Transition Dynamics in Social-Ecological Systems

The Case of Dutch Water Management

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The Case of Dutch Water Management

Transitiedynamiek in sociaal-ecologische systemen

De casus waterbeheer in Nederland

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Preface

Writing a dissertation is more than writing a book. It starts with just a few thoughts inspired by something you have read somewhere or heard someone say. Then your own mind ponders on the idea, mixing the original thought with information stored somewhere in your brain. Then follows a process of association and exploration. Wild hypotheses are formulated, careless of whether they are measurable. Just exploration. Finding the boundaries. Finding what you are really interested in, what your drives are. This is often the most valued phase for scientists. After that, it becomes harder. The playfulness and creativity is interchanged with the analytical mode. It is not about seeking what you find interesting anymore, but to show the world that it is worthwhile looking into. The process becomes more externally oriented. You need to find evidence and it just becomes hard work. Decisions need to be made and every decision needs to be motivated. Standing on the shoulders of the ones before you, building further on their ideas, or criticizing them and arguing why you need to go your own way. It is really about finding your place among your peers. Different from writing a novel, where you just wander off into a direction and see where it ends, regardless of what others have written before. You need to start fulfilling the promise your place holds. Can you do it? Can you make the right decisions to find out the answers you seek? What kind of data should you look for? How do you get access to the data? Along the way you might adjust some things, you never stop learning and your mind develops new ideas, but slowly a picture of the whole begins to emerge. Then you start writing the book and you discover that a lot of the decisions require still more grounding. Writing the dissertation is the test. Is everything accounted for? What are the main insights? How does it relate to what others have said earlier? So you see, writing a dissertation is more than writing a book. It is a harsh learning process. A hard and long one. I wish I had known it all before. But then again, I wouldn't have learned as much as I did.

I have learned on three different levels. On the first level, I learned a lot about the content of my research, about transitions, about how systems in general tend to work, about the conceptual gap between theory and practice and about water management. On the second level, I have learned a bunch of scientific competences. For instance, how to bring your message across in a short presentation. I've learned a lot about writing. How to structure the book, how to present the line of reasoning and how to lift yourself up, so you are up and above the individual chapters, which is necessary to be able to reflect on the whole and to see what has come out of it. Finally, I have managed to do science. On the third level, I have learned a few important personal things. I have seen my fallacies and I have come to face some of them. I have also seen my own resilience and endurance. I will not forget that source from which I know I can always draw strength.

These last ones are probably the most valuable lessons I have learned as I shall take them with me for the rest of my life in each situation. I will endure, I shall overcome.

My research would not have been possible without the help of some people and I want to show them my gratitude. First of all, I want to thank my promotor, Professor Jan Rotmans. He truly is an optimist, a man who is more into opportunities than barriers. He is a visionary and he has inspired me. I want to thank him for giving me the opportunity to write this dissertation! Secondly, I want to thank my co-promotor Professor Josee van Eijndhoven. She has inspired me in a whole different way. She has helped me a lot in the last stages. Without her, I am not sure if I would have succeeded. She is a very nice person.

I want to thank Derk Loorbach for being a companion all these years. We have had a lot of discussions, brainstorms and raw ideas. If we ever have the discipline to write it all down… We have been more than just colleagues. I also want to thank him for the mental support he has given me during the writing process.

I want to say thanks to all my colleagues at Drift. They are a bunch of let's say 'present' individuals. Drift is not your average scientific institute. Transdisciplinary as we are, we never tend to agree, rather we agree to disagree. I think we are unique in combining scientific efforts and doing consultancy projects in practice. This mixture triggered a lot of debate about our role as scientists. In this, we also tend to agree to disagree. Either way, this kind of openness is better than keeping things implicit. In the real world it is no different.

I want to thank Roel van Raak for doing the Amstelland case study with me. I want to thank Rutger de Graaf from the TuDelft for doing the Rotterdam case together. I want to thank Liedewij van Tuin-van Driel for all her editing efforts.

I want to thank my family. My father and Yvon, my mother and Tom, Marjolein and Idde, Annelies and Koen, Ineke and Wim, Gerard and Antonie, Djim and Samantha and Ruben. They have all supported me in their own way. You are all very dear to me. I want to dedicate this book to my unborn child and my nieces, Janne, Roos, Marieke, Eva, Veerle and my nephew Jens. Sustainability is about providing your generation with a pleasant society.

I want to say thanks to all my friends. For the fun, the depth and the shared history and future.

Most grateful I am to Wietske. We had a rollercoaster of a year, but I'm glad it was a ride with you. Stronger we have become. 'We are who we are, not what we achieve'. Thanks for that life's lesson. I want to thank you for your support. I have asked a lot from you, patience mostly, but also time we could have spent together and more. I want to thank you for getting me back on track. For helping me structure my thoughts and the book. You have been there for me, when I most needed you.

Finally, I am grateful to the *Knowledge network on System Innovation and transitions* (KSI) for financing this research. The KSI-research programme involves scientific research into historical transitions, the dynamics of current transitions and various aspects of transition management. A full text description of the programme can be found on www.ksi-network in: Multi,- Inter- and Transdisciplinary Research Program into Transitions and System Innovations (Rotmans et al. 2004). In addition, this research was linked to the *NeWater*-programme (www.newater.info) which is an EU-funded research programme dealing with transitions to adaptive water management regimes. This research was also linked to the *Leven met Water*-programme, a Dutch research programme concerned with new and innovative ways of water management (www.levenmetwater.nl).

Rutger van der Brugge, spring 2009.

Contents

Chapter 1

Introduction

1.1 This dissertation

This PhD dissertation aims to be of interest to three kinds of audiences: to those who are interested in societal transitions, to those who are interested in water management, and to those who are interested in socio-ecological systems and resilience. It aims to generate insight into the dynamics of transitions in social-ecological systems and in particular into the transition dynamics in Dutch water management.

