvers, 2007), the Channel Islands (Flannery & Ó Cinnéide, 2012), Spain (Suárez De Vivero & Rodríguez Mateos, 2012), France (Trouillet, Guineberteau, De Cacqueray, & Rochette, 2011) and Germany (Kannen, Gee, & Licht-Eggert, 2008; Swaney et al., 2012). In addition, several EU or nationally funded projects have examined MSP processes and activities from an analytical and/or scientific point of view; for example, MESMA (www.mesma.org), MASPNOSE (www.surfgroepen.nl/sites/CMP/maspnose), BALANCE (www.balance-eu.org), BaltSeaPlan (www.baltseaplan.eu), PlanCoast (www.plancoast.eu), KnowSeas (www.knowseas.com) and Coastal Futures (Garthe & Mendel, 2010; Lange et al., 2010). Similar initiatives are pending in other regions of the world, too, such as North America (Halpern et al., 2012) and China (H. Li, 2006). An international professional community, collecting and sharing best practices in MSP, is emerging within ICES, HELCOM, VASAB, OSPAR, the EC and other international regimes.[10]

2.3 Challenges of marine spatial planning

Marine spatial planning is addressing the socio-technical complexity of marine systems through understanding and designed change. Kannen, (2012) for instance has characterised some of the challenges for MSP as dealing with: a) cumulative impacts arising out of specific sea use patterns; b) (spatial) conflicts among different sea uses; c) a multitude of perceptions and attitudes of stakeholders and public, and; d) trans-national and trans-boundary scales. This makes the dynamic, longer term effects of exogenous developments (economic growth, ecology) and endogenous decision (planning) highly unpredictable. It spirals into even greater STC in the heart of the *Science-Policy Interface* because of: 1) unclear system boundaries; 2) system ambiguity; 3) scientific uncertainty, and; 4) fragmentation, the latter partly resulting out of the three other topics. These aspects of complexity in the SPI are briefly discussed below, as they form the foundation for the game-based experiment of MSP Challenge.

2.3.1 Unclear system boundaries

2.3.1.1 Spatial scales

In most simple terms, MSP is 'spatial planning at sea', thereby dealing with human use of sea space. MSP can (and in many cases needs to) be done at several spatial scales ranging from local areas to larger parts of national sea areas, territorial seas as defined by the 12nm (nautical miles) limit, the exclusive economic zones (EEZs) and – at least theoretically - the high seas. Internationally, the united nations convention on the law of the sea (UNCLOS) forms the basis for legalisation and utilisation of marine resources outside the territorial waters (delimited by the 12 nm zone in which governments have full legal control), but including the exclusive economic zone (EEZ). The EEZ extends 200 nm (370 km) beyond the outer limit of a nation's territorial waters – the coastal baseline – unless the EEZs of two or more countries meet because their coastal baselines are less than 400 nm apart. From 2009 the UN has opened for extension of the EEZ past the 200 nm limit to encompass the edge of the continental shelf. Countries can now claim an EEZ up to where the continental shelf edge starts at the deep-sea abyssal plains. The need for spatial planning in sea areas, in particular in the EEZs is quite new and follows an increase in and intensification of human demand for the use of marine space. In Germany, for instance, the trigger for development of a marine spatial plan for the EEZ came from offshore wind farming – a new type of spatial claim at the time – which required co-ordination with existing uses such as shipping, protected areas and fishing (Kannen & Burkhard, 2009). In such cases, difficult questions can arise. For example, what are the boundaries of the planning system: territorial waters out to 12 nm, ecosystem considerations, the EEZ, the continental shelf or a combination of them all, depending on the issue under consideration? What kind of human activities and what pressures and effects emanating from them should be taken into consideration? What are the transnational dimensions? What should be the temporal planning horizon? What data and information are needed and available? And last, but not least, which are the responsible and competent authorities? In the light of the above, the EU directorate-general for maritime affairs and fisheries defines maritime spatial planning as follows:

> […] planning and regulating all human uses of the sea, while protecting marine ecosystems. It focuses on marine waters under national jurisdiction and is concerned only with planning activities at sea. It does not cover management of coastal zones or spatial planning of sea-land interface (cited in: (Kannen, Kremer, Gee, & Lange, 2013).

This definition clearly separates MSP from terrestrial spatial planning, even though there might be many interfaces which have to be taken into account. For example, cables or pipelines need connections from the sea to the land and ports need access from both the sea side and the land side, which requires strategic planning to consider hinterland links as well as, say, deepening waterways in order to allow access by large ships. Another open component is how to deal with the seaside boundary to other countries from a national perspective, which is discussed below. However, spatial planning processes in the EEZ need to develop links to terrestrial planning and to similar processes in adjacent countries – and, given the restrictions of the UN Law of the Sea, need to take into account a number of international regulations as well as national and European policies (in Europe).

2.3.1.2 Five-dimensional space

Even more than terrestrial planning, MSP involves planning in at least five dimensions – and maybe more when long-term horizons are taken into consideration. In different ways, these various dimensions are not always readily accessible for human observation.

(1) *Deeply below sea floor* – for example oil and gas exploration and carbon dioxide capture and storage (CCS) facilities;
(2) *Sea floor and slightly below* – for example clam fishing and similar activities, cables and pipelines, wind farm piles;
(3) *Below sea level* – for example fishing, aquaculture and wind farm piles;
(4) *Sea level* – for example commercial and recreational shipping;

(5) *Above sea level* – for example helicopter flight paths, but also recognizing the impact of activities at sea and subsea level on migrating birds such as effects from wind mills and shipping;

In practice, MSP needs to take into account that there are significant interactions between these five dimensions. This concerns uses as for example offshore wind farms, with piles below sea floor and affecting seafloor integrity, the water column (e.g. with noise effects and changes in habitats, the sea level (excluding shipping while needing access for service ships) and above sea level (impact on migrating birds), but also ecological processes and habitat structures. Therefore, a two-dimensional understanding of sea space might be considerably misleading from a systems point of view.

2.3.1.3 Time scales

In addition to geographical and planning scale, time scales also play a big role (Swaney et al., 2012). Some interaction effects within or between the eco- and socio-political system are immediate, like the building of a wind farm impacts shipping routes. Other kinds of impact may take some time, like the gradual emission of pollutants. Pressures by human activities may gradually build up until a tipping point is reached and the system collapses. Other pressures and effects, sea level rising, are long term. In a way, the cumulative pressures of all human activities in a sea basin are also long term. Slow and gradual changes, with delays between cause and effect, make ecosystems complex and hard to manage.

2.3.1.4 Institutional boundaries

In many cases (especially in Europe) two or more countries share the same sea basin or marine space, as in The Sound, the Kattegat and the Skagerrak, the Gulf of Finland, the Baltic Sea and the North Sea. The cumulative effect of all human maritime activities and all sectoral planning decisions in one or more countries in a marine basin can impact the entire basin as an ecological and economic system. In other words, marine ecosystems are not bounded by administrative borders. Consequently, there is a need for transnational co-operation in MSP to ensure that these pressures and effects are adequately managed and planned, and also that opportunities are identified and realized. Based on the recognition for international co-operation to identify common pressures and opportunities, the BaltSeaPlan 'Vision 2030' (Gee et al., 2011) has identified four key topics for transnational co-operation: (1) a healthy marine environment; (2) a coherent pan-Baltic energy policy; (3) safe, clean and efficient maritime transport; and (4) sustainable fisheries and aquaculture. Furthermore, the vision recommends three key principles to harmonize MSP in different countries, namely: (1)

pan-Baltic thinking, which requires putting long-term objectives first, recognizing differences between regions and aiming for fair distribution of advantages and disadvantages; (2) spatial efficiency, which implies encouraging the coexistence of multiple activities within sea areas; and (3) connectivity thinking, meaning a focus on the connections which exist functionally between areas, for example between shipping lanes and ports or between breeding grounds and feeding grounds (Gee et al., 2011). Given the efforts by individual countries and international organizations to promote transnational co-operation on MSP as outlined above, there are clear benefits to be achieved through improved co-operation of this kind even though mechanisms and structures still need to be developed. The Baltic Sea – based on experiences from the projects BaltSeaPlan and Plan Bothnia – seems with its establishment of a joint working group between HELCOM and VASAB at the forefront of developing such transnational mechanisms.

2.3.2 Ambiguity

While the spatial system boundaries are relevant in order to define 'where' MSP should act, which places, locations and at which scale, ambiguity also can be observed in terms of what MSP can or should deal with, which problems it can solve and what needs to be recognised when talking about sea uses or human demands for sea space.

2.3.2.1 Ambiguity in definitions

Definitions of MSP vary in the literature and policy documents of countries and organizations (Douvere & Ehler, 2007; Young et al., 2007). Even though using similar terms there are subtle differences in interpretation:

> Ecosystem-based MSP is an integrated planning framework that informs the spatial distribution of activities in and on the ocean in order to support current and future uses if ocean ecosystems and maintain the delivery of valuable ecosystem services for future generations in a way that meets ecological, economic, and social objectives. In addition, this integrated planning process moves away from sectoral management by assessing and managing for the cumulative effects if multiple activities within a specific area (Foley et al., 2010).

Concerning the priorities in MSP Foley et al. (2010) state:

> […] it must be based on ecological principles that articulate the scientifically recognized attributes of healthy, functioning ecosystems. These principles should be incorporated into a decision-making framework with clearly defined targets for these ecological attributes (Foley et al., 2010).

This definition gives a clear priority to ecological targets, while the EU in its statements on the integrated maritime policy and on MSP provides a stronger focus on use:

> MSP is a tool for improved decision-making. It provides a framework for arbitrating between competing human activities and managing their impact on the marine environment. Its objective is to balance sectoral interests and achieve sustainable use of marine resources in line with the EU Sustainable Development Strategy (Commission of the European Community, 2008).

The focus in these definitions is on characterising MSP as a tool or framework, while others clearly understand MSP as a process:

> Maritime spatial planning is commonly understood as a public process for analysing and planning the spatial and temporal distribution of human activities in sea areas to achieve economic, environmental and social objectives. The ultimate aim of maritime spatial planning is to draw up plans to identify the utilisation of maritime space for different sea uses (Commission of the European Community, 2013, p. 2; see also: Ehler & Douvere, 2009, p. 18).

The result is expected to be a spatial plan or a spatial vision:

> Marine spatial planning works through the allocation of space, utilizing the ecosystem approach and integrating all available relevant datasets, and forms the basis for decision-making. The MSP process usually results in a comprehensive plan or vision for a marine region. MSP is an element of sea use management (Blaesbjerg, Pawlak, Sorensen, & Vestergaard, 2009).

In terms of time scales, in particular visions frame MSP as

> […] proactive and future-oriented. It delivers the desired outcome of sustainable socio-economic development within a healthy marine environment by balancing all relevant interests in a fair and unbiased manner (Gee et al., 2011).

According to these definitions the object of MSP, spatially organising human activities, becomes clear. However, its challenge is to deal with several policies for different sectors and for the marine space, and recognising a range of policy arenas, discourses and actors including their different values, beliefs and interests. The weakness is that the definitions cited above use a variety of vaguely defined terms such as 'sustainable', which provide room for interpretation by different actors in the process, in particular concerning the threshold between sustainable and not sustainable. Priorities in a spatial plan then are the result of negotiations, influenced by power relations and discourses. Therefore the same process can lead to different outcomes and priorities in different areas and actor constellations and at different times.

2.3.2.2 A clash of frames

Underlying this ambiguity are different values – economic, social and ecological – as well as different perceptions on things like the role of planning. Stable and coherent combinations of values, beliefs and opinions are commonly referred to as frames or belief systems, and tend to have a major impact on policymaking (Sabatier, 1998; Weible, Sabatier, & Lubell, 2004; Weible & Sabatier, 2005). Changing policymaking usually implies changing the dominant frames of the influential stakeholders – through informed stakeholder discourse, for instance or – in the longer term – due to changes in attitudes, beliefs, values and priorities within society.

Policy actors concerned with the rapid deterioration of marine ecosystems around the world are likely to frame MSP as a path towards 'sustainable development', protection of 'marine ecosystems' and 'nature conservation'. It is generally accepted that marine ecosystems all over the world are strongly affected by pollution, fishing and other human activities. Seen from this perspective, no country or region in the world has yet an adequate or at least successful MSP system. Other actors apply a more moderate or pragmatic view by accepting that trade-offs need to be made between ecology and the many different economic functions. One primary concern is that such trade-offs be well-informed, with an eye for the future. In this context, MSP can be framed as part of a wider movement towards ecosystem-based management (EBM) (Douvere, 2008).

Others still are more concerned with balancing all the social, economic and ecological functions of the marine system, with ecology being one of the values and concerns considered but not necessarily the dominant one. In short, depending on one's position MSP is either part of a sustainability strategy, part of ecosystem-based management (EBM) or part of integrated management (IM). There are similarities and overlaps between the three, but they are not identical. Social, economic and ecological functions are all involved but the priority of these is different in the three. The discourse amongst planning professionals, policy advisers and issue and stakeholder advocates can become confusing, since the same words may have different meanings.

2.3.2.3 Competing claims and strategic games

Essentially, MSP is about making choices between competing spatial claims of various kinds (Kannen & Burkhard, 2009). These claims can be mutually exclusive – as is typically the case with shipping and wind farms, military and recreational use – or they can be combined: shipping with recreation, nature with recreation, aquaculture with wind farms and so on. Other claims can be qualified as sustainable in themselves – wind farms, for instance – but the associated construction or exploitation requirements might conflict with other claims of sustainability. Construction noise, for example, is known to disturb marine mammals that use sonic communication. Spatially separating such activities is one way of minimizing negative interactions between them, whilst still allowing them to occur to the greatest extent possible. But spatial zoning is not a universal solution for all problems and non-spatial measures might be needed in addition or can create the possibility to combine uses which seem incompatible with each other at the first glance.

Competing claims and the stakeholder interests associated with them have the characteristics of a 'strategic game'. Sometimes, when competing claims cannot be combined, this is a zero-sum game: one stakeholder wins at the expense of the others. When multiple claims can be combined, it is a sum-sum game: two or more competing stakeholders win. Or it can be a zero-zero game: no stakeholder wins, or perhaps only the ecosystem. The outcomes of the strategic games played by the various stakeholders in the political arena can be unpredictable and can make decision-making highly erratic or dependent on power- and actor relations.

Given the fact that MSP is about competing spatial claims, assessing the potential impact of human activities is bound to lead to controversy (Voyer, Gladstone, & Goodall, 2012). Societal or stakeholder discussions are likely to flare up about the potentially negative impact of, say, constructing wind farms (Jay, Street, & Sheffield, 2007; Kannen & Burkhard, 2009) or offshore drilling for gas on sea birds and mammals. Or, as during the Brent Spar controversy, scientific claims may be used to win a strategic game (Huxham, Sumner, & Park, 1999; Side, 1997).

2.3.3 Scientific uncertainty

In cases of uncertainty and controversy, planning professionals and stakeholders commonly turn to science for answers – that is, for facts and proof – and arbitration. Although we know a lot about marine ecosystems, there is even more that we do not know, especially when marine ecosystems are influenced by the cumulative activities from socio-political systems. One major uncertainty, for instance, concerns the amount of stress that specific human activities put on the marine ecosystems and how then marine ecosystems respond in the short, medium or long term. This becomes even more problematic when we consider the cumulative effects of so-called stressors. I.e. the negative impact of the marine eco-system such as reef degradation and habitat destruction (Garthe & Mendel, 2010; Halpern et al., 2009; Halpern, McLeod, Rosenberg, & Crowder, 2008). Actually, dealing with cumulative impacts is one of the big challenges for MSP. GIS technology allows us to overlay various activity, pressure and impact maps and at the first glance to determine the sum of those impacts, but the effects may actually be much more complicated and subtle than simply adding together impacts.

Cumulative impacts may also involve indirect effects and impacts that act in synergy or antagonistically, creating situations in which one impact substantially increases another. Moreover, cumulative impacts may act indirectly through the interlinked pathways of the ecosystem, creating effects that were not expected at much later times. The emission of multiple pollutants from diffuse sources has worse effects upon sea life than the sum of individual pollutants individually (Garthe & Mendel, 2010; Halpern et al., 2009) Assessing total human impacts is therefore a very challenging task, and no methods currently exist to allow this to be done in a comprehensive manner (Halpern et al., 2009, 2008).

2.3.4 Fragmentation

It is clear that dedicated marine research centres around the world are highly institutionalized. But they do tend to approach marine policy research and advice from a natural or life-science perspective. Insights, methods and tools from the social sciences, like policy analysis, need to be integrated into marine research to cope with the STC of MSP as described above. As well, more studies linking perceptions, attitudes and values as well as representative surveys will be needed to understand the relationships of local and professional communities with coastal and marine areas (Kannen, 2012). However, such knowledge integration in MSP remains yet relatively undiscovered territory for the science and practice of planning (Douvere & Ehler, 2006; Jay et al., 2012).

2.3.5 Socio-technical problem

How can the STC complexity underlying MSP be depicted, using my simple model? Figure 2.2, shows the duality of NTP and SP complexity into STC as follows:

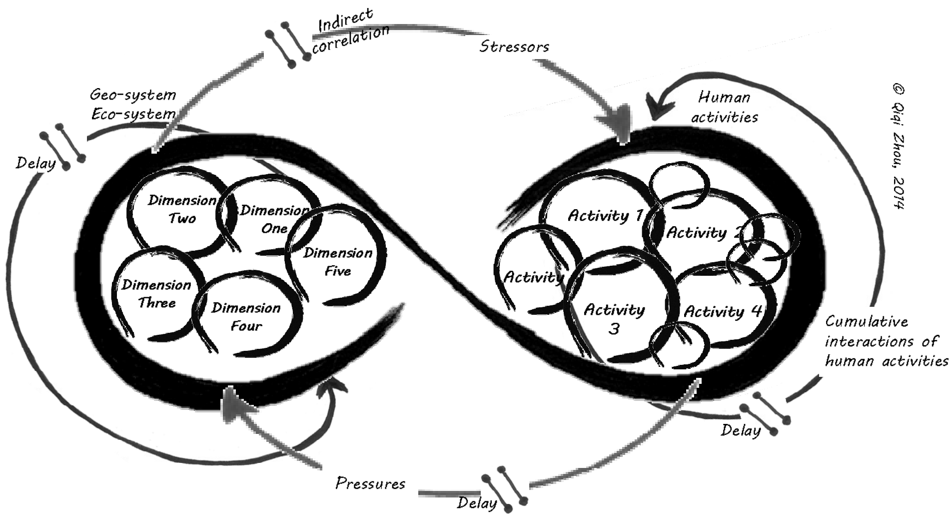
(1) *NTP-complexity:* This is represented by the feedback loop and delay symbols in the left part of Figure 2.2. Geo-system and eco-system by themselves are of staggering complexity, full of non-linear behaviour, feedback relations, delays, and rules. There is no saying how much we know about the complexity of marine ecosystem, but is fair to say that there is more that we do not know, than know. Scientists for instance model the build-up of pollutants in the ecosystem, and the effect it has on sea life (Halpern et al., 2009). Yet, it may take some time before the interaction effects within geo and ecosystems become apparent. In terms of scales and levels - from deep below sea floor to high above sea level - there is enormous heterogeneity of elements. Boundaries of subsystems are almost arbitrary: when it comes of seas and oceans, everything is connected to everything. Therefore we break up our knowledge into disciplines, theories and methods. Parts of what we know are

captured in *geographical information systems* (GIS). Data about wind speed, currents, sea depth, sea levels, geological layers and minerals are stored in numerous data bases and models. Marine biologist, ecologist, and others have become quite advanced in modelling eco-systems, for instance with models and simulations like Eco Path (a food chain model) (Christensen & Walters, 2004; Pauly, 2000). Some of this can be publically accessed but many data-systems and simulation-models are proprietary; and there is so much scattered information that searching and finding it, is almost impossible. The coupling of more data and more simulation-models is proposed to find more integrative knowledge about the complexity of the marine geo- and ecosystem.

(2) *SP-complexity:* This is represented by the feedback loop and delay symbols in the right part of Figure 2.2. Human activities at sea are wide ranged and profound: from recreational sailing, diving and fishing, to mineral exploitation, wind farming. Many of the human activities at sea are linked to other complex systems, such the global energy or innovation system. One human activity at sea – for instance off shore wind farms or oil platforms - may cause or hinder other human activities, such as the redirection of shipping routes, the flying of helicopters, or the ban of fishing. A human activity today may prevent other human activities in the future. Unclear system boundaries due to divergence in values, interests, beliefs, power, etc. i.e. the interactions among all socio-political who have divergent beliefs, stakes, interests, actions, claims etc. with regard to the marine area.

(3) *STC:* The spiralling interactions between the NTP and the SP complexity into an even higher level of complexity, e.g., flaring stakeholder disputes on the cumulative impact of several human activities in a marine area. Despite the trend to more data, better models and more integrative simulations, there is an awful lot that scientists do not know about the marine geo- and ecosystem. There are cumulative effects of many human activities upon the marine ecosystem, but these are largely unknown and/or disputed. Indicators to monitor the stress of human activities put on the geo- and ecosystem are insufficient, inadequate or disputed. Trans-boundary issues spiral the complexity of MSP: e.g., human activities or policy measures in/by one country can be the problem of another country.

Figure 2.2 A STC model of MSP



2.4 Looking for synthesis

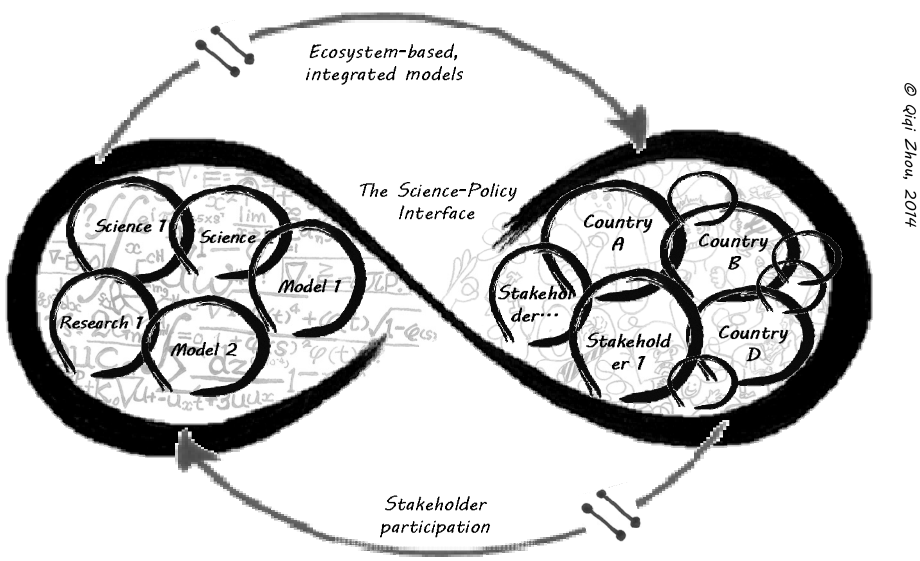
2.4.1 The science-policy interface

The STC of marine systems spirals into the *nexus* of science and policy, culminating into calls, proposals and methods for an integrated, eco-system based approaches to MSP. The two forms of complexity are in a *dialectic relation*, as thesis and antithesis, for which a synthesis needs to be found. Figure 2.3 represents the socio-technical complexity transcended at the science-policy interface of MSP.

2.4.2 Challenges of integrated MSP

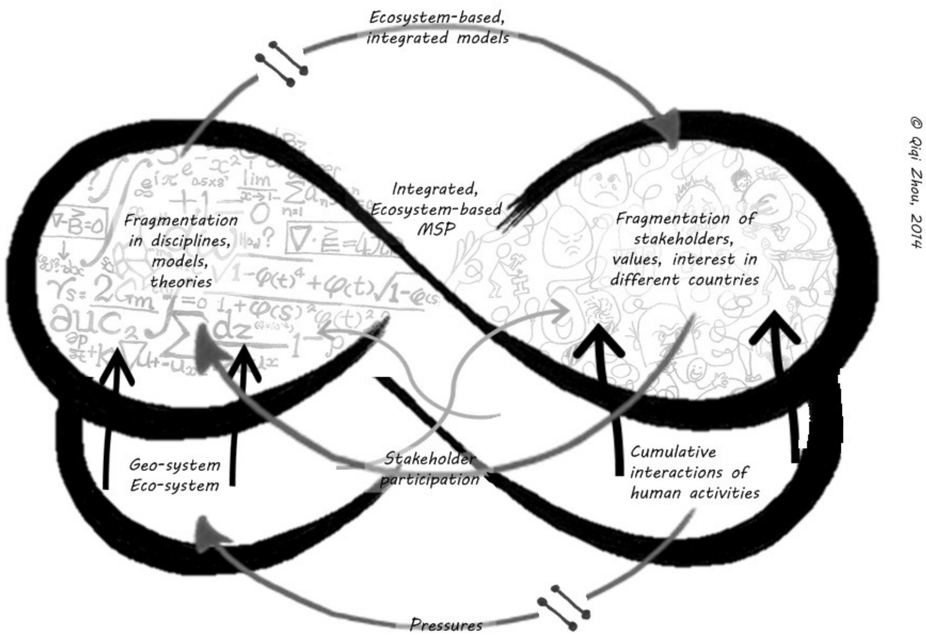
With unclear system boundaries for planning, uncertain knowledge and competing social political stakes, planners, stakeholders and scientists involved in MSP, face problems to make effective plans for MSP. One of the big challenges is that alignment of planning practices – a certain level of mutual understanding, sharing of frames and shared practices, knowledge and data – is required for an integral approach to MSP. From a governance perspective, and given the great complexity of MSP, it is essential to understand the requirements for effective MSP processes. Criteria such as 'integrated', 'participatory', 'ecosystem-based' and 'adaptive' planning are rhetorically powerful but often poorly defined, at least in practical terms (Farmer et al., 2012). Figure 2.4 illustrates the challenges of STC in establishing integrated, ecosystem based marine spatial planning.

Figure 2.3 World of science and world of politics in MSP



It may prove difficult to find common understanding on such matters when different countries sharing marine areas have different and often conflicting values, interests, administrative and legal systems and planning cultures. The SP complexity therefore tends to be highly distinguished in the process of MSP. Integrated planning process requires a tight coupling between political stakeholder interactions on the one hand and, on the other, input from science and analysis. Planners need insight in the longer term consequences of actions to avoid disasters. Given the strong transnational dimension of MSP, particularly in Europe what can be done to improve co-operation and co-ordination of the various planning practices of the EU member states so that we can utilize marine goods and services in a planned and fair manner? And what is the role of science (data, models) and scientists in the integrated participative planning process?

Figure 2.4 The STC of integrated, ecosystem-based MSP



2.5 Conclusion and discussion

In this chapter, the STC of *Marine Spatial Planning* (MSP) has been examined. The case shows how marine ecosystems are influenced by human activities, and vice versa, and how this STC spirals into a higher level of complexity at the heart of the science-policy interface.

2.5.1 Short answers

(1) *What constitutes the social-technical complexity of MSP?* The interaction between the marine ecosystem and human activities in marine waters constitutes a complex, socio-technical system that transcends into the heart of the SPI of MSP and is characterized by unclear system boundaries, system ambiguity, scientific uncertainty and fragmentation.
(2) *How can it be represented into a synthetic model that could serve as a starting point for integrated policymaking and game-play?* Figure 2.2 pictures the socio-technical complexity of marine areas. Figure 2.3 pictures the interface between science and policy, and Figure 2.4 shows how the two interact. In Chapter 7, I will examine

how the game structure of MSP has been modelled into a serious game for serving the purpose of integrated analysis and planning.

2.5.2 Discussion

MSP has similarities to a game of which the rules and playing field are unlevelled and partly unknown to the players. Players have competing claims, make partial decisions that have far-reaching effects for other players, the rules or the playing field. Now, it becomes more insightful why STC is at the heart of the SPI of MSP. Here the tensions need to be resolved and the plea for integration is made. Yet, integrated, eco-based MSP can mean many different things and can easily create confusion.

2.5.3 Continuation

In Chapter 3, I will therefore continue the theoretical strand, to examine and explain how tensions at the Science-Policy Interface arise and how integration can be reached.

3 Finding a Synthesis between Two Worlds

> Between two worlds life hovers like a star, twixt night and morn, upon the horizon's verge. *Lord Byron* (English writer and poet, 1788-1824)

3.1 Introduction

In this chapter, I pick up the *theoretical strand* of this thesis, that is, the conceptualization of socio-technical complexity and how game play can serve integrated policy analysis and planning. I argued in Chapter 1 that the inherent causes of complexity in the natural–technical–physical (NTP) world and the socio-political (SP) realm, spiral into an even higher level of complexity, which we call socio-technical complexity (STC). I designed an embryonic model of socio-technical complexity that emerges at the interface of two worlds (see Figures 1.1 and 1.2): the world of science (WoS) – where complexity is represented through the formal languages of the natural sciences – and the world of politics (WoP), where complexity is represented through the languages of politics, media, art, etc. In Chapter 2, I used the example of marine spatial planning (MSP) to clarify that the two forms of complexity should be viewed as being in a dialectic relation, as thesis and antithesis, which is driving the search for a synthesis. The search for synthesis takes place at the interface or in the nexus of science and policy. This, however, does not yet explain:

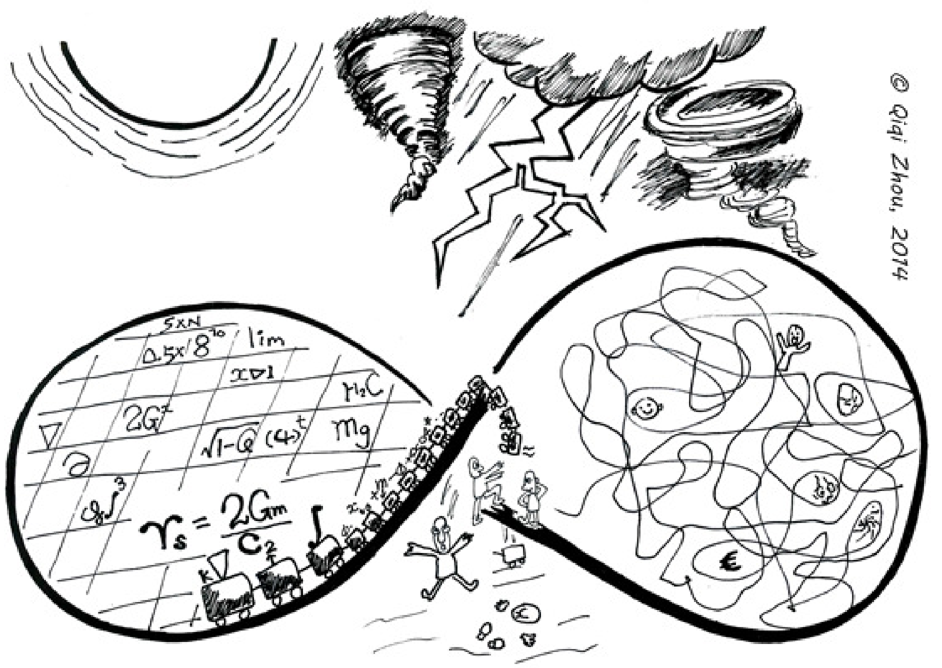
- Why the WoS and the WoP are like thesis and antithesis.
- How synthesis can be created between these two worlds.

In order to conceptualize these two questions, we need to examine where the tensions at the *science–policy interface* (SPI) come from. Furthermore, I develop a foundation for integrated policy analysis and planning. In the following chapter, I will continue the empirical story line with an analysis of integrated water management in China and the Netherlands.

3.2 Where do tensions at the SPI originate from?

Many have struggled with the observation that the actual impact of science on politics is much less than we think, and that the influence of politics on science is far greater than we suppose (Clarke & McCool, 1996; Fischer, 2000; Hoppe, 1999; Ingram, Schneider, & McDonald, 2002; Page, 1985; Samuel, 1977; Stone, 2011; Susan & Woodhouse, Edward, 1995; van de Graaf & Hoppe, 1996; Wesselink & Hoppe, 2010). Hoppe et al. (2009, 2010a, 2010b) have described this in terms of boundary work and boundary tensions at the science policy nexus (see Figure 3.1).

Figure 3.1 Boundary tensions at the science–policy interface



Boundary tensions at the science-policy interface

On a random walk through the literature, we can find many suspected causes of boundary tensions (Caplan, 1979; Hoppe, 2005, 2009; Rich & Oh, 2000; van Dijck, 2003; Weingart, 1999; Weiss & Bucuvalas, 1980a). Here, I cluster them into six groups, although one should be aware that there is considerable overlap and interdependency:

(1) *Language, communication:* boundary tensions originate from the fact that complexity in the WoS and the WoP is represented with different languages, literally because different words are used, and metaphorically because of the formal and natural languages, respectively.
(2) *Values, norms, culture:* boundary tensions originate from the fact that in the WoS and the WoP there are different values and norms that have been enculturated through different kinds of professional training.

(3) *Knowledge, epistemology, ontology:* boundary tensions originate from the fact that in the WoS and the WoP, there are different understandings of reality, how we know the world, and how we can influence and change it.
(4) *Power, influence*: boundary tensions come from the fact that the WoP will view and treat the WoS as just one of the many values in society that needs to be distributed under conditions of limited resources. In other words, within the WoP the resources of the WoS are controlled and trade-offs with other values are made. The extent to which the WoP can exert control over the WoS is dynamic, because the WoS will claim scientific autonomy and freedom.
(5) *Institutions, rules, routines*: boundary tensions come from the fact that in the WoP and the WoS there are different institutions – organizational routines, rules, etc. Especially the bureaucratic nature of organizations in the WoP may create tensions with innovation, professionalism, academic freedom in the WoS.
(6) *Technology, method, tools:* the technology, methods and tools through which knowledge is produced in the WoS may not be easily grasped in the non-technological WoP. This is particular manifest with regard to, for instance, the use of social media, or computer models in knowledge construction.

In the following section, I discuss the above factors with specific reference to relevant branches of theory.

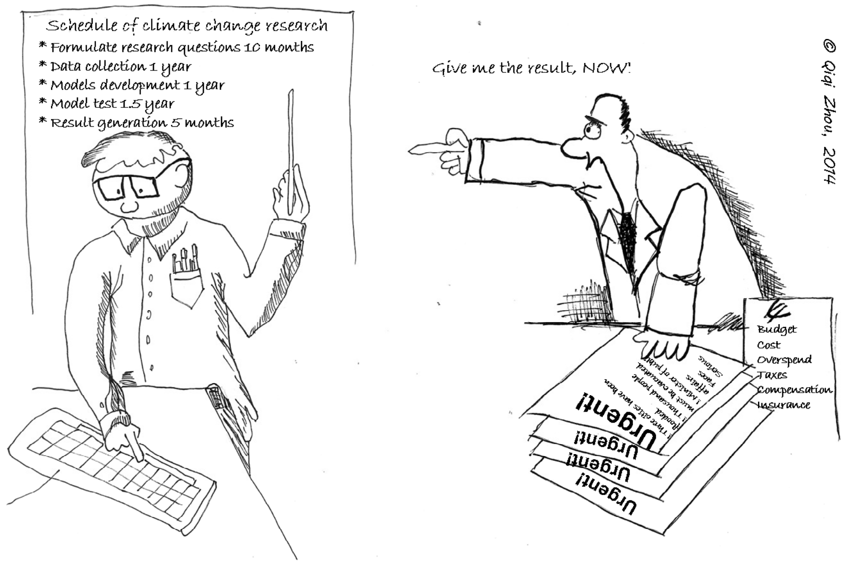
3.2.1 Utilization of knowledge and two communities theory

In an early discussion on the SPI (from around the 1970s), we find the 'two cultures' or 'two communities' theories (Comfort, Sungu, Johnson, & Dunn, 2001; Dunn, 1980; Weiss & Bucuvalas, 1980b; Weiss, 1979). Researchers at the time were mainly concerned with finding the influential factors of knowledge non-utilization; that is, the observation that knowledge produced by the fundamental and applied sciences is often disregarded and not used by policymakers (Boogerd et al., 1997; Caplan, 1979). In simple terms, it was driven by researchers who found that research reports were too often filed away in a drawer (and, later, that computer models were left unopened, stored in a computer folder or put on an unvisited website). In a case-comparative and semi-quantifiable manner, the researchers aimed to identify the factors that could explain why some reports and studies were used while others were not. The factors were found to lie in the communication between the researchers, the policymakers (client) and the intended users of the research. In short, studies needed to be timely, the insights needed to be disseminated for instance through seminars, media attention needed to promoted, users needed to be involved earlier, etc. An important bottleneck was, for instance, the lead-time of research, which is asynchronous with public policymaking (see Figure 3.2).

> Policy makers are accustomed to working on immediate problems and meeting deadlines, whereas scientists see no harm in delivering a better model some time later (Boogerd et al., 1997, p. 732).

In deeper conceptualizations of the two worlds theory, it was argued that the communication problems were not only instrumental, but also rooted in underlying structural differences. Basically, scientists and policymakers were living in different worlds, with different values (e.g. validity vs. strategic use), different time perspectives (e.g. slow vs. fast reporting), different reward systems (e.g. academic standing vs. societal influence) and institutional routines (e.g. professional organization vs. bureaucratic organization).

Figure 3.2 Communication problems



The mind of researcher and the mind of politician are definitely occupied by different things

Since culture is the most basic element in the world for people to create their collective mind on identification (Hofstede, Hofstede, & Minkov, 2010), it is quite obvious that things like distrust or even antagonism can easily occur at the SPI. This brings us to the more psychological factors at work at the SPI. Agreement and understanding is easier to achieve when people share experiences, that is, when they have a common frame of reference. When faced with big problems like climate change, a collective and shared memory from the past has not been formed. Disagreement then comes not only from the fact that people have different interests or speak a different language, but also from the fact they have radically different belief systems or frames to describe the world. Beliefs systems can be deeply rooted in values; challenges to the belief system can feel extremely threatening. When there is no shared frame or belief system, scientists and policymakers in one frame will challenge the beliefs systems that are upheld by other scientists and policymakers. Then a political–scientific war is imminent, with firing discussions and/or cold stalemates (Eeten, 1999; Hisschemöller & Hoppe, 1995; Hommes, Vinke-de Kruijf, Otter, & Bouma, 2008; Hoppe, 1999; Huys & Annema, 2009; Kolkman, Kok, & van der Veen, 2005; Kruijf, 2007; Schön & Rein, 1994; van Bueren, Klijn, & Koppenjan, 2003).

3.2.2 Scientification vs. politicization

Power and control are other factors in the SPI. Since the enlightenment, the natural sciences have freed themselves from politics, that is, first from the pope and the king, and later from administration and bureaucracy. Since positivism, the social sciences have become independent of politics, for example the modern state. Absolute segregation between politics and science has never occurred and will never occur. With the birth of the decision sciences (operations research, systems analysis, policy analysis, etc.) science became more embedded in politics than ever before. Before 1960, the tensions at the SPI were hardly felt, or at least were not voiced loudly enough to trigger radical change. The period has often been labelled the age of scientification and technocratization.

During the 1960s, however, and under the influence of civil rights, environmental issues and peace, women and student movements, things started to change. The relationship between science (and technology) and policy was questioned: who should listen to whom? Should politics listen to science, or the other way around? Was science trustworthy, since scientists disagreed among themselves – and had produced the nuclear bomb, and chemicals that caused environmental pollution? The influence of science on politics was already significant through operations research and systems analysis. But where do they derive their legitimacy from? Politicians derived their legitimacy from being elected, not from science. Scientists had their own political interests – and why would scientific knowledge be better than that of ordinary people with everyday experiences with societal problems, like neighbourhood degradation and environmental pollution? Jasanoff (1990) and others argued that scientists were mainly stakeholders in the policy process and that they are influenced by social, political and personal interests. The technocratic model of public policymaking was under severe attack from participatory models, where scientists were only one of the contributors. This is called the democratization of science, as opposed to the technocratization of politics.

On the other hand, science has its own responsibilities and politicians sometimes prefer to ignore, suppress or manipulate the facts, with potentially disastrous consequences. Wildavsky (1987) argued that science has the right and obligation to 'speak truth to power'. In modern society, with its emphasis on performance-driven efficiency, the WoP has tight control over scientific budgets and research prioritization. Policymakers are safely 'on top', and scientists are 'on tap' (Hoppe, 2005). This is called the politicization of science, and is the opposite of scientification.

3.2.3 Knowledge construction

In the WoS, the golden standard is the formal language – with its emphasis on unambiguous definitions, taxonomies, natural laws, rules, structures and quantifications. The question can be asked whether the golden standard can be met. Asking the question is giving the answer! Especially with big problems, things are 'messy'; we don't know what we do not know, and what we think we know is ambiguous (Funtowicz & Ravetz, 1994; Hoppe, 2010b; Rittel & Webber, 1972). Under such circumstances there is no true/false dichotomy. Knowledge gets distorted by human limitations, by institutional complications, and by value-laden opinions. In short, the conceptualization of knowledge at the SPI deviates from the golden standard of science (Nutley, Walter, & Davies, 2003). Knowledge becomes multi-interpretable, discussable, questionable and negotiable.

Now, one could argue that such constructed knowledge leaves the WoS and enters the WoP; it is simply no longer science. This position would be defendable if there were only one epistemological and ontological premise: namely that reality shows itself as it really is; that truth just needs to be uncovered. The problem is that this premise has been weakened at its core by a range of alternative ontological and epistemological premises: that reality gets distorted by our ideas and knowledge is therefore socially constructed. The consequence is that the WoS opens up to other less formal languages; however, these are still very much judged upon the extent to which they imitate or replicate the formal language. The more cynical take is that science can now be reduced and deformed to a weapon of choice to achieve one's political interests, or to back up one's political viewpoint. Science can now become an excuse to legitimize power (Eeten, 1999; Hoppe, 2005; Mintrom, 1998); scientists can become hired guns. And if this is done too often, the values of science itself will get discredited, as just another form of power. Even when science does speak truth to power, we simply no longer trust it.

3.2.4 Institutional theory

Individual politicians and scientists get acculturated in their organizations; their positions or jobs require them to do something that they would have disapproved from the other side. This is particularly apparent when scientists become politicians, and vice versa. As soon as scientists and politicians cross over to the other world, they tend to voice different opinions. The many tensions between the WoS and the WoP transcend to the level of their institutions. Once transcended, they influence individual behaviour. Neo-institutionalism analyses the SPI from the institutional perspective, where scientific communities and government departments are characterized by their own institutionalized norms, disciplines, rules and routines (Friedland & Alford, 1991). Politicization and scientification may be the result of a more subtle way of influencing where the WoS and the WoP have more in common than we think. Neo-institutionalism (Ingram et al., 2002; Weingart, 1999) has claimed that:

> Bureaucracy and science have a special affinity because of their mutual interest in specialization and respect for disciplinary credentials. The influence of science within bureaucracy has grown as people trained in scientific disciplines have gradually colonized government agencies and come to shape the institutional culture, transforming it from one based mainly on management and policy skills into one that is subject-matter oriented and reflects the rationality, methodologies and values of science (Ingram et al., 2002, p. 4).

By preselecting information from different sources, policymakers also influence the WoS:

> Policymakers often selectively acquire information from specific sources, disseminate certain information to a specific group of people, and use only the information that can validate or confirm their policy positions. In doing so, policymakers explicitly or implicitly establish a certain or biased pattern of information processing (Rich & Oh, 2000, p. 174).

That the WoS and the WoP act according to different rule sets comes to the surface for the general public when they interface in scientific advisory committees, planning agencies, hearings, etc. The tensions in the SPI become most apparent when there are reciprocal accusations (in the media) of things like:

- Research manipulation, for example by biased selection of researchers, political influence on methods, questions, silencing of dissident researchers.
- The filing away of politically undesirable reports and the over-profiling of favourable reports, and the burying of controversial decisions in scientific research.
- Discrediting the unfavourable researchers as sloppy or biased; the mobilization of favourable researchers to support one's own viewpoint or position.

- Political influence on research prioritization, involving only certain selection of scientists to set the research agenda; putting issues on the political agenda merely to favour one's own budget.
- Changing the rules for research budget allocation, cutting the budgets for unfavourable research institutions.

All of these phenomena and more do not prove that all policymakers are immoral Machiavellists and/or that all scientists are opportunists who do not care about academic standards. That is far beyond the point. The rules of the game played at the SPI cause such phenomena to occur. Many policymakers or scientists may not be aware of, and not feel comfortable with the above behaviour; they simply follow the rules of the game.

Neo-institutionalism also can shed a light upon 'boundary institutions', namely the many temporary or permanent organizations that operate at the SPI. In the Netherlands' water policy (see Chapter 4), these are organizations like the Planbureau voor de Leefomgeving (PBL; Netherlands Environmental Assessment Agency), which is the Netherlands' institute for strategic policy analysis in the fields of environment, nature and spatial planning. Or they are the Delta committee (Deltacommissie, n.d.), which examined whether the Netherlands is sufficiently well protected to cope with the scenarios of climate change. They can also be engineering consultancy companies like TNO ((website) TNO, n.d.) or Deltares (Deltares, n.d.-a) that do contract policy research at the interface of NTP and SP systems. These and many other boundary organizations commonly look at integrated policy and integrated assessment, and develop integrated models, simulations and games.

3.2.5 The methodological divide

Policymakers are seldom interested in technological or methodological innovations; they desire on-time deliverables expressed in the most simple and utilitarian manner.[11] Scientists on the other hand do not care so much for ready-made tools and easy answers. They like to pioneer with new approaches, innovative methods and tools, also because then their funding request goes up. Yesterday's tools are much less interesting than tomorrow's promise. This leads to all kind of frictions. On the side of scientists, it often means delays and cost overruns; it may also imply the delivery of methods and tools that are hardly fit to leave the designer's table. When policymakers appear to be interested in financing or using innovative research methods and new tools, they are suspected of being interested in them for subsidiary reasons, for instance in order to stimulate the creative industries (e.g. with games), to give policy an air of science (e.g. with agent-based model), to create an image of ICT-savvy politician (e.g. by using social media) or to add a flavour of democracy (e.g. with e-participation).

Such frictions come to the surface especially in the field of modelling, simulation and gaming (MSG), as Brewer already observed in the 1970s.

> Many of the people in the US departments of Housing and Urban Development and Health, Education, and Welfare, who are directly responsible for the millions of dollars that have gone into some of the public sector models, simulations, and games, really could not care less what those MSGs produced as long as they, the research sponsors, got credit for having been modern, management-oriented and scientific (Brewer, 1975a, p. 3).

The interface between public policymaking and MSG became problematized during the late 1960s/early 1970s. Lee (1973, 1994) argued that the problems with large-scale urban modelling for public policymaking were fundamental and due to the limitations of computer modelling and a naiveté of modellers about the world of politics and planning. According to Lee, many of the assumptions underlying MSG – for example linearity and comprehensive rationality – were not in line with political reality, which is bounded and incremental.

> (..) none of the goals held out for large scale models have been achieved, and there is little reason to expect anything different in the future (…) Methods for long range planning—whether they are called comprehensive planning, large scale systems simulation, or something else—need to change drastically, if planners expect to have any influence on the long run. (D. B. Lee, 1973)

In a similar fashion, Cecchini and Rizzi, (2001) later argued that the reason many of the MSG projects in urban planning fail is due to problematic epistemological, methodological and practical aspects. Brewer (1975) criticized the uses and abuses of MSG for decision making especially in the area of defence and security. He pinpointed the many perverse mechanisms behind MSG for policymaking, such as the use of MSG to defer or stall decisions, as pure advocacy or as 'science for effect'. In addition, MSG has been also used with unclear purpose, inefficiency, lack of communication, documentation, and academic and critical scrutiny.

> (…) close inspection (..) reveals a divergence of purpose between those who build and those who use MSGs having a policy assisting intent; users are inadequately trained to know what they are buying from technical experts; and this inadequacy also exists with respect to the experts knowing or caring about the users. What results are ill-developed controls over the building and use of MSGs because (1) the actual users do not know how the information contained in the model was generated; and (2) the experts responsible for the information contained in the model have abnegated responsibility for the products through disinterest, contempt, and ignorance. (Brewer, 1975b)

Similar, more recent viewpoints on the abuse of certain types of simulations and models (in business) have been presented by Schrage (2000):

> Some of the most seemingly sophisticated simulation models in enterprise management are little more than voodoo dolls dressed up in quantitative clothing. They do not represent virtual realities in which meaningful trade-offs are explored but fantasies in which hard choices are avoided. Built with scraps of reality, they are ultimately disconnected from reality. (Schrage, 2000, p.131)

3.3 Framing policymaking

3.3.1 Not only the pieces…

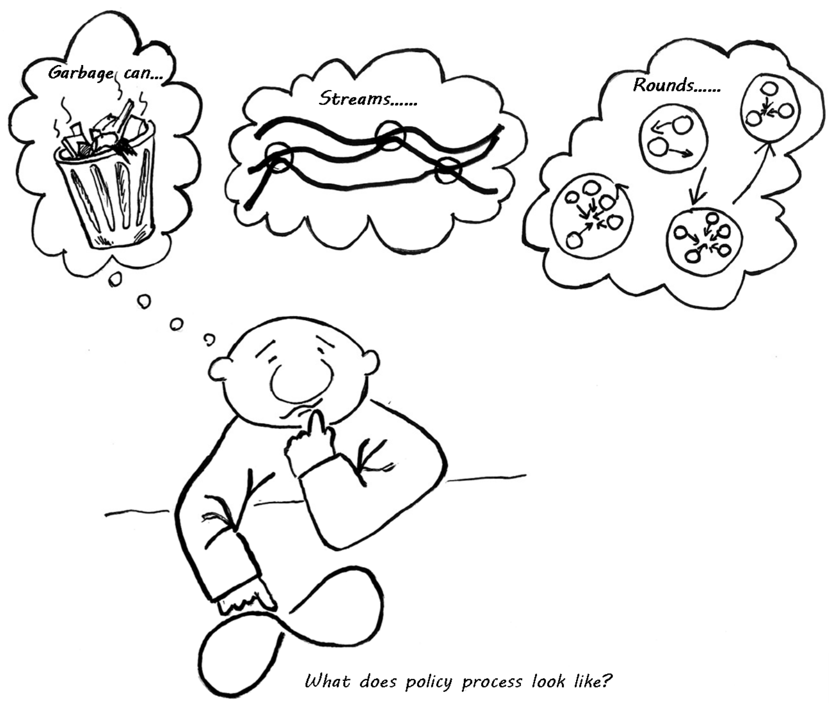
When we meet noise, and fail to see a pattern in it, we get frustrated and give up. But once we see a pattern we delight in tracing it and in seeing it reoccur (Koster, 2005, pp. 23–27). The identification of various factors is useful to understand the complex interaction between the WoS and the WoP; but simply ticking off each factor is not a remedy for the frictions that occur at the SPI. When immersed in the policy or research process, boundary tensions are not so easily recognized and interpreted, let alone remedied; many factors play a role at the same time, raising the frictions to a higher level. Managing the individual factors is like doing a jigsaw puzzle without a reference picture: we have all the pieces, but no frame of reference to help us put them in the right places. In order to see the whole puzzle, and not only the pieces, we need to define what policymaking is and how we think it can be supported by science and research (see Figure 3.3).

3.3.2 Rational choice

The rational model of public policymaking has been well described in many publications. By and large, it frames public policymaking as a selection process among a set of alternatives where there is near perfect information about the problem, the alternatives, the consequences of each alternative and the value preference for each consequence. Defining the value preferences belongs to the world of politics. Rational choice theory is commonly matched with an ordered and sequential selection process. Looking through this frame, one could argue that tensions at the SPI arise because of deviations from the norm in one or both worlds. The WoS and the WoP are simply, and unfortunately, not perfect; but this is no reason to give up the norm. The role of science is to produce the best available knowledge about the problem, the alternatives and the possible consequences. At the SPI interface, specific tools and methods can be found to help the selection process, for instance with decision-support techniques. Still, the interaction between the WoS and the WoP can be problematic, as the following questions may illustrate:

(1) What scientific knowledge should be given to policymakers at what time in the policy process? On science's own initiative or upon the request of policymakers?
(2) Do policymakers understand scientific knowledge correctly? How can one correct misinterpretations of the information in the policy process?
(3) If new knowledge or new alternatives come up, what are the consequences and how can they be integrated into the process?
(4) How should complex, dynamic consequences of alternatives be presented (e.g. decreasing the flood risk in the short term, but increasing the flood risk in the long term)?
(5) How to communicate the limitations of knowledge, when science has no answer, or scientists disagree?

Figure 3.3 Framing policymaking



3.3.3 Garbage cans and boxing rounds

The rational choice model has been messed up by a number of theories that attacked each of its assumptions (see e.g. Teisman, 2000). One strong assumption – namely that the policy process is neatly ordered, sequential and progressive – has come under attack from the *garbage can model* (Cohen, March, & Olsen, 1972), the *streams model* (Kingdon, 1995) and the *rounds model* (Koppenjan & Klijn, 2004).

Cohen et al. (1972) conceptualized the erratic nature of decision-making in the garbage can model. According to this frame, decision making is like a garbage can into which participants deposit all sorts of problems and solutions that at some moment in time may become connected without too much of an obvious relationship. Apart from the fact that problems will get connected to solutions, it happens that solutions get connected to a random problem, for example budgets looking for projects. Participants in the decision making will get connected to problems that are looking for solutions, but it can happen that solutions/problems are looking for participants (e.g. who can support my solution?).

With some modifications, Kingdon (Kingdon, 1995) applied the garbage can model to public policymaking and called it the streams model. He identified three streams: problems, solutions and political events. A political event is, for instance, a change in government that causes certain problems and solutions to gain or lose political support. Participants operate within and between the streams, because problems and solutions cannot be seen independently of participants; they articulate them. An important new element in the streams model is the metaphor of a policy window. A policy window occurs when there is an opportunity to couple – that is, bring together – the three streams. At those moments, decisions can be taken and policies come about. A policy window is temporal. It may be open or closed, due to developments in one of the streams. There may have been changes in government, certain actors may have left the arena, the salience of problems may have changed, or new technologies may have become available. Policy windows may appear or disappear coincidentally. They are sometimes created by 'policy entrepreneurs', that is, actors who are looking for solutions to problems, or for problems that match a solution. Or they are looking for political support for a problem–solution combination.

An important assumption of the rounds model is that public policymaking is pluricentric and networked, rather than unicentric and hierarchical. The decision process is not viewed as a logical consequence of stepwise phases, but as interdependent rounds, intermediated with deadlocks and breakthroughs. A round ends when there is a new deadlock or a decision is made; a new round starts when there is a breakthrough of the deadlock or the decision in the previous round has come under attack. Within each round there is pushing and shoving among the many actors, although the decision making within each round can be fairly rational. It is, however, a conditional rationality, because as soon as the problem or constraints are redefined, or some actors leave the arena, the process can start over again. It is like a boxing match among more than two competitors, with many rounds, until finally somebody goes down. What we can take from the models above is that public policymaking is fragmented in the following sense:

- Multi-actor, interweaving, networked.
- Diffuse authorities and resources, fluid involvement and commitment.
- Erratic, one step at a time, reversible, fits and starts, emergent decisions.

3.3.4 Tensions and frictions again…

By and large, the frames of public policymaking in garbage cans, streams and rounds fundamentally conflict with the ordered, systematic way of working in science, where all steps need to be accounted for. Many scientists, especially those trained in the natural sciences, simply do not grasp and are not particularly fond of the erratic nature of policymaking. And in turn, policymakers often find that scientists do not exhibit enough political sensitivity.

Tensions at the SPI arise because the WoS finds it inherently difficult to cope with the erratic and diffuse nature of the WoP. Scientists lack centrality, a clearly identified decision-maker with enough authority to make decisions. Instead they need to educate a network of diffuse actors with unclear authorities and ambivalent motivations. Even when knowledge is unambiguous and the need for action is pressing, the policy process might go wearingly slowly. And when issues seem to have been resolved at one moment, it can easily happen that through some occurrence, the decision-making process starts all over again. Policy entrepreneurs without special expertise can be more influential than the top experts in the field. Decisions may tie problems to solutions without obvious logic. And when experts or scientists warn about the irrationality of a decision and point at the future negative consequences, their reports are filed away; until one day, in another round, the report is found again, because somebody finds it strategically opportune. In these situations the SPI can lead to public policymaking of lower analytical quality due to, for example:

- Hasty decisions rushed through when conditions are favourable: decisions in the absence and ignorance of evidence, facts, analysis.
- Taboos: certain facts, evidence, reports may not be discussed.

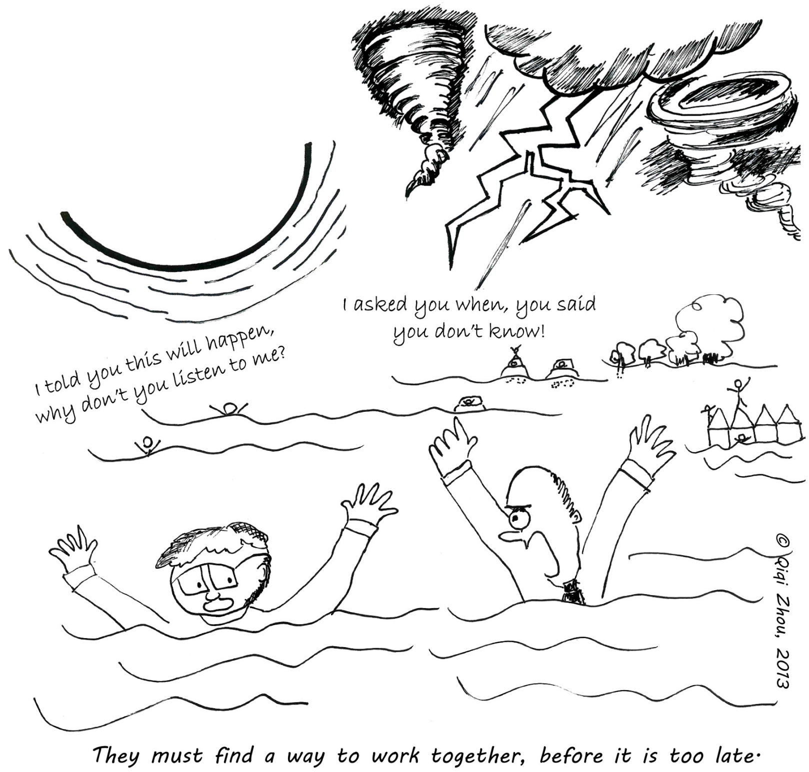
One could argue that the picture painted of the WoS is exaggerated; that scientists know very well how the WoP works and how to influence it. This is true to some extent. Science has become aware of the social and political context in which it needs to operate; and it has also become aware of its own social and political operations, for example academic politics, university bureaucracy, academic restructuring processes that follow the logic of the garbage can, the socio-political factors at play around academic publications, peer reviews, promotions, etc. There are persons in interlocking positions who operate in both worlds simultaneously or sequentially. So, despite the communication difficulties, the WoS and the WoP act sensibly. They are willing to work together to solve big problems (Woodhouse & Collingridge, 1993). If they fail, the laws of nature or the hand of God might strike (see Figure 3.4). However, even when there is willingness to cooperate, the SPI can turn into a problematic situation, namely with endless debates. There are many ways such tensions at the SPI can also lead to public policymaking of lower analytical quality:

- Paralysis by analysis: too much research, evidence, data prevents decisions.
- Report war: opponents fight each other with research reports.
- Negotiated nonsense: the debate leads to a definition of reality that is not in line with the facts.
- Endless debate: everything is discussed with everybody in great detail, without ever coming to a substantive conclusion.

3.3.5 Making sense together…

The streams model and the rounds model suggest that public policymaking is an open process with multiple interactions among actors or communities thereof (Emery & Trist, 1960; Emery, 1965; Herrmann et al., 2007; Leitch & Warren, 2010; Rice, 1970; Trist, 1981). From this perspective, the value of integrated policy analysis lies not only in the knowledge or decision, but also in the quality of the process itself: building trust, developing a common language among stakeholders. Hoppe (1999) called it the shift from *speaking truth to power*, to *making sense together* (Hoppe, 2005; Rogers, 2002; van Dijck, 2003; Weingart, 1999). It often implies that the adjective 'participatory' is added to integrated policy analysis – for instance in the form of participatory integrated assessment (PIA) or participatory integrated coastal zone management (PICZM). It means constructed knowledge. As a summary, knowledge and values are two critical criteria for integrated policymaking. The construction of value-based knowledge can only be done when stakeholders, scientists and policymakers are all involved in the policy analysis process and produce effective, meaningful dialogues.

Figure 3.4 Communication at SPI goes wrong



In policy practice, participatory integrated policy analysis is arranged in different styles, with different meaning and values. Hoppe et al. argue that the style of participatory integrated policy analysis depends on the characteristics of political and social context of the problem (Hisschemöller, 1993, 2005; Hoppe, 2010a; van de Graaf & Hoppe, 1996). Ideally and typically, there are four meta situations where the focus of the debates in policy analysis lies differently:

- *Debate on technicalities*: when knowledge is available and the level of social agreement is high, the policy problem is structured and the focus of debating is on the technicalities of realizing the options. For example, if there is no disagreement about building a reservoir to solve the flooding problem, policy analysis is then on the design and the technological details.
- *Debate on means*: when there is a high level of social agreement but knowledge is uncertain, the policy problem is moderately structured. The claim of competing knowledge and facts is then the main issue in policy analysis. For example, disagreement on whether to choose to build a reservoir, change the land use or invest in ad-

vanced forecasting techniques. And there is no convincing evidence to prove which option is the best.

- *Debate on values*: when the policy problem is moderately structured with available knowledge but the level of social conflict is high, there is little discussion about facts, but a lot about ethical and political principles. For example, serious conflicts over the cultural, economic, environmental and political values of a riverside area where a land reconstruction project is proposed in order to prevent flooding.
- *Debate on all of the above*: when knowledge is uncertain and the level of social disagreement is high, the policy problem is highly unstructured and policy analysis becomes endless debates – the typical situation in, for example, long-term, sustainable urban planning or environmental protection projects.

There are several ways to use these situations to find integrated methods to deal with socio-technical complexity. Socio-technical complexity, such as the climate change issue, has an image of the unstructured type. In reality these big problems are seldom handled in the same way as unstructured problems. This is normal, because no policymaker would like to turn policy analysis into endless debates. And for scientists and experts, the most comfortable situations are where the debate revolves around the means and technicalities. These are the situations where the WoS has methods and tools to sell. The moderately structured problems render themselves well to the natural language of politics, philosophy, arts and media. The pressure will be to reframe an unstructured problem into a structured problem. Since the characteristics of an unstructured problem are high level, spiralled uncertainty and long-term effects, the style of participatory, integrated policy analysis can be in an interweaving process where scientists deconstruct the problem into their models, policymakers look for a strong backup and stakeholders find an acceptable option for their values.

3.4 The three faces of integrated policy analysis

The policy analysis of complex socio-technical problems is like a dialectic process in the heart of the SPI. I define the objective of integrated policy analysis as:

- The deliberate attempt to bring together two or more loosely coupled subsystems, each of which in its own right can explain the socio-technical complexity of their focal problem, into another subsystem that can explain the social technical complexity of a transcended focal problem.

And I define the process of integrated policy analysis as:

- Subsystems are continuously constructed and reconstructed in the WoS and/or in the WoP for understanding and intervening in the socio-technical complexity. The reconstruction of subsystems implies that things like system scale, elements, relations and

> boundaries are constantly examined and defined. Integrated policy analysis is one way of transcending two or more representations of socio-technical subsystems to another representation.

The definitions of and directions for integrated policy analysis are now clearly settled, but they do not present a way to do it, let alone a connection to game play. In the remainder of this chapter, I present three strategies for socio-technical integration.[12] They are based upon an eclectic reading of three philosophical concepts in Chinese philosophy (Tao) and Western philosophy (Kant, Hegel, Marx). The concepts for these three faces are *balance*, *inclusion* and *synthesis*.

3.4.1 Balance

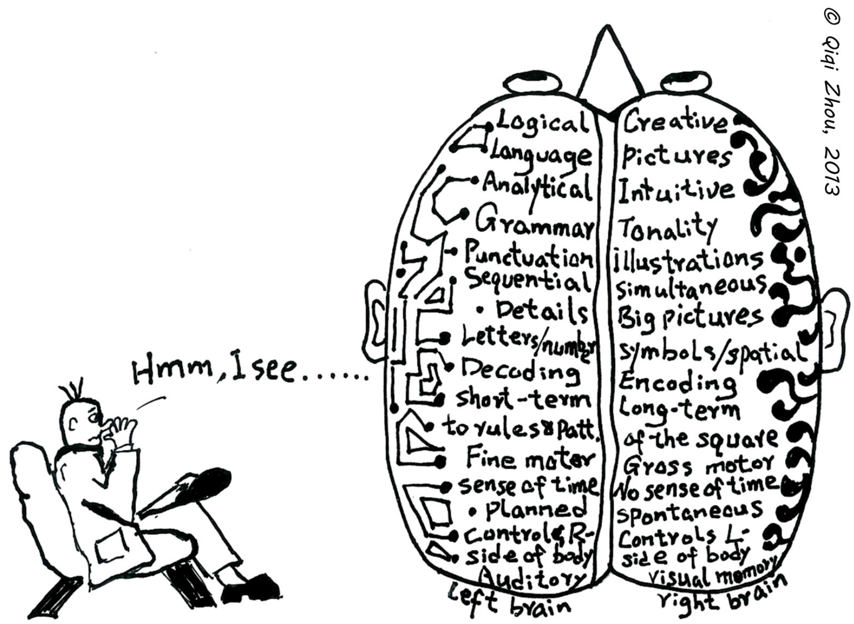
Balance derives from Chinese philosophy (Tao) yin yang, namely that seemingly opposite or contrary forces have an interdependent relationship in the natural world (in Chinese, Qi) and that they compensate for each other's force. In other words, things in the natural world consist in duality (e.g. female/male, light/dark, hot/cold, water/fire, life /death, father/mother). Yang has typical attributes of powerfulness, destruction and decision, and yin has typical attributes of weakness, inclusion and consideration. But each of the attributes has the power to compensate for the opposite one in the duality. The yin yang relation explains the understanding of systems in Chinese philosophy. Everything in the natural world can be regarded as a system that has the duality of the yin and the yang part. A human is also a system in this way. A good condition of a system means the balance of yin and yang. If one of them becomes too dominant, the balance will be destroyed and cause the problem in the system. Human illness, for example, is due to the loss of yin yang balance (Chen, Tsai, Chang, & Lin, 2009; Ji, 2001; Yang, 2010). The yin yang theory has significant influence on the development of Chinese society: family, state or the country, all exist as a small or big system. The attribute of a single element in the system has been accepted as its natural gift: for example, man is powerful and woman is weak. But it is not necessarily a problem, because woman's power can compensate for man's power, and therefore the balance – the harmony – between the dualities is preserved (see Figure 3.5).

Figure 3.5 A scene of balance

In light of the discussion about socio-technical complexity and the SPI, one interpretation of integrated policy analysis is that the two sides (NTP complexity and SP complexity) need to be in balance. At times, one part can be more active than the other, but the balance between the natural language (yin) and the formal language (yang) should not get lost. From a Western perspective, it would probably be more common to represent a duality in terms of 'left side-right side' of the brain: the left side, as representation of logic and analytical thinking; the right side as representation of emotions, creativity, intuitions and art (see Figure 3.6).

When we interpret these Asian or Western dualities *metaphorically*, one important interpretation of 'integration' emerges: the two sides of complexity - NTP and SP complexity - cannot do without another and need to be 'in balance'. At times, one part can be more active than the other, but the balance between the natural language (e.g., yin, right brain) and the formal language (e.g., yang, left brain) should not get lost. Creating balance in public policy making can be done by alternating different representations of complexity for example by combining computer models with art; by combining technocratic methods with participatory approaches etc. Play can bridge the duality, for instance when we are able to engage scientists or technocrats to look at a complex problem in a more creative way, to use languages that they are less familiar with. Or vice versa, when we are able to let politicians, citizens understand the formal structure of evidence-base of a complex problem. Integration as balance is therefore represented as *1/a* (see Table 3.1)

Figure 3.6 Balancing the left and right brain



3.4.2 Inclusion

Inclusion is derived from many branches of philosophy. According to scepticism (Descartes, 2010), science is founded upon radical 'doubt' – as the main principle to find truth. According to *idealism* (Kant, 2008), the human mind constructs – filters, colours – reality. *Constructivist epistemology* (Berger & Luckmann, 1967) argues that knowledge therefore does not exist independently of the observer: knowledge is temporal and conditional. According to *hermeneutics* we are involved in an ongoing process of reinterpretation. In science and politics, man is fallible – *l'homme fallible* (Ricoeur, 1986) – and errors are made. Knowledge needs to be continuously updated; criticism must be mobilized; problems can be reframed. These are a few of the philosophical foundations of what I call the inclusion type of integration: the incorporation of new, and more perspectives, stakeholders, data and facts.

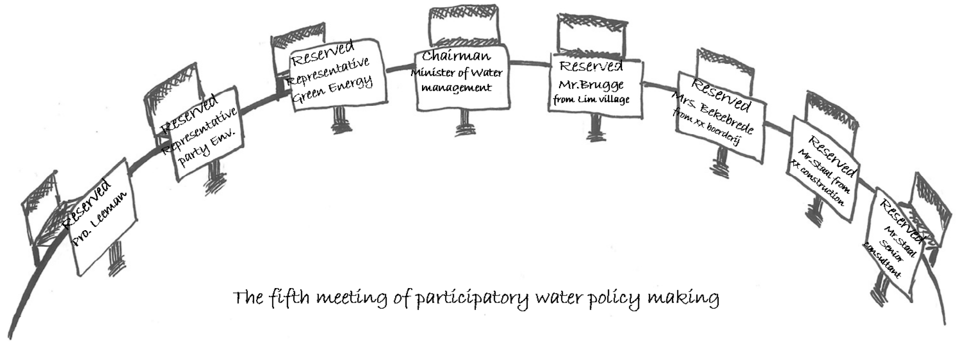
3.4.2.1 Socio-political inclusion

In the context of Western societies, *socio-political inclusion* is highly valued and has been identified as one of the EU's grand challenges. Regardless of race, gender, social class or region, people should have an equal chance to access formal education and the labour market, to join clubs and organizations, and to be heard and be politically active. If a group of people has a higher risk of falling overboard, corrective actions are needed to include and empower them. In Western policymaking, public and stakeholder participation is highly valued: the common way of public policymaking is to get all stakeholders around the table (see Figure 3.7), at least that is how it will be communicated (Fischer, 2003). The reasons are often very strategic: if the minimal requirements of public and stakeholder consultations – for instance in public hearings – have not been met, legal barriers are likely to show up further on. And policymakers might miss out on some crucial information or pieces of the puzzle. We call this *inclusive participation* and represent it as: $a + b + c = (a,b,c)$ (see Table 3.1).

Giving everybody a place at the table does not solve everything, especially if policymakers do not listen, or listen more to some than to others, or some people at the table are lying in order to get their way. The discourse that takes place at the table therefore should also be truthful, authoritative and sincere. We should assume that someone speaks the truth, that he/she is authorized to make the claims and that he/she is sincere. Habermas's theory of communicative action gives the fundamental rules for an 'ideal speech situation' (Habermas, 1984, 1985):

(1) Every subject with the competence to speak and act is allowed to take part in a discourse.
(2) Everyone is allowed to question any assertion whatever.
(3) Everyone is allowed to introduce any assertion whatever into the discourse.
(4) Everyone is allowed to express their attitudes, desires and needs.
(5) No speaker may be prevented, by internal or external coercion, from exercising his rights as laid down in (1) and (2).

Figure 3.7 A place at the table for everybody

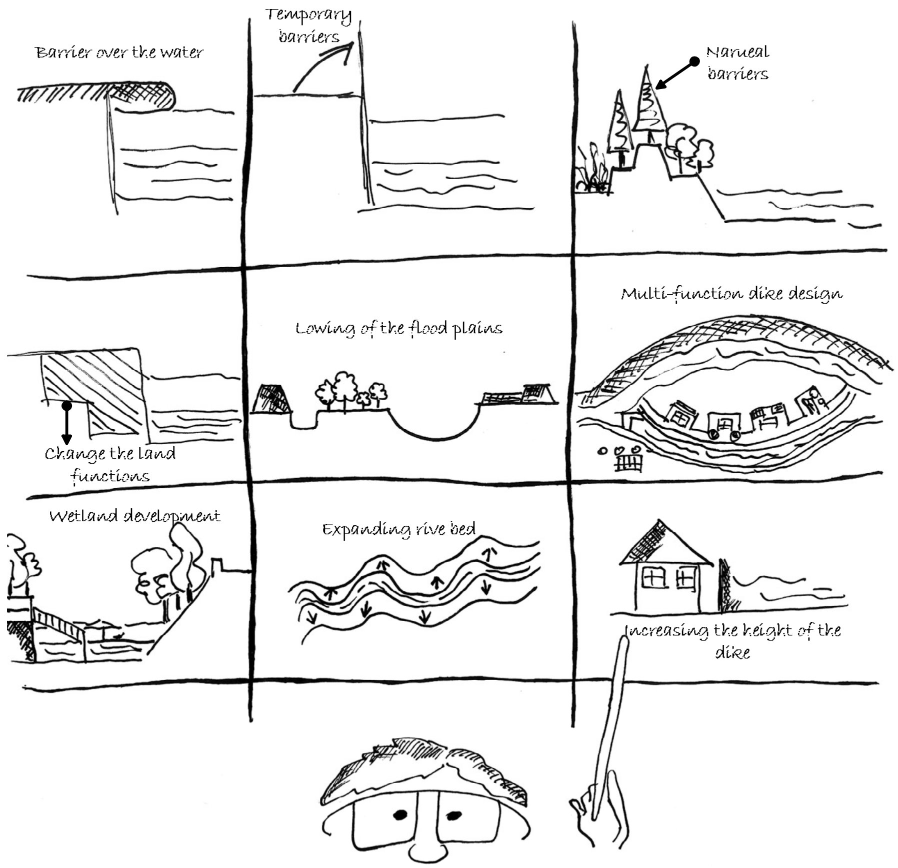


Give everybody a place at the table

3.4.2.2 NTP inclusion

Inclusion is a way not only to get all stakeholders around the table, but also to get all relevant information, data, etc. on the table. The silo'ing of knowledge and policy problems into disciplines, departments, sectors, etc. leads to the fragmentation of information, data, evidence, facts, tools, methods, etc. Especially in the case of a big problem, these need to be put back together again. This may become a matter of big data collection, big data storage and big analysis, both literally and figuratively. Contemporary ICT systems, the Internet and rapid advancements in the field of modelling and simulation provide an unlimited number of ways to collect and analyse data for policy analysis. We can also include more data about more problems that have so far been only loosely coupled. In other words, it is not only the extensiveness of the data but also their scope. In integrated policymaking, we include multiple policy domains, sectors and levels into one system (see Figure 3.8). In integrated policy analysis, we can let transport models communicate with water models with geographical information systems with environmental models, etc. We call this *inclusive modelling-simulation* and represent it as: *1 + 1 + 1 = 3* (see Table 3.1).

Figure 3.8 Inclusion



3.4.2.3 STC Inclusion

The ultimate goal of socio-technical integration, however, is the integration of modelling technology and participatory approach. We call this *inclusive participatory modelling*, represented as *(1 + 1) * (a + b) = 2(a,b)* (see Table 3.1).

3.5 Synthesis

Synthesis is based upon the philosophical method called dialectics, whose origins lie in the philosophies of Socrates, Hegel[13] and Marx. In *dialectics*, two contradictory positions – thesis and antithesis – are reconciled into an overarching position, called synthesis.[14] Central to the method of dialectics is negation and contradiction. It may very well be that the original thesis and antithesis are both right and/or wrong, but the negation of both thesis and antithesis leads to a transcending unity, the synthesis.[15] The process of dialectics drives the evolution of ideas as well as the ownership of capital and material (Horowitz & Hayes, 1980; Ollman, 2003; Pomeroy & Halewood, 2004; Schaff, 1960). Positions can differ on whether this dialectical process will ever come to a final synthesis – which for Karl Marx and Friedrich Engels would be Communism, for Hegel absolute truth and for Fukuyama 'capitalism' (Fukuyama, 2006). If one accepts the possibility of a final synthesis – which Hegel, Marx, Engels and Fukuyama do – the final synthesis, where no negation is possible, equals 'truth'. But it might very well be that such final synthesis will never happen, and that the dialectical process itself is more important than the final synthesis (Barton & Haslett, 2007; Ritchey, 1991). The transcension of thesis and antithesis into an unknown synthesis is visualized in Figure 3.9.

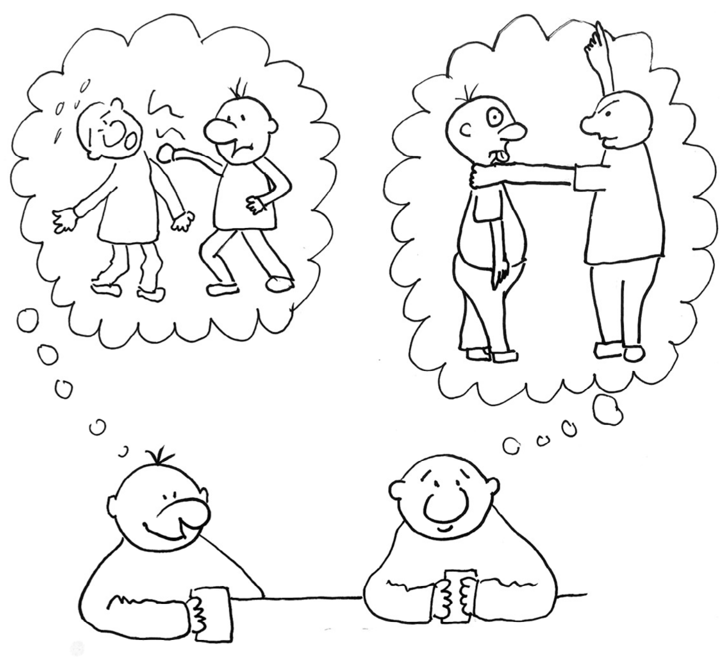
Synthesis is not a good condition of the system that is produced by the harmonized, balanced union of two opposites; even if it were, it would not continue to exist, albeit not without the two opposites; nor is it produced by the inclusion of more knowledge or more stakeholders. Instead, synthesis consists in the elements themselves and how the different attributes of the thesis and antithesis confront each other and create something new out of the confrontation. It is important to realize that in synthesis, the opposite elements do not balance each other to make the whole duality in good condition; rather, they actively interact and change the system's condition until the system reaches a new stage. From my point of view, of the three faces of integration, only synthesis reaches a complexity level where 1 + 1 > 2. It explains how society evolves through the conflict between opposites, not through the harmony among them. The deeper challenge of socio-technical integration is to use, guide and control conflicts between thesis and antithesis into something better. Although the philosophical argument of class struggle does not sound too manageable, it can be used to see how disagreement can be guided with intellectual intervention to create innovation and creativity.

The difference in nature is the intrinsic energy to stimulate innovation and creativity. The argument is: the opposite interests and opinions of other participants can cause uncomfortable feelings and negative responses; the same force generated from such a situation can also drive the participants to create something new (e.g. a new idea or a new perspective), if it can be guided with positive emotions in a safe environment. The participants in such an environment can deconstruct their original claims and re-identify their original frames from the confrontation of difference and disagreement (Cowley, Moutinho, Bateman, & Oliveira, 2011; Koppenjan & Klijn, 2004; Raadgever, Mostert, Kranz, Interwies, & Timmerman, 2008; Raadgever, 2009; Ravetz, 2004; Schrage, 2000b; Senge, 2006; Toth, 1995; van de Kerkhof, 2004; van Dijck, 2003).

Figure 3.9 Synthesis

The context of social, political and cultural characteristics of the policy problem decides which face of socio-technical integration will be the process in policymaking. For example, if the politicians get more credit for solving the problem at hand, an inclusion face will be quickly shown to work out the solution. When social democracy is deeply embedded in the social structure, public policymaking will be very carefully involving all the necessary stakeholders in the process. These two faces can be actually found in most of the cases for integrated policy analysis and policymaking. They can be regarded as the 'safe' ways to innovate in order deal with complex problems and arrange the social consequence. However, they are not the real innovation but more an instrumental or strategic arrangement of social conflicts. That is why in the socio-technical integration literature, social experiments and trial & error are argued as the methods towards innovation. On the one hand, its intellectual challenge draws attention to research and political agenda, on the other hand, the task to arrange suitable tools and process to present and guide conflicts is much more difficult to achieve. We distinguish here, three different types of synthesis: *complexity simulation* represented as $1 + 1 > 2$, *complexity play* represented as $a + b > (a, b)$ and *serious game-play* (simulation-gaming or similar terms, as in Table 1.1) represented as $(1 + 1) * (a + b) > 2\ (Y)$ (see Table 3.1). Figure 3.10 illustrates the face of synthesis in modern society.

Figure 3.10 Synthesis in modern society



3.6 Conclusion and discussion

In this chapter, I have extended the embryonic model on socio-technical complexity (Figure 1.1) by focussing on the dialectic nature of the science–policy interface. I have subsequently demonstrated that there are three ways of integration to bring together the duality: balance, inclusion and synthesis.

3.6.1 Short answers

(1) *Why are the WoS and WoP like thesis and antithesis?* There are many forms and causes of boundary tensions between the World of Science (WoS) and the World of Politics (WoP).

(2) *How can synthesis be created between the two worlds?* There are three strategies for integration: 1) *Balance* implies that the formal and natural language are alternated, in either a synchronous or a sequential fashion; 2) *Inclusion* implies that two or more representations in a formal language are integrated (i.e. inclusive modelling-simulation) or that two or more representations in the natural language are integrated (i.e. inclusive participation), or that inclusive modelling and inclusive participation are combined (i.e. inclusive participatory modelling-simulation); 3) *Synthesis* implies the deliberative, designed, guided confrontation of disputed knowledge, values, norms and power in complexity simulation, complexity play and serious game-play.

3.6.2 Discussion

The stronger the level of *integration the* more policy analysis will start to become – to feel, to look – like game play. The synthesis between NTP and SP complexity is the realm where serious game play truly emerges: 1) the representation of NTP complexity as in a complexity models and simulations; 2) the representation of SP as in complexity play, role-play, etc.; and 3) the representation of STC as in serious game-play. I have also argued that all three can lead to a partially integrated approach of policy analysis, and all forms will have an element of playfulness or game. A summary of the findings is presented in Table 3.1.

Socio-technical integration can be categorized into three dimensions: 1) a socio-political dimension, 2) a technical analytical dimension and 3) the socio-political + technical analytical dimension. Integration on the socio-political dimension brings together the many stakeholders and socio-political networks. This allows for the:

- Integration of the various opinions, preference, values, etc. of stakeholders.
- Integration of different sources of information (e.g. laymen, local stakeholder, experts, scientists).
- Integration of different forms of information (formal and informal).
- Integration of different aspects of problem definition (water safety, economic growth, local development, environmental value, ecological situation).
- Integration of short-term and long-term interests.
- Integration of different levels of authority (local, regional, national, transnational, etc.).

Table 3.1 Finding the synthesis

	NTP complexity	STC complexity	SP complexity
Balance		Talking about the problem in formal and natural language Thinking about the problem with the left and right side of the brain	
Representation		1 / a	
Inclusion	Inclusive mod-sim	Inclusive participatory mod-sim	Inclusive participation
Representation	1 + 1 + 1 = 3	(1 + 1) * (a + b) = 2(a,b)	a + b + c = (a,b,c)
Synthesis	Complexity mod-sim	"Serious game" "Simulation game"	Complexity play
Representation	1 + 1 > 2	1 + 1 * (a + b) > 2 (Y)	a + b > (a,b)

Integration on a technical analytical dimension brings the many variables, data, information and analytical approaches together, which allows for:

- Integrated scientific disciplines (physical–chemical–ecological–computer science).
- Integrated, large scale models (climate–water–transport–land use models).
- Integrated databases (national–international–global).
- Advanced analytical, control capacity (prediction, accuracy, low-uncertainty, technical complexity, automation, long-term effects).
- Advanced design forms (3D, visualization, simulated reality, animation, agent-based models).

Integration on the socio-political and the technical analytical dimension aims to achieve the purpose of integration on both dimensions, which means:

- Integration of the analytical process (research, analysis), the design process and the decision-making process.
- Integration of the strategies and tools from both dimensions (hard tools and soft tools).
- Room for all forms and sources of knowledge, analysis and social values, and preferences.
- Integration of the process and outcome from participatory and modelling approach.

My supposition is that in all the cells in Table 3.1, integrated policy analysis can become 'like game play' but with specifications that still need to be defined (Chapter 5). The stronger the level of integration, the more policy analysis will start to become – to feel, to look – like game play. And the stronger the level of play, the more policy analysis can start to produce innovation. Some simulation games or serious games, for example, are very playful representations of inclusive participatory modelling-simulation. The synthesis between NTP and SP complexity is the realm where serious game play truly emerges: 1) the representation of NTP complexity as in game theory, system dynamics simulations and agent-based models; 2) the representation of SP complexity as in participatory play, role play, etc.; and 3) the representation of STC as in serious game play or simulation-games (or other preferred notion).

3.6.3 Continuation

Before I continue my theoretical storyline by examining what precisely makes integrated policy analysis become like game play, I will first continue my empirical story line. In the following chapter (When Two Worlds Meet…), I present a study into what happens when the WoS and the WoP in China and the Netherlands interact and how MSG plays a role.

4 When Two Worlds Meet…

> Nothing is softer or more flexible than water, yet nothing can resist it. *Lao Tzu* (Chinese philosopher, 6 century BC)

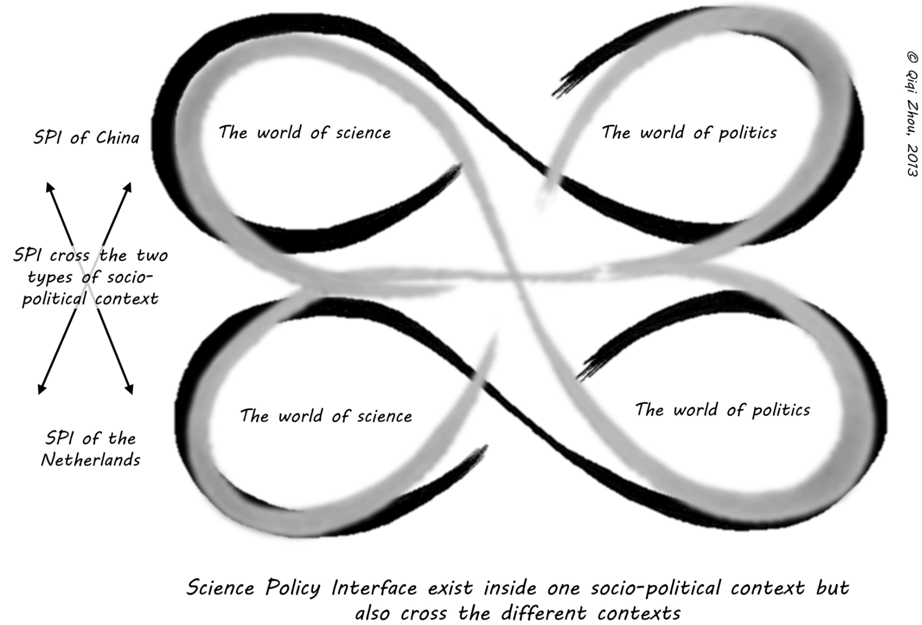
4.1 Introduction

4.1.1 Empirical questions

In Chapter 2, I discussed socio-technical complexity in marine spatial planning (MSP). I picked up the theoretical story again in Chapter 3, by investigating the tensions at the *science–policy interface* (SPI). I concluded that there are three ways to form integrated policymaking and analysis (balance, inclusion and synthesis) and argued that integrated methods (IM) become game-like. In this chapter, I introduce the second part of the empirical study – integrated water management (IWM) – which takes the discussion and conceptual model on integrated policy analysis a step further.

The title of this chapter – 'When Two Worlds Meet…' – refers to the world of science (WoS) and the world of politics (WoP). It also refers to two countries with rather different policy regimes (institutions, cultures, procedures, etc.): the Netherlands and China. In recent years, there has been increasing cooperation between the Netherlands and China on the topic of IWM. University researchers from both countries cooperate in projects to develop IWM approaches, methods and tools through the sponsorship of national scientific institutes, such as *NWO* (Nederlandse Organisatie voor Wetenschappelijk Onderzoek) and *KNAW* (Koninklijke Nederlands Akademie van Wetenschappen). And vice versa, there is sponsorship from the Chinese government and science foundations to cooperate with the Netherlands. As a result, government officials, scientists, modellers and consultants in China and the Netherlands visit each other regularly as part of joint projects on IWM. Furthermore, Dutch universities, engineering and consulting companies are increasingly contracted to advise on, design and support planning processes in China. Under these conditions, the SPI becomes cross-boundary because Dutch scientists and experts interact with Chinese policymakers and experts, as portrayed in Figure 4.1. The figure visualizes the WoS and the WoP of two different countries when they interact. Furthermore, we can see what happens at the SPI when different policy regimes influence water management and the use of integrated methods.

Figure 4.1 Cross-boundary SPI



IWM in the Netherlands is fairly well developed, researched and described. China is still on a threshold and is looking for suitable arrangements. In the context of the Netherlands–China cooperation, I have often witnessed how Dutch policymakers, policy analysts and scientists advocate and even try to sell an integrated approach to water management to their Chinese counterparts. Methods like integrated modelling, interactive simulation, participatory approaches and serious gaming (SG) come almost automatically with the IWM approach. The WoS in China is quite familiar with computer simulation in water management, for instance for the design and control of infrastructures, like the Three Gorges Dam. Especially in the rapidly developing urban areas of China – the Shenzhen, Hong Kong, Shanghai and Beijing regions – both the science and the practice of urban planning, including the use of urban planning tools, are at a high level. The whole idea of integrated planning and integrated methods (IM) as discussed in Table 3.1, however, is quite new to China. There is definitely interest in and fascination with such approaches and methods, but the potential use for policymaking and planning has far-reaching consequences for the SPI. It raises some fundamental questions, namely: what forms of expertise and knowledge, and whose values and interests, are policymakers and scientists willing to consider for IWM and IM?

By and large, Chinese authorities and policymakers attach high value to being 'scientific', 'modern' and 'evidence-based'; whereas in China notions like stakeholder participation have meanings that are quite different from the meanings they have in Europe or the USA. When Western policymakers and policy analysts try to sell or use their tools in China, it can cause great confusion, even scepticism – and most Western policymakers and analysts are unaware of this. To understand socio-technical integration in a national and cross-national context, the black and grey parts of the conceptual model presented in Figure 4.1 need to be carefully analysed. This means that we need to consider not only the tensions at the SPI within one and the same planning regime (the black part of the model), but also the tensions between and across planning regimes (the grey part of the model) (Yoshida, 2008). The driving questions in this chapter therefore are:

- How do Dutch and Chinese scientists, modellers and policymakers frame IWM and IM?
- To what extend are there frames similar or different? And how do they contribute to possible integration at the SPI?

4.1.2 Outline

In section 4.3, I briefly discuss the concept of integrated water management (IWM) and why IWM compensates for the shortcomings of traditional water management for socio-technical complexity. In section 4.4, I analyse the socio-technical complexity of water management in China, and in section 4.5 I do the same for the Netherlands. For each country, relevant events are discussed to illustrate socio-technical complexity at the SPI. From section 4.5 onwards, I present the results of structured interviews with policymakers, model experts and scientists on IWM in the Netherlands and China. The interviews were held with 33 respondents in the Netherlands and 22 in China. For the interviews, I used Q methodology – a card sorting technique that allows the researcher to reconstruct frames and discourses around a main issue through factor analysis.[16] In the conclusion, I discuss and analyse the cross-boundary interactions at the SPI (the grey part of the model in Figure 4.1). What happens when Dutch experts on integrated water management advise Chinese policymakers?

4.2 Integrated water management

The main social functions of water include the allocation of water resources to satisfy the multiple requirements of water demand, water supply and water safety. Water management refers to the whole complex of technologies and institutions that manage these social functions. A water management regime is characterized by several structural dimensions: management paradigm, including system approach and intervention strategy; governance, including institutions, policy arenas and actors network; scales of operation vertically (local, regional and national) and horizontally (sectoral); information system and technological infrastructure; and risk management and the consideration of environmental factors.

Water management in most countries is gradually formed for the development of massive infrastructure. Its main characteristics can be described as technocratic, centralized, hierarchical, fragmented, quantitative, etc. It is therefore regarded as a 'prediction and control' regime (Pahl-Wostl, 2006; van der Brugge & van der Raak, 2007). Such a management system has been criticized for its many shortcomings for policy-making of socio-technical complexity. In general, it lacks the flexibility to deal with changes: the centralized decision structure does not encourage learning; fragmented information and understanding becomes an obstacle to new insights; it is difficult or even impossible to adjust expensive, large-scale infrastructures; and the quantitative approach alone is limited for the analysis of uncertainty.

A transition is required to make water management more interactive, more integrated and more adaptive to the induced change of socio-technical complexity. Integrated water management (IWM) is characterized as an 'integrated, adaptive regime' in contrast to the 'prediction and control' regime. It is typified by a complex system approach; self-organization and learning; polycentric, participatory governance structure; interactive and integrated information system, analysis and policy implementation; etc. (Biswas, 2004; Bressers & Kuks, 2004; Castelletti & Soncini-Sessa, 2006, 2007; Global Water Partnership (GWP), 2000; Wesselink, Vriend, & Krol, 2008; Wesselink, 2007; M. Wiering & Immink, 2006; Woltjer & Al, 2007; World Water Council, 2000). Table 4.1 compares the typical characteristics of the conventional water management regime and integrated water management regime[17].

The comparison of the two water management regimes in Table 4.1 makes it clear what integration we expect to achieve and for what reasons. The transition towards IWM is:

> .. a 'soft path' that complements centralized physical infrastructure with lower cost community-scale systems, decentralized and open decision-making, water markets and equitable pricing, application of efficient technology, and environmental protection. (Gleick, 2003)

Learning is regarded as the key internal logic to induce these changes. Notions like integrated, evidence-based, adaptive, participatory and collaborative are rhetorically powerful for learning. But the integration approach is still local and can vary from country to country.

> Each country should develop its own IWRM approach depending on its capacity and problems at hand […] it should be custom-made on the basis of the country's priority objectives, capacity and resources endowment (Yoshida, 2008).

Table 4.1 The conventional and integrated water management regimes

	Conventional water management regime 'Prediction and control'	Integrated water management regime (IWM) 'Integrated, adaptive'
Management paradigm	Prediction and control based on a mechanistic systems approach	Learning and self-organization based on a complex systems approach
Governance	Centralized, hierarchical, narrow stakeholder participation	Polycentric, horizontal, broad stakeholder participation
Sectoral integration	Sectors separately analysed, resulting in policy conflicts and emergent chronic problems	Cross-sectoral analysis identifies emergent problems and integrates policy implementation
Scale of analysis and operation	Trans-boundary problems emerge when river sub-basins are the exclusive scale of analysis and management	Trans-boundary issues addressed by multiple scales of analysis and management
Information management	Understanding fragmented by gaps and lack of integration of information sources that are proprietary	Comprehensive understanding achieved by open, shared information sources that fill gaps and facilitate integration
Infrastructure	Massive, centralized infrastructure, single sources of design, power delivery	Appropriate scale, decentralized, diverse sources of design, power delivery
Finance and risk	Financial resources concentrated in structural protection (sunk costs)	Financial resources diversified using a broad set of private and public financial instruments
Environmental factors	Quantifiable variables such as BOD/COD or nitrate concentrations that can be measured easily	Qualitative and quantitative indicators of whole system states and ecosystem services

Source: Pahl-Wostl (2007)

Applications of IWM can focus on one specific subsystem or function in an integrated way: for example, we have integrated water resource management (IWRM), integrated coastal zone management (ICZM), integrated flood management (IFM) and integrated river basin management (IRBM). The underlying analysis is very similar to that of marine spatial planning, especially when IWM is organized internationally (e.g. in international river basin management). So on the one hand, we see that water management in China is mainly a 'prediction and control regime'. The extent to which water management in China will be integrated depends on the socioeconomic, cultural, technological and expertise results in the Chinese context of policymaking and SPI. On the other hand, the boundary blurs when, for instance, Western water policy analysts and engineers are brought in to implement integrated river basin management and IM for the Mekong River, which arises in China, runs through Laos and Myanmar, has its delta in Thailand and Cambodia, and flows into the sea in Vietnam.

4.3 My country and my people[18]

Many big rivers run through China. There are seven major domestic rivers – such as the Yellow River, the Changjiang River (or the Yangtze) and the Pearl River – and several international rivers, such as the Mekong and the Amur. Among them, the Changjiang and the Amur are well known as the world's fourth and seventh longest rivers, respectively. Nowadays, many of these rivers face the threat of water shortage and water pollution; at the same time, however, they cause regular, serious flooding. All these problems are major threats that need to be handled by water management.

Considering the enormous size and diversity of China, dealing with these problems is a staggeringly complex task for the government. And the socio-technical complexity of these problems increases with the rapid urbanization: whereas the modern society of China requires a much higher standard of water management to safeguard living standards, rapid urbanization and unplanned land use interconnect the water problems with various social aspects. Water management in China is no longer a matter of water engineering: it is now a trans-boundary and trans-jurisdictional issue (Turner & Otsuka, 2005; Y. Wang, 2003, 2005). In this section, I introduce the story of flood management and the socio-technical complexity of controlling floods.

4.3.1 NTP complexity

In the summer, there is heavy rainfall in the middle and downstream areas of the big rivers, making around 11 per cent of the regions prone to flooding (Y. Wang, 2005). These regions are in the heart of China, where there are more than 400 major cities, including Beijing, Shanghai and Ha'erbing. Over 60 per cent of the population live in these cities; between them, they produce more than two thirds of the country's GDP (MWR, 2012). Major river flooding has been a serious problem here throughout China's long history. For example, the widespread flooding in the Yangtze and Huai river basins in 1931 affected 51 million people and took the lives of more than 400,000. Then in 1954, another 40,000 lost their lives in a large flood (X. Cheng, 2012). In cities like Harbin, monuments have been erected in squares and on riverfronts to commemorate the many lives taken by river flooding.

As a logical response, the Chinese strategy has always been to build large infrastructures and water works to contain the rivers, and to enact top-down legislation on flood control. Especially after the establishment of the People's Republic of China in 1949, a huge number of large and small dams, dikes, reservoirs and floodgates were built. By the end of the 20th century, around 245,000 km of dikes had been newly built or strengthened, and 84,000 large, medium and small reservoirs and around 100 inundation plains had been developed. These water infrastructures have successfully reduced the number of casualties and the economic loss caused by seasonal river flooding (Zhang & Wen, 2001). However, new problems of flooding have emerged. I come back to that below.

The government of this enormous, rapidly developing country needs to deal with many socioeconomic challenges simultaneously; at the same time, water shortages are becoming more serious in northern China. In order to deal with these urgent problems, the Chinese government prioritizes the supply side and energy planning in water management. This leads to the development of many extremely huge, costly and socio-environmental impactive hydroelectricity dams and large-scale infrastructures, such as the Three Gorges Dam and the South–North water transfer project, to provide the water resources and energy production needed to sustain economic growth and industrialization.

Unfortunately, these gigantic projects have had severe consequences for communities, ecology and hydrology. Natural water systems have been fundamentally changed, leading to erosion on mountain slopes in large areas. Large communities need to be relocated, which has unimaginable social and ecological consequences. Water pollution and environmental degradation in the water system is already a serious problem due to the ill-conceived economic development derived from the political period of Mao Zedong and the remarkable economic growth during the economic reform of the last two decades. Now with the continuous impact of the big projects on the river system, many environmental scientists and experts are worried that the situation will lead to an increasing risk of water disasters and the degradation of the quality of the living environment.

Many scientific organizations and NGOs have therefore protested in the recent past against the planning and construction of these dams. The Three Gorges Dam, for example, was the outcome of a contentious political process that took almost a century. Contrary to common perceptions, many national and international groups were involved in the political discussion and policy analysis, not only from the engineering side, but also from the socio-political side. In 1992, the 7th National People's Congress decided to give the construction of the dam the go-ahead. The construction of the dam was completed in 15 years (People's Daily, 2006). Despite the reputed engineering mistakes in the design and construction of the dam, and the negative ecological consequences, such giant infrastructures cannot be realized without proper science and decision analysis. The completion of the Three Gorges Dam therefore illustrates the capacity of the Chinese government to plan and build the world's largest hydrological infrastructure with its own, non-Western tools for and approach to policy analysis and planning. However, the government and people of China are now facing new flood management issues as a result of climate change, which is thought to play a critical role in the increasing number of flood and water disasters occurring at unexpected times and in unexpected locations, such as what happened very recently in Beijing.

4.3.2 Inundation in Beijing

One weekend in the summer of 2012, Beijing experienced unexpectedly heavy rainfall. Rainfall had never been so heavy and concentrated: a 16-hour downpour brought an average of 179 mm of precipitation, with peaks as high as 541 mm. Beijing and neighbouring areas were inundated, causing power blackouts and traffic paralysis. Many roads in the city and parts of the Beijing–Hong Kong–Macau expressway were turned into lakes. In the suburbs around Beijing, torrents from small rivers and canals flooded villages and washed away people and their belongings. It was an unbelievable disaster. More than 1.9 million people were affected and 79 lost their lives; of the latter, many drowned in submerged traffic tunnels (ITalk, 2012; People's Daily, 2012). The northern part of China always used to suffer from droughts. Due to climate change, however, rainfall there has become extreme: since 2008, it has been receiving almost as much rainfall as subtropical southern China (Y. Cheng, 2012).

Nowadays, rainfall in densely populated urban areas is a more serious problem than river flooding. In recent decades, more than 250 cities have suffered markedly from inundation. Two thirds of the total damage caused by flooding is damage to industry and infrastructures in urban areas, far more than the damage to agriculture, fishery, etc. caused by river flooding (X. Cheng, 2012). Shan Chunchang, vice director of the Emergency Management Department of the State Council, points out that although flood control has been significantly improved, the focus of the management still lies too heavily on the construction of dams (Y. Cheng, 2012). According to Cheng Weizhong, former general engineer of Chengdu Water Resources, most cities are now less flood-proof than they were in 1980s (People's Daily, 2006).The failure to take water into account in China's huge urbanization projects causes major problems. The recent frequent floods in urban areas and the inability of modern metropolises to deal with flood events have increasingly led to politicians, experts and managers being held accountable for such disasters. They have also raised the question how a long-term, sustainable plan can be made to merge urban development and water management into an integrated theme.

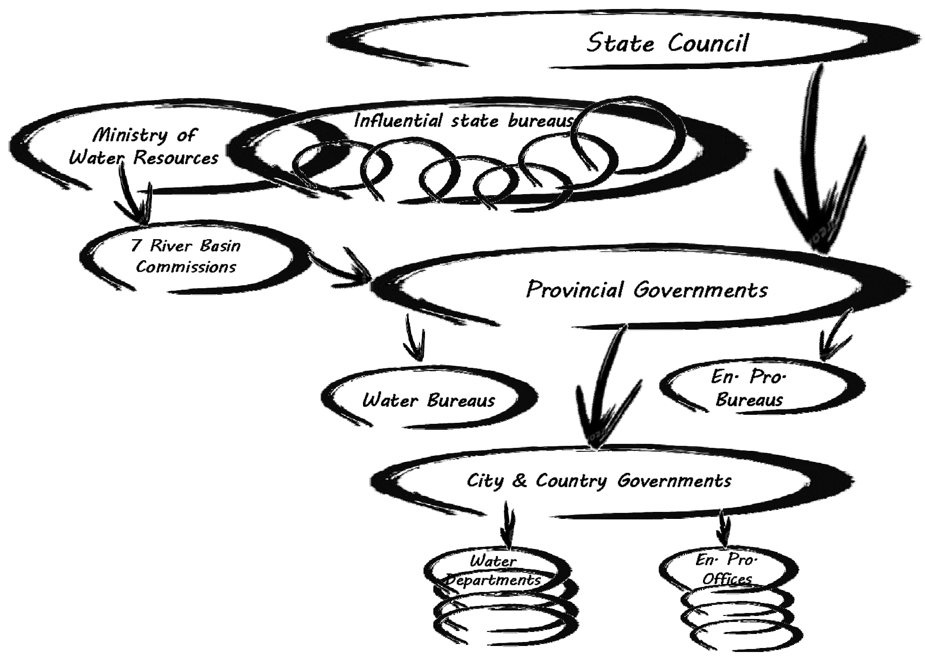
4.3.3 SP complexity

The Chinese government's very strong and very centralized power is rooted in thousands of years of dynastic rule. The government is hierarchical and top-down. The Ministry of Water Resources (MWR) represents water management at the highest level. In addition to the MWR, eight national bureaus under the State Council and independent of MWR have an influence on water policymaking; these bureaus include the State Electric Power Company, Ministry of Environmental Protection Administration, State Forest Bureau, Ministry of Transportation and Ministry of Health. Their representation shows the importance of producing hydroelectricity, environmental protection, public health and crisis management involved in water and flood management.

At the subnational level, the government implements a river basin system as the management structure. Seven major river basin commissions (RBCs) are responsible for implementing water policies in the big river basins. The RBCs coordinate all the relevant water management in the river basin area, such as flood and drought protection, and mediate in water disputes (X. Cheng, 2012; Y. Wang, 2005; Zhang & Wen, 2001). They are principally the arms of the MWR operating water management at the regional level. However, since the big rivers flow through several provinces, water management in the river basins is actually carried out quite separately by provincial, municipal and many prefecture governments through their own water bureaus. The relationships involved in such multilevel water governance are very complicated. For example, the local water bureaus are principally the operational institutes of the MWR for technical advice and the implementation of water laws. The actual communication between the MWR and local water bureaus, however, is very limited: the local water bureaus report their work to their local governments rather than directly to the MWR. Figure 4.2 shows the structure of the water management in China.

Thus, water governance in China is very fragmented. This is an obstacle to the promotion of innovative, integrated strategies in the practice of water management, because power, resources, knowledge and interests are distributed very unevenly at the different levels of water governance (S. Lee, 2006). At the national level, river flood management is the core theme due not only to its major social and economic impact, but also to the interest in combining the management strategy for national hydroelectricity development. Between 1958 and 1988, the MWR was reformed two times to establish the Ministry of Water Resources and Electric Power (MWREP). The MWR, the RBC and local governments are united in their interest in building dams for river flood control and energy production.

Figure 4.2 Governance structure of China's water management



Source: based on Lee (2006, p.14)

4.3.4 Three Gorges Dam

The decision process of the Three Gorges Dam demonstrates the science–policy interfaces (SPIs) involved at the higher level of water and flood management. The national bureaus MWREP, Ministry of Science and Technology (MST) and Chinese People's Political Consultative Committee (CPPCC) are the main parties in the policy process. Regionally, the Changjiang River Basin Commission and Chongqing municipality (where the project is located) are involved. The main disagreement in this case was on the part of the MWREP and the MST. These two ministries can be regarded as the representatives of science, and at the same time their political influence is quite similar. Water experts and scientists in these two ministries had very opposite opinions on whether or not to build the dam. The debates between the two ministries lasted for quite a long time and delayed the central government's decision on building the dam.

In the end, the policy problem was settled by the centralized political power. The central government gave the power to the MWREP, the main advocator of building the dam, to make the final round of policy analysis (Guo, 2011). The consequence of this decision was quite obvious. The result of the final policy analysis showed that building the dam would have ‘more benefits than disadvantages’ and ‘it is better to build it as soon as possible’ (Guo, 2011; Liblog, 2008; Qian, 2006). Expertise is used to serve the desired decision of the national government. It can suggest such conclusions: for the critical decisions at the national level, science plays an important role for policy analysis. It increases both the rationality of decision making and the complexity of policy process. The central government is willing to incorporate the scientific evidence and technology in its decision making, but will take over when a decision needs to be made. On the other hand, social disagreement and stakeholders’ conflicts are not yet really the complex problem at hand for the central government. Increasing the capacity of water control and management is the main issue and lies heavily on the input of more science and technology.

With the increasing importance of climate change and the occurrence of more unexpected inland inundations, the central government paid more attention to developing IWM. In early 2011, a series of policy documents aimed at accelerating the reform of water management were issued. In 2002, some important modifications were made to China’s Water Law to emphasize integrated river basin management and sustainable water resource management (IGSNR, n.d.; Meijerink & Huitema, 2010; te Boekhorst et al., 2010). The budget allocated by the central government for alternative strategies, such as non-structural measures for early warning of flash floods, is increasing every year. However, the enforcement of the legal requests and the dissemination of knowledge to the lower levels of governance are not very effective. On one hand, local governments lack the power, resources and incentives to implement water innovation, while on the other hand, they are strongly protective of their local industries and jobs, the perks of being in power and their big interest in rapid and sustainable economic growth (Gleick, 2008; He, 2006; Y. Wang, 2005).

Since the big rivers are mostly quite far from the big cities, urban flooding gets very little attention from the national level. In China there is no official legislation on urban flood management. Municipalities must arrange the budget for their own cities. According to media reports, in 2011 RMB 9 million was spent on flood management in Beijing, which is only just over 1per cent of the total administration cost (RMB 864 million) (Sun & Zhao, 2012). The practical work is fragmented among municipalities and local authorities, which are in charge of drainage, environmental protection, electricity supply, communication, etc. The different departments focus on only their own interests during the city development; for example, the city development bureau is in charge of the infrastructure development, but the drainage system is in the hands of the hydraulic department. The lack of budget and the fragmented functions make the enforcement of the design and development of proper drainage system very weak. This situation is even worse in suburban areas, where the management structure is very backward. Water drainage plans are largely ignored during urbanization projects. Data show that in the past 10 years the amount of urban area increased doubly. Many agricultural fields and waterways have been taken over in order to develop commercial buildings. According to Wanghao (China's institute of Water Resources and Hydropower Research), more than 80 per cent of roads in cities like Beijing are covered by impermeable material, for example concrete and asphalt. This seriously obstructs the infiltration of water.

The centralized policy system puts social stakeholders in China – namely ordinary citizens and farmers without specific political or economic powers – at a great distance from governments' policymaking. In the past, there was hardly any voice of disagreement from these groups or people. In the traditional policymaking process, governments in China do not need to consider participation or social interaction as useful methods for tackling their problems. But things are changing. Since the reform and opening-up process, the Chinese government has been more willing to build a modern image of being democratic, free and open-minded. It raises the possibility to consider the Western interactive and participatory methods in the Chinese process of policymaking. So while on the one hand the government announces that China will continue to develop dams as part of its energy and water policy, on the other hand it is willing to take the social and environmental impacts into account through interactions with various NGOs. While it is easy to think of it as a mere lip-service, it can also be seen as an indication that the Chinese government is looking for a more interactive, integrated approach to complex policy problems. From the social perspective, a growing number of Chinese NGOs began to use their knowledge and influence to challenge the environmental and social interests in water projects. The power of Chinese NGOs is growing in the sense that they have delayed several large infrastructures that seem potentially damaging (Gleick, 2008). However, the question how collaborative, integrated planning can be formed through a participatory, interactive approach is still far from being answered.

4.3.5 Integrated approaches and methods

In China, computer simulations are used quite often in research into sustainability. Institutes of water research develop and use advanced simulation models for technical analysis and engineering studies, such as on the interdependency between groundwater levels, water flow, hydrological values, etc. (recent examples can be found in e.g. (Hu et al., 2010; J. Li, Zeng, Wang, & Shen, 2008; Qin, Sun, Zhang, & Zheng, 2010; Xu, Ma, & Ni, 2006). Compared to the rapid development and application of computer modelling, however, interactive approaches and SG are still quite unfamiliar to researchers and policy analysts. A literature review also provides evidence for the lack of experience of SG in China. This is not surprisingly, considering that MSG for policymaking is not yet used very much even in Western countries, where interactive, integrated management regimes are already more or less established. And in China, the hierarchical, control management regime is still dominant.

However, policymaking and management in China are starting to become more modern, and increasing use is being made of modern ICT technology in public policymaking. By 2010, most government departments had established websites to share information with citizens. Online forums are now one of the main ways to obtain the public's opinions. In addition, citizens can acquire information about candidates in the run-up to political elections (Du, Yang, Xu, Harashina & Li, 2010; European Commission: Information Society and Media, 2012; Ren, 2010; Yuhua Wang & Nan, 2011). These activities can be regarded as the early stages of integrated policymaking and approaches. In the world of science, many researchers are starting to pay attention to the use of innovative information technology for interactive policymaking and analysis, and argue that there is a great need for innovation and effectiveness.

4.4 Dutch water managers

Like many regions in Asia (e.g. the Pearl River delta and the Mekong Delta), the Netherlands is a delta, although of a different size. And like Bangladesh, most of the country lies below sea level and a substantial proportion of land has been won from the sea through land reclamation and the building of dikes. If the Netherlands has learned one thing, it is to how to manage water. And the Netherlands is proud to share that knowledge. It is a rather awkward notion that seems to indicate that a man-made, bureaucratic control system – with rules, regulations, institutions, procedures and methods – can contain a highly complex natural system. The question is, what can China learn from Dutch water managers?

4.4.1 NTP complexity

Three of Europe's major rivers flow through the Netherlands and into the North Sea: the Rhine (which originates in Germany), the Meuse (which runs from France through Belgium) and the Scheldt (which flows from Belgium into the far south-western corner of the Netherlands). Each of these rivers branches off, forming a delta in the coastal area of the North Sea. For hundreds of years, the rivers, lakes and canals in the Netherlands were kept under control by water works and an intricate system of sea and river dikes or levees. Flood events were responded to by raising and reinforcing the dikes. For many centuries, flood protection has been a major and everyday concern for water management authorities in Netherlands. In 1953, a storm surge broke through the sea levees and flooded the south-western part of the Netherlands, killing 1,836 people. This disaster triggered the construction of the Delta Works, which now comprise a complex system of dams, sluices, and river and sea levees to hold back the water. This high-tech infrastructure is a major part in the Dutch flood defence system, but has frequently met with opposition.

First of all, the negative consequences – such as like the demolition of houses, and the disappearance of nature and recreational areas – were fiercely opposed. Secondly, environmental and ecological concerns (e.g. water degradation and desalination) were raised. The initial plans for the Eastern Scheldt dam, for instance, would have closed off an entire estuary from the sea. Environmental groups and fishermen raised strong objections until the government found a more integrated solution. The storm surge barrier can now be closed when a storm is approaching, but it remains open under normal conditions to allow seawater into the estuary (Mayer, van der Most, & Bots, 2002; van Schie, 2010). Thirdly, given the effects of climate change, it is better to give some space to the river, that is, to mitigate the effects of flooding rather than trying to prevent flooding by building costly water works. Fourthly, and more recently, it has been argued that flood prevention measures can be 'smart' and 'innovative' by combining them with other spatial functions. Over the years, the above arguments have gradually shifted attention away from top-down, technocratic planning of water works, to adaptive, integrated planning with more consideration for socio-ecological values and smart solutions.

4.4.2 Room for the River

Floods in 1993 and 1995 triggered the policy process of giving space to the rivers. During these floods, the dikes did not collapse but a serious social crisis arose due to the potential risk posed by relying solely on dikes. If they had collapsed, the water would have been up to six metres deep in a large lowland area along the river. In the 1995 flood, around 250,000 people had to be evacuated for more than a week to ensure their safety. The large number of evacuations caused huge economic damage and provoked a lot of intense emotions (Jak & Kok, 2010). In response, the Dutch government decided not only to accelerate the execution of the dike reinforcement, but also to put much emphasis on developing more risk-tolerant, long-term strategies for flood prevention. In 1996, the policy document 'Room for the River' (RfR) was put into effect. The government organized a committee to do policy analysis. The main part of the study was published in 2001 (Klijn et al. 2001). Adaptive, integrated spatial planning is designated as the objective of the RfR project: in order to ensure that the discharge capacity of the river will not cause flooding, extra space should be permanently reserved for the higher water discharge; and at the same time, the RfR measures should improve the environmental quality of the area (Ministry of Transport, Public Works and Water Management, 2006b). The measures that form part of the RfR strategy include:

- Relocating the dikes further inland (the river bed becomes wider, giving the river more room).
- Deepening the rivers and flood plains (the cubic metres gained mean more space for the river).
- The construction of bypasses (river beds or dry river beds that can carry water quickly towards the sea).
- The construction of retention areas (specially designed polders that can flood once every 10–20 years without causing too much damage).

In the second half of the 1990s, the government body responsible for the safety of the river areas, Rijkswaterstaat (Directorate-General for Public Works and Water Management), compiled in consultation with local authorities a list of some 700 potential projects that fit in with this new policy. The idea was to make a further selection from this list. The selected measures are sufficient to protect the Netherlands from high river levels. This eventually resulted in a government memorandum, for which the state secretary was politically responsible. It soon became clear, however, that this selection would not be an easy matter. The process revealed the socio-political complexity in the Dutch water management process.

4.4.3 SP complexity

The selection was difficult for three reasons (Klijn, Dijkman, & Silva, 2001; Zhou, de Bruijn, ten Heuvelhof, & Mayer, 2009a):

- Most of the projects fall into the category of NIMBY ('not in my back yard') projects; that is, projects about which many individuals and administrators would say: 'I'm all for it in principle, but this particular project that is planned in my territory is less desirable.' Municipalities that are located along rivers would prefer not to have dike repositioning that involves relocating residents. Furthermore, the need for retention areas is difficult to explain to those who live or have a business in a polder that is earmarked for transformation into a retention area.
- The timing of the strategy change is difficult to justify. Although it cannot be denied that raising and reinforcing dikes cannot continue indefinitely, not everyone agrees that now is the right time for a change of strategy. Certainly those individuals and administrators who seek to prevent the realization of a NIMBY project in their area will argue that it has not been convincingly demonstrated that RfR is the only strategy at

the present moment. They will argue that the dikes can quite feasibly be raised one more time, and it will be difficult to deny this.

- Rijkswaterstaat had recently lost considerable standing in that part of the country (the Betuwe), where a great many of these measures are needed. It constructed a railway line for freight through the open and rural river landscape there, against the wishes of many individuals and administrators. Local administrators were glad to see the back of Rijkswaterstaat and a new policy from this body would not therefore automatically find support.

The administration of water management in the Netherlands is organized at four levels: the local level (around 400 municipalities), the regional level (around 25 water boards), the provincial level (12 provinces) and the national level (government, Ministry of Infrastructure and Environment, Rijkswaterstaat, etc.).[19] In a traditional structure, water boards (Waterschappen) are powerful players in the water management system. Founded in the 12th century as an early form of collective action by farmers and the nobility to manage the water in their polders, the water boards have evolved into a specialized layer of government with their own elections, politicians, administrators and authorities. Through the centuries they have been manned and equipped with all forms of knowledge and technologies needed to manage the water systems. For a very long time, they operated almost independently of other government sectors (Van Steen & Pellenbarg, 2004). Contemporary water management in the Netherlands is more integrated and interactive in the sense that ecological and spatial criteria are involved as an essential part of water solutions (Bressers, Huitema, & Kuks, 1994; Edelenbos et al., 2009; van der Brugge, 2009). Municipalities, water boards and provinces in the integrated structure are required to work together for integrated plans of water solution. The power and interests involved in the policy process is therefore very diverse and widely distributed.

Stakeholder participation has quite a long history in Dutch policymaking. NGOs, social groups and individuals have fairly strong positions in policy processes. If the involved parties – regional and local administrations, NGOs and individuals – have different interests and even conflicting preferences (as in the case of the RfR project), the policy process becomes a 'dialogue of the deaf' (van Eeten 1999), that is, there are many time-consuming debates among the involved parties.

4.4.4 Integrated approaches and methods

To facilitate the selection of measures in the RfR project, an interactive computer model called the Blokkendoos (Dutch for a 'box of building bricks' for children) was developed to facilitate the participatory policy process. During the selection, around 3,000 copies of the Blokkendoos were distributed to the participants. By 2006, 40 projects had been affirmed by the Upper House of Parliament as the final outcome of the selection. The evaluation afterwards showed that the model was extremely useful to tackle the SP complexity. The feeling that the tool had been used 'to play with' was confirmed by some of the participants.

Interactive, integrated simulations and SG are used increasingly often in contemporary IWM projects. They are regarded as innovative approaches to socio-technical complexity. In another national IWM project in the Netherlands – Leven Met Water (Living With Water) – two interactive simulations are used for collaborative water planning among stakeholders. One of them, the Climate Game, integrates role play and scientific modelling in a computer game. In Chapter 6, I continue my empirical storyline by showing the 'game play' features of the Blokkendoos tool and the Climate Game for integrated policy process.

4.5 Finding the Dutch and Chinese frames

I wanted to find out what, in the different policy contexts, Dutch and Chinese scientists, modellers and policymakers think about integrated water management (IWM) and the usefulness of integrated methods (IM). To do so, I used Q methodology. This method combines surveys and interviews into a card sorting procedure, whereby each participant ranks a number of cards on a scale of -3 to +3. They rank the cards according to their opinion on the importance of the statements written on the cards. After the card sorting process, I asked the participants to explain to me the reasons for such distribution. In the end, I clustered the opinions of all the participants in a number of frames that represent opinions that are similar to each other. In this way, I found some cognitive representation of existing reality and how respondents are related to their frames.

4.5.1 The Dutch frames

Research with Q methodology has been done with a comparatively small number of participants. With this small number of participants it is necessary not only to configure the frames from quantitative evidence, but also to interpret them with rich insights from discussion.[20] In 2009, I used Q methodology with 33 representatives of the world of science and the world of politics in the Netherlands to configure their frames about integrated water management and the role of MSG. From a factor analysis, five frames are distinguished. Each frame shows some special perspectives and discourses about IWM and the role of MSG:

- Frame NL 1: Bureaucratic alignment
- Frame NL 2: Stakeholder interaction

- Frame NL 3: Learning
- Frame NL 4: Uncertainty
- Frame NL 5: Science versus emotions.

I discuss these frames successively. For each discussion, I present the statements that were ranked on this frame. I interpret the frame by first looking at the extremes (+3 or -3). I then use the moderate scores to fill the gaps. The transcripts of the interviews are very influential for the interpretation, and I therefore give a few characteristic quotations for each frame. It should be noted that all respondents in the Netherlands had quite a positive attitude towards the use of simulation games or serious games (SG) for policymaking. Three respondents had 'no trust at all' in SGs and one had a 'little doubt' (see Appendix B, tables B3–B7). None of these respondents was in frame NL 2 or NL 3, which indicates that the trust in SG is perhaps a little higher in these frames.

4.5.1.1 Frame NL 1: Bureaucratic alignment versus learning

Frame NL 1 is represented by eleven respondents (see Appendix B, Table B3). I coded three respondents as belonging to the world of science (consultants), and eight as belonging to the world of politics (national, provincial and local policymakers). Table 4.2 shows the distinguished statements about IWM in this frame.

Table 4.2 Distinguished statements about IWM in frame NL 1

Number	Statement	Ranking
16	Reinforcing levees (dikes) etc. is insufficient to keep the Netherlands safe from flooding in the 21st century.	+3
18	Socioeconomic developments in flood-prone areas should be mitigated through spatial planning and construction regulation.	+3
11	A strong degree of integration of water management and spatial planning at different administrative and spatial levels is crucial for water management.	+3
5	Uncertainty in water management is deepened by a lack of integration among social, political, technological, ecological, economic (etc.) knowledge.	-3
7	Water managers should set more 'social learning' activities on their agenda.	-3
8	A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	0

The statements give a rather clear picture of how the respondents frame the issue of IWM, namely as predominantly a matter of integrating engineering works and infrastructures with spatial planning, regulation and levels of governance. This frame is rather neutral about more central governance, whereas the others are rejected. Furthermore, water management at the different administrative levels of governance should be integrated. At the other extreme, the integration of stakeholders' values and things like collaborative learning and stakeholder participation are most strongly rejected. I therefore label this frame 'Bureaucratic alignment', because it is mainly the administrators and experts who integrate (or should integrate) their expert knowledge and authority. Stakeholder integration is mainly a power play. One interviewee who scored high on frame NL 1 expressed quite honestly why he rejects learning and stakeholder interaction:

> At the national level, the spatial solution has been chosen as the necessary solution to flood management in the future. However, until now the top-down decision is not fully accepted and cooperated with at regional and local levels. According to a project director in a national government sector, there is still resistance and a regional and local tendency to focus again on the dikes. The land use interest is the key issues in the resistance. To deal with these issues you need to have a clear understanding of the power and interest of the stakeholders. It is complicated but you learn how to handle it by experience. For example, people act differently individually than they do as a group. When people in a group are against the spatial solution you brought, it is hard to talk to and convince them. However, if you come in the evening to communicate individually, the chance of negotiation will increase. They will ask you what your offer is. (Interviewee no. 16).

In other words, agreement with stakeholders can better be reached through power, by making deals and by buying people off. Top-down decisions simply need to be sold locally. There is little need for or influence of learning, since stakeholders already know what they do and do not want.

Now, the question should be asked what the role of integrated approaches and methods is. Probably not a lot, except for making package deals and getting things done, preferably behind closed doors. This is reflected in the respondents' framing of MSG in IWM. Five respondents had no experience of MSG; one had, but does not trust it (see appendix B, Table B3). Table 4.3 shows the distinguished statements about MSG presented in this frame (see Table 4.3).

In line with the bureaucratic tendency in this frame and the rejection of things like learning and stakeholder participation, low-tech games and human play are regarded as not very useful. Computer simulation and (3D) visualization are much more preferred.

Table 4.3 Distinguished statements about MSG in frame NL 1

Number	Statement	Ranking
23	The key function of 'policy analysis' is to support the stakeholders' learning process.	-3
31	Policy simulation does not need to be computerized. 'Low-tech' gaming based on human behaviour is also a scientifically proven method for water policy analysis.	-2
43	Playing together in a simulation game increases the stakeholders' willingness to co-operate in the real world.	-2
36	Visualization (e.g. by pictures, animations or 3D graphics) significantly increases the users' understanding of models and simulations.	+3
39	Computer simulations can accommodate poorly with conflicting values and interests of stakeholders in water management and water policy.	-3

The reason for this is nicely illustrated in the following quotations:

> Simulating the richness of social values is impossible because a lot of social values, individual values, are not possible to involve in the model. I do not see the need to develop other measures to help deal with this issue. A spatial solution needs people's property. They have different reasons to refuse to give you their property. For example, one would say that his father had lived there for a very long time. The reasons are all individual ones. How can you explore those through gaming? […] In such an environment the most important issues of integration are network cooperation and visualization technology. Visualization increases the policymakers' understanding of technical analysis and therefore contributes to cooperation. The Blokkendoos model is a good example. The visualization demonstrates very clearly the consequences of the measures. The policymakers can see and understand the different effects of the options. Therefore, they find it is useful. (Interviewee no. 16).
>
> Experience shows that it is very hard to change players' beliefs by playing games. That is especially so when the purpose of gaming is to try to impart information that goes against what they do and practise in their professional work. They often found it fun to spend a couple of hours participating – their boss pays, okay, they deserve a free afternoon because they work hard. However, when they look back at the game, they don't really think they learned something that they want to know more about it or that changed their beliefs. They don't really relate the game to their real-world problem or seriousness. (Interviewee no. 18).
>
> Policymakers look for excuses to not to learn from the game. Gaming is not the thing to change the behaviours of individuals. However, it can be used strategically to show the community the need to make the long-term decision and stimulate the discussion. (Interviewee no. 20).

From the interviews, it becomes clear that in frame NL 1 the bureaucratic process can only be supported with simulation and visualization technology. Think of models that can calculate the consequences of plans, or visualization tools to integrate plans in 3D. Such analyses are powerful for bureaucratic integration and when negotiating with stakeholders. The social value of MSG, however, is deemed irrelevant and impossible in this frame.

4.5.1.2 Frame NL 2: Stakeholder interaction versus technocracy

Nine respondents loaded in frame NL 2 (see appendix B, Table B4). I coded four respondents as belonging to the WoS (researchers, consultants) and five as belonging to the WoP (public policymakers, water managers). Table 4.4 shows the distinguished statements about IWM. I label this frame 'Stakeholder interaction'.

Table 4.4 Distinguished statements about IWM in frame NL 2

Number	Statement	Ranking
22	The key solution to the consequences of climate change lies in active public involvement and stakeholder participation. Societal interaction will provide the most significant contribution to water management and policymaking in the near future.	+3
2	The key problems in water management today are more socio-political than technological-infrastructural in nature.	+2
9	A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+2
11	A strong degree of integration of water management and spatial planning at different administrative and spatial levels is crucial for water management.	+2
18	Socioeconomic developments in flood-prone areas should be mitigated through spatial planning and construction regulations.	0
3	The increasing complexity of society leads to a problematic compartmentalization and fragmentation in water management.	-3
8	A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	-3

This frame relies more strongly than frame NL 1 on a network view of society and policymaking, whereby many stakeholders are and should be involved in water management. Let me try to capture what I believe to be the way of thinking in this frame. Water management problems are more socio-political than technological–infrastructural in nature; solutions should therefore come from stakeholder interaction and public involvement. Fragmentation is not a problem, but the nature of governance. Governance should accommodate the network character of society. The centralization of governance should be strongly rejected (difference from frame NL 1).

Water management in the Netherlands has always been the domain of autonomous water authorities and experts. It is therefore understandable that they are not very interested in liaising with spatial planners and stakeholders. When other actors start to claim their role in water management and planning, it becomes difficult to interact with them. Power, authority and competences are unequally distributed in the interaction between water authorities and stakeholders and other authorities: the region of a water board can be as big as ten municipalities or a province. This can cause a lack of trust and frustrate the cooperation between water boards and municipalities. This needs some time and effort to change, to build enough trust to cooperate. Now, the question should be asked what the role of integrated approaches and methods is. Table 4.5 shows the distinguished statements about MSG in this frame.

Table 4.5 Distinguished statements about MSG in frame NL 2

Number	Statement	Ranking
23	The key function of policy analysis is to support the stakeholders' learning process.	-2
31	Policy simulation does not need to be computerized. Low-tech gaming based on human behaviour is also a scientifically proven method for water policy analysis.	+3
28	The outcomes of computer simulation are generally more authoritative (trustworthy) for water policymakers and water managers than the outcomes of a simulation game with real stakeholders.	-3
42	Simulation gaming can effectively facilitate and support the interaction among stakeholders from different governance sectors.	+3
43	Playing' together in a simulation game increases the stakeholders' willingness to cooperate in the real world.	+3
37	Computer simulations for water management and water policymaking should be easy to use and understand by non-expert users.	-3

As in frame NL 1, the respondents in this frame disagree that the function of policy analysis is to support a learning process. But in contrast to frame NL 1, playing together in an SG is seen to have effects on stakeholders' interaction in the real world. According to frame NL 2, strategic interaction in an SG is a social intervention to further stakeholder interaction, and not a learning process (difference from frame NL 3). Two quotations illustrate how respondents in this frame distinguish SG from computer simulation, that is, they are not comparable. Respondents in this frame seem to prefer the power of games and social interaction to computer simulation:

> Computer simulation and gaming simulation are on different dimensions. Computer simulation is on the vertical dimension, to do technical analysis in depth. Gaming simulation is on the horizontal dimension, to understand the interrelation of different aspects. These two methods are not comparable. It is rare to combine the lateral and the vertical analysis in a game. The decision to use either gaming or simulation depends on the stage of decision making and how many de-

> tails are needed to make the decision. The accurate scientific details are not important for gaming because it is the tool to help exploration and interaction. It is an interface between science and policymaking. The interaction of the interface is necessary because scientific model cannot directly support decision-making. (Interviewee no. 2).

> Gaming should be completely omitted from the field of computer simulation. Gaming is a method to build relationship between real stakeholders, but not to model social processes, to understand how social dynamics are going. Social simulation, such as the multi-agent type of modelling, should be reconceptualized in order to get the real understanding of social integration: the main idea is when you really want to intervene in the social process, like what is going on in water management. And if the simulation of social process is done by engineers, who are really trained to believe that the model of reality is reality, then already this type of measure to deal with social processes should come not first but last, because of the underlying basic attitude, which should be changed. The underlying point of you enforce a kind of approach of controlling social reality, should be changed. (Interviewee no. 25)

4.5.1.3 Frame NL 3: Policy-oriented learning versus stakeholder interaction

Only three respondents loaded in frame NL 3, and I coded all of them as 'water manager'. In contrast to the other frames, these three respondents put significant emphasis on learning, that is, increasing stakeholders' understanding of the complexity of water management. Table 4.6 shows the most distinguished statements about IWM in this frame.

As in frame NL 1, but in contrast to frame NL 2, the three respondents in this frame do not consider problems in water management to be mainly socio-political in nature. From the statements, it also appears that respondents are rather technology-oriented (contrast with frames NL 1 and NL 2), and rejective of stakeholder interaction and network governance. The following quotation illustrates the frame:

> The water management problem is very dependent on the local conditions. Generating the solution needs a lot of local knowledge. Water governance should be more decentralized. In the Netherlands, the surroundings of the local area is really different, both the socio-political issues and the characteristics of the water problem. The solutions must satisfy the needs of local development. For example, agriculture in greenhouses is a typical economic activity in the area around Delft. The policy strategy needs to involve the calculation of the cost and impact of policies on this activity, which is not necessary in the other areas. Central government cannot generate solutions but only make political choices. The practitioners in the local sectors are the experts to get the job done. (Interviewee no. 1).

Table 4.6 Distinguished statements about IWM in frame NL 3

Number	Statement	Ranking
2	The key problems in water management today are more socio-political than technological–infrastructural in nature.	-2
22	The key solution to the consequences of climate change lies in active public involvement and stakeholder participation. Societal interaction will provide the most significant contribution to water management and policymaking in the near future.	-3
16	Reinforcing levees (dikes) etc. is insufficient to keep the Netherlands safe from flooding in the 21st century.	-2
9	A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	-1
11	A strong degree of integration of water management and spatial planning at different administrative and spatial levels is crucial for water management.	-1

The focus on 'learning' in a complex technological setting, rather than stakeholder interaction, seems to be why the respondents consider the combination of computer simulation and stakeholder participation important. SG is valued as a good method for innovative learning in water management. It can be effective to analyse the future, to test policy options in a safe environment, etc. Table 4.7 shows the most distinguished statements about MSG in this frame.

What is interesting is that the respondents strongly disagreed with the statement that gaming increases stakeholders' cooperation in the real world, whereas this statement was strongly valued in frame NL 2. Upon closer inspection, however, this is not so strange. Respondents value SG for their capacity to learn from it, and not as socio-political intervention, as in frame NL 2. I believe that frame NL 3 is present among a small number of experts in water management who have a focus on engineering but are open to social innovation. They believe in interactive simulations and games for learning, but reject the negotiated nonsense and the wheeling and dealing that commonly occur in interactive stakeholder processes:

> I do not believe in the complex integrated model. You can, for example, combine the groundwater model with the surface water model. In such a model you get more parameters that can also be wrong. It will not give more certain results but create more doubt. For instance, models often give incorrect predictions of the water level rise. Simulation games should be used first to explore the possibilities. It can mean a lot at the start of a process to explore each other's views and understand the opportunities and constraints analysis. Computer simulation can be used after a game to analyse the best option. (Interviewee no. 33).

Table 4.7 Distinguished statements about MSG in frame NL 3

Number	Statement	Ranking
20	Methods that combine computer simulation with stakeholder participation are supportive of water management.	+2
29	Rational thinking should always be combined with human emotions in policy analysis for integrated water management.	-2
30	A simulation game with real stakeholders as players is generally more effective to foresee and analyse what can happen in the near future than a computer simulation.	+3
23	The key function of policy analysis is to support the stakeholders' learning process.	+3
24	Most computer models are not flexible enough to deal with complex water problems. Models that can be quickly developed and changed to fit the circumstances are needed.	+3
27	Gaming simulation with real stakeholders as players is a better strategy for the innovative process than using computer simulations in integrated water management.	+2
30	A simulation game with real stakeholders as players is generally more effective to foresee and analyse what can happen in the near future than a computer simulation.	+3
34	Testing various policy options in a safe environment (such as simulation gaming with real stakeholders as players) is crucial to avoid serious consequences of water policymaking to the real world.	+2
43	Playing together in a simulation game increases the stakeholders' willingness to cooperate in the real world.	-3
37	Computer simulations for water management and water policymaking should be easy to use and understand by non-expert users.	-3

4.5.1.4 Frame NL 4: Uncertainty and planning scales

Six respondents loaded in frame NL 4. I coded two respondents as belonging to the WoS (researchers) and four as belonging to the WoP (public policymakers, water manager). Table 4.8 shows the most distinguished statements about IWM in this frame.

Frames NL 4 and NL 2 have in common a strong preference for network governance, cooperation and integrated policymaking among administrative levels. Like frame NL 1, frame NL 4 does not agree that water management problems are more socio-political than technological-infrastructural in nature. The main distinction between frame NL 4 and the other frames lies in the emphasis put upon uncertainty and the interactions between the global and the local system.

Table 4.8 Distinguished statements about IWM in frame NL 4

Number	Statement	Ranking
23	The key problems in water management today are more socio-political than techno-	-1

	logical–infrastructural in nature.	
4	There are significant uncertainties about the local and regional impacts of global climate change.	+3
17	There is a need to collaboratively find local solutions to water problems (flooding, draughts, pollution, etc.).	+2
9	A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+3
11	A strong degree of integration of water management and spatial planning at different administrative and spatial levels is crucial for water management.	+3
12	A strong degree of cooperation among public water management authorities is crucial for water management.	+3

The respondents in frame NL 4 markedly agree that the local and regional impacts of climate change are very uncertain and that this makes integration between planning scales and water management authorities necessary. This becomes clear in the interviews:

> There are a lot of technical uncertainties and they are rarely communicated to policymakers. At the same time, decision makers don't like to take uncertainty into their policy. This brings the risk that we spend a lot of money on analysing the measures, which may not be as useful as we think. More effort should be made to increase the communication of uncertainty to decision makers. In this way, decisions can be made in a more robust and flexible way to deal with uncertain situations, instead of aiming to reach the number that indicates the coming water level, a goal that can be both unrealistic and risky. (Interviewee no. 15).

Respondents in this frame have a strong systems orientation towards policy analysis. They like to see the big picture and the longer term future. In contrast to frame NL 3, they do not attach much value to learning from MSG, but they do seem to approach MSG as a kind of 'integrated assessment' (see Chapters 3 and 5). Table 4.9 shows the most distinguished statements about MSG in this frame.

The respondents are very aware that politicians have a limited capacity to incorporate scientific information in policymaking, and that this is a problem. Enhanced cooperation and communication between the WoS and the WoP is necessary. Three respondents in this frame do not have any experience with SG, and one of them does not trust it. In contrast to frame NL 3, the value of SG as a more innovative strategy for future problems is strongly rejected. Social conflicts can also be addressed with computer simulations.

Table 4.9 Distinguished statements about MSG in frame NL 4

Number	Statement	Ranking
6	A system approach is useful for water management only when it addresses the techno-physical and socio-political aspects in an integrated fashion.	+2
23	The key function of policy analysis is to support the stakeholders' learning process.	-3
27	Simulation gaming with real stakeholders as players is a better strategy for the innovative process than using computer simulations in integrated water management.	-2
30	A simulation game with real stakeholders as players is generally more effective to foresee and analyse what can happen in the near future than a computer simulation.	-2
39	Computer simulations can accommodate poorly with conflicting values and interests of stakeholders in water management and water policy.	-2
36	Visualization (e.g. by pictures, animations or 3D graphics) significantly increases the users' understanding of models and simulations.	+1

Quotations about MSG in frame NL 4:

> Simulation should not be only technical, but also involve socio-political aspects. Computer simulation can shine a light on the conflicts. If you have a clear view on the social conflicts and values you should be able to put them in the computer simulation as well, in graphics or in other forms. But it has not been done very well yet. A lot of experience of technological development has been gained. However, social simulation is very hard because reading the exact interests of stakeholders is difficult. I don't know how far computer simulation can go, but I think technologies for such analysis have improved. But there is a lot of room to improve them further. (Interviewee no. 4)

> I do think it's useful to talk to each other and share information and ideas. But it's only good when you have a good start, already have the information and foundation. For example, the model can show which approach is more promising and do the analysis. In many cases, the information is available. You just need to study more to get it. However, the situation in the Netherlands is that in some areas they really talk too much. They have so many workshops to talk about things that are easier to study by water modelling and analysis. I think they should study more before doing the workshops, do more of the analysis. (Interviewee no. 6)

4.5.1.5 Frame NL 5: Science versus emotions

Four respondents loaded in frame NL 5. I coded three respondents as belonging to the WoS (researchers, consultants) and one as belonging to the WoP (public policymaker). Table 4.10 shows the most distinguished statements about IWM in this frame.

Table 4.10 Distinguished statements about IWM in frame 5

Number	Statement	Ranking
2	The key problems in water management today are more socio-political than techno-logical–infrastructural in nature.	+3
12	A strong degree of cooperation among public water management authorities is crucial for water management.	+3
29	Rational thinking should always be combined with human emotions in policy analysis for integrated water management.	+2
16	Reinforcing levees (dikes) etc. is insufficient to keep the Netherlands safe from flooding in the 21st century.	-3

A somewhat cynical attitude towards the science–policy interface and the value of SG emerges in frame NL 5. Based upon the interviews, it appears that some of the statements were answered with a kind of alternative interpretation (see Quotation 4-8). First, frame NL 5 most strongly believes in 'reinforcing levees' as the solution to keep the Netherlands from flooding. Secondly, and equally strongly, the frame agrees that problems in water management are more socio-political than techno- infrastructural. It becomes clear from the interviews that respondents in this frame believe that the technical solutions are available and that science has provided most of the answers, but that politicians and societal stakeholders do not listen: they should trust water experts to get the job done, but unfortunately emotions and irrationalities play too big a role. It seems that the respondents have come to accept it:

> Science and knowledge generation are not the problem in the current water decision-making process. In the Netherlands a lot of investigations have been made on scientific research for the long-term water management. The result is based on very good investigation and therefore does not need to be doubted. But on the other hand, the lack of communication of management sectors is the big problem in the Netherlands. A lot of failures to make a decision on a development plan happened due to the lack of willingness to cooperate. It is very often that sectors make plans by themselves; there is not so much communication. (Interviewee no. 19)

> Science is no longer taken seriously enough in decision making. Emotion and power dominate the decision-making process. The politicians are not interested in rational evidence. The priority of interest and power determines what will happen. Scientific evidence can help, but it depends on the political situation. It can be easily denied if it does not match the political interest in the problem. We should move back to the situation that the socio-political power does not constrain the technical power (Interviewee no. 11).

So, if this is the case, what is the role of integrated policy analysis and MSG? In the interviews, some respondents indicated that it could be useful to find a balance between science and emotions. But it is not clear whether MSG can help to find a balance. But for the most part, the respondents seem to have mixed feelings about MSG. They disagree strongly that computer simulations are difficult for policy stakeholders to use and understand. They also highlight the importance of visualization to increase policymakers' understanding of models and simulation. Gaming is regarded as useful only for learning, and low-technology games are not scientifically valued (see Table 4.11). From the discussions it seems that gaming is regarded as useful to reflect the human emotions (but not to change them) and it needs the support of technology to gain the trust of players if it tries to simulate the reality (see Quotation 4.9).

Table 4.11 Distinguished statements about MSG in frame NL 5

Number	Statement	ranking
28	The outcomes of computer simulation are generally more authoritative (trustworthy) for water policymakers and water managers than the outcomes of a simulation game with real stakeholders.	-3
31	Policy simulation does not need to be computerized. Low-tech gaming based on human behaviour is also a scientifically proven method for water policy analysis.	-1
33	The process of decision making simulated by human players in a gaming environment is generally more useful for learning than for real policy analysis.	-2
36	Visualization (e.g. by pictures, animations or 3D graphics) significantly increases the users' understanding of models and simulations.	+3
38	Computer simulations in water management are generally difficult to use and understand by policy stakeholders.	-3

Quotations about MSG in frame NL 5:

> For me, the concept of gaming means computer model based, role playing, rules and group activity. Gaming is a way to use simulation. I never use a game in a real decision-making process. We use games in academic exercises. With the students the experience often shows the non-rational outcome, which is not what I expected. The decision always depends on the political and social power of some of the roles. I think the reason behind it is that people are selfish. If they are powerful enough they will push their selfish interest. In such a situation, gaming does not help at all. So I think gaming can help to make a quicker decision, but it does not help to make a better decision. (Interviewee no. 11)
>
> If we do simulation we need represent the reality. If it is not realistic enough people do not believe it. If you use even low-tech simulation people have less trust, although I do believe that some low-tech games do bring very nice point of view on issues (Interviewee no. 12)

> The dilemma is that gaming works with respondents who are willing to be involved and communicate. But if the respondents are already open and willing to interact, is the value of gaming still significant, considering the time and money consuming process to organize it? (Interviewee no. 9)

4.5.1.6 A princess in every castle

By constructing frames NL 1–5, we are able to find our princess in several castles. Table 4.12 summarizes the key values presented in each of the five frames. Through the analysis of data from a comparatively small size sample (33 representatives), we found some rationality between how the respondents view water management, policymaking, the role of science, stakeholders in the policy process, and the role that MSG can or should play. I list the following conclusions for the first research question in this chapter "*How do Dutch scientists, modellers and policymakers frame IWM and IM"?*

- The largest group of eleven respondents fall in frame NL 1, and a second large group of nine respondents fall in frame NL 2.
- One important dimension that separates frames NL 1 and NL 2 is on IWM and policymaking: hierarchy, administrative vs. bottom-up, open.
- Both frames consider IWM a political power game, but they have different solutions. Frame NL 1 just plays the game, but realizes that in the end it is about making deals. Frame NL 2 aims to find win–win situations and compromises.
- In frame NL 1, the many considerations and plans that emerge somewhere in the compartmentalized administration can be integrated so that more coherent, synchronized information sources come about. Of course, techniques from gaming – like 3D visualization and interactive tools, maps and dashboards – can help.
- In frame NL 2 we find the most ambitious understanding and belief in gaming as a way of social intervention influencing stakeholder behaviour. Game technology seems not really necessary for that; a low-tech, role play or playing with a simple tool can be effective. The value of gaming in this frame will probably be judged upon the extent to which a solution space for a real problem has been created.
- Frames NL 3–5 have relatively few respondents, whereas frames NL 2 and 3 seem rather close in their views. It is the focus upon 'uncertainty', 'time and planning scales' that seems to separate NL 4 from NL 3.
- In these frames, we find the most common forms of innovation of integrated methods, such as the methodological innovation for integrated assessment, for future studies, and for testing and validating policy. I think this comes close to the idea of the policy exercise. Albeit, the respondents tend to be scientifically and technology oriented. The biggest risk for gaming is that it cannot meet the standards of science and simulation. It is also dependent on 'who plays', as they should be knowledgeable.
- Frame NL 5 has a special position: it seems to have a rather pessimistic view on policymaking. In contrast to frames NL 1 and 2, and like frames NL 3 and 4, it adheres to

the values of engineering and science, but in contrast to frames NL 3 and 4 it does not see so many problems with science and engineering. We know rather well what we should do. The problem is that policymakers do not act on the advice, for whatever reasons that are irrational or emotional. In this view, gaming does not really help; it may even aggravate the situation when people come to think 'this is science' or 'this is engineering'.

Table 4.12 Summary of frames NL 1–5

	Science-policy interface			Interest and values		Knowledge and expertise			
Issues / Frames	NTP complexity of IWM	SP complexity of IWM	Integrated policy analysis	Policymaking	Stakeholder participation	Role of science	MSG	Gaming	Form of gaming
Frame NL1 Bureaucratic alignment	Medium	High	Strategic	More centralized, hierarchical, administrative	Power play, bargaining	Low, politicization of knowledge	Visualization, spatial information	High-tech, computer visualized; can make scientific information easier to understand	Visual computer simulation
Frame NL2 Stakeholder interaction	Low	High	Participatory, interactive	Networked, bottom-up, open	Collaboration, compromises	Low, democratization of knowledge	Interactive governance	Low-tech, multi-stakeholder game, social intervention, aiming at real life solutions, compromises.	Role play, with some evidence and back up.
Frame NL3 Learning	High	High	Learning	Informed learning	Not clear	Medium, social innovation in science is possible	Learning type of analysis	With experts as innovative method for knowledge integration. No immediate consequences for real world.	Digital and interactive
Frame NL4 Uncertainty	High	Low	Systems analysis	Not clear	Not clear	High, but science also faces uncertainty	Integrated assessment	Combining with computer models, to reduce specific types of uncertainties, like ex ante testing of policies.	Digital and interactive
Frame NL5 Science vs. emotions	Low	Low	Traditional, engineering	Rational, linear	Not clear	High, politics should listen to science	Visualization, real information	Sugar-coated cover of a scientific model	Visual computer simulation

4.5.2 Finding frames in China

In 2011, I interviewed 22 representatives of the WoS and the WoP in China about IWM and the role of MSG as an integrated method. I used the same Q methodology, with revisions as discussed in Chapter 9 (Study Design and Methodological Innovations). The 22 respondents were senior staff members with many years of experience who worked at regional water authorities and research institutes at several locations in China (see Appendix B, tables B10–B13). Four of them have a technological background in computer modelling and simulation. Their attitude towards gaming comes not from personal experience, but from what they already knew or from what I showed them. Using the same process of Q factor analysis as for the NL frames, I identified four Chinese frames the clustered opinions of which are presented in order to show the different perspectives and discourses on IWM and the role of MSG in China:

- Frame CH 1: The doctrine of the mean
- Frame CH 2: Uncertainty and the contribution of technology
- Frame CH 3: Science-based
- Frame CH 4: The open-minded reformer.

I discuss the frames in the same fashion as I did for the Netherlands. It must be noted that respondents in China were quite sceptical about the use of simulation games or serious games (SG) for policymaking. Three respondents had ‘no trust at all’ in SGs and one had ‘a little doubt’ (see Appendix B, tables B10–B13).

4.5.2.1 Frame CH 1: The doctrine of the mean

Twelve respondents loaded in frame CH 1. I coded all of them as belonging to the WoP (provincial and local water managers). Table 4.13 shows the most distinguished statements about IWM in this frame. The importance of socio-political problems in water management in China is clearly stated in this frame. The best form of governance is for central government to have a strong leading position, and more interaction and cooperation among different levels of government sectors. Methods to enhance the cooperation are needed, but methods to analyse conflicts are not needed. The topics related to the science–policy interface, such as the impact of uncertainty and fragmentation, and matters like stakeholder participation and collaborative learning for policy analysis, are regarded as unimportant or are strongly rejected. The attitude here sheds light on the traditional view of Chinese policymaking, which I call the ‘doctrine of the mean’ (see Table 4.13).