1.2 Introduction: Sustainable development and transitions

Sustainable development is one of the great challenges of this century. On a global scale, sustainable development is needed because of the detrimental human impact on the biosphere, the depletion of natural resources (i.e. oil-reserves), the reduction in biodiversity and climate change. Following the Brundtland report "Our Common Future" (WCED, 1987), a sustainable development combines economic wealth, environmental protection and social cohesion. In the report, sustainable development was defined as development that 'meets the needs of the current generation, without compromising the needs of future generations' (WCED, 1987), which means that the concept in itself is normative, subjective and ambiguous (Rotmans et al., 2001). It is normative, since it prescribes that future generations should have the same possibilities as the current generations; it is subjective, since it requires an assessment of what these future needs are; and it is ambiguous, since these future needs can be weighed in more than one way. Rotmans et al., (2001) defined three basic characteristics of sustainable development. The first is that sustainability is an inter-generational phenomenon, which means that a long-time horizon of at least one or two generations (25-50 years) should be taken into account. Secondly, sustainability is a cross-scale phenomenon, so local or regional sustainability does not necessarily mean national or global sustainability and vice versa. A sustainability analysis therefore requires taking into account multiple scales. The third characteristic is that it encompasses the economic, the ecological and the socio-cultural domains. Sustainability thus encompasses a context-specific balance between ecological, economic and socio-cultural values and stakes.

Rotmans et al (2001) argue that problems of unsustainably are persistent, because they are so deeply rooted in our societal fabric: in our culture, habits, institutional structures, infrastructure and economic investments (VROM, 2001, Rotmans et al., 2001, Loorbach, 2007). It is therefore increasingly recognized that a more fundamental societal reform, or a transition, is needed to achieve a sustainable development. According to the Dutch Council for Housing, Spatial Planning and the Environment the traditional management

instruments - financial incentives, legislation and information sharing and awareness campaigns - are not sufficient for dealing with transitions (VROM-raad, 2001). Partly due to the four-year democratic election cycle, the instruments are used for short term incremental change rather than to stimulate fundamental societal reform on the very long term. In response, Rotmans et al (2001) argued that, in principle, it should be possible to formulate governance principles, methods and tools for dealing with transitions on the long term through the improved understanding of the underlying dynamics of transitions and introduced the idea of transition management. Transition management (Rotmans et al., 2001, Loorbach, 2007) is a promising approach and is currently an important pillar of Dutch environmental policy (see box 1). In section 1.4.5 we will outline the concept of transition management.

However, it is not fully understood how transitions unfold and so it is not clear how they can be stimulated or facilitated. There is a clear need for a more thorough understanding of the underlying dynamics, and therefore, the main objective of this dissertation is to generate insight into dynamics of transitions and more specifically into the dynamics of the transition in Dutch water management.

The Dutch water management sector is currently struggling with a persistent problem. As a result of climate change, the Dutch water professionals expect a rise of the sea level, an increase in the run off of the rivers Rhine and Meuse during the winter and an increase in extreme precipitation and so this abundant water needs to be stored. However, over the last decades, the actual space available for water retention has been reduced due the increasing spatial claims of agriculture, housing industry and cities. There are large scale changes necessary in the water system and in the water infrastructure, which require changes in the institutions and in the culture.

In the next section we will further explain what we mean by transitions. In section 1.4 we will explain how transitions are studied, which further specifies what is needed in order to address the main objective. In section 1.5 we will summarize the problem definition and formulate research questions.

Box 1. Third generation environmental policy

The concept of transitions and transition management is one of the pillars of the 4th Environmental Policy Plan in The Netherlands. Grin et al (2003) argue that thinking about transitions and transition management represents a third generation of environmental policy. During the first generation (~1970s), environmental problems were perceived as health hazards and it was considered to be a governmental task to regulate emissions of pollutants into air, water and soil. Although a whole range

of legislation emerged, some of the environmental problems appeared to be more persistent than expected and a set of additional policy measures was developed. This second generation of policy measures (~1990) aimed to influence public awareness and the behaviour of target groups to stimulate closure of biochemical cycles. During the 1990s, it became clear that target groups were willing to change, but were confronted with the high costs of changing due to the existing infrastructure, societal conventions, the organization of economies, regulations and availability of knowledge (Grin *et al.*, 2003). This triggered the third generation of environmental policy (~2000), which assumes that the persistence of environmental problems is due to the way societal systems are organized and that in order to solve them, there is a need for more fundamental transitions. The 4th National Environmental Policy Plan (NEPP) (VROM, 2001) presented transitions and transition management as a new *leitmotiv* for dealing with these persistent environmental problems.

Currently, there is a growing international scientific research community studying the dynamics and the management of transitions. Transition management is applied in various countries, among which are the energy sector in The Netherlands and the waste sector in Belgium (see (Loorbach, 2007). In addition, it is currently applied in the health care sector, reflecting that transition management is not limited to environmental policy, but can be applied in different kinds of societal systems that require fundamental reform.

1.3 What are transitions?

A transition can be defined as: *"a long term continuous process of societal change during which the structure of society, or a sub-system of society, fundamentally changes"* (Rotmans et al., 2001). A transition is a complex phenomenon of change, encompassing an array of interacting social changes, operating simultaneously at different scales in the technological, economic, ecological, socio-cultural and institutional domains. A transition refers to specific kind of change, namely the kind of change we tend to depict as 'structural', 'fundamental', or 'transformative' in contrast to 'incremental change' or 'optimization'. It refers to a change of the *deep structure* of a societal system, which can be understood as the dominant culture, structure and practice (Rotmans et al, 2005). With culture, Rotmans et al (2005) refer to a shared paradigm (in terms of way of defining problems and solutions) and the underlying shared set of values, norms, perspective (in terms of coherent, shared orientation). The structure includes the physical infrastructure (roads, buildings etc), the economic infrastructure (market, consumption, production) and the institutional structure (rules, regulations). The practices involve the routines, behaviour, and coping strategies at the individual level (Rotmans and Loorbach, Forthcoming). Following this view, a transition can thus be understood as a fundamental change in the

dominant culture, structure and practice of a societal system (Loorbach and Rotmans, 2006). An important point of departure in the emerging field of transition studies is the