Table 4.13 Distinguished statements about IWM in frame CH 1

Number	Statement	Ranking
2	相比起发展科学技术及基础建设，公共政策及政府管理的有效性在区域（流域）管理中显得更为关键。 The key problems in water management today are more socio-political than technological-infrastructural in nature.	+2
6	集中的国家政府管理形式，确保足够的权威和决策权，是实现区域（流域）综合管理的关键。 A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	+2
7	建立网络型的政府管理形式，使得各个部门之间能够利益共享，相互依存，共同协作，是实现区域（流域）综合管理的关键。 A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+1
8	我们需要找到更好的方法来促进跨部门，跨地区和跨领域合作。 There is a need for methods that can enhance the cooperation among different sectors and levels of governance in water management.	+2
9	我们需要找到更好的方法来分析区域（流域）中不同地区之间的冲突和潜在的合作关系。 There is a need for methods that can analyse the conflicts and cooperation among different regions in river basins.	0

The doctrine of the mean is further expressed by one of the interviewees who scores high on frame CH 1. Another interviewee in this frame admitted quite honestly that the interaction among government sectors is more of a network routine than for meaningful policy analysis (see quotation 4-10).

Quotation 4-1 About IWM in frame CH 1

> The focus of water management and flood control in China is still on the development of infrastructure. At the moment, it is definitely beneficial for most of society. With such a focus, a centralized government is efficient. Enhancing the cooperation among sectors increases the efficiency of management. However, the advanced development in Western countries is dependent not on participation and social interaction, but on the standardization of rules. The standardization in China is still at a low level. This is the critical reason for the problems in water management. It takes longer to move towards a better situation. You know the situation, but you can do nothing besides just handle your practical work. (Interviewee no. 7)

> Interactive, participatory policy analysis in China is still more of a 'lip service'. During the policy process many meetings are organized with different government sectors. However, there is no clear process and outcome of such activities. I think compared to the Western situation, contemporary China is less advanced not in technology, but in the modern management and the way of dealing with people and social problems. (Interviewee no. 11)

Table 4.14 presents the distinguished statements about MSG. It is quite obvious that in this frame MSG is neither trusted nor preferred. All the key statements about the values of MSG for policymaking, whether for providing real-life insights or for increasing cooperation, are strongly rejected. Low-tech games are certainly not a scientific method. A computer model is more trustworthy for analysis. It seems that under the doctrine of the mean, there is very little desire for new, unfamiliar methods. The culture gap can also explain the distrust of MSG, as expressed by two of the interviewees (see quotation 4–11).

Table 4.14 Distinguished statements about MSG in frame CH 1

Number	statement	Ranking
19	通过让利益攸关人在模拟的环境中'扮演'自己在真实世界的的决策行为（实现利益，做出决定等），我们可以再现在管理中出现的实际问题和解决方案，并从中获得对制定决策提供帮助的宝贵见解。 By letting stakeholders play their own role (interests, behaviour, etc.) in a gaming environment, we can simulate real problems and solutions in water management and derive valuable insights for water policymaking.	-2
25	决策游戏模拟不一定需要电脑技术支持。'低技术'的决策游戏也可以用来进行有效的科学分析。 Policy simulation does not need to be computerized. Low-tech gaming based on human behaviour is also a scientifically proven method for water policy analysis.	-2
34	一起参与决策游戏模拟可以有效的增加利益攸关人在'现实利益'里的合作意愿。 Playing together in a simulation game increases the stakeholders' willingness to cooperate in the real world.	-2
33	决策游戏模拟可以有效地促进和支持跨部门之间的协同合作。 Simulation gaming can effectively facilitate and support the interaction among stakeholders from different governance sectors.	-2
22	对于决策者来说，计算机模拟的分析结果比利益攸关人参与的游戏决策模拟的分析结果更为权威和值得信赖。 The outcomes of computer simulation are generally more authoritative (trustworthy) for water policymakers and water managers than the outcomes of a simulation game with real stakeholders.	+1

Quotation 4-2 About MSG in frame CH 1

> The situation of 'treatment after pollution' is not avoidable in the developing process, which the developed countries also experienced. Based on the earlier experience such as the eight environment pollution events in Belgium, the USA and Japan, China can prepare more for the consequences. However, whether the Western method of such participatory role playing game is also useful for the 'Chinese solution' is still too early to see. It is an advanced method after a certain stage of achievement, and for China it might be too early. (interviewee no. 18)
>
> The power relation and strategic game in China's policy environment is deeply embedded in its routine. Chinese politicians follow 'the doctrine of the mean' to be able to survive in the environment, which makes it impossible for them to articulate their needs and interests, and express their emotions. The Chinese political game contains many uncertain and un-parameterized variables to design a game for. (Interviewee no. 22)

The very realistic view is shared by the 12 respondents as the biggest group among the four frames. The attitude in this frame provides quite a good understanding of the values in the view of the doctrine of the mean: 'Say as little as possible while knowing perfectly well what is wrong, to be worldly wise and play it safe'. It represents a dominant aspect in the current socio-political environment in China due to the deeply embedded power relations and the need to survive in the political world. MSG is regarded as too Western or too early for the complex Chinese politics. This is especially the situation in the regional and local areas. The local politicians feel less safe in standing up for innovation.

4.5.2.2 Frame CH 2: Uncertainty and the contribution of technology

Only two respondents loaded in frame CH 2; one of the two also loaded on frame CH 1 (see appendix B, Table B11). The respondent who loaded on both frames is coded as belonging to the WoP (provincial policymakers), the other respondent as belonging to the WoS (researchers).

As a consequence, here there is also agreement on the importance of centralized governance in water management and the good network sectors at the same time. What makes frame CH 2 different from frame CH 1 is that the role of science and technology is also put in the most important position. The two respondents strongly emphasized uncertainty and agreed that the fragmentation of both social and technical knowledge make the uncertain situation worse. At the opposite extreme, the cause of fragmentation in government sectors is rejected (see Table 4.15). I therefore label this frame 'Uncertainty and the contribution of technology'.

Table 4.15 Distinguished statements about IWM in frame CH 2

Number	Statement	Ranking
2	相比起发展科学技术及基础建设，公共政策及政府管理的有效性在区域（流域）管理中显得更为关键。 The key problems in water management today are more socio-political than technological-infrastructural in nature.	-2
1	区域（流域）管理中出现的问题常常是由于多部门的责任分散以及缺少协作机制造成的。 Failures in water management are frequently caused by compartmentalization and fragmentation among different sectors and levels of governance.	-2
6	集中的国家政府管理形式，确保足够的权威和决策权，是实现区域（流域）综合管理的关键。 A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	+2
4	全球气候变化对不同区域或流域造成的影响存在很多的不明确性。 There are significant uncertainties about the local and regional impacts of global climate change.	+2
3	区域（流域）管理中的不确定性由于缺乏对社会，政治，科技，生态，经济各方面知识的综合运用显得更为突出。 Uncertainty in water management is deepened by a lack of integration among social, political, technological, ecological, economic, etc. knowledge.	+1

Socio-technical integrated approaches are regarded important way to support water policy analysis. There is realization of the need for socio-political simulation and the limitations of computer models. However, whether MSG can be a good candidate for socio-political simulation is quite reluctant. The use of only low-tech games is obviously not the choice. In addition, almost all the statements about the value of MSG are scored as unimportant. It seems that using gaming for learning is much more accepted than for real policy analysis (see Table 4.16).

The respondent who loads only on this frame has a background in hard technology and computer modelling. Having both an academic background in innovative technology in Japan and senior research experience for large-scale infrastructure in China, he seems to be quite open-minded towards ideas about and method for socio-technical integration. Although this frame is only loaded by him, his attitude might represent the new generation of researchers in China, many of whom have education backgrounds in Western countries. Due to the hierarchy and centralization in governance, policymaking at the local level will not become the pioneers of innovation. At the current stage, advanced technology will still be the core of innovation (see quotation 4-12).

Table 4.16 Distinguished statements about MSG in frame CH 2

Number	Statement	Ranking
5	在区域（流域）管理中运用’系统分析方法’需要着眼于对社会政治及科学技术的综合分析。 A system approach is useful for water management only when it addresses the techno-physical and socio-political aspects in an integrated fashion.	+2
13	区域（流域）的综合政策分析应该使用定量及定性结合的分析方法。 The methods for water policy analysis should integrate quantitative and qualitative criteria.	+2
15	我们需要更多的使用社会政策模拟方法来研究流域（区域）管理中利益攸关方之间的复杂决策问题。 There is a need for socio-political simulations that provide valuable insights into the multi-actor complexity of water management.	+2
26	在区域（流域）管理中，仅仅依靠电脑模拟来探索可能存在的决策问题和决策方案是不够的（即使所使用的电脑模型是用当前最先进的技术开发的）。 It is not enough to rely on computer simulation for the exploration of policy problems and the testing of policy options (even they have been developed on the basis of best-available scientific knowledge).	+1
25	决策游戏模拟不一定需要电脑技术支持。’低技术’的决策游戏也可以用来进行有效的科学分析。 Policy simulation does not need to be computerized. Low-tech gaming based on human behaviour is also a scientifically proven method for water policy analysis.	-2
27	相比于作为真正的决策分析方法，游戏模拟更适合于提高综合决策能力的学习过程。 The process of decision making simulated by human players in a gaming environment is generally more useful for learning than for real policy analysis.	+1

Quotation 4-3 About MSG in frame CH 2

> Developing methods and technology for socio-technical integration in China is only a matter of time. The experience in the developed countries demonstrates the benefit and necessity of its innovation and contribution to the long-term sustainability of development. In China there are already some demonstration projects going on at the national level, big institutions. However it is still quite new and needs more time to be introduced to the local level, due to the limitations of budget and decision power of the lower level of government. In Europe it is more accepted and used due to the greater availability of project funds and the power independence of the small-scale local authorities. But the benefit of developing integrated technology at a central level is that it can be ensured that it involves the best available researchers and technology. The technology in China has been

developing quite rapidly in recent years. We now have a lot of advanced 3D visualization technology and integrated simulation models. They are used successfully in technological control and management in large-scale infrastructures. So far, however, there has not been much convincing evidence concerning long-term uncertainty problems. (Interviewee no. 5; senior researcher)

4.5.2.3 Frame CH 3: Modern and rational governors

Four respondents loaded in frame CH 3; two of them are coded as belonging to the WoS (researchers), while the other two belong to the WoP (regional and local policymakers). In contrast to the other frames, the four respondents in this frame gave the impression that they appreciate the modern type of network governance. Table 4.17 shows the most distinguished statements about IWM in this frame. I label this frame the 'modern and rational governors': that they modestly agree on the importance of socio-political problem in water management reflects their modern outlook. They prefer the network type of governance to the hierarchical one, and they strongly agree upon the need to enhance collaboration among government sectors. They are also rational governors, because they strongly disagree with the contribution of public participation to solving the problem and consequences of climate change. They reject the suggestion that policy analysis should involve human emotions.

Table 4.17 Distinguished statements about IWM in frame CH 3

Number	Statement	Ranking
6	集中的国家政府管理形式，确保足够的权威和决策权，是实现区域（流域）综合管理的关键。 A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	-2
2	相比起发展科学技术及基础建设，公共政策及政府管理的有效性在区域（流域）管理中显得更为关键。 The key problems in water management today are more socio-political than technological-infrastructural in nature.	+1
7	建立网络型的政府管理形式，使得各个部门之间能够利益共享，相互依存，共同协作，是实现区域（流域）综合管理的关键。 A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+1
8	我们需要找到更好的方法来促进跨部门，跨地区和跨领域合作。 There is a need for methods that can enhance the cooperation among different sectors and levels of governance in water management.	+2
16	'公众参与'对区域（流域）管理中制定应对气候变化的长期策略提供最重要的贡献。	-2

	The key solution to the consequences of climate change lies in active public involvement and stakeholder participation. Societal interaction will provide the most significant contribution to water management and policymaking in the near future.	
23	在区域（流域）管理中，科学的政策分析也必须始终包括人为因素的影响。 Rational thinking should always be combined with human emotions in policy analysis for integrated water management.	-2

Quotation 4-13 gives a respondent's thought on the urgent needs to develop a rational, science-based cooperative government.

Quotation 4-4 About IWM in frame CH 3

> The governance and management situation in China is still in a backward situation. In the traditional form of centralized government, political power often takes over the regulations and rules. Rational, science-based governance is urgently needed to improve the efficiency of management. However, the bottom-up type of social participation is not a suitable method due to the very complex social situation in China. It will lead to a big crisis and loss control if too much emotion is allowed in policy analysis process. A good governmental regulation system based on rational priorities is the proper way to achieve better water management. (Interviewee no. 4; water manager)

Like frame CH 2, frame CH 3 also agrees on such things as the need for social simulation, the limitation of using computer modelling alone, and using SG for learning rather than for policy analysis. What makes this frame different from frames CH 1 and 2 is that the scientific value of human interaction in SG is agreed upon, as is visualization. It seems that policy analysis is regarded as a rational process to find optimal solutions. At the same time, increasing communication of science to policymakers is regarded as important (see Table 4.18).

Table 4.18 Distinguished statements about MSG in frame CH 3

Number	Statement	Ranking
15	我们需要更多的使用社会政策模拟方法来研究流域（区域）管理中利益攸关方之间的复杂决策问题。 There is a need for socio-political simulations that provide valuable insights into the multi-actor complexity of water management.	+2
18	大多数现有的电脑模型不能够灵活的分析复杂的区域（流域）管理问题。我们需要开发可以在不同的问题类型中迅速灵活运用的模型。 Most computer models are not flexible enough to deal with complex water problems. Models that can be quickly developed and changed to fit the circumstances are needed.	+2

25	决策游戏模拟不一定需要电脑技术支持。“低技术”的决策游戏也可以用来进行有效的科学分析。 Policy simulation does not need to be computerized. Low-tech gaming based on human behaviour is also a scientifically proven method for water policy analysis.	+1
30	用于政策分析的电脑模拟应该便于让非技术专业的用户理解和使用。 Computer simulations for water management and water policymaking should be easy to use and understand by non-expert users.	+1
26	在区域（流域）管理中，仅仅依靠电脑模拟来探索可能存在的决策问题和决策方案是不够的（即使所使用的电脑模型是用当前最先进的技术开发的）。 It is not enough to rely on computer simulation for the exploration of policy problems and the testing of policy options (even they have been developed on the basis of best-available scientific knowledge).	+1
29	使用当前电脑游戏产业中的可视化技术，（比如图片，动画或三维场景等）， 可能有效的提高政策决策人对科学模型分析结果的理解和运用。 Visualization (e.g. by pictures, animations or 3D graphics) significantly increases the users' understanding of models and simulations.	+1
27	相比于作为真正的决策分析方法，游戏模拟更适合于提高综合决策能力的学习过程。 The process of decision making simulated by human players in a gaming environment is generally more useful for learning than for real policy analysis.	+2

The reason for the attitude towards the potential sue of MSG becomes clear in the interview (see Quotation 4-14).

Quotation 4-5 About MSG in frame CH 3

> The development and application of integrated models is quite advanced due to the large investment from the national government. However, developing socio-political simulation is a different topic. In developed countries such as the Netherlands, they are interested because the development of infrastructures is completed. Water management can now focus more on the small-scale, 'soft' issues and use the more 'soft integrated' approaches such as gaming for less urgent issues in a long-term perspective. It is important to address the long-term planning in water management, but in China the more urgent issue is developing infrastructures, especially in the northwest area. Gaming will not be considered in these tasks. It is useful to learn new perspectives in policy analysis, but only after the fundamental structure has been completed. (Interviewee no. 8)

4.5.2.4 Frame CH 4: The open-minded gamers

Four respondents loaded in frame CH 4; one of them also loaded on frame CH 1. I coded one respondent as belonging to the WoS (researcher) and three as belonging to the

WoP (public policymaker). Table 4.19 shows the most distinguished statements about IWM in this frame.

Like frame CH 2, frame CH 4 also regarded science and technology as more important topics in water management. Uncertainty is seen as a problem in management due to the lack of integration of knowledge from different disciplines, both social and technical. This is the reason to agree that network type of water governance is better than the centralized form.

Table 4.19 Distinguished statements about IWM in frame CH 4

Number	Statement	Ranking
4	区域（流域）管理中的不确定性由于缺乏对社会，政治，科技，生态，经济各方面知识的综合运用显得更为突出。 Uncertainty in water management is deepened by a lack of integration among social, political, technological, ecological, economic, etc. knowledge.	-2
6	集中的国家政府管理形式，确保足够的权威和决策权，是实现区域（流域）综合管理的关键。 A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	0
7	建立网络型的政府管理形式，使得各个部门之间能够利益共享，相互依存，共同协作，是实现区域（流域）综合管理的关键。 A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+1
2	相比起发展科学技术及基础建设，公共政策及政府管理的有效性在区域（流域）管理中显得更为关键。 The key problems in water management today are more socio-political than technological-infrastructural in nature.	-1

This is the only frame that shows quite strong agreement with the values of MSG in policymaking in China. Unlike the other three frames, almost all the statements addressing the values of MSG were strongly agreed with. MSG is regarded a more innovative strategy for IWM than computer simulation, and it can bring valuable insight for real-life policymaking. Therefore, it is not only for learning, but can also be used for real policy analysis. Besides the scientific values, MSG is also regarded useful for increasing the real-life communication and willingness of collaboration among government sectors (see Table 4.20).

Table 4.20 Distinguished statements about MSG in frame CH 4

Number	Statement	Ranking
19	通过让利益攸关人在模拟的环境中'扮演'自己在真实世界的的决策行为（实现利益，做出决定等），我们可以再现在管理中出现的实际问题和解决方案，并从中获得对制定决策提供帮助的宝贵见解。 By letting stakeholders play their own role (interests, behaviour, etc.) in a gaming environment, we can simulate real problems and solutions in water management and derive valuable insights for water policymaking.	2
21	在区域（流域）管理中，真实利益攸关人参与的游戏模拟是比电脑模拟更为创新的管理决策分析方法。 Simulation gaming with real stakeholders as players is a better strategy for the innovative process than using computer simulations in integrated water management.	2
22	对于决策者来说，计算机模拟的分析结果比利益攸关人参与的游戏决策模拟的分析结果更为权威和值得信赖。 The outcomes of computer simulations are generally more authoritative (trustworthy) for water policymakers and water managers than the outcomes of a simulation game with real stakeholders.	-2
25	决策游戏模拟不一定需要电脑技术支持。'低技术'的决策游戏也可以用来进行有效的科学分析。 Policy simulation does not need to be computerized. Low-tech gaming based on human behaviour is also a scientifically proven method for water policy analysis.	+1
32	决策游戏模拟提供了一种可以将科学技术方面的'硬'知识和社会利益价值冲突方面的'软'知识进行综合分析的方法。 Simulation gaming with real stakeholders as players integrates 'soft knowledge' from stakeholders with 'hard knowledge' from scientific research.	+2
34	一起参与决策游戏模拟可以有效的增加利益攸关人在'现实利益'里的合作意愿。 Playing together in a simulation game increases the stakeholders' willingness to cooperate in the real world.	+2
33	决策游戏模拟可以有效地促进和支持跨部门之间的协同合作。 Simulation gaming can effectively facilitate and support the interaction among stakeholders from different governance sectors.	+2
27	相比于作为真正的决策分析方法，游戏模拟更适合于提高综合决策能力的学习过程。 The process of decision making simulated by human players in a gaming environment is generally more useful for learning than for real policy analysis.	-2

Interest in trying to play SG was also expressed by the respondents (see Quotation 4-15).

Quotation 4-6 About MSG in frame CH 4

> I'd never really used any such gaming simulation like the one you introduced, but I can understand the mechanisms behind it and the reasons to try it. (Interviewee no. 10)
>
> I'd like to use it but we won't have a budget for it. So getting a free contribution will be nice. (Interviewee no. 13)

4.5.2.5 Consensus statements

All frames in the WoS and the WoP in China have a rather strong belief in the network type of governance and the need for social simulation for multi-actor complexity. However, they all disagree that public involvement and stakeholder participation can make a significant contribution to water management. The methods that combine models and stakeholder participation are therefore also scored as unimportant in all the frames (see Table 4.21).

Table 4.21 Consensus statements in frames CH 1-4

Number.	Statement	CH 1	CH 2	CH 3	CH 4
7	建立网络型的政府管理形式，使得各个部门之间能够利益共享，相互依存，共同协作，是实现区域（流域）综合管理的关键。 A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+1	+1	+1	+1
14	结合电脑模拟和利益攸关人参与的分析方法对支持区域（流域）管理非常有效。 Methods that combine computer simulation with stakeholder participation are highly supportive of water management.	0	0	0	0
15	我们需要更多的使用社会政策模拟方法来研究流域（区域）管理中利益攸关方之间的复杂决策问题。 There is a need for socio-political simulations that provide valuable insights into the multi-actor complexity of water management.	+1	+2	+2	+1
16	"公众参与"对区域（流域）管理中制定应对气候变化的长期策略提供最重要的贡献。 The key solution to the consequences of climate change lies in active public involvement and stakeholder participation. Societal interaction will provide the most significant contribution to water management and policymaking in the near future.	-1	-1	-2	-1

4.5.2.6 The princess in the Chinese castles

By constructing frames CH 1–4, we are now also able to find the princess in the Chinese castles. Table 4.22 summarizes the key values presented in these four Chinese frames. The general impression gained from a comparison of frames CH 1–4 is that the difference in attitude between the four frames is quite subtle. The following conclusions were drawn from the analysis of the four Chinese frames as the second part of evidence for the empirical question in this chapter: *"How do scientists, modellers and policymakers in China frame IWM and IM"?*'

- The largest group of 12 respondents fall in frame CH 1 and all the respondents in that frame are provincial or local governors. All the other frames have quite small number of respondents, but they are a mixture of governors and researchers.
- Frames CH 2 and CH 4 both have one respondent who also loaded in frame CH 1. Frame CH 1 therefore represents the most important attitude in the current regime of water management in China.
- Frame CH 1 represents the traditional value of policymaking that still dominates the current policy context in China: hierarchy, control and safety first.
- All frames consider participation and social involvement as not the most important issue in the current structure of centralized, hierarchical governance and the need to complete large-scale infrastructures. Participatory oriented approaches for policy analysis are therefore regarded as a 'too early topic'.
- All frames believe that IWM in China needs network governance and a solution for multi-actor complexity, but seem to link to different purposes. In frame CH 1, it is regarded supportive of the power and control of centralized government. Frames CH 2 and 3 aim to increase scientific rationality through collaborative management. In frame CH 4, networked governance increases knowledge integration and compromises.
- What makes frames CH 2, 3 and 4 different from frame CH 1 is that they allow more space for modern ideas about governance and innovative science.
- Frames CH 2, 3 and 4 have few respondents, and frames CH 2 and 3 seem rather close in their views. It is the focus upon socio-technical integration and rationality that seems to separate frame CH 3 from frame CH 2.
- In frames CH 2 and 3, the role of gaming is presented slightly differently. In frame CH 2, gaming is a technical tool to help integrate quantitative and qualitative criteria and to formulate social problems in scientific analysis.
- In frame CH 3, human interactive games can have a role to increase the rational thinking of policymakers. As a common view in both frames, gaming is regarded as being more relevant to learning than to real policy analysis.
- In frame CH 4 we find the greatest understanding of and belief in gaming: SG is regarded as a method of social intervention, or a way to influence the stakeholders' behaviour in the real world, a viewpoint that is quite similar to that in frame NL 2. The

respondents are willing to try low-tech, face-to-face role play, or to play with a simple computer tool.

Table 4.22 Summary of frames CH 1–4

	Science-policy interface			Interest and values		Knowledge and expertise			
Issues / Frames	NTP complexity of IWM	SP complexity of IWM	Integrated policy analysis	Policymaking	Stakeholder participation	Role of science	MSG	Gaming	Form of gaming
Frame CH 1 The doctrine of the mean	Low	High	Strategic	More centralized, hierarchical, administrative	Not clear	Low, politicization of knowledge	Computer models	Not clear	Not clear
Frame CH 2 Uncertainty and the contribution of technology	High	Low	Systems analysis	More centralized, hierarchical, administrative	Not clear	High, contribute to the development of infrastructures, reduce uncertainty	Computer simulation	For system approach, socio-technical integration	Can be combined with computer models
Frame CH 3 Modern and rational governors	High	Medium	Rational, linear	Networked	Not clear	Medium, science should be interactive with policymaking	Visualization, communicating scientific rationality in policymaking	Can open new perspectives but it is too early at the current stage	Digital and visualization / Low-tech, role play
Frame CH 4 The open-minded gamers	Medium	Medium	Knowledge integration, social interaction	Networked	Not clear	Medium, contribute to social interaction	Integrated, interactive assessment	Knowledge integration, social intervention, aiming at real life solutions	Low-tech, role play, interactive

4.6 When two worlds meet…

My observation when comparing the Dutch frames with the Chinese frames is that the former represent stronger socio-political inclusion, that is, integration through the involvement and interaction of stakeholders. The Chinese frames show more interest in techno-analytical inclusion, namely integration through big data, big models and advanced calculations.

In China, policymaking takes place in a centralized, powerful political system. Opposition from stakeholders outside of this system is not an immediate threat to the government in control. The power game is so crucial that all policymaking issues are affected, and thus also those at the science–policy interface. In the modern development of the society, the troubles made by the out-dated governance style have become so obvious that the government is making an effort to change the situation. Here, science is playing an important role in making policymaking look and become more evidence-based and rationally oriented. That is why developing models and advanced scientific tools is heavily supported by the government.

As a contrast, making room for participation, debates and stakeholder interaction has contradictory effects: on the one hand it can improve the image of the Chinese government as being more open and more democratic; on the other hand, the government does not really want to distribute power and face the huge risk of losing control. The consequence of China's modern policymaking under such international pressure and influence is that when it 'does not matter', the government and policymakers are quite willing to be open to the discussion of modern ideas like gaming. But when it 'does matter' –namely when real interests (i.e. money and risks) are involved– the strategic game becomes so complicated that almost no-one believes that it can be reflected by any design method or approach, that is, gaming. This also explains why the core value of the representative Chinese frame is the doctrine of the mean: the strategic game is so complicated that the best way to remain safe is to keep one's head down. Bearing the responsibility for failure is too dangerous.

This discussion provides insights that help us to understand the behaviour of policymakers and officials at different levels of the power system: at the national level, where the power is concentrated, the government and organizations are quite actively involved in international projects of participatory, integrated studies and projects. At the lower level of the power system, where the main practical things take place, participatory integration is far from being the real topic and practice. Participatory integration has a low priority, especially when it threatens economic growth for the local government and stakeholders that have strong economic power.

However, we can still identify many niches where innovative methods of participation and interaction are practised in various areas in China, especially in the southern part where economic development is already quite advanced. In recent years, many municipalities in, for example, Guangzhou, Shenzhen, Shanghai and Beijing have developed their own interactive modelling and simulation, such as digital cities in 3D models or the real-time simulation of traffic. Although no real investment has been made in developing and using gaming for public policymaking, the idea brought by the Western researchers has already been approached in many cases. Further investigation is needed to get a deeper understanding of how the Western form of game play can be tailored to the Chinese transformation.

Water management in the Netherlands is characterized by more decentralized power, stakes and social interest. Knowledge of and expertise in interactive IM and gaming are more present in policymaking and analysis. By reviewing what happened in, for example, the Room for the River project, it becomes obvious that if Dutch governments ignore the social groups and stakeholders, they face serious deadlocks in policymaking. The experience of involving stakeholders in the policy process shows that participation is the only way to deal with conflicting stakes. Equality and personal rights are deeply embedded in the social value system. The cost of going against these values can be very high. This does not mean that policymaking in the Netherlands is a purely open and fair process: it is also a strategic process among various policy actors, as emphasized in frame NL 1. However, the higher level of power equality means that the game can be more played out. That is why in the Dutch frames we found more and stronger beliefs in increasing social interaction through game play, to articulate stakeholders' opinions, preferences and values in policy analysis, and to share them equally with experts and policymakers.

However, whether game play can promote more effective participation in complicated strategic political behaviours is not yet clear. The NTP complexity of water management in the Netherlands currently also has a different focus. After some decades of concentrated work, large-scale water infrastructures to protect the whole country have almost been completed. The Dutch water managers no longer face the immediate threat of flooding. Future problems and future solutions are therefore much more the topic on the political agenda. Scientists and modellers made a rich body of big databases, large-scale integrated models and advanced simulation for the analysis of future situations. Applying small-scale, flexible, innovative and smart design is becoming a common ground among the socio-political situation and research interest. In such a context, using participatory methods and gaming seems more suitable for the needs of integrating social complexity in the design and analysis of water solutions.

It is clear that water management in China and in the Netherlands face different problems and challenges. Through the analysis of NTP–SP complexity in both countries, we understood the reasons behind the difference. More important, we see the difference is not a fundamental one but a matter of having a 'mission at a different level'. China might take a very long time to move to a level of integration that is similar to that in the Netherlands. However, we believe it is happening now (slowly and fragmentally), due the needs of development and the influence of the outside world, as illustrated in the grey parts of Figure 4.1. Comparing frames NL 1–5 and frames CH 1–4 provides further insights into the roles and usefulness of game play for the needs of integration at different levels. The lessons learnt are:

- The five Dutch frames prefer different types of games. The features of visualization, human interactive play, combining computer model and role-playing are emphasized in frames NL 1–4 for different purposes in the policy process. Generally speaking, the usefulness of gaming from the Dutch experience does not show so much difference from those expected in the Chinese policy process. In frames CH 2–4, a similar preference for using gaming can be found.
- In frame NL 5, gaming is rather cynically rejected because of the embedded reality of power and interest relation. This Dutch attitude is similar to the attitude present in frame CH 1, where the central attitude is a realistic one but is interpreted as 'the doctrine of the mean'. Although there is no actual experience, gaming is also rejected as a useful tool from the expectation of this frame.
- The consequence, however, for the real use of gaming in these two types of policy context – that is, more interactive, integrated vs. more centralized, hierarchical – can still be quite different. The difference is not fundamental but a result of different stages of development. In frames NL 1–5, 88 per cent of the respondents (29 of the 33 respondents) agree on the usefulness of gaming, including frame NL 1, which represents the biggest group of water managers and policy analysts. In frames CH 1–4, the percentage is 45% (10 of the 22 respondents), while gaming is rejected by frame CH 1, the major representation of the traditional, centralized policy regime.
- This evidence becomes stronger with the impressions derived from the interviews. Many respondents in China agree that IWM is a general trend in both countries and also globally. Water management is moving from its hard-core engineering domain to become an inherent part of integrated spatial development in order to achieve the ecology-based, sustainable, risk-involved management of water resource. However, the integrated pathway will be curved differently. The current situation in China is still quite tradition based and at a lower stage of participation (i.e. more short-term thinking, economy based, interest based, conservative, uninformed, disjointed). In the Chinese SPI, the culture, tradition and capacity of governance might show that for a very long time participation and social interaction will not be core themes for integrated approach and outcome. However, they might attract much more attention in the later progress of IWM. Water management in the Netherlands is much more integrated (i.e.

ecology-based, long-term thinking, innovative, well-informed and integral, system consideration). In the Netherlands, SPI is represented in a much more decentralized variety. Methods and approaches address different values, and water managers have plenty of time to tackle the long-term problems. The existence of many consultancy and gaming companies for public policymaking can demonstrate such a situation from one perspective.

4.7 Conclusion and discussion

The purpose of this chapter was to understand what knowledge, expertise, values and interests in real-world policymaking are willing to be considered for integration and the development of integrated method. Integrated water management (IWM) and integrated methods (IM) in China and the Netherlands were examined for that purpose. With using Q Methodology I interviewed 33 Dutch policymakers, and water managers and modellers, and 22 their Chinese colleagues. Their shared opinions about IWM and IM are clustered into five Dutch frames and four Chinese frames.

4.7.1 Short answers

(1) *How do Dutch and Chinese scientists, modelers and policy makers frame integrated water management and integrated methods?* The five Dutch frames are: 1) Bureaucratic alignment; 2) Stakeholder interaction; 3) Learning; 4) Uncertainty; 5) Science versus emotions. For China these are: 1) The doctrine of the mean; 2) Uncertainty and the contribution of technology; 3) Science-based 4) The open-minded reformer.

(2) *To what extend are these frames similar or different? In which way do they contribute to possible integration at the SPI?* The Chinese and Dutch frames are quite different and show little overlap. In both countries, we find believers as well as sceptics and cynics. However, the Chinese frames show more interest in techno-analytical inclusion, namely integration through big data, big models, 3D visualizations and advanced calculations. In the Dutch frames, there is more space for socio-political inclusion, and learning (synthesis). The frame-differences confuse Chino-Dutch co-operation projects on integrated water management and integrated methods.

4.7.2 Discussion

The empirical studies in this chapter provide insights into the role and usefulness of SG from a macro level, namely not from one case or one gaming experiment, but from the generalized overviews at the higher level of institutions and political system, where knowledge, expertise, interests, power and stakes are interwoven at the SPI.

The usefulness of gaming technology that appeared in these frames established real-world-based insights for further exploration. For example, 3D visualization was believed as a way to improve the usability of scientific tools for both experts and laymen, and interactive role play as a way to motivate participants and handle the dialogue. Based on these insights, further empirical studies at the meso level and the micro level will be conducted.

4.7.3 Continuation

In the following chapter, I will pick up my theoretical line again to investigate why game play serves policy analysis, how more integration leads to more play and how game play manifests itself at the different levels of integration represented in Table 3.1. I will do this by deconstructing the principles of game play and then presenting more examples to show how they serve integrated policy analysis.

5 Principles of Play (and how they serve Policy Analysis)

> In every real man a child is hidden that wants to play. *Friedrich Nietzsche* (German philosopher and poet, 1844-1900)

5.1 Introduction

At the end of Chapter 3, I interrupted my theoretical storyline with the following thesis:

> The stronger the level of integration, the more policy analysis will start to become – for example to feel, to look – like game play. In inclusive participatory modelling, for instance, the simulation game or serious game is one representational method among other methods. The synthesis between NTP and SP complexity is the realm where game play truly emerges: 1) The representation of NTP complexity as in game theory, computer simulation and agent-based models. 2) The representation of SP complexity realm as in participatory play, role play, etc.; 3) And the representation of STC as in serious game play (see Chapter 3).

So, what does it actually mean when I say that integrated policy analysis becomes like game play? And how does game play manifest itself at the different levels of integration represented in Table 3.1? In this chapter, I aim to answer these questions by means of a threefold analysis. First, we need to know a little more about the philosophy behind serious games and simulation games (both abbreviated as SG) for policymaking. Secondly, I need to show what integrated methods and approaches have emerged, and how they fit into Table 3.1. Thirdly, I need to show that these integrated methods become like game play. I can do this by deconstructing the principles of game play and then showing how they serve integrated policy analysis. By analysing the principles, I give the answer to the research question of this chapter: *What does it mean 'to serious game play' and how does this serve policy analysis, or any other system in the real world?*

In Chapter 6, I use two pilot studies – the Blokkendoos planning kit and the Climate Game – to illustrate further how they rely upon game play to support policymaking. I make a few comments about the methodological approach in this chapter (see also appendix A, Study Design and Methodological Justifications).

In this chapter, I continue the theoretical story, although I present examples and illustrations of integrated methods to make my point. Similar to the way I analysed the

SPI and integration, I analyse SG through the method of deconstruction and reconstruction. In short, I want to find the questions behind the answers. The deconstruction and reconstruction of SG is now increasingly being done in terms of game design patterns or game mechanics. Games are increasingly analysed ex post with game analytics. That is not the approach I have chosen, because I feel that it focuses too much on the design of the game as an artefact and on the engagement (immersiveness etc.) factor of games. My critique is that the game artefact is instrumental to the game play and that game play can be induced with any artefact. Secondly, immersiveness and engagement are important principles of game play, but in a context of policymaking they are certainly not the only, and probably not the most significant ones. Others have tried to deconstruct and reconstruct games in terms of learning mechanics/analytics, but I find this approach less suitable because it tends to focus on the game for individual and formal learning and training. I am therefore interested in how game play can serve policy analysis, which transcends the learning to a higher level.

During the five years of my research, I took part in many paper-and-pencil and digital SG. I observed, studied and facilitated some of them, including the Climate Game (Chapter 6) and the Marine Spatial Planning game (TU Delft; see Chapter 7). My approach is therefore more similar to that of Salen and Zimmerman (Salen & Zimmerman, 2004), who in their book Rules of Play analyse games in terms of 18 schemas or conceptual frameworks, including games as systems of emergence and information, as contexts for social play, as a storytelling medium, and as sites of cultural resistance. In this chapter, I simply call such conceptual frameworks, frames. I aim to find the frames for SG in policy analysis and the principles of play that can turn integrated policy analysis into game play, and vice versa.

5.2 Definitions and taxonomies

So far, I have used notions like game/serious game play, simulation games or serious games (SG) rather casually, interchangeably and without proper definition (see Table 1.1). It is now time to indicate what these notions mean within the context of my research. This can be done by, for example, providing definitions and/or developing classifications and taxonomies (Anderson, Krathwohl, & Bloom, 2001; Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012; Elverdam & Aarseth, 2007; Mueller, Gibbs, & Vetere, 2008; Sawyer, 2008).[21] In a recent co-authored book chapter, my co-authors and I show that definitions or taxonomies are generally problematic, especially in emerging interdisciplinary research areas such as SG.[22] To begin with, there is the philosophical position that 'games' cannot be defined at all (Rockwell & Kee, 2011; Wittgenstein, n.d., 1953). According to Wittgenstein, games are 'a family of resemblances' and there is no essence among them. However, this lack of essence does not stand in the way of the fact that even children learn what games are fairly easily. In short, we do not need a definition in order to be able to communicate about games, serious or otherwise:

> How should we explain to someone what a game is? I imagine that we should describe games to him, and we might add: 'This and similar things are called 'games'. And do we know any more about it ourselves? Is it only other people whom we cannot tell exactly what a game is? But this is not ignorance. We do not know the boundaries because none have been drawn. To repeat, we can draw a boundary for a special purpose. Does it take that to make the concept usable? Not at all! (Except for that special purpose.) (Wittgenstein, 1953)

In *Gaming: the Future's Language*, Duke explicitly supported Wittgenstein's anti-essentialism in relation to SG (Duke, 1974a). Duke himself may or may not have been aware of the underlying philosophical debate, but his argument was solely based upon his extensive experience with simulation games.

> A careful review of the variety of products currently available as serious games 23 turned up the startling disclosure that they seem to share no single characteristic: neither subject matter nor technique, nor duration, nor client, nor audience configuration, nor paraphernalia, nor style. […] Curiously, professionals have no difficulty in alluding to all of these as games. Or addressing the phenomenon they use as 'gaming' even though the particulars are so varied and diffuse. (Duke, 1974, p xvi)

Nevertheless, unaware of Wittgenstein's language games, or as a critique of his anti-essentialist argument, many have tried to define games. Albeit, to define 'game' is not the same as to define serious game or simulation game, because the latter concepts are less universal, and a variety of partly overlapping concepts, such as those in Table 1.1, are used to refer to more or less the same thing. The number of concepts and corresponding definitions that have been proposed in reference to 'the utilization of games for …' is wide ranging: from war gaming, free-form gaming, operational gaming, scientific gaming and policy exercises, to gamification, ludification, persuasive games and gameful design. SG comprise quite an extensive family – unfortunately, however, the family tree cannot be fully reconstructed from the different family names. Moreover, whether certain members rightfully or legitimately belong to the family is questionable.

The problem with definitions (and taxonomies) is that they define who or what is 'inside' and who or what is 'on the edge of' or 'outside' the scientific, professional or other type of community. 'In' or 'out' makes a big difference with respect to access to resources (grants, funding, subsidies), publications, projects, meetings, workshops, conferences, etc., regardless of anonymous peer reviews. In other words, underlying the search for definitions and taxonomies is a socio-political struggle driven by the search not only for truth but also for control over institutions and resources, and thereby the power to control (Kuhn, 2012; Nola & Sankey, 2002). One of the strategies in this struggle could be to initiate or support the replacement of SG by persuasive games (or another concept); but, of course, the potential threat to persuasive games from the introduction of gamification (or any other concept) needs to be fiercely resisted:

> Despite the possibility of rescuing serious games under the definition I have just offered, I do not want to preserve that name. Instead, I would like to advance persuasive games as an alternative whose promise lies in the possibility of using procedural rhetoric to support or challenge our understanding of the way things in the world do or should work. (Bogost, 2007: 59)

> Gamification is bullshit. (Bogost, 2011)

New terms such as 'gameful design' do not express a more inherent value, and their definitions do not have more essence, since there probably is none. They mainly express support for or rejection of institutionalized norms, beliefs, culture and the funding of the 'serious game' (or any other) movement. In order to gain support and be convincing, and thus to succeed, in the language game surrounding the utilization of games, the values of the academic or professional community at large should be taken into account.

However, while the essence of SG still proves hard to determine or sell through definitions, variety can also be managed by a proposed clarification of the relationships among the different concepts, and above all by clarifying the underlying structure through which we can see similarities, differences and relationships; in other words, by defining genres, styles, typologies, classifications and taxonomies. Very few SG taxonomies have really clarified anything or contributed to a deeper insight into what games, serious or otherwise, really are. Moreover, since there is no taxonomy of taxonomies (which would lead to an infinite regress), the utility of the SG taxonomy – what it is for and whether it does it – cannot be defined. More importantly, taxonomies reify creativity; they kill innovation, because new combinations – Schumpeter's *neue Kombinationen* – cannot be boxed (Schumpeter, 1961). Taxonomies frame games as things, as artefacts, and hardly prompt a critical discourse about the underlying worldviews or assumptions. So, is there a better way to manage variety than by definitions and taxonomies?

5.3 Frames

We have recently started to use *framing theory* (Fisher, 1997; Giddens, 1988; Goffman, 1974; Scheufele, Iyengar, Kenski, Hall, & Eds, 2002) and *frame-reflective discourse analysis* (Rein & Schön, 1996; Schön & Rein, 1994) to shed some light on games.[24] Framing is the act of attributing meaning to events and phenomena; a way of creating order out of chaos by providing a critical analysis of the multiple, often conflicting ways in which we perceive and discuss the utility of games for society, business and politics. Rather than definitions or taxonomies, it is important to have a better understanding of the frames that people construct and use when they address and answer the following questions:

- What is the relation between game play and policymaking?
- How do games serve the making of water policy?

So what are the possible frames to understand the relation between games and policy? A detailed discussion of the philosophy of science would obviously exceed the scope of this publication. For our purposes, we need only define two 'drivers' with which to construct four frames on the utility of games (see Table 5.1). These drivers are:

(1) Whether the world as we know it is more likely to be real (ontological realism) or constructed (ontological idealism): If the world is real, we are more likely to be able to observe it, measure it and come as close as possible to understanding it as it really is. If it is grounded in our ideas (mind), we can only explore and try to understand our relationship to the world as we think it is, expanding our understanding through interaction with others who may think differently (phenomenology).

(2) How we consider change in the world (and in 'ourselves' within it): If we assume that the subject ('I'/'we') can exercise some degree of control in changing its environment, we acknowledge 'interventionism'. We then assume that we can 'decide' to act on (build, construct, repair, steer) parts of the world in which we live as we see fit. If we assume that actual change is less the creation of one or several individuals than the emergent result of various intentional and unintentional forces within a system, we accept a type of 'evolutionism' or 'determinism'. The system is assumed to influence subjects to a much greater extent than subjects can influence the system.

Table 5.1 Four frames of gaming-policy relations

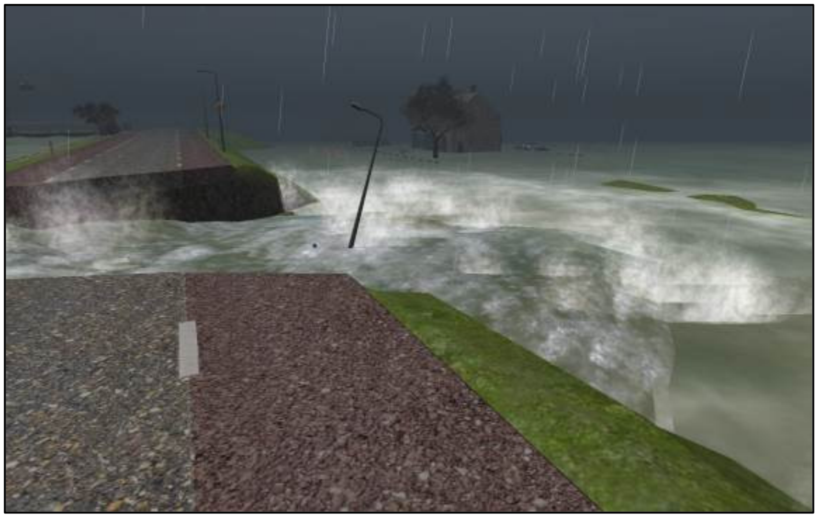
	Interventionism-Decisionism	Evolutionism-Determinism
Realism, Empiricism	I. SG = Tool, therapy	II. SG = Creative innovation
Idealism, Phenomenology	III. SG = Persuasion	IV. SG = Complexity

When reviewing how researchers reflect on the potential role of games in policy, we can construct a two-dimensional space in which at least four frames seem to arise. Each frame has its own ontological assumptions, concerning gaming itself and gaming's objectives (see Table 5.1). These frames are:

(1) *SG as a tool*: This frame reflects the majority and most frequently cited examples of SG used for a wide range of purposes (e.g. therapy, education, health, decision making and training). Through this frame, we see a 'thing' that can be measured, indexed and taxonomized. In other words, we see a 'tool' that might or might not work (de Caluwé, Hofstede, & Peters, 2008). The language in this frame is pervaded by words such as 'effectiveness', 'efficacy', 'randomized controlled trials' (RCTs) and 'evidence-based'. The tool itself is measured in terms of 'metrics' and its effects in terms of 'analytics'. Especially within the context of health, it is treated as a new type of therapy, the effectiveness of which must be assessed in clinical trials (Fernández-Aranda et al., 2012). Research revolves around the question whether the game offers a more effective tool for learning, education, health and training. Proponents do their best to prove that and understand how it works. Opponents might argue that this serious game play does not work, that there is inconclusive evidence or even that it has countervailing effects, such as addiction. In the domain of water management, there are several such tools. The virtual training simulator called Levee Patroller is a successful one that has been thoroughly evaluated and assessed on its learning efficacy among dike inspectors (see Figure 5.1,

Text box 5.1) (Harteveld, Guimarães, Mayer, & Bidarra, 2009; Harteveld, 2011, 2012).

Figure 5.1: Levee Patroller



Text box 5.1 Levee Patroller

> Operational serious game for professional and volunteer dike inspectors. The game consists of a virtual environment that simulates a range of serious situations relating to dikes. The players can walk around without restrictions and decide for themselves which are the important places that need checking. Not only when water levels are high, but also during dry periods. Both extremes can lead to problems with dikes and involve the risk of a dike failure. Dike inspectors learn what to focus on during dike inspections. They also learn how to report observations and about the procedures required so that the right steps can be taken without delay. (Deltares, n.d.-b)

(2) *SG as creative innovation*: In this frame we see SG as a part of evolutionary change, and as an especially significant factor in the competitive race among nations, regions, companies and even individuals. The argument in this frame is that the phenomenon of digital games is built upon highly competitive business models that might be more suitable for the Society 2.0 initiative, and that the games are surrounded by technological innovation, creativity and other processes that could generate a competitive advantage in design, production and organization

(Nieborg, 2011; Schrage, 2000a). Failure to use game technology, game principles or related resources comes close to dropping out of the race. The arguments of a great many policymakers and business leaders are derived from within this frame, promoting SG as ‘a way to build the future’ or ‘a chance for innovation’. Here, the understanding of SG for policymaking changes significantly, because it becomes associated with ‘economic innovation’ policies. In the field of water management, it is less easy to find examples, although many game projects like the Climate Game have been sponsored and subsidized by governments from this perspective. The Flood Control 2015 project was defined in 2008 with the ambition to build an integrated control room for flood control, using among others technologies and concepts from serious gaming (see Text box 5.2). Another example is the game Evoke developed by the World Bank Group as a creative solution to social problems (see Figure 5.2, Text box 5.3).

Text box 5.2 Flood Control 2015

> During a flood, a few hours can make all the difference between a disaster and a near disaster. The Flood Control 2015 integrated forecasting systems ensure that better information reaches the right place more quickly. This not only increases safety, but also limits damage and the number of victims. What is more, the day-to-day management of water systems is significantly improved.

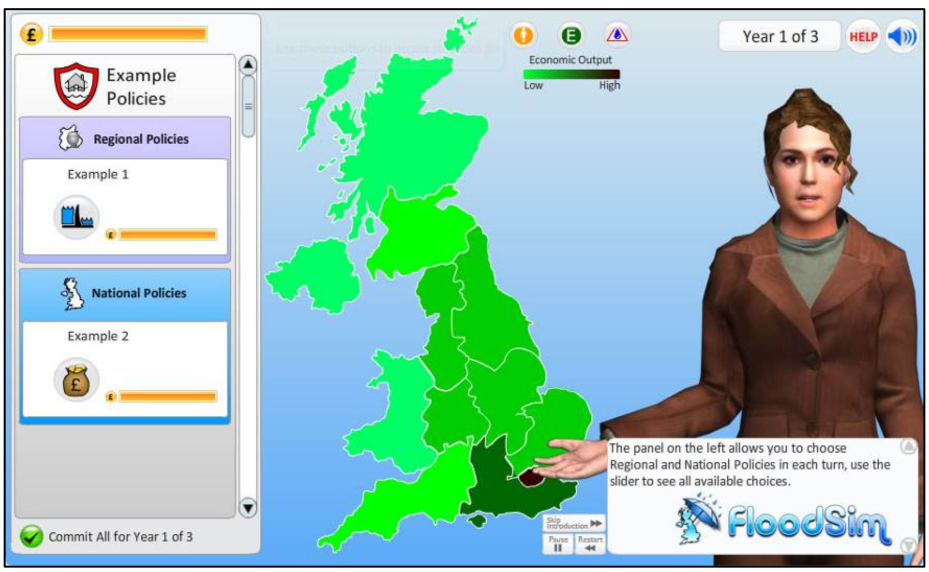
Figure 5.2 Evoke

Text box 5.3 Evoke

> EVOKE is a ten-week crash course in changing the world. It is free to play and open to anyone, anywhere. The goal of the social network game is to help empower people all over the world to come up with creative solutions to our most urgent social problems. EVOKE was developed by the World Bank Institute, the learning and knowledge arm of the World Bank Group, and directed by alternate reality game master Jane McGonigal. (World Bank Group, n.d.)

(3) *SG as persuasion*: In this frame, we see the world as engaged in a power struggle between beliefs and ideas. Games are seen as a powerful new means of communication, and an even more powerful means of persuasion and rhetoric (Bogost, 2007). This new means can be used to sell products or services (e.g. adver games, many forms of gamification, games for branding), as well as to effect change in social behaviour (e.g. bullying prevention) or political ideas. In this frame, we find many SG around the topic of integrated water management. They can be small, simple games that communicate a socio-political message to the general public, like FloodSim (see Figure 5.3; Text box 5.4).

Figure 5.3 FloodSim



Text box 5.4 FloodSim

> FloodSim is an accessible online policy simulation that helps raise public awareness of issues around flood policy and provides feedback to insurers and policymakers about public attitudes towards different flood protection options. FloodSim puts the player in control of flood policy in the UK for three years. Players decide how much money to spend on flood defences, where to build houses and how to keep the public informed. But as in real life, money is limited. The player must weigh up flood risks in different regions against the potential impact on the local economy and population. The game brings to life the complexity of the issue and the trade-offs that policymakers are grappling with in real life. (PlayGen, n.d.)

(4) *SG as complex systems*: Through this frame, we see games as part of an evolution in society and cultures at large. Adherents argue that we are witnessing the ludification (Raessens, 2006, 2009) of cultures, due to the growing pervasiveness of digital games, especially amongst the younger generation. Ludification (or gamification) affects the ways in which people organize and interact in everyday life (e.g. in social, political and cultural life, or at work). For many, this cultural change might be subtle, slow and unnoticed. It might also become submerged in self-organizing communities on the web or in our efforts to gamify science by using games to organize crowd sourcing or political participation. One of the best examples of SG as self-organization is Foldit (S. Cooper et al., 2010). Although some researchers attempt to explain ludification within this frame, most attempt to find and exploit game principles for self-organization as part of gamification (McGonigal, 2011). Critics might argue that ludification and gamification could potentially create a new divide based upon access or lack of access to and literacy in digital games. Furthermore, a wide range of ethical questions arise with regard to the use of games for self-organization (e.g. in the workplace). Or there are more extensive games like Aqua Republica, which translates real-world problems into an imaginative world (see Figure 5.4; Text box 5.5), or like in the game-like simulation Deltaviewer, which reflects the complex interdependency among various factors in water and urban development in a 3D virtual reality (see Figure 5.5; Text box 5.6).

Figure 5.4 Aqua Republica

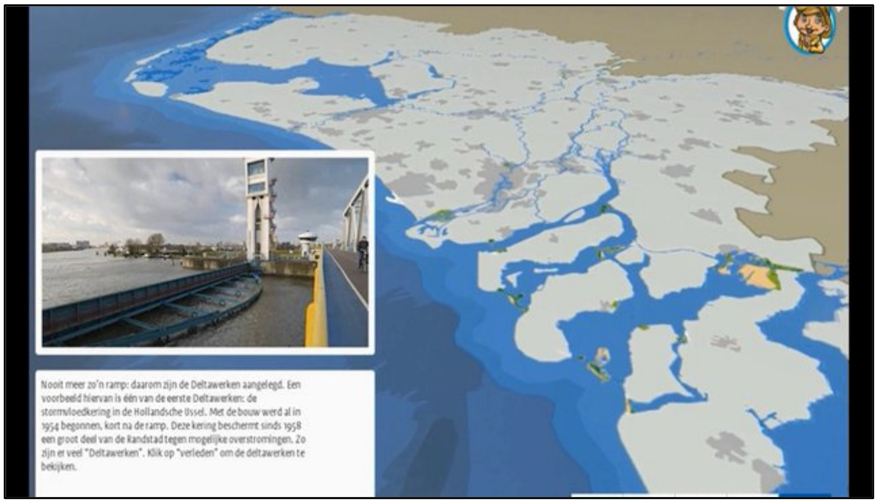
Text box 5.5 Aqua Republica

Aqua Republica is a DHI and UNEP-DHI project that focuses on the development and promotion of a not-for-profit serious game in collaboration with a number of partners. The aim of the project is to promote sustainable water resources management by sharing knowledge, to raising awareness and building capacity in some of the most critical issues in water resources management through serious gaming, where participants can experience making decisions in managing a catchment in an interactive and engaging way, and in doing so learn about the connectivity and importance of water resources, as well as the need for careful management. While the world of Aqua Republica is fictitious, the challenges of sustainably managing a limited supply of water resources in a situation of growing demand between multiple users and uses are very much based on real life scenarios. (UNESCO-ISCED (website), n.d.)

Text box 5.6 Deltaviewer

Deltaviewer uses data and knowledge about safety, liveability, ecology and economic development. You can see how all these different factors are connected. You will also find out that safety issues are indeed related to the availability of fresh water, nature, urban (re)development, shipping and raw material extraction. You and your fellow decision makers will see how all these factors affect each other. (Tygron, n.d.-b)

Figure 5.5 Deltaviewer



5.3.1 Policy discourses

The above frames colour the various policy discourses at the national and the EU level, thereby defining supply, demand and research in the area of SG in the following way.

(1) *Discourse on 21st-century leaning*: In this policy discourse, SG are seen as a possible means for 21st-century learning, such as lifelong learning, authentic learning and technology enhanced learning (TEL). Games are primarily viewed as a modern, cheaper or more effective educational and training instrument. For some policymakers, the development and use of SG can be promoted as a pedagogical instrument for children and students. Others may also believe in its utility for professional training and education in the public or semi-public sector (e.g. medical staff, crisis managers, control room operators), or for teaching general management or personal competencies, such as project management and communication skills.

(2) *Discourse on creative industries and innovation*: In this policy discourse, digital games are viewed as belonging to the creative industries (Howkins, 2002, 2009), along with industrial and product design, fashion, performing arts, architecture, etc. In many cases, technology or principles from the game industry are used to innovate product designs. The public sponsoring of SG is part of local, national or regional or economic innovation policy. And of course, within the public sector there are many products, organizations and procedures that could be innovated with the use of SG technology or concepts. One global game company, for instance, recently introduced a 'head-mounted image processing unit' for endoscopic image

display, so the surgeon can now 'peer inside you' like he would in a 3D video game.

(3) *Discourse on social cohesion and empowerment*: In this policy discourse, the utility of games is viewed through a socio-cultural lens, with values like social cohesion and empowerment, or similar notions like public awareness or public participation or even 'e-democracy'. SG becomes a way to influence socio-politico-economic behaviour, or a way of political communication and participation. Policy scientists would call it 'steering' or 'governance' with games. Politicians can aim to attract votes or manage relations with constituents. Policymakers can try to create awareness of societal issues like poverty, child education, climate change or energy reduction. But stakeholders can do the same – even when they are directly opposing government policy.

(4) *Discourse on complex systems*: In this discourse, the main question is: 'How can we still design, control and manage systems that are increasingly complex?' The fourth discourse on complex systems is highly relevant because here the game becomes a strategy to manage complexity. This discourse is closely nested in the complex systems paradigm, although not all discourse participants may be aware or familiar with it. In Chapter I, we saw that complex systems have emergent properties that make their behaviour unpredictable, even counterintuitive and surprising. Because society increasingly depends upon the proper functioning of complex systems, it is crucial that we find new strategies to understand, design, manage and operate such systems. If we do not, society may grind to a halt as a result of power blackouts, economic crises or flooding. Certain types of models and simulations – such as system dynamics, agent-based modelling and social simulations – specifically address complex system behaviour and play a role in policymaking and operations. SG are another way of addressing system complexity, because they combine technical complexity with socio-political complexity. There are plenty of examples of SG in EU and national policies on energy (Knol & de Vries, 2011), urban planning (smart cities), air traffic control, water management, and safety and security. Self-organization is one strategy to make complex systems work, and this might explain the recent interest in the 'gamification' of organizations and social communities.

5.3.2 New wine in old bottles?

We have now created some order out of chaos by reconstructing four frames that influence the discourse on games and policymaking. The question is where the origins of and foundations for the use of games for integrated policy analysis come from. The search for a link between technical and socio-political complexity is apparent in the

Crossover – Policymaking 2.0 project, where analytical approaches (data-mining, visualization, agent-based modelling) can be found alongside participatory approaches (e-democracy, e-participation).

Text box 5.7 Crossover – Policymaking 2.0 (EU, FP7 project)

> The Crossover project (www.crossover-project.eu) is seeking the best applications for policymaking 2.0: technological solutions such as open and big data, visual analytics, modelling and simulation (beyond general equilibrium models), collaborative governance and crowd sourcing, serious gaming, opinion mining. (Crossover, n.d.)

This was also the original ambition of the SG revival in 2002 when the Woodrow Wilson Center organized a seminar on 'Improving Public Policy Through Game-based Learning and Simulation'.

> Given the importance of models and simulations in public policymaking, and the need to improve their effectiveness, the governmental and non-governmental model and simulation building communities should be striving to explore and build on other existing model-building practices. Some of the most interesting work being done is within the interactive entertainment industry. (Sawyer, 2002, p.1)

The SG movement has staggered worldwide since then, but the main emphasis is now on game-based learning backed with arguments from economic innovation, because games are seen by policymakers as cool and creative forms of digital technology, whereas the original intention to use games to improve public policy (i.e. the persuasion and complex systems frames) receives much less attention. Of the two frames, the complex system frame is the most difficult to identify because it tends to operate in other domains of research and policymaking – for example in transport, environment and water – and it is sometimes reluctant to identify itself with gaming.

Long before the SG revival in the mid-2000s, the use of gaming for complexity was well-founded and well-studied. Duke's Gaming: The Future's Language presented gaming as a new language for holistic or Gestalt communication particularly relevant for complex policy, organization and management problems:

> Real world systems are based on many variables that interact with each other in dynamic feedback relations leading to uncertainty (…) many variables cannot be quantified and there exists no proven conceptual model or precedent to base decision and action. The social political context (…) shows many actors that may be strategic or a-rational and finally there is a futures context in the sense that the

> decision is irrevocable and the results will not be understood well into the future. (Duke, 1980b, P.364)

This argument of holistic communication was further detailed and elaborated in a stream of studies, a stream that continues to this day. These studies have one thing in common: they view gaming as a third way of human inquiry. Gaming is presented as an unconventional method that bridges mathematical models, computer simulations and participation. It resides between the formal language of the mathematical sciences and the natural language of socio-politics. The argument frequently starts with a consideration of the weaknesses of two types of scientific policy support: formal models (e.g. climate change computer models) and multidisciplinary expert panels, such as the International Panel on Climate Change (IPCC). This leads Parson (1997) to argue that:

> These two conventional methods can usefully address some knowledge needs of global change issues, but are systematically ill-equipped to address others. To address the knowledge needs that are not well met by conventional methods, the paper argues for the use of a set of alternative methods, known by various names, including policy exercises, simulation gaming, and scenario exercises. (Parson, 1997)

In the Policy Exercise, we explicitly find this integration of scientific analysis and intuitive, creative and moral reasoning.

> [the policy exercise] can and should integrate methods, models, techniques, and indeed anything useful from the actual field to which it is applied. (Toth, 1989)

> Disciplined use [of the policy exercise] permits explicit presentation of model predicated on known facts but supplemented by intuition of actors. (Duke & Geurts, 2004a, P.37)

And although the names and definitions of such integrated methods vary, it is recognized that such methods become game-like.

> One important design variant is that such methods may have more or less of the character of a 'game.' While some authors argue that the hypothetical character of these methods make them all games, it is more common to define games as showing some combination of the conditions: structure and rules that guide participants' choices. (Parson, 1997, p. 274)

Another way to consider the relation between games and policymaking is through the notion of play. Around 2000, Schrage more or less unintentionally played an important role in the revival of the SG movement. Sawyer's consideration of SG for policymaking came not from Abt's Serious Games (1970), but from Schrage's Serious Play – How the World's Best Companies Simulate to Innovate (2000). Using examples like Boeing's breakthrough 777 jet,25 Schrage argued that serious play induces and supports innovation. It inspired Lego to develop Lego Serious Play, which is used by all sorts of companies and organizations to tap into their creative power to innovate. It also inspired designers to look into 'playful design' and 'playful interaction'.

5.4 Approaches to integration

What are the methods for integrated policy analysis and do these methods become like games? Using Table 3.1, I distinguish the following methods for integration. I discuss them in the following sections.

(1) Inclusive modelling-simulation
(2) Inclusive participation
(3) Inclusive participatory modelling-simulation
(4) Complexity simulation
(5) Complexity play
(6) "Serious game-play"

5.4.1 Inclusive modelling-simulation

In the scientific world, computer models have a long tradition in integrated studies. In IWM, for example, analysis relies strongly on scientific and expert knowledge captured in a great variety of models. Models are used to calculate air quality, water and soil pollution, land use, population growth rate, etc. Later, methods and approaches were developed to integrate single, yet still analytical models/modules into integrated models. In other words, the output from one model is the input for the next one. The data from different models influence the calculation interactively for the final model output. In this way, integrated models are developed into computer simulations where the integrated data and analysis represent the problem and the possible solution for the studied system in different temporal and spatial scales (Ackoff & Sasieni, 1968; Pidd, 2003).

The integrated, dynamic simulation models used in the many types of spatial planning, such as IWM, as well as sustainable urban development, are often equipped with geographic information systems (GIS) to facilitate the analysis by providing visualized geographical information (Kammcicr, 1999; Zúñiga-Arias, Meijer, Ruben, & Hofstede, 2007). Urban Strategy is one such simulation featured in this way (see Figure 5.6 and Text box 5.8). This model was developed to facilitate the interactive planning of sustainable cities. It calculates the causal relationship between air quality, noise and safety hazards with the various aspects of impact on human health by using a series of integrated modules. The results are presented not only in traditional diagrams and tables, but also in the form of 2D and 3D visualized maps that provide immediate feedback on the consequence of choice.

Some other inclusive simulations provide the 3D visualization in more detail and smaller scales, such as a street view with people walking around. Figure 5.6 and Text box 5.8 present such a visualized interface capture from the UrbanSim model.

Figure 5.6 Urban Strategy

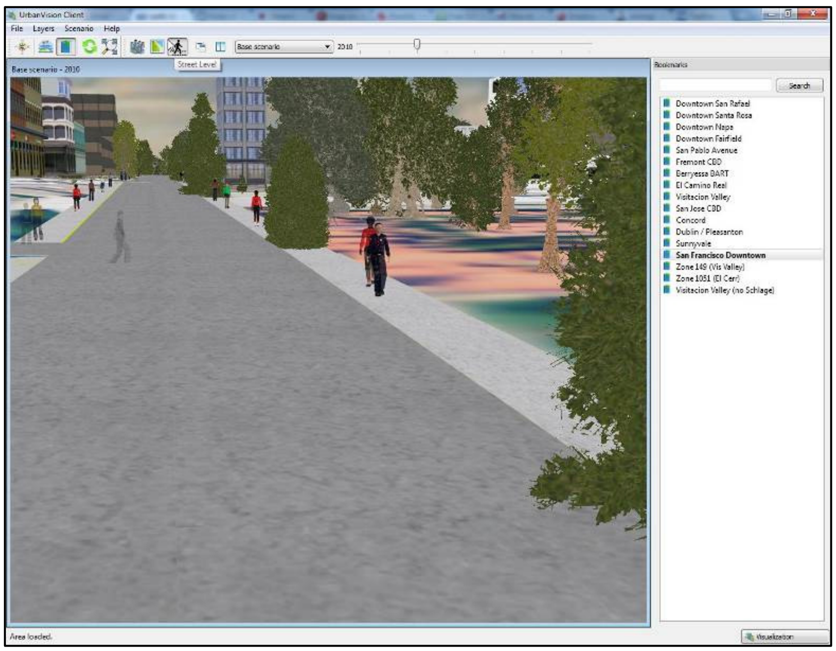
Text box 5.8 Urban Strategy

> The balance of a tightrope walker is needed to intervene among all the different vested interests in urban areas and major infrastructures. Any modification to a particular terrain will almost always have an impact on other areas. For instance, you can boost the air quality of a city district by allowing access exclusively to clean trucks or by rerouting all freight traffic. But the two measures turn out quite differently when it comes to accessibility and traffic safety. ((Website) TNO, n.d.)

Text box 5. 9 UrbanSim

> UrbanSim is a software-based simulation system for supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, the economy, and the environment. It is intended for use by Metropolitan Planning Organizations (MPOs), cities, counties, non-governmental organizations, researchers and students interested in exploring the effects of infrastructure and policy choices on community outcomes such as motorized and non-motorized accessibility, housing affordability, greenhouse gas emissions, and the protection of open space and environmentally sensitive habitats. (UrbanSim, n.d.)

Figure 5.7 UrbanSim



Another example is the SimWaterScape model (see Text box 5.10), which was developed to facilitate the collaborative planning of IWM among various water authorities and spatial planners in the Netherlands. Based on the calculating modules, this model includes a quite interactive and visualized interface to enable easy communication among policymakers. It is a formal model – an instrument – but it is also regarded as a game.

Text box 5.10 SimWaterScape

> SimWaterScape is a model that can simulate the consequences of water interventions. It is tested for designing integrated spatial water plan in the area of the Brabant Water Board. Water managers and spatial planners can use SimWaterScape to see the consequences of their choices in a particular area. All information about planning, water level and water flow are involved in this model. The game [sic! QZ] can be played by the various actors in a process area, which contributes to recognizing and balancing each other's interests. It facilitates discussions between governments, as well as serving as a presentation tool. Various actors – for example water boards, provinces and municipalities, as well as the planning service department – used this tool in a design workshop. ('Leven met Water Kennisopbrengsten', n.d.)

5.4.2 Inclusive participation

The rationality of involving non-scientists in policy analysis and policy processes was explained in Chapter 1 (see section 1.6). In general, a participatory approach is organized as a process of pure discussion among a group of selected representatives of political parties, scientific communities and stakeholder groups. In the process, the participants are enabled to articulate their specific interests, relevant knowledge, values and preferences regarding the decision issue. It is argued that sharing all the information leads to a better understanding of the problem and a greater chance that a better decision will be made (van Asselt & Rijkens-Klomp, 2002).

Some participatory methods are argued to be the way to empower citizens and stakeholders and thus promote democracy. Here, the involvement of stakeholders and the presenting of values are the most important issues. Participatory methods, as practised in, for example, integrated assessment (IA), are means to elaborate knowledge and enrich assessment. They prioritize knowledge production rather than pure democracy.

In integrated knowledge production, a big challenge is to clarify the scientific operational procedures. When non-scientists and participants from various disciplines come together for policy analysis, the process often becomes messy. In order to structure the participation into a meaningful process, the difference between the diverse forms of knowledge and evidence has to be recognized. The criteria, steps and outcome of the analysis in a multidisciplinary process need to be established (Barbour & Barbour, 2003).

Such structured, clarified procedures of participation can be found in the methods of, for example, scenario analysis and policy exercises. In scenario analysis, a group of people are invited to identify key issues and interactively develop a series of narrative stories about the possible future situation. The participants are people with a thorough knowledge of the problem. During the interactive teamwork process, the participants gradually create the building blocks of their scenarios. In policy exercises, such exercises are even put into a 'gaming atmosphere'. Here, gaming atmosphere refers to the simulated policy problem or system whereby roles are designed as part of the simulation and are played by the participants themselves. This method is regarded as a new vehicle for jointly developing knowledge.

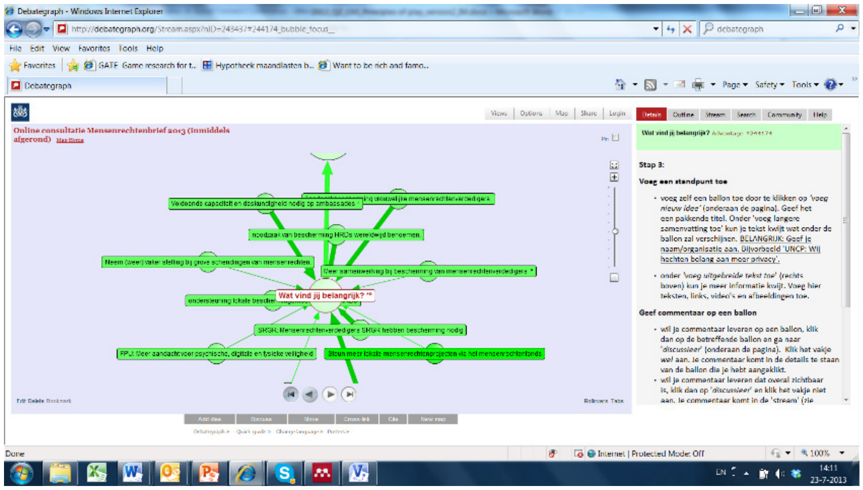
In recent years, various ICT tools and new social media technology have been developed to facilitate dialogues among large groups. The qualitative information from participants' arguments, reasons and thoughts are structured and visualized in these new ways of facilitation. One example is the new media tool DebateGraph, which is described below (see Text box 5.11).

Text box 5.11 DebateGraph

> DebateGraph is an award-winning, cloud-based service that offers individuals and communities a powerful way to learn about and deliberate and decide on complex issues. It does so by enabling communities of any size to externalize, visualize, question, and evaluate all of the considerations that any member thinks may be relevant to the topic at hand – and by facilitating intelligent, constructive dialogue within the community around those issues. Moreover, each public map contributes to, and forms part of an accumulating graph of structured understanding across a growing range of topics, which, as the topics intersect, accelerates and enriches each community's understanding of the topics each is addressing. (DebateGraph, n.d.)

One of the features of this new media-supported participation is almost like a game. Information from different people is categorized in vivid presentations on the smart and artistic interface. The users can easily 'play' with the information by clicking around and can structure his/her own reasoning by interrelating information at different scales and levels. Figure 5.8 shows such an attractive and vivid presentation.

Figure 5.8 DebateGraph



The Opinion Space tool is another example of such a design to support inclusive e-participation. The design applies a similar structure and visualization to calculate and present information (see Figure 5.9).

Figure 5.9 Interface of the Opinion Space tool

The ‘game features’ of this participatory tool are explained on its official information website (see Text box 5.12):

Text box 5.12 Opinion Space

> Using an experimental gaming model [sic! QZ], Opinion Space incorporates techniques from deliberative polling, collaborative filtering, and multidimensional visualization. The result is a self-organizing system that uses an intuitive graphical 'map' that displays patterns, trends, and insights as they emerge and employs the wisdom of crowds to identify and highlight the most insightful ideas.
> (Opinion Space 3.0, n.d.)

5.4.3 Inclusive participatory modelling-simulation

Inclusive modelling and participation as separate methods address the different dimensions of complex problem analysis. Modelling enables the analysis in depth, and participation broadens the scope of discussion. The ultimate goal of socio-technical integration, however, is the integration of modelling technology and participatory approach.

In an ideal situation, these approaches should be mutually reinforced approaches to each other, in order to combine the depth and breadth of the analysis. At first sight, however, it seems that these two approaches are irreconcilable because they use irrelevant technology and are based on conflicting epistemologies (Hisschemöller, Tol, & Vellinga, 2001). The common earlier practice was to bridge the gap by incorporating stakeholders' values and preferences and local knowledge into the expert models. In this way information is collected through a participatory approach and formulated by the modelling expert as input for mathematic models. Earlier examples of such activity can be seen in the participatory modelling of, for example, the IMAGE model and the RAINS model. In the development of these computer models, the crucial parameters and criteria are jointly selected and designed with the stakeholders' community in the design phase (Ritchie & Spencer, 1993; van Asselt & Rijkens-Klomp, 2002).

The more recent practice enables non-scientific people to participate in the modelling process. By using user-friendly ICT (information communication technology) tools and modelling technology, participants can interact with the computer model themselves to develop policy options (Bourget, 2011; Hagen, 2011; Langsdale et al., 2013). In the policy fields of water management, spatial planning, urban development, etc. such interactive modelling is becoming an important way to bridge the gap of the SPI. Two examples are given in the two following text boxes (5.13 and 5.14).

Text box 5.13 U@MARENOSTRUM

> The project aims at supporting citizens and local actors to identify and solve important environmental problems related to the management of water and marine environmental protection in the Valencian and Ionian Islands regions in order to enhance their participation in the environmental legislative and decision making processes. The U@MARENOSTRUM technological platform will be a web-based Public Participation GIS created through the customization of the Gov2Demoss open source platform integrated with a Geographic Information System (GIS). (Mare Nostrum, n.d.)

The description of the U@MARENOSTRUM project and the 2050 Calculator shows that an interactive technological platform has been developed for the participatory analysis of water and marine management problems. Geographic information system (GIS) in interactive modelling nowadays often provides a basic platform to allow users to assess, store, transmit and manipulate information in a visible way. In many models, the GIS is presented in 2D or 3D visualization. To encourage participation, attractive audio-visual systems are added to make the modelling environment vivid and immersive. Pictures, cartoons and 3D visualization increase users' immediate understanding of the information and possibility to operate the model. Complex analysis becomes no more difficult than playing a computer game. To illustrate, Figure 5.10 shows the interface of the Pathway 2050 model. This web-based model can be used by anyone who wants to develop his/her own policy strategy to reduce greenhouse emissions in the UK:

Text box 5.14 2050 Calculator

> The UK is committed to reducing its greenhouse gas emissions (GHG) by at least 80% by 2050, relative to 1990 levels. For this to happen, we need to transform the UK economy while ensuring secure, low carbon energy supplies to 2050. The 2050 Calculator is a user-friendly model that lets you create your own UK emissions reduction pathway, and see the impact using real UK data. The Calculator helps everyone engage in the debate and lets Government make sure our planning is consistent with the long-term aim. The 2050 Calculator outlines, in minutes, months of work from technical experts. It can be used to engage a range of audiences on the challenges and opportunities of the energy system. It brings energy and emissions data alive, showing the benefits, costs and trade-offs of different versions of the future. It allows you to explore the fundamental questions of how the UK can best meet energy needs and reduce emissions. Source:(UK government, n.d.)