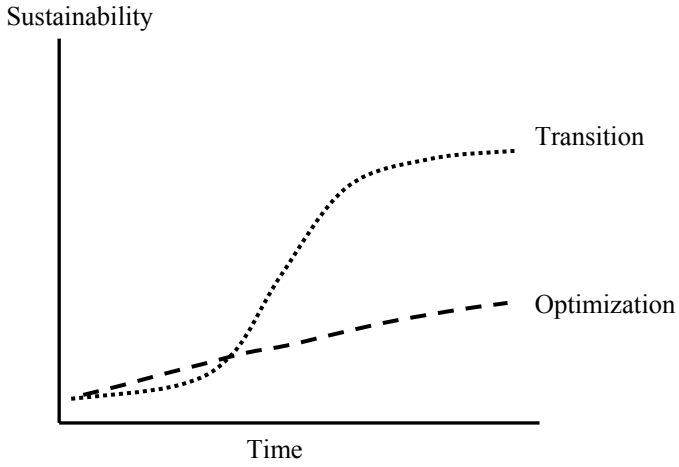


Figure 1.1 Illustration of optimization versus transition (Rotmans et al., 2000).

assumption that, in terms of sustainability, incremental change leads to a suboptimal situation and that there is a need for a more fundamental societal transition (Fig. 1.1). Rotmans et al (2001) attribute the following three characteristics to a transition:

- A transition is a long-term process, spanning one or two generations;
- A transition involves technological, economical, ecological, socio-cultural and institutional developments that influence and reinforce each other;
- A transition is the result of mutually reinforcing developments at different scale levels.

The first characteristic is the long-term scale of transitions (25-50 years), which has two important implications. The first implication is that predictions over such long time spans are extremely uncertain. This uncertainty is partly the result of inadequacies in the models, the sensitivity to initial conditions, or a lack of data; and partly due to more structural uncertainties (Van Asselt, 2000). We do not know all the possible mechanisms involved, but we do not know which ones are unfamiliar (the so-called "unknown unknowns"). For instance, the future might bring new insights which are unknown to us now and so we cannot foresee them. The second implication is that there is gap between the time span of transitions and the time span of normal policy cycles (5-10 years). One of the crucial challenges for transition management is therefore to connect the long term with the short term. Crucial ingredients are long-term anticipation, experimentation and keeping open several promising options at the same time (Rotmans et al., 2001).

The second characteristic is that of multi-causality. Transitional change is the outcome of interactions between technological, economic, ecological, socio-cultural, political and institutional developments, although some factors may be more important than others. Technology is often seen as one of the major driving forces of transition, but this is not always the case. All domains are co-shaping the transition since they create the environment in which innovations are selected or not. Therefore co-evolution, which is mentioned in later publications (see Rotmans *et al.*, 2004) is a more accurate term than multi-causality, because it emphasizes the processes of variation and selection.

The third characteristic of a transition is that it is a cross-scale phenomenon. This implies that transitions cannot be understood by analyzing the phenomenon at a single level. Allan and Starr (1982) argue that phenomena in complex systems can only be understood properly by looking at the scale (N) at which the phenomenon occurs and one level below (N-1) and one level above (N+1). The processes at N-1 give rise to the phenomenon at level N and the processes at N+1 constrain it. Transitions are understood as the result of interactions between the macro-level, meso-level and micro-level (section 1.4.1). The main hypothesis is that a transition occurs when micro-level innovations (N-1) are reinforced by developments at higher levels of scale (N+1) and force the system at level N to transform (Rotmans et al., 2001).

A fourth characteristic is pointed out by Ness et al (1996). Transitions encompass the shift from slow to fast change and a shift back from fast to slow change. This characteristic is captured by the S-curve of figure (1.1). Rotmans (1994) points out that the flat parts of the curve represent *dynamic equilibria*, during which the system only changes slowly. Though the system is at equilibrium there is a continuous flux of people, material, energy and information, but the deep structure of the system does not change. The middle part of the curve represents fast change, during which the deep structure becomes instable and the system transforms. The S-curve should be seen as a metaphor illustrating the shift from one dynamic equilibrium to another; at dynamic equilibrium there is relatively slow change, but in between the equilibria there is relatively fast transformative change. Related to this is the notion of points of no return, or thresholds, which if exceeded, rule out the return to the initial equilibrium (Rotmans et al., 2001).

1.4 The transition framework

'Transition studies' is a relatively new field of interdisciplinary science. It attempts to integrate insights from the fields of Integrated Assessment (Rotmans et al., 2001, Martens and Rotmans, 2002, Loorbach, 2007, Van der Brugge et al., 2005), Science and Technology (Rip and Kemp, 1998, Berkhout et al., 2004, Elzen et al., 2004), History studies (Schot, 1998b, Geels, 2002, Verbong et al., 2002), Innovation Studies (Smits and Kuhlmann, 2004)

and Governance (Rotmans et al., 2001, Loorbach, 2007, Loorbach and Van Raak, 2006, Grin, 2008a). At the core of transition studies are two basic questions: how do transitions unfold and how can we manage them? At this stage, there are still many questions open with regard to both questions. A fully-fledged transition theory does not yet exist; rather it is considered to be a theory-in-development. In addition, there is no validated methodology either for studying transitions. The transition theory-in-development consists of a conceptual framework of four interrelated concepts: the multi-level concept; the multi-phase concept, the multi-pattern concept and the transition management concept (Rotmans *et al.*, 2004). In the remainder of this dissertation we will refer to this conceptual framework as the transition framework. These four concepts are the starting points for studying transitions and will be discussed below.

1.4.1 The multi-level concept

The first concept in the transition framework is the multi-level concept (MLC), which makes a distinction between developments that operate at different scales, from quasi-autonomous and relatively slow changes at the macro-level to relatively fast changes at the micro-level. The concept can be used to identify the developments at different scales that are involved in the transition (fig 1.2).

Originally, the multi-level concept was developed by Rip and Kemp (1998) to understand technological innovation and breakthrough. They discriminated between three different scales: the micro-level, meso-level and macro-level. At each level, they made a distinction between the view of technological systems as tangible technological artifacts that are organized in a 'configuration that works' and the view of technological systems as seamless webs (Hughes, 1987) including social aspects, like networks, rules, financial investors, research programs, etc. The MLC suggests that the technological artifacts and the social aspects co-evolve in terms of variation and selection, which results in user-scripts and fixations on specific technologies at the micro-level. At the meso-level, this manifests itself as a regime of technical systems, sectoral structures and strategic games. This technological regime is embedded in a macro-landscape, in which patterns of transformation of society play out that may change the technological regime, such as globalization or climate change.