In the interface, the users are provided with the key information required for decision making, such as the data on supply and demand, and the cost and effects of each choice. The information bars, indicators and the cartoon drawings of the emission source give the model a gaming environment (see Figure 5.10).

Figure 5.10 Pathway 2050

5.4.4 Complexity simulation

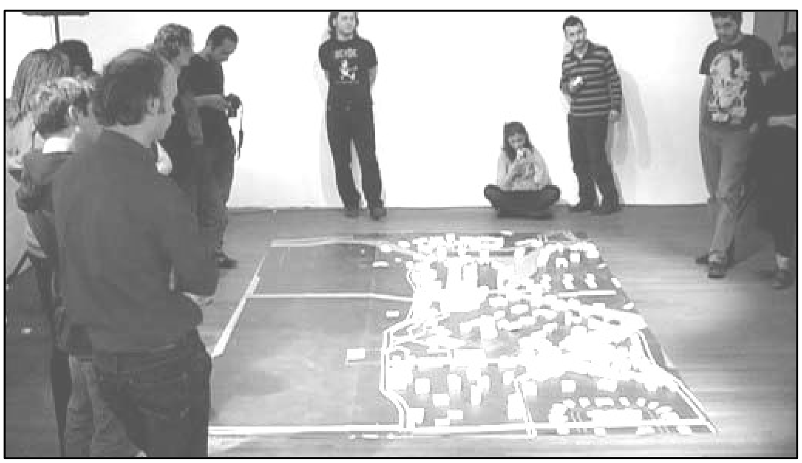
Some games are built upon computer simulation technology. System dynamics (SD) and agent-based modelling (ABM) are the two most relevant simulation approaches for these complexity simulation. The socio-technical complexity is represented by the formal computer language. Complexity simulation are regarded as the representation of the formal system, the core of which is a set of formal rules and elements that induce the motions and effects of the system behaviours. Objects, properties, behaviours and relationships are for example defined as the basic elements (Szymanezyk, Dickinson, & Duckett, 2011; van Os, 2012). The interconnection among the basic elements is defined by formal rules, for instance a objective of action is defined by the interest of properties (Abrahamson & Wilensky, 2005; Fullerton, 2008; Sacerdotianu, Ilie, & Badica, 2011). In SD games, mathematical calculations are applied on the feedback loops and time delays of the interaction of elements and the non-linear effects as the systems' behaviours.

ABM, a more recent approach, simulates human actors as agents with different attributes in a computer model. Actors are presented as multiple autonomous agents (either individuals or organizations). The human behaviour and interaction is quantified into a number of variables such as roles, rules, objectives and constraints. As a digital agent, the humanity is reduced to computable factors like variables in a computer model. In both approaches, the actions and objectives in a system are based upon logics. The logics can be explained by using mathematical formulas and therefore can be formulated in computer models (Macal & North, 2006; Wooldridge & Jennings, 1995). Since complexity simulations are based upon purely logical actions, gaming in this sense is a computer operation process. They are therefore also regarded as the thin representation of socio-technical complexity (Meijer, 2009). We can see such complexity simulation in, for example, the City games. Although the City games are played by the human players, their planning activities are analysed only by using the formal rules. The construction of the city is analysed and explained in computer language. Human players in this way play the games in the same way as the computer agents (see Figure 5.11 and Text box 5.15).

Text box 5.15 City games

> The responsive city game is a response that searches a new way where the town expansion emerges as a natural organization. Thus in the game, there is neither a global, conscious, pre-set design order at stake, nor a predefined programme. On the local level, the participants have a goal: finding the best fit location for their aim in a given round. (Tan, 1996)

Figure 5.11 City games



5.4.5 Complexity play

Compared to complexity simulation, participatory games are the soft method of play. In the participatory gaming process, a number of selected academics, policymakers/practitioners and stakeholders are invited to play the simulated roles in the game. The roles normally represent the key ones in the real-life problems. Here, the rules and attributes represented in mathematic formula in the complexity simulation are assigned human roles and played as human activities. The players, with their assigned roles, work together on developing or deciding the possible policy solutions. The strategic complexity of the decision process is reflected not through digital agents but as an informal process of real human interactions that bring in tacit knowledge, emotions, intuitions and all the other elements that cannot be reflected by computer systems (Duke & Geurts, 2004a; Duke, 1998; Toth & Hizsnyik, 1998; Toth, 1989).

A participatory role-playing game is therefore regarded as an un-calibrated, free-form method. Human players' imagination and creativity are the essence of the gaming process. Players are encouraged to play with their ideas and invent the future. What happens in the gaming process depends fully on how the players behave in the process. The 'play' adds values on discovery and exploration to the uncertain future. It is an un-calibrated and intuitive approach that is intended to produce profound counterintuitive results. Knowledge is synthesized through the process of human interaction, from learning by doing, trial and error, and creating a shared future (Brewer, 1986; Duke & Geurts, 2004b). An example of the participatory role-playing game is given in the following text box (text box 5.16).

Text box 5.16 Trade-Off!

> Trade-Off! is a board game that lets you play the role of different coastal stakeholders—from natural resource managers, commercial fishers, scientists, developers to elected officials and others—who negotiate uses and activities in a coastal community. During this process, a coastal management plan takes shape and the stakeholders gain an understanding of the compatibility and potential conflicts of multiple-use objectives. The goals of the game are to: Deepen understanding of the broader concepts of multi-stakeholder negotiations; Gain insight into the goals and perspectives of various stakeholders participating in negotiations in ocean zoning/ marine spatial planning; and Become familiar with the framework of marine and coastal spatial planning and the implications of good (and poor) decision-making. (SeaWeb, n.d.)

5.4.6 Serious game-play

Serious game play combines formal computer simulation with role play as an integrated method for complex policymaking. One such approach is the combination of ABM and the role play process. ABM is designed to address the formal rules and issues in the system, but also as an adaptive tool that can quickly react to the changes and uncertain situation of the system. Role play is applied to let participants be involved in different scenarios, and to play with their own ideas as part of the scenarios, such as trying to develop different strategies to reduce environmental pollution, design a management plan or build a sustainable infrastructure (Brewer, 1986; Parson, 1996, 1997). It is also designed to trigger the discussion and learning among stakeholders. The ComMod (companion modelling) approach is a good example of serious game play. Since 2000, some researchers working in the field of renewable resource management have been combining agent-based models with role-playing games, to tackle issues regarding decision processes, common property, coordination among actors, etc. Integrating models and games is an approach to cross disciplinary boundaries and to acknowledge the complex socio-technical nature of the problem. In recent years, the ComMod approach has been applied in various cases of the relevant topics, including water management, sustainable land use, etc. (see Text box 5.17).

Text box 5.17 Companion modelling

> In conservation areas, land use conflicts frequently occur due to the increasing number of land resource managers and users who usually have different interests, objectives and perceptions. Sharing all these a priori legitimate differences is a prerequisite for better collective management of the land. The companion modelling approach is used to build a shared representation of interactions between vegetation dynamics, reforestation efforts and livestock grazing in a forest conservation area of northern Thailand. This article focuses on the participatory modelling process that led to the co-construction of an agent-based model. Sensitizing exercises on vegetation dynamics and an agent-based simulator associated with a role-playing game were the main tools used. The social interactions and decision-making processes observed during the gaming and simulation sessions were used to construct a set of rules implemented in a subsequent autonomous agent-based model. It will be used to simulate future land management scenarios with local stakeholders (Dumrongrojwatthana et al., 2011).

In serious game play, formal modelling is regarded as no more than an intermediary tool to facilitate the collective and interdisciplinary thoughts of humans. Modelling and models are therefore used to apply the advantage of computer models to a participatory process and collective decision-making. They are used to mediate and support dialogues, and to formulize the integration of knowledge in different types and the perceptions of different stakeholders (Daré & Barreteau, 2004; Dumrongrojwatthana et al., 2011; Guyot & Honiden, 2006; Sotamaa, 2007).

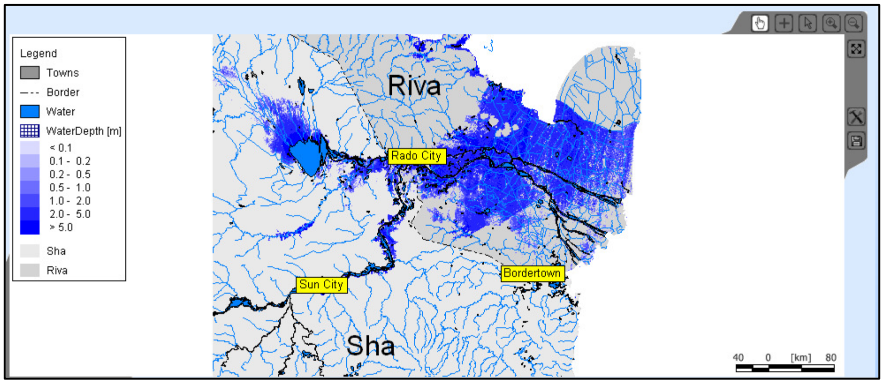
Serious game play can also refer to the use of SG in policymaking. Here, the technical artefact of the game is used to integrate scientific models, large databases, gaming technology and simulation environment into a system that can be played as a computer game, but that also generates output that is serious and reflects real life. When playing an SG, players start by selecting a role, and then make their decisions on policy options step by step. The players' knowledge, experience, emotions and interests integrate the input of the modelling to the database and formal calculation behind the game.

The ShaRiva game jointly developed by UNESCO-IHE and Deltares is a recent illustration of how serious game play can support policy analysis. As a component of the Vietnam Facility Project for 'Advanced training in modelling and information management applications for water, environmental management and climate change adaptation issues' (Deltares, 2011), game play had been used as one of the innovative ways to use models for policy analysis. The problem addressed in the game is trans-boundary flood management. Based on the decision support system BlokkenDoos, role play is added to reflect the multi-actor complexity in the area of the Mekong River. The BlokkenDoos model has been adapted with real data and information in the local area to provide a serious analysis of the real-life issues. Trans-boundary, complex socio-political issues are addressed in a role playing context of the countries 'Sha' and 'Riva'. The players are provided with information about, for example, agriculture, fisheries, aquaculture, roads, infrastructure, etc. by the Shariva River Commission Secretariat. All the relevant data in the information are provided by a scientific model; the potential conflicts in the real-life situation, however, are safely guided in a game play environment. The interface of the simulation tool is presented in Figure 5.12. Text box 5.18 contains a description of the background information on the river delta provided in the game, to illustrate how real-life, serious information can be addressed in a game play environment.

Text box 5.18 Background information on the river delta provided in the ShaRiva game

> The river Shariva enters Sha 1,200 km from the source. In Sha, the river has dug itself into the alluvium and drops about 20 m in the first 100 km. The river in this section is mainly confined to the floodplains, as the surrounding country side rises steeply besides the river channel. Once the slope decreases the floodplain is widening and flooding becomes an issue, locally flood recession agriculture is practiced. During the flooding season, the lake is filled, and the water area is increased twofold, with a lot of agricultural and aqua cultural activities as a result. During the dry season, the lake drains. (UNESCO-IHE, 2011)

Figure 5.12 The interface of the ShaRiva river management simulation tool



5.4.7 What do we learn from these examples?

The main thing these examples have in common is the artefact. The artefact can be advanced computer models as we see in the modelling based approaches or a set of rules and elements to guide human interaction. In one of the other types of artefact, real-world problems are reflected. But more important, the artefact encourages the users to do something with it. These artefacts are therefore playable systems. They are different from purely analytical tools, because their models and systems can more or less be played with. To understand how game play serves policy analysis, it is necessary to understand the effects of play, in a context where the artefact is played with.

5.5 Principles of play

5.5.1 Game-like methods

I demonstrated above and in Chapter 3 how inclusive modelling can be seen as the inclusion of more data from more models to form a new inclusive model: a symbolic representation, $1 + 1 + 1 = 3$. Similarly, inclusive participation is the inclusion of more natural languages from more actors, symbolized as $a + b + c = (a\ b\ c)$· Integrated methods of the inclusion type use techniques and principles that make them game-like. Inclusive computer models use visualization techniques borrowed from game technology; game-like user interfaces can improve the usability of the software for experts and non-experts alike. Game-like dashboards may enhance the feedback of data to the user. Inclusive participatory methods on the other hand, use game technology and mechanics to attract, recruit and intrinsically motivate participants, to handle the dialogue among the participants, to feedback information in an aggregated way, etc. All such techniques are innovations that may cope with tensions at the SPI, and improve the communication between modeller, policymakers and stakeholders. Developers innovate with game technology and play to make the methods more user-friendly and attractive, and with faster performance, more flexible use, better graphics, more visual analytics and more diverse participation. Inclusive participatory methods combine game-like techniques such as engines, visualizations and analytics with mechanics that motivate and enable a larger or specific audience to play with it. The playing itself can lead to policy-oriented learning, analysis of the problem or policy-relevant information. In short, the use of game technology and play make the integrated methods perform better at the SPI.

But these methods are not full-blown games; they are game-like because they simply borrow from games. And here we need to come back to Wittgenstein's language game discussed above. As it is impossible to define what a game is, the scholarly discourse about these methods becomes confusing. For some, the methods of inclusion are a game, because they have certain characteristics, (*1*, *a*) etc. For others these methods are not a game, because they lack characteristics, (*2*, *b*).

For the integrated methods of synthesis, the game-like characteristics are different: here it is emergence $1 + 1 > 2$ that makes the method game-like. A few system elements, under a few simple rules, can create emergent complexity that feels like a game. The reason, I believe, is that games are complex systems in themselves. And the artefacts in the complex system are playable and playful to stimulate synthesis. On the basis of this, I now formulate three basic principles of synthesis.

Complexity modelling, with agent-based models and system dynamics, lies at the heart of many entertainment games and SG. On the other hand, complexity can also be played without a computer, as games like Harvest and the City game clearly demonstrate. The best entertainment and SG are essentially very simple: they are the simplest, playable representation of a complex system. The system dynamics that arise from complexity modelling, interactive human play and serious game play are presented in three general principles of synthesis.[26]

1: Principle of games as complex systems

> A game is a complex system that derives its distinct features, like challenge and surprise, from emergence.

2: Principle of games as playable complex systems

> A game is the simplest, playable representation of complexity.

The most game-like integrated methods are combinations of computer simulation and playing with complexity: they are playable representations of a complex real-world system. We want the playable representation to help us understand how players play with it and what it means to policy analysis. Answering the central question – What does it mean 'to play' and how does this serve policy analysis or any other system in the real world? – is therefore key to knowing how game play serves policy analysis. The meaning of serious game play is rooted in the general principles of play.

5.5.2 General principles of play

To play lies deep in the nature of animals and humans. Children play because they are full of curiosity and passion to learn new things. Play can captivate them for a long time; if they fail (not too harshly) they will keep trying until they master it. Artists play with any kind of artefact, mentally or physically, to create their art works. We can play with artefacts that have regular functional purposes, like children play with their food or anything else on the dining table, and teenagers play with their smart phones. The wooden construction blocks known as Kapla were conceived by someone who wanted to make scale models for the renovation of his country house in France. One day, he simply started playing the renovation of his estate. We can even play enemies, colleagues or lovers.

3: General principles of play: Play

> We can play with any artefact – mental or physical – but this is not necessarily and generically identified as playing a game.

So, what does it mean to play with an artefact? Here, I simply take Suit's observation: when we play, we turn an artefact into an unnecessary challenge. In other words, we challenge ourselves, or voluntarily agree to be challenged, in the expectation that the challenge itself will be rewarding (e.g. enjoyable, makes us feel better) even if we fail.

4: General principles of play: Unnecessary challenge

> When we play with an artefact, we turn the artefact into an unnecessary challenge.

The challenge itself may come from others, like in sports, or from the artefact, like a puzzle. The challenge might be to collaborate with others, because we have a natural inclination to compete. The challenge may come from within – the challenge to be different from or better than what we are – because in many role playing games, and theatre games, we play somebody or something else. In play therapy, we play with the aim of healing ourselves.

In contrast to games, play does mean anything about safety for the player. Although unadvisable, we can voluntarily agree to play Russian roulette or casino games with high stakes. The unnecessary challenge of extreme sports implies taking the calculated risk of losing one's life. When the chance of losing (or winning) approaches, it is no longer play, but certain failure (or guaranteed success). When we cannot control the outcomes through personal mastery of skills, it is not a game, but a gamble. Playing therefore also implies learning to master the necessary skills in order to control the risks and not be foolish.

While we can play with any artefact, some artefacts have been designed in a certain way to induce play. They can be daily objects, like paper clips or little pieces of wire that have some kind of attractiveness. These are the things we cannot leave alone when they are lying on the table in front of us. We need to fiddle with the object and turn it into an animal. For many people all over the world, this playful object is a ball, a tablet or smartphone, or some piece of computer software that induces us to play. That is why these artefacts that induce us to play are called sports or games. They send out 'pheromones' to get us to play, like flowers gives off a scent to attract bees. In a game, all ingredients – the artwork, the rules, the storyline and so on – have been designed to get us to play, to continue to play, to return to the play, etc. (T. Bekker, Hummels, Nemeth, & Mendels, 2010; Copier et al., 2012; Juul, 2005; Koster, 2005; Malaby, 2007; Susi, Johannesson, & Backlund, 2007). The reason is that the artefact gives us feedback on how we are doing, that is, to what level we have mastered the skills as compared to others.

5: General principle of Play: Game for play

> When an artefact has been intentionally designed with a specific set of components following a specific set of rules that encourage starting and continuing to play with the artefact, this artefact is generally recognized as a game.

We need to make a distinction between the activity of playing, the artefact with which we play and the context in which we play. This is why the English and the Chinese language are more correct than the Dutch and the German language: I *play a game*, or in Chinese, *Wo* (I) *Wan* (Play) *Youxi* (Game); In Dutch, *Ik speel een spel*, and in German *Ich spiele ein Spiel*.

6: General principle of play: Playing a game

> When we interact freely with the artefact identified as a 'game', we call it 'playing a game'.

The question whether the playing with an artefact in a specific context has any bearing on the world before, outside or after the playing (i.e. the external world or reality), is subject to heated debate. Some have argued that the playing of a game stands on its own. Any link between the game and the external world reduces the intrinsic value of game play. The game is isolated from the external world by a magic circle. Others have argued that the game play is isolated from the external world, but that there are constant interactions between them. The magic circle is like a membrane, through which things slip. Yet others have argued that there is no distinction at all between the game play and the external world, because in fact game play is real and the external world is like a game. In my opinion, this magic circle controversy is itself like a little language game.

5.5.3 Principles of serious game play

When we grow up, we run the risk of forgetting how to play. After all, schools, universities, government departments and companies do not consider play to be a very worthwhile activity. In many work organizations, searching for words like 'game' on the Internet is not allowed. In some smaller, creative organizations, however, play at the workplace to create a better atmosphere, to relax and to perform better. The Lego Group, for example, has developed workshops for innovation, design and change that use their world-famous bricks. The rediscovery of play may come at some management course. The discipline of simulation gaming or serious gaming (SG) also reintroduces game play to professionals, managers, scientists: it challenges them to be flexible, creative and open-minded, to see the complexity of a problem (Breitlauch, 2012; Koster, 2005; Moreno-Ger, Sancho Thomas, Martínez-Ortiz, Sierra-Rodríguez, & Fernández-Manjón, 2007). But even in day-to-day policymaking and planning, it is not uncommon to play with serious artefacts, such as design concepts, maps, proposals, models and political beliefs.

7: Principles of serious game play: Play seriously

> It is not uncommon in worlds like business or policy to seriously play with serious artefacts, like ideas, design concepts, money, physics, business plans and computer models.

In a professional work environment, we can casually play with a serious object, like a smartphone, without any external meaning; we can also use non-serious artefacts like Lego bricks or Kapla blocks to design a new product with a team. And we can play with serious artefacts like a city plan or data from computer models in order to tackle a real and future challenge. It is even possible that we pretend to play non-seriously while it is actually the opposite, and vice versa.

8: Principles of serious game play: Play seriously or non-seriously

> We can play non-seriously with a serious artefact (and this can have political meaning), just as we can play seriously with a non-serious or a serious artefact.

Even non-serious play with plain artefacts can convey serious meaning. For example, Marcel Duchamp turned a urinal into art in order to criticize art itself (see Figure 5.13).

The question what it means to play seriously should therefore be asked. I have defined play as voluntarily engaging in an unnecessary challenge. In serious play, the challenge may be necessary because some urgent problem needs to be solved. But somewhere inside the human constitution lies the capacity to pretend for a moment that the necessary challenge is unnecessary, because this might help to find new ways to overcome the real challenge. This pretending, though, is far from easy. A lot of people find it impossible to do. They think it is silly and a waste of time. They prefer to go from A to B in a straight line. But sometimes the straight line does not go to B, or when we get to B we don't want to be there, or in a wider context it is more efficient to also connect X, Y and Z.

Figure 5.13 Playing with a non-serious artefact gives meaning

Fountain 1917, by Marcel Duchamp

9: Principles of serious game play: Serious play

> When we interact with an artefact as though it were an unnecessary challenge, but the playing with this artefact actually produces some social, political or economic value, we recognize this interaction as serious play.

In a policymaking context, we can literally play a game, where the play part refers to the context of use – the rules of play – and the game refers to the representation of reality. But we can also use other ways to represent reality (e.g. mathematics, a computer simulation, a story, art, visuals) and build a context of play around it. In a policymaking context, this will be a plan, a scenario, a model, a simulation or social software. Such a shell of play around an artefact can be a non-explicit, informal kind of play, where the rules have hardly been defined. But it can also be a more formal kind of play, with assigned roles and objectives, and with rules in a certain story (Salen & Zimmerman, 2004; van Bree, 2013).

The art of serious game design teaches us to design an artefact in such a way that a proper representation of the necessary or unnecessary challenge for a specific audience is achieved.

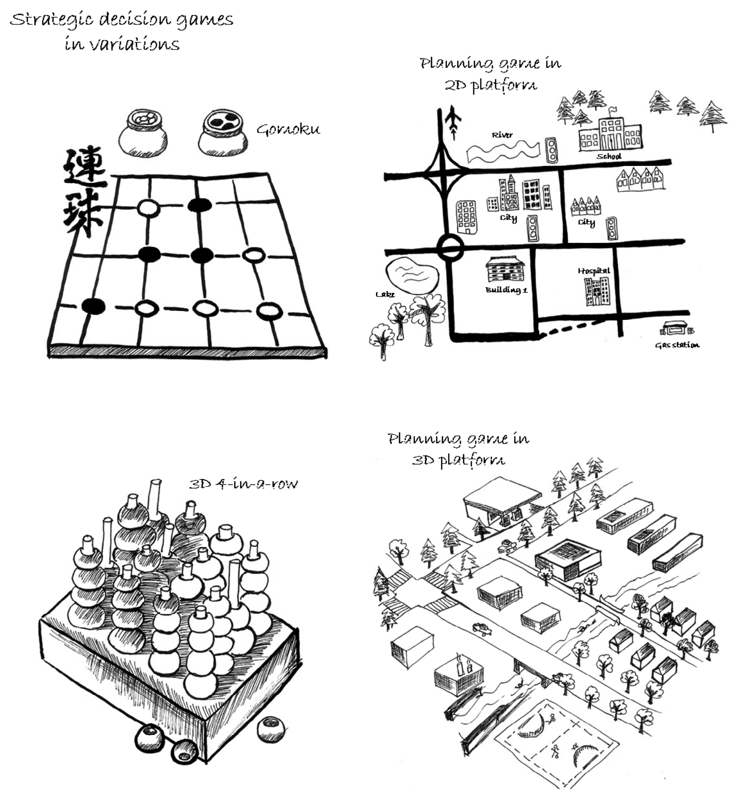
10: Principles of serious game play: Seriously game play

> When we seriously play with an artefact that has been intentionally designed with a specific set of game rules and game components, but the playing of this artefact is intended to realize some societal, political or economic value, this artefact is generally recognized as a serious game or a simulation game.

SG comes in many, many forms. Like music, the innovation in game design is endless, because the game is a complex system. Small changes in just a few ingredients can completely alter the game play. A variety of spatial planning games are shown in Figure 5.14. The players can play with stones on a board (like in the Chinese five-stone Gomoku game), play with stones in a 3D wooden structure (4-in-a-row), or play with houses, trees and people in a 2D or 3D planning game. What ingredients are the same, and which ones are different? We can give a list, but essentially the question is impossible to answer.

So, games use any and many kinds of ingredients. But perhaps that is less important when one wants to know the role of serious game play in policymaking. There are certain principles of serious game play that go beyond the ingredients of the game artefact. Some of them are principles sine qua non; game play is not possible without them. Others are principles of effect because this is how the game involves the player.

Figure 5.14 Variations of a game



And in fact, all types of game run a bunch of variations on the principles of play.

5.6 Principles sine qua non

Human nature triggers us to play and to learn through play. But both playing and learning decrease with an increase in age, experience and professional position. Adults no longer play so easily, and when they do play, they tend to play carelessly, as a little distraction. So how does serious game play happen? We argue that just as there is communicative rationality in political and societal debate – for example, principles of fairness, equality and openness – there are also conditions for play, without which serious game play is not possible. They form what I call a *ludological rationality*.

One of the most important principles concerns the chance that the player may fail the challenge, namely he/she loses. Because in games it is a temporal, largely nonconsequential failure, the player can or should accept it. The acceptance of failure is more essential to games than the expectation of fun. One can play without much fun, but one cannot play without the chance of failing and the acceptance of it. In SG, the acceptance of failure on the one hand is necessary to play, while at the same time the real-world context – the learning, the problem solving – is putting pressure upon the game play because a real-world challenge needs to be met. However, the risk of failing in a game may be exactly what makes the player succeed better in the real world. A lion cub that play fights with his brothers may lose over and over again, but his failure may contribute to his victory when it finally matters.

Failures cause pain, but you learn through the painful experience (no pain, no gain). In professional sports, competitive athletes endure pain in order to achieve professional excellence, and the same applies in arts or mathematics. Failures in real-world games cause much more pain because they lead to serious consequences and risks. But sometimes when the price is too high (you lost your life), you no longer have a chance to learn. Failures in a game therefore give players unique opportunities to learn and correct themselves because here no real-life threatening consequences are produced. The positive emotions generated by accepting the failures and trying to correct them next time explains why game players are willing to play, even though they know they will encounter many failures (Juul, 2013).

11: Principles sine qua non: Acceptance of failure

> The player acknowledges that he/she may fail the challenge.

Consent is closely associated with the acceptance of failure. Others can persuade a reluctant person to join in their game, for instance when one more player is needed. A mother may reluctantly agree to play with her daughter, even though she needs to do some housework. But a player can never be forced to play a game, because the failure then has no effects on him/her, and this destroys the meaning of play.

Once in a game, the decision to stop playing is taken with an eye on the system that has emerged: the interest of fellow players, as well as what has been achieved so far. It may be that one player wants to stop, but continues for a while because without him/her the game cannot continue.

In SG, the value of the game play may go far beyond the personal interest of one or two players, so that the pressure to start or continue playing is stronger than in leisure games. In SG, there might be considerable pressure from a boss, an organization or an urgent problem to play the game. However, it is up to the players to consent to step in, and to agree to play as long as the SG play is meaningful to the player, to others or to the external world.

12: Principles sine qua non: Consent

> The players play the game for as long as they agree that it is meaningful to the individual players and/or to the player group or game as a whole.

From the moment a player agrees to play, he/she is committed to the game and should play full-heartedly; playing half-heartedly is disengaging and ruins the game. A reluctant father and husband who is persuaded to play a game with his family, but inattentively throws the dice while preparing dinner, is reducing the meaning of family game play.

13: Principles sine qua non: Commitment

> By entering the game, players voluntarily commit to play full-heartedly.

Players are an intrinsic part of the game. When somebody is playing, he/she should not comment about the game itself, or about other players, as though the player were an outsider, that is, a spectator, designer or operator of the game. When somebody is a spectator, he/she should not interfere as though he/she were a participant.

14: Principles sine qua non: Intrinsicality

> The player is an intrinsic part of the game system, not merely a spectator or operator.

What do you do when you play golf against your boss? Culture and personalities will determine how the game is played, but I assume it can be wise anywhere in the world to let the boss win, not too obviously. But at the same time, it destroys the game play. Things like power, status, hierarchy or any other external structure should not influence the game play or game outcome.

In SG, this can be a difficult issue, because it can very well happen that a lower ranked staff member is asked to play with or against the whole management team. Or he/she is asked to play the SG while the management is watching it or waiting to hear the results. This is certainly a reason why in countries with more hierarchical cultures, the use of SG for policy, organization and management is problematic.

15: Principles sine qua non: Equality

> Players are equal in the sense that power, status and hierarchy outside the game should not influence the play or outcome.

'… not that each player has an equal chance to succeed, but that they all play by the same set of rules' (Wikipedia, Level playing field). In real-world games, 'level playing field' is a concept about the minimum standard of fair chance to compete. Governments, businesses, sports, etc. all have their basic rules to define the participants' behaviours. In a game, a set of rules is also the basic element of a playing ground. Game defines the players' behaviours based on the game rules. The outcome of the play will then be decided by the players' capacity to control the game, and not be influenced by external interference. With an equal chance to compete, players play in a game as seriously as in a real-world situation.

16: Principles sine qua non: Level playing field

> The game gives a fair and equal chance to the player/all players and is not steered/biased towards a predetermined outcome.

It is certainly not acceptable when a player has an ace up his sleeve. This does not mean that players cannot cheat, as long as the game allows (that is, has rules about) cheating. There is a legendary game called So Long Sucker (first called, F*** Your Buddy) that revolves around the principle expressed in the game's title. In SG, there may often be cheating or foul play, because it is part of real life. Fairness also means that the game itself does not steer the players towards a certain outcome. The developer of an SG usually has a client who pays, and it is not unthinkable that a bias sneaks into the game design. When the board of company X wants to test its business strategy in a business war game, it may want the competitor team to play foul, perhaps even use fraud as a last resort to win. But it will not allow Godzilla to sweep away their company.

17: Principles sine qua non: Fairness

> Players agree that they do not give themselves an advantage without the other players knowing about and consenting to it.

Gnomes can raise the dead. That Gnomes do not exist, and can certainly not raise the dead, should not matter within the context of a game. One of the best ways to ruin game play is to question the reality level of things that happen in the game. Players should suspend their disbelief, or at least refrain from expressing it. This certainly applies to SG, because when one or more players question things like the purpose, limitations, symbols, back story or simplifications of the game while they are playing, it will seriously hinder the game play and learning. Such questions are legitimate and relevant but should be discussed before or after the game play.

18: Principles sine qua non: Suspending disbelief

> The players accept the game as 'true' for as long as they play.

You're no longer my friend! Players should not be subject to any consequence of the game play, other than what they agreed upon when they entered the game. This does not mean that the game cannot have external consequences, because SG are deliberately designed to have external consequences; but such consequences should be transparent, follow from the outcome of the game, and be agreed upon by the players before, or negotiated during the game (for example, the loser does the dishes).

19: Principles sine qua non: Safety

> The game play does not have any consequences for the player or the outside world other than those agreed upon by the players before starting the game.

The above principles constitute the rationality of game play, or what I call the ludological rationality. Without these principles, the meaning of game play is reduced or destroyed. This does not mean, however, that a transgression of one or more of these principles never happens. On the contrary, it happens a lot: you cheat; you let your boss win; you hate it when you lose a game; you don't do the dishes after losing. But all of these transgressions break down the meaning of game play, even if only a little. When this happens, some kind of repair is necessary in order to be able to play again: we can ignore the transgression or pretend we don't see it; we can tolerate the transgression for the sake of gaining something else, like the smile of our beloved child that has won the game; we may throw away the game board, angrily; we can apologize and talk it over with our game friends, refine or renegotiate the rules so that it does not happen again, and start another round of the game. This is how we learn not only to manage ourselves, our frustrations and failings, but also the transgressions of rules by ourselves and others, and the conflicts that arise over them.

20: Principles sine qua non: Repair

> Transgressions of the principles sine qua non happen all the time and can be repaired. If they are not repaired, the possibility of future game play is seriously endangered.

5.7 Principles of effect

Adults normally do not expect to learn from playing with a ball or a piece of paper (unless they are professional ball players or origami artists). Principles of effect make the game attractive to join and play, and trigger emotions. They also make the player learn (change, adapt) to the extent that he/she can meet the challenge that is meaningful to him/her. Given the fair amount of attention to pleasure and fun from games, it is high time to say something about their role. I have already indicated that the game artefact is intentionally designed to draw players into it. And although it is true that failures and pain are the art of game play for learning, it is also true that without making the game pleasurable and fun (and cool), nobody will want to play it.

21: Principles of effect: Pheromones

> A game is designed to draw target players into playing it.

In SG, however, the role of pleasure and fun may be a little different from what it is in leisure games. The 'pheromones' of an SG should attract a specific category of players, for example engineering students, water management professionals or biophysicists. The intended players of an SG can easily distinguish between the games they play for leisure and those they play as professionals. In other words, SG need to be engaging for the target audience in their specific capacity, but do not necessarily have to be engaging for the general public (unless this is the target group). An SG like the MSP Challenge 2050 might be seen as a non-engaging game from a general game perspective, but it is very engaging for a certain group of (perhaps even fewer than a few hundred) professionals because this game is about their world. Even games like MSP Challenge send out the right pheromones to attract a specific group of players who play voluntarily. The game therefore needs to be designed in such a way that the target players do not get bored or frustrated and therefore want to stop playing.

22: Principles of effect: Engagement

Players will not feel bored or frustrated during the game to the extent it will make them want to quit the game, but continue until the challenge is met.

As I mentioned, no pain, no gain. Although considerable attention in game studies is paid to flow (i.e. not being over- or under challenged) in games, less attention is paid to the notion of hard fun. In SG, being taken out of one's comfort zone and learning from failure is as important as engagement. Many game designers falsely interpret engagement as making the game pleasurable, not too difficult and with many positive rewards. Perhaps that is a good sales strategy for commercial games, but SG should also use frustration, pain and discomfort as a first step towards change and learning.

The fact that the player is involved will commonly show in his/her bodily responses. Only in a lab setting can one measure a player's pupils, heart rate, brain activity, perspiration, etc. But for fellow players, involvement will show in a player's cheering and swearing, jumping up and down, and emotional responses that may turn into a quarrel. It is not only involvement in the game play itself, but also commitment to that what has been created through the game play. A mother clearing up her child's Lego construction, or the accidental deleting of a game level or game score can cause great frustration or anger.

23: Principles of effect: Emotional involvement

> The game play affects the player's bodily responses, emotions, commitment to the outcome of the game, etc.

No game is the same, by which I mean that no round of a game will produce exactly the same experience and results as another round of the same game. The individual or collective experience of playing a game cannot be derived from the single elements and rules of the game as an artefact. One of the reasons is that the game as an artefact merely induces the playing. It is the players themselves who construct the game play. They interpret, recombine, alter or change the formal rules of the game. But even if they do not change the formal game, there are numerous non-formalized and informal rules that sneak into each round of the game play. This makes SG very different from the classic lab experiment where everything is done to prevent any reinterpretation and alteration of the rules by the players.

24: Principles of effect: Construction

> Players not only follow the game but also change and construct it.

Players' construction is an important reason why it is difficult to capture the experience and outcomes of a game or serious game and transfer its meaning to people who have not played it. In the game of chess, for instance one can note down the sequences of moves in the following way:

1. *d4 Nf6* 2. *c4 g6* 3. *Nc3 d5* 4. *cxd5 Nxd5* 5. *e4 Nxc3* 6. *bxc3 Bg7* 7. *Bc4 c5* 8. *Ne2 Nc6* 9. *Be3 O-O* 10. *O-O Bg4* 11. *f3 Na5* 12. *Bxf7 Rxf7* 13. *fxg4 Rxf1* 14. *Kxf1 Qd6* 15. *Kg1 Qe6* 16. *Qd3 Qc4* 17. *Qxc4 Nxc4* 18. *Bf2 cxd4* 19. *cxd4 e5* 20. *d5 Bh6* 21. *h4 Bd2* 22. *Rd1 Ba5* 23. *Rc1 b5* 24. *Rc2 Nd6* 25. *Ng3 Nc4* 26. *Nf1 Nd6* 27. *Ng3 Nc4* 28. *g5 Kf7* 29. *Nf1 Nd6* 30. *Ng3 Nc4* 31. *Kf1 Ke7* 32. *Bc5 Kf7* 33. *Rf2 Kg7* 34. *Rf6 Bb6* 35. *Rc6 Na5* 36. *Bxb6 Nxc6* 37. *Bc7 Rf8* 38. *Ke2 Rf7* 39. *Bd6 Rd7* 40. *Bc5 Na5* 41. *Nf1 Rc7* 42. *Bd6 Rc2* 43. *Kd3 Rxa2* 44. *Ne3 Kf7* 45. *Ng4 Nc4* 46. *Nxe5 Nxe5* 47. *Bxe5 b4* 48. *Bf6 b3* 49. *e5 Rxg2* 50. *e6 Kf8*

Source: www.chessgames.com/perl/chessgame?gid=1067264

This notation allows us to replay the match. Then probably only chess masters will know that this was a defining match between Karpov and Kasparov in Seville, 1987. To grasp more of their experience, one should also know that at the end of the match, Karpov made a famous blunder:

> A fourth match for the world title took place in 1987 in Seville, as Karpov had qualified through the Candidates' Matches to again become the official challenger. This match was very close, with neither player holding more than a one-point lead at any time during the contest. Kasparov was down one full point at the time of the final game, and needed a win to draw the match and retain his title. A long tense game ensued in which Karpov blundered away a pawn just before the first time control, and Kasparov eventually won a long ending. See: Wikipedia

Nevertheless, we do not grasp the experience of their game play. Kasparov could not believe Karpov's blunder and made silly faces that can still be seen on YouTube. But even if we know the backstory, can replay the match and watch emotions on video, we are still very far from the original game experiences. We cannot relive them. Only by having similar experiences of blundering, losing or winning our own defining matches, may we feel what the chess masters may have felt back in 1987.

25: Principles of effect: Fluidity

> The game experience is and can only be shared by the players. It is very difficult to convey what happened in the game to others who were not there, or to people who have never played the game.

Observing others play a game is not the same as playing the game yourself. But playing this game (or many other games) will give a rich variety of game play experiences. Game designers, game masters and game facilitators draw upon their own experiences to create meaningful experiences for others. Game facilitators use their previous play experiences to help novice players interpret their play experiences. This is commonly called facilitated debriefing, which is at the basis of game-based learning.

From individual experiences there emerges a collective and shared experience that – if the game experiences are intense – can tie the group together and form a collective memory. Sports, and soccer in particular, have this anchoring and bonding effect on supporting teams and nations. Just think back to when your favourite team or country scored the winning goal in the finals. If you are into soccer, you will remember it vividly.

26: Principles of effect: Anchoring and bonding

> The shared game-experience can form a collective memory: going through the same experience can convey the feeling of togetherness, of closeness.

Such anchoring and bonding experiences give a sense of ownership of the game experience and outcomes. SG use these mechanics in, for instance, team building exercises or organizational change processes. The feeling of ownership can be particularly strong in SG projects, where initiators and player groups become far stronger advocates – the game's PR officers, salespersons, recruiters – compared to the situation in non-game projects.

27: Principles of effect: Ownership

> Players develop a sense of individual and/or collective ownership over their instance of the game.

Oops, dead again! Becoming good at game play has to do with the challenge. A game of effects invites players to apply their effort to the challenge and to evaluate their effort. It is the challenges that drag the players into the game. In SG, challenge is not about killing and surviving, but about strategic decision making. Decision making that represents or reflects decision making in the real-world situation. Players try to use their logic and strategic behaviours to make their solutions work. That is why SG for policymaking are also called policy exercises. By presenting proper challenges, the game offers the player chances to practice.

Starting the game with a proper challenge is very important if the game is to work. It links to the players' background, knowledge and expertise. For example, if the players in an urban planning game need to spend most of their time doing statistical calculations, they might very soon give up or become distracted. This is why game theory can be used for research on strategic decision making, but not for NTP inclusion, SP inclusion and synthesis. Serious games for complexity policymaking needs to reflect the grand challenge in a series of tangible tasks that the players can start to do something with, by using their skills and knowledge. They gradually feel the difficulty of handling complex situation instead of focusing on one specific assignment, such as a design or calculation.

28: Principles of effect: Challenge

> A game challenges the player to do something or accomplish something that is at the real edge of what the player is capable of doing when he/she entered the game or level.

Becoming good at game play also has to do with making inferences about how the game works. For a novice, inexperienced player, in the beginning it will largely be through trial and error. But then he/she will start to see patterns. If three times in the game the player does X and then Y happens, then there is probably some rule (pattern, law) in the game that says: if X > Y. So the player starts to reason inductively from experiences; but once the generic rule has been constructed, the player will also reason deductively. When the player wants Y to happen, he/she knows that he/she needs to do X. Now, rules in a game are usually not so simple and they tend to become more complicated as the game progresses. At the beginning of the game, the player may find out that stepping on a marked stone will open a door, but later in the game, this rule will be combined with other rules to give an emergent effect: the player may need to open a door while a fire ball comes through. It may be that X only causes Y under the condition of Z. Or that X and Y are independent, but the player also did something else that made Y happen immediately after X. In other words, players make partially correct or even false inferences that need to be corrected by learning. If not corrected, the player will get stuck at a certain point in the game for a long time – trying to climb a tree for a long time, when this actually has no effect at all. Especially in a cohesive group, false inferences can be notoriously sticky and difficult to self-correct.

29: Principles of effect: Inference

> The player reconstructs the game by inference – a combination of inductive and deductive reasoning.

The player will gradually understand the game as a complex system by inductive and deductive reasoning. This is possible because the game will give feedback on the consequences of player actions. These consequences might be programmed into the game, and might also come from other players or the game masters.

30: Principles of effect: Action–consequence feedback

> The player gets feedback on the consequences of his actions.

Game over – try again. Experiencing the consequences of actions, with the ultimate consequence of a Game Over, is meaningful only when the player has control over his/her actions and has a fair chance to advance in and complete the game. If not, the player will feel 'cheated' by a poorly designed, unbalanced game. If a door should open when the player steps upon a button, but because of some design flaw or programming bug a door does not open properly, which gets the player killed by some monster, the player will feel that he/she has no control over the challenge.

31: Principles of effect: Control

> The player has enough control over the game to have a fair chance to play, advance in and complete it.

Having control over the actions and consequences is dependent upon the player's background, skill, ability, available time, play-style preferences, etc. So, game designers have found ways to let the game adapt to the player. Games can be played at different difficulty levels – from easy to difficult; the player progresses through game levels, whereby a certain skill needs to be mastered in levels 1 and 2 before level 3 etc. can be entered. A player can set a game into a practice or 'God' mode, where he/she has unlimited resources or cannot die. Games also test what the player has already mastered in order to automatically adjust the difficulty level, making enemies easier or more difficult to kill.

32: Principles of effect: Adaptability

> The game adapts or can be adapted to the user's skill level or play preferences.

Now, we reach the point where we can go into numerous game mechanics, game design patterns and learning patterns. They have been described extensively and in great detail in other publications. In my view, they are important for the designer to make the game more persuasive, engaging, etc. They are, however, less important as a principle of play in a policymaking context. One important exception is visualization, because this significantly increases the understanding of complexity. There are numerous ways in which games use visualization: pictures, game boards, diagrams, colour schemes, etc. Digital games have the power to visualize in a dynamic way; that is, the game world itself changes over time, as a result of player actions. So, the player and the game world become one through the action–consequence sequence. Game technology is revolutionizing the way players can experience the 'game world' in many ways. They can be immersed through 3D visualization, first person or in God mode; through stereoscopic, virtual reality, through mixed reality and augmented reality (i.e. Google glasses) and in the near future most likely through personal robots, drones and human enhancements.

Immersive visualization is an enormously powerful way to simulate a complex socio-technical system; that is, when it comes with playful interaction. That is why many of the game-like integrated methods rely strongly on game-like immersive visualization techniques. The danger of course is that the playful interaction disappears into the background, and few policymakers or stakeholders will appreciate or understand how the immersive visualization represents their complexity. If well done, the visualization will have some attractiveness, a wow factor, but this will soon fade if the audience cannot play with the complexity.

33: Principles of effect: Immersive visualization

> Immersive visualization makes players feel that they are an intrinsic part of the game world, not merely spectators.

One important way to visualize complexity is through analytics: game analytics, which track and show what the players have done and how the game has progressed; player analytics, which show who the players are; learning analytics, which capture and show the learning by the individual or collective players; system analytics, which capture and show how the players contribute to the game system; and transfer analytics, which capture and show how one or more of the above analytics have had an impact on real life.

The data upon which these analytics are based can be a small set and very game specific; but increasingly they will be big data sets, for instance when game play is combined with social media and e-participation, like some of the examples above. Big data analysis and visual analytics are needed to make sense out of the game play. But it then becomes uncertain to what extent the data and the meaning will be shared with the players.

34: Principles of effect: Analytics

> Analytics capture the emerging complexity of game play. They help to make sense of individual and isolated experiences and can fill the transfer gap between the game and the world outside (before, after the game).

5.8 Overview

All the principles of serious game play discussed above are presented in Figure 5.15.

- Principles 1–6 (two general principles of game and four general principles of play) are in the white grids, because they explain the fundamental mechanism of game and play: game constructs a playable artefact to represent a complex system, and playing with artefacts is part of human nature. These principles allow game play to become a valuable method to induce learning. However, these principles do not explain how this can happen.
- Principles 7–10 (the four principles of serious game play in the light grey grids) show that play itself can be serious or non-serious, thus the same as playing with game and other artefacts. From these four principles we understand that certain conditions of play and game effects need to be created in order to make game play serious for learning.
- Principles 11–20 (the principles sine qua non in the coloured girds) explain the indispensable conditions of play. They describe the rationality and emotional attachment to induce serious play.
- Principles 21–34 (the principles of effect) are given in the dark grey grids. They explain what the essential elements of game are and why they encourage players to immerse themselves in the game play.
- The principles sine qua non and the principles of effect together create a context of play around the complex system of game artefact. Elements in this context are tightly integrated and they trigger the rationality and emotion for learning.

- In the centre of the table are the three dimensions of synthesis and their partial approaches. The implementation of a certain principles of serious game play can increase the level of integration. The more effective the principles, the stronger the level of integration and the greater the potential to induce synthesis.

5.9 Conclusion and discussion

In this chapter, I have deconstructed serious games for policy making into four frames with examples of integrated methods. The combined insights are summarized in Table 5.15. From the examples, I have reconstructed 34 principles into four categories: 1) game as complex system; 2) general principles of play; 3) principles sine qua non; 4) principles of effect.

5.9.1 Short answers

What does it mean to serious game play and how does this serve policy analysis? 34 principles of play explain why certain activities (like the policy analytic methods in Table 3.1) are like game-play, and why game-play may have effects on policy making beyond the game itself. The role and usefulness of serious game for integrated policy analysis cannot be established by simply ticking off each principle.

5.9.2 Discussion

In a context of policy analysis and policymaking, we should look for interesting moments of serious game play, rather than focussing heavily on the artefact of an SG. It is possible that policymakers seriously play with something other than a game, most likely a simulation model; they can also non-seriously play with the artefact of an SG or pretend to be playing. For instance, when an external structure predetermines the outcome (10% of the players will be made redundant after the assessment game); there is no real challenge or players do not feel the challenge; players do not feel involvement in or commitment to the game play; they play half-heartedly, etc.; they feel like spectators, not participants; or they do not have control over their actions.

The proper understanding of SG is relevant from the perspective of design, and to answer the question whether an SG is better able than non-game artefacts to trigger game play in a policy context. If the answer is no, we would be better off inducing play with simple artefacts, or simulation models, or simply make non-game artefacts more playful. It is my supposition, however, that some SGs are better at inducing play than non-game artefacts. A better understanding of how to design an SG can also help to make other policy-relevant artefacts more playful.

Game play does not have to be present through all principles at the same time. The presence of just one or a few of the principles can make a method or approach game-like or playful. Close scrutiny is needed to find out why some people find a particular method or approach, game-like or playful. It does not matter if it is or is not a game; it just has to feel like a game.

Each of the above principles of play has some kind of playful effect that may serve the integrated policy analysis of complex socio-technical systems. But they are principles and not rules or guidelines ready to copy & paste into a method or policy process. Designers of models and simulations, and designers of political participation and policy interaction, can find in the principles the conditions and ways to design for more playfulness. Clients can find some guidance on what to expect from designers and players, and why they are or are not very willing to play their game. Stakeholders and citizens can check the conditions and rules before they join a game; they can also renegotiate the rules if they do not like them or change them while playing.

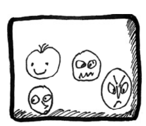
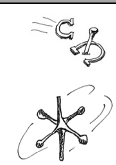
The principles explain why integration happens in game play, namely because the players integrate different ways of reasoning – inductive, deductive, social, analytical, practical, etc. – in order to meet an unnecessary challenge. Once they have done so, they feel a sense of collective achievement, commitment and ownership of the experience and result.

Finally, game play can serve the management of socio-technical complexity in policymaking at two levels. At a micro level, it is possible to create more playfulness around models, simulations, decision support tools, even meetings and workshops in which socio-technical complexity is addressed. Creating a context of play around plans, models and simulations at the micro level can serve policy analysis in the ways discussed above. Playfulness can also go in the direction of better and more attractive visualization of policy support tools, for instance 3D immersive worlds, the use of better game-like analytics, game-like user control, adaptability and scalability. Using an SG at the right moment in a policymaking process can certainly add to the game play.

5.9.3 Continuation

In Chapter 6, I will investigate whether or not my claim about policy games is warranted by taking a closer look at two projects of integrated water management where the governance of socio-technical complexity was supported through some kind of game-play.

Figure 5.15 Principles of serious game play

Principles of serious game play							
4: General principles of play: Unnecessary challenge	6: General principles of play: To play a game	9: Principles of serious game play: Serious play	10: Principles of serious game play: Serious game play	11: Sine qua non: Acceptance of failure	12: Sine qua non: Consent	13: Sine qua non: Commitment	14: Sine qua non: Intrinsicality
3: General principles of play: Play	5: General principles of play: Game for play	21: Effect: Pheromones	22: Effect: Engagement Control	23: Effect: Emotional involvement	24: Effect: Construction	25: Effect: Fluidity	15: Sine qua non: Equality
 2: General principles of game: Playable complex system	8: Principles of serious game play: Play seriously	34: Effect: Analytics	Dimensions of synthesis Complexity mod-sim $1 + 1 > 2$	Serious game play $1 + 1 * (a + b) > 2$ (Y)	Complexity play $a + b > (a,b)$	26: Effect: Anchoring and Bonding	16: Sine qua non: Level playing field
1: General principles of game: Complex system	7: Principles of serious game play: Play non-seriously	33: Effect: Immersive visualization	32: Effect: Adaptability	29: Effect: Inference	28: Effect: Challenge	27; Effect: Ownership	17: Sine qua non: Fairness
			31: Effect: Control	30: Effect: Action-consequence feedback	20: Sine qua non: Repair	19: Sine qua non: Safety	18: Sine qua non: Suspending disbelief

6 Room to Play…

Mountains cover the white sun,
And oceans drain the golden river;
But you widen your view three hundred miles
By going up one flight of stairs.

登鸛雀樓 王之渙
白日依山盡，黃河入海流
欲窮千里目，更上一層樓

AT HERON LODGE *Wang Zhihuan* (Chinese poet, 688–742 AD, China) [27]

6.1 Introduction

As we have seen in Chapter 5, game play is regularly applied to support integrated policymaking (IPM) especially in the field of integrated water management (IWM). Given the importance of water in the Netherlands, there are quite a few examples of policy gaming for water management (see Chapter 4), but the topic is being raised in other countries too (PlayGen, n.d.; UNESCO-ISCED (website), n.d.).

We have seen that the idea of playing out socio-technical complexity (STC) at the science–policy interface (SPI) may feel strange in other political regimes and planning cultures, for example in China (see Chapter 4). The need for integrated planning may be more pressing in a small and densely populated, consensus-oriented country like the Netherlands where the relation between the sea, water and terrestrial planning is high on the agenda. This may explain why integrated methods, like policy gaming with real decision-makers and stakeholders, seem to be more common and accepted in the Netherlands than in other countries.

But playing is deeply entrenched in human nature, and computer gaming is pervasive in nearly all countries. Thus, provided the sine qua non principles (see Chapter 5) can be accepted (which is impossible in totalitarian regimes, under conditions of structural inequalities between an elite and an impoverished mass, or under armed conflict), there is no reason why policy gaming cannot be applied in many countries in the world. Yet, even under circumstances where the sine qua non principles can be safeguarded, policy gaming is usually only one of a range of activities at the SPI, alongside modelling, data collection through surveys, innovative design activities, stakeholder consultations, etc. The activity of policy analysis (PA) itself takes place at the SPI. According to Dunn (2011), PA is an applied social science discipline that uses multiple research methods in argumentation and debate contexts to create, estimate critically and communicate knowledge that is relevant to policies. Dunn considers integrated policy analysis (IPA) to be an integrated process of inquiry, by looking at problems from multiple perspectives, using multiple methods, looking backwards and forwards, involving actors and communicating knowledge in different ways. In my view, the increasing need for more and better integration of scattered pieces of knowledge for public policymaking (see Chapter 1) is the reason why policy gaming is taken up in the first place. This brings me to the following claim:

> Policy gaming is a designed way of informed discourse for the integrated analysis of socio-technical complexity in the heart of the science–policy interface.

The key elements in this definition – namely socio-technical complexity (Chapter 1), integration (Chapter 3) and science–policy interface (Chapter 3) – have already been defined. The remaining question is, of course: are policy games able to realize this claim or do we have inflated expectations about what they can do? To investigate whether my claim about policy games is warranted, I take a closer look at two IPM projects where the governance of STC was supported through some kind of game play. After a careful review of potential cases (see also Chapter 5 and the appendix), I selected two cases of policy gaming that are generally reported as being fairly effective and innovative beyond the purpose of education, training or behavioural change. My aim was not to validate the quality of these games as tools or artefacts, or to go into a micro analysis of what happened during the game play. Instead, I wanted to see whether and, if so, how principles of play are able to support integrated policymaking. In Chapter 7, I will look more at the micro level, to see how integration happens during game play itself. The two cases analysed in this chapter are:

(1) The Blokkendoos planning kit (BPK) (Deltares, n.d.-c): the BPK is a digital tool used in the Room for the River (RfR) project in the Netherlands. It is regarded as having been quite successful in preventing a deadlock in policymaking. According to the actors, working with the tool felt like game play.
(2) The Climate Game (CG) (Tygron, n.d.-a): the CG is a multiplayer, 3D serious gaming suite that was used in, for example, the planning of the reconstruction of the Feijenoord district of Rotterdam, the Netherlands.

The above cases are presented in subsequent order, on the basis of the following questions:

- What is the socio-technical complexity in the science–policy interface?
- What are the main principles of play?
- Did the game play serve integrated policy analysis, and if so, how?

The above cases are presented in subsequent order, on the basis of the following questions:

- What is the socio-technical complexity in the science–policy interface?
- What are the main principles of play?
- Did the game play serve integrated policy analysis, and if so, how?

6.2 How the BPK model prevented a deadlock in water management

6.2.1 The Room for the River project

As discussed in Chapter 4, the Room for the River (RfR) project marks a change towards more integrated spatial planning with an eye to climate-proof flood prevention (Schut, Leeuwis, & van Paassen, 2010; van Herk, Rijke, Zevenbergen, & Ashley, 2013; M. A. Wiering & Arts, 2006). The RfR project is a government plan (2000–15) with the legal status of a key spatial planning decision (Planologische Kern Beslissing) that aims to address flood protection, master landscaping and improve environmental conditions in the areas surrounding the Netherlands' rivers (Netherlands government, 2006; ten Heuvelhof et al., 2007). The plan has three main objectives (Ruimte voor de Rivieren, n.d.):

- By 2015, the branches of the Rhine will safely cope with an outlet capacity of 16,000 cubic metres of water per second.
- The measures implemented to achieve this will also improve the quality of the environment of the river basin.
- The extra room the rivers will need in the coming decades to cope with higher discharges due to the forecast climate changes will remain permanently available.

The plan consists of nine types of measures implemented at more than 30 locations (Klijn et al., 2001; Netherlands government, 2006; Ruimte voor de Rivieren, n.d.):

- Lowering of floodplains: lowering (excavating) an area of floodplain increases the room for the river at high water levels.
- Deepening the summer riverbed by excavating the surface layer of the riverbed. A deepened riverbed provides more room for the river.
- Water storage: the Volkerak–Zoommeer lake provides temporary water storage when exceptional conditions result in the combination of a closed storm-surge barrier and high river discharges to the sea.
- Dike relocation: relocating a dike land inwards increases the width of the floodplain and provides more room for the river.
- Lowering groynes: groynes stabilize the location of the river and ensure that the river remains at the correct depth. However, at high water levels groynes can obstruct the flow of water in the river. Lowering groynes increases the flow rate of the water in the river.

- High-water channel: a high-water channel is a diked area that branches off from the main river to discharge some of the water via a separate route.
- Depoldering: the dike on the river side of a polder is relocated land inwards. The polder is depoldered and water can flood the area at high water levels.
- Removing obstacles: removing obstacles from the riverbed where possible, or modifying them, increases the flow rate of the water in the river.
- Strengthening dikes: dikes are strengthened in areas in which creating more room for the river is not an option.

The RfR project, which is expected to finish around 2015, was approved by the Upper House of Parliament (Tweede Kamer; TK) in December 2006. The parliamentary decision was preceded by a lengthy process of technical analysis and stakeholder consultation. The main question was: which measures to take? Seven hundred potential measures needed to be narrowed down to about 40 cost-effective, environmentally and socio-politically acceptable measures. A formal evaluation of this process based on, for example, observations and interviews, showed that a computer tool called the Blokkendoos planning kit (BPK) had been very helpful (Kors, 2004; Wesselink, Reuber, & Krol, 2005; Wesselink, Vriend, & Barneveld, 2009). This was a rather surprising finding, because the process had been dogged by controversies and at some point faced an imminent deadlock. Moreover, the BPK was relatively straightforward and conceived as just another decision support system. During the consultation process, however, the BPK had become much more than a tool because the actors felt it was 'like game play'. Although much of the underlying hydrological data and calculations in the BPK remained a black box, the outcomes of the model were hardly challenged. Actors confirmed that they believed that after playing with the tool, they comprehended the hydrological and economic consequences much better. In the following analysis, I demonstrate how principles of play were able to support integrated policymaking.

6.2.2 Socio-technical complexity

The socio-technical complexity of the Room for the River case consisted of the following duality:

- *NTP complexity*: the complexity of the hydrological geosystem and ecosystem of the Netherlands in the face of the increasing risk of flooding due to climate change and increasing human activities in flood-prone areas. With input from all kinds of actors, Rijkswaterstaat (RWS)[28] had drafted more than 700 potential technical and infrastructural measures that could give more space to the Rhine and its branches (see Chapter 4). These measures included removing hydraulic obstacles, excavating flood plains, setting back levees, and constructing side channels and detention basins. An analysis showed that combined implementation of about 40 measures could be sufficient to solve the problem, but that many different combinations were possible. There were also many interdependencies and cumulative effects among the measures.

- *SP complexity*: for political and legal reasons, numerous actors at different spatial levels were involved: municipalities, provinces and water boards, as well as land owners, scientists, and social and environmental groups. All these actors had many conflicting views and interests with respect to the proposed measures, and they were making coalitions. Conflicts among actors emerged, and they manoeuvred strategically to push the proposals that were in line with their own interests and to block those that were not. One actor's gain was another actor's loss.
- *STC:* strategic play among actors with regard to, for example, knowledge: data and technical reports were being challenged and alternative measures proposed. The cumulative effect of measures was highly uncertain.

6.2.3 Science–policy interface

The above socio-technical complexity spiralled onto the science–policy interface. For instance, the feasibility, environmental impact, and costs and benefits of the 700 measures had to be assessed. Engineering and consultancy companies, as well as scientists, were involved in producing data and knowledge and providing advice. A great many models and simulations were developed and used to analyse the NTP complexity and provide information about the impact and interdependencies of the 700 measures. Two dynamic hydrological models were key to calculating the water level: the WAQUA simulation model for the Lower Rhine and the river Waal, and the SOBEK model for other branches of the Rhine. In addition, there were models for cost–benefit analysis, geographic information systems, land use models, etc. Together they produced an enormous pile of fragmented data and information about hydrology, ecology, cultural and natural heritage, economy, infrastructure, safety, farming, etc. for different locations along the river branches.

On the socio-political side, parliament was planning to decide (in 2006) on which combination of measures to implement. For legal and political reasons, the Dutch national authorities needed to involve municipalities, provinces, water boards and numerous other actors in a consultation process that would lead to the selection of measures. The technical data, however, was simply too much and too rich for a proper stakeholder discourse. Too much giving in and compromising could lead to low quality decision-making leading to the implementation of ineffective or even counter-effective measures. A deadlock in the RfR policy was imminent. Table 6.1 summarizes the STC complexity and the SPI for the RfR case.

Table 6.1 Analysis of the RfR project

RfR		
	Issues	Description
STC	NTP complexity	Divergence in time scales and spatial scales. Many different subsystems: ecology, infrastructure, hydrology, cultural and natural heritage, etc. Many interdependencies, feedback relations, delays in cause and effect. Large number of potential measures to make room for the river, with numerous interdependent consequences.
	SP complexity	Many actors and stakeholders at different levels, diverging power and views, interdependencies. NIMBY attitudes Strategic behaviour, zero-sum games.
	STC	Strategic play among actors, e.g. with regard to knowledge.
SPI	WoS	Large amount of data, numerous diverging models, simulations at different levels. Need for integrated view on the complex behaviour of interrelated systems
	WoP	Stakeholder process hard to control. Risk of negotiated nonsense, manipulation. Imminent deadlock.
	SPI	Informed discourse needed.
IPA	Integration	Integration of top–down (list of measures) and bottom–up (alternative selections by stakeholders). Integration of measures along the rivers. Integration of different subsystems: ecology, infrastructure, hydrology, cultural and natural heritage, etc. Integration of stakeholder views. Integration of planning levels (local, regional, provincial, national, transnational and EU).

6.2.4 The Blokkendoos planning kit

Then, in 2001 The Ministry of Transport, Public Works and Water Management (Ministerie van Verkeer en Waterstaat) commissioned Delft Hydraulics (now part of Deltares) to develop what became known as the Blokkendoos planning kit (BPK) (Deltares, n.d.-c; Zhou, 2009). The BPK is an easy to use, digital tool that could quickly present the individual and cumulative effects of any selection from the 700 potential measures on 40 indicators.[29] The tool gave additional information about each measure in the form of text explanations, situational sketches, aerial photographs and pictures. In interviews, actors involved stated that the use of the BPK in the RfR process had been like playing a game. In the following, I use the principles identified in Chapter 5 (see also appendix E) to analyse why it was like playing a game.

6.2.5 Validating the principles of play

The BPK reduced the complexity (combinations of 700 potential measures and their cumulative effects) to the simplest playable representation of reality. Actors got a sense of what these measures were, their consequences, and how they reinforced or negated each other (see principles 1 and 2: complex system).[30] The BPK was not designed as, or to be used as, a game (see principles 5 and 6: play): it was intended to be a decision-support tool. That stakeholders started playing with it, in meetings and at home, surprised even its developers (as they confided to me in talks) (see principle 9: serious play).

However, the potential use of the playful artefact was soon recognized, and a great many copies of the software were distributed. Here we see a confirmation of principles 3 and 7, namely that it is not uncommon to play with any kind of artefact in a policy context. During the process, actors were encouraged to provide their ideas as a kind of game play. They were asked to write down, draw or sketch their ideas for flood prevention. These ideas, together with the measures from experts, formed the 700 measures that were incorporated into the BPK model, giving a sense of equality and fairness to the BPK (principle 15: equality; 16: level playing field; 17: fairness).

The simplicity of the tool made it usable by both experts and non-experts (principle 31: control). No special hardware or software was required, just a simple installation on a laptop or desktop computer. The interaction with the tool was pretty basic. It could be used at many levels of difficulty, ranging from demonstration through workshop facilitation to in-depth analysis. In short, the tool allowed actor–players to make their own game (principle 24: construction). One of the main differences between the BPK and common computer games like SimCity or the Climate Game below, lies in the principle of intrinsicality (principle 14). The actors in the BPK were not an intrinsic part of the modelled complexity. In other words, it did not matter so much which person or stakeholder made the choices. Given a repeated selection of the same choices, the output of the BPK will be exactly the same. In other words, the output of the BPK is limited in comparison to many computer games. In games like SimCity or the Climate Game, it is simply impossible for one or more players to make exactly the same design. In SimCity, small changes by an individual player (e.g. building the fire department two minutes later than in the first version) lead to a different city. In multiplayer games, small changes are likely to cause big changes. The intrinsicality principle of the BPK was apparent only in the social interaction, for example in a workshop, not in the BPK as a digital artefact.

Strangely enough, but not uncommon to computer games like SimCity, the calculations behind the BPK tool were a kind of black box. It is unclear, for instance, how things like costs and hydrological effects of measures are calculated. The calculations were validated by models and experts, but this was impossible to verify by common users. Actors simply needed to work from the assumption that the tool was good enough to learn from. There was a considerable risk, however, that the tool would not be accepted due to its lack of transparency. Interestingly enough, the actors did not question the BPK while playing with it. The external validity seemed to matter less than the fact that actors got a fairly good idea about the possible combinations of measures and their emergent effects on a broad range of indicators. In other words, while they were playing, the users suspended their disbelief (see principle 18: suspension of disbelief; and 19: safety). Furthermore, the tool was certainly not the only source of information; there were enough checks and balances. Using the tool was like a play; whether and, if so, how to make a transfer from play to reality would have to be negotiated.

Figure 6.1 Screenshot of the Blokkendoos planning kit (BPK)

Although the BPK was nothing like a computer game, it did make use of a number of game mechanics, such feedback and immersive visualization. One also has to realize that the BPK was developed around 2004, when the serious gaming revolution was only just emerging. Figure 6.1 shows the interface of the BPK model.

Although the underlying computations are complicated, the feedback of effects is attractive and visual, making it easy to understand, even for non-experts. In short, the BPK made use of action–consequence feedback (principle 30), immersive visualization (principle 33) and analytics (principle 34), similar to games. I give two examples: the effect of a measure upon water level and upon budget. For each river section in the BPK, a simple graph shows the relation between the projected future water level, the height of the levee and the risk of inundation. By selecting one or more measures, the BPK calculates and visualizes how far the water level and the risk of inundation will drop. The objective, of course, is to get the water level safely below the height of the levee. In a similar fashion, the BPK calculates the consequences of a measure upon the available budget. Every time a measure is selected the remaining budget drops by the projected cost of the measure. In interviews, administrators indicated that they very much appreciated the immediate feedback of effects, hydraulic, financial or otherwise. This proved conducive to the popularity of the BPK among administrators.

The results of the measures are shown pictorially on the interface of the BPK. Also important is the database of every measure, for example how many centimetres lower than the water levels, how much nature you need to develop, how much it will cost, etc. The database contains a long list of expert analysis. By combining the different measurements, one gets an overview of the results of different combinations (interview, water management consultant).

The navigation and the action–consequence definitely gave a sense of 'fun': if I choose this measure, what will happen? Users could try many different strategies: select their own preferred measures and see the effects. They could also play around and choose radically opposing or strange combinations of measures, just to see what would happen. Actors even had limited possibilities to add new measures, giving them some sense of ownership (principle 27). All these capabilities, which are quite common in digital games, increased the engagement and immersion of the BPK and made it feel like a game. Playing with the tool proved to be 'serious fun'.

> They can put, see and play with it. It is just like a computer game, like SimCity, it is the same. You combine the ones you like and see the different results. If it is not good, you just change to another one (Interview, project leader BPK in Deltares).

The sense of playing a game emerged in two ways; first, as playing with the BPK as a digital game-like artefact. The participants were given copies of the BPK on a CD so that they could play as much as they wanted at home or in their office. Secondly, the sense of game play was enhanced by the fact that the BPK mediated the collaborative and social game play. The results and outcomes of the BPK were discussed in meetings and workshops, and actors started playing collaboratively with the tool. They could compare their results and try to improve them. The inferences about cause and effect were frequently mentioned during meetings (principle 29).

One factor that contributed to the impact of the BPK is the fact that it made stakeholders view the real policy process as a game. It is hard to say whether the developers intended it, or whether it was serendipitous, but the rules of play at the micro level – that is, the playing with the BPK – gradually changed the rules of play at the macro level, namely the selection of measures. In the language of the policy sciences, one would say that the playing opened up and funnelled the consultative selection process. Assuming that the BPK was sufficiently founded in science to play with, it created some equality among the players and levelled the playing field a bit more. By raising the curiosity of the [stakeholder-players and by engaging them, the tool drew them into the process (principle 21: pheromones). They at least needed to commit themselves to playing with the tool (principles 12 and 13), and it can be assumed that this also increased their commitment to the real process. The way this works must have been very subtle, and I am by no means implying that the process was absolutely fair and that all problems were resolved. Game play is not magic. But transgressions of fairness were resolved (principle 20: repair); otherwise the [player-stakeholders would have stopped playing. Based upon the post-game talks and appreciative comments, it is fair to say that the BPK made a significant contribution to the real technical and socio-political process. Participant stakeholders were also more inclined to take or accept their loss (principle 11: acceptance of failure). During an interview, one of the participant policymakers told me:

> With the openness of information, people said: Okay, I don't like this solution, but I can understand that this is the most suitable one according to the information I have received. (Interview, project leader for the regional decision making process in RWS).

Applying the principles of game play at a meta-level of policy process made the BPK model useful in managing conflicts and averting the imminent deadlock. In short, latitude – freedom – was given to local administrators to construct their own administrative game. These administrators were faced with the difficult task of selecting a basket of measures. Firstly, the projects were indeed described rigidly and unequivocally in the model, but there was considerable leeway in the combination of measures. They were of the opinion that the model gave them considerable freedom to select combinations of measures. Indeed, administrative freedom lay at the level of these combinations. They also felt that they had been given sufficient opportunity to justify the combination of measures they eventually selected.

Secondly, the BPK model provided an opportunity for the knowledge, expertise, interest and values to come together. Uncertainty and disagreement were significantly reduced. Due to the increased understanding among experts and administrators at different levels and scales, consensus among the participants was made possible. At crucial moments, the vice minister (*staatssecretaris*) of the Netherlands de-emphasized the importance of the model and gave administrators the freedom to transcend the model. For example, at a certain point the state secretary said that local administrators could use and even modify the projects that had been included in the BPK model in order to realize their own, local objectives. If, for example, a new road was needed in a municipality and a dike was to be repositioned, the state secretary would agree to the construction of the road provided that it was built on top of the dike. Another example: if an RfR measure could be realized in such a way that it also served a recreational purpose, the state secretary would approve it. Local administrators made grateful use of this opportunity. Projects were modified with great ingenuity, as a result of which they were transformed from NIMBY projects, imposed by central government, into locally desired projects. In short: from NIMBY to PIMBY (Please In My Back Yard).

Thus, local administrators now had a very different attitude towards the process. They had initially been hesitant about the projects: 'It's necessary, but preferably not here.' Subsequently, however, they became enthusiastic proponents of the projects. In sum, many of the principles of ownership (principle 27) and challenge (principle 28) contributed to the gradually transcending of game play from the micro level to the macro level. Table 6.2 presents an overview of the analysis of using the BPK model, including its representation of STC, the applied principles of play, the integrated policy result and its role of game play for IPM.

Table 6.2 Overview of the results of using BPK

Question	Principle
Representation of STC	In general: an interactive context around scientific models and complex simulations. NTP complexity: using many scientific models and simulations, e.g. to predict the water level. A link of NTP–SP complexity: multi-criteria and cost–benefit analysis of 700 potential local projects. SP complexity: participatory process of policymaking and analysis.
Principles of play	Both principles of game effects and conditions of play are applied mainly at a macro level; i.e. making playful meta-rules of policy interaction. The essential conditions of play – e.g. consent, equality, fairness, intrinsicality, suspending disbelief, and safety – are realized by arranging a playful context around the complex scientific models. Some simple gaming techniques are used to apply the game effects, espe-

	cially for the action–consequence feedback and visualization.
Integrated results	Providing understandable and usable scientific information to support non-expert stakeholders' policy analysis and selection. A selection of local projects based on the consensus of the participants.
Role of game play for IPM	For participatory integrated modelling. Creating a playable context and design complexity. Increasing the effect of the NTP–SP inclusion type of integration, reinforce the participatory integrated modelling represented as (1 + 1) * (a + b) = 2(a,b) due to: Creating playfulness by using simply gaming techniques at a micro level, e.g. visualization, game analytics, game control. Individual play increases the stakeholders' understanding of scientific information, consequently also increasing the trust of expertise. Making policy analysis a fun and experimental process. Creating collective memory. Making scientific information usable for stakeholders negotiation and trade-offs.

6.3 How the CG integrates flood protection into urban reconstruction

6.3.1 The Rotterdam Climate Initiative

Rotterdam is a low-lying delta city in the western part of the Netherlands. It has one of the world's most important seaports, and the largest seaport in Europe. Flood protection and climate change adaption are vital to the city's longer term development. In order to realize its ambition to become the world's most sustainable port city (being CO2 neutral in 2020), the municipality of Rotterdam is collaborating with many authorities, industries, knowledge organizations and NGOs on such working platforms as the Rotterdam Climate Initiative (Rotterdam Climate Initiative, n.d.), Rotterdam Climate Proof, and the Water Governance Centre (WGC, n.d.). These cooperation platforms are a kind of playground for innovations for integrated, climate adaptive planning.

The Rotterdam Programme on Sustainability and Climate formed part of the municipal executive committee working programme 2010–14 (Rotterdam Climate Initiative, n.d.). Change windows of opportunities for experimentation open when parts of the city need to be developed or reconstructed. The continuous development of new port areas (around the 2nd Maasvlakte area) is a good example of strategies for climate adaptation and flood protection being tried out; but there is also experimentation in the older, populous districts of the inner city. As one of the key sustainability tasks in the Rotterdam Programme on Sustainability and Climate, preparing for climate change has been included in the reconstruction plan for the Rotterdam district of Feijenoord. It seemed an excellent opportunity to try out an integrated strategy of renovation, climate change adaptation and flood protection (Rotterdam Climate Initiative, n.d.). And serious gaming was part of this experimentation.

6.3.2 Socio-technical complexity

Compared to the RfR project, the STC complexity in the Feijenoord reconstruction plan is predominantly local (although the main driver behind it – climate change – is of course global). The underlying complexity, however, is largely the same as in the RfR project, as described in detail in Chapter 4. I can therefore be brief here.

Climate change is suspected of causing sea-level rise and more extreme weather conditions, which is likely to increase the risk of urban flooding from the sea, rivers and rainfall, especially in low-lying, densely populated metropolitan areas in river deltas, like the Delta Metropolis (de Randstad) in the Netherlands. There is still scientific uncertainty about the gravity and speed of climate change, but climate mitigation strategies are now being implemented on scales ranging from the local to the global. Climate adaptation strategies are mainly implemented on a local or regional scale, because this is where the problems are felt the hardest and concrete measures can be taken. Climate adaptation measures, however, are still innovative and technologically challenging. There are very few proven concepts and methods, and data and evidence about the effectiveness of measures and their consequences for liveability, sustainability, infrastructure, economy and finances are scarce. A key question in the Feijenoord urban reconstruction case was therefore: what measures are feasible and practical to achieve in the future, taking into account climate change and rising sea levels? In short, the socio-technical complexity of the Feijenoord reconstruction case consisted of the following duality:

- *NTP complexity:* The district of Feijenoord is a densely populated, somewhat deprived neighbourhood, with a relatively high percentage of immigrants, that is in dire need of affordable housing and good public facilities (Dekker & van den Toorn, 2011). In light of the integration of urban reconstruction and flood protection, there were many uncertainties: what would be the consequences of the construction of a delta dike for the measures that can be taken or inside the dike? What possibility would such a dike provide for the construction of housing and public parks? How much space should be reserved for water and what would that mean for the amount of housing that can be built? The available budget and possible funding opportunities also play an important role.

- *SP complexity:* the water sector and the local urban development sectors, however, have little communication in their practice. Accommodating water safety design in urban planning may cause conflicts between the parties. In such a situation, collaborative planning with water board, municipalities and core stakeholders has been proposed for policymaking and analysis. This requires the involvement of a broad group of directors from the community, housing associations, water boards and Rijkswaterstaat.
- *STC*: a layered safety approach (*meervoudige veiligheid*) (van den Berg et al., 2013) was deemed necessary with regard to flood-protection measures: for example, safety behind the dike, facilities in homes and infrastructure in the district (Kronberger-Nabielek & van Veelen, 2012) form the second layer of flood protection and climate change adaptation, in addition to raising the dikes (first layer) and disaster management (third layer). Possible measures are fragmented at different water and spatial departments. Information is hardly shared. It is therefore highly uncertain to what extent these measures will contribute to the multilayer safety, what indicators are proper to use, and whether they will be agreed upon by all policymakers and stakeholders.

6.3.3 Science–policy interface

The above socio-technical complexity spiralled onto the science–policy interface. Table 6.3 presents a summary of the STC, the SPI and the need for integration in the Feijenoord case.

6.3.4 The Climate Game

The Climate Game© was developed from scratch by a company called Tygron (Tygron, n.d.-a). It can best be described as a suite of tools (van Houten, 2007) for making and playing serious games about integrated water management and spatial planning. Briefly, the underlying technology (the game engine) allows programmers to tailor multiplayer games about long-term spatial planning in a context of climate change, to specific needs, objectives and data. Non-programmers can use a scenario builder to set up their own preferred game play, for instance by inserting their own geo-map, defining player roles and objectives, and selecting indicators. A precursor to the Rotterdam Climate Game – The Water Game© – was developed and piloted in the Living with Water project (Leven met Water, n.d.), a Dutch government co-funded research and knowledge project (2004–10) to find innovative water management solutions through integrative policy analysis.[31]

Table 6.3 Analysis of the Feijenoord case

Climate Game Feijenoord		
	Issues	Description
STC	NTP complexity	High, aims to find innovative technology and solutions to various issues of water management, participation, integrated spatial design, water economics, safety, governance, etc. Developing more social houses. Space for water storage. Importance of both water safety and urban development options, interests among water and urban development sectors might be quite conflicting
	SP complexity	Currently medium, at the pre-planning stage no emergent issues and disagreement need to be dealt with. Expected to be high: at a local scale but similar to the Room for the River project, province, Rotterdam municipality, water board, port of Rotterdam, and many other stakeholders in the district will be involved.
	STC	Potential disagreement and conflicts between actors concerning the projects to work out the multilayer safety approaches.
SPI	WoS	Developing more social housing. Space for water storage. Importance of both water safety and urban development options, interests among water and urban development sectors might be quite conflicting. Need for integrated view on the complex behaviour of interrelated systems.
	WoP	Province, Rotterdam municipality, water board, port of Rotterdam, others may include industry, businesses and citizens.
	SPI	Informed discourse needed.
IPA	Integration	Integration of top–down (the multilayer safety approach) and bottom–up (alternative selections by stakeholders) Integration of possible projects for the multilayer safety approach Integration of different geographic subareas: inside dike, outside dike; public space and industrial areas, etc. Integration of important stakeholder interests: personal risk level, cost and benefit, etc.

Since around 2006, the suite has been continuously developed and improved with support from numerous public and private partners. The version of the suite used for the Rotterdam Climate Game integrates simplified scientific models, high quality 3D-visualized maps, real-time action–feedback, and interactive virtual reality. Since 2011, the Rotterdam Climate Game (one of the games included in the suite) has been developed by Tygron with the involvement of the Rotterdam Climate Initiative, the Delta Programme, Rotterdam municipality, the Water Governance Centre (WGC, n.d.) and various knowledge institutes, such as TU Delft and HKV Consultancy. One game session for the Feijenoord case was organized, but the suite has been used to make a number of games for such cities as New York and Cape Town. These cases were not within the scope of this research.

In the Rotterdam case, the aim of the Climate Game was to contribute to the administrative decision-making surrounding the redevelopment of a district with multi-layer safety as an important element (WGC, 2013). It was played in February 2013 with representatives from the province of South Holland (Provincie Zuid-Holland), the Rotterdam municipality and the regional water board. In the rest of the section, we analyse the principles of play in CG. The Rotterdam Climate Game session is analysed reconstructively (ex post) as an example to demonstrate the application of serious game to the challenge in similar situations.

6.3.5 Validating the principles of play

The main characteristics of the Climate Game are:

(1) Multiplayer: usually 4–5 roles and 4–6 players in each round of the game.
(2) Computer supported: realistic database, 2D and 3D graphics, simulation, advanced player–computer interaction.
(3) Socially interactive: players interact socially in the same physical space.
(4) Multi-actor strategy games: long-term decision making, strategic behaviour of the players.
(5) Interactive, integrated water management: stakeholder involvement, multiple policy domains, levels, etc.
(6) Urban or spatial planning: player interactions revolve around spatial planning in a shared virtual space (SimCity style).

Using these characteristics, the CG addresses the socio-technical complexity in the real world in the form of a realistic, playful and immersive computer game. Intentional design and specific rules are used to involve players as an integral part of the game system. Computer simulation and human role play interactively simulate the behaviours and dynamic changes of complex system (principles 1 and 2: complex system). It turns the experience of policy analysis to deal with unnecessary challenge into a game play (see principles 4, 5 and 6: play). The gaming experience increases the capacity of policy actors to deal with the complexity in the upcoming event (see principle 10: serious game play).

> The Climate Game is like a dance floor to practice on in preparation for the decision at the negotiating table with each other. Source: Waterforum online www.waterforum.net/Nieuws/Nieuws.aspx?ID=4272

In the Rotterdam Climate Game, all the information needed in the game play – such as the size and ownership of the different areas, the data of all the projects for planning, and the considered values for the different layers of the safety approach – are collected from the local government and water board. Two critical indicators of water safety (the water level) and climate change impact (the temperature) are calculated by two scientific models: the SOBEK hydrological simulation model developed by Deltares, and the Hittestress Barometer developed by UNESCO-IHE. With the support of the scientific analysis and real data, the game gives the policy actors a 'true' simulation of the real-world complexity (see principle 18: suspending disbelief). The simulated planning area in the game involves the area inside and outside the dike. This area can face all the risks at the same time: sea-level rise (outside the dike), river-level rise (inside the dike) and increased street inundation as a result of heavy rainfalls. Making plans for this area means that the players need to incorporate all these challenges in their reconstruction plan (principle 28: challenge). The players will become then more familiar with the multilayer complexity and approach through playing the game.

To make a better measurement of the multilayer safety approach, the LIR (local individual risk) is added as an indicator. The value that being given to the LIR, namely a 0.00001 per cent chance of a local inhabitant being flooded, is still under discussion by the Dutch government. In the Rotterdam Climate Game, the LIR has been adopted as an important indicator in the project design. The calculation of the LIR value is provided by the Damage & Victim model developed by HKV.[32] However, the players are allowed to increase or decrease its value by 5–10 per cent if they have a valid reason for their own design (see principle 29: inference).

A typical game session goes like this. At the beginning, the group is split up into a number of parallel subgroups each consisting of four to six persons. Each subgroup forms a team that plays one round of the simulation game. Within a team the players are divided over the roles. When two or more subgroups play, the experiences of and results from different subgroups can be compared, which is a trigger for learning. Figure 6.2 shows the players' interaction during the game play. After a short introduction to the game and the objective of play, the first round commences. The players must choose which of many possible decisions to take. They can choose from a multitude of projects that are predefined in the game for each role. For example, the municipality can decide to improve housing conditions, develop green areas or give permits to other players to develop more new buildings; the water board can decide to develop more water storage or new water works and infrastructure. Their decisions must result in the achievement of their objectives and interest, such as climate proof, living quality, water safety or making a profit.

Figure 6.2 Players interacting during the game play

When the players start to make choice, they can use the relevant information about the planning area and the project as presented in Figure 6.3. The plane map (1D) on the right-hand side indicates the location of the planning area; on the left-hand side a list of possible projects is given together with all the details of each project. The indicators at the top of the screen can be used to judge the consequence of the selected projects. In the middle of the screen, a 3D virtual reality is presented in great detail. When the players make their decision, they immediately see the development of the projects and the results. The changed values of the indicators make the players aware of the consequence of their decision, the budget they still have, the environmental impact, the effect on water safety, etc. If they are not satisfied with the result, they start all over again (see principle 30: action–consequence feedback; and 33: immersive visualization).

Playing this strategic game requires the players quickly to familiarize themselves with the computer system and to be able to use the large amount of information presented in the form of maps, menus, bars, numbers, text, colours, etc. The computer interface is therefore designed for easy operation so that players without any technical background can also easily explore and operate the computer system. Players from different backgrounds have an equal opportunity to concentrate on their strategic actions (see principle 31).

Figure 6.3 The user interface of the Rotterdam Climate Game

The Rotterdam Climate game involved four public sectors and one business unit to represent the key policymakers and stakeholders in the real-world policy negotiation: the overarching government (*Overkoepelende overheid*), the Feijenoord municipality (Gemeente Rotterdam Feijenoord), the regional water board (Waterschap IJsselmonde), the housing association (*woningbouwvereniging*) and the project developer (*projectontwikkelaar*). Collective targets and interests are shared among all or some of the public sectors. For example, all the public sectors need to involve the LIR (local individual risk) in their planning choice and to ensure that there is enough budget for project development; the municipality and the housing association both need to reduce the temperature by two degrees in the rebuilding plans for three neighbourhoods and realize 75 m^2 of green and/or more houses. Conflicts can arise when, for example, the water board needs to reserve an area of 4,000 m^2 for surface water and another 3,000 m^2 for water storage while the project developer wants to develop 500 new houses and 20 new housing facilities at the same place. The players' roles in the game represent the complexity of real-world planning strategies. Each role has its own objectives, budget, resources, targets and core interests, and these reflect the reality. Political power distance, however, is removed from the game to ensure that everyone enters the game equally, and has fair chance to play the strategic game (see principles 15, 16, 17).

The role descriptions invite cooperation, especially from the overarching government and local municipality. Why they need to cooperate, however, is not explicitly explained. At the beginning of the game play, the players do not cooperate. They make decisions aimed at realizing their own interests. After some time, the players start to discover that some of their objectives, such as reducing the flood risk or increasing the size of the green area, will most likely not be achieved by their individual choice only. They realize that this affects the group performance and thus might also affect their individual performance (see principle 11: acceptance of failure). This stimulate the players to try different strategies, until they find an effective way to work together. For example, they try to find out whether trading, negotiating or cooperating with each other will enable them to achieve those objectives sooner. For instance, negotiations between the water board and the housing association when building a new water storage facility means that the building next to it cannot expand its parking capacity in the future. Or if the housing association does not have enough area for new projects, it can make a trade-off with the municipality to get permission to build in another place (see principle 24). Trying different strategies involves the players actively in the game play. They are busy running between their computers and the negotiation table, seeking new information, new evidence and new questions (see principle 22: engagement; and 23: emotional involvement). The process is full of disagreement over which planning choice is better to achieve a higher level of safety of the areas both inside and outside the levees. But gradually proposals are made among the players, and new solutions for water storage are generated ('Water Forum,' n.d.).

After each round, the game is paused for reflection and intermediate debriefing. The performance of the various roles is judged on the basis of the scores on some indicators, such as flood risk, water safety, liveability, realized development and the management of budget. Budget is quite crucial, because if the players run out of money their score will be 0%. Since each role has both collective and individual targets and interests, the players are asked to reflect upon which indicators they find the most important. For the team performance the score is calculated on the average of the sum of the individual scores. In this way, the various player and team performances can be compared. The players reflect on the progress so far and on the intensity of working together. After some time, the second round starts with the same process as the first round so that the players can remedy the undesired situation in the last round (see principle 20). This continues until the area is developed or redeveloped, or the playing time is over.

At the end of the session, the game experience is debriefed to discuss the lessons learnt. The transfer of the game-based learning to the real-life policy problem is normally facilitated by the game leader (Tygron Serious Gaming, 2013; Zhou, Bekebrede, Mayer, Warmerdam & Knepflé, 2013). A participant from Feijenoord municipality reflected that in reality she had never worked with the water board before. In the game play she had a meeting with a representative from the water board, and she was enthusiastic about the insights and knowledge gained from their conversation: ‘I have quite a different viewpoint now. I now understand their important role in the district and of course, we also do not want any flooding problems.’ (‘Water Forum,’ n.d.) (principle 34: analytics)

The final plans resulting from the Rotterdam Climate Game are not intended for use in the upcoming Feijenoord reconstruction. However, the gaming experience shows that integrating long-term flood prevention solutions in the redevelopment of the area is possible. And even a win–win solution can be achieved if the policy actors are willing to sit down together and look at the alternatives (see principle 27: ownership). A collective experience and the feeling of achievement were derived from playing together (see principle 25: fluidity; and 26: anchoring and bonding).

> ‘Serious games can form a bridge between the interests of different users of space,’ Bert Satijn from the Water Governance Center says. ‘By visualizing geographical components in an area, water, green area, urban infrastructure and buildings, and the interests of the various policy actors, players in the game start to recognize and appreciate each other's interests. As a result, they are able to unite the interests to pursue an acceptable solution for all. This is why the serious game is like a dance floor in preparation for the decision-making at the negotiating table.’
> Source: www.rotterdamclimateinitiative.nl/nl/energie-efficientie/nieuws?news_id=968 (translation from Dutch by the author)

The Rotterdam Climate Game shows the usefulness of serious game play for integrated policy analysis. It also suggests that at a higher level of integrated environment (like in the game play), policymaking becomes more like game play. The upcoming project to reconstruct the Feijenoord district will unavoidably face the problems of multiple design choice and the conflict of interests among policy actors. Doing policy exercise as game play in this situation has provided the policy actors with more reasoning and evidence. But what is more important is that serious conflict might be reduced or resolved by the shared experience of achievement and positive feelings.

For water managers, joining the game play makes them realize that there is no single technical solution that can meet all the social demands in the redevelopment. Negotiation and trade-off is more realistic than optimized design for an integrated water–spatial plan. For the local administrators and the housing sector, they are more convinced to incorporate flood risks in the spatial development. By freely experimenting with various options without the fear of serious consequences, many of the principles of fluidity (principle 25) and of anchoring and bonding (principle 26) contribute to the gradually transcending of game play from the micro level to the macro level.

The policy actors are the intrinsic part of the modelled complexity. Their actions and choices have a decisive influence on the game result, which they can be aware of immediately. Since they can dance, they want to dance freely and try to dance better. In reality, all the untreatable political issues – that is, power distance, buying off, and other political issues that cannot be dealt in any scientific subjects – are impossible to separate from the treatable issues in integrated policy analysis. Policymaking in reality often becomes too difficult to allow experimentation with innovations. In game play, these unnecessary obstacles are removed. The experimental environment in the game play is fair, safe and stimulating. Challenges are dealt with seriously, and failures are accepted less seriously. Policy actors are able to experience innovative solutions and they become more confident when they achieved their goals. As a summary, the principle of intrinsicality of game play makes game a suitable method for social experiment. It teaches the players to be more integrative and to become more playful and innovative.

Table 6.4 presents an overview of the analysis of the Climate Game, including its representation of STC, the applied principles of play, the integrated policy result and its role for integrated policymaking.

Table 6.4 Overview of the results of using CG

Question	Principle
Representation of STC	In general: a simulation of STC by integrated 3D visualization simulation game and simplified scientific models. NTP complexity: using simplified scientific models to provide rational, realistic analysis and evaluation for the reconstruction options. A link of NTP–SP complexity: human role play in virtual reality, computer program generates immediate action feedback and presents indicators of both social and natural aspects such as water level, temperature reduction, size of green area, the quality of life, etc. SP complexity: simulating the conflicting interests in the policy analysis and negotiation among five key policy actors: water sector, local administrator and business sector in a multi-role game played by policymakers from the same department in the real world.
Principles of play	All of the principles of game effects can be identified, especially for action–consequence feedback; analytics; immersive visualization; Essential conditions of play, e.g. acceptance of failures, consent, equality, fairness, intrinsicality and safety, are easy to identify; some others, e.g. to what extent for the commitment; suspending disbelief; and to repair the transgressions of the principles are less obvious.

Integrated results	Integrated process of policy analysis and negotiations with rational reasons, evidence and interest of water managers, local administrators and business sectors. Ideas and collective feelings to work together on long-term, multilayer water safety oriented urban renewal options.
Roles of game play for IPM	For participatory integration. Exercising collaborative planning in a complex situation with conflicting interests and multiple design choice. At a higher level of integration, synthesis arises from policy analysis. Especially address the participatory effect represented as a + b > (a,b) = Y due to: The needs for integrated plans and cooperation have been recognized by the policymakers from their own experience. Scientific information and evidence are used and adapted for negotiation and trade-offs. Increasing playfulness at especially a micro level of policy analysis, i.e. 3D visualization, game analytics, game control. Stimulating creative thinking through the integration of different ways of reasoning. Creating collective memory on the feeling of achievement and successful experience. Replacing the excessive seriousness in policymaking with fun and a feeling of 'it is just play'.

6.4 Conclusion and discussion

I concluded in Chapter 3 that the usefulness of serious gaming for integrated policy analysis cannot be established by simply ticking off each principle. To understand how to use the principles, it is necessary to play many serious games and observe the results. In this chapter, I examined two policy games to see how far the principles of game play serve integrated policy analysis.

6.4.1 Short answers

What are the main principles of play and did the game play serve integrated policy analysis? If so, how? Although the Blokkendoos planning kit is not a game, it was playfully used and averted an imminent deadlock in water management. Although the Climate Game is a sophisticated serious game for integrated planning, some of the sine qua non principles were opaque. Its effect on policymaking is diffuse.

6.4.1.1 Discussion

Although the BPK was never intended to be a game, its playfulness was quickly recognized during its usage. Even without typical game effects – such as role playing, gaming interface and immersive 3D virtual reality – a non-game artefact like BPK becomes like a game with simple pictures, sketches and aerial photographs. Through the playable tool, a playful environment was established by applying a lot of sine qua non principles – the essential condition to play. These play conditions applied at a meta level of policy process are quite subtle. It is also difficult to conclude whether the game play is intended or just naturally happened. But what can be learnt is that game play in the policy process does not mean introducing kaleidoscopic tools to the policymakers, but increasing their playfulness, that is, allowing policymakers to try the alternatives without being scared of the potential consequences.

Some serious games might be better at inducing play than non-game artefacts. In the case of the Climate Game, most of the principles of game effect are immediately recognized in the game play. The specially designed rules and interface of the CG draw the policy actors into the game artefact. A safe and stimulating environment has been built around them to integrate knowledge, share interest and cooperate. And it has been observed that when such a perfect floor for dancing is there, policy actors are stimulated to innovate: they try different strategies, they act actively and interactively, and they make more integrated water–spatial plans together. The induced play is obvious to see in this case. On the other hand, since the game play is a specially designed policy exercise, the game result is not intended for use in the upcoming policy negotiation. It is therefore difficult to judge its actual role and usefulness for the policymaking. Perhaps it is just a game; perhaps the collective emotions produced in the game play will contribute to a better integration. But in this instance, some of the sine qua non principles – such as commitment, consent and suspending disbelief – that are critical for the roles and usefulness of SG in policymaking, are not clearly evident. The Climate Game shows that games can be made very serious and realistic by integrating various scientific models and real data and presenting a detailed 3D virtual reality. Playing with the sine qua non principles and the principles of game effect strikes a good balance between being serious and being playful. This sounds contradictory, but this is how the principles of serious game play work: they make serious gaming an interaction between the different ways of reasoning. That is why game play raises socio-technical integration in the heart of the science–policy interface.

6.4.1.2 Continuation

In the following and final empirical chapter, I pick up the story from Chapter 2, about marine spatial planning, through the design and results of the MSP Challenge game.

7 Gaming Integrated Marine Spatial Planning

Flaunt out O sea your separate flags of nations!
Flaunt out visible as ever the various ship-signals!
But do you reserve especially for yourself and for the soul of man
one flag above all the rest,
A spiritual woven signal for all nations, emblem of man elate above death,…
SONG FOR ALL SEAS, ALL SHIPS, *Walt Whitman,* (American poet, 1819-1892)

7.1 Introduction

So far, I have examined the role of gaming for integrated policymaking in a theoretical, conceptual and retrospective way. I have de- and reconstructed integrated policymaking (Chapter 3) and game-play (Chapter 5). I have interviewed policy makers in the Netherlands and China about integration and the role of models, simulations and games (Chapter 4). I have inventoried game-like methods for integrated policymaking, and analysed two cases for integrated water management in depth (Chapter 5 and 6). However, the proof of the pudding is in the eating; I have not yet, designed, experienced and studied game-play for integrated public policymaking. By designing and analysing the game MSP Challenge, I pick up the story from Chapter 2, about integrated MSP. At this point in the research, further questions can still be asked: How can the level of integration of policy be assessed, both in reality as well as in a game? Is it feasible to develop a policy game from the perspective of STC and play it in the heart of the SPI, with experienced policy makers and researchers (or is game-play merely a didactic method to be used for students in a context of education and training)? To what extend is this type of policy gaming, culturally dependent, does it work in other countries than the Netherlands, as well? Does the game-play help the policy-makers/players to better understand the STC-complexity and their own roles and interaction in the SPI? Does policy-gaming have any bearing upon policymaking, and how? In this chapter, I describe the design and use of the game for integrated, eco-based MSP and the evaluation of the game play with pre and post questionnaires and in-game data. The analysis and observation of the players, the game process and outcome show to what extent integration occurred, and how it relates to the real-life complexity. The study design and methodological justifications are in appendix A.[33]

7.2 The relevance of SG to policymaking

7.2.1 Lisbon, 2011

Our project comprised the collaborative development and facilitation of a serious game (SG) on Marine Spatial Planning (MSP) which at the time of writing has been played at three occasions: in 2011, 2012 and 2013 respectively.[34 35] The first event for which the game was developed, took place at the joint HELCOM-VASAB, OSPAR, and ICES[36] workshop held in Lisbon, Portugal, on 2-4 November 2011. The objective of this two-and-a-half day workshop was defined as follows:

> [To] contribute to the further development of … marine spatial planning [by] reinforcing and extending existing networks and sharing knowledge and experience between scientists, managers and planners… [and to] test how (ICES, HELCOM, OSPAR, planning and scientific) data can be used in the development of an MSP plan…

The objective of the MSP Challenge 2011 was to contribute to the international learning process with regard to ecosystem-based, integrated and participatory MSP (as described above), with a particular focus on the following aspects:

- The underlying socio-technical complexities of MSP.
- The underlying regulatory principles and institutional frameworks of MSP, and how they might vary from country to country.
- The joint development of best practices for MSP amongst stakeholders and countries.
- The use of science, knowledge, data, methods and tools in MSP.

The workshop was prepared by a planning group made up of three representatives from ICES, one from HELCOM and two from OSPAR. The three-day programme of the Lisbon workshop included presentations, group discussions and reflections based on a case on the first day, a simulation game including a debriefing on the second day and an 'after-action review' on the third day. The Netherlands Ministry of Infrastructure and the Environment (I&E) commissioned and financed the design and facilitation of the simulation game on behalf of the planning group. The Serious Gaming Research Group at Delft University of Technology in the Netherlands was requested to develop and run the simulation exercise in Lisbon. Actual design of the game took place between August and November 2011. This process involved a detailed analysis of existing MSP systems and practices, the analysis and adaptation of data on the Baltic Sea, consultations with the client and planning group, the design and production of the game material, logistical planning (as the game was to be played in Lisbon with an uncertain number of participants) and, most of all, the design and programming of the digital map software which would play a significant role in the game.

7.2.2 Leeuwarden, 2012

Following the success of the Lisbon game, the team was asked by the Centre for Marine Policy, part of Wageningen University [37], to play the MSP Challenge game in a master class on MSP in the Dutch town of Leeuwarden on October, 31, 2012. This international event was aimed at policy makers, spatial planners, users, stakeholders and researchers to share new and innovative insights about MSP. Unlike the Lisbon session, this game session was short (4 hours) and had objectives and characteristics of a professional training. Data collected through the pre-questionnaires about the level of integration in the respective countries, are therefore used, but not the in-game data.

7.2.3 Reykjavik, 2013

On 12-13 November 2013, around 60 policy makers from the Nordic countries[38] played the MSP Challenge game in Reykjavik, Iceland. The one-day game-play was part of a two day workshop commissioned by 'Havgruppen' (transl., marine group) under The Nordic Council of Ministers (Nordic Council of Ministers, n.d.). Due to the lower number of participants, country Yellow was not played in Reykjavik. The aim was to establish a common understanding of the ecosystem approach and the application and administration of the Nordic seas. The Northern seas unofficially refers to the North-East area of the North Atlantic ocean, roughly from Greenland in the top, via Iceland to northern Scotland, then right to Denmark (upper part of the North sea) into the Finish straits and Baltic sea, back up along the coast of Sweden and Norway (Norwegian sea, Barents sea), and closing the area again at Greenland. The Nordic seas are extremely rich on natural minerals (oil and gas) and fish, but are also the habitat of very endangered and protected sea life, such as cetaceans, like whales and dolphins. But for all human activities in this part of the ocean, applies that weather conditions can be extreme in all seasons. Also the marine ecosystem in this part of the ocean is very vulnerable to the effects of climate change, especially through the shrinking of the Arctic sea ice, which may open up a Northern shipping route and gives way to exploitation of mineral resources in the Arctic region. Although, the Nordic countries share history and the Scandinavian languages are quite similar, we find enough diversity among the Nordic countries and their administrations. On the one hand, there are a few tiny, semi-independent islands like the Faroe Islands (sovereignty Kingdom of Denmark) and Åland (Finnish autonomous region) where the population firmly holds on to their traditions and protects their cultural heritage and connection with the sea. For the Faroe Islands, Iceland and Greenland this includes whaling.[39] On the other hand, we have countries like Norway, one of the wealthiest countries in the world but heavily depending upon its off shore gas and oil industry. Overall, there is no comparable legislation for the planning of marine areas in any of the Nordic countries (Blaesbjerg et al., 2009; Secretariat NEAFC, 2007). Countries like Greenland (autonomous country within the Kingdom of Denmark) and Iceland have a vast coastline; but a population of only a few hundred thousand inhabitants, and therefore only a small public administration. In Sweden and Finland, the economic zone is contemplated in the Planning Act; in Sweden with municipal planning and in Finland with regional plans. Norway has created management plans in an entirely different way. Other countries like the Faroe, have no MSP policies at all, whereas the UK and countries around the Baltic seas are quite advanced in integrated MSP. As we have seen in Chapter Two, the sea and environmental impacts do not respect national borders, and therefore it is important that the Nordic countries formulate a common understanding, principles and core values of the planning of their shared marine environment, despite the fact that each country may perform marine and coastal planning its own way. The Marine Group (HAV) of the Nordic council of Ministers (Nordic Council of Ministers, n.d.) therefore focuses on developing a basis for joint Nordic initiatives and means to improve the marine and coastal environment. The Group's focus reflects NCM's Environmental Action Plan priorities for 2013-2018 in marine areas. The group limits its scope of work to the Nordic marine areas and the factors within the catchment areas that affect the marine environment. A first workshop was held in the Faroe Islands in 2011 and resulted in recommendations to the Nordic Council of Ministers Environmental Action Programme for 2013 -2018, about the need for a holistic, ecosystem-based administration. One of the conclusions was to develop a common toolbox (methods, processes, and implementation) from which countries should be able to select tools that suit the individual country or region. The question driving the Reykjavik meeting was: Is there a need for a joint Nordic forum for marine spatial planning, and if so, how should such a forum so be organised? What role should it have, or could any of the current Nordic institutions undertake the task?

7.3 MSP Challenge: the game

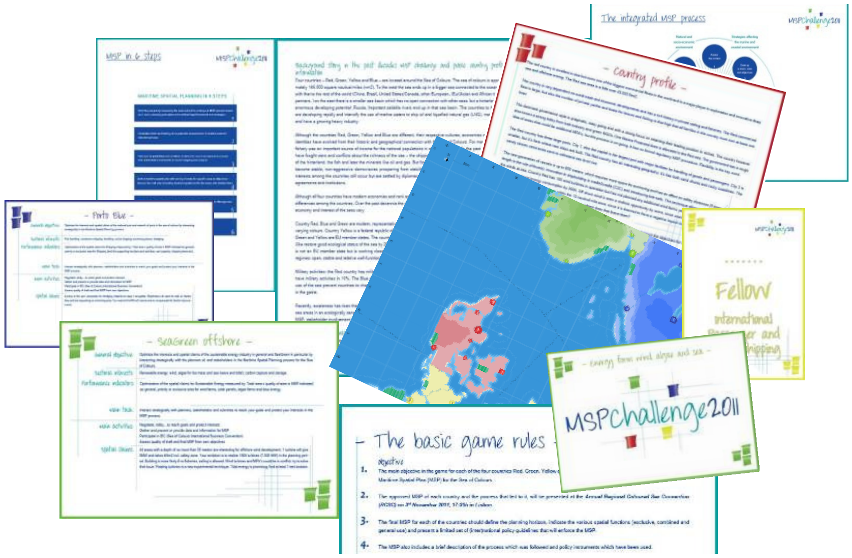
7.3.1 Principles of Play

MSP Challenge is a computer-supported game involving considerable social interaction between the stakeholders. It is supported by a simulation model running in the background and a feedback system for measuring performance and enhancing learning. The game reflects many of the principles developed and discussed in Chapter 5: It is a playable representation of the complexity of MSP as represented in Chapter 2. The players play with a digital map tool but form an intrinsic part of the complexity.

Figure 7.1 Becoming an intrinsic part of complexity

The game is not well-suited for, or interesting to players who lack affinity for its content and context. The players receive general information on paper about the geographical, ecological, political and other characteristics of the countries concerned. The game is designed to make maximum use of participants' general and expert knowledge about the northern countries and the Baltic Sea region. The map of the area was changed slightly, but not so much that it was not clear to the participants where it referred to. The game MSP Challenge features four countries – Red, Blue, Green and Yellow – located around a single shared sea area. Information and data are derived from and inspired by the Kattegat-Skagerrak and Baltic Sea areas and the countries of Norway, Germany, Denmark and Sweden, although they have been simplified, abstracted and reduced in order to create a level playing field and to make the game process manageable and educational (Ekebom, Jäänheimo, & Reeker, 2008) (see Figure 7.1 and Text box 7.1).

Figure 7.2 Impression of the game materials



Text box 7.1 Impression of the background story

Four countries – Red, Green, Yellow and Blue – are located around the Sea of Colours. This body of water covers approximately 146,500 square nautical miles (sq. nm). To the west it opens into a larger sea connected to the ocean and the rest of the world (China, Brazil, the United States, Canada and other European, Asian and African trading partners). To the east there is a smaller sea basin with no open connection to other seas but with a hinterland with enormous and developing potential (Russia). Several important navigable rivers empty into that basin. The countries to the east are developing rapidly and intensifying their use of marine waters to ship oil and liquefied natural gas (LNG). They trade goods and have growing heavy industry. The marine and maritime space known as the Sea of Colours is a unique area. It is formed by various peninsulas, islands and land areas belonging to one or other of the four coloured countries bounding it. Its unique geographical position makes it both an important area for shipping and a noteworthy ecosystem zone containing a number of rare species. Its scenic rocky shores and beaches are highly valued by both residents and tourists. However, the increasingly intensive economic development in the region is seriously threatening the ecosystem. In 1970 it was listed as one of the first marine 'dead zones', where seawater quality is insufficient to support aquatic life. The pressure on the sea comes from intensified traditional maritime activities, such as shipping and fisheries. At the same time new economic activities, like aquaculture and offshore renewable energy, have now emerged and are trying to claim space in the Sea of Colours. Spatial planning (marine and/or maritime) is regarded as a helpful tool to address the challenges ahead. Recently, awareness has increased that MSP is a useful 'cross-cutting' tool to manage sea areas in an ecologically sound manner. In addition, the EU is promoting the use of MSP to enhance economic growth. Stakeholder involvement is a crucial element of MSP.

Each of the four 'countries' in the game consists of four or five stakeholder roles, and each role is played by between two and five people. A country is thus made up of about 15-20 actors, requiring a total of 60-80 players with knowledge and expertise in the field.[40]

- Planners are in charge of the process of making a marine spatial plan. They are responsible for delivering the plan for their country at the end of the game. Their task is difficult, as they handle the content and substance of the plan, as well as the stakeholder interaction process.
- Stakeholders (businesses and NGOs) must ensure that their spatial claims are included in the MSP.
- Policy analysts/scientists are dedicated to analysing the problems and taking care of the flows of information and knowledge. Although they may know more than the other players, they also have their own biases and interests.
- There are several roles in the game that are not played by players but simulated by the game-team. Journalists, Country facilitators, G(ame) O(verall) D(irector): G.O.D. rules and intervenes in all situations for which the game does not provide rules or actors – like quality or impacts of decisions – acceptance of certain decisions by parliament in a country; rejection of low quality decisions et cetera. In case of conflicts, the players can go to court.

Text box 7.2 Information given to the players at the start of the game.

The objective for each country: Produce a draft integrated marine/maritime spatial plan (MSP). Define its planning horizon, indicate the various spatial functions and present a limited set of national and international policy guidelines which will enforce the MSP. The policy report (two pages) also includes a brief description of the process followed and the policy instruments used. The approved MSP of each country and the process which resulted in it will be presented at the annual Regional Coloured Sea Convention (RCSC) at 6pm on 3 November 2011 (i.e., at the end of the game day).

The objective for the planners: Design and manage the process of producing an integrated marine/maritime spatial plan (MSP). Define its planning horizon, indicate the various spatial functions on a digital map and present a limited set of policy guidelines that will enforce the plan. There are multiple criteria for success. Choices and trade-offs need to be made! In terms of the planning process, the planners responsible should at least prepare an inventory of the various spatial claims and manage the potential conflicts.

Figure 7.3 A place at the table

Note: Game session in Reykjavik, Iceland

Each country and player is provided with a specific profile containing goals and objectives to achieve during the game (see Text box 7.2). In addition, players are assigned powers and obligations to be used at their own discretion. Although the effects of player actions are transparent, players are free to interpret whether they have achieved their goals. We deliberately aimed to create a realistic and ambiguous policy setting, including the following:

(1) *Information overload*: There is too much information to handle.
(2) *Information asymmetry*: Different roles have access to different information; some have more information than others do.
(3) *Ambiguity*: Some things and notions are simply not clear, and the interests and goals of the players within each country are conflicting.
(4) *No single best solution*: Different countries have different outcomes based on a set of performance indicators. There is no objective measure stating which indicator is more important. Players must compile their own rankings.
(5) *Vagueness*: The planning horizon and the policy-implementation guidelines are not clear. It is also unclear what an integrated MSP is and what should be included

in it. Furthermore, it is not obvious whether the MSP should be considered a national or an international process.

(6) *Imperfect information*: Many things are simply not known. Finding them out is difficult or impossible, and the search takes considerable time and resources.

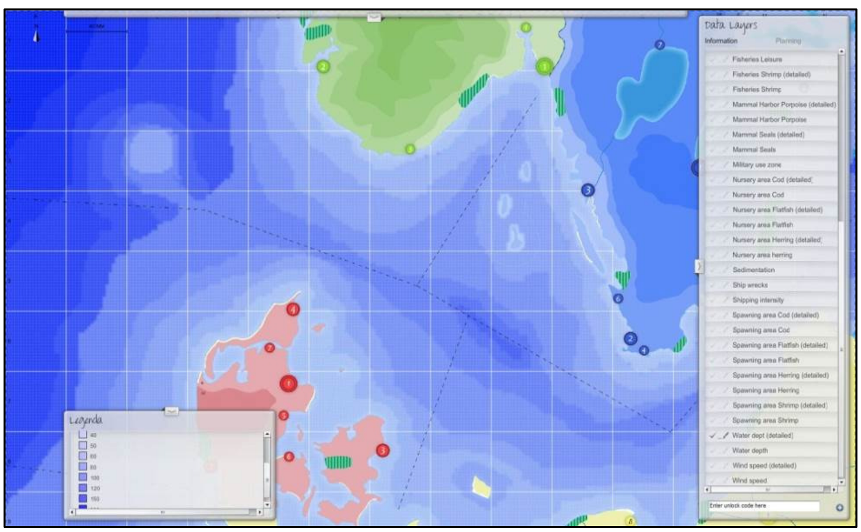
(7) *Objectivity and neutrality* do not exist, not even for scientists, analysts, modellers or other sources.

(8) *Reframing and rhetoric*: Conflicts and controversies can be intensified or settled by changing frames or wordings.

7.3.2 Information system

The emergent complexity of the eco- and geo-system (see Figure 2.2) of the game version discussed here, is still limited. The version launched in March 2014, has a simulation model, with more (realistic) data and calculations, and produces more emergent effects, through feedback, delays et cetera. A computer tool consisting of an interactive digital map with 75 layers of spatial information about the Sea of Colours played a crucial role in the game. Figure 7.4 provides an impression of the screens in the map tool. Real databases of the Kattegat, Skagerrak and Gulf of Bothnia sea area were used to develop the maps, although they were simplified and altered (see acknowledgements for the use of Harmony data).

Figure 7.4 Emergent complexity in the layers of the planning tool



The layers of the maps with information and knowledge presented sufficient detail and richness without becoming overwhelming. Examples of map layers include oil and gas infrastructure (platforms); commercial fishing; energy; sea cables and pipelines, and marine protected areas (see Table 7.1). The tool was designed to be highly interactive, robust and stable, in addition to being attractive for gameplay.

All participants were asked to bring their own laptop to be able to play with the digital map tool during the game. The required software was installed the day before the game, and each laptop was checked for such items as a current Flash player. Each layer for each country has a unique code, which needed to be entered by a player to gain access to his or her role-dependent information in the map tool. In all, about 30 codes are given to the 60-70 players in Lisbon and Reykjavik, creating a web of information interdependencies. Some general layers in the tool – like shipping routes, currents and sea depths – were available to all players, but many were accessible only with the player-specific codes. Maps of oil reserves, for instance, were accessible only by the oil companies. The nature organizations had specific information about nature reserves, sea life and so on. And some layers with very specific data and hidden information were visible only to scientists or marine institutes in the game.

7.3.3 Game validation

One of the important aspects in the further consideration of the results and insights of the game-play, is whether the game is, 1) engaging enough, 2) valid enough and 3) meaningful enough for the purpose of policy analysis. Low player satisfaction is low may be an indication that the players are over- or under challenged. User unfriendly tools or malfunctions disturb the game-play. When players do not trust the game to be valid or realistic enough, they may have a problem to connect the game-play to the real world. Insufficient or low quality debriefings may hinder the participants learning and learning transfer. In short, although user satisfaction is not the only and probably not the most important indication of learning, it is an important starting point for the validation of the game in its specific context. Tables D3-7 in Appendix D give the results of the player-user satisfaction with the quality of the game. The conclusion is that the Lisbon session scored a little higher than the Reykjavik session in terms of game-quality. Overall, the game quality and learning seemed high for Lisbon and more than adequate for Reykjavik.

Table 7.1 Abridged list of map tool layers.

Layer number	Layer title
Energy	
Layer 1	Oil and gas infrastructure (platforms).
Fishing/aquaculture	
Layer 8	Commercial fishing.
Shipping and ports	
Layer 13	Shipping routes.
Marine aggregates and dredging	
Layer 22	Land reclamation (nature compensation, island in sea, et cetera.).
Sea cables and pipelines	
Layer 26	Subsea cables.
Defence and national security	
Layer 27	Defence and national security.
Tourism and recreation	
Layer 28	Recreation areas (diving, racing, sailing, kitesurfing, et cetera.)
Archaeology	
Layer 32	Historic environment areas (shipwrecks, et cetera.)
Marine protected areas (MPA)	
Layer 34	International designation.
Bird species	
Layer 39	Bird species 1.
Fish species	
Layer 43	Fish species 1.
Mammals	
Layer 47	Mammal species 1.
Physical maps	
Layer 50	Geography.
Biological maps	
Layer 57	Macrobenthos.
Chemical maps	
Layer 59	Concentration and distribution of chemicals (cadmium).
Layer 64	Ballast water exchange zone.

7.4 Research questions and data gathering

The analysis of the game results in the remainder of this paper is based on the following questions:[41]

- How does an international panel of MSP professionals assess the state of integrated, eco-system based MSP in its members' own countries?
- What are the characteristics of integrated, eco-system based MSP processes and outcomes when simulated by this international group of professionals in a quasi-experimental game-based environment?
- What does the international panel consider to be the main insights gained about integrated, eco-system based MSP from the quasi-experimental game-based environment?
- Does this international panel view SG as an effective tool for policy-oriented learning and policy analysis?

7.5 Participant-respondents

In the three game-sessions, there were around 150 player-participants from 20 countries, with a bias towards Northern Europe (e.g. Scandinavia, the Baltic States, Germany, Poland, Russia, the Low Countries, UK), and a few participants from Canada and the US. Taking into account around 20 % non-response and some missing values, the data-set about the three game-session consists of data collected from 112 for the pre-, and around 70 respondents for the post questionnaires.

The average work experience in MSP for all three sessions was 3.2 years, the average age was 44.3 years, and the gender distribution was exactly equal (see Table D.1 and D.2 in appendix D). There were some differences among the sessions. The participants in Leeuwarden 2012 were somewhat less experienced and younger than in Lisbon and Iceland, but still had an average work experience of more than two years in the field; The participants in Reykjavik were somewhat older, than in Lisbon. In Lisbon the female participants slightly outnumbered the male participants.

Participants in all three sessions shared medium professional interest and involvement in MSP, from the perspective of maritime policymaking, maritime science and research, or both (see tables D2 in Appendix D). Their motivation to participate in the game, was high, especially in Lisbon and a little less in Reykjavik (see tables D.3 and D.4, in appendix D). Table 7.2 and 7.3 shows that that there were not so much differences in background among the players in Lisbon and Reykjavik. However, it seemed that the Lisbon players were more continental oriented and the Reykjavik players more national to (sub) local (see tables 7.2 and 7.3).

Table 7.2 At which level do you primarily practise your profession?

	Lisbon	Leeuwarden	Reykjavik	Total
International (e.g. multinationals, UN, international NGO)	3 (5,4%)	3 (11.1%)	4 (12.9%)	10 (8.9%)
Continental (e.g. Europe, Asia, America)	18 (32.7%)	7 (25.9%)	2 (6.5%)	27 (23.9%)
National (e.g. country)	30 (54.6%)	10 (37%)	20 (64.5%)	60 (53.1%)
Regional (e.g. province, department, states)	4 (7.3%)	5 (18.5%)	3 (9.7%)	12 (10.6%)
Local (e.g. city, municipality)	0%	0%	1 (3.2%)	1 (0.9%)
Sub local (e.g. neighborhood, city district	0%	0%	1 (3.2%)	1 (0.9%)
Total	55 (100%) (49%)	25 (100%) (23%)	31 (100%) (28%)	111 (100%)

Table 7.3 In which societal sector do you primarily practise your profession?

	Lisbon	Leeuwarden	Reykjavik	Total
Public sector (e.g. government, public administration, public policy advice et cetera.)	43 (77%)	7 (28%)	26 (84%)	76 (68%)
Private sector (e.g. fishing, shipping, tourism, energy, consulting, et cetera.)	1 (2%)	4 (16%)	1 (3%)	6 (5%)
Non-profit sector (e.g. science, NGOs, academia, et cetera.)	12 (21%)	14 (56%)	4 (13%)	30 (27%)
Total	56 (50%) (100%)	25 (22%) (100%)	31 (28%) (100%)	112 (100%)

Table 7.4 presents information about the extent to which participants considered themselves knowledgeable in MSP and marine ecosystems, as well as the extent to which they were involved and influential in MSP, sorted by country of professional activity in MSP. From this information, we calculated two 'impact factors', which were later used to perform statistical tests for potential bias in the results.

(1) *Individual impact factor*: This indicates the total 'weight' of input into the games by players working in the same country. It is calculated as follows: the number of participants from the same country is multiplied by the individual scores of each respondent from that country on each of the four items (min. = 4, no max.).
(2) *Country impact factor*: This indicates the relative 'weight' of input into the games by one country. It is calculated as follows: the average score for all participants

working in a country for each of the four items is divided by four (min.=1, max.=5).

In Table 7.4 last two columns the calculated individual impact factor results are ranked from high to low. These results indicate that respondents from Canada, Ireland, Norway, Sweden and England consider themselves the most knowledgeable, involved and influential. In terms of the weight of country input (table 7.5), England, Portugal, the Netherlands and Iceland were likely to be most determinant in the game results of the three sessions.42 Note that the respondents from Italy and Romania indicated a low level of expertise and involvement; but later assessed their countries to have a well-developed MSP.

Table 7.4 Player knowledge, involvement and influence by country

Country	N	Influence on MSP	Professional involvement in MSP	knowledge of ecosystems	knowledge of MSP	Individual impact factor	Country impact factor
Canada	1	5	5	4	4	18	18
Ireland	2	4 (1,4)	4,5 (0,7)	4 (0)	4 (0)	16,5	33
Norway	3	3 (1)	3,7 (1,5)	4 (1)	3,7 (1,5)	14,4	43,2
Sweden	7	3,3 (1,6)	3,4 (1,5)	2,8 (1)	3 (1,5)	12,5	87,5
England	14	3,2 (1,6)	3,4 (1,3)	2,6 (1,1)	3 (1,2)	12,2	170,8
Finland	5	3 (1,2)	2,8 (1,1)	3,2 (1,3)	2,8 (1,3)	11,8	59
Poland	2	3 (1,4)	3 (2,8)	2 (0)	3,5 (0,7)	11,5	23
USA	1	1	2	4	4	11	11
Belgium	2	3 (1,4)	2,5 (2,1)	1,5 (0,7)	3,5 (0,7)	10,5	21
Germany	7	2,4 (1)	2,6 (1,8)	2,5 (0,6)	2,9 (1,8)	10,4	72,8
EU*	2	1,5 (0,7)	2,5 (2,1)	3 (1,4)	3 (1,4)	10	20
Spain	1	2	3	3	2	10	10
Netherlands	14	2 (0,8)	2,6 (1,2)	2,4 (1,5)	2,4 (0,8)	9,4	131,6
Denmark	6	2,3 (0,5)	2,2 (0,4)	2,6 (1,8)	2,2 (1,2)	9,3	55,8
Russia	1	4	3	1	1	9	9
Baltic*	1	2	1	4	2	9	9
Portugal	16	2,1 (0,7)	2,3 (1,1)	2,4 (0,9)	1,7 (1,2)	8,5	136
Iceland	14	2,6 (0,9)	2 (1,2)	2,1 (1,2)	1,7 (0,8)	8,4	117,6
Romania+	1	2	2	-	2	6	6
Italy+	2	1,5 (0,7)	1,5 (0,7)	-	1 (0)	4	8

Note to Table 7.4 * region; + = respondent with self-indicated low level of expertise.

Table 7.5 Knowledge, involvement and influence in MSP by country

Country	N	Influence on MSP	Professional involvement in MSP	knowledge of ecosystems	knowledge of MSP	Individual impact factor	Country impact factor
England	14	3,2 (1,6)	3,4 (1,3)	2,6 (1,1)	3 (1,2)	12,2	170,8
Portugal	16	2,1 (0,7)	2,3 (1,1)	2,4 (0,9)	1,7 (1,2)	8,5	136
Netherlands	14	2 (0,8)	2,6 (1,2)	2,4 (1,5)	2,4 (0,8)	9,4	131,6
Iceland	14	2,6 (0,9)	2 (1,2)	2,1 (1,2)	1,7 (0,8)	8,4	117,6
Sweden	7	3,3 (1,6)	3,4 (1,5)	2,8 (1)	3 (1,5)	12,5	87,5
Germany	7	2,4 (1)	2,6 (1,8)	2,5 (0,6)	2,9 (1,8)	10,4	72,8
Finland	5	3 (1,2)	2,8 (1,1)	3,2 (1,3)	2,8 (1,3)	11,8	59
Denmark	6	2,3 (0,5)	2,2 (0,4)	2,6 (1,8)	2,2 (1,2)	9,3	55,8
Norway	3	3 (1)	3,7 (1,5)	4 (1)	3,7 (1,5)	14,4	43,2
Ireland	2	4 (1,4)	4,5 (0,7)	4 (0)	4 (0)	16,5	33
Poland	2	3 (1,4)	3 (2,8)	2 (0)	3,5 (0,7)	11,5	23
Belgium	2	3 (1,4)	2,5 (2,1)	1,5 (0,7)	3,5 (0,7)	10,5	21
EU	2	1,5 (0,7)	2,5 (2,1)	3 (1,4)	3 (1,4)	10	20
Canada	1	5	5	4	4	18	18
USA	1	1	2	4	4	11	11
Spain	1	2	3	3	2	10	10
Russia	1	4	3	1	1	9	9
Baltic*	1	2	1	4	2	9	9
Italy	2	1,5 (0,7)	1,5 (0,7)	-	1 (0)	4	8
Romania	1	2	2	-	2	6	6

Note to Table 7.5 * region; + = respondent with self-indicated, low level of expertise.

7.5.1 Intermediate conclusion

In all three sessions, a very mixed, international and heterogeneous group of knowledgeable and partly influential professionals played the MSP game.

7.6 Measuring integration in MSP

Can integration in MSP be assessed? In order to measure the level of integration of MSP, and changes in the level of integration during the game play, and relate the game-play to the real world, we developed three scales for profiling the process and outcomes of participants and measuring their progression in the game (see below). These scales were loosely based on the 'ten key principles for MSP' promoted by the European Commission.

Scale 1: Level of integration in MSP outcomes (seven-point scale, measured for both real and gamed country)

(1) National orientation – international orientation
(2) Economy-based – ecology-based
(3) Short-term thinking – long-term thinking
(4) Interest-based – evidence-based
(5) Conservative – innovative
(6) Uninformed – well-informed
(7) Disjointed – integral

Scale 2: Level of integration in MSP process (seven-point scale, measured for both real and gamed country)

(1) Centralized – networked
(2) Top-down – bottom-up
(3) Out of control – well-managed
(4) Viscous – decisive
(5) Every man for himself – good cooperation
(6) Contentious – harmonious
(7) Closed process – open process

Scale 3: How well-established is MSP in your country? (seven-point scale from 1 = not established at all, to 7 = very well established; measured for both real and gamed country)

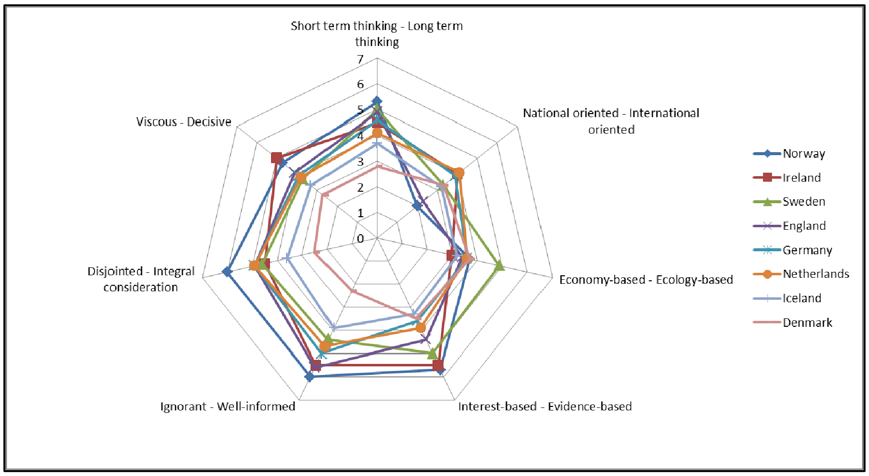
(1) Coordination with other states
(2) Stakeholder participation
(3) Vision and ambition
(4) Clear objectives
(5) Implementation guidelines
(6) Science-based and evidence-based

(7) Knowledge and data infrastructure

7.6.1 Analysis of pre-game survey data

Based on the three MSP scales (as described above), we now discuss the experts' opinions regarding the level of integration in the real-world MSP outcome (the final plan) and process (e.g. stakeholder participation, management of decision-making). We also assess the opinions of the expert panels with regard to the 'establishment of MSP' in the various countries. Statistical testing of the reliability of the three 'integration' scales yielded Cronbach's α values of 0.9. We therefore calculated an integrated MSP outcome factor and an integrated MSP process factor (see the last columns in Tables 7.5 and 7.6). Once again, we list the countries by their factor scores, ranging from high to low. The results reveal significant statistical variance amongst the 20 countries. In other words, the expert panel rated the level of integration within the countries quite differently, probably indicating differences in policy approaches. Scores for the Baltic, Spain, Norway, Italy and Ireland were quite high, whereas those for Denmark and Russia were relatively low. The level of integration in MSP in each country is indicated by the pattern of its 'spider web', such that variations in the patterns highlight differences between countries. Table 7.6 presents the results for each country according to the scale measuring the level of integration in MSP outcome. Table 7.7 does the same for the MSP process (min. = 1; max. 7). Note that a lower score on outcome and/or process does not say much about the quality or effectiveness of MSP in a country. It merely indicates that the country is less integrative in its policy (e.g. more short-term, national, economy-based or hierarchic). Figures 7.5 and 7.6 present the results graphically: larger areas in the 'spider webs' indicate higher levels of integration in the MSP outcome and processes, according to the experts working as MSP professionals in that country. Table 7.6 shows large differences for a number of Northern European countries.43 The difference in depth and scope of MSP integration among the countries is striking. Norway has a well-developed MSP policy, but seems to be very national-based. Denmark, with its many offshore wind farms, has one of the least integrated MSP among the countries. Sweden is assessed as the most ecology-based MSP country. Table 7.5 gives the exact data. The Netherlands score average on integration, but are quite internationally oriented in its MSP.

Figure 7.5 Profiled integrated MSP outcome, by country



In a similar fashion, we can look at the level of integration in the MSP process (Figure 7.6 and Table 7.7). Again there are significant differences. Norway has a well-managed MSP process, but is rather top down. Denmark, again, scores markedly low on all aspects of MSP process integration. The Netherlands has average scores, a little low on decisiveness. England and Sweden are characterised as quite open.

Figure 7.6 Profiled integrated MSP process, by country

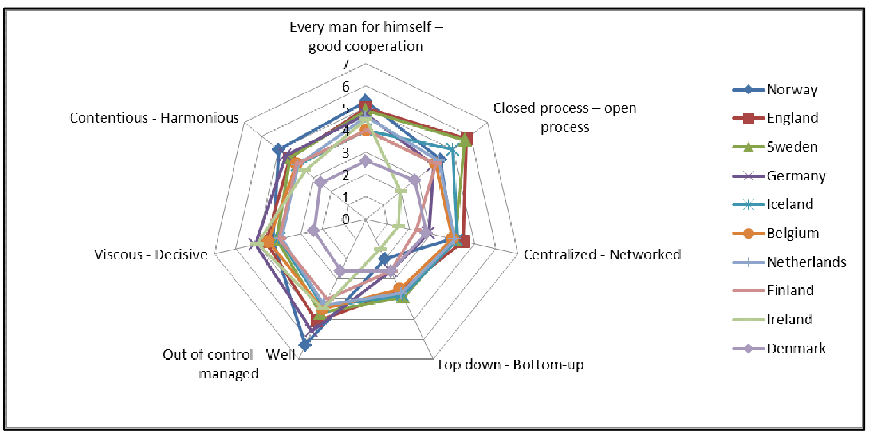


Table 7.6 Profiled integrated MSP outcome by country

Country	N	Short term thinking - Long term thinking	National oriented - International oriented	Economy-based - Ecology-based	Interest-based - Evidence-based	Ignorant - Well-informed	Disjointed - Integral consideration	Viscous - Decisive	Integrated outcome factor
Baltic*	1	7	7	7	6	7	7	7	6,9
EU*	2	5,5 (0,7)	6,5 (0,7)	4 (0)	6 (0)	5 (1,4)	4 (2,8)	5 (1,4)	5,1
Spain +	1	3	5	4	5	6	6	6	5,0
Norway	3	5,3 (1,5)	2 (1)	3,7 (2,1)	5,7 (0,6)	6 (0)	6 (0)	4,7 (1,2)	4,8
Italy +	2	5 (1,4)	4 (0)	4 (0)	4,5 (0,7)	4,5 (0,7)	5,5 (2,1)	5,5 (2,1)	4,7
Ireland	2	4,5 (0,7)	4 (2,8)	3 (1,4)	5,5 (0,7)	5,5 (0,7)	4,5 (0,7)	5 (0)	4,6
Belgium	2	5 (1,4)	3 (1,4)	4 (0)	5 (1,4)	5 (1,4)	4 (0)	5 (1,4)	4,4
Canada	1	6	1	5	4	6	5	4	4,4
Sweden	7	5 (1)	3,3 (1,7)	4,9 (0,9)	5 (0,8)	4,4 (1,4)	4,6 (1,6)	3,7 (1,6)	4,4
England	14	4,9 (1,6)	2,3 (0,8)	3,4 (0,8)	4,4 (1,7)	5,6 (1)	4,9 (1,3)	4,1 (1,5)	4,2
Germany	7	4,6 (0,5)	3,9 (1,1)	3,6 (1)	3,6 (1)	5 (0,6)	4,9 (0,4)	3,9 (0,7)	4,2
Netherlands	14	4,1 (1,4)	4,1 (1,6)	3,6 (1,3)	3,9 (0,8)	4,7 (0,8)	4,9 (1)	3,8 (1)	4,2
Poland	2	5 (1,4)	2,5 (0,7)	4 (1,4)	4,5 (0,7)	4 (1,4)	4,5 (3,5)	4 (2,8)	4,1
Finland	5	4,5 (1)	4 (0,8)	3,8 (0,8)	3,8 (0,5)	4,8 (1)	4 (1,4)	3,3 (1)	3,9
Portugal	16	4,1 (1,6)	2,2 (1,2)	3,9 (1,4)	3,7 (1,4)	3,9 (1,7)	4,4 (1,5)	3,6 (1,4)	3,7
USA	1	4	1	3	3	5	5	4	3,6
Iceland	14	3,7 (2,1)	3,2 (1,7)	3,2 (1,3)	3,3 (1,7)	3,9 (1,8)	3,6 (2)	3,3 (1,2)	3,5
Romania +	1	2	3	4	4	5	4	2	3,4
Denmark	6	2,8 (2)	3,3 (1,5)	3,7 (1,9)	3,5 (1,6)	2,3 (1)	2,5 (1,2)	2,7 (1,9)	3,0
Russia	1	3	2	2	2	1	1	2	1,9

Note to Table 7.6 * region; + = respondent with self-indicated low level of expertise.

Table 7.7 Profiled integrated MSP process by country

Country	N	Every man for himself – good co-operation	Closed process – open process	Centralized - Networked	Top down - Bottom-up	Out of control - Well managed	Viscous - Decisive	Contentious - Harmonious	Integrated process factor
Baltic*	1	7	7	7	4	7	7	4	6,1
Spain+	1	6	6	6	5	5	6	6	5,7
Canada	1	6	7	5	4	5	6	5	5,4
Italy +	2	5 (1,4)	5 (1,4)	5,5 (2,1)	5 (1,4)	5 (1,4)	5 (1,4)	5 (1,4)	5,1
Norway	3	5,3 (0,6)	4,3 (2,5)	4 (2)	2 (1)	6,3 (1,2)	4,3 (2,1)	5 (1)	4,9
USA	1	4	6	6	6	5	4	3	4,9
England	14	5 (1,5)	5,8 (0,8)	4,5 (1,6)	3,6 (1,5)	5,1 (1,2)	4,6 (1,5)	4,4 (1,4)	4,7
Sweden	7	4,9 (1,5)	5,7 (0,5)	4,1 (1,2)	3,9 (1,1)	4,7 (1,4)	4,1 (0,7)	4,4 (0,8)	4,5
Portugal	16	4,7 (1,1)	5,1 (1,1)	4 (1,8)	3,3 (1,5)	4,5 (1,4)	4,1 (1,5)	4,1 (1,1)	4,3
EU*	2	4,5 (2,1)	4 (1,4)	4,5 (2,1)	3,5 (0,7)	4,5 (2,1)	4,5 (2,1)	4 (1,4)	4,2
Germany	7	4,7 (0,5)	3,9 (0,7)	2,9 (1,2)	2,6 (1)	5,6 (0,5)	5,1 (0,7)	4,6 (0,5)	4,2
Iceland	14	4 (1,9)	5 (1,2)	4,2 (1,6)	3,8 (1,1)	4,4 (1,6)	4 (1,5)	3,9 (1,6)	4,2
Belgium	2	4 (0)	4 (0)	4 (0)	3,5 (0,7)	4,5 (0,7)	4,5 (0,7)	4 (0)	4,1
Netherlands	14	4,6 (0,6)	4,2 (1,1)	4,1 (1,2)	3,7 (1,5)	4,3 (0,9)	3,9 (1)	3,9 (0,9)	4,0
Poland	2	4,5 (2,1)	4,5 (2,1)	1,5 (0,7)	2,5 (2,1)	5 (0)	4,5 (0,7)	5 (1,4)	3,9
Finland	5	4 (1,4)	4 (1,2)	2,3 (1,9)	2,6 (0,9)	4 (1,2)	4 (0)	4 (0,8)	3,6
Ireland	2	4,5 (0,7)	2 (0)	1,5 (0,7)	1,5 (0,7)	4,5 (0,7)	5 (0)	3,5 (0,7)	3,2
Romania +	1	2	2	2	2	4	5	4	3,0
Denmark	6	2,6 (1,3)	2,8 (1,3)	2,8 (1,3)	2,6 (1,1)	2,6 (1,1)	2,4 (1,1)	2,6 (1,3)	2,6
Russia	1	2	2	1	1	1	1	3	1,6

Note to Table 7.6: * region; + = one respondent with self-indicated low level of expertise.

7.6.2 MSP establishment

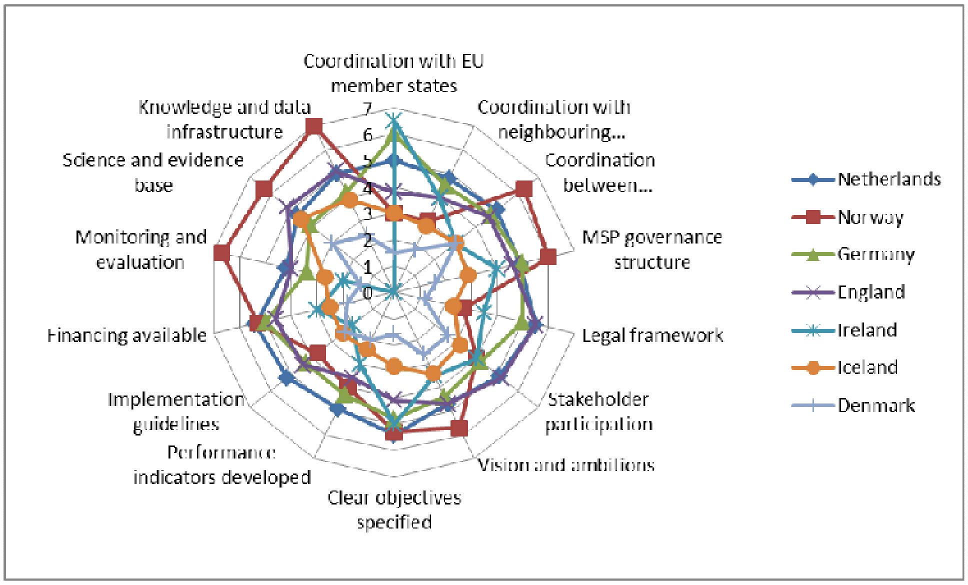
Table 7.8 and Figure 7.7 present the results of the participants' scores with regard to how well-established MSP is in their countries. Unlike the previous scales, this one is based on 14 indicators derived from the set of EU principles for good practice in MSP.

As before, our analyses yielded a high reliability factor amongst the principles, and we calculated an establishment factor for each of the countries (last column of Table 7.7). The countries are listed in descending order, with the Netherlands, Norway, Italy, Sweden and Spain at the high end. Again we see marked differences among the countries. Norway having a well-developed knowledge and governance infrastructure but much less developed implementation guidelines, performance indicators, stakeholder participation and legal framework. Countries Denmark and Iceland scoring low on all criteria. The Netherlands mid-ranged on all indicators, but above average on stakeholder participation and a little dent in the spider shape with respect to 'monitoring and evaluation'.

7.6.3 Intermediate conclusion

One of the conclusions must be that the many countries are in different stages of development and have rather different approaches with regard to MSP outcome and process. A rather generalized picture is as follows. Some countries who are very active in deploying human activities at sea, like Denmark with its off shore wind farming, are reported to be markedly less developed in their planning of such human activities at sea. Their level of policy integration scores remarkably low on all criteria of integration. Other countries, like Norway, are quite advanced and well developed in MSP but in a rather top down, and technocratic way. Still other countries, like Germany, are well aligned with European guidelines and EU countries, but less on stakeholder interaction. The Netherlands seem to have a rather open stakeholder approach to MSP, but pay less emphasis to monitoring and evaluation, and so on.

Figure 7.7 Profiled MSP establishment, by country (selection)



Countries can probably not integrated everything to the same extend, and there are definitely different stages and strategies. The general and underlying problem is that many of these countries will (have to) interact when it comes to the planning of a shared sea area, like the North Sea (the Netherlands, UK, Belgium , France, Denmark, Germany et cetera.) or the countries around the Mediterranean (Italy, Spain, Croatia, et cetera., not speaking of Malta, Cyprus or the North-African countries). Integrated MSP has different meanings, which can lead to semantic confusion or conflict in approaches. Some countries will emphasize coordination with neighbouring countries, whereas others will focus on stakeholder interaction. Some will focus upon being science-based, while others emphasize political negotiations. In the transnational arena, such different cultures and strategies may come together. And this is what also happened in the MSP game sessions.

Table 7.8 Profiled MSP establishment, by country

Country	N	Coordination with EU member states	Coordination with neighbouring countries	Coordination between government department and agencies	MSP governance structure	Legal framework	Stakeholder participation	Vision and ambitions	Clear objectives specified	Performance indicators developed	Implementation guidelines	Financing available	Monitoring and evaluation	Science and evidence base	Knowledge and data infrastructure	MSP Quality Factor
Baltic	1	7	7	-	-	-	7	7	7	-	7	-	-	-	5	6,7
Netherlands.	14	5 (0,8)	4,8 (1,9)	5 (1,2)	4,9 (2,4)	5,5 (1,3)	5,1 (1,9)	4,7 (1,7)	5,4 (1,2)	4,9 (2,4)	5,2 (1,9)	5,4 (2,2)	4,2 (1,2)	4,7 (1,6)	5 (1,5)	5
Norway	3	3 (1,7)	3 (1)	6,3 (0,6)	6 (1)	2,7 (1,2)	4 (1)	5,7 (1,5)	5,3 (2,1)	4 (2)	3,7 (2,5)	5,3 (1,5)	6,7 (0,6)	6,3 (1,2)	7 (0)	4,9
Italy +	2	5 (1,4)	5 (4,2)	4 (1,4)	6	7	6 (2,8)	6,5 (2,1)	4	3,5 (2,1)	5 (1,4)	5,5 (0,7)	5	3,5 (2,1)	2	4,9
Sweden	7	5,3 (1,4)	4,7 (1,8)	5,4 (1,4)	5,5 (2,8)	4,4 (2,9)	4,4 (2,1)	4,9 (1,9)	4,6 (2,5)	4,2 (3,2)	5 (3)	5,3 (2,1)	4,1 (2,9)	4,3 (1,8)	5 (1,8)	4,8
Spain +	1	4	4	4	4	7	5	5	5	5	1	4	5	5	7	4,6
Romania +	1	6	6	4	5	4	3	5	4	2	6	7	3	5	-	4,6
Germany	7	6 (2,2)	4,5 (1,4)	4,7 (1,4)	5 (2,2)	5 (2,5)	4,2 (1,7)	4,4 (1,1)	4,8 (1,3)	4,3 (1,9)	4,3 (1,9)	5 (1,6)	3,4 (1,1)	4,1 (1,7)	4,2 (0,8)	4,6
England	14	3,8 (1,5)	4 (1,1)	4,6 (1,9)	4,6 (1,6)	5,5 (2,1)	5,2 (1,8)	4,7 (1,8)	4,1 (1,8)	3,6 (1,8)	4,4 (2)	4,6 (1,6)	4 (2)	5,2 (1,3)	5,1 (1,8)	4,5
EU	2	3 (1,4)	3 (1,4)	4,5 (0,7)	4,5 (0,7)	4,5 (0,7)	5 (1,4)	5 (1,4)	5 (1,4)	4,5 (0,7)	4 (0)	4,5 (0,7)	4,5 (0,7)	4,5 (0,7)	4,5 (0,7)	4,4

Country	N	Coordination with EU member states	Coordination with neighbouring countries	Coordination between government department and agencies	MSP governance structure	Legal framework	Stakeholder participation	Vision and ambitions	Clear objectives specified	Performance indicators developed	Implementation guidelines	Financing available	Monitoring and evaluation	Science and evidence base	Knowledge and data infrastructure	MSP Quality Factor
Portugal	16	4,8 (2,8)	4,4 (2,8)	4 (1,9)	3,6 (1,9)	4,5 (2,1)	4,5 (2,4)	4,6 (2,3)	4,4 (2,3)	4,4 (2,5)	4,6 (2,4)	4,4 (3,1)	4,4 (2,2)	4,4 (1,8)	3,4 (2)	4,3
Canada	1	6	5	4	3	4	3	5	4	3	2	3	2	6	5	3,9
USA	1		3	4	5	6	6	4	2	2	2	5	3	5	4	3,9
Belgium	2	4 (0)	3,5 (0,7)	3,5 (0,7)	3,5 (0,7)	3,5 (0,7)	3,5 (0,7)	4,5 (0,7)	4,5 (0,7)	3 (1,4)	3 (1,4)	4 (0)	3 (1,4)	5,5 (2,1)	5,5 (2,1)	3,9
Finland	5	4,3 (2,9)	5 (0,7)	3,8 (2,1)	4 (2,7)	5 (2,2)	3,8 (1,5)	3 (0,8)	2,8 (1)	2,8 (1,5)	3,5 (3)	3,4 (2,8)	4 (3,2)	3,6 (2,1)	4,6 (1,1)	3,8
Ireland	2	6,5 (2,1)	4 (1,4)	3 (1,4)	4 (1,4)	3,5 (3,5)	4 (0)	3,5 (2,1)	5 (4,2)	3 (2,8)	2	3 (2,8)	2 (1,4)	-	-	3,6
Poland	2	3 (1,4)	3 (1,4)	4,5 (2,1)	5 (2,8)	3 (2,8)	2,5 (2,1)	5 (1,4)	3 (1,4)	1 (0)	3,5 (2,1)	3 (0)	1,5 (0,7)	3 (0)	3,5 (0,7)	3,2
Iceland	14	3 (2,9)	2,8 (2,5)	3 (2,2)	2,9 (2,7)	2,3 (2,2)	3,2 (2,1)	3,4 (2,1)	2,8 (2,5)	2,4 (2,6)	2,5 (2,5)	2,5 (2,5)	2,7 (2,5)	4,5 (2,5)	3,9 (2,2)	3
Denmark	6	1,5 (0,8)	1,8 (0,8)	3 (1,9)	1,6 (1,3)	1,2 (0,4)	2,6 (1,5)	2,6 (2,5)	1,6 (0,9)	2 (1,7)	2,4 (3,1)	1,8 (1,3)	1,3 (0,5)	3 (2,4)	2,4 (0,5)	2,1
Russia	1	1	2	3	1	1	1	2	1	1	1	1	1	1	1	1,3

Note to Table 7.6: * region; + = one respondent with self-indicated low level of expertise.

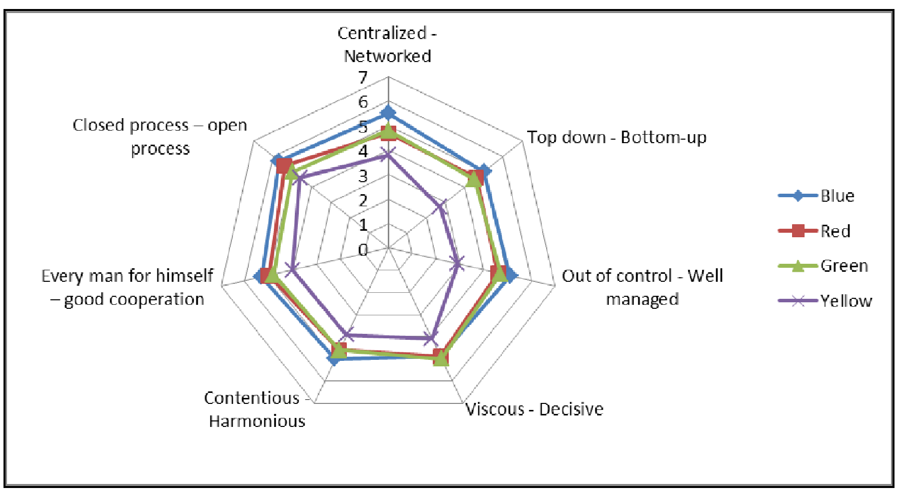
7.7 Integrated MSP in the game

So, a next logical question is: what happened with respect to integrated, eco-system based MSP – it's processes and outcome – in the games with international group of MSP professionals. To what extent, were the players and their simulated countries able to reach integration? We begin taking a closer look at the processes in the four game countries (i.e. Red, Yellow, Blue and Green), before analysing the four MSP plans that were compiled and considering how and where they achieved 'integration' in the game.