The idea of embedded societal levels is also discussed more broadly in institutional economies, for instance by authors such as Williamson. Williamson (2000) points out to the four levels, each level having a different frequency of change and higher levels imposing constraints on lower levels. The top level is where the norms, customs and traditions are located and change over 10^2-10^3 years. At the second level are the formal rules (constitutions, laws and property rights) which change over 10 – 10^2 years. The third level is where institutions of governance are located and deals with contracts and

transactions rules. These elements have a frequency of 1-10 years. The lowest level is about resource allocation and prices. According to Grin (2008b) thinking in multiple levels has important implications for policy as it suggest to focus more on the interlinkages between the dynamics at the various levels and more particularly to the routes, patterns and mechanisms trough which change processes may result.

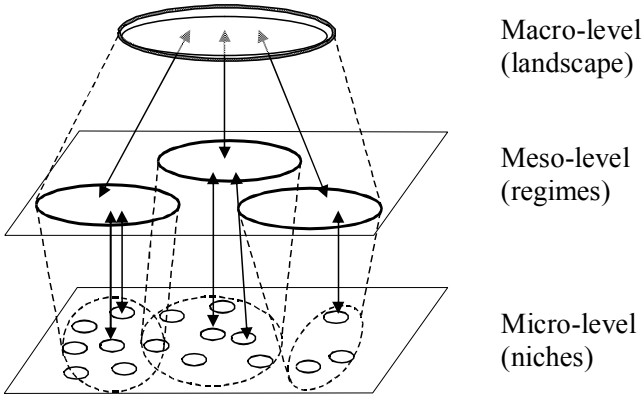


Figure 1.2 Multi-level concept (Geels, 2002). Developments at the macro-level correspond to slow broad societal trends. Dynamics at the meso-level are determined by the regime. The regime is the dominant pattern of actors, artifacts and structures in the social system. At the micro-level, individual persons, organizations, or innovations are distinguished.

According to Rip en Kemp, novelty originates at the micro-level of local practices, however in interaction with a broad context. "Technologies are introduced against the backdrop of existing regimes and landscapes, following diffusion trajectories in which the technology and social context co-evolve under influence of large scale trends" (Rip and Kemp, 1998). Thus, at the micro-level, variations to and deviations from the status quo - such as new techniques, alternative technologies and social practices – are developed as a result of new ideas, new initiatives, or innovations (Rip and Kemp, 1998). This variation is not random, but guided by search heuristics or other promises of success. Innovations themselves are often *neue Kombinationen* (Schumpeter, 1942). Rip en Kemp (1998) argue that the selection environment of the innovation may be "actively modified to increase the survival chances of a search product and " and "one way of doing this is by the creation of a niche or protected space, in which the product can survive more easily—for the time being". Schot (1998a) describes these *niches* as "local alliances, or networks, between the party that produces the new technology and the party that uses it (the sponsor), which shields the development from the existing regime". In this dissertation, we understand

the niche as having simultaneously an element of structure (structure that protects or shields the nichew) and the group of people that occupies the space. Hence, a niche refers to both aspects. However, if we want to focus on either the structure or the people, we will specifically use niche-structure respectively niche-group.

The concept of regime as it was used by Rip and Kemp (Rip and Kemp, 1998) was based on Nelson and Winter's (1977) notion of technological regime, which emphasized that technological advance is to a large extent shaped by the cognitive frames of actors, and which may be understood as a technological paradigm (Dosi, 1982). Rip and Kemp (1998) described the regime as the "rule-set or grammar […] embedded in institutions and infrastructures". Berkhout et al (2004) re-defined regimes as the "dominant cluster of artifacts, institutions, rules and norms assembled and maintained to perform economic and social activities". Geels and Schot (2007) argued that scientists, policy makers, users and special interest groups also contribute to technological development.

The regime concept has a different meaning in other scientific disciplines. In political science, regimes refer to the system of government in terms of the formal laws and regulations, as well as to the informal socio-cultural norms. Krasner (1983) defined regimes as a set of explicit or implicit principles, norms and decision making procedures.

Rotmans (2003, 2005), Loorbach (2007), Van der Brugge et al (2005) and Van Raak (2006) have applied the regime concept to societal sectors, such as the energy sector, agriculture, water management and healthcare (Van Raak, forthcoming). They did not take the technological artifact and its network as the starting point, but the way in which social structures give rise to the fulfillment of particular functions of the sector. They emphasized the cultural aspects and the institutional settings, which led them to define the regime as a 'deep' structure consisting of a dominant culture, structure and practice.

Though all of these definitions tend to emphasize different entities in the regime, they all share a main point, namely that the interconnectedness and interdependence of the entities that constitute the regime creates rigidity and gives rise to barriers for radical innovation. The niches form a way out of this lock-in. One advantage of the regime concept is that it offers a way to address the whole, without needing to individually deal with every actor involved.

De Haan (2007) and De Haan and Rotmans (forthcoming) consider niches and regimes as two different subsystems (or constellations) and each subsystem has its own culture, structure and practice. In addition, they introduced a third kind of subsystem, the so-called niche-regime. The niche regime has passed the stage of a niche, but is smaller than the regime. In the multi-level concept, the niche-regime might be located in between the micro-level and the meso-level. However, one must be aware that these are abstract representations of the behavior of many individual actors, who in most cases will not be acting explicitly with a unified purpose (Rotmans and Loorbach, Forthcoming).

In this dissertation we take the regime definition of culture, structure and practice of a societal system as a starting point, but we also make an adjustment because of the following reasons. In our view, this representation of the regime suggests a rather static entity, while in fact it determines most of the dynamics in the system. Secondly, this aggregated representation suggests a rather homogenous entity, while in fact it is a collection of heterogeneous entities of different nature. Therefore, we will further elaborate on this regime concept and differentiate between the different kinds of regime elements.