7.7.1 Integration of MSP-process

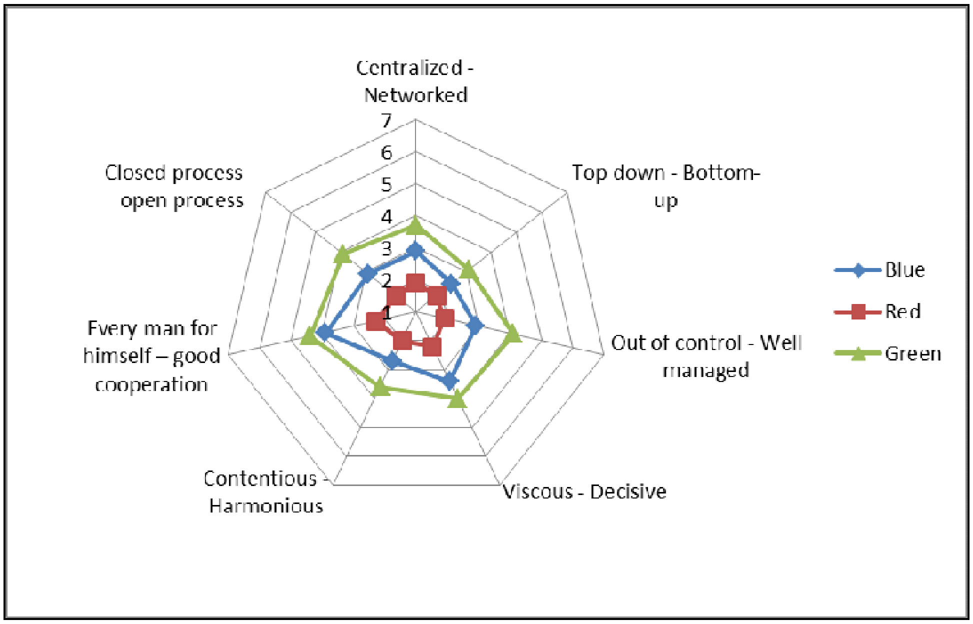
Twice during the game (at about 13:00 and 17:00), we measured the players' experiences of the MSP process in their simulated countries, using the seven-point scales described above. The detailed results of this exercise are presented in tables D.13 and D.14 in the appendix D. For the purpose of discussion, Figures 7.6 and 7.8 present this information graphically for the Lisbon session. Figures 7.7 and 7.9 for the Reykjavik session. The differences between Lisbon and Reykjavik are easy to see when we compare the spider graphs in 7.6 and 7.7. The level of integration in the process is much less for all countries Red, Blue and Green in Reykjavik, than in Lisbon. Country Red in Reykjavik score noticeable low.

Figure 7.8 MSP process in the game as experienced by the players[44]



Note: data from game session in Lisbon, Portugal, at 17:00h

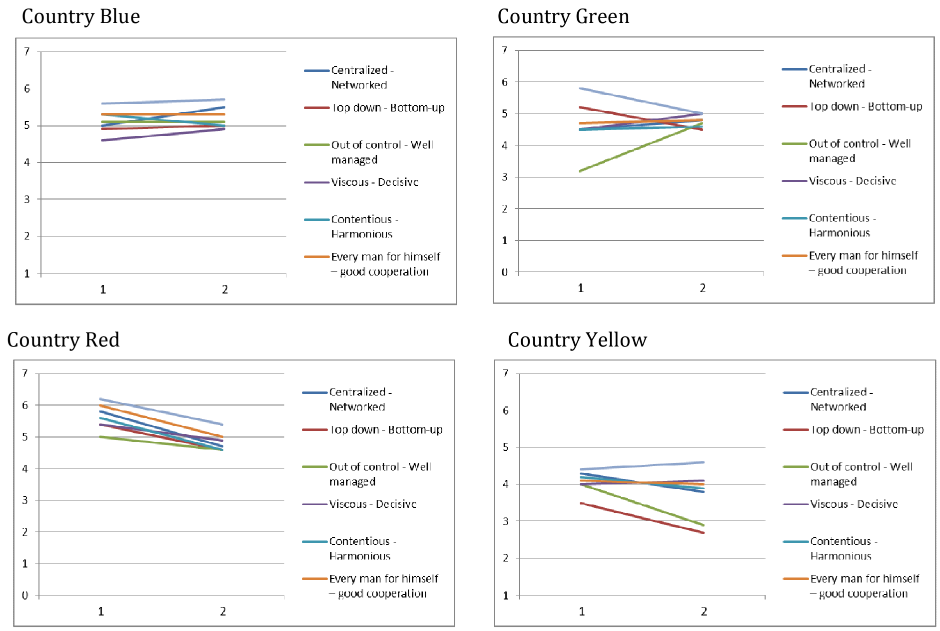
Figure 7.9 MSP process in the game as experienced by the players



Note: data from game session in Reykjavik, Iceland, at 17:00h

The difference between the Lisbon and Reykjavik session can also be observed in terms of improvements during the game. Figure 7.8 and 7.9 give a graphical analysis of the changes between T1 (13.00) and T2 (17.00) on all process indicators for all countries in Lisbon and Reykjavik. Countries Blue in Lisbon and Reykjavik improve their process; whereas some other countries show mixed changes (Green and Yellow, Lisbon). Other countries seem not able to reach a satisfying level of process integration. For country Red in Reykjavik the already very low level of integration decreases even further between T1 and T2.

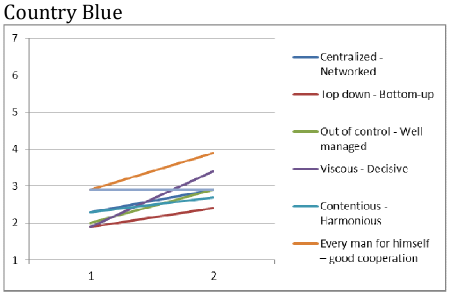
Figure 7.10 a-d MSP process in the game as experienced by the players [45]



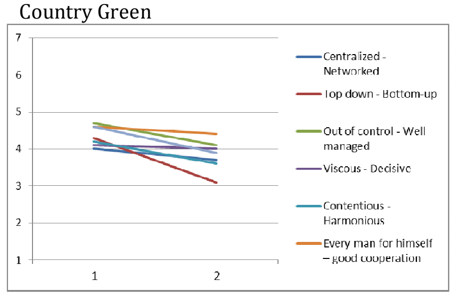
Note: data from game session in Lisbon, Portugal, 13:00 - 17:00h

Figure 7.11 a-d The MSP process in the game, as experienced by the players

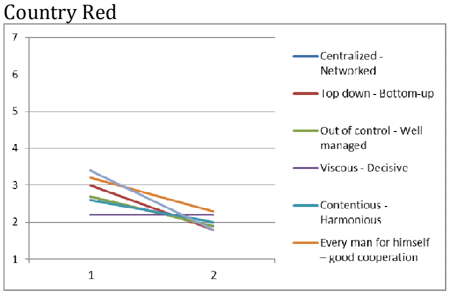
Country Blue



Country Green



Country Red

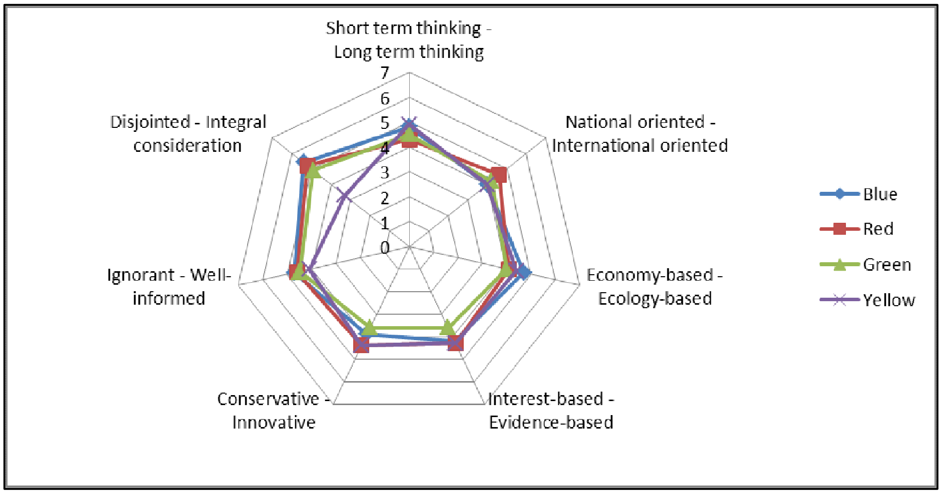


Note: data from game session in Reykjavik, Iceland, 13:00 - 17:00h

7.7.2 Integration of MSP outcome

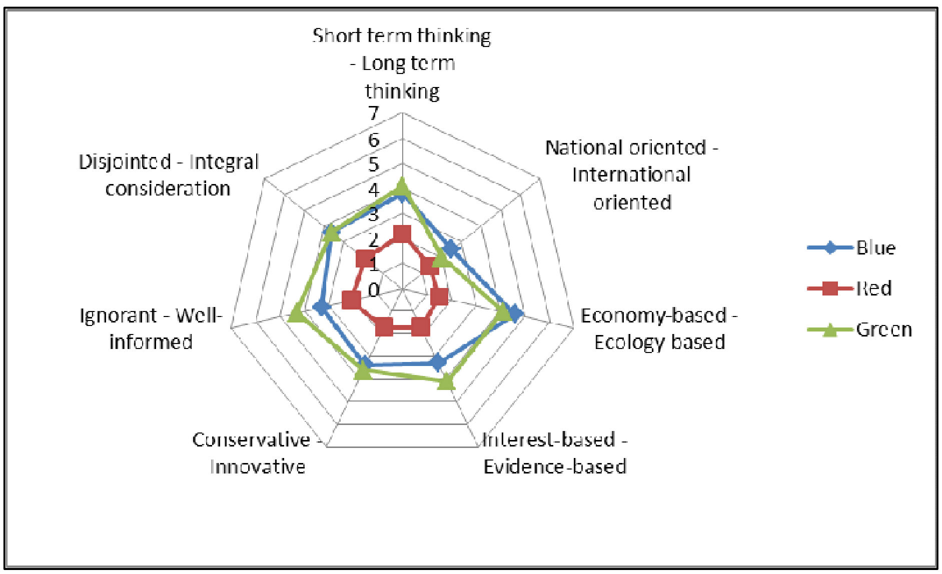
We performed the same analysis for integrated MSP outcome (see Figures 7.12-15 below), with similar results as with regard to process. The countries in the Lisbon session, have a much higher level of integration than the three countries in the Reykjavik session. All countries in the Lisbon session reach the same, fairly adequate level of integrated outcome; however country yellow shows a dent in the spiral with respect to disjointed / integral consideration. For the Reykjavik session, the level of integrated outcome is significantly less. The low level of integration in country Red (Reykjavik) is striking. The overall pattern in Lisbon is improvement of integrated outcome between T1 and T2. In Reykjavik, country Blue and Green slightly improve their level of integrated MSP; whereas country Red declines.

Figure 7.12 MSP outcome in the game as experienced by the players



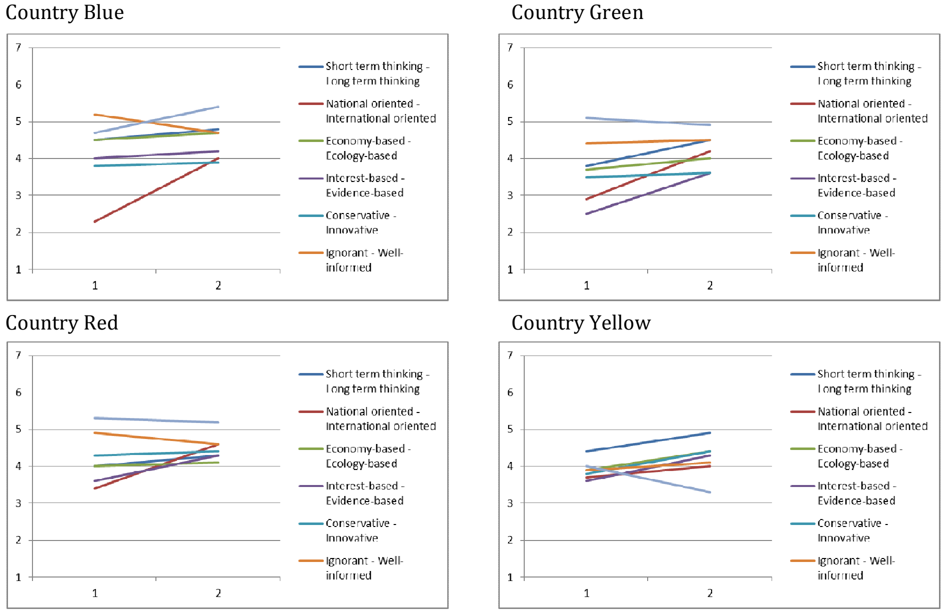
Note: data from game session in Lisbon, Portugal, at 17:00h

Figure 7.13 MSP outcome in the game as experienced by the players



Note: data from game session in Reykjavik,Iceland, at 17:00h

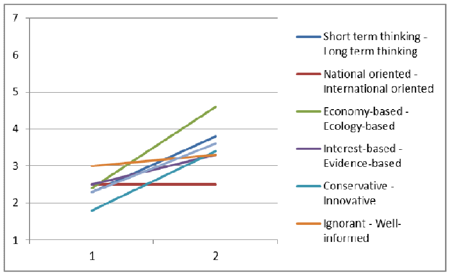
Figure 7.14 a-d MSP outcome in the game as experienced over time by the players



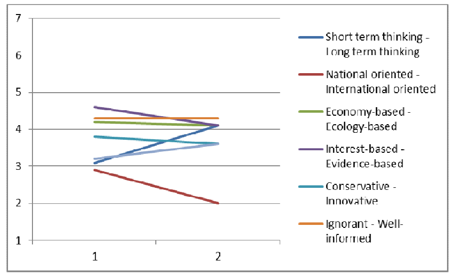
Note to Figure 7.14: Key: x axis = time of measurement during the game; y axis = seven-point scale (e.g. 1 = national orientation, 7 = international orientation)

Figure 7.15 a-d MSP outcome in the game as exp. over time by the players

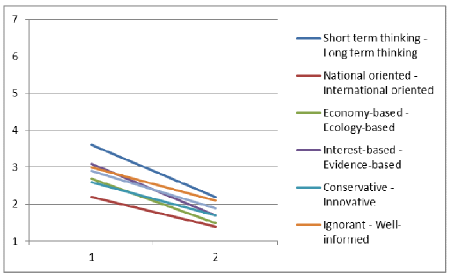
Country Blue



Country Green



Country Red



Note: data from game session in Reykjavik, Iceland

7.7.3 Intermediate conclusion

The variety observed in MSP process and outcome among the countries in Lisbon and Reykjavik may be taken to indicate that the countries applied different strategies or took different routes to achieving an integrated MSP (although the relative success of these strategies remains to be seen). Some players, countries struggled severely to reach integrated MSP. The various changes within the countries between T1 and T2, however, may be taken as an indication of policy change, because planning problems emerged and/or because the participants learned how to play the game better. In one or two countries (yellow in Lisbon, and Red in Reykjavik) the actors seemed to lost grip upon the challenge to develop an integrated MSP. This is in line with our more qualitative observations, discussed at the end of this chapter.

7.8 Integration in the MSP maps

7.8.1 It all comes together

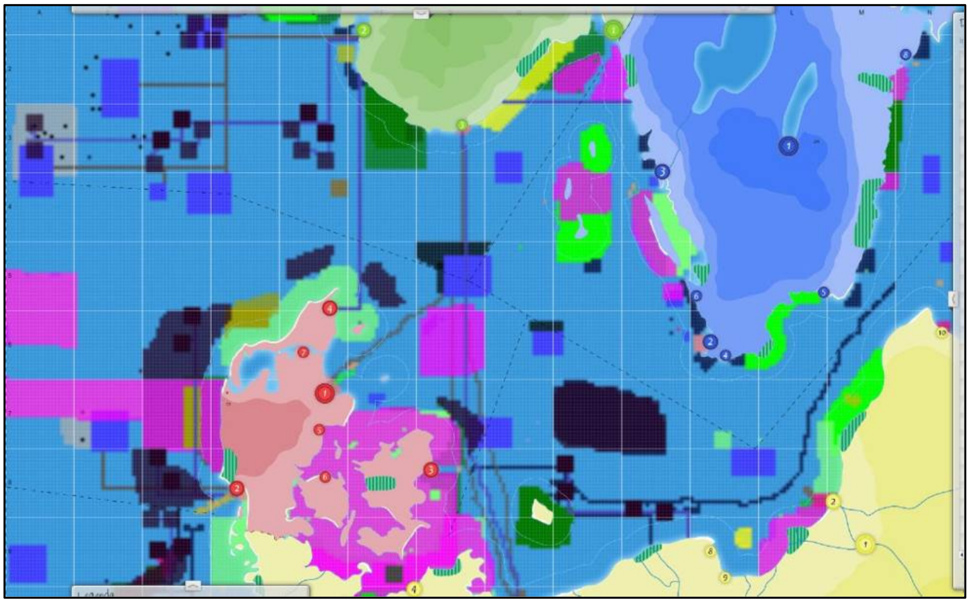
The variety and change in actor-player perceptions of integration, may indicate learning (or the opposite, an imminent crisis), but they say little about the targets reached in the MSP plan. Stakeholder-players may be dissatisfied with the process or outcome, but, it may still be a high quality, for instance in terms of sustainability or balancing ecology and economy. Stakeholders may also negotiate out problems, leaving the real problems or conflicts for later or for someone else to solve. In other words, socio-political satisfaction with the level of integration is one, important dimension. But a plan should also be looked at in a more critical and objectified way. With respect to the game, we can now take a closer look at the four country plans in Lisbon and the three country plans in Reykjavik. They form two integrated MSPs for the sea of colours.

Figure 7.16 Synthesis

Note: game session in Reykjavik, Iceland

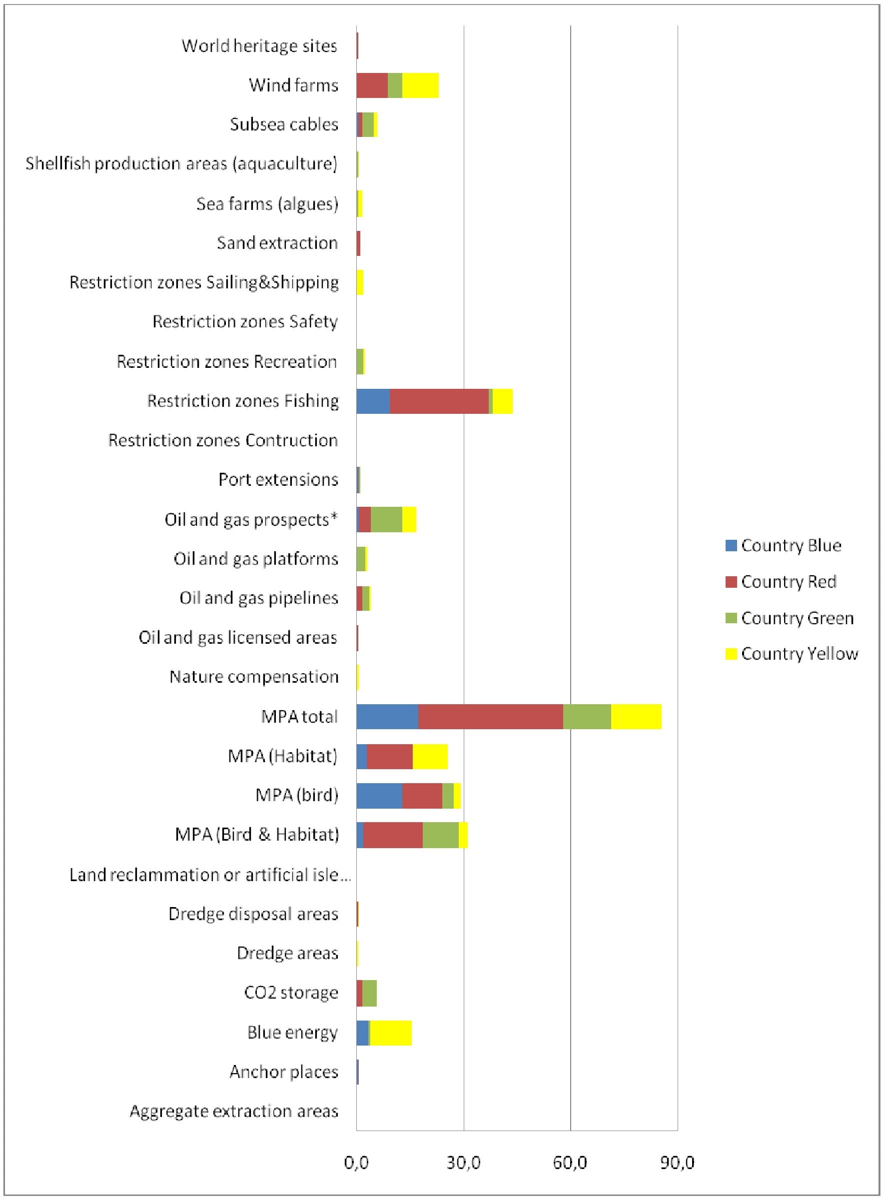
It took some time in the game, before the players-actors realized that the challenge of making an integrated MSP for the Sea of Colours is quite ambiguously formulated. Was it an integrated plan for each individual country, possibly with some co-ordination? Or was it one integrated plan for the whole sea of Colours, with national implementation? Or somewhere in between? In practice, all countries developed their own plans, and only at the end of the game they tried to sell their vision, objectives and measures to the neighbouring countries. Which of course, proved very difficult and sometimes made them feel they needed to start all over again. Only after the final presentations of the individual country plans, the game leaders merged the individual maps into one integrated map of the sea of colours. Only then the actors-players realized that their drawings were not very well aligned. If this had been reality, they would have to start all over again. That strange things had happened in the process, became visually clear: some MPA's bordering the EEZ of a neighbouring country were straight lines as on the map of northern Africa (see Figure 7.17 and 18).

Figure 7.17 Integrated MSPs of the four countries



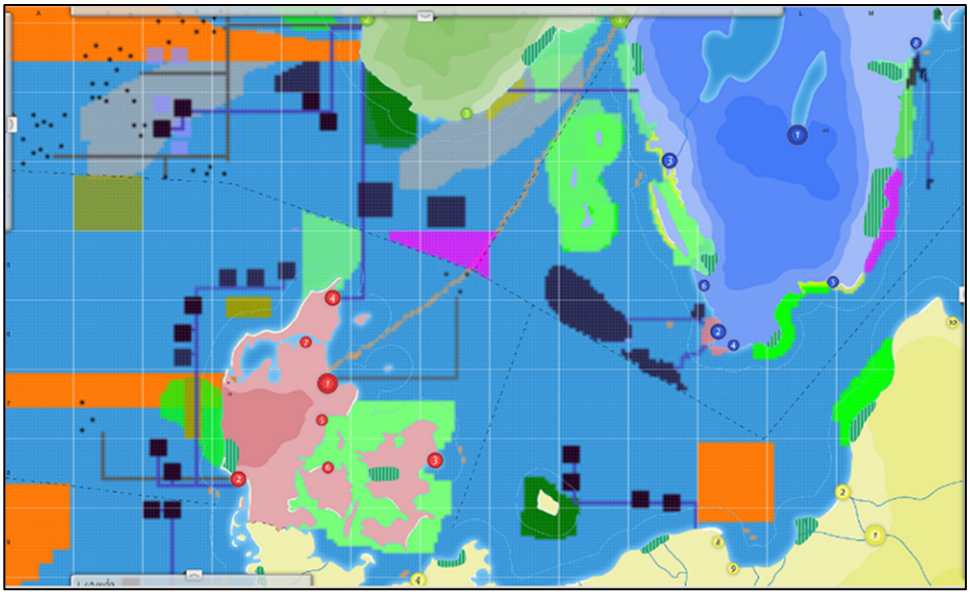
Note: data from game session in Lisbon, Portugal

Figure 7.18 Profiles of the spatial claims in the four simulated countries



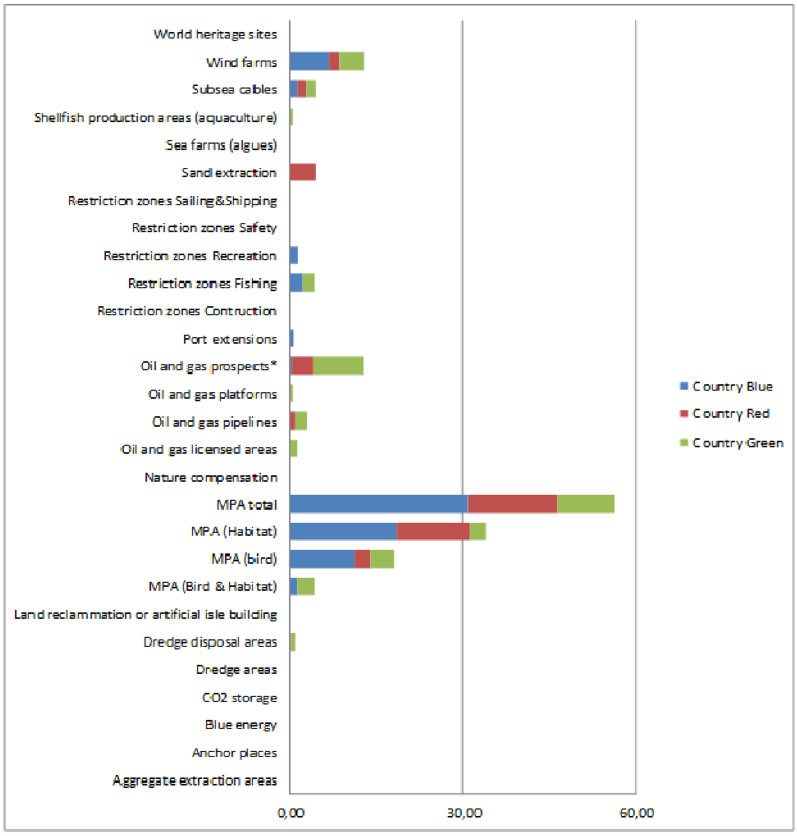
Note: data from game session in Lisbon, Portugal [46]

Figure 7.19 Integrated MSPs of the four countries



Note: data from game session in Reykjavik, Iceland

Figure 7.20 Profiles of the spatial claims in the four simulated countries

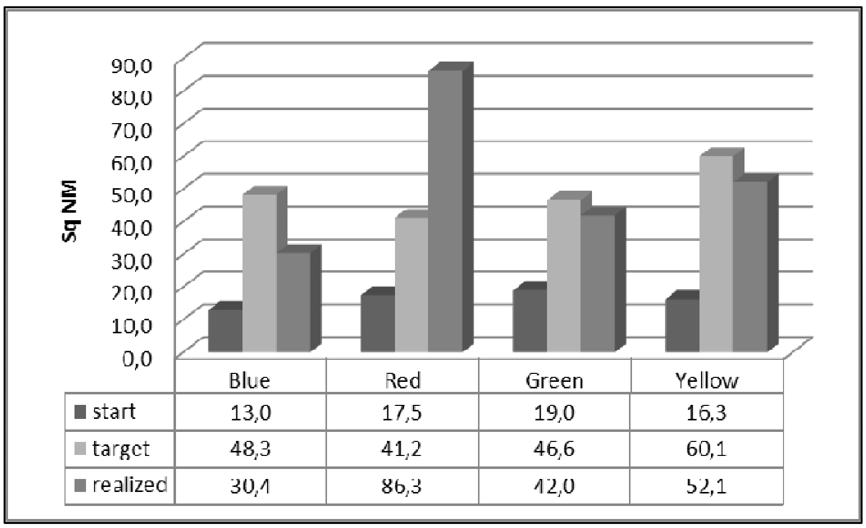


Note: data from game session in Reykjavik, Iceland

7.8.2 *Quality of the MSPs*

As indicated in Figure 7.21, with regard to the gap between 'starting position' and 'target objectives' provided at the start of the game, country Red was in the easiest position and country Yellow in the most difficult. In terms of sq. nm in their plans, country Red Lisbon more than doubled its target, whereas the other countries did not even reach theirs. As indicated in Figure 7.18, the sq. nm for country Red Lisbon can be attributed primarily to marine protected areas (MPAs) and restricted fishing zones. Country Blue Lisbon had a slightly more difficult starting position, and it achieved the fewest sq. nm relative to its target. Closer examination reveals that country Blue Lisbon reserved a lot of sq. nm for MPA and restricted fishing, but hardly any areas for other economic and social functions. In contrast, the MSPs of country Yellow and country Green Lisbon demonstrate much more variety, paying a comparatively large amount of attention to 'blue' energy, oil and gas, pipelines, sand extraction, sea farms, sailing and recreation. In other words, the policy agendas in these countries were broader and more diverse. Taking into account the scope of the policy agenda and the sq. nm designated in the MSP, we could argue that country Red Lisbon performed the best in terms of establishing an integrated, eco-based MSP, whilst country Blue did not perform very well at all. It could be argued that country Blue Lisbon avoided conflict in a well-managed process (see above) although this is very likely to have consumed time and attention. The underlying controversies probably never made it into the plan. Country Yellow's initial target was higher, and its agenda of issues was much broader. As indicated above, this led to considerable controversy during the process, which made it hard for the project managers.

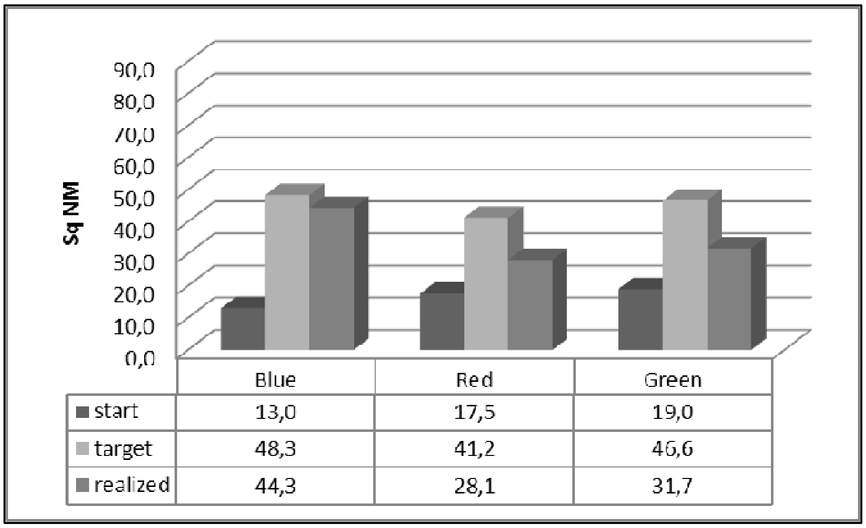
Figure 7.21 Spatial claims by the four countries



Note: Data from game session in Lisbon, Portugal

In Reykjavik, the performance is a little different. Here country Blue comes close to reaching its target of sq. nm, whereas country Red is falling behind. Note that country Red also scored very low upon the stakeholders assessment of MSP process and outcome integration. But also here, country Blue is very ecology-based, with a large sq. nm. of MPAs and restriction of fishing, while reserving no space for oil and gas.

Figure 7.22 Spatial claims by the four countries

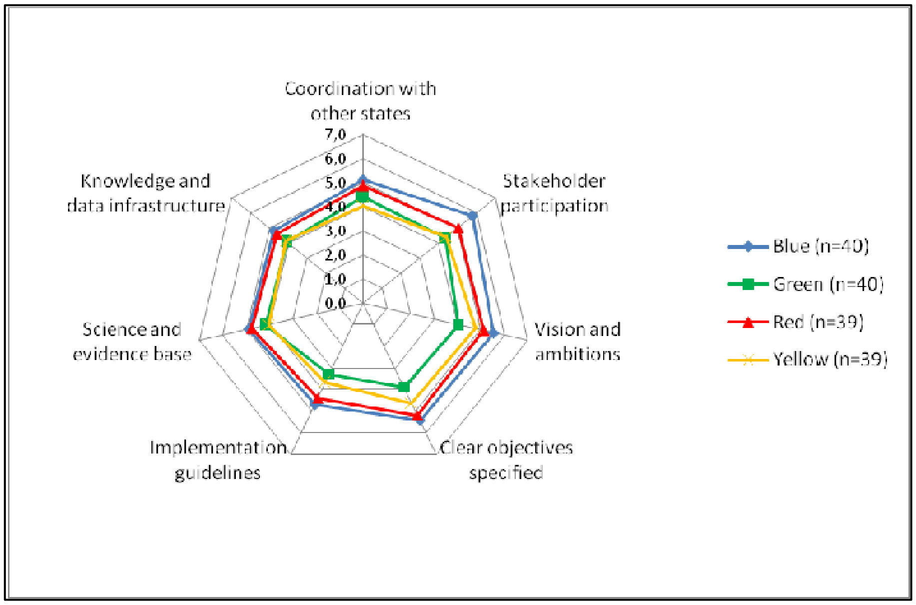


Note: data from game session in Reykjavik, Iceland

7.8.3 Satisfaction

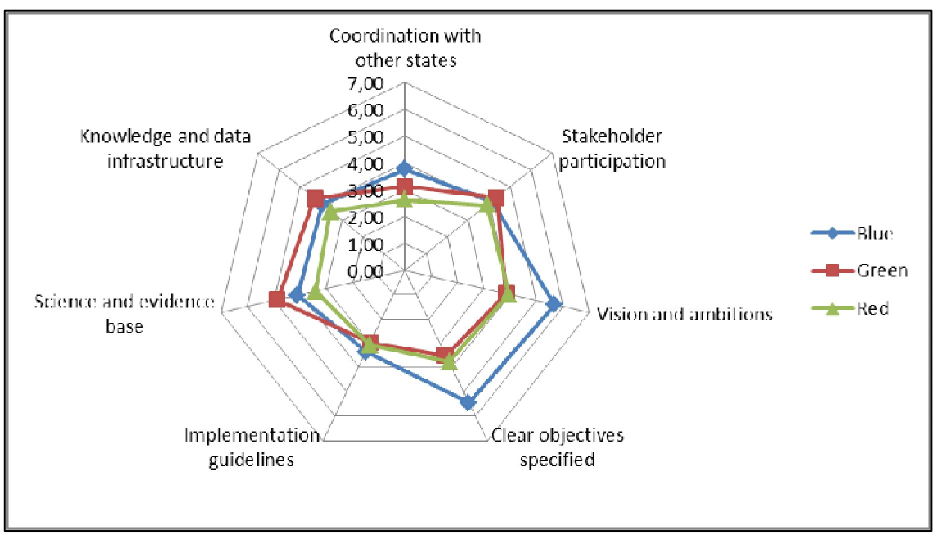
At the end of the game, the project managers of the four countries presented their MSP plans to all of the participants, who were then asked to assess them – as MSP experts, rather than as players – according to seven criteria derived from the EU principles. Participants were excluded from assessing their own countries. In this way, each of the four plans was assessed by about 40 participants. The results are presented in Figure 7.23 and 7.24 which shows that the plans of countries Blue and Red (Lisbon) were assessed as considerably better established than were those of countries Yellow and Green (Lisbon). In Reykjavik, country blue was valued significantly better than the plan of country Red. In other words, having listened to the presentations by all four countries, the other 40 player-participants found that country Blue in Lisbon and Reykjavik had the best MSP plan at the end the game.

Figure 7.23 Performance indicators for the four MSP outcomes



Note: data from game session in Lisbon, Portugal

Figure 7.24 Performance indicators for the four MSP outcomes

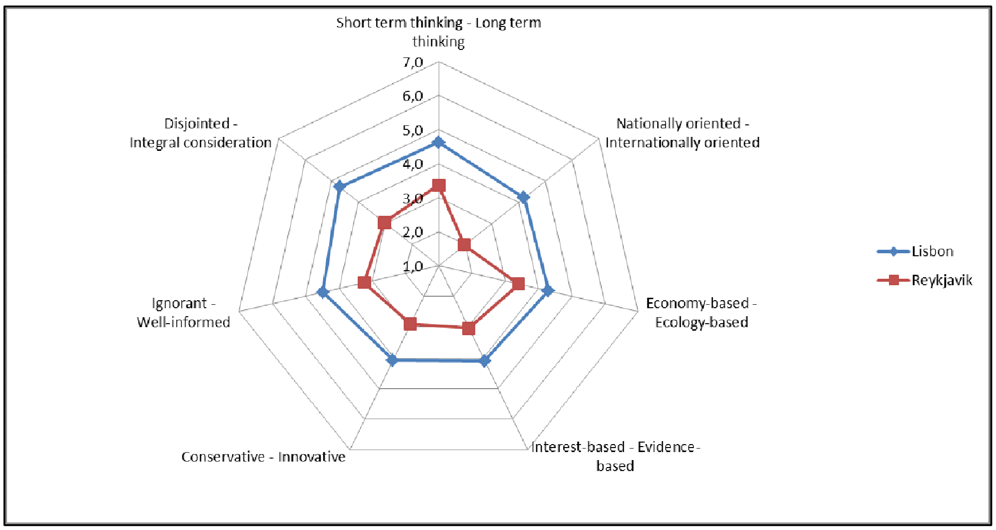


Note: data from game session in Reykjavik, Iceland

7.8.4 Intermediate conclusion

Analysis of the maps and player scoring provides indications of the effectiveness of integrated MSP process and outcome. It is important to note that the assessment of MSP according to process (as opposed to outcome) or according to objective methods (as opposed to subjective methods) might produce different patterns. Conflicts and controversies can easily be negotiated out, thereby increasing stakeholder satisfaction whilst decreasing the quality of the MSP plan. Although higher ambitions from the onset may trigger additional conflicts amongst stakeholders, they may ultimately achieve more in terms of integrated spatial claims. Overall, it seems that the players in Lisbon were much better able to manage the integrated process and outcome than in Reykjavik (see Figure 7.25). Note also the dent in the spider at 'national-internationally oriented' in Figure 7.26 Reykjavik. Players in Reykjavik were definitely struggling to reach international coordination.

Figure 7.25 Comparison Lisbon and Reykjavik integration MSP process



7.9 Conclusion and discussion

7.9.1 Research question 1: How does an international panel of MSP professionals assess the state of integrated MSP in their own countries?

Integrated, ecosystem-based marine spatial planning (whether real or simulated) takes place within a trans-sectoral and transnational context. Transnational interaction between institutions and stakeholders is complicated by differences in the various legal, administrative and planning systems, as well as by the presence of planning systems at differing stages of development (ranging from non-existent to well-established) and planning processes in differing phases of development (from preparation to implementation). 'Soft' factors (e.g. culture and language) and 'hard' factors (e.g. data systems) exacerbate these complications. The harmonization of MSP within the EU and the alignment of its transnational contexts could be greatly improved by improving the profiling and monitoring of its processes and outcomes within and between countries. If anything, the game-based quasi-experiments triggered reflection on the fundamental aspects of 'integration': what is being integrated, for what purpose and how it can be assessed? It also showed what may happen when different styles of integrated planning, meet in the transnational arena. In many cases, it leads to confusion. Our game-based experiment delivered and validated several useful scales and tools for the comparative analysis of integrated, ecosystem-based MSP. We are aware of the limitations of our approach, including the fact that our experiment relied on self-reporting by a relatively small set of respondents. Nevertheless, we believe that our scales and tools could be developed further and that they could be used more rigidly and widely to support real and simulated MSP within or between countries.

Figure 7.26 Comparison Lisbon and Reykjavik integration MSP outcome

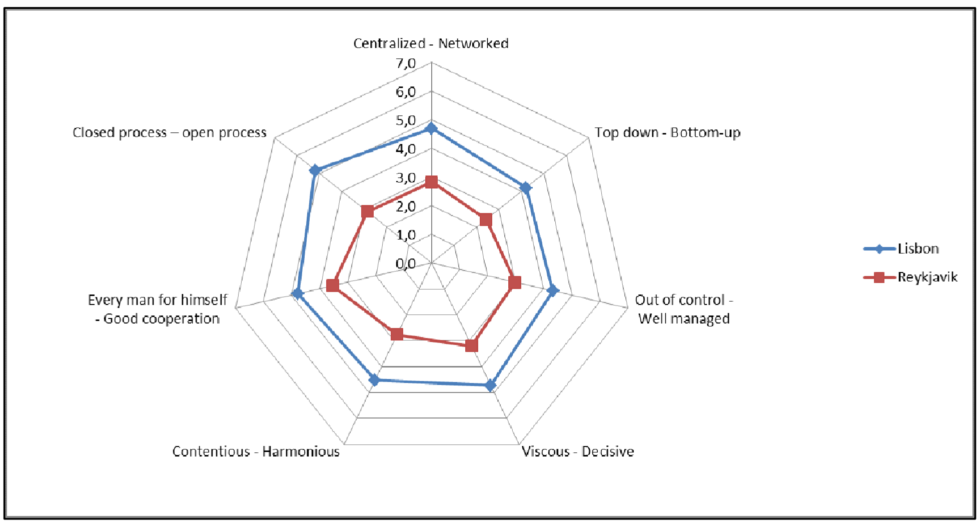


Figure 7.27 How do you assess MSP in your country?

Note: game session in Lisbon, Portugal

7.9.2 What are the characteristics of integrated MSP processes and outcomes when simulated by this international group of professionals in a game-based environment?

The game appears to have provided a sufficiently realistic and meaningful representation of reality. During the day, we observed many changes in planning processes and outcomes, both within and between the countries (e.g. top-down or bottom-up; closed or open; chaotic or in control; emphasizing ecosystems or economics). In one country, (Blue Lisbon) the MSP process appeared to be 'under control'. Closer examination of the final plan, however, reveals that important issues had apparently been 'negotiated out'. In Reykjavik also, the process was very professional and ended in an integrated plan that was certainly very ecology-based, but hardly coordinated with other economic sectors and neighbouring countries. In another country (Yellow, Lisbon), the process was erratic, chaotic and difficult, but the final MSP plan contained a much broader range of ecological and economic claims. The process had been difficult, but the conflicts contributed to the integrated'ness of the plan. In still another country (Red, Reykjavik), the stakeholders almost completely lost grip on the MSP-process and outcome. The result was an MSP of relatively poor quality as compared to all other plans. In sum, there is an intricate relationship between MSP process and outcome with regard to stakeholder satisfaction, as opposed to the scope and quality of the plan. Although a smooth process might increase stakeholder satisfaction, this could be due to the 'negotiating out' of difficult issues and conflicts. Although a contentious process might result in stakeholder dissatisfaction, it might also improve the consideration of real issues and conflicts (and thus to more innovation in the plans). But flaring controversies in combination with poor management, leads to weak plans. In that case, the marine eco system is likely to suffer the consequences. The NTP complexity of the system will hit back hard, when problems are negotiated out, or dissolved.

7.9.3 What does the international panel consider to be the main insights gained about MSP from the quasi-experimental game-based environment?

The participants reported a moderate learning effect in terms of insights (ranging from 3.6 to 4.0 out of 5; see tables D.7-10 in appendix D). We also found several coherent factors. More specifically the results provide insight into: (1) the political complexity of MSP; (2) multi-level governance; (3) science and models, and (4) attitudes towards MSP. The players apparently became more interested in MSP and gained some good ideas to take home. At the end of the game, there was general consensus amongst participants that MSP Challenge had been particularly useful in improving their understanding of 'the big picture' and in promoting 'systems thinking' (i.e. how the various elements, factors, planning scales and stakeholders in MSP interconnect and the how the system steers and is steered at the same time; see Table D.7).

> 'A clearer picture of processes within MSP and a broader understanding of the diverse objectives and interests of the MSP-practitioners involved.' (Quote from one of the German participants)

By and large, the Lisbon respondents were more positive about the learning effects than the Reykjavik respondents. This may be related to many factors – but my main feeling is that the players in Reykjavik were a little over challenged with the task. The had a little more work experience, seemed confident that they could do it, but actually had not so much experience with MSP itself, because in most countries it was only starting to become an issue. The game challenge proved quite difficult, time was just enough to finish the game. Hence, some respondents were slightly more critical about the event. I strongly believe, that they might not fully realized yet what they actually had learned, but the new insights and knowledge is already in their mind as the principles of game play work. Our discussion of insights on the STC of MSP, is limited to twelve important aspects of participant learning:

(1) It is important to define the main criteria for the ecosystem and to consider MSP at the level of the sea basis, to assign responsibilities and to monitor the process along the way. Otherwise, the plan might suit the stakeholders whilst endangering the ecosystem. In addition to managing the stakeholder process, planners should avoid the trap of appeasement and 'negotiating out' at the expense of the ecosystem.

> Did the ecosystem-based planning approach by country make us think across boundaries from the beginning of the planning process and, if so, did we run into constraints for planning from an ecological and/or economical/social perspective? (from the post-action review)

(2) Intergovernmental organizations, treaties and conventions play an important role in the real world. The lack of these aspects in the game illustrated the necessity of establishing functioning marine management on transboundary issues. Although there is a requirement for transnational consultation on projects (EIS) and plans (SEA), in many cases, this does not occur until the later stages of the planning process. It would therefore be useful for national plans and planning to be aligned at some point during MSP process.

> For me, the need for agreements regarding cross-border cooperation between countries became even more evident than it had already been (Finnish participant).

(3) All of the countries struggled to find a balance between the planning process and planning outcome. In some cases, this led to irritation and frustration amongst the players. As facilitators, we had to expend considerable effort to convince the players that both dimensions (process/outcome, politics/analytics) are important and that they should be managed in an integral fashion. One should not go without the other.

> Some of us focus on the plan, whilst others focus on the process of making a plan. Keeping an open mind in order to improve both is a challenge for planners and others who take part in MSP (from the post-action review).

(4) Different countries have different planning regimes, and they apply different planning styles. There is no single 'best way' of planning. It is important to realize the strengths and weaknesses of different planning regimes and styles, as well as to be able to 'play' them. The transnational dimension makes this particularly relevant.

> The game clearly demonstrated the differences between closed and open planning processes, emphasising that the latter might be more effective and that it might receive stronger support amongst stakeholders taking part in the process. Moreover, transparency and open planning processes require frequent and clear communication amongst planners and stakeholders, as well as with regard to their individual roles in the process (Dutch participant).

(5) International collaboration did not start at the beginning of the game and most of the teams came to the international meetings with clear views on how their own MSP should be developed. Whilst there is a requirement for transnational consultation on projects (EIS) and plans (SEA), this quite often happens in the later stages of the planning process. At some stage in an MSP process, therefore, it would be useful for national plans and planning to be aligned. This seldom happens in reality, however, for many reasons – including the fact that countries start their MSP processes at different times. Sectoral transnational co-ordination is easier to achieve, though, as sectors often have common goals and objectives across national boundaries. It is also important to identify the links between MSP and terrestrial planning. The relevance of this depends on the boundaries of the planning process, of course. Plans that border on land need a closer and more direct link to terrestrial planning than oceanic plans with no land border.

> 'For me the need for agreed cross-border co-operation between countries became even more evident than it already was.' (Quote from Finnish participant.)

> 'Does it help to start planning at the same moment in time? If we think so, in what way and what arguments could persuade politicians to do so?' (Quote from after-action review.)

(6) During the game and the debriefing, participants realized that the governance of the stakeholder process is quite complicated. A wide range of issues and dilemmas can emerge (e.g. the process should be clear and transparent, whilst also being flexible and adaptive). Establishing milestones is helpful, as it breaks the entire process down into manageable work packages. Roles and responsibilities should be established and made transparent at a very early stage in the planning process. It is particularly important to identify the decision-makers and leaders in the process. Similarly, the expectations of all parties in the process should be clarified at the start, in order to allow for their management and consideration. This includes setting rules and procedures on how to handle input into the planning process. It is particularly important to ensure that all relevant data are considered (even if they are not actually used). Setting goals and objectives early in the process is important for identifying and highlighting the most important issues at stake in any

MSP process (e.g. the treatment of major economic activities, the conservation of unique habitats, transboundary issues requiring international collaboration).

> Who was in charge of the planning process? Was the mandate clear? In addition, which objectives guided the planning? What did we learn from the different approaches of each country? What is the actual role of a planner (and of others involved)? (from the post-action review).

(7) It is necessary to consider both direct and indirect effects, as well as the net effect of cumulative pressures from different activities. Direct effects can be measured, but indirect effects are more difficult to establish. The monitoring, mitigation and modification of plans should therefore focus on direct effects. Although it is also possible to monitor indirect effects, responding to these effects requires a process if adaptive management. Cumulative effects were not included in the game, as they could not be evaluated and because no information about them was available to any of the players. In the real world, assessing and managing cumulative effects should be an integral part of MSP.

> Integrated transnational plans in relation to cumulative impacts: what do we define as a truly integrated maritime/marine spatial plan? One in which the effects on the marine environment, economics and society are fully captured before adoption? (from the post-action review)

(8) Access to data, knowledge and information has the potential to improve the delivery of evidence-based planning, but it can also overwhelm practitioners and stakeholders. Although scientists were drawn into the planning process in a very active manner, actual scientific information was underutilized by many of the teams, which concentrated on user needs instead of on such aspects as the requirements of conservation. This demonstrates that planning processes are anthropocentric, focusing on the human activities. It also indicates that scientific input into the planning process should be in a format and of a type that planners can use directly and that allow direct comparison with human uses. Habitat vulnerability maps in relation to human activities are more useful than are habitat maps alone. Similarly, sectoral knowledge and expertise are often underutilized in MSP processes.

> The accessibility of data/knowledge/information improves plans or helps to build the evidence base for planning. The problem is the amount of data and information, along with the need to maintain a focus on what is necessary for the plan and/or the planning process' (from the post-action review.)

(9) In the real world, the socio-economic implications of MSP are at the heart of the process. Strategic environmental assessment (SEA) is required for MSP in the EU, and this considers the ecological and socio-economic consequences of the plan. Information, particularly spatial, on goods and services is necessary to make connections between ecosystem and socio-economics, and in turn forms the best basis for management decisions balancing different uses and conservation activities.

(10) A number of participants identified the need to carefully consider whether a plan for a particular sea area was actually necessary, and stated that the focus should be on areas where marine planning is required.

> 'The importance of clearly setting an objective for the MSP process as a whole; why do we actually need to engage in MSP and what do we want to get out of it?' (Quote from Swedish participant.)

> 'That every step, principle, act of MSP shall be reflected upon, since some things are assumed (eg. ecosystem approach) without thinking about what they mean and how they should steer the process.' (Quote from Belgian participant.)

(11) The nature of the game was very visual, focusing on the map and the zonal planning. But real MSP is about more than just zoning and preparing spatial maps. Issues like governance, establishing objectives and goals are crucial. Practitioners need to keep in mind that they are both developing the actual plan and managing the process at the same time. Nonetheless, it is around the map that spatial conflicts have to be resolved.

> 'The main insight I acquired was how "dangerous" a map can be in planning. As soon as we started working on a map, we forgot our country's vision and objectives and focused only on getting our sector's objectives marked on the map. So in real life I would warn planners to be very wary of putting maps on the table too soon and making sure it is clear that it is the planners' role to achieve the plan objectives rather than share out all the space to all sectors.' (Quote from UK participant.)

(12) The game ended with the establishment of MSP plans for the four countries. Their subsequent implementation, monitoring and effectiveness evaluation were not included. But in real-world MSP, the implementation and revision phase is just as important as establishing the plan itself.

7.9.4 Does this international panel view SG as an effective tool for policy-oriented learning and policy analysis?

As a by-product of the exercise, the player-participants learnt about gaming as a method, as well as about its strengths and limitations. The participants started to think about whether and under what conditions the method might be 'taken home' – either by playing the same MSP Challenge game in their own policy contexts or by modifying it or even developing a new game for use in training or policy development. Opinions on whether such a gaming approach would work and would be accepted in their own countries varied greatly. For example, in the Netherlands, such exercises are quite common and are accepted by decision-makers, researchers and stakeholders alike. Other participants, however, observed that this approach would probably be difficult for them, as their countries are not very 'playful' in this way. Such a game would be considered as 'just for fun' or the real stakeholders would either refuse to play or not reveal their real interests and behaviours in the game. Many participants also realized that it would probably be difficult to use simulation gaming for direct policy support, stating that it would be more effective for things like 'training', 'education', 'getting to know each other', 'problem elicitation', 'exploration during an early policy phase' and so on.

> 'Simulation-gaming is not common in Belgium, but once running this game would clearly present its added value to support the establishment of MSP and would convince the players.' (Quote from Belgian participant.)

> 'In Ireland I think the tool would be most valuable as, in my opinion, MSP is not taken too seriously. I think the game would highlight the complexities of the issues involved and the extensive consultation required. Therefore, it would emphasise the need for introducing legislation and guidance as early as possible. It would also highlight the need for a multidisciplinary approach to the process.' (Quote from Irish participant)

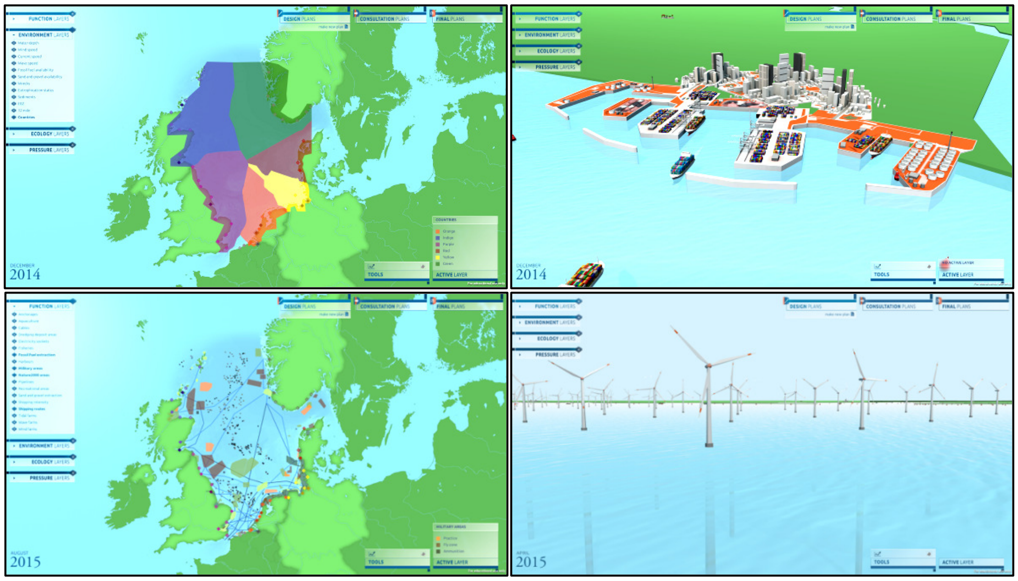
> 'It would be very useful as part of an actual decision-making process rather than a simulation. Denmark is not very playful in this regard and has a recent history of brief, effective and minimal implementation.' (Quote from Danish participant.)

> 'May not be applicable to an actual process given that the entire project would have to be loaded, in addition to all the detailed GIS layers and constraints. However, the approach is very applicable for preliminary stakeholder discussions and training. The tool could be used for EA and SEA as well as ICOM applications.' (Quote from Canadian participant.)

As described above, the results of our analyses of quantitative and qualitative pre-game, in-game and post-game data provide multiple strong indications that MSP lends itself to comparative assessment in real and simulated environments. The observed variety and changes in the game-based intervention indicates that the participants engaged in experimentation with different strategies, policy change and policy-oriented learning. The game-based intervention proved an effective and promising method for international experimentation and exchange amongst professional MSP planners. One relevant question concerns whether the SG and the learning that took place in this context had (or will have) any concrete, observable impact on MSP. Our experiences from several decades of research on the utilization of knowledge in policymaking (see Chapter 3) suggest that this question is not easy to answer, in addition to exceeding the scope of this paper (Meadows & Robinson, 2002). It could be some time before any relationships between MSG and changes in policy documents, political agendas or belief systems can be observed and well understood. Such relationships are most likely to be observed through reconstructive case studies of 'policy change' or 'policy-oriented learning' after a decade or so (see Chapter 4). Nevertheless, we believe that the way of thinking and experimenting with SG portrayed in this paper offers new possibilities for managing the multi-actor, socio-technical complexity of MSP. In a more general sense, interest in the use of modelling, simulation and gaming (MSG) for policymaking is increasing significantly, particularly with regard to questions of 'big data', 'visualization' and 'stakeholder and citizen participation' see ('Crossover. Bridging Communities for Policy-Making 2.0,' n.d., 'Crossover. Research roadmap on Policy-Making 2.0,' n.d.). The policymakers involved in the project noted that the SG had significantly influenced the ways in which they deal with cross-border MSP. The method was successful in improving understanding, building a community of practitioners, challenging agencies (e.g. Rijkswaterstaat in the Netherlands) to upgrade their own Geoweb systems, encouraging Russian planners and politicians to visit their German colleagues for further study on this new profession and enhancing awareness in Belgium with regard to their dealings with other countries (e.g. the Netherlands). The European Commission's Member States Expert Group on Integrated Maritime Policy has expressed a genuine interest, as has the expert group on data management (EMODnet).

As a result of the Lisbon experience, there were several serious negotiations to play the game in other regions of the world. This proved not so easy to arrange, due to the large number of players needed (60-80), and the corresponding budget to host such a large number of players and facilitating team. The game is a kind of a big event. The sessions in Leeuwarden (2012) and Reykjavik (2013) were a continuation of Lisbon, in the same fashion that Reykjavik spurred the interest for other sessions. The most important follow up of Lisbon, is the development of the game MSP Challenge 2050, which needs less players (around 20), can be tailored to specific regions, is more valid in terms of data and simulations models, has an even stronger target to policy support, and includes stronger digital game elements. The possibilities to visualize effects and to gather, collect and analyse game data is more pronounced in the new version. Figure 2.28 gives an impression of the MSP challenge 2050.

Figure 7.28 Visualization in MSP Challenge 2050



8 After the Challenge…

Being a princess isn't all it's cracked up to be. Diana, Princess of Wales (1961–97)

8.1 Introduction

The overarching question 'What is the role and usefulness of serious game play for integrated policy analysis and planning?' was broken down into specific working questions at the end of Chapter 1, which were then reformulated into sub-questions at the beginning of each chapter. I answered the questions in the conclusion (and intermediate conclusion) sections in the corresponding chapters. In this, the concluding chapter, I review and synthesize these answers, reflect upon the main question – through the metaphorical 'princess' – and then discuss the implications for policymaking and future research of policy games. In section 8.2, I give a tabled overview of the sub-questions and the partial answers generated in each chapter, which I then briefly review.

8.2 Looking back…

Table 8.1 presents an overview of the working questions as they were drafted in Chapter 1, and the sub-questions formulated in the corresponding chapters. The three grey-shaded columns on the left are identical to those in Table 1.7, where I presented the outline of this thesis (see also Figure 1.6). The insights and answers from the individual chapters are summarized in the right-hand columns.

Table 8.1 Questions and answers

Parts	Chapters	Working questions	Sub-questions	Insights	Answers
Big problems and the need for integration	Chapter 1 Policymaking in the Wake of Complexity	Why do we need integrated policy analysis and serious game play as integrating method?	Why do we need integrated policy analysis and serious game play as integrating method?	An embryonic model of STC and how it transcends into the SPI (figures 1.1, 1.3 and 1.4).	The STC of big problems calls for integrated science, which needs integrating methods that become (feel, look) like game play.
	Chapter 2 The Complexity of Marine Spatial Planning (MSP)	What do we know about the complexity and integration of socio-technical systems in MSP?	What constitutes the socio-technical complexity of MSP?	STC of marine areas as summarized in figures 2.1 and 2.2.	The interaction between the marine ecosystem and human activities in marine waters constitutes an STC system that transcends into MSP characterized by unclear system boundaries, system ambiguity, scientific uncertainty and fragmentation.
			How can it be represented in a synthetic model that could serve as a starting point for integrated policymaking and game play?	Figure 2.3.	See Figure 2.3
Finding a synthesis between different worlds	Chapter 3 Finding a Synthesis Between Two Worlds	What are the discourses of socio-technical integration and how do they relate to integrated methods?	Why are the WoS and WoP like thesis and antithesis?	Analysis of tensions at the SPI summarized in Figure 3.1.	Boundary tensions between the world of science (WoS) and the world of politics (WoP). Central to dialectics is negation and contradiction. It may very well be that the original thesis and antithesis are both right and/or wrong, but the negation of both thesis and antithesis leads to a transcending unity, the synthesis.
			How can synthesis be created between the two worlds?	Three strategies for integration summarized in Table 3.1.	There are three strategies for integration: 1) balance; 2) inclusion; 3) synthesis. The stronger the level of integration, the more policy analysis starts to become – to feel, to look – like game play The synthesis between NTP and SP complexity is the realm

					where serious game play truly emerges: 1) the representation of NTP complexity as in a complexity simulation or model; 2) the representation of SP as in complexity play, role play, etc.; and 3) the representation of STC as in serious game play.
	Chapter 4 When Two Worlds Meet	What are the roles of modelling simulation and gaming in different types of integrated policymaking?	How do Dutch and Chinese scientists, modellers and policymakers frame integrated water management and integrated methods?	Five Dutch frames vs. four Chinese frames on the role of MSG in water management summarized in tables 4.12 and 4.22.	Netherlands: 1) bureaucratic alignment; 2) stakeholder interaction; 3) learning; 4) uncertainty; 5) science versus emotions. China: 1) the doctrine of the mean; 2) uncertainty and the contribution of technology; 3) science-based; 4) the open-minded reformer.
			To what extent are these frames similar or different? How do they contribute to possible integration at the SPI?		The Chinese and Dutch frames are quite different and show little overlap. In both countries, we find believers as well as sceptics and cynics. However, the Chinese frames show more interest in techno-analytical inclusion, namely integration through big data, big models, 3D visualizations and advanced calculations. In the Dutch frames, there is more space for socio-political inclusion and learning (synthesis). The frame differences complicate Sino–Dutch cooperation projects on integrated water management and integrated methods.
Integrated policy analysis as serious game play	Chapter 5 Principles of Play (and How They Serve Policy Analysis)	What are the principles of serious game play? How do they make integrated policy analysis become like game play?	What does it mean 'to serious game play' and how does this serve policy analysis, or any other system in the real world?	Analysis of integrated methods and how they become like game play. Examples of play-like integrating methods. Combined insights summarized in Table 5.15.	Four frames to look at policy games and integration: 1) tool; 2) innovation; 3) persuasion; 4) complex system. Six ways of integration through gaming: 1) inclusive modelling-simulation; 2) inclusive participation; 3) inclusive participatory modelling-simulation; 4) complexity simulation; 5) complexity play; 6) serious game play. Thirty-four principles of play clustered into four categories: 1) game as complex system; 2) general principles of play; 3) sine qua non principles; 4) principles of effect. The principles of play explain why certain activities in policymaking and analysis may feel like game play, and why game play may have effects on policymaking beyond the game itself.

	Chapter 6 Room to Play	How are the principles of game play applied? What is their usefulness for integrated policy analysis and planning?	What are the main principles of play?	Analysis of the Blokkendoos planning kit summarized in Table 6.2. Analysis of the Climate Game summarized in Table 6.4.	
			What is the socio-technical complexity at the science–policy interface?	Analysis of the Blokkendoos planning kit summarized in Table 6.1. Analysis of the Climate Game summarized in Table 6.3.	
			Did the game play serve integrated policy analysis and, if so, how?		Although the Blokkendoos planning kit is not a game, it was playfully used and averted an imminent deadlock in water management. Although the CG is a sophisticated serious game for integrated planning, some of the sine qua non principles were opaque. Its effect on policymaking is diffuse.
A taste of the pudding	Chapter 7 Gaming Integrated Marine Spatial Planning	How do integrated policy analysis and planning happen in game play? What do we learn from the gaming experiment?	How does an international panel of MSP professionals assess the state of integrated, ecosystem-based MSP in its members' own countries?	Profiles of MSP process, outcome and establishment summarized in figures 7.5, 7.6 and 7.7 and tables 7.6, 7.7 and 7.8	Countries are in different stages of development and have rather different approaches with regard to MSP outcome and process.
			What are the characteristics of integrated, ecosystem-based MSP processes and outcomes when simulat-	Profiles of MSP process, outcome and establishment summarized in figures 7.8, 7.9, 7.10,	Countries in the game applied different strategies/took different routes to achieving an integrated MSP. Some players/countries struggled severely to reach integrated MSP but learned, while other countries seemed to lose grip. A smooth process does not say much about the quality of the

			ed by this international group of professionals in a quasi-experimental game-based environment?	7.11, 7.12, 7.13 and 7.14	plan. Conflicts are sometimes negotiated out.
			What does the international panel consider the main insights gained about integrated, ecosystem-based MSP from the quasi-experimental game-based environment?	Twelve insights from the game described	General consensus amongst participants that MSP Challenge had been particularly useful in improving their understanding of 'the big picture' and in promoting 'systems thinking'. Concrete lessons for real MSP were generated.
			Does this international panel view SG as an effective tool for policy-oriented learning and policy analysis?		Opinions on whether a gaming approach would work and would be accepted in their own countries varied greatly. Nevertheless, the MSP game continues…

8.2.1 *Picturing socio-technical complexity*

The starting point of my research was the following working question: what principles make societal problems socio-technically complex, and how can we support public policymaking in the wake of socio-technical complexity? This question is highly relevant because socio-technical complexity (STC) is key to some of the challenges of our time, especially to some of the big problems we are facing with earth systems, like the flooding of urban areas and the degradation of oceans.

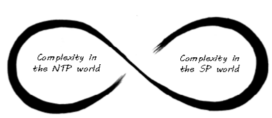
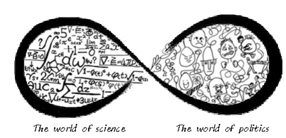
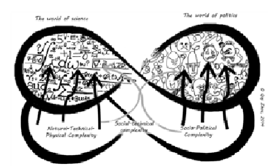
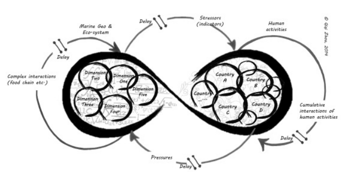
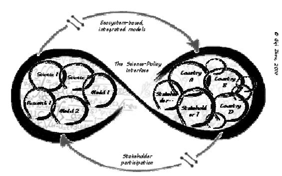
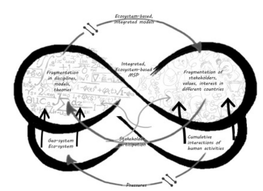
After investigating the characteristics of complex systems in general, such as emergence (1 + 1 > 2), I presented an embryonic model that pictures the dual-sided and spiralling complexity in the NTP (natural–technical–physical) realm and the complexity in the SP (socio-political) realm (see Table 8.2, picture a). This simple model shows that there is no clear boundary between an NTP complex system and an SP complex system. They are a duality, like yin and yang, or the two sides of a coin. Yet, when it comes to science and management, it proves difficult to understand and represent this dual complexity in an integrated fashion. In order to reduce the complexity of big problems, system boundaries need to be drawn, but this gives rise to further fragmentation and compartmentalization into numerous 'silos' of governance and research.

Furthermore, the language of science itself is reductionist because it breaks down into numerous sub-languages in disciplines, communities, schools and theories that tend to focus on isolated relationships between system elements, rather than systems as a whole. The many formal and natural languages we use to capture complexity – science, models, journalism and art – are difficult to unite. The fragments of big problems, lying scattered on the floor like Humpty Dumpty, need to be put back together again. Integrated policymaking, integrated policy analysis and integrated planning are deliberate attempts to bring together the two forms of complexity and the different languages in which these complexities are represented. This is a classic theme that comes under many different names and proposals, such as integrated holistic science or integrated management. Yet, it remains unclear what integration implies, what exactly we are integrating, how and why. I argue that in order to understand and achieve integration, we need to turn to the investigation and use of serious game play (answer to question 1, Chapter 1). Throughout the book, I argue that integrated science, integrated management and especially integrated methods are becoming 'like game play', and that understanding how we play with certain artefacts is relevant to integrated policy analysis and planning.

8.2.2 *Transcending complexity*

The STC of big problems transcends into the heart of the science–policy interface (SPI), where it takes a similar duality: between representations in the formal language of science, namely with models and simulations, and representations in a natural language, with participation and human interaction (see Table 8.2, picture b). This duality in the SPI has far-reaching consequences because words like ‘integrated’, ‘participatory’, ‘ecosystem-based’ and ‘adaptive’ planning are rhetorically powerful but often poorly defined, at least in practical terms. We easily get confused about what we are integrating and why. Hence, in order to understand the management of socio-technical complexity, we need to investigate the science–policy interface and see how integration here is defined and practised (Chapter 3). These insights are summarized in pictures a, b and c (see Table 8.2).

Table 8.2 Model

a) STC model	b) SPI model	c) Transcending complexity
		
d) STC model of Marine ecosystems	e) SPI model of MSP	f) Transcending complexity MSP
		

8.2.3 *The complexity of marine ecosystems and marine spatial planning*

Marine ecosystems are degrading rapidly due to increasing human exploitation of the sea. I therefore used the example of marine ecosystems and marine spatial planning (MSP) to further investigate how STC transcends into the heart of the SPI. The STC of a sea basin is constituted by the dual complexity of marine ecosystems on the one hand and human activities in marine waters (and a great many corresponding actors, institutions, etc.) on the other. I have pictured their interaction through stressors and pressures, and with feedback and delays (see Table 8.2, picture d). The STC of a sea basin transcends onto MSP in the form of: 1) unclear system boundaries, 2) system ambiguity, 3) scientific uncertainty and 4) fragmentation (see Table 8.2 picture e) (answer to question 2, Chapter 2). The high level of ambiguity, uncertainty, fragmentation, etc. creates an urgent need for an integrated, ecosystem-based MSP where the various economic demands and environmental impacts are balanced and where scientists, stakeholders and politicians interact. MSP therefore resides in the heart of the SPI. A further complication is that MSP is transnational because multiple countries share a common sea. Table 8.2, figures d, e and f are used for the design of the MSP Challenge game that addresses socio-technical complexity and integrated policy analysis in MSP (answer to question 3, Chapter 2).

8.2.4 Tensions at the SPI

The search for integration takes place at the interface or in the nexus of science and policy. This, however, does not yet explain why the world of science (WoS) and the world of politics (WoP) are like thesis and antithesis and how synthesis can be created between these two worlds. In Chapter 3, I therefore investigated the sources and causes of the tensions between the WoS and WoP such as: 1) language, communication; 2) values, norms, culture; 3) knowledge, epistemology, ontology; 4) power, influence; 5) institutions, rules, routines; and 6) technology, method, tools. I showed how such factors tie together in different theories about policymaking and the role of science in it. The main insight is that the WoS and the WoP are in a dialectical relation to each other, because when it comes to the formal and natural representation of big problems, they may both be right and/or wrong. The negation of the negation leads to a transcending unity, or what is called a 'synthesis'. I defined integrated policy analysis as a dialectical process at the heart of the SPI. It brings together two or more loosely coupled subsystems, each of which can explain the socio-technical complexity of its focal problem, into another subsystem that can explain the social technical complexity of a transcended focal problem (answer to question 4, Chapter 3).

8.2.5 Three strategies for integration

On the basis of an eclectic reading of three philosophical concepts in Chinese and Western philosophy, I formulated three strategies for socio-technical integration: balance, inclusion and synthesis. The answer to question 5, Chapter 3, is summarized in Table 8.2 (which is identical to Table 3.1). In all the cells in Table 8.2, integrated policy analysis can become 'like game play'. The stronger the level of integration, the more policy analysis starts to become – to feel, to look – like game play. The synthesis between NTP and SP complexity is the realm where serious game play truly emerges: the representation of NTP complexity as in a formal game, for example as in game theory, computer simulation and agent-based models; the representation of SP complexity as in participatory play, role play, etc.; and the representation of STC as in serious game play (answer to question 5, Chapter 3).

Table 8.3 Insights

	NTP complexity	STC complexity	SP complexity
Balance	Talking about the problem in formal and natural language Thinking about the problem with the left and right side of the brain		
Representation	1 / a		
Inclusion	Inclusive mod-sim	Inclusive participatory mod-sim	Inclusive participation
Representation	1 + 1 + 1 = 3	(1 + 1) * (a + b) = 2(a,b)	a + b + c = (a,b,c)
Synthesis	Complexity mod-sim	"Serious game" "Simulation game"	Complexity play
Representation	1 + 1 > 2	1 + 1 * (a + b) > 2 (Y)	a + b > (a,b)

8.2.6 Cross-cultural, science-policy interfaces

In the context of cooperation between the Netherlands and China, I have often witnessed how Dutch policymakers, policy analysts and scientists advocate and even try to sell an integrated approach to water management to their Chinese counterparts. Methods like integrated modelling, interactive simulation, participatory approaches and SG come almost automatically with the integrated water management approach. I therefore studied and compared the relation between policy regimes, integrated water management, and the role of modelling, simulation and gaming (MSG) in China and the Netherlands through a series of structured interviews. I found five frames in the Dutch case and four frames in the Chinese case. They are summarized in tables 4.12 and 4.22, respectively. Table 8.3 summarizes how the frames view the role of MSGs (answer to question 6, Chapter 4).

Table 8.4 Summary of the frames

Frame NL 1: Bureaucratic alignment: high-tech, computer visualized; can make scientific information easier to understand.	Frame CH 1: The doctrine of the mean: role of MSG undefined.
Frame NL 2: Stakeholder interaction: low-tech, multi-stakeholder game, social intervention, aiming at real life solutions, compromises.	Frame CH 2: Uncertainty and the contribution of technology: for system approach, socio-technical integration.
Frame NL 3: Learning: with experts as innovative method for knowledge integration. No immediate consequences for real world.	Frame CH 3: Science-based: can open new perspectives but it is too early at the current stage.
Frame NL 4: Uncertainty: combining with computer models, to reduce specific types of uncertainties, like ex ante testing of policies.	Frame CH 4: The open-minded reformer: knowledge integration, social intervention, aiming at real-life solutions.
Frame NL 5: Science versus emotions: sugar-coated scientific model.	

The main finding is that the Chinese and Dutch frames are quite different and show little overlap. In both countries, we find believers as well as sceptics and cynics. In the Netherlands, two frames view policymaking as a power game, and hence regard game play as being of limited value. One frame sees a role for MSG only when it integrates multiple data, for instance through visualization. Two strong frames emphasize socio-political inclusion and stakeholder learning. In the Chinese case, techno-analytical inclusion is most dominant: integration through big data, big models, 3D visualizations and advanced calculations. This is because socio-political participation and learning are viewed and valued differently in China, where being scientific and evidence-based is highly valued; things like role play or digital computer games are not regarded as very trustworthy or influential. The frame differences cause considerable complications in Sino–Dutch cooperation projects on integrated water management and integrated methods (answer to question 7, Chapter 4).

8.2.7 Four frames and many examples

What does it actually mean when we claim that integrated policy analysis becomes like game play? I analysed the different connotations and uses of ‘game’ and ‘play’ in a policy context through four frames: SG as a tool, SG as innovation, SG as persuasion and SG as complexity (self-organization). These four frames colour the discourse on what we expect from SG in a policy context. Furthermore, I briefly analysed a variety of game-like methods relevant to water management to validate the six ways of integration in Table 8.2 (and 3.1) and to derive the principles upon which they are based.

8.2.8 Principles of play

Many of the integrated methods in the examples I found are not full-blown games: they are game-like simply because they rely upon certain principles, like feedback, suspension of disbelief, emergent effects (surprise) and the engagement that we know from games and play. As it is impossible to define what a game is, the scholarly discourse about whether or not these methods and approaches are games becomes confusing. For some, the methods of inclusion (e.g. interactive simulations) are games, because they have certain game-like characteristics. For others, these methods are not games, because they lack other game-like characteristics. To examine what makes these integrating methods game-like, I clustered 34 principles of serious game play into four categories: game as a complex system, general principles of play, sine qua non principles and principles of effect. These principles explain why certain activities in policymaking and analysis may become like game play, and why game play may have effects on policymaking beyond the game itself. Table 5.15 summarizes the answer to question 8, Chapter 5.

8.2.9 Room to play is key

I described policy gaming as a designed way of informed discourse for the integrated analysis of socio-technical complexity in the heart of the science–policy interface. The question is, does it work? I took two cases for further exploration: the Blokkendoos planning kit (BPK) in the Room for the River (RfR) project, and the Climate Game (CG) in the Feijenoord district reconstruction in Rotterdam.

The BPK was not designed to be a game, but its playfulness was quickly recognized during its use. Many of the sine qua non principles proved essential for the stakeholders to play with the many options that could give room to the river. The BPK is reputed to have opened up the policy process and to have prevented an imminent deadlock in water management.