In this dissertation, the regime is defined as the dominant set of actors, processes and structures in a system. The structure refers to three different types of structures, namely the cultural, or soft structure, the formal institutional structure and the physical infrastructure. These structures will be further subdivided into different structure elements (see chapter four). Actors are influenced by these structures, but they can also change them by initiating processes. Processes can be seen as series of specific practices. In this way, this view of the regime is consistent with the culture-structure-practice triplet, but emphasizes the role of actors. The advantage of this differentiated regime perspective is that it provides the opportunity to understand the dynamics within the regime and which kind of regime structures are actually changing during a transition. In chapter four we will further outline this new perspective on the regime.

In summary, the application of the MLC to the various kinds of systems has resulted in a 'stretching up' of the MLC beyond its socio-technical origin. The MLC is now used primarily to describe and analyze the history of a particular system of interest, by discriminating between (a) developments in the regime, (b) innovations at the micro-level and (c) long-term trends at the macro-level. The MLF has been applied in a range of case-studies, such as energy (Verbong, 2006), transport (Schot *et al.*, 2000), aviation (Geels, 2006), waste management (Parto, 2007) and water management (Van der Brugge et al., 2005, Brown and Clarke, 2007).

However, a regular misconception is that the levels are absolute, rather than that they depend on the system of interest. A direct consequence of this is that there is no rule as to which kind of entity should be located on which level, but that it depends on the choice of the system of interest. According to Rotmans et al (2004), the multi-level concept is essentially a static concept. It provides a multi-level snapshot of the state of a system at a certain point in time, or a sequence of such snapshots, but it does not 'play the movie'. The concept is not a dynamic concept in the sense that it explains how the system moves from one state to the next. We will come back to this in section 1.4.4.

1.4.2 Multi-phase concept

The second concept in the transition framework is the multi-phase concept (Rotmans et al 2001). The multi-phase concept (MPC) distinguishes between four phases in a

transition and describes the dynamics during each of these phases. The MPC enables us to recognize in which phase of transition a system may be. Using different phases to describe a long-term transition is a common way of approaching transitions and to understand them. For instance, Rostow (1960) described the transition from a controlled economy to a market economy in five phases and the demographic transition (Davis, 1945) consists of four phases (Box 2). Each phase has a qualitative different dynamic. The multi-phase concept distinguishes between the following four phases (fig 1.3):

1. During the pre-development phase, the system dynamics do not visibly change, but the macro-circumstances have changed. Innovations do not break through yet.
2. During the take-off phase, the innovations break through and the system begins to transform.
3. During the acceleration phase, the system transforms structurally. New socio-cultural, economic, ecological and institutional capital accumulates.
4. During the stabilization phase, the system stabilizes into a new dynamic equilibrium.

The multi-phase concept frames a transition as the adaptation process of a societal system to a changing social and environmental macro-landscape. The strength of this four-phase-model is that it provides a relatively simple description of what happens during a transition and it relates to peoples' intuition. The concept suggests a cyclic pattern and so the stabilization phase may be the predevelopment phase of a next transition.

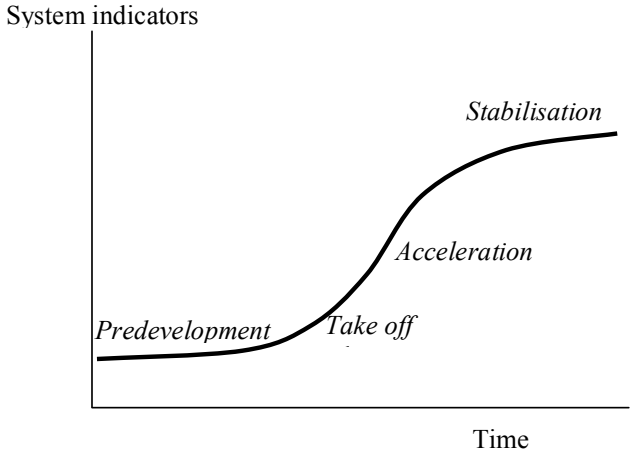


Figure 1.3 The different phases of a transition (Rotmans et al., 2000).

An important assumption of this four-phase model is that transitions are highly non-linear phenomena and which unfold according to so-called punctuated equilibria. The

idea of punctuated equilibria (Gersick, 1991, Gould and Eldredge, 1977) means that there are relatively long periods of relative stability, alternated with periods of instability and rapid change. There is a long pre-development phase and a relatively short period of transformation during the take–off and acceleration phases. According to Gersick (1991), disruption of the dynamic equilibrium is due to two different sources: (1) internal changes that pull parts and actions out of alignment with each other or with the environment, and (2) environmental changes that threaten the system's ability to obtain resources. This is accompanied by the destabilization of the old system and brings a burst of creativity and innovation in the sense of Schumpeter's (1942) creative destruction.

The multi-phase concept should not be used as a deterministic concept, but it represents an 'ideal' transition during which a system adapts successfully via these four phases. It represents an aggregated picture of underlying dynamics and in reality the smooth curve displays all kinds of erratic variation. An important point of debate is whether there may be one generic indicator for the y-axis for all types of transitions. Currently, the indicator differs per transition.

The purpose of ordering the transition into phases is not to forecast the course of the transition through time, but to help us to recognize where we are in the process. However, in its current form it is still rather generic and lacks detail so the main challenge lies in refining the phases. For instance, the pre-development phase, which may take a decade or more, should be divided further into different sub-phases. Another main challenge is to demarcate the various phases, including tipping points (Rotmans et al., 2004, Van der Brugge, 2005).

Box 2. The demographic transition

One of the most extensively studied transitions is the demographic transition (Davis, 1945). This transition describes demographic changes in nations and has been observed in more that 30 countries. Four phases of distinct qualitative different dynamics can be distinguished during this transition, though the duration of each phase varies per country (fig 1.4.a). During the first phase both birth and death rate are high. During the second phase the death rate drops because of increasing hygiene but the birth rate is still high. During the third phase the birth rate drops faster due to contraceptives and women's education. And during the fourth phase, both birth and death rate have stabilized and a new dynamic equilibrium is established. The transition leads to structural change in the distribution of age segments of the population, shifting from a pyramid shape to a peer-shape (fig 1.4b).