In the CG case, many of the principles of effect – such as feedback, immersion and analytics – are easily identified. The CG was designed to be a serious computer game from the beginning. Yet, its impact in the Feijenoord reconstruction seems more diffuse than the influence of the BPK in the RfR project. The actual role and usefulness of the CG for policymaking is difficult to judge. I believe that the reason may be that some of the sine qua non principles, such as commitment, consent and suspending disbelief, are opaque. Nevertheless, these two cases show that in a policymaking context playful interaction with a tool that was not designed as a game can be at least as powerful as, or even more powerful than, interaction with artefacts that were intentionally designed to be an SG (answer to sub-questions 9 to 11, Chapter 6). In short: the room to play is more important than the game artefact itself.

8.2.10 A journey of synthesis

Finally, I designed and studied game play for integrated public policymaking with an SG on marine spatial planning, played with international professionals on three occasions. If anything, the game-based quasi-experiments triggered reflection on the fundamental aspects of integration: what is integrated? For what purpose and how it can be assessed? I measured the level of integration of MSP process and outcome in the countries the players came from. The conclusion is that these countries are in different stages of development and have rather different approaches with regard to MSP outcome and process. They may use the same words like participation, integration and evidence-based, but (as we have seen with integrated water management in China) they have different meanings in the various countries. The game also showed what might happen when different styles of integrated planning meet in the transnational arena. In many cases, it leads to confusion (answer to question 12, Chapter 7). The harmonization of MSP within the EU and the alignment of its transnational contexts could be greatly improved by profiling and monitoring integrated MSP within and between countries.

With respect to the game itself, I found that there is an intricate relationship between MSP process and outcome with regard to stakeholder satisfaction, as opposed to the scope and quality of the plan. Like in reality, countries in the game applied different strategies or took different routes to achieve an integrated MSP. Some players/countries struggled hard to achieve integrated MSP, but they learned, while other countries seemed to lose grip. Nevertheless, a smooth stakeholder process does not say much about the quality of the integrated plan. A smooth process might increase stakeholder satisfaction, but this could be due to the 'negotiating out' of difficult issues and conflicts. Although a contentious process might result in stakeholder dissatisfaction, it might also improve the consideration of real issues and conflicts (and thus lead to more innovation in the plans). However, fierce controversies in combination with poor management lead to weak plans. In that case, the marine ecosystem is likely to suffer the consequences. The NTP complexity of the system will hit back hard when problems are negotiated out or dissolved (answer to question 13, Chapter 7).

At the end of the game, there was general consensus amongst the participants that the MSP Challenge had been particularly useful in improving their understanding of 'the big picture' and in promoting 'systems thinking' (i.e. how the various elements, factors, planning scales and stakeholders in MSP interconnect, and the how the system steers and is steered at the same time). I derived 12 lessons from the game, which I will not repeat here (answer to question 14, chapter 7).

As a by-product of the exercise, the participants also learnt about gaming as a method, as well as about its strengths and limitations. The participants started to think about whether and, if so, under what conditions the method might be 'taken home' – either by playing the same MSP Challenge game in their own policy contexts or by modifying it, or even developing a new game for use in training or policy development. Opinions on whether such a gaming approach would work and would be accepted in their own countries varied greatly. For example, in the Netherlands, such exercises are quite common and are accepted by decision-makers, researchers and stakeholders alike. Other participants, however, observed that this approach would probably be difficult for them, as their countries are not very 'playful' in this way. Such a game would be considered as being 'just for fun', or the real stakeholders would refuse to play or would not reveal their real interests and behaviours during the game. Many participants also realized that it would probably be difficult to use SG for direct policy support, stating that it would be more effective 'training', 'education', 'getting to know each other', 'problem elicitation', 'exploration during an early policy phase' and so on (answer to question 15, Chapter 7).

8.3 Did we find the princess?

Now I have recapitulated the various fragments of serious game play for integrated policy analysis and planning, I come to the following conclusion.

(1) *Is there a princess in the castle of integration?* Yes. I truly think that she exists. SG has the potential to integrate what has become fragmented, to bring together what is lying scattered around. Nevertheless, some people might dislike, generally and principally, the idea of inherited royalty. SG is not for everybody and for all problems. And she (it) should be handled with care.

(2) *What does the princess look like?* She might look quite serious (appearing as an agent-based model), she might look cool (as a strategy or online computer game), she might look very trendy and fashionable (as augmented reality), or she may look old-fashioned (as a board game). She might be uncomplicated, plain or have an attitude. But you can only know who she is, what she is like and whether she is worth it, when you start playing with her. Playing with a simple artefact might be very rewarding, and playing with a fancy game may give diffuse outcomes.

(3) *Is there a princess in more than one castle?* Yes. I believe that each princess has her own castle. And before you go looking for the princess, it is important to identify the kind of castle you want her to be in. The castle may tell you something about

the princess. You may be looking for a weak form of integration in the form of balance, a moderate kind of integration in the form of inclusion or a strong kind of integration in the form of synthesis. These three types of integration will become (look, feel) like game play, but synthesis is the type where serious game play truly emerges.

(4) *Is 'my' princess the same as 'your' princess?* Probably not. The princess will be like her country and her people. It matters for SG whether policymaking is viewed as a power game, as a knowledge process or as stakeholder learning. It also matters whether planning authorities can commit, can suspend disbelief, can accept equality and are willing to accept failure. This is why serious game play in China (and many other countries) will be different from that in the Netherlands.

8.4 Implications

8.4.1 Policymaking

As SG researchers and as advocates, we should first realize that both policymakers and scientists have a habit of not following scientific theories and methods. Like the rest of us, they only observe the law of human imperfection: humans are not always noble, not always altruistic and certainly not always reasonable. Things like self-interest, risk avoidance, short-sightedness and blunt exertion of power stand in the way of the principles of rationality, morality and … game play. When there is no room to play, an SG can easily become an expensive waste of time. In order to play, the players need to be willing to adhere to certain sine qua non principles, that is, to engage, to commit, to play fair, to suspend disbelief, to accept failure, etc. Of course, transgressions will happen all the time, but they should be non-structural, and repairable. If lying, cheating, corruption and brute force dominate the policy arena, it makes no sense to introduce serious game play. Like in childhood, serious game play brings imperfections to the surface. By playing (and gaming) a lot, we come to know ourselves in relation to others.

At the same time, I believe that the need for integrated science, integrated policymaking and integrated methods is more urgent than ever. The ecosystem is striking back, because we choose to ignore some of the important laws of nature. China (like India) is now facing a severe crisis of air pollution. Major cities like Beijing are close to becoming uninhabitable. Air traffic in major parts of Asia is frequently disrupted by heavy smog. Glaciers are melting in Alaska, groundwater is becoming polluted by shale gas extraction in the USA, there are earthquakes in the province of Groningen (the Netherlands), and so it goes on. Yet, policymakers everywhere in the world tend to negotiate out the complex reality side of big problems by denial and negotiated nonsense. I believe it is high time that we gave policymakers and stakeholders the insights and methods to put the reality side of complexity firmly on the negotiating table. The challenge is to put big data on big tables.

8.4.2 Run game, run!

When I was doing my research, it took me a lot of effort to convince policymakers and experts to play. Many times, I did not succeed. This made me reflect upon what worked, and what did not. Here are a few of the lessons I learnt:

(1) *Develop the playful mind:* few people outside the immediate field of game research have heard about SG, especially when it comes to games for policymaking. In addition, affinity with games varies markedly among genders, ages, professions and personalities. Although an older professional may be surprisingly playful, in general the older generation of policymakers have very little familiarity with computer games. Some are quite willing to try new things, while others resist or bluntly refuse. In short: before getting out the digital toys, do not be afraid to reawaken the playful mind with paper-and-pencil games.

(2) *No harm being a salesperson:* salespersons usually win you over with attractive features, not by demonstrating all the functions of the product. Likewise, you may persuade potential clients or players to play your game because it has nice 3D graphics. That is okay, as long as you believe in the value of the product itself. Once they start playing, the rest will follow.

(3) *No model is perfect:* because a game is a model, it is also a simplification, abstraction and reduction of reality. Some expert players will immediately start to question the validity and fidelity of the game. It then becomes important to remind them that by giving up some of that, you gain something else. A good game is the simplest playable representation of complexity. The game should be judged upon 'emergence' (1 + 1 > 2), not on its predictive value. It is not a decision-support system; it is a learning experience.

(4) *You only prepare the dance floor:* the game developer and moderator create the excuse and the conditions for playing. How well the players play the game, and with how much enthusiasm, is up to them. Not all players will jump in.

(5) *It's the playing, stupid!* SGs are becoming a commodity; a product to be boxed and distributed. In my experience, it is not so much a one-time SG play that does the trick. It is the frequent and repeated playing of many different SGs that induces the deep learning and profound change. In short: do not expect one SG session to change the world and give you easy answers to difficult questions. Just use the experience to deepen the game play.

8.4.3 Research

Game research pays a lot of attention to game-based learning (frame 1, game as a tool), much more than it does to games as complex systems (frame 4) (for a discussion of frames, see Figure 5.1). Theories and methods to systematically study policy games in real life are rather poor. Many interesting case studies lie hidden, either because they contain confidential information or because the case is so specific that it would take a lot of effort to explain it to a wider audience. Getting case studies about policy games published in good journals is far from easy; also because it is difficult to convey how the game works, what happened and why this matters. In many cases, the expertise and experience required to set up a good academic study parallel to the game development is often missing in project teams. It takes a lot of effort to follow and study a policy game over a longer period – usually longer than the three or four years given to a PhD researcher. Reconstructive case studies are difficult, because the opportunity to capture some of the experiences is no longer there. The different levels of aggregation – from individual to systems learning – complicate research further.

Overall, there is a lot of groundwork to be done. I see two directions for developing the field of policy game research further. Firstly, it would contribute greatly to the field were similar cases of policy gaming disclosed more systematically and comparatively. A way to collect meta data about policy games and to make the data accessible is very necessary in my view: how often, where and for what is policy gaming used? What was the outcome? Case studies are a good start, but comparative and longitudinal databases with evaluation and impact data seem needed.

Secondly, I believe that we need to reconsider and improve our data collection methods, especially when we aim to set up longitudinal and comparative research. The field needs a much better operationalization of concepts like policy process and policy outcome, stakeholder interaction, influence, etc. One of the strong points of policy games is that we can observe policymaking in all its dimensions, while it is happening. In games like MSP, we captured the data and visualized it; but this could be done much better with the help of proper theories, the operationalization of constructs, the tools for unobtrusive measurement, the dashboards for feedback and analysis. Many of these aids do not exist, or are reinvented again and again. Visualization of game data in heat maps, graphs or dashboards is another unexplored territory in policy gaming. Here, the field can and should connect to game and learning analytics.

8.5 Closing

So, here is my best answer to the overarching question...

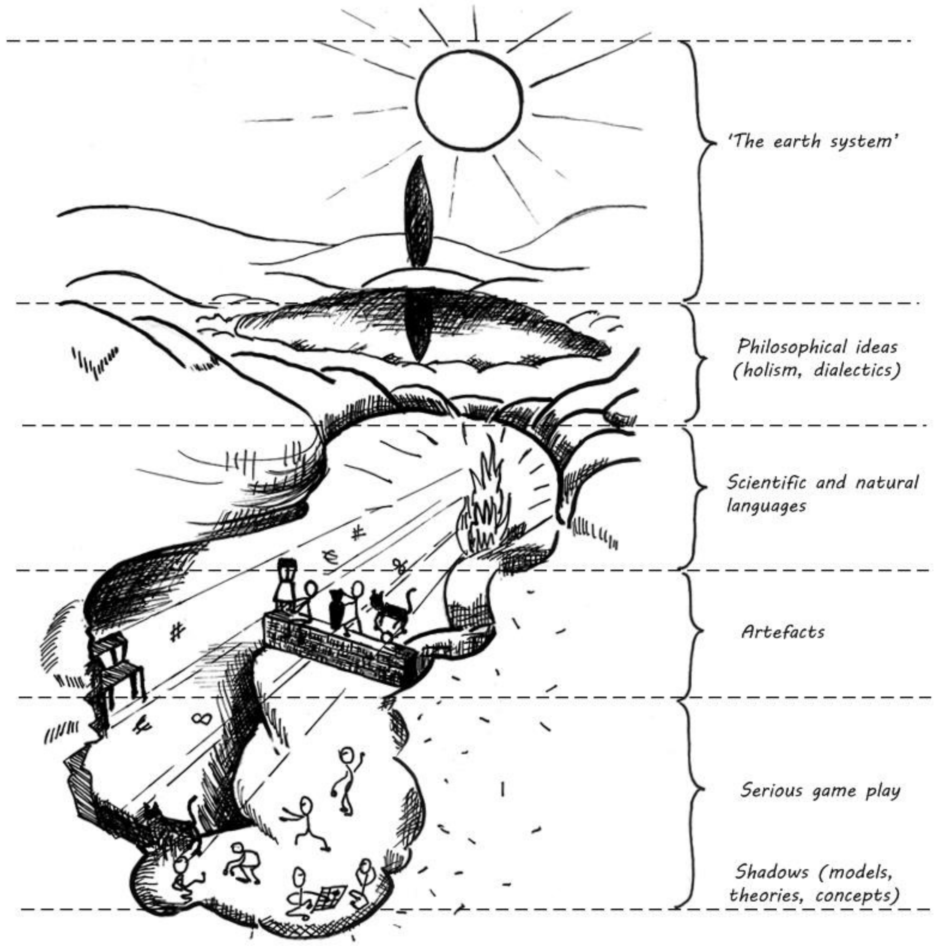
Many grand challenges, like the vitality of the Earth's rivers and oceans, the cities we live in and the infrastructures we build, can be viewed through the frame of complex, socio-technical systems. Looking through this frame, we pick up some important signs that their vitality is under serious threat: the deteriorating status of the oceans and the increased flooding of metropolitan areas are just two examples.

I strongly believe that each person has an elusive notion of a 'holistic earth system' whereby everything is connected to everything else, whether through religion, art or system science; but in Western–modernist society we break it up into numerous partial representations we call theories, concepts, models, simulations, etc. They project various forms of shadow on a wall in a *Platonic cave* (see Figure 8.1). Trapped inside the cave, we give authority to speak and decide about certain shadows to institutions we call scientific disciplines, societal sectors, organizational departments, and so on. This takes us further and further away from the original notion of a *holistic earth system.* If the world outside the cave didn't affect life inside the cave, it wouldn't be such a problem. Unfortunately, it does; even to the extent that we feel at risk.

Especially after something has gone wrong, there are calls to look at 'the big picture' or to 'think in terms of the whole'; in other words, to look through the shadows. Scientists and experts know very well that their theories, models and simulations are shadows; but they need to feel safe and free to acknowledge it. Decision-makers know very well that their authority is as legitimate as anyone else's, but they can only acknowledge it when they do not feel threatened. So what can we do? Once in a while, we detach ourselves from staring at singular shadows on the wall. We start 'playing' with them, as illustrated in the area of game play in Figure 8.1. And only then do we feel free and safe enough to:

(1) Challenge what we believe to be true
(2) Do things differently than we commonly do
(3) Connect to beliefs and people that are distant
(4) Think and speak critically about authorities that otherwise cannot be criticized
(5) 'See' the whole through the parts.

Figure 8.1 The use and useful of serious game play in allegory of Plato's cave



Adapted and redrawn based on the picture retrieved from
http://p-adamek0912-whatisgood.blogspot.nl/2010/09/platos-analogy-of-cave.html

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Appendix A. Study Design and Methodological Justification

> It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something. *Franklin D. Roosevelt* (American president, 1882-1945)

> All errors in this thesis are mine! But I think I cannot be blamed too harshly for what I could have done more or differently. A PhD takes four years and I took a little more than five. I think, I am now fully aware of the / my limitations. *Qiqi Zhou* (1974 - , author of this thesis)

Introduction

In this appendix chapter, I present the study design of this thesis with more details and justifications than in the main text. In Chapter 1, I have chosen to structure the story line in a circular manner; by alternating the theoretical chapters with the empirical chapters (see Figure 1.1). There is little scientific reason for that – other than that it seems appropriate and more fascinating to read. There is one major disadvantage to this approach – and that is that a methodological chapter placed somewhere in the middle of the thesis can easily break the flow of the alternating theoretical and empirical story lines. Likewise, detailed descriptions, for instance on what Q methodology is and how I got the Q-set and P-set, can break the flow within a chapter (in this example, Chapter 5). I have therefore decided to put all methodological considerations - what I did, why when and how – as well as the detailed analyses in the form of tables and statistics in the appendices. The appendices after this chapter contain things like the Q factor analysis tables, the Q statements, the questionnaires used in the MSP game, supportive tables for the MSP game analysis etc. In the main text, I have referred to all appendices when needed or appropriate.

In this chapter, I present the study design (Bryman, 2012; Creswell & Clark, 2007; Creswell, 2013; Eisenhardt, 1989; Malterud, 2001; Miller & Salkind, 2002; Morse, 2003; Robson, 2002; Yin, 1998) and the justifications of my methodology, as far as it has not been explained in chapter 1 or individual chapters. The reader can scrutinize this chapter to check the appropriateness and validity of the methods; she (or he) can also scan it, check a few facts, look up some methodological references, or just give it a glance to get a general impression of what I did.

Methodological approach

Deconstruction…reconstruction

Without too much bothering about the philosophical roots, I want to stress that this study is set up as a *deconstruction* and *reconstruction* (McCarthy, 1993) of integrated policymaking (and its analysis) and serious games (Djaouti, Alvarez, Jessel, & Rampnoux, 2011). I think a *de/reconstruction* is needed because in my professional opinion, *integrated policymaking* or *integrated policy modelling* are too easily and frequently voiced as some kind of solution to 'fragmentation?' without too much further consideration of the questions to which it is an answer. And the same goes for the propagation of serious games for change.[47]

- If integration is the solution, what is the problem?
- What exactly are the 'things' that needs to be integrated?
- If these 'things' are now scattered how have they become scattered?
- What forms of integration are there?
- How far do we go with integration?
- How does integration work in practice?
- Can integration also cause other problems?
- Etc.

In the same casual way, *serious games* are discussed: as a *one size fits all* solution – or as an *ignorant rejection*. *Deconstruction* means that I want to *reveal the questions behind the answers*. In our case, the answers are *integrated policymaking* (and its analysis) and *serious games*. I deconstructed integrated policy by looking at the questions in *socio-technical complexity,* the *science-policy interface*. I reconstructed integrated policymaking as: *balance*, *inclusion* and *synthesis*. With regard to serious games, I deconstructed it by examining the *principles* upon which *serious game play* is based in a policy or decision-context. The marine spatial planning game but also the climate game, are examples of how the combination of these principles can form integrated policy analysis. In the conclusion, I made a strong plea to look at the principles of play in a context of policymaking, more than at the artefacts of games. The games are just a means to induce the play, and it is the play that has a function in the policy process because the policy process itself can be framed as a kind of play.

Multiple methods

As discussed in Chapter 1, I eclectically use a combination of methods – sometimes called triangulation, mixed or multiple methods (Creswell, 2013; Harrits, 2011; Hesse-Biber, 2010; Johnson & Onwuegbuzie, 2004; Molina-Azorin, 2010; Morse, 2003; Rocco, Bliss, Gallagher, & Pérez-Prado, 2003; Sale, Lohfeld, & Brazil, 2002; Yin, 2006). For the theoretical chapters my research method is evident: searching, reading and interpreting the data-bases for relevant literature. The empirical line of this study consists of:

(1) *Pilot studies:* two case studies around the *Blokkendoos planning kit* and *Climate Game*, with data gathering based upon open interviews, observations, documents etc.
(2) *Structured interviews* with policy makers and modellers in China and the Netherlands using *Q methodology*.
(3) *Game-based quasi experiment,* design, organization, facilitation and evaluation of a policy game around *Marine Spatial Planning* (MSP) played in three game sessions from 2011 to 2013, with around 150 policy experts.

Table A.1 gives an overview of the methods used for each empirical part of the study. I discuss the details and justifications of the methods in the remainder of this chapter.

Table A. 1 Overview of the four empirical studies

	Study 1 Pilot studies	Study 2a,b Structured interviews	Study 3 Game experiment
Chapter	Chapter 6	Chapter 4	Chapter 7
Time	2008 and 2009	2009 - 2011	2011 - 2013
Number of cases	Two cases: Planning Kit Blokkendoos; Climate game.	Two countries: China and the Netherlands	Three game sessions: Marine Spatial Planning Challenge
Unit of analysis	The role of SG in policy analysis at meso-level	The role of SG in policy analysis at macro-level	The role of SG in policy analysis at micro-level
Nature of the study	Exploration	Exploration, interpretation	Description, explanation
Case-specific method for study	Pilot case study	Q-methodology	Game design; quasi experimental design (Cook & Campbell, 1979a, 1979b; Shadish, Cook, & Campbell, 2002)
Data-collection	Interviews, documents, observations.	33 Structured interviews with policy makers and scientists in the Netherlands and 22 in China.	Questionnaires, logging of game data, observations.
Pre publications	(Zhou et al., 2013)		(Mayer et al., 2012; Mayer, Zhou, et al., 2013)

Pilot studies

A *pilot study* is useful to shed first light on a real-life phenomenon before suitable methods for deeper investigation are designed. In my view, it is used too little in academic research. A pilot study can be used to refine preliminary research questions or do a first trial of a method (Tellis, 1997; Yin, 2009, 2013). In my research, I used two pilot studies to get a first perspective on integrated water policy where gaming appeared to have been used with some effect. The pilot studies were selected on the basis of the following criteria:

(1) Explicit reference to integrated policymaking etc. (e.g. in policy documents, website).
(2) Application in the field of (integrated) water management, flood management or similar.
(3) Fairly recent and innovative in the way 'game-play' is used in combination with models, simulations, games.
(4) Project completed to give me the opportunity to look back.
(5) An indication that the integrated approach has had some influence on policymaking, e.g. that it was not only educational nor generally considered irrelevant.

Over the years, I considered the following *short list* of cases as candidates for pilot studies:

(1) Integrated (static) models: Blokkendoos planning kit (Deltares), Deltaviewer (Tygron)
(2) Integrated simulations models: Urban Strategy (TNO), UrbanSim (US), SimLandscape, SimWaterscape.
(3) Serious games: Floodsim (UK), Climate game (Tygron, also referred to as Krimpgame, Watergame)
(4) Policy games: Shariva River Basin Game (IHE, Unesco) etc.

In the early years of my research, most of these projects were at their initiation stage, making them unsuitable for a reconstructive pilot. No certainty could be given that requested subsidies for the projects would be granted. The games still needed to be designed and played before they could be evaluated. It would take some time before the 'dust' of the game had settled and the impact would become clear. Foremost, I wanted *to look back* on a few successful cases, to see what happened with game-play in policymaking: could I find cases, where it made a difference beyond training, education, PR?

Some cases on my short list, like SimWaterscape / SimLandscape (de Waard, 2005a, 2005b; Ligtenberg, de Vries, Vreenegoor, & Bulens, 2010; Slager, Ligtenberg, de Vries, & de Waard, 2007) have been the subject of other PhD research, so I could use them anyway for general reference. Some, like Urban Strategy (TNO) (Borst, Lohman, Eisses, Miedema, & Polinder, 2008; Borst, 2010; Minderhoud & Borst, 2010), Urban Sim (Borning & Waddell, 2006; Felsenstein & Ashbel, 2010; Felsenstein, Axhausen, & Waddell, 2010; Patterson & Bierlaire, 2010; Waddell, 2002) and Sim-Landscape (de Waard, 2005a), were definitely relevant for integrated planning, but focus less on integrated water management. They could be included as general reference. Further, there are many games 'out there', like FloodSim (PlayGen, n.d.) (Rebolledo-mendez, Avramides, & de Freitas, 2009), ABC Catchment Detox Game (ABC Science, n.d.) (Wallis, Graymore, Matthews, & Byrne, 2012), Aqua Republica (UNESCO-ISCED (website), n.d.), Water alert (Water Alert (Website), n.d.) (Leland, C., Harste, & Kuonen, 2008; Liarakou & Sakka, 2011; Lucas, Cabral, & Colford, 2011), that are about water problems and policymaking but not for water policymaking; many serious games are educational or persuasive; very few policy makers will play them to make better decisions.

Between 2008 and 2013, I witnessed the initiation of an increasing number of projects about gaming for water management, like the *IPDD Delta Envisioning Support System* (DENVISS) game (IPDD, n.d.) and the *Unesco IHE's* game in the *Shariva River Basin*, Mekong Delta (UNESCO-IHE, 2011). They came on my path when I was well under way, too late to study them in-depth. I sometimes had the impression that I had started my PhD research a few years to early. All in all, in 2008 I selected the *Blokkendoos planning kit* (BPK) in the *Room for the River* project as my initiation study. In my first round of interviews, policy makers and modellers repeatedly mentioned the BPK as a point of reference; the playing with a fairly simple model called *the Blokkendoos* was claimed to have had considerable impact on policymaking. Hence, I was curious to know if that was true and what had happened. After reading relevant papers and documents, I held a series of open interviews with some people in University, Waterboards, Rijkswaterstaat and Deltares who had been involved in the case.

From 2008 until now, the so-called *Climate Game* (Tygron, n.d.-a) (CG, first called the Water Game) has been under development by the company Tygron with sponsoring of the *Living With Water* project and a selection of public and private partners. At the time, it was estimated that cases would soon be available for reconstructive studies. Although the game was played many times between 2008 and 2012, it was still mainly used for educational and training purposes. Tygron was asked to do some policy games with policy makers and stakeholders on the problem of urban planning in regions were populations were shrinking; interesting, but hardly case studies on integrated water management. Game experiments with the climate game could be set up, but it proofed not easy to study the use of the game environment within a real policy context. The irony is that the climate game is now increasingly being used in real policymaking, in the US, South Africa and the Netherlands. Especially after *Sandy*, the urgency of water management has increased; and the climate game is now being used to contribute to integrated policy. Nevertheless, I have followed the climate game in its evolution between 2008 and 2013. I observed a number of sessions, and interviewed a number of people about it. I have also arranged and facilitated a number of sessions with the climate game myself, but only in a context of education and promotion. I therefore decided to include the climate game as a pilot study and not as an in-depth case study, like the MSP Challenge game.

Both pilot studies – BPK and CG - are reconstructive. The insights are derived from an *ex post analysis* of what has happened. Relevant documents and reports are used to collect information: advisory reports, government decisions (key spatial planning decision), program proceedings, internet sites of the projects and academic publications. The information is used to first distinguish the characteristics of the policy environment, then to discuss the role of MSG. Although I did some surveying of players with regard to the climate game, I decided not to include the statistics in this thesis because the set-up and outcomes are rather generic.

China / Netherlands

The use of MSG in policymaking is not uncommon in the Netherlands, but in 2008, I had little knowledge how it would be received in China. I assumed that the whole concept of stakeholder interaction and game-play in a context of integrated policymaking and planning would feel awkward to Chinese policy makers and modellers. One of my ambitions was to bring the *Climate Game* and/or similar games to China as a new tool for integrated policy analysis, to try and evaluate it. Now, at the end of my PhD, I have come quite far in the implementation of it, but unfortunately I have not been able to get empirical results before the completion of my PhD. Over the years, I gave a number of talks and lectures about the method of gaming in China or to Chinese visitors in the Netherlands; I facilitated simple games like *Harvest* (Sweeney & Meadows, 2001) and / or we played demos of the *Climate Game* and MSP challenge with Chinese policy makers and scientists. In 2011, I joined a Netherlands-Chinese mission on integrated water management where one of the Dutch provinces visited their Chinese counterparts. I played *hostess* to a group of thirty Chinese policy makers on a tour around the Netherlands and China to visit six high tech companies working on modelling, simulation and visualization. And, there are now quite a few examples where gaming-simulation is used in Asia, especially in the field of emergency and crisis management.

During all these informal occasions, I talked to many people to better understand how Chinese policy makers responded to the notion of integrated water management, and how they framed the use of knowledge, models, simulation and games in it. This may not be regarded a scientific method; but making notes or taping the conversations for scientific analysis would have been highly inappropriate. Nevertheless, the informal meetings and talks were very informative and put their marks upon the thesis.

Q-methodology

Background of the Q-method

I used *Q-methodology* in Chapter 4 to reconstruct the frames of policy makers and scientists in the Netherlands and China about water management, integrated policymaking and the role of MSG. The concept of *frame* refers to a cognitive representation of external reality. In the literature it also referred to as 'cognitive map' or 'mental model' (Kolkman et al., 2005; Raadgever, Mostert, & van de Giesen, 2008). Q-methodology combines the advantages of survey and interviews, because interviews are conducted following a specific card sorting procedure (see below). The end-result – the sorted Q-cards – is used for quantitative (factor) analysis to find clusters of respondents that frame the issue at hand in the same way (Barry & Proops, 1999; M. Brown, 2004; S R Brown, 1996; Dziopa & Ahern, 2011; Eden, Donaldson, & Walker, 2005; Ellingsen, Størksen, & Stephens, 2010; Herrington & Coogan, 2011; McKeown, 1990; Rajé, 2007; Ramlo, 2011; Shinebourne & Adams, 2008; van Exel & Graaf, 2005; Watts & Stenner, 2012). In this fashion, we find a number of *configurations* of frames and how respondents relate to them. The (logged) discussions between interviewer and interviewee are used for additional analysis and interpretation of the frames.

The Q methodology can be used for a range of purposes, for instance to examine the structural basis of controversies in a policymaking process: e.g., a *clash of frames*. In my study, I used the Q methodology to give empirical foundation to how different frames on water management, policymaking and the role of modelling, simulation and gaming, influence tensions at the science, policy interface. It is a similar use of the Q method as in studies previously conducted by (S. R. Brown, 1980; Davies & Hodge, 2007; Focht, 2002; Hoppe & Jeliazkova, 2006; Raadgever, Mostert, & van de Giesen, 2008; Steelman & Maguire, 1999; Webler, Danielson, & Tuler, 2009).

Data-collection

The 'Q set'

The collection of statements used in the Q method *card sorting* is called the *Q set*. I first collected a wide range of statements about the core topic: the so-called *Q samples*. Statements express an opinion about the topic. I collected them by scanning the literature in the widest and most diverse coverage possible. The number of statements can be calculated as the number of *main issues* identified in the topic multiplied by the number of *alternative replications* of the statement.

Q sample = (Main issues) * (Replications)

Based on the conceptual framework developed in Chapters one to Three, I identified three main issues:

(1) Water management problems, e.g., causes, urgency etc. < A >
(2) Policymaking, policy analysis, e.g., technocratic or participatory, top down or bottom up, fragmented or integrated etc., < B >
(3) The role of Models, Simulation and Games, eg., for visualization, calculation, interaction, learning etc., < C >

For each issue a number of statements were selected. The number (n) of selected statements for each issue can vary in the Q method.

Q sample = (Main issues) (Replications) = (<A> <B> <C>) (n)

My initial Q sample consisted of *sixty-five* statements divided over the three main issues. I then checked and validated the initial set among peer researchers, colleagues with expertise in at least one of the three main issues. I iterated revisions several times before I came up with a near final version of the Q sample. I then did several test runs of the *card sorting* with colleagues to train myself in the technique and get feedback. Some more revisions were done on the basis of that experience. The original sixty five statements had by then been reduced to *forty three*:

Water problem < A > = 5
Policymaking < B > = 19
Modelling, simulation, gaming < C > = 19

I had the Q statements *language checked* and translated into Dutch. Later, I translated the statements myself into *Chinese*. Not all policy makers in the Netherlands can understand the Q statements well-enough in English; but the level of English is certainly not good enough among Chinese policy makers and scientists to do it in any other language than Chinese. Ideally, I would have liked to have *validated* the three language sets but this would have been far beyond the aim of the Q technique and my resources.

I put each individual statement on a *laminated card* so they would look professional and I could re-use them. Later I also put the Q set in the online *Flash Q* system for use in China.

By the time, I was ready to do the Q interviews in China, I found a few questions to be less clear - respondents had commented about them. I also found some of them rather 'Dutch' and difficult to translate into Chinese. I therefore the reduced the Q set in the Chinese version to thirty four. The scale therefore also had to be adapted to <-2, +2>

Ideally, I would have first tested the Q statements in both the Netherlands and in China, and then validate them, select the definitive set, and do my research for real. For obvious reasons this was impossible. In my view, the changes between the Netherlands and Chinese version did not affect the validity of the result in a significant way (S R Brown, 1996; van Exel & Graaf, 2005). One should also understand that the objective of the Q method is to reconstruct the frames in an iterative way; and not to rely solely upon the statistical analysis. The Q cards are a means, not an end. I got much information from the many hours of conversation and discussion with the respondents. The forty three statements Q set in English and the thirty four statements Q set in Chinese are included in a separate appendix. Table A.2 gives an overview.

Table A. 2 The structure of the Q set

Main issue	Components	N, the Neth.	N, China
A. Water problem	Nature of the problem Uncertainty Fragmentation	5	3
B. Policymaking	Management style (network or top-down) Methodology (participatory /interactive or hierarchical) Rationality on infrastructural functions (information, knowledge, functional design, prediction) Rationality on social political emotions (interest, power, preference) Learning, Innovation and creativity	19	14
C. Modelling, simulation, gaming	Attitude on computer simulation and SG Functional analysis: realistic, key information, Social interaction (emotional: distance, trust) learning, innovation and creativity (may create surprising results out of the design purpose)	19	17

The 'P set'

The selection of respondents in a Q method is called *the P set.* The number of respondents normally lies around thirty. They should be a representative sample of the actors / stakeholders involved in the main issue. The respondents in the Netherlands and China are *senior policy makers and stakeholders in water management*, mostly male, with quite a lot of work experience in the field. Both in China as in the Netherlands, I selected my respondents from three domains:

(1) Public authorities, s.a. water policy makers, water managers
(2) Stakeholders involved in water management
(3) Modelling, simulation and gaming professionals, mainly consultants

I made sure to have more than ten respondents in all three categories, in China as well as in the Netherlands. It should be mentioned however that a few respondents cannot unambiguously be put into one of the three groups above. Some respondents can be put in more than one group.

In the Netherlands, I approached candidates for an interview through organizations like *Rijkswaterstaat*, the *Water Boards*, *Provincial* and *local governments*, universities, consultant and engineering companies like *Deltares* and *TNO*. I approached the candidates by e-mail and letter, with some recommendations, asking for an interview. Then I used *snowballing* –to increase my list of candidates, asking respondents to refer me to others in their network. The long list of candidates went up to around fifty in the Netherlands, of which thirty three were interviewed with a fully completed Q sort (see Table A.3).

Table A. 3 Respondents in the Netherlands

Category	Institution	Number of respondents
Governmental sector-National level	Dutch national department of water and transportation [1] Ministry of Infrastructure and Environment [2]	6
Governmental sector-	Provincial government of South Holland [3]	5

[1] In Dutch: Rijkswaterstaat
[2] In Dutch: Ministerie van Infrastructuur en Milieu
[3] In Dutch: Zuid Holland Provincie

Regional level		
Governmental sector- Local level	Municipality	5
Water Board	Water board 4	5
Research institute	University TNO Deltares	4
Consultancy	Water project consultancy	4
	Gaming consultancy	4

Interviewees in China were selected through a similar procedure, making use of my professional contacts in cities of *Dalian, Nanjing* (my home town) and *Guangzhou*. I contacted officials in the local municipality, water management sectors, infrastructure design institutes, water research institutes and university. Finally, I had useful interviews with twenty-two persons from different institutions who also completed the online Q-sort. The respondents are representative of the science-policy interface in water policymaking in China (see Table A.4).

Data collection

As some of my dear colleagues have experienced also, doing interviews in China is not easy – not even for a born Chinese with a background in journalism and television. For the *reverse* reason, it was also not easy for me to do interviews in the Netherlands, although I am educated at *Wageningen University* and my Dutch and English are not too bad. The first obstacle is persuading people to talk to you. *Presents* are highly appreciated both in the Netherlands as in China – but they should be nothing more than a token of appreciation. In my case, exchanging such tokens from China to the Dutch respondents and from the Netherlands to the Chinese respondents worked perfectly. *Status* also matters when asking for an interview and status unfortunately is not high for a PhD *student!* At one Chinese university, I was denied at last notice to give a confirmed guest lecture to MPA students - where I hoped to recruit interviewees for my Q. The university administrators had found out I was *only a PhD student*.

[4] In Dutch: Hoogheemraadschappen or waterschappen

Table A. 4 Respondents in China

Category	Institution	Number of respondents
Governmental sector-Regional level	Water Resource Department in Hebei Province	10
Governmental sector- Local level	Dalian Water resource Department	8
Research institute	University	4

The Q-interviews in the Netherlands were held between April and Dec, 2009. The Chinese part of Q-methodology research was conducted between March and December, 2012. The whole interview would take between one and three hours, with the card sorting consuming about an hour. I did all interviews myself to avoid interference from different interviewers. Both in the Netherlands and in China, the Q-sorting technique feels a bit strange to the respondents; but after some experience and local adaptations, it works rather well in both countries. In the Netherlands, interviews commonly take place in offices. In China, diners and lunches work best – but these are not the best places to do a *Q sorting*. Hence, in China, I commonly did an interview over lunch / diner, while the respondent filled out my Q online later at home or in the office. In the Netherlands, all but five respondents used the card version of Q. In China, I only used the online Q tool, no respondents used the cards. My feeling was that they would have found the cards childish. When respondents agreed to see me in their office, I brought my lap top and let them fill out the Q digitally. I considered developing my own Q tool that could run on a *tablet* – still a great idea that could *gamify* the Q method– but too much effort for the limited number of interviews I needed to do.

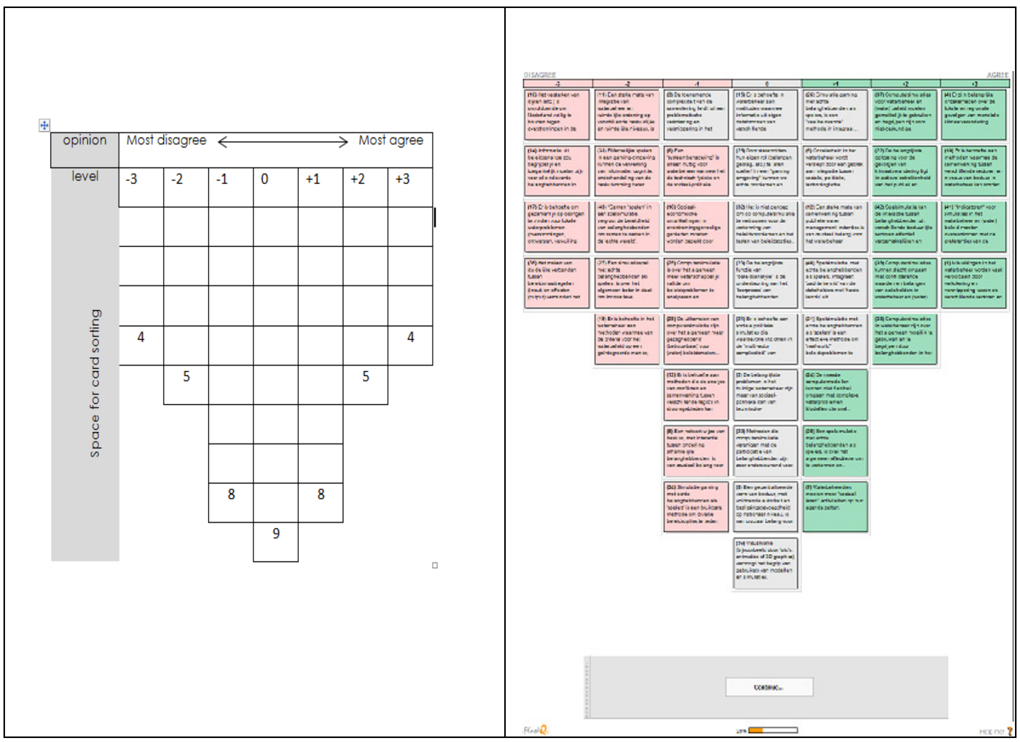
All interviews were fully transcripted. In the Netherlands I noted down the end-result of the Q sorting when the respondents were done, and later in my office inserted the data into the Q-software. The Q ranking processes in China was done with the *Flash Q-software.* The results were stored digitally on my lap top and later transferred to my results database. At the end of the interview, respondents were asked to answer some questions related to their professional affiliation, their expertise, and knowledge about MSG and additional things if there were any (see appendix B). I coded all additional information and inserted the data into one database.

Some respondents may initially have felt lack of interest for a PhD, the topic or the Q, but overall, the interviews were done in a good atmosphere. It was my impression, that when I left, the interviewees had become to appreciate the topic, the interview and the card sorting.

The 'Q-sorting'

After some introduction of interviewer, objective and technique, the respondent is asked to read (aloud) the statements on the cards and subsequently rank the cards in a *quasi-normal distribution*. Normally, the rule is to rank all cards on a scale from -3 to +3 (used in this study). The range of the scale depends upon the number of statements; the numbering of the scale depends upon the topic and question. The number of the cards that need to be assigned to each number on the scale is fixed to a quasi-normal distribution, with a minimum number of cards at the extremes and majority of cards in the middle. Table A.5 gives an impression of a quasi-normal distribution as in this research in paper-based form (left) and as digital interface (right). The procedure is easy and fun to do. I asked all respondents to talk aloud during the process, explaining me what the statements implied in their view, and why they ranked them as they did. Respondents are allowed to make changes until they indicate that they are done.

Figure A. 1 Card sorting examples



Analysis

The results are analysed with factor analysis, supported with the software *PQ Method*.

With the factor analysis (Varimax rotation) I grouped respondents with the same answer patterns together. The factor analysis extracts factors on two layers: a frame about integrated water management and a frame about Modelling, Simulation and Gaming. The results have been discussed in Chapter Four.

The analysis for the Chinese case and the Dutch case was done in exactly the same fashion; but of course with separate sets of data. The factor loadings for the Netherlands and Chinese case are presented in appendix B, tables B.1 and B.2.

Interpretation

The Q method is not a rigid statistical method; it is used as a structured approach to interviews, to give some empirical backing to the reconstructed frames and arguments. In this manner the *Toulmin method* has been used in Q analysis (Toulmin, 1958). According to the Toulmin method of *argumentation analysis* a proper argument consists of a *claim* or conclusion, the *data collection*, the *reasons* to support the argument (the so-called *warrant* and *backing*), the *qualifier* and the *evidence* (Raadgever, Mostert, & van de Giesen, 2008; Toulmin, 2000). The data supporting the claim must be collected from the analytical samples that represent the population. The stated reasons are the warrant that can explain the data. The warrants need to be supported by backing such as statistic data, examples, witnesses or professional testimony, and any other forms of so called 'non-rhetorical means of persuasion'. These are the evidence to make the stated reason strong and convincing. To use what form of backing to support your stated reason depends on the nature of the argument itself. In the Q methodology, the backing consists scores of the statements related to the different conclusions (the factors), and the conversation with the loadings (the people that most correlated to one of the factors). The qualifier is the situation under 'probably' or 'unless' that make up a rebuttal condition. An argument is then constructed as an arguable statement with all these elements, which states the relations between the different type of stakeholders and the different usefulness of game. Now with these two studies the matrix can be filled with the insights of water managers perspectives on the usefulness of SG, and what different meaning it has in different policy environments as the outcome of the studies in the Netherlands and in China.

Game-based, quasi-experiment

Opportunity for a game experiments

An opportunity to observe a game experiment on the topic of Marine Spatial Planning emerged just before the summer of 2011. The serious gaming research group of Delft University (Delft, the Netherlands) was requested to contribute to the development and running of a simulation game on the topic of MSP at the joint HELCOM-VASAB, OSPAR, and ICES workshop, Lisbon Portugal 2-4 November, 2011. We had around three months to develop the game; and no time or resources for testing. The workshop was prepared by a planning group consisting of three representatives from ICES, one from HELCOM and two from OSPAR. The three-day program of the Lisbon workshop included presentations, group discussions and reflections based on a case (1st day), a simulation-game including debriefing on the 2nd day, and an after action review on the 3rd day. Following the success of the Lisbon game, the game was subsequently played again in a master class on MSP in the Dutch town of Leeuwarden on October, 31, 2012; and with 60 marine spatial planners from the Nordic countries in Reykjavik, Iceland, in November 2013.

The Netherlands' Ministry of Infrastructures and Environment (I&E), commissioned and financed the design and facilitation of the simulation-game on behalf of the international organizing committee. To have a first overview of the policy environment in marine spatial planning, a brief literature review was done. I soon found that integration in the field of MSP is even more important and less clearly defined than in terrestrial planning or water management.

My role in the team

There is probably only one way to use games as a research method and that is *in a team*. Apart from the fact that very few people have the skills, competences and resources to design, program, organize, run and evaluate a game, the solo'ing of an academic researcher has a high chance that the end-result will be irrelevant. A policy game is a *contextualized intervention* – it is not the game makers who have a policy problem, they are just enablers for someone willing to act as client or sponsor.

This makes academic PhD research into policy games complicated. The PhD researcher can observe the game project, as an outsider, and report the findings later. But then there is little influence on how the project goes – stakeholders may find the researcher irrelevant or even a nuisance to the project. The researcher can also become an integral part of the team. Then, in the turbulence of the project, intellectual ownership over ideas and results becomes messed up: the game is a collaborative design. Nevertheless, I decided to be part of the team – participating actively in all meetings, contributing to the game design with specific tasks, helping to organize and facilitate the game. I tried to not become too much absorbed in the game design process that my research would be delayed or compromised. Hence, I played the role of *journalist* during the actual game-play, and I made a video registration of the whole event. With regard to the data-collection, I constructed the questionnaires and did parts of the analysis. Questionnaires needed to be validated and approved also by the organizers ICES, OSPAR, HELCOM and VASAP of the event where the game was played. The construction of the questionnaire (see appendix D) went through several iterations and modifications within the team.

The game design

The actual design of the game (Duke & Geurts, 2004a; Duke, 1974b, 1975, 1980; Fullerton, Swain, & Hoffman, 2008; Toth, 1988a, 1988b; Wenzler, 1997)took place between August and November 2011. This involved the detailed analysis of the MSP system and practices (Geurts, Wenzler, & van Kuppevelt, 1993), the analysis and adaptation of data on the Baltic sea, consultations with the client and organizing committee, the design and production of the game material, the planning of logistics (as the game needed to be played in Lisbon with an imprecise number of international participants) and most of all, the design and programming of the digital map software that would play a significant role in the game. The digital map software uses simplified data and interface inspired from the scientific research in the HARMONY project.

Study design

Data were gathered through pre-game, in-game and post-game observations, both quantitative by means of online and paper questionnaires (Weedon, 2013) and logging of computer data (Drachen, El-Nasr, & Canossa, 2013; Plass et al., 2013), as well as qualitative observations in the form of video registrations and in-game participant interviews (Mayer et al., 2014; Mayer, Bekebrede, et al., 2013). Table A.6 gives an overview of the data gathering.

Table A. 5 Overview of data gathering

When?	Pre-game	In-game				Post-game
Observation number	O1	O2	O3	O4	O5	O6
How?	Online survey	Paper questionnaire	Paper questionnaire	Paper questionnaire	End of game debriefing	Online survey
What?	Soc. Dem.					Analysis of maps
	Involvement in MSP	MSP process	MSP process	Influence	After action review	
	Knowledge in MSP					

	Influence in MSP	Game play				
	MSP in country	Emotions				
Response	112	50	40	41		70
Additional data gathering		Video registration – Observation – Data logging				

Taking the Lisbon game as an example, about one week before the game session, we distributed an online questionnaire to all persons who registered for the workshop. Around seventy-three persons started up the online system, but not all of them inserted information or completed the questionnaire. Around forty-five filled out the questionnaire before turning up at the conference registration desk the first day. Those who had not filled out yet, were urgently requested to do so before the next morning when the game would start, increasing the total number of valid respondents to sixty-three including people involved in the organization of the conference. The second day – the actual game day held in the impressive Marine Aquarium in Lisbon – sixty-eight people turned up and nearly all had completed the questionnaire. Some participants turned up a little later, and/or without registration, and a few left early, explaining differences in numbers and a slight non-response.

Questionnaire for the in-game measurement (O2) was filled out by around fifty participations in the three sessions – a sheet of paper was distributed among the players around 11.00 h. with some questions on the MSP process in the game. This was repeated at 15.00 h. (O3) and 19.00 h. (O4) with responses around forty participants. The drop in response can partly be explained by the fact that some eight MSP experts were involved in co-facilitating the game – e.g. as a journalist, country facilitator, etc. and did not fill out in-game questionnaires. Immediately after the game, we send out another online questionnaire (O6) through e-mail, promising everybody that after filling it out, they would receive some PR documentation about the game, and internet links to a video and photo impression of the game-day. After two weeks, 38 participants had filled out the last questionnaire. Furthermore, an extensive after action review (O5) was held between 18.00 and 20.00 on the actual game day, followed by a more in-depth concluding session facilitated by the conference organization and experts, during the morning of the third day. Much of the qualitative conclusions about MSP were formulated, based on, and in terms of the game-experience. The participant coming from Canada did not fill out country specific information (and therefore discarded in detailed analysis), one respondent filled out information for the EU as a whole and one for the Baltic. One of the most significant problems was the 'falling response' in the series of six questionnaires given to the player-participants before, during and after the game. Every effort was made to keep the measurement process as unobtrusive and easy as possible, but the expected drop in response rate occurred nonetheless.

The game was designed for the Lisbon workshop for around 70 participants and 68 actually started. Of them, about 50 were active throughout day and about 40 completed all or almost all the questionnaires. Some of the respondents did not answer all the questions in the pre-game or post-game survey for various reasons, thus generating 'missing' values. In the end, 32 respondents provided a complete set of valid data for all measurements (O1-O6). We also noticed that although all the player-participants had a professional affiliation with MSP, not all considered themselves very knowledgeable about how it was practised, even in their own countries. Many did not believe themselves to be very influential and some commented that MSP in their country was at an early stage of development and that they were just delving into the issue. The experience from the Lisbon game and the other two game sessions shows that setting up the game and making sure that it was engaging, whilst at the same time using it to gather a large amount of reliable data, is challenging. The game session in Leeuwarden, the Netherlands, unlike the Lisbon session, was short (4 hours) and had objectives and characteristics of a professional training. Data collected through the pre-questionnaires about the level of integration in the respective countries, are therefore used, but not the in-game data. In the third game session in Reykjavik, Iceland, the game was played by around 60 policy makers from the Nordic countries, as part of a two day workshop commissioned by 'Havgruppen' (transl., marine group) under The Nordic Council of Ministers (Nordic Council of Ministers, n.d.). Within the three game sessions, one hundred and twelve fifty filled out the pre-game online survey, and seventy for the post questionnaires (see Table A.6 for exact numbers).

From the outset, it was clear that the majority of the participants in the three game sessions were very committed to MSP, as well as to the workshop and the game. This facilitated the acquisition of valuable information about and insight into the MSP process (as set up in the game). It also explains the high level of intrinsic motivation amongst the participants (see Table D.3 in appendix D).

The data presented here therefore gives an indication of perceptions – best judgements – of the state of MSP as provided by participants from the various countries concerned, rather than a well-represented, validated judgement. In other words, the data provided here is based on the views of participants in the three game sessions and does not represent the entire population of MSP practitioners; however, it does provide a valuable insight into the current state of play in the evolution of MSP in

Europe. A further shortcoming in this approach, of course, is that the experts were asked to assess the countries for which they have the most expertise – often their own – and were not requested to score MSP in, or by comparison with, other countries. Moreover, cultural, psychological and cognitive factors are likely to have influenced the overall scoring process. Nevertheless, we believe that the results are interesting and we have conducted reliability tests where possible and relevant.

User-based validity of the game

The participants evaluated the game design as 'good' or 'very good'. In other words, they described it using such terms as clear, well-led and straightforward (see tables D. 4-6 in Appendix D). The game content and reality model were evaluated as sufficiently detailed and realistic (table D.4). The computer-based map tool was easy to operate, with few malfunctions (table D.6). In general, the participants found the game engaging and enjoyable, as illustrated in the following quotations:

> I would encourage countries to play this game with the stakeholders in their own countries. I have been involved in marine spatial planning at both the national and international levels for many years now, but I probably learned more about planning in one day than I have in a long time (UK participant).
>
> It was stressful, maybe because we had so little time and because I didn't read enough beforehand, so I was quite lost in the beginning. It began to feel funnier in the second part of the day. The MSP tool was of great help (Finnish participant).

Participants had high intrinsic motivation (Guay, Vallerand, & Blanchard, 2000; Lepper & Malone, 1987; Malone & Lepper, 1987). Their attitude towards computer simulations and decision support was fairly positive and they felt that gaming could also be supportive of decision-making. The computer tool was easy to operate, with few malfunctions. In general, the participants found the game engaging and enjoyable. The participants reported a moderate learning effect in terms of insights (3.6-4.0 out of 5; see tables D. 7-10 in Appendix D). I also found several coherent factors, specifically insights into: (1) the political complexity of MSP; (2) multi-level governance; (3) science and models; and (4) attitudes towards MSP. It appears that players became more interested in MSP and gained some good ideas to take home. Most scales for profiling MSP had high reliability scores (0.9 Cronbach's α).

The idea of using the participants in a policy game as a panel of experts generates food for thought and discussion. Expert judgement on complex policymaking is not an uncommon approach and is, for instance, used in the *Delphi method* (Gordon, 2002). What's more, our generated method of profiling the countries through expert judgement can be repeated with a larger set of respondents and/or countries. More sessions with the MSP Challenge game are foreseen in the near future and we will continue to gather data in the same fashion, thereby expanding the original dataset. We believe that the triangulation of methods – survey and experiment, self-reported and observed, stated and revealed, quantitative and qualitative – makes a game-based experiment particularly interesting and valuable in a policy context.

Analysis

The quantitative data acquired from the participant survey (O1-O6) as well as the data from the four digital maps of the game-countries (see below) were put into SPSS for statistical analysis. The descriptive results of the analysis were subsequently given to the conference organizers and clients, and more detailed analysis is used for scientific and policy purposes.

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MSP planning game study have previously been published with co-authors as: Mayer, I. S., Zhou, Q., Lo, J., Abspoel, L., Keijser, X., Olsen, E., Kannen, A. (2013). Integrated, Ecosystem-based Marine Spatial Planning: Design and Results of a Game-based Quasi-Experiment. *Ocean and Coastal Management*, *82*, 7–26. doi:dx.doi.org/10.1016/j.ocecoaman.2013.04.006

Appendix B. Analytical Results of Q Methodology

This appendix presents the data and analytical results of Q Methodology in the Netherlands and in China. It consists of the Q statements, factor scores, factor loading and the background of the respondents in each factor.

Data and analytical results of Q Methodology in the Netherlands

Table B. 1 Q Statements and factor scores in the Netherlands

Number	Statement	F1	F2	F3	F4	F5
1	Failures in water management are frequently caused by compartmentalization and fragmentation among different sectors and levels of governance.	-1	-1	-1	-2	-1
2	The key problems in water management 'today' are more social-political than technological-infrastructural in nature.	-1	+2	-2	-1	+3
3	The increasing complexity of society leads to a problematic compartmentalization and fragmentation in water management.	-2	-3	0	-2	+2
4	There are significant uncertainties about the local and regional impacts of global climate change.	-1	-2	-1	+3	0
5	Uncertainty in water management is deepened by a lack of integration among social, political, technological, ecological, economic, (etc.) knowledge.	-3	0	-2	-1	0
6	A 'system approach' is useful for water management only when it addresses the technical-physical and social-political aspects in an integrated fashion.	0	-1	0	+2	-1
7	Water managers should set more 'social learning' activities on their agenda.	-3	+1	0	0	-1
8	A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	0	-3	-2	-3	-1
9	A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+1	+2	-1	+3	+2
10	There is a need for methods that can enhance the co-operation among different sectors and levels of governance in water management.	+1	+1	+1	+1	-1
11	A strong degree of integration of water management and spa-	+3	+2	-1	+3	0

	tial planning at different administrative and spatial levels is crucial for water management.					
12	A strong degree of co-operation among public water management authorities is crucial for water management.	+2	0	0	+3	+3
13	There is a need for methods that can analyze the conflicts and co-operation among different regions in river basins.	+1	0	+1	0	-2
14	Information from policy analysis should be understandable for and accessible to, all relevant stakeholders in water management.	+1	-1	0	+2	0
15	There is a need in water management for methods that can bring together the information from proprietary data sources of different stakeholders.	0	-1	0	0	-2
16	Reinforcing levees (dikes) etc. is insufficient to keep the Netherlands safe from flooding in the 21st century.	+3	-1	-2	-1	-3
17	There is a need to collaboratively find local solutions to water problems (flooding, draughts, pollution etc.).	+2	+1	+1	+2	0
18	Socio-economic developments in flood prone areas should be mitigated through spatial planning and construction regulation.	+3	0	+1	0	0
19	The methods for water policy analysis should integrate quantitative and qualitative criteria.	+2	0	-1	0	-1
20	Methods that combine computer-simulation with stakeholder participation are highly supportive for water management.	0	+1	+2	0	+2
21	There is a need for social political simulations that provide valuable insights in 'multi actor complexity' of water management.	-1	+1	+1	-1	+2
22	The key solution to the consequences of climate change lies in active public involvement and stakeholder participation. 'Societal interaction' provides the most significant contribution to water management and policy making in the near future.	+2	+3	-3	-3	-2
23	The key function of 'policy analysis' is to support the stakeholders' learning process.	-3	-2	+3	-3	0
24	Most computer models are not flexible enough to deal with complex water problems. Models that can be quickly developed and changed for different circumstances are needed.	-2	-2	+3	+1	+1
25	By letting stakeholders 'play' their own role (interests, behaviour, etc.) in a 'gaming environment' we can simulate real problems and solutions in water management and derive valuable insights for water policy-making.	0	-1	+1	+2	+1
26	Simulation gaming with real stakeholders as players is a 'promising' method in integrated water management and policy making, but the transition will take very long.	-1	-2	0	-1	-2

27	Simulation gaming with real stakeholders as players is a better strategy for the innovative process than using computer simulations in integrated water management.	0	0	+2	-2	-1
28	The outcomes of computer-simulation are generally more authoritative (trustworthy) for (water) policy makers and (water) managers than the outcomes of a simulation-game with real stakeholders.	-2	-2	-3	-1	-3
29	Rational thinking should always be combined with human emotions in policy analysis for integrated water management.	+1	0	-2	+1	+2
30	A simulation-game with real stakeholders as players is generally more effective to foresee and analyse what can happen in the near future than a computer-simulation.	-1	+1	+3	-2	+1
31	Policy simulation does not need to be computerized. 'Low technology' gaming based on human behaviour is also a scientifically proven method for water policy analysis.	-2	+3	+2	-1	-1
32	It is not enough to rely on computer simulation for the exploration of policy problems and testing of policy options (even they have been developed on the basis of best-available scientific knowledge).	0	+2	0	0	0
33	The process of decision making simulated by human players in a gaming environment is generally more useful for learning than for real policy analysis.	0	0	+1	-3	-2
34	Testing various policy options in a safe environment (such as simulation gaming with real stakeholders as 'players') is crucial to avoid serious consequences of water policy making to the 'real-world'.	-1	-1	+2	0	+1
35	Inviting stakeholders to provide their own policy actions as model inputs is a good strategy to reduce the 'black box' problem of simulation models in water management.	-1	+1	-1	+1	0
36	Visualization (e.g. by pictures, animations or 3D graphics) significantly increases the users' understanding of models and simulations.	+3	+2	0	+1	+3
37	Computer simulations for water management and (water) policy making should be easy to use and understand by non-expert users.	+1	-3	-3	0	+1
38	Computer simulations in water management are generally difficult to use and understand by policy stakeholders.	0	+1	-1	-1	-3
39	Computer simulations can accommodate poorly with conflicting values and interests of stakeholders in water management and (water) policy.	-3	-1	-1	-2	0
40	Simulation-gaming, with real stakeholders as players, integrates 'soft knowledge' from stakeholders with 'hard knowledge' from scientific research.	+2	0	+2	+1	+1

41	'Indicators' for simulations in water management and (water) policy should reflect the preferences of the stakeholders.	+1	-2	+1	+1	-3
42	Simulation-gaming can effectively facilitate and support the interaction among stakeholders from different governance sectors.	+1	+3	+3	+2	+1
43	'Playing' together in a simulation-game increases the stake-holders' willingness to co-operate in the 'real world'.	-2	+3	-3	+1	+1

(P < .05)

Table B. 2 Correlation between Q-sorts and factor loadings-NL

Q-sort	Loadings				
	1	2	3	4	5
P1	0.1175	0.0377X	0.3736X	0.1238	-0.0110
P2	-0.0931	0.5702X	0.1296	0.1011	0.0255
P3	0.2867	-0.1709	0.3205	0.6604X	0.0794
P4	0.3769	0.1978	-0.1287	0.5432X	0.0719
P5	0.4022X	0.3899X	-0.0889	0.2228	-0.1262
P6	-0.1225	0.0406	-0.0780	0.4878X	0.0089
P7	0.1230	0.0879	0.1249	0.3751X	0.0415
P8	0.1559	0.1242	-0.0536	0.6454X	0.0991
P9	-0.2446	0.4090X	0.0357	0.0180	0.4325X
P10	0.5098X	0.1511	0.0652	0.3686	0.0528
P11	0.0310	-0.0489	0.0152	0.2732	0.3817X
P12	0.2038	0.5087X	0.3340	0.0342	0.0853
P13	0.0728	0.0537	0.0766	-0.0306	0.4206X
P14	0.0007	0.1398	0.1494	-0.0275	-0.0177
P15	0.0803	0.2937	-0.0727	0.4073X	-0.2567
P16	0.5801X	-0.1088	-0.2178	0.1266	0.0139
P17	0.0952	0.5175X	-0.0521	-0.0089	-0.1651
P18	-0.5628X	0.2838	-0.0187	-0.0088	0.1647
P19	-0.0934	-0.1292	-0.1842	0.1690	0.5155X
P20	0.3380X	0.1839	-0.2524	0.3472	-0.1654
P21	0.4933X	0.1630	0.0719	0.1573	-0.1943
P22	0.5501X	0.3601	0.1115	0.2106	0.0196
P23	0.1294	0.3763X	0.0441	0.3224	0.1921
P24	0.0252	0.4814X	-0.1273	0.0318	0.0162

P25	0.0508	0.1916	-0.1632	-0.2071	-0.0420
P26	0.2298	0.2520	-0.3339	0.2458	-0.0790
P27	0.4046X	0.1844	-0.0554	-0.0336	0.1345
P28	0.6487X	-0.1267	0.1731	-0.0925	-0.2539
P29	0.3868X	0.0794	-0.1270	0.1926	-0.4284
P30	0.5978X	0.0891	0.1459	0.0854	0.1748
P31	-0.3015	0.1886	0.5118X	0.2684	-0.1359
P32	0.0407	0.3736X	0.0461	0.1333	0.0011
P33	0.0546	-0.0632	0.6809X	-0.1297	0.0966

Table B.3 to B.7 present the relevant background of the respondents in the five factors and their attitude towards the use of gaming for policy analysis, from the questionnaires distributed in the interviews.

Table B. 3 Frame 1–NL

No. of Respond spond-ent	age	Institu-tion	Position	Expertise [5]	Gaming ex-perience	General trustworthi-ness of gaming-simulation
5	36	National govern-ment	Senior advisor projects RWS	1,2	yes	high
10	51	Consul-tancy	Advisor strategic management	1,2	yes	yes
16	53	National govern-ment sector	Director	1,2	yes	no
18	52	consul-tancy	Independent consultant	1,2,3,4	yes	As part of a larger analysis, it has high values. As a tool by its own the function is limited.
20	35	National govern-	Project manager	1,2	no	I believe only in mod-els for assist in deci-

[5] 1 = water management, 2 = policy making, 3 = computer science and modelling, 4 = simulation.

		ment				sion-making. Decision-making is a human activity based on scientific information.
21	48	National government	Technical manager	1,3	yes	if well set up and used can be useful for increasing the awareness (of urgency)
22	48	consultancy	Director secretary	1,2,3,4	yes	If coupled to models yes.
27	34	Provincial government	Policy advisor	1,2	no	Good if rightly explained and implemented.
28	46	Local government	Senior policy advisor	2	no	It is tool for opening mind. I would very much like to try it.
29	44	Local government	Environmental manager	1	no	no
30	37	Local government	Policy advisor	1	no	It will open mind. I am curious to see what it can bring.

Table B. 4 Frame 2–NL

No. of Respondent	age	Institution	Position	expertise	Gaming experience	General trustworthiness of gaming-simulation
1	42	Water board	Economics for water management	1,2	yes	Players are the key. If the players play right, the outcome of game is trustworthy.
2	48	Research institute	Senior research scientist	2,3,4	yes	Good and positive
5	36	National government	Senior advisor projects	1,2	yes	high
9	50	consultancy	Senior advisor projects	1,2,3,4	yes	I trust it, but think it is an expensive tool, that still needs a lot of efforts to make it work in the real process
12	38	consultancy	Advisor; consultant; process manager	1,2	yes	helpful and useful; not ‘holy’ and the ‘one and only’
17	32	Local government	Urban water management advisor	2	yes	You always have to remain a bit critical but generally, their trust-

						worthiness is quite high.
23	36	consultancy	Consultant	2,4	yes	Yes, in learning and designing policy
24	34	Water board	Policy Advisor for interactive planning	1	yes	The outcome can be used for reflection, not directly to solve real time urgent, direct projects.
32	44	Water board	Senior policy advisor	1,2	no	

Table B. 5 Frame 3–NL

No. of Respondent	age	Institution	Position	expertise	Gaming experience	General trustworthiness of gaming-simulation
1	42	Water board	Economics for water management	1,2	yes	Players are the key. If the players play right, the outcome of game is trustworthy.
31	30	Local government	Assistant project manager	1	no	Average
33	32	Water board	Advisor on Hydrology, in knowledge and advice department	3	yes	Simulation gaming can be very useful at the early stage of spatial planning, to understand each other's' standing point and to discuss - analyze the opportunities.

Table B. 6 Frame 4–NL

No. of Respondent	age	Institution	Position	expertise	Gaming experience	General trustworthiness of gaming-simulation
3	57	Research institute	Senior research scientist	1,2	yes	yes
4		National government	Top policy advisor	1,2	no	yes
6	36	Research institute	Senior researcher; consultant water management and environmental modelling	1,3	yes	they can give useful results for the purpose for which they are made; I think they can be used for: screening of strategies; find consensus;

						find new solution together with stakeholders
7	55	Water board	Policy maker	1,2	no	yes
8	53	Provincial government	Project manager	2	no	no
15	28	National government	Policy maker	1,2,3	yes	good for general ideas and understanding the process

Table B. 7 Frame 5–NL

No. of Respondent	age	Institution	Position	expertise	Gaming experience	General trustworthiness of gaming-simulation
9	50	consultancy	Senior advisor projects	1,2,3,4	yes	I trust it, but think it is an expensive tool, that still needs a lot of efforts to make it work in the real process
11	62	Research institute	Water resource specialist	1,3	yes	I believe in models
13	32	consultancy	Consultant	4	yes	yes
19	54	Provincial government	Programmer director	1,2	yes	I doubt the trustworthiness a bit

Data and analytical results of Q Methodology in China

Table B.8 presents the Q statements used in the Q Methodology in the Chinese IWM case. The first column No-NL (in grey) in the table shows the number of the Q statements. The Dutch Q statements presented in lighter grey colour are those that didn't use in the Chinese case. The readers can get a clear view of the relationship of these two sets of Q statements in this table. The methodological justification of the modification of the Q statements in different context can be found in Appendix A: Research Design and Methodological Justification.

Table B. 8 Q Statements and factor scores in China

No-NL	No-CH	Statement	F1	F2	F3	F4

1	1	区域（流域）管理中出现的问题常常是由于多部门的责任分散以及缺少协作机制造成的。 Failures in water management are frequently caused by compartmentalization and fragmentation among different sectors and levels of governance.	0	-2	+1	-1
2	2	相比起发展科学技术及基础建设，公共政策及政府管理的有效性在区域（流域）管理中显得更为关键。 The key problems in water management 'today' are more social-political than technological-infrastructural in nature.	+2	-2	+1	-1
3	The increasing complexity of society leads to a problematic compartmentalization and fragmentation in water management.					
4	3	全球气候变化对不同区域或流域造成的影响存在很多的不明确性。 There are significant uncertainties about the local and regional impacts of global climate change.	0	+1	+2	-1
5	4	区域（流域）管理中的不确定性由于缺乏对社会，政治，科技，生态，经济各方面知识的综合运用显得更为突出。Uncertainty in water management is deepened by a lack of integration among social, political, technological, ecological, economic, (etc.) knowledge.	0	+2	-1	-2
6	5	在区域（流域）管理中运用“系统分析方法”需要着眼于对社会政治及科学技术的综合分析。 A 'system approach' is useful for water management only when it addresses the technical-physical and social-political aspects in an integrated fashion.	+1	+2	0	0
7	Water managers should set more 'social learning' activities on their agenda.					
8	6	集中的国家政府管理形式，确保足够的权威和决策权，是实现区域（流域）综合管理的关键。 A centralized form of governance, with sufficient authority and decision power at the national level, is crucial for water management.	+2	+2	-2	0
9	7	建立网络型的政府管理形式，使得各个部门之间能够利益共享，相互依存，共同协作，是实现区域（流域）综合管理的关键。 A network type of governance, with interaction between interdependent stakeholders, is crucial for water management.	+1	+1	+1	+1
10	8	我们需要找到更好的方法来促进跨部门，跨地区和跨领域合作。 There is a need for methods that can enhance the co-operation among different sectors and levels of governance in water management.	+2	-1	+2	+1
11	A strong degree of integration of water management and spatial planning at different administrative and spatial levels is crucial for water management.					
12	A strong degree of co-operation among public water management authorities is crucial for water management.					
13	9	我们需要找到更好的方法来分析区域（流域）中不同地区之间的冲突	0	+1	+1	-1

		和潜在的合作关系。 There is a need for methods that can analyse the conflicts and co-operation among different regions in river basins.				
14	10	政策分析应该为所有利益攸关方提供容易理解及获取的信息。 Information from policy analysis should be understandable for and accessible to, all relevant stakeholders in water management.	+2	-1	-1	0
15	11	我们需要在区域（流域）管理中找到更好的方法将各个利益攸关方拥有的信息资源加以综合运用。 There is a need in water management for methods that can bring together the information from proprietary data sources of different stakeholders.	+1	-1	-1	-2
16	Reinforcing levees (dikes) etc. is insufficient to keep the Netherlands safe from flooding in the 21st century.					
17	There is a need to collaboratively find local solutions to water problems (flooding, draughts, pollution etc.).					
18	12	水灾易发地区的社会经济发展，应当通过空间规划和建设监管得以减轻。 Socio-economic developments in flood prone areas should be mitigated through spatial planning and construction regulation.	+1	0	-1	-1
19	13	区域（流域）的综合政策分析应该使用定量及定性结合的分析方法。 The methods for water policy analysis should integrate quantitative and qualitative criteria.	+2	+2	-1	0
20	14	结合电脑模拟和利益攸关人参与的分析方法对支持区域（流域）管理非常有效。 Methods that combine computer-simulation with stakeholder participation are highly supportive for water management.	0	0	0	0
21	15	我们需要更多的使用社会政策模拟方法来研究流域（区域）管理中利益攸关方之间的复杂决策问题。 There is a need for social political simulations that provide valuable insights in ‘multi actor complexity’ of water management.	+1	+2	+2	+1
22	16	“公众参与”对区域（流域）管理中制定应对气候变化的长期策略提供最重要的贡献。 The key solution to the consequences of climate change lies in active public involvement and stakeholder participation. ‘Societal interaction’ provides the most significant contribution to water management and policy making in the near future.	-1	-1	-2	-1
23	17	政策分析”的关键是支持利益攸关人的学习及提高能力的过程。 The key function of ‘policy analysis’ is to support the stakeholders’ learning process.	-2	-1	-1	-1

24	18	大多数现有的电脑模型不能够灵活的分析复杂的区域（流域）管理问题。我们需要开发可以在不同的问题类型中迅速灵活运用的模型。 Most computer models are not flexible enough to deal with complex water problems. Models that can be quickly developed and changed for different circumstances are needed.	-1	0	+2	0
25	19	通过让利益攸关人在模拟的环境中"扮演"自己在真实世界的的决策行为（实现利益，做出决定等），我们可以再现在管理中出现的实际问题和解决方案，并从中获得对制定决策提供帮助的宝贵见解。 By letting stakeholders 'play' their own role (interests, behaviour, etc.) in a 'gaming environment' we can simulate real problems and solutions in water management and derive valuable insights for water policy-making.	-2	0	0	+2
26	20	邀请真实的利益攸关人参与的游戏模拟，是在区域（流域）管理中非常有前景的分析方法。但是推广使用会需要很长的时间。 Simulation gaming with real stakeholders as players is a 'promising' method in integrated water management and policy making, but the transition will take very long.	0	+1	0	0
27	21	在区域（流域）管理中，真实利益攸关人参与的游戏模拟是比电脑模拟更为创新的管理决策分析方法。 Simulation gaming with real stakeholders as players is a better strategy for the innovative process than using computer simulations in integrated water management.	-1	0	0	+2
28	22	对于决策者来说，计算机模拟的分析结果比利益攸关人参与的游戏决策模拟的分析结果更为权威和值得信赖。 The outcomes of computer-simulation are generally more authoritative (trustworthy) for (water) policy makers and (water) managers than the outcomes of a simulation-game with real stakeholders.	+1	-2	-2	-2
29	23	在区域（流域）管理中，科学的政策分析也必须始终包括人为因素的影响。 Rational thinking should always be combined with human emotions in policy analysis for integrated water management.	+1	+1	-2	+1
30	24	相比起电脑模拟， 真实利益攸关人参与的决策游戏模拟能够更为有效的预见和分析长远规划中可能发生的问题。 A simulation-game with real stakeholders as players is generally more effective to foresee and analyse what can happen in the near future than a computer-simulation.	-1	-1	0	+1
31	25	决策游戏模拟不一定需要电脑技术支持。"低技术"的决策游戏也可以用来进行有效的科学分析。 Policy simulation does not need to be computerized. 'Low technology' gaming based on human behaviour is also a scientifically proven method for water policy analysis.	-2	-2	+1	+1

32	26	在区域（流域）管理中，仅仅依靠电脑模拟来探索可能存在的决策问题和决策方案是不够的（即使所使用的电脑模型是用当前最先进的技术开发的）。 It is not enough to rely on computer simulation for the exploration of policy problems and testing of policy options (even they have been developed on the basis of best-available scientific knowledge).	0	+1	+1	+1
33	27	相比于作为真正的决策分析方法，游戏模拟更适合于提高综合决策能力的学习过程。 The process of decision making simulated by human players in a gaming environment is generally more useful for learning than for real policy analysis.	-1	+1	+2	-2
34	28	在游戏模拟中反复演绎各种决策的可行性可以非常有效的帮助避免在真实政策环境中实施这些决策可能产生的严重后果。 Testing various policy options in a safe environment (such as simulation gaming with real stakeholders as 'players') is crucial to avoid serious consequences of water policy making to the 'real-world'.	-1	0	0	-2
35	Inviting stakeholders to provide their own policy actions as model inputs is a good strategy to reduce the 'black box' problem of simulation models in water management.					
36	29	使用当前电脑游戏产业中的可视化技术，（比如图片，动画或三维场景等），可能有效的提高政策决策人对科学模型分析结果的理解和运用。 Visualization (e.g. by pictures, animations or 3D graphics) significantly increases the users' understanding of models and simulations.	0	0	+1	0
37	30	用于政策分析的电脑模拟应该便于让非技术专业的用户理解和使用。 Computer simulations for water management and (water) policy making should be easy to use and understand by non-expert users.	0	0	+1	0
38	Computer simulations in water management are generally difficult to use and understand by policy stakeholders.					
39	31	用电脑模拟不能很好的分析利益攸关人之间的利益与价值的冲突。 Computer simulations can accommodate poorly with conflicting values and interests of stakeholders in water management and (water) policy.	-1	-2	0	0
40	32	决策游戏模拟提供了一种可以将科学技术方面的“硬”知识和社会利益价值冲突方面的“软”知识进行综合分析的方法。 Simulation-gaming, with real stakeholders as players, integrates 'soft knowledge' from stakeholders with 'hard knowledge' from scientific research.	0	0	0	+2
41	'Indicators' for simulations in water management and (water) policy should reflect the preferences of the stakeholders.					
42	33	决策游戏模拟可以有效地促进和支持跨部门之间的协同合作。 Simulation-gaming can effectively facilitate and support the interaction	-2	-1	0	+2

		among stakeholders from different governance sectors.				
43	34	一起参与决策游戏模拟可以有效的增加利益攸关人在“现实利益”里的合作意愿。 ‘Playing’ together in a simulation-game increases the stakeholders’ willingness to co-operate in the ‘real world’.	-2	0	-2	+2

($P < .05$)

Table B. 9 Correlation between Q-sorts and factor loadings-CH

Q-sort	Loadings			
	1	2	3	4
P1	-0.1859	0.0465	0.6769X	0.1445
P2	0.3192	0.0584	0.1358	-0.0868
P3	0.3172	0.1975	0.4089X	0.0345
P4	-0.0281	-0.0098	0.6137X	0.0582
P5	0.2975	0.5743X	0.1204	-0.0897
P6	0.0302	-0.3043	-0.0123	-0.0913
P7	0.7545X	-0.0064	-0.1515	0.0127
P8	0.1173	-0.4186	0.4503 X	0.3452
P9	0.3957 X	0.3792 X	0.0737	-0.3855
P10	0.3962 X	-0.3637	-0.0104	0.3914 X
P11	0.7314X	-0.2580	-0.0151	-0.3654
P12	0.7785X	0.1567	-0.1058	-0.1770
P13	-0.2270	0.0468	0.1931	0.5148X
P14	0.7301X	0.1912	-0.1555	-0.0524
P15	0.5220X	0.1102	0.2289	0.1326
P16	-0.0499	0.1074	0.0592	0.7026X
P17	0.1688	-0.2853	0.1410	0.3879X
P18	0.8504X	-0.0702	-0.0196	0.0013
P19	0.7535X	-0.0438	-0.2185	0.1062
P20	0.6994X	-0.1826	0.3139	-0.1845
P21	0.4721X	0.0680	0.0065	0.1829
P22	0.6565X	-0.1090	0.2088	-0.2359

Source: statistic report of this study from PQ-Method. Note: P1-P22=individual ranking, 1-4 = factors. Loadings marked with X are significant, with $p<.05$.

Table B.10 to B.13 present the relevant background of the respondents in the four factors and their attitude towards the use of gaming for policy analysis, from the questionnaires distributed in the interviews.

Table B. 10 Frame 1–CH

No. of Respondent	age	Institution	Position	Expertise	Gaming experience	General trustworthiness of gaming-simulation
7	57	Provincial water resource management department	Project director	2	no	neutral
9	41	Provincial water resource management department	Water manager management	2	no	neutral
10	40	Provincial water resource management department	Water engineer	2,3	no	Using models in analysis
11	44	Provincial water engineering research institute	analyst	2	no	interested
12	51	Provincial water resource management	Water manager	1	No, but heard about it	Used computer model to control the operation of the technical system.
14	55	Provincial water resource management	Director of technical department	2	no	
15	42	Provincial water engineering bureau	Director of research department	1	no	Must be useful
18	59	Provincial water engineering research institute	Senior researcher	1,2	no	Using computer model for data analysis
19	49	Provincial water resource management	Water engineer	1	no	
20	45	Local department of waterway management	Civil servant, water manager	1,2	No, heard about it	no
21	55	Provincial water engineering research institute	Senior researcher, scientist	1,2.3	No, heard about it	See the usefulness, willing to try if there is chance.
22	43	Local department of waterway management	Civil servant, water manager	1, 2	no	

Table B. 11 Frame 2–CH

No. of Respondent	age	Institution	Position	Expertise	Gaming experience	General trustworthiness of gaming-simulation
1	43	University	Researcher	1, 2,3	no	Positive about the usefulness in the future
3	46	University	Water researcher	2	no	Have no concrete idea
4	40	Local water department	Water manager	1, 2	no	Have no concrete idea
8	44	Provincial water resource management department	Water manager, analyst	2	no	interested

Table B. 12 Frame 3–CH

No. of Respondent	age	Institution	Position	Expertise	Gaming experience	General trustworthiness of gaming-simulation
5	36	University	University researcher	2	no	Using computer model for analysis
9	41	Provincial water resource management department	Water manager management	2	no	neutral

Table B. 13 Frame 4–CH

No. of Respondent	age	Institution	Position	Expertise	Gaming experience	General trustworthiness of gaming-simulation
10	40	Provincial water resource management department	Water engineer	2,3	no	Using models in analysis
13	39	Provincial water resource management department	Water management consultant	1, 2	no	Interested and has positive attitude of its future in China
16	51	Provincial water resource management department	Director of the provincial water department	1, 2	no	Interested, willing to try
17	55	Provincial water engineering research institute	Senior researcher	1,2,3	no	Interested, willing to try

Appendix C. MSP Challenge 2011 Questionnaires and Coding

MSP Challenge 2011 pre-game questionnaire

Table C. 1 Pre-questionnaire Background

(PVAG2)	What is your (active) e-mail address? (information used to relate pre- and post-game survey)	
(PVAG12)	What is your date of birth? (information used to relate pre- and post-game survey)	dd / mm/ yyyy
(PVAG6)	Are you male or female? (information used for general research purposes)	1. Male 2. Female
(PVAG32open)	What is your (first) nationality?	
(PVAG33_1 PVAG33_2 PVAG33_open)	Which of the following categories best describe your disciplinary (educational, academic) background? (max. 2 answers possible)	Humanities (arts, history, language, cultural studies, etc.) Natural sciences (mathematics, physics, chemistry etc.) Medical sciences (health sciences, biochemistry, biology, etc.) Engineering (civil engineering, architecture, aerospace, etc.) Social sciences (sociology, psychology, etc.) Fisheries Environmental, ecology Computer sciences (informatics, systems and operations research, etc.) Economics and business (Economics, MBAs etc.) Political and policy sciences (urban planning, political sciences, public administration, etc.) Legal studies (law, etc.) Other, namely…
(PVAG34)	In which societal sector do you (mainly) practice your profession?	Public sector (e.g. government, public administration, public policy advice etc.) Private sector (e.g. fishing, shipping, tour-

		ism, energy, consulting, etc.) Non-profit sector (e.g. science, NGOs, academia, etc.)
(PVAG35)	At which global-local scale are you mainly practicing your profession?	International (e.g. multinationals, UN, international NGO) Continental (e.g. Europe, Asia, America) National (e.g. country) Regional (e.g. province, department, states) Local (e.g. city, municipality) Sub local (e.g. neighborhood, city district)
(PVAG36_1 PVAG36_2 PVAG36_open)	Which of the following categories best describe your current (and main) professional occupation? (max. 2 answers possible)	Policy maker Resource manager Planner Scientific advisor Socio-economic advisor Applied researcher Consultant Politician Lobbyist Business person (e.g. sales, finance) Legal person (e.g. judge, lawyer, etc.) Engineer Artist Teacher / lecturer Other, namely …
(PVU1)	Have you also participated in the first Workshop on Coastal Marine Spatial Planning (WKCMSP) in 2010 (last year)	Yes / no / n.a.
(PVAG37)	How many years of professional work experience in the field of Marine/Maritime Spatial Planning, MSP do you have?	number
(PVES13)	To what extent are you knowledgeable about Marine/Maritime Spatial Planning, MSP?	I have minimal, or 'textbook' knowledge without connecting it to practice. I have working knowledge of key aspects of the area of practice. I have good working and background knowledge of the area of practice. I have depth of understanding of the dis-

		cipline and area of practice. I have authoritative knowledge of the discipline and deep tacit understanding across the area of practice.
(PVES14)	To what extent are you knowledgeable about marine ecosystems?	I have minimal, or 'textbook' knowledge without connecting it to practice. I have working knowledge of key aspects of the area of practice. I have good working and background knowledge of the area of practice. I have depth of understanding of the discipline and area of practice I have authoritative knowledge of the discipline and deep tacit understanding across the area of practice.
(PVES15)	To what extent do you have professionally involvement in actual MSP planning processes?	I am not, or hardly involved at all. I am involved in a few issues from time to time. I have quite some involvement in a few important issues. I have strong involvement in a number of important issues. I am deeply involved in a great many of important issues.
(PVES16)	How much personal and professional influence do you think you can exert in MSP in your country?	I have no / hardly any influence at all. I may have some influence on some issues. I can have quite some influence on a few important issues. I can have strong influence on a number of important issues. I think I can deeply influence a great many important issues.

Table C. 2 Pre-questionnaire Open

In which country are you predominantly practicing your profession in MSP? (PVAG38open)	open

Table C. 3 Pre-questionnaire MSP outcome

	MSP outcome								
1 PVPS19	National oriented	1	2	3	4	5	6	7	International oriented
2 PVPS20	Economy-based	1	2	3	4	5	6	7	Ecology-based
3 PVPS14	Short term thinking	1	2	3	4	5	6	7	Long term thinking
4 PVPS21	Interest-based	1	2	3	4	5	6	7	Evidence-based
5 PVPS22	Conservative	1	2	3	4	5	6	7	Innovative
6 PVPS23	uninformed	1	2	3	4	5	6	7	Well-informed
7 PVPS24	Disjointed	1	2	3	4	5	6	7	Integral consideration

Keeping in mind the country where you are predominantly practicing your profession (see Q above), how would you assess the outcome and process of Marine/Maritime Spatial Planning (MSP) in that country? Please indicate on the scales below, 1-7.

Table C. 4 Pre-questionnaire MSP process

	MSP process								
1 PVPS25	Centralized	1	2	3	4	5	6	7	Networked
2 PVPS26	Top down	1	2	3	4	5	6	7	Bottom up
3 PVPS27	Out of control	1	2	3	4	5	6	7	Well managed
4 PVPS28	Viscous	1	2	3	4	5	6	7	Decisive
5 PVPS10	Every man for him-self	1	2	3	4	5	6	7	Good cooperation
6 PVPS29	Contentious	1	2	3	4	5	6	7	Harmonious
7 PVPS13	Closed process	1	2	3	4	5	6	7	Open process

Table C. 5 Pre-questionnaire establishment of MSP

Keeping in mind the country where you are predominantly practicing your profession, how well established are the following aspects of Marine/Maritime Spatial Planning (MSP) in this country? Please indicate on the scales below.
1= Not established at all. 7= Very well established

	MSP in selected country								
1 PVPS30	Coordination with EU member states	1	2	3	4	5	6	7	N/A
2 PVPS31	Coordination with neighboring coun-tries	1	2	3	4	5	6	7	N/A

3 PVPS32	Coordination between government department and agencies	1	2	3	4	5	6	7	N/A
4 PVPS33	MSP governance structure	1	2	3	4	5	6	7	N/A
5 PVPS34	Legal framework	1	2	3	4	5	6	7	N/A
6 PVPS35	Stakeholder participation	1	2	3	4	5	6	7	N/A
7 PVPS36	Vision and ambitions	1	2	3	4	5	6	7	N/A
8 PVPS37	Clear objectives specified	1	2	3	4	5	6	7	N/A
9 PVPS38	Performance indicators developed	1	2	3	4	5	6	7	N/A
10 PVPS39	Implementation guidelines	1	2	3	4	5	6	7	N/A
11 PVPS40	Financing available	1	2	3	4	5	6	7	N/A
12 PVPS41	Monitoring and evaluation	1	2	3	4	5	6	7	N/A
13 PVPS42	Science and evidence base	1	2	3	4	5	6	7	N/A
14 PVPS43	Knowledge and data infrastructure	1	2	3	4	5	6	7	N/A

Table C. 6 Pre-questionnaire Gaming experience

During the 2nd day of the three-day workshop in Lisbon, the participants will simulate the MSP process in a game between four countries around a realistic, but fictitious Sea of Colors. In order to evaluate and understand the simulation-game process, we ask you to fill out a couple of questions on simulation games.

Game use	
How often in your private capacity (i.e. not part of education or work) do you play regular games, like board games and role plays? (PVES1)	1. Never 2. A couple of times per year 3. Monthly 4. Weekly 5. Daily 6. Don't know
How often in your private capacity (i.e. not part of education or work) do you play computer games (e.g. video games with game consoles, or Internet-based games)? (PVES2)	1. Never 2. A couple of times per year

	3. Monthly 4. Weekly 5. Daily 6. Don't know

Table C. 7 Pre-questionnaire Gaming attitude

Please indicate whether you agree or disagree with the statements by checking the appropriate box.
1 = Strongly disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly agree
N/A = Not Applicable

	Gaming attitude Strongly disagree Strongly agree						
(PVLE1)	Taking part in this simulation game sounds like fun	1	2	3	4	5	N/A
(PVLE2)	The subject of the simulation game appeals to me, content-wise	1	2	3	4	5	N/A
(PVLE50)	I would give my best when playing this simulation game	1	2	3	4	5	N/A
(PVLE51)	I am looking forward to participating in this simulation game	1	2	3	4	5	N/A
(PVLE52)	I am worried that I will miss out on interesting learning experiences if I skip this simulation game	1	2	3	4	5	N/A
(PVLE53)	I am participating in this simulation game, because it is part of the [workshop/course]	1	2	3	4	5	N/A
(PVLE54)	I am participating in this simulation game, because it is expected by someone/others (e.g. boss, colleagues, friends)	1	2	3	4	5	N/A
(PVLE55)	I would like a little friendly competition with others in this simulation game	1	2	3	4	5	N/A
(PVLE56)	I will not have a choice about participating in this simulation game	1	2	3	4	5	N/A
(PVCG2)	When I use a computer, I prefer to learn by trial and error	1	2	3	4	5	N/A
(PVCG3)	In general, I enjoy trying out new uses and applications for computers	1	2	3	4	5	N/A
(PVCG11)	In general, I quickly become comfortable in using new computer applications	1	2	3	4	5	N/A
(PVCG12)	In general, I think the use of simulation games to support decision making is worthwhile	1	2	3	4	5	N/A
(PVCG14)	Simulation games can be valuable for decision making purposes	1	2	3	4	5	N/A
(PVCG15)	Decision making can be affected by outcomes from simulation games	1	2	3	4	5	N/A

Table C. 8 Pre-questionnaire individual competences in team work

If you think of recent situations in your professional life where you operated in a team. How would you describe your competences (your role in a team and way of operating)? Please indicate on the scales below, 1-7.

(PVTR1-RECODE!)	Cooperative	1	2	3	4	5	6	7	Competitive
(PVTR2)	Hierarchical	1	2	3	4	5	6	7	Egalitarian
(PVTR3)	Performance-oriented	1	2	3	4	5	6	7	Relation-oriented
(PVTR4)	Specialist	1	2	3	4	5	6	7	Generalist
(PVTR5)	Enterprising	1	2	3	4	5	6	7	Wait and see
(PVTR6)	Consensus-oriented	1	2	3	4	5	6	7	Conflict-oriented
(PVTR7)	Systematic	1	2	3	4	5	6	7	Intuitive

MSP Challenge 2011 post-game questionnaire

Table C. 9 Post-questionnaire Gaming Process

During the 2nd day of the three-day workshop in Lisbon, the participants simulated the MSP process in the game. In order to evaluate and understand the simulation-game process, we ask you to fill out some questions about the game process, the policy relevance of the game and your personal experiences in the game.
Please indicate on the scales below on how you assess the game process?
1=Strongly disagree
2=Disagree
3=Neither agree or disagree
4=Agree
5=Strongly agree
N/A=Not Applicable

Game process							
Satisfaction (fluency game)	The instructions and explanations at the start of the simulation game were clear – PAKS2	1	2	3	4	5	N/A
	The tasks in the simulation game were understandable and clearly described – PAKS7	1	2	3	4	5	N/A
	The rules of the game were clear and straightforward – PAKS9	1	2	3	4	5	N/A
	The game materials were understandable and clearly written – PAKS35	1	2	3	4	5	N/A

	The simulation game was well-led by the instructor(s) – PAKS8	1	2	3	4	5	N/A
realism	Given the aims of the game, it was sufficiently detailed.- PAKS36	1	2	3	4	5	N/A
	Given the aims of the simulation game, the simulation was sufficiently realistic – PAKS37	1	2	3	4	5	N/A
	The issues in the game represent the challenges in MSP accordingly. – PAKS42	1	2	3	4	5	N/A
	The structure of the game was too predefined. – PAKS43	1	2	3	4	5	N/A
Gaming attitude towards decision making	In general, I think the use of the game to support decision making is worthwhile (PACG12)	1	2	3	4	5	N/A
	The game is valuable for decision making purposes (PACG14)	1	2	3	4	5	N/A
	Decision making can be affected by outcomes from the game (PACG15)	1	2	3	4	5	N/A
Game components	Style attributes used on the computer screens are attractive and suitably designed – SAKC33	1	2	3	4	5	N/A
	The digital mapping materials in the game were understandable – SAKC34	1	2	3	4	5	N/A
	Navigation through the user screens (interfaces) was logical and easy to use – SAKC35	1	2	3	4	5	N/A
	The user screens (interfaces) in the game gave enough of a sense of the changes in the process – SAKC36	1	2	3	4	5	N/A

Table C. 10 Post-questionnaire open

Taking into account, the culture and institutions of policy making and planning in the country were you mainly practice your profession , how well would simulation-gaming in general be accepted as a potentially useful method to support planning and decision-making? Why? PAOQ11

Table C. 11 Post-questionnaire insights from the game

Please indicate on the scales below to what extend you (dis)agree with the following statements about gaining insights from the game.
1 = Strongly disagree
2 = Disagree
3 = Neither agree nor disagree

4 = Agree
5 = Strongly agree
N/A = Not Applicable

As a result of my participation in the simulation game MSP Challenge 2011,...							
PAPS19	I gained more insights who the important stakeholders in MSP are and how they (can) influence each other.	1	2	3	4	5	
PAPS20	I gained more insights what the important factors in MSP are and how they (can) influence each other. –	1	2	3	4	5	
PAPS1	I gained more insights how decisions on different planning scales (local, regional, national, intern. Etc.) (can) influence each other .	1	2	3	4	5	N/A
PAPS21	I gained more insights how MSP decisions in different countries (can) influence each other.	1	2	3	4	5	
PALE26	I gained more insights in the long-term effects and pitfalls of MSP.	1	2	3	4	5	N/A
PAPS22	I gained more insights in the (mis)use of science (data, knowledge) in MSP.	1	2	3	4	5	N/A
PAPS23	I gained more insights in the conflicts and cooperation, between different sectors (e.g. fishery, energy, environment, etc.).	1	2	3	4	5	N/A
PAPS24	I gained more insights why and how different marine spatial planning frameworks and institutions must be in sync.	1	2	3	4	5	N/A
PAPS25	I have a clearer picture how MSP can be turned into an integrated process.	1	2	3	4	5	N/A
PAPS26	I gained useful ideas for strengthening MSP in my country.	1	2	3	4	5	
PAPS27	I have become more interested in certain issues in MSP.	1	2	3	4	5	
PAPS28	I have become more concerned about certain issues in MSP.	1	2	3	4	5	
PAPS29	I have practiced and improved some useful skills for my professional involvement in MSP.	1	2	3	4	5	
PAPS30	I have a clearer picture how stakeholders can participate in MSP.	1	2	3	4	5	
PAPS31	I have a clearer picture how datasystems (digital maps, models, etc.) can be used in MSP.	1	2	3	4	5	

Table C. 12 Post-questionnaire open insight

What is the main insight about MSP that you acquired through the game (if any)? – PAOQ12

Table C. 13 Post-questionnaire personal performance

When you think of the way you played your role in the game, how would you describe your personal performance (your role in a team and way of operating)? Please indicate on the scales below, 1-7.

	Team role scale								
(PATR1-RECODE!)	Cooperative	1	2	3	4	5	6	7	Competitive
(PATR2)	Hierarchical	1	2	3	4	5	6	7	Egalitarian
(PATR3)	Performance-oriented	1	2	3	4	5	6	7	Relation-oriented
(PATR4)	Specialist	1	2	3	4	5	6	7	Generalist
(PATR5)	Enterprising	1	2	3	4	5	6	7	Wait and see
(PATR6)	Consensus-oriented	1	2	3	4	5	6	7	Conflict-oriented
(PATR7)	Systematic	1	2	3	4	5	6	7	Intuitive

Table C. 14 Post-questionnaire gaming experience

When you think back of what you experienced, how would you describe your feelings during the game? Please indicate on the scales below, 1-7

	Personal experience								
1 PAGF1	Stressful	1	2	3	4	5	6	7	Relaxing
2 PAGF2	Boring	1	2	3	4	5	6	7	Engaging
3 PAGF3	Easy	1	2	3	4	5	6	7	Challenging
4 PAGF4	Threatening	1	2	3	4	5	6	7	Safe
5 PAGF11	Conflict	1	2	3	4	5	6	7	Harmonious
6 PAGF10	Frustrating	1	2	3	4	5	6	7	Encouraging
7 PAGF5	Chaotic	1	2	3	4	5	6	7	Controlled

Table C.15 Post-questionnaire additional comments

Any additional comments you might have - PAOQ13

MSP Challenge 2011 in-game questionnaire one and two

The in-game questionnaires one and two have been distributed during the game session.

Table C.16 In-questionnaire MSP outcome

MSP Challenge 3rd November 2011 in-game questionnaire 1 (morning)
Taking in mind the country that you are now playing in the game MSP Challenge 2011, how would you assess the outcome and process of Marine Spatial Planning (MSP) in this country, so far? Please indicate on the scales below, 1-7.

	MSP outcome								
1 PT1PS19	National oriented	1	2	3	4	5	6	7	International orient-ed
2 PT1PS20	Economy-based	1	2	3	4	5	6	7	Ecology-based
3 PT1PS14	Short term thinking	1	2	3	4	5	6	7	Long term thinking
4 PT1PS21	Interest-based	1	2	3	4	5	6	7	Evidence-based
5 PT1PS22	Conservative	1	2	3	4	5	6	7	Innovative
6 PT1PS23	Ignorant	1	2	3	4	5	6	7	Well-informed
7 PT1PS24	Disjointed	1	2	3	4	5	6	7	Integral considera-tion

Table C. 17 In-questionnaire MSP process

	MSP process								
1 PT1PS25	Centralized	1	2	3	4	5	6	7	Networked
2 PT1PS26	Top down	1	2	3	4	5	6	7	Bottom up
3 PT1PS27	Out of control	1	2	3	4	5	6	7	Well managed
4 PT1PS28	Viscous	1	2	3	4	5	6	7	Decisive
5 PT1PS10	Every man for himself	1	2	3	4	5	6	7	Good cooperation
6 PT1PS29	Contentious	1	2	3	4	5	6	7	Harmonious
7 PT1PS13	Closed process	1	2	3	4	5	6	7	Open process

Table C. 18 In-questionnaire stakeholder influence

In your opinion, how much influence do the various roles in the game have on the Marine/Maritime Spatial Planning in the Sea of Colors? Give a score from 1 (No influence) to 5 (very strong influence).

	No influence					Strong influence	
1 PT1ROLE1	Planners	1	2	3	4	5	
2 PT1ROLE2	Oil & Gas companies	1	2	3	4	5	
3 PT1ROLE3	Sustainable energy companies	1	2	3	4	5	
4 PT1ROLE4	Shipping and Cargo companies	1	2	3	4	5	
5 PT1ROLE5	Ports	1	2	3	4	5	
6 PT1ROLE6	Fishing companies	1	2	3	4	5	
7 PT1ROLE7	Ecology NGOs	1	2	3	4	5	
8 PT1ROLE8	Policy advisors	1	2	3	4	5	
9 PT1ROLE9	Marine research centers	1	2	3	4	5	
10 PT1ROLE10	Nat. resources research centers	1	2	3	4	5	

Table C. 19 In-questionnaire game-play rate

How would you rate the game-play so far?

1 PT1GF1	Stressful	1	2	3	4	5	6	7	Relaxing
2 PT1GF2	Boring	1	2	3	4	5	6	7	Engaging
3 PT1GF3	Easy	1	2	3	4	5	6	7	Challenging
4 PT1GF4	Threatening	1	2	3	4	5	6	7	Safe
5 PT1GF10	Conflict	1	2	3	4	5	6	7	Harmonious
6 PT1GF11	Frustrating	1	2	3	4	5	6	7	Encouraging
7 PT1GF5	Chaotic	1	2	3	4	5	6	7	Controlled

MSP Challenge 2011 in-game questionnaire three (end of the game session)

The third In-game questionnaire has been distributed at the end of the game session.

After filling out this questionnaire, please hand it in at the support desk. The results will be used for debriefing and evaluation of the game. Thank you kindly for your assistance.

Table C. 20 Questionnaire Country Blue

	Not established at all							Very well established	
1	Coordination with other states	1	2	3	4	5	6	7	PT3REVB1
2	Stakeholder participation	1	2	3	4	5	6	7	PT3REVB2
3	Vision and ambitions	1	2	3	4	5	6	7	PT3REVB3
4	Clear objectives specified	1	2	3	4	5	6	7	PT3REVB4
5	Implementation guidelines	1	2	3	4	5	6	7	PT3REVB5
6	Science and evidence base	1	2	3	4	5	6	7	PT3REVB6
7	Knowledge &data infrastructure	1	2	3	4	5	6	7	PT3REVB7

Table C. 21 Questionnaire Country Green

	Not established at all							Very well established	
1	Coordination with other states	1	2	3	4	5	6	7	PT3REVG1
2	Stakeholder participation	1	2	3	4	5	6	7	PT3REVG2
3	Vision and ambitions	1	2	3	4	5	6	7	PT3REVG3
4	Clear objectives specified	1	2	3	4	5	6	7	PT3REVG4
5	Implementation guidelines	1	2	3	4	5	6	7	PT3REVG5
6	Science and evidence base	1	2	3	4	5	6	7	PT3REVG6
7	Knowledge &data infrastructure	1	2	3	4	5	6	7	PT3REVG7

Table C. 22 Questionnaire Country Red

	Not established at all							Very well established	
1	Coordination with other states	1	2	3	4	5	6	7	PT3REVR1
2	Stakeholder participation	1	2	3	4	5	6	7	PT3REVR2
3	Vision and ambitions	1	2	3	4	5	6	7	PT3REVR3
4	Clear objectives specified	1	2	3	4	5	6	7	PT3REVR4
5	Implementation guidelines	1	2	3	4	5	6	7	PT3REVR5
6	Science and evidence base	1	2	3	4	5	6	7	PT3REVR6
7	Knowledge &data infrastructure	1	2	3	4	5	6	7	PT3REVR7

Table C. 23 Questionnaire Country Yellow

	Not established at all							Very well established	
1	Coordination with other states	1	2	3	4	5	6	7	PT3REVY1
2	Stakeholder participation	1	2	3	4	5	6	7	PT3REVY2
3	Vision and ambitions	1	2	3	4	5	6	7	PT3REVY3
4	Clear objectives specified	1	2	3	4	5	6	7	PT3REVY4
5	Implementation guidelines	1	2	3	4	5	6	7	PT3REVY5
6	Science and evidence base	1	2	3	4	5	6	7	PT3REVY6
7	Knowledge &data infrastructure	1	2	3	4	5	6	7	PT3REVY7

Appendix D. Quantitative Results of MSP Challenge

This appendix gives an overview of the means (M.) and standard deviations (Sdv.) found through primary analysis of the MSP Challenge game questionnaires. It consists of a few background variables, the validity of game design, self-reported learning effect, the game process and outcome.

Social demographic variables

Table D. 1 Work experience, Age, gender

Game session		years of professional work experience in the field of MSP	Male - Female percentage	Age
Lisbon (n=56)	M.	3.4	57% - 43%	44.2
	Sdv.	4.1		11.0
Leeuwarden (n = 25)	M.	2.7	48% - 52%	37.3
	Sdv.	3.1		9.6
Reykjavik (n=31)	M.	3.2	39% - 61%	48.5
Total (n=112)	M.	3.2	50% - 50%	44.3
	Sdv.	3.8		11.4

Table D. 2 Knowledge, influence

		To what extent are you knowledgeable about Marine/Maritime Spatial Planning, MSP?	To what extent are you knowledgeable about marine ecosystems?	To what extent do you have professionally involvement in actual MSP planning processes?	How much personal and professional influence do you think you can exert in MSP in your country?
Lisbon (n=56)	M.	2.6	2.5	2.7	2.6
	Sdv.	1.205	1.144	1.35	1.212
Leeuwarden (n = 25)	M.	2.04	-	2.52	2.2
	N	25	-	25	25
	Sdv.	1.06	-	1.194	1.041
Reykjavik (n=31)	M.	2.35	2.61	2.55	2.65
	Sdv.	1.404	1.23	1.287	1.17

Total (n=112)	M.	2.38	2.55	2.61	2.54
	Sdv.	1.239	1.169	1.29	1.169

Validity of the game design

Table D. 3 Intrinsic motivation

	Lisbon		Leeuwar-den		Reykjavik	
	M	Sdv.	M	Sdv.	M	Sdv.
I would give my best when playing this simulation game	4.5	0.8	-	-	4.2	0.6
I am looking forward to participating in this simulation game	4.3	0.8	-	-	3.6	1.1
I am worried that I will miss out on interesting learning experiences if I skip this simulation game	4.0	1.0	-	-	3.8	0.9
Taking part in this simulation game sounds like fun	4.0	1.1	-	-	3.8	0.8
The subject of the simulation game appeals to me, content-wise.	4.2	0.9	-	-	3.6	0.9

Cronbach's alpha 0.87

Table D. 4 Extrinsic motivation

	M	SDV.
I am participating in this simulation game because it is part of the [workshop/course].	3.6	1.2
I am participating in this simulation game because it is expected by someone/others (eg. boss, colleagues, friends).	2.0	1.1
I will not have a choice about participating in this simulation game.	1.9	1.0

Lisbon only, Cronbach's alpha = 0.69

Table D. 5 Clarity of the game

	Lisbon		Leeuwarden		Reykjavik	
	M	Sdv.	M	Sdv.	M	Sdv.
The instructions and explanations at the start of the simulation game were clear	4.2	0.6	3.9	0.8	3.3	1.1
The tasks in the simulation game were understandable and clearly described	4.2	0.8	3.7	1.0	3.6	0.9

The simulation game was well-led by the instructor(s)	4.5	0.6	3.4	0.9	3.7	1.0
The rules of the game were clear and straightforward	4.1	0.8	3.5	1.1	3.6	0.9
The game materials were understandable and clearly written	4.5	0.7	3.8	0.9	4.1	0.7

Cronbach's alpha = 0.79

Table D. 6 Validity of the game

	Lisbon		Leeuwarden		Reykjavik	
	M	Sdv.	M	Sdv.	M	Sdv.
Given the aims of the simulation game, the simulation was sufficiently detailed	4.2	0.9	3.7	1.5	3.6	0.8
Given the aims of the simulation game, the simulation was sufficiently realistic	4.2	1.0	3.9	1.0	3.9	1.2
The issues in the game represent the challenges in MSP accordingly	4.2	0.8	3.6	0.9	3.7	1.1

Cronbach's alpha =0.78

Table D. 7 User interaction

	Lisbon		Leeuwarden		Reykjavik	
	M	Sdv.	M	Sdv.	M	Sdv.
Style attributes used on the computer screens are attractive and suitably designed.	4.1	0.9	3.6	0.9	3.7	0.7
The digital mapping materials in the game were understandable	4.3	0.8	3.6	1.0	4.0	0.7
Navigation through the user screens (interfaces) was logical and easy to use.	4.2	0.8	3.5	0.9	3.7	0.8
The user screens (interfaces) in the game gave enough of a sense of the changes in the process	3.7	1.0	3.6	1.4	3.4	0.6

Cronbach's alpha = 0.77

Table D. 8 Attitude towards gaming in DM

	M	SDV.
The game is valuable for decision-making purposes.	3.8	1.1
In general, I think the use of the game to support decision-making is worthwhile.	4.2	1.1
Decision-making can be affected by outcomes from the game.	3.6	1.1

Lisbon only, Cronbach's alpha = 0.74

Validity of the game: self-reported learning

Table D. 9 Political complexity

	Total		Lisbon		Leeuwarden		Reykjavik	
	M	Sdv.	M	Sdv	M	Sdv	M	Sdv
I gained more insights what the important factors in MSP are and how they (can) influence each other	3.8	1	3.9	.9	3.5	1.1	3.7	.9
I gained more insights how MSP decisions in different countries (can) influence each other	3.6	1	3.8	.8	3.2	1.2	3.5	.9
I gained more insights in the conflicts and cooperation, between different sectors (e.g. fishery, energy, environment, etc.).	3.6	1.1	3.8	1	3.4	1.3	3.4	1.1
I gained more insights why and how different marine spatial planning frameworks and institutions must be in sync.	3.6	1.0	3.8	.8	3.4	1.3	3.4	1
SAPS25 I have a clearer picture how MSP can be turned into an integrated process	3.4	1.0	3.6	.8	3.2	1.3	3.1	.9
SAPS30 I have a clearer picture how stakeholders can participate in MSP	3.5	1.1	3.6	1.0	3.5	1.3	3.1	1.1

N=68, a =0.89

Table D. 10 Multi-level governance

	Total		Lisbon		Leeuwarden		Reykjavik	
	M	Sdv.	M	Sdv.	M	Sdv.	M	Sdv.
I gained more insights how decisions on different planning scales (local, regional, national, intern. Etc.) (can) influence each other	3.4	1.0	3.7	.857	3.3	1.4	2.9	.8
I gained more insights who the important stakeholders in MSP are and how they (can) influence each other	3.6	1.1	3.9	.948	3.4	1.3	3.3	1.1

N=68, a=0.69

Table D. 11 Science and models

	Total		Lisbon		Leeuwarden		Reykjavik	
	M	Sdv.	M	Sdv.	M	Sdv.	M	Sdv.
I gained more insights in the (mis)use of science (data, knowledge) in MSP	3.4	1.0	3.7	.857	3.1	1.3	2.9	.9
I have a clearer picture how datasystems (digital maps, models, etc.) can be used in MSP	3.6	1.0	3.8	.917	3.3	1.2	3.4	1.0

N=68, a=0.77

Table D. 12 Attitudes and skills

	Total		Lisbon		Leeuwarden		Reykjavik	
	M	Sdv.	M	Sdv.	M	Sdv.	M	Sdv.
I gained useful ideas for strengthening MSP in my country.	3.6	1.3	4.00	1.1	3.29	1.4	2.9	1.4
I have become more interested in certain issues in MSP.	3.6	1.1	3.89	.9	3.59	1.2	2.8	1.
I have become more concerned about certain issues in MSP	3.7	1.0	4.00	.9	3.71	1.1	2.9	1.1
I have practiced and improved some useful skills for my professional involvement in MSP	3.4	1.2	3.57	1.2	3.47	1.3	3.1	1.1

N=68, a=0.82

Game process and outcome

These two tables show the game process and outcome from the analysis of the in-game questionnaires at 13.00 (T1) and 17.00 (T2), (seven-point scale, M. shown).

Table D. 13 MSP outcome by country

	Lisbon								Reykjavik					
	Blue		Red		Green		Yellow		Blue		Red		Green	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Short term thinking - Long term thinking	4.5	4.8	4.0	4.3	3.8	4.5	4.4	4.9	2.3	3.8	3.6	2.2	3.1	4.1
National oriented - International orient-ed	2.3	4.0	3.4	4.6	2.9	4.2	3.7	4.0	2.5	2.5	2.2	1.4	2.9	2.0
Economy-based - Ecology-based	4.5	4.7	4.0	4.1	3.7	4.0	3.9	4.4	2.4	4.6	2.7	1.5	4.2	4.1
Interest-based - Evi-dence-based	4.0	4.2	3.6	4.3	2.5	3.6	3.6	4.3	2.5	3.3	3.1	1.7	4.6	4.1
Conservative - Inno-vative	3.8	3.9	4.3	4.4	3.5	3.6	3.8	4.4	1.8	3.4	2.6	1.7	3.8	3.6
Ignorant - Well-informed	5.2	4.7	4.9	4.6	4.4	4.5	3.9	4.1	3.0	3.3	3.0	2.1	4.3	4.3
Disjointed - Integral consideration	4.7	5.4	5.3	5.2	5.1	4.9	4.0	3.3	2.3	3.6	2.9	1.9	3.2	3.6

Table D. 14 Game process by country

	Lisbon								Reykjavik					
	Blue		Red		Green		Yellow		Blue		Red		Green	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Centralized - Networked	5.0	5.5	5.8	4.7	4.5	4.8	4.3	3.8	2.3	2.9	2.7	1.9	4.0	3.7
Top down - Bottom-up	4.9	5.0	5.4	4.6	5.2	4.5	3.5	2.7	1.9	2.4	3.0	1.8	4.3	3.1
Out of control - Well man-aged	5.1	5.1	5.0	4.6	3.2	4.7	4.0	2.9	2.0	2.9	2.7	1.9	4.7	4.1
Viscous - Deci-sive	4.6	4.9	5.4	4.9	4.5	5.0	4.0	4.1	1.9	3.4	2.2	2.2	4.1	4.0
Contentious - Harmonious	5.3	5.0	5.6	4.6	4.5	4.6	4.2	3.9	2.3	2.7	2.6	2.0	4.2	3.6
Every man for himself – good cooperation	5.3	5.3	6.0	5.0	4.7	4.8	4.1	4.0	2.9	3.9	3.2	2.3	4.6	4.4
Closed process – open process	5.6	5.7	6.2	5.4	5.8	5.0	4.4	4.6	2.9	2.9	3.4	1.8	4.6	3.9

Appendix E. Principles of Serious Play

Table E. 1 Principles of serious game play

	Principle	Name	Description
1	Game	Complex system	A game is a complex system that derives its distinct features like challenge and surprise, from emergence.
2	Game	Playable complex system	A game is the simplest, playable representation of complexity.
3	Play	Play	We can play with any artefact – mental, physical – but this is not necessarily and generically identified as (playing) a game.
4	Play	Unnecessary challenge	When we play with an artefact, we turn the artefact into an unnecessary challenge.
5	Play	Game for play	When an artefact has intentionally been designed with a specific set of components following a specific set of rules that encourage starting, continue playing with the artefact this artefact is generally recognized as a game.
6	Play	To play a game	When we interact freely with the artefact identified as 'game' we call it to play a game.
7	Serious game play	Play seriously	It is not uncommon in worlds like business or policy to seriously play with serious artefacts, like ideas, design concepts, money, physics, business plans and computer models et cetera.
8	Serious game play	Play (non) seriously	We can play non-seriously with a serious artefact (and this can have political meaning.), like we can play seriously with a non-serious or a serious artefact.
9	Serious game play	Serious play	When we interact with an artefact as if it was an unnecessary challenge, but the playing with this artefact actually produces some (social, political or economic) value, we recognize this interaction as serious play.
10	Serious game play	Seriously game play	When we seriously play with an artefact that has intentionally been designed with a specific set of game rules and game components, but the playing of this artefact aims to realize some (societal, political, economic) value, this artefact is generally recognized as a serious game or a simulation game.
11	Sine Qua Non	Acceptance of failure	The player acknowledges that she (or he) may fail the challenge.
12	Sine Qua Non	Consent	The players play the game for as long as they agree that it is meaningful to the individual player and/or to the player group or game as a whole.
13	Sine Qua Non	Commitment	By entering the game, players voluntarily commit to play with heart.
14	Sine Qua Non	Intrinsicality	The player is an intrinsic part of the game-system, not merely a spectator or operator.

15	Sine Qua Non	Equality	Players are equal in the sense that power, status and hierarchy outside the game should not influence the play or outcome.
16	Sine Qua Non	Level playing field	The game gives a fair and equal chance to the / all players and is not steered / biased to a pre-determined outcome.
17	Sine Qua Non	Fairness	Players agree that they do not give themselves an advantage without the other players knowing and consenting.
18	Sine Qua Non	Suspending disbelief	The players accept the game as 'true' for as long as they play.
19	Sine Qua Non	Safety	The game-play does not have any other consequences to the player or outside world than those agreed upon by the players before starting the game.
20	Sine Qua Non	Repair	Transgressions of the principles sine qua non happen all the time and can be repaired. If they are not repaired, the possibility for future game-play is seriously endangered.
21	Effect	Pheromones	A game is designed to draw (target) players into playing it.
22	Effect	Engagement	Players will not feel bored or frustrated in the game to the extent it will make them want to quit the game, but continue until the challenge is met.
23	Effect	Emotional involvement	The game-play affects the player in his bodily responses, his emotions, his commitment to the outcome of the game, et cetera.
24	Effect	Construction	Players not only follow the game but they also change it and construct it.
25	Effect	Fluidity	The game experience is and can only be shared by the players. It is very difficult to convey what happened in the game to others who were not there, nor to people who did not play the game themselves.
26	Effect	Anchoring and Bonding	The shared game-experience can form a collective memory: going through the same experience can convey the feeling of togetherness, closeness.
27	Effect	Ownership	Players develop a sense of individual and/or collective ownership over their instance of the game.
28	Effect	Challenge	A game challenges the player(s) to do something or accomplish some-thing that is at the real edge of what the player is capable of doing when he entered the game or level
29	Effect	Inference	The player reconstructs the game by inference – a combination of induc-tive and deductive reasoning.
30	Effect	Action-consequence feedback	The player gets feedback over the consequences of his actions.
31	Effect	Control	The player has enough control over the game to have a fair chance to play, advance and complete.
32	Effect	Adaptability	The game adapts or can be adapted to the user skill level or user play

			preferences.
33	Effect	Immersive visualization	Immersive visualization makes players (feel that they are) an intrinsic part of the game-world, not merely a spectator.
34	Effect	Analytics	Analytics capture the emerging complexity of game-play. They help to make sense of individual and isolated experiences and can fill the transfer-gap with the world outside (before, after the game).

SUMMARY

What are the principles that make societal problems socio-technically complex? And, even more important, how can we support public policymaking in the wake of socio-technical complexity?

In my doctorate thesis, *The Princess in the Castle, Challenging Serious Game Play for Integrated Policy Analysis and Planning*, I investigate if, why and how serious games and simulation games (SG) can support integrated policy making and planning, especially in relation to management of rivers and oceans. The overarching question that guides my thesis is:

> What is the role and usefulness of serious game play for integrated policy analysis and planning?

There are many examples that can back the proposition that socio-technical complexity is at the forefront of public policymaking, and that managing socio-technological complexity is the common denominator among the grand challenges of modern-day society. The starting point of my investigation (Chapters 1 and 3) is that inherent causes of complexity in what I call the *natural-technical-phyical* (NTP) realm and the socio-political (SP) realm, spiral into an even higher level of complexity, which I call *Socio-Technical complexity* (STC). STC culminates even further at the so-called *science-policy interface* (SPI) where it triggers calls for 'integration'.

In order to reduce the complexity of big problems in policy analysis, system boundaries need to be drawn but this gives rise to further fragmentation and compartmentalization into numerous 'silos' of governance and research. Furthermore, the language of science itself is reductionist because it breaks down into numerous sub-languages in disciplines, communities, schools and theories that tend to focus on isolated relationships between system elements, rather than systems as a whole. The many formal and natural languages we use to capture complexity – science, models, journalism, and art - are difficult to unite.

As a consequence, actors in the World of Science (WoS) and the World of Politics (WoP) are constantly trying to find and construct methods for integrated analysis and management of STC. Examples of such methods and tools are big data analysis, visual analytics, citizen science, crowd sourcing, e-participation, and… new forms of modelling, simulation and gaming (MSG). The reason is that 'playful methods' are particularly suited to surround sophisticated analysis with extensive participation.

Starting from a simple model in the form of an 'infinity sign', I develop the above ar-

guments step by step into a conceptual model of integrated policy making. After which I apply the model to understand the STC complexity of marine ecosystems and Marine Spatial Planning (MSP) (Chapter 2). This forms the basis for a game-based experiment on integrated, eco-system-based MSP in Chapter 7.

In Chapter 3, I show that the NTP (natural-technical-physical) complexity and the complexity in the SP (socio-political) realm are a duality, like *yin and yang / left and right brain / thesis and anti-thesis* with no clear boundary separating the one from the other. Integrated policy-making, analysis and planning are deliberate attempts to bring the two forms of complexity, and the different languages in which these complexities are represented, together. This is a classic theme that comes under many different calls and proposals for an integrated, holistic science and integrated management, policymaking and planning. Policy analysis of complex social-technical problems is like a dialectic process in the heart of the SPI.

I present and discuss three strategies for socio-technical integration: *Balance*, *Inclusion* and *Synthesis*. Each of the three can lead to a partially integrated policy analysis in either a socio-political dimension, a technical-analytical dimension, or the socio-political and technical-analytical dimension. The stronger the level of integration, the more policy analysis will start to become – feel, look – like game-play. Serious games for example are very playful representations of integrated participatory modelling. The synthesis between NTP and SP-complexity is the realm where serious game play truly emerges as 1) the representation of NTP complexity as in a complexity models and simulations; 2) the representation of SP as in complexity play, role-play, etc.; and 3) the representation of STC as in serious game-play. I have also argued that all three can lead to a partially integrated approach of policy analysis, and all forms will have an element of playfulness or game.

To illustrate and validate my premises and theoretical arguments, I study two different cases in two empirical domains: 1) integrated water management (IWM) (in Chapters 4 and 5), and; 2) integrated marine spatial planning (MSP) (Chapters 2 and 7).

In *water management,* there is an on-going paradigm shift from engineering-driven solutions (more, higher and stronger levees) to solutions where nature, technology and human aspects are in balance. IWM advocates cross-disciplinary, cross-sectional and ecologically sustainable spatial planning in which the effects of climate change are anticipated. In highly developed, flood-prone countries like the Netherlands, IWM is fairly well established.

China is one of the countries to which the Netherlands disseminates and exports the principles and methods of IWM, along with many of the tools to realize it. I investigate how the SPI operates in the Netherlands and China and how *modelling, simulation & gaming* (MSG) plays a role at this interface. Structured interviews with seventy-seven policy-makers, planners, researchers in these two countries show how IWM and possible contributions through integrated methods are framed very differently in these two countries and how this creates confusion when the two worlds meet (Chapter 4).

In the transformation of integrated, long term flood prevention in China, the simulation of complexity is regarded more useful than game-play. 3D virtual reality and game-like tools are seen to increase the communication and use of scientific evidence. In the Netherlands 'game play' for effective participation is regarded useful because the use of science in policymaking is already at a higher level, and participatory policymaking answers to a need for integrated flood prevention strategy in urban redevelopment. The findings lead me to the premise that in order to play out complexity, there must first be a context that promotes and allows 'play'.

I therefore de- and reconstruct 34 principles of serious game play (Chapter 5). One of the essential principles is that a game is the simplest, playable representation of complexity. Other principles such as 'the acceptance of failure' are a *sine qua non*. Without these principles there can be no game-play. The incorporation of one or more of these principles into methods for policy analysis will make this method 'game-like' or 'playful'. The method itself however, does not have to be designed as a game. One of the principles therefore says that it is not uncommon in worlds like business or policy to seriously play with serious artefacts, like ideas, design concepts, money, physics, business plans and computer models.

Analysis of the BPK in the Room for the River (RfR), clearly demonstrates how a straightforward simulation-model not developed as a game, can feel like a game to the users-players. Playing with the BPK in the RfR project helped to manage conflicts and avoid an imminent deadlock. The principles of game play make clear that a SG needs to be designed in such a way that it is more likely to trigger more profound game-play in a policy context than non-game artefacts.

In chapter 6, I go deeper into the role of games and play for integrated planning, through an analysis of: 1) The Blokkendoos – a planning kit developed and used in a project called Room for the River, and; 2) The Climate Game, which was originally developed and used in 2004 as part of the Living with Water innovation project, and is now used in urban reconstruction projects such as the planning of Rotterdam Feijenoord reconstruction in 2013.

Analysis of the BPK in the Room for the River (RfR), clearly demonstrates how a straightforward simulation-model can feel like a game to the users-players-stakeholders. Playing with the BPK in the RfR project helped to prioritize and select projects and avoided an imminent deadlock. The Climate Game was designed and used to prepare for upcoming policy negotiations in a urban reconstruction project taking into account climate adaptation. 3D virtual reality and player roles are some of the mechanics used to draw the policy actors into the game and learn by experimenting. Although the CG was much more like a game, it was not necessarily more effective into creating a context of play. Playing with a simple artefact might be very rewarding; while playing with a fancy game may give diffuse outcomes.

A similar paradigm shift towards integration is happening in Marine Spatial Planning (MSP) – basically, spatial planning at sea (chapter 7). In 2011, I became involved in the development of the game MSP Challenge 2011, which was played in November of the same year in the Marine Aquarium in Lisbon with 68 international policymakers and scientists working in the field. Second and third experiments with the MSP Challenge where held in the form of a master class in the Dutch town of Leeuwarden in 2012; and with 60 marine spatial planners from the Nordic countries in Reykjavik, Iceland, in November 2013. Using the MSP game-experiments, I studied integrated policymaking and gaming *in action* with pre and post questionnaires and in-game data.

The MSP Challenge game triggered an intricate relationship between MSP process and outcome with regard to stakeholder satisfaction, as opposed to the scope and quality of the plan. One of the insights was that 'a smooth process might increase stakeholder satisfaction, but this could be due to the 'negotiating out' of difficult issues and conflicts'. 'A contentious process might result in stakeholder dissatisfaction, it might improve the consideration of real issues and conflicts (and thus to more innovation in the plans).'

SG has the potential to integrate what has become fragmented. It matters for SG, whether policymaking is viewed as a power game, as a knowledge process, or as stakeholder learning. It also matters whether planning authorities can commit, suspend disbelief, can accept equality and are willing to accept failure. When there is *no room to play*, a SG can easily become an expensive waste of time. In order to play, the players need to be willing to engage, commit, play fair, suspend disbelief, accept failure, and more of these *sine qua non* principles.

摘要

是什么原因导致现代社会的公共发展决策日益突显出复杂交错的社会和技术问题？在复杂的决策分析和规划过程中，怎样才能制定出有效的发展策略呢？

在我的博士论文《The Princess in the Castle- 论严肃游戏在综合决策分析及规划中的应用》一书中，我深入探讨严肃游戏是否能够用于支持复杂决策的综合性分析和规划，以及如何支持和应用。 本书中所涉及的复杂规划决策主要是关于长期气候变化下的可持续发展规划，以综合水资源管理及海洋规划为代表课题。

本书中的核心研究问题是：

严肃游戏在综合决策分析与规划中有哪些作用及实际应用？

理论

作为理论阐述的基础，我认为对社会和技术双重复杂问题的研究基于两大领域：一个是自然、技术、物理领域，另一个是社会、政治领域。这两个方面的问题，性质不同形式也不同。当他们同时出现在决策过程中时，就会不断的相互作用。在第一章和第三章中，我将逐步阐述这些相互作用是如何产生的，以及他们给复杂决策带来了怎样的影响。

我认为，复杂决策与规划应当放在一个科学和社会领域交互的层面上来研究。在这个层面上，决策的分析和规划过程，需要找到一个有效的方式来处理这两个领域同时出现的问题。

制定长期气候变化下的可持续发展规划往往涉及到包括公共交通、运输、健康、水资源管理在内的很多部门。决策的分析需要依据对未来 50 到 100 年的气候变化、以及社会发展变化等各个方面的研究数据和经验。虽然每个研究领域都有大量的历史数据库、地理信息系统 、以及电脑模拟系统，可以对可能发生的变化作出一定范围内的分析，但是由于预测研究本身的高误差、大规模跨领域研究的高复杂度的不确定性，决定了来自任何领域的单方面分析都不能被直接用作制定整体规划的依据。而缺少具有说服力的证据会使得决策分析和规划中各个社会群体及管理部门之间的利益纠纷更为突出。在这样的情况下，只有提高综合分析能力，并加强部门间的协同合作，才能解决这些同时出现又互相影响的技术和社会问题。

科学与社会政策领域的合作是一个由来已久的话题。作为社会的两个最基本领域，他们与解决复杂问题都有着重大的关系。但他们在语言与工具、价值规范与文化、认识论与方法论、制度与规则等六个方面又有着强烈的反差。这两个领域因此有着互相关联又对立的本质关系。在第三章中，我从哲学角度深入阐述这种正（相关）、反（对立）合（综合）的辩证关系，以及在中西方不同的文化背景中，技术社会综合决策分析和规划所呈现的三种不同状态，即平衡、包容或者激发新事物的状态。在每一种状态中，综合决策分析都可以用数字模拟方法，利益攸关人参与方法，或者两者结合的方法进行。

近年来，各种新型的多媒体数字技术被普及与运用到利益攸关人参与性决策研究及过程中。

比如说用用大型综合数据库提高综合分析的准确性，用可视化操作提高非专家型的利益攸关人对分析数据的理解，用公众科学、群众外包、电子政务等渠道，增加政府部门和利益攸关群体之间的沟通。这些方式的应用，将一个复杂决策的过程，变成了既能提高综合分析能力，又加强利益攸关人及政府部门间合作的技术社会综合进程。同时在这个过程中所运用到的许多方式变得更加具有"游戏"特色。比如说一些娱乐游戏产业的技术（如三维仿真虚拟界面）、游戏式分析以及角色扮演等被应用到政策分析工具和过程中。这些以游戏形式出现的政策分析被称之为"严肃游戏"。

"严肃"游戏的概念产生于 60 年代美国的军事战略研究。在之后的商业管理中得以大量发展应用并逐渐成为独立的理论体系。很多时候，"严肃"游戏也被称为游戏模拟。其理论核心是指为体验式学习专门设计的模拟环境，以及其中进行的游戏行为。"严肃"游戏中的主题通常与现实生活中的问题相关，并将其简化及结构化。游戏参与者在玩游戏的过程中尝试对问题的各种处理方法，并对比由此产生的后果和影响。游戏参与者通过亲身体验提高对现实世界中复杂问题的理解及处理能力。而他们本身也成为整个游戏模拟系统的内在组成部分。这种方式使得游戏成为可以模拟技术和社会问题相互作用的独特系统。在综合决策及规划的研究中，"严肃"游戏可以以数字模拟或者公共参与方式的其中一个为主要方式，也可以使用同时结合两者的方式。 "严肃"游戏在学术界的经验性研究主要源自大学等研究部门组织的游戏实验。由于邀请政府部门工作人员和专家参加实验相对困难，大部分的政策游戏由在校学生参与完成。这样的实验往往使得研究结果与现实问题及状况相距较远。大量严肃游戏的研究成果也因此被局限在仅仅是学术讨论当中，却没有在现实问题的分析过程中发挥作用。

我认为在这样的情况下，对"严肃"游戏的研究必须更为深刻的理解游戏与综合决策分析之间相互关联的本质，并将对严肃游戏的经验性研究与真实的政策分析与规划问题更为紧密的联系起来。在第五章中，我结合大量的相关文献探讨不同的游戏方式怎样让综合决策分析在不同程度上达到平衡、包容或者是激发新事物的状态。从中我归纳出 34 个游戏原理，并使用大量实例，逐一阐述每个原理对综合决策分析和部门合作所产生的作用。

案例研究

本研究中所包含的所有案例，涉及水管理和海洋规划这两个相关领域。目前，对于水资源的管理在从以技术为主导的大规模基础建设，向平衡自然、社会与技术因素的综合管理领域转变。综合水资源管理主张建立跨领域、跨部门合作的流域管理模式，以水域生态健康发展为本，并在规划中考虑地区发展的整体性，以求灵活应对长期的气候变化。

数字分析模型在传统的水管理中应用广泛。在目前的管理转型过程中，新型的分析模型加强了对部门及地区间的技术与社会发展，同时也加强了信息的综合运用和整体分析。其中的一些模型可以快速灵活地适用于不同问题的分析，并可以方便地给不同专业背景的政策分析参与人使用。

在海洋空间规划中，同样的转型也正在发生。由于海洋生态环境的日益恶化，综合规划成为

政策分析中日渐重要的课题。相对于综合水资源管理来说，综合海洋规划还是一个较新的领域。不同国家及领域对于综合海洋规划的定义及目的，还存在着许多歧异和模糊的解释。尽管如此，许多国家早已经积极地开始了综合海洋规划的课题研究与实践。这些初期的综合规划活动，为我的博士研究提供了很好的实践平台和研究数据。在六年的研究中，我参与了多个模拟游戏的设计开发与研究试验。其中包括论文第七章中介绍的“挑战综合海洋管理模拟游戏”的设计，以及三次由来自世界各地的多名专家参与的实验分析。

整体来说，本书中的研究案例包括：

(1) 用结构型的 Q 方法，组织荷兰和中国的一些水管理及政策分析专家进行访谈，了解他们对综合水管理及防洪政策规划的看法，以及对应用各种不同类型的严肃游戏的经验与态度（第四章）。
(2) 横向对比案例研究：在荷兰的一些水管理项目中，决策分析被模拟进专门设计的严肃游戏中。这些游戏用三维的虚拟现实空间以及角色扮演，将基于科学模型分析结果和现实世界的利益冲突模拟成电脑游戏。而除了专门设计的游戏之外，一些科学分析模型也使用类似于电脑游戏的界面给决策分析中的参与人使用。本研究选取了其中的两个案例，用来探讨在这两种不同的实际政策决策方式中，严肃游戏原理的不同作用和实际应用（第六章）。
(3) 深度分析游戏实验：一个针对挑战综合海洋管理的游戏模拟了四个国家在一个共有海域进行的规划活动，以及反映出的技术与社会的双重复杂问题。这个海域的主要信息储存在包含 75 个层面的电子地图中。游戏中每个国家中的四个主要的利益攸关群体都可以以不同的权限读取信息，并在地图上规划希望达到的方案。整个游戏实验由大约 150 名来自 20 个国家的相关学者和专家分三次进行。游戏实验过程采用电脑录入和问卷提供定量分析数据，以及从观察游戏过程，访谈和讨论中得出的结果为依据对分析结果进行进一步的解释（第七章）。

在第四章的介绍中可以看到，目前中国主要地区的水资源管理仍然处在传统的以大规模基础建设为主的阶段。但随着大量防洪设施的完成， 综合防洪政策和规划成为下一阶段的目标。在与中国 22 个与水资源管理相关的政府工作人员及科研人员的访谈中，我总结出四种对综合防洪策略的意见，并将它们分为四类。其中，大部分意见认为使用可视化技术和 3D 虚拟现实可以更直观地呈现科学分析结果，并使这些结果在今后的决策分析中的达到更好的应用。而在五类基于 33 名荷兰的水管理专家和政府工作人员意见的综合防洪策略中，大多数意见更认同游戏的社会交流功能。虽然其中少部分认为，政策决策中的权力争斗和利益纠纷过于现实，无法真正用游戏来分析，但大部分仍然认为一起参与严肃游戏能够很好地促进决策参与人之间的相互理解、沟通和合作。通过分类和比较这两个制度不同的社会政策环境中的专家意见，可以看出，在技术先进、权力分散和自由平等程度更高的政策环境中，社会利益攸关群体的不同意见及愿望，以及因此引起的矛盾被关注的程度更高。而相对宽松的言论环境和自主权，使得决策人更愿意用游戏的方式尝试各种策略行为。

在第六章介绍荷兰综合防洪政策规划的两个案例中，我们看到游戏效果可以体现在高度仿真的三维虚拟现实中，就如同许多现代的电脑游戏，其三维虚拟空间就是为了给游戏参与者一

个沉浸式的环境。但是游戏效果也可以通过简单地添加图片，立刻呈现显示政策后果等方式，让科学分析软件变得‘游戏化’。对比这两种有着不同游戏效果的决策分析看到，不管是专门设计的游戏软件还是在科学模型中结合游戏化方法，都可以使得游戏原理直接应用于真实问题的解决。而从实际的作用来看，专门设计的模拟游戏中产生的规划方案一般不会直接成为实际项目的规划依据。但是，这样自由、有趣、安全的体验给在现实环境中被各种因素束缚的决策参与者一个自由发挥的领地。让他们能够将想法、行为更为自由地表达和尝试，而不管他们怎样尝试和挑战，都不会产生任何真正的危险。因此，这样的游戏更有可能地激发参与者的创新能力，并让他们为今后的决策分析及谈判准备更加全面和多角度综合考虑的依据。

在第二章的介绍中可以看到在综合海洋规划实践中，国家之间，部门之间对综合规划的定义，规划区域的范围确定具有不同的意见，对海洋生态环境的知识分散在少数的研究部门，而决策部门的综合决策分析及规划能力不足。在这样的情况下，怎样才能找到有效的方式进行综合海洋管理呢？从第七章介绍的《挑战综合海洋管理游戏》的实验中可以看到，有些国家将利益攸关方之间的矛盾控制的比较好，但最后的综合规划却无法达到对生态环境的持续发展的要求。有的国家的决策过程组织得很专业，规划方案也达到了维持海洋生态平衡的要求，但由于缺少与国内和国际的经济发展部门之间的良好沟通，从而导致整体规划中经济发展战略的不足。还有的国家在决策过程中利益攸关方之间的矛盾冲突较大，但从最后的决策方案来看，整个规划却更体现出既注重生态平衡，又能持续经济发展的综合策略。结合正-反-合的辩证关系来看这些实验结果，在综合分析和规划中，为了减少利益冲突（正-反关系）造成的混乱局面，可以采取融合或者平衡的方式来管理整个过程，但要注意决策结果过于迁就其中一方，比如说生态保护或者经济发展的利益。而如果管理部门能够策略地利用这些正-反关系，将利益冲突和不同观点变成共同寻找新的解决方法的动力，反而能让综合分析和规划更为有效，并在信息不足，依据不足的情况下提高处理复杂问题的能力。

结束语

严肃游戏可以使综合政策分析和规划更为有效。而在政策分析过程中应用“玩”游戏的原理比应用游戏本身更为重要。 在目前大部分的社会状态下，采用 34 个游戏原理的其中一些，就能够让政策分析变得游戏化，从而对提高综合分析的有效性产生影响。但是其选择和实际产生的效果，在很大程度上决定于既定存在的社会和政治环境。而且，如果政策分析者对于参与游戏没有任何自发意愿，再好的游戏也不会产生影响，只能变为成本昂贵的资源浪费。在第八章中，我总结出 5 条在现实环境中组织游戏实验的建议。而鉴于游戏能够综合技术-社会平台的适用特性，对游戏实验的分析及评估应该使用除了问卷之外更多的数据收集及分析方法，比如说借鉴目前娱乐游戏产业兴起的可视化分析方法，以及运用更多种在心理学及影像分析学科中的方法与工具。

Curriculum Vitae

Qiqi Zhou was born in Nanjing, China on 4 July 1974. In 2004, she went to the Netherlands to do a Master in Environmental Assessment, in Wageningen University, which she completed in 2006. Before she came to the Netherlands, she obtained her bachelor's degree (1996) in graphic design in China and worked as a graphic designer for a newspaper. Between 1999 and 2004, she was a news presenter and journalist for Zhuhai TV station in China. Since 2008, she has been working as a PhD researcher in the faculty of Technology, Policy and Management (TPM) at Delft University of Technology, the Netherlands. Her professional interests lie in environmental and water management, especially its intercultural and interdisciplinary affairs. Over the years, she has gained much experience in the management of China-Netherlands relations in policy, business and science. She acted as organizer, liaison, host and scientific interpreter at several larger and smaller China-Netherlands meetings. She speaks fluent Mandarin, Cantonese, English and Dutch. She is currently working on several projects of cooperation between Delft University of Technology and universities in China (Dalian University of Technology and South China University of Technology).

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List of Abbreviations

BPK	Blokkendoos planning kit
CCS	Carbon Dioxide Capture and Storage
CG	Climate Game
CPPCC	Chinese People's Political Consultative Committee
EBM	Ecosystem-based Management
EEZs	Exclusive Economic Zones
EU	European Union
GIS	Geographical Information Systems
GWP	Global Water Partnership
IA	Integrated Assessment
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management
ICT	Interaction and Communication Tool
IFM	Integrated Flood Management
IM	Integrated Management
IRM	Integrated River (basin) Management
IWM	Integrated Water Management
IWRM	Integrated Water Resource Management
KNAW	Koninklijke Nederlands Academie van Wetenschappen
MPA	Marine Protected Areas
MSG	Modelling, Simulation and Gaming
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
MST	Ministry of Science and Technology (in China)
MWR	Ministry of Water Resources (in China)
MWREP	Ministry of Water Resources and Electric Power (in China)
NTP	Natural-Technical-Physical realm
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
PIA	Participatory Integrated Assessment
PPA	Participatory Policy Analysis
RBCs	River Basin Commissions (in China)
SG	Serious games / Simulation games
SPI	Science-Policy-Interface
SP	Socio-Political
STC	Socio-Technical Complexity
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea

WoS	World of Science
WoP	World of Politics

End notes

1 The notion of socio-technical complexity will be explained at length in the thesis. There is an obvious relation with (the complexity of) socio-technical systems predominantly used in organization, management and innovation theory. The difference between the two formulations is that I consider systems to be a whole; management and governance break up the system up into a social and/or technical part or definition. Systems themselves are never social and/or technical (or, better: they are always both); the complexity of the system is framed by managers, scientists and policymakers as social and/or technical. Hence, I prefer to speak of the socio-technical complexity of policy problems, systems, etc.

2 On 21 September 2012, a party in the small Dutch town of Haren got out of control after an invitation to it appeared on Facebook. News reports indicated that 'There were multiple mentions of an American film called Project X', and that some revellers wore T-shirts marked 'Project X Haren'. It was estimated that it would cost over €1 million ($1.32 million) to repair the damage. Similar events have occurred in the USA (Houston, Texas) and Germany. (Commissie 'Project X' Haren, 2013; 'Facebook party invite sparks riot in Haren, Netherlands,' 2012)

3 'Big problems' in my view are problems that are or seem extraordinarily significant because of their scale (involving a large number of people or a large part of the planet) and depth (deep impact on ecosystems or people's lives). It is logical that such problems will also be 'complex'; but the general reference to 'messy, wicked' problems does not say anything about the scale and depth of the problem. The reorganization of a university is a wicked, messy problem, but in my view, not a big problem. Similarly, in the literature 'big' decisions are defined as discontinuous, abrupt and unique, in contrast to 'little' decisions, which are marginal, commensurable and additive (Krieger, 1986). 'Big science is … in contrast to "small" science' (Madison, 2000).

4 Hence, social and technological are both taken in a very broad meaning. Under social, I include all aspects of human interaction, especially political interaction. Under technological, I include all forms of interactions that are fundamentally governed by the natural laws. Hence, I use socio-technological complexity to also refer to socio-ecological and socio-natural systems (Medema et al., 2008).

5 The most important ones, relevant for public policymaking and sustainability, are: systems dynamics (SD) (Carlsson, 1990; Forrester, 1960, 2007; Senge, 2006); complex adaptive systems (CAS) (Brown, Beyeler, & Barton, 2004; Lansing, 2003; Lei et al., 2010; Mayer et al., 2010; Shafritz, Ott, & Jang, 2010); sociotechnical systems (STS) (Herrmann et al., 2007; Laracy, 2007; Mayer et al., 2005).

6 Similar ideas have been adopted in many relevant topics in water management, such as integrated watershed management, integrated water catchment management, integrated costal management and integrated flood management. In a bigger scope of water planning issues, integrated science can also be found in, for example, integrated marine spatial planning and integrated urban planning (IUP).

7 In publications that I co-authored with Mayer et al., we developed a conceptual research model where the policy context determines individual game play, and the individual game play transfers and transcends to the context.

8 The butterfly effect is used in, for example, chaos theory to describe delayed big effects as a nonlinear result of a local, small change. The name of the effect literally means that when a distant butterfly flaps its wings, it may cause the formation of a hurricane several weeks later. A more detailed description of the butterfly effect can be found in, for example, Wikipedia.

9 This chapter is a revised and adapted version of sections I have co-authored and published in: (Mayer et al., 2012; Mayer, Zhou, et al., 2013)

10 The International Council for the Exploration of the Sea (ICES) co-ordinates and promotes marine research on oceanography, the marine environment, the marine ecosystem and living marine resources in the North Atlantic, including the Baltic Sea (see www.ices.dk). HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, more usually known as the Helsinki Convention (see www.helcom.fi). The OSPAR Convention is the current legal instrument guiding international co-operation on the protection of the marine environment of the Northeast Atlantic. Work under the Convention is managed by the OSPAR Commission, made up of representatives of the governments of fifteen contracting parties and the European Commission, representing the European Union (see www.ospar.org). VASAB is an intergovernmental multilateral partnership of eleven countries in the Baltic Sea region in the field of spatial planning and development (see www.vasab.org).

11 Parts of this section, the quotes in particular, have previously been published in: (Mayer, Bekebrede, Bilsen, Zhou, & van Bilsen, 2009) and (Zhou, de Bruijn, ten Heuvelhof, & Mayer, 2009b).

12 In the title I use the words ‘three faces’ to describe these three strategies. I do so to express that these are not limited to the strategy to implement, but also apply to the conceptual level, namely three different culture, belief and value systems (faces). The role and usefulness of integrated strategies in the different faces of integrated policy analysis will be deeply influenced by the embedded values and beliefs.

13 Although there is extensive debate about whether or not Hegel actually used the dialectical method, at least not formulated as thesis, antithesis and synthesis. http://en.wikipedia.org/wiki/Dialectical

14 Hegel took contradictions and tensions as part of a comprehensive, evolving, rational unity that he called ‘the absolute idea’ or ‘absolute knowledge’. This unity evolves through and manifests itself in contradiction and negation. This drives the evolution of things like consciousness, history, philosophy, art, nature and society until a rational unity at a higher level is achieved (Aufhebung).

15 For Hegel, it would be: 1) thesis: natural (man); 2) antithesis: artificial (God); 3) synthesis: natural = artificial (man = God). For Marx, it would be: 1) thesis: common ownership + poverty (primitive communism); 2) antithesis: private ownership + wealth (slavery, feudalism and capitalism); 3) synthesis: common ownership + wealth (final Communism).

16 The justification, design, research approach and analysis of the Q methodology are described in Appendix A (‘Study Design and Methodological Justification’).

17 The dimensions listed in table 4.1 are used for the selection and design of the statements about IWM in Q methodology. Details of the design of Q methodology can be found in Appendix A: Chapter Methodological Justification, section A5.

18 This is the title of a classic book by the Chinese scholar Yutang Lin (1936). It is regarded a classic, first written in English, that explains Chinese culture to the West. It is still a powerful book.

19 Exact numbers vary over time due to government restructuring.

20 Details of the design of Q methodology in this research are given in Appendix A: Study Design and Methodological Justification. The analytical data and results are presented in Appendix B.

21 It would probably also entail a lengthy discussion of the literature on SG for learning, policy, organization and management. This has been done extensively in many other publications and in my view does not have to be repeated here.

22 This and the following sections are revised from: Mayer, I. S., Warmelink, H. J. G., & Zhou, Q. (2014). The Utility of Games for Society, Business and Politics: A Frame Reflective Analysis. In Nick Rushby & D. Surry (eds.), Wiley Handbook of Learning

Technology (in press). Wiley. Similar arguments have also been presented in Mayer, Bekebrede, Warmelink & Zhou, 2013.

23 Note that Duke himself rarely uses the notion ‘serious games’ and preferred ‘simulation games’ or ‘gaming simulation’. This in fact is the only reference in his work to ‘serious games’ that I know of.

24 In a recent PhD thesis by Warmelink, several frames re used to understand the relation between games and organization. I tend to do the same for public policy-making.

25 Boeing used a virtual design environment (CATIA) to simulate and integrate the whole design process of the aircraft in order to solve design conflicts (Schrage, 2000, pp.16-17).

26 An overview of all principles can be found in Appendix E.

27 There are hundreds of different translations of this classic Chinese poem – almost like a game of words that you can make your own. See: http://lgdata.s3-website-us-east-1.amazonaws.com/docs/2082/427641/Up_the_Stork_Tower_-_hurtt.pdf.

28 Rijkswaterstaat is part of the Dutch Ministry of Infrastructure and the Environment. It is responsible for the design, construction, management and maintenance of the country’s main infrastructure facilities.

29 The educational version of the tool can be downloaded from: (Deltares, n.d.-c).

30 The principles of serious play can be verified in Chapter 5 and in Appendix F.

31 The original ideas for this type of simulation game go back to earlier versions of serious planning games developed at TU Delft, such as SimPort-MV2, which is about a major port expansion project in the Port of Rotterdam (Bekebrede, 2010; Mayer et al., 2010).

32 HKV is a Dutch consultancy company that specializes in water management and innovative approaches.

33 This chapter is a revised and extended version of the following publication: Mayer, I. S., Zhou, Q., Lo, J., Abspoel, L., Keijser, X., Olsen, E., Kannen, A. (2013). Integrated, Ecosystem-based Marine Spatial Planning: Design and Results of a Game-based Quasi-Experiment. Ocean and Coastal Management, 82, 7–26. doi:dx.doi.org/10.1016/j.ocecoaman.2013.04.006

34 At the time of writing, a second, even more integrated game version is nearing its completion. I will say a few words about the new version, but results fall outside the scope of this thesis.

35 The serious game, MSP Challenge has been designed by the Delft gaming centre (Signature Games, n.d.). As part of the research team, I joint the game development and evaluation process.

36 The International Council for the Exploration of the Sea (ICES) co-ordinates and promotes marine research on oceanography, the marine environment, the marine ecosystem and living marine resources in the North Atlantic, including the Baltic Sea (see www.ices.dk). HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, more usually known as the Helsinki Convention (see www.helcom.fi). The OSPAR Convention is the current legal instrument guiding international co-operation on the protection of the marine environment of the Northeast Atlantic. Work under the Convention is managed by the OSPAR Commission, made up of representatives of the governments of fifteen contracting parties and the European Commission, representing the European Union (see www.ospar.org). VASAB is an intergovernmental multilateral partnership of eleven countries in the Baltic Sea region in the field of spatial planning and development (see www.vasab.org).

37 The initiation of the Centre for Marine Policy is co-funded by the Province of Fryslân. Partners are the Wageningen University department of Social Sciences, Van Hall Larenstein University of Applied Sciences, IMARES and LEI. The Centre facilitates interactions within the broader marine and maritime research and policy network in Europe. (Centre for Marine Policy, n.d.)

38 Åland Islands, Denmark, Finland, Faroe Islands, Greenland, Iceland, Norway and Sweden.

39 Every year, especially in summer, around 950 Long-finned Pilot Whales (Globicephala melaena), sometimes erroneously called Calderon Dolphins, are killed on the Faroe Islands.

40 The new version of the game reduces the number of players to around 20.

41 The methodology used for the evaluation and data-gathering is described in the Appendix Chapter 9: Study Design and Methodological Justification.

42 Note that the respondents from Italy and Romania indicate that they have a low level of expertise and involvement. They later assessed their countries to have a well-developed MSP.

43 The Baltic, Canada and US, and a number of southern European countries with only one low expertise respondent excluded from the spider graph.

44 Seven-point scale 1-7. First item is 1; second is 7, for instance: 1 = top-down, 7 = bottom-up.

45 Note to Figures 7.10, 7.11, 7.14 and 7.15: x axis = time of measurement during the game, T1 (13.00) and T2 (17.00) ; y axis = seven-point scale (e.g. 1 = top-down, 7 = bottom-up)

46 Explanation to Figures 7.18 and 7.20: x axis = square nautical miles; y axis = marine spatial functions

47 By the way, the same casual and superficial voices can be heard about *adaptive planning.*