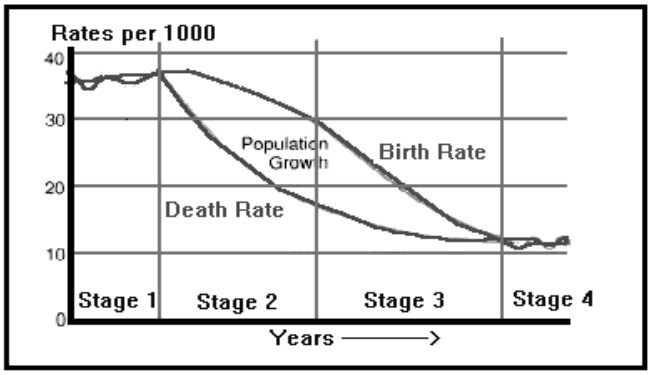


Figure 1.4a The four stages in the demographic transition. In the first stage both birth and death rate are high. In the second stage death rates drops faster than the birth rate. In stage three the birth rate drops faster than death rates. In stage four birth and death rates stabilize, but both are much lower than in the initial equilibrium.

Figure 1.4b Overview of how population structure (age segments) changes.

1.4.3 Combining multi-level and multi-phase

Interlinking these two concepts suggests the following generic pattern of transition dynamics and which simultaneously might be considered the main hypothesis of transition studies (Rotmans *et al.*, 2004). A transition starts with changes at the macro-level. Initially, the regime resists transformative change and only minor changes are made. During the predevelopment phase, niches emerge, presenting innovations in order to anticipate further macroscopic changes. The top-down pressure from the macro-level and the build-up of bottom-up pressure from niches eventually force the regime to change. The take-off is thought to be a crucial phase, because it is assumed that during this phase the system 'chooses' new directions. It is assumed that in the shift from the pre-development to the take-off various niches cross-pollinate each other and cluster into a larger compatible network, or a niche-regime. During the take-off phase the niche-regime expands rapidly. If there is enough pressure, the incumbent regime will destabilize. During the acceleration phase, large amounts of capital are re-allocated and invested in a new economic infrastructure and institutional structure. During the stabilization phase, the large scale transformation slows down and incremental change

takes over as the new regime is built up. This new regime represents a new, but different dynamic equilibrium.

Van der Brugge and Rotmans (2007) summarized this view of transitions as the result of two generic forces:

- The destabilization of the existing regime, due to internal developments and macro-level trends;
- The emergence and up-scaling of niches, contributing to the rise of an alternative regime.

The system is in the dynamic equilibrium as long as both forces are relatively weak. When both forces gain strength, the system begins to change more rapidly. This opens up opportunities for new niches and in turn these innovations can further disrupt the regime by creating instabilities. Hence, both forces reinforce each other, causing an accelerating speed of change. This view, however, means that regimes do not need to destabilize as a whole, but that the different kinds of structures can destabilize and renew.

If we take these two forces as a starting point, it is clear that a transition is only one of many possible trajectories a system can go through. Fig 1.5 shows four possible system trajectories. The first system trajectory is represented by the S-curve, in which initially both these forces gain strength – thus innovations break through and the regime destabilizes – leading to accelerating change. The S-curve implies that after a period of regime re-organization, both these forces decrease, leading to regime stabilization. The second system trajectory is the lock-in path, in which the regime remains stable and so blocks the up-scaling of innovations. The third system trajectory – the backlash - can be considered a special case of lock-in; niches appear to break through, but then after a while the niche-regime destabilizes and the system will return to its earlier state. The last system trajectory mentioned here is system breakdown. This is the case when the regime destabilizes, but there are no suitable niches that could take over. Further breakdown can be the result of progressive de-alignment of actors or depletion of resources.

Smith, Berkhout and Stirling (2005) have raised three concerns with regard to the view of transition dynamics put forward by the multi-level and the multi-phase concept. They argued that this view is uni-linear, since it tends to over-emphasize the process of niches scaling up and to downplay the processes within the regime or landscape that operate downwards. Secondly, they regarded it as uni-valent, since it underplays the problematic nature of political intentionality and choice, power and strategic behaviour. Thirdly, they considered it to be uni-dimensional, since it disregards different transition contexts. Transitions could be driven internally as well as externally, and due to contingency as well as deliberate action. They thus argued that there is a much greater plurality of possible transition pathways, which triggered the search for other dynamical patterns of transitions. Rotmans et al (2004) argued that an additional concept was needed in order to account for the different dynamic patterns that can give rise to a transition

and to explain the dynamics of transitions. Rotmans et al (2004) refer to this search for patterns as the search for the multi-pattern concept. This concept is the third concept in the transition framework and will be discussed in the following section.

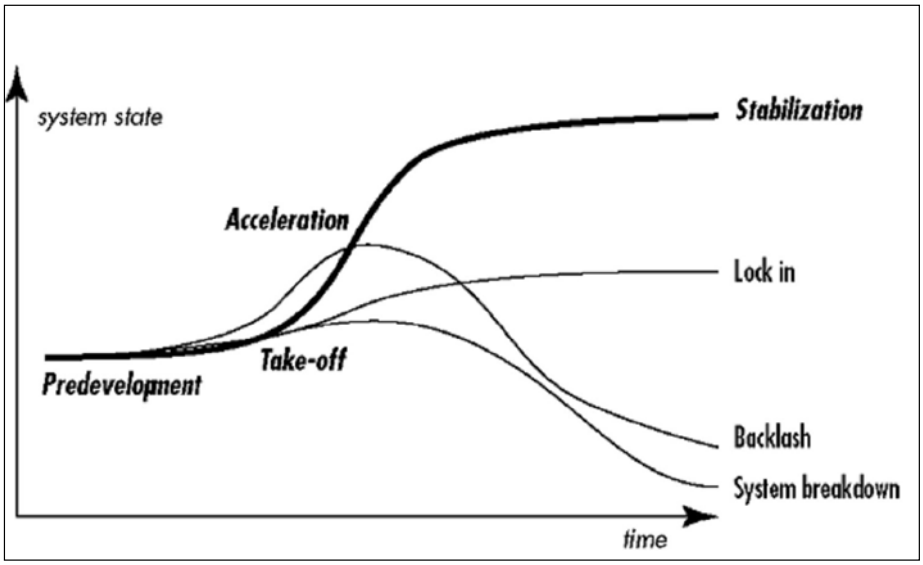


Figure 1.5 Four possible system pathways. The transition is the desired pathway in achieving sustainable development. However, the complexity of the interaction processes limits control over societal developments which may lead to less desired pathways, such as the lock-in, the backlash or the system breakdown.

1.4.4 The multi-pattern concept

The multi-pattern concept aims to describe the way in which systems transform (Rotmans et al., 2004, Rotmans, 2005). The multi-pattern concept distinguishes between different patterns of transformative change. A pattern of transformative change refers to how a certain transformative change is taking place, for instance through a bottom-up dynamic or a top-down dynamic. The multi-pattern concept can be used to describe a transition as a series of different patterns of transformative change. An underlying hypothesis is that a transition can be explained by only a limited set of patterns of transformative change.

Currently there are two different approaches that are associated with the multi-pattern concept. One is the 'Typology of transition paths' developed by Geels and Schot (2007), the other is the 'Pillar theory' developed by De Haan (2007) and De Haan and Rotmans (forthcoming).

Geels & Schot (2007) based their typology of transition paths on a database of case studies describing historical transitions. They found two crucial aspects, namely the nature and timing of interactions between the levels. With the *nature of the interaction* they mean that niches and the macro developments can disrupt (pressurize) the incumbent regime, or that they can have a symbiotic interaction with the incumbent regime. *Timing* refers to whether the niches have matured enough to replace the regime when the macro developments occur. The macro developments themselves can be shocks or trends, affecting single domains or multiple–domains of the incumbent regime. Based on their case study work, Geels and Schot identified four different transition paths. The first path is the *Transformation* path, which occurs in the case of moderate landscape pressure and when niches have not yet matured sufficiently. The regime actors have to respond themselves, which is the trigger for other actors to respond and change as well. Over time, the changes add up to a transformation of the regime. In the second pathway - the *Technological substitution* pathway - there is a heavy macro pressure and the niche has developed sufficiently. In this pathway the niche replaces the incumbent regime. The third pathway is the *De-alignment / Re-alignment* pathway. This path occurs when there is a heavy macro level pressure, but niches have not matured enough. Geels and Schot (2007) suggest that in this case regime actors may lose faith. This may lead to a de-alignment in the regime which brings opportunities for new niches. Eventually, the actors re-align and a new regime is established, including new actors. The last pathway they distinguish is the *Reconfiguration* path. During this pathway niches are adopted, which triggers the emergence of new niches. This path suggests a rather continuous renewal of the regime.

The second approach is developed by the De Haan (2007) and De Haan & Rotmans (forthcoming). Their patterns of change were theoretically derived through combining the multi-level concept with insights of complex adaptive systems theory (e.g. Gell-Man, 1994, Kauffman, 1995, Holland, 1995), which led to a typology of three generic patterns of transitional change. According to De Haan (2007) and De Haan and Rotmans (forthcoming) transitions can be described and explained by these three different patterns of transformative change. The rationale behind these three patterns is that a transition can be the result of a either a small scale niche that expands and replaces the incumbent regime, or a large scale alternative that is somehow forced upon the system. The incumbent regime is responding to these changes through adaptation. This leads to the following three patterns of transitional change.

The first pattern is called *Empowerment*. This pattern describes how a small scale niche grows and eventually replaces the incumbent regime. This is one pattern of how niches can scale up (Van der Brugge, 2005). The niche-regime competes with the incumbent regime and eventually takes over. The second pattern is called *Re-constellation*. This pattern describes how a large scale alternative is forced upon the regime. An example of this

pattern is a large scale reform of a sector or the implementation of a radical alternative national policy. This pattern implies a powerful actor who has the power to impose the change. A third pattern they have identified is called *Adaptation*. This pattern describes how the incumbent regime responds to niches which may happen in two ways. The incumbent regime adopts the innovative ideas or products, which leads to a change of the practices. This is called niche-absorption and may be seen as a second pattern of how a niche may scale up. In the case of a niche-regime, the incumbent regime co-evolves with a niche-regime and both adopt certain aspects of the other (co-evolution).

According to De Haan (2007) and De Haan & Rotmans (forthcoming) these patterns of transformative change work simultaneously in an intertwined manner, but unraveling complex transition processes into these patterns help us to understand transitions. However, these patterns are still rather abstract and generic and there is a need to empirically ground them.

Moreover, these patterns of transformative change help us to understand *how* the regime is transforming, but they do not provide us with information on *what* is changing in the regime. During a transition, different kinds of regime structure need to change and as we have suggested earlier, these structures can be cultural, institutional and infrastructural. It is not clear yet if each of these structures should change, when they should change, or how they are related to the patterns of transformative change.

Therefore it is necessary to further develop the multi-pattern concept into this direction. In this dissertation, we will develop the patterns described by De Haan (2007) further and focus on which kind of elements of structure are changing during a transition. We will come back to this in section 1.5, but we will first discuss the fourth concept in the transition framework: transition management.

1.4.5 Transition Management

The fourth concept in the transition framework is transition management (TM). This concept is not used to explain transition dynamics, but attempts to understand how the pace and direction of a transition can be influenced. Rotmans, Kemp and others (2000, Rotmans et al., 2001) have introduced the concept of transition management into the field of sustainability, governance and policy. Since then others have contributed to its further development (e.g. Loorbach, 2007, Dirven, 2002, Van der Brugge and Rotmans, 2006, Loorbach and Van Raak, 2006). Transition management may well be considered to be more than just a concept. It has been applied in a number of cases in the Netherlands, among which Parkstad Limburg (Loorbach, 2007), the energy sector (Loorbach and Kemp, 2005), healthcare (Van Raak, 2009, forthcoming) and the waste sector and housing sector in Belgium (Loorbach, 2007). Loorbach (2007) refers to transition management as a 'new governance mode for sustainability for resolving persistent societal problems'.

Transition management can be characterized as a joint search and learn process though envisioning, experimentation, and organizing multi-actor coalition of frontrunners (Rotmans, 2005, Loorbach, 2007). The underlying assumption is that while full control and management of transitions is impossible, it is possible to 'manage' transitions in terms of adjusting, adapting and influencing the direction and pace (Rotmans and Loorbach, 2007). Transition management is explorative and design-oriented and attempts to link the 'content' and the 'processes'. This link is established by organizing a participatory process and to let the participants analyze the problem at hand, to let them develop a long term sustainability vision, and to let them set up experiments. In effect transition management comes down to creating space for frontrunners in so-called transition arenas, forming new coalitions around these arenas, driving the activities in a shared and desired direction and developing a social movement that puts pressure on regular policy (Rotmans, 2003) and developing so-called testing ground for experimentation in which a temporal exemption of rules and laws is allowed (Avelino, submitted). An important point of debate is the notion of selection of frontrunners for the arenas. The literature lacks a good account of how to identify frontrunners and to what criteria they should comply. In addition, it is not clear who the 'critical actors' are who is make the actual selection of participants, which raises a number of ethical concerns, in particular the legitimacy of the transition arena (Shove and Walker, 2007).

The theory of transition management has two underlying concepts: a descriptive and a prescriptive concept (fig 1.6). The descriptive concept distinguishes between three

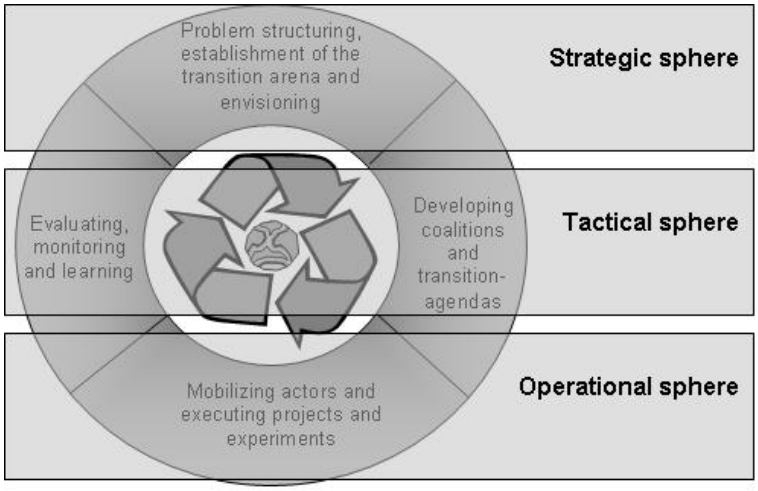


Figure 1.6 Transition management is a cyclical coordinated multi-actor process at strategic, tactical and operational levels and is organized around four co-evolving activity clusters (1) the establishment and development of a transition arena, (2) the creation of long-term integrated visions, transition pathways and agendas, (3) mobilizing actors and knowledge development through experimenting and (4) monitoring and evaluating the transition process (Loorbach and Rotmans, 2006).

innovation spheres: the strategic, tactical and operational innovation spheres. These spheres were originally labeled as TM-layers by Loorbach (2004, 2007). The prescriptive concept is a cyclic process design of activities connecting these spheres, developed by Rotmans & Kemp (2001) and Loorbach (2007). The activities associated with the innovation spheres focus on different aspects. In the strategic sphere, the activities and developments aim to change *cultural aspects,* such as values, identity and ethics. The activities include vision development, strategic discussions, long-term goal formulation, collective goal and norm setting. In the tactical sphere, activities relate to change of structures, such as resource distribution, rules, incentives and other institutional arrangements. The operational sphere includes activities linked to practical experiments. These activities are often embedded in innovation programmes and have shorter time horizons. In each of these spheres, people have a different focus, problem scope and time scale (table 1.1). Table 1.2 lists the competences required in each sphere (table 3).
An important insight derived from this descriptive distinction is, that there is a need for coordinated activities across spheres in order to scale up the niches. In practice, the activities run largely parallel. If spheres interact too little, developed alternatives might remain isolated. Often, innovation is not properly embedded as a result of the tension with cultural and structural elements (Bijker *et al.*, 1987).

Table 1.1 Management spheres distinguished within transition management literature. Between the spheres, management activities differ in focus, scope and time scale (adapted from (Loorbach and Van Raak, 2006)).

TM sphere	Focus	Problem scope	Time-scale
Strategic	Culture	Abstract/societal system	Long-term (30 y)
Tactical	Structures	Institutions/regime	Mid-term (5-15y)
Operational	Practices	Concrete/project	Short-term (0-5y)

Table 1.2 Distinctive capabilities of actors for each TM sphere. Note that some capabilities, such as communication learning and Leadership skills are present in all spheres, see (Loorbach, 2007) for full table.

Sphere	Distinctive capabilities of actors
Strategic	Systems thinking, creativity, integrative skills
Tactical	Co-production, negotiation, consensus building, and networking skills.
Operational	Project management and entrepreneurial skills,

Rotmans et al (2001) and Loorbach (2004) developed the prescriptive framework, or TM-process cycle to structure and coordinate between these activity spheres. The TM-cycle consists of four activity clusters (figure 1.6): (1) the establishment and development of a transition arena; (2) the creation of a shared problem perception, long-term integrated visions, transition pathways and agendas; (3) mobilizing actors and knowledge

development through experimenting; and (4) monitoring and evaluating the transition process, resulting in adjustment of the problem perception and potential solution paths in a next cycle. Central to the cycle is learning-by-doing. The TM-cycle is not meant as a blue-print for action, but is put forward as a guideline, or 'logical order of reasoning'. Again, in practice the activities run parallel instead of sequentially. The TM-cycle must always be adapted to the local circumstances. For instance, TM processes usually start with strategic arenas, then link up with tactical and operational networks. However, if operational networks already exist, then the strategic arena could be useful in evaluating whether all topics have been covered, or which kind of learning experiences might be worthwhile in addition. Regardless of its starting point, communication between the clusters is important throughout the cycle.

Some of the criticism revolves around the claim that TM enables us to manage transitions. However, transition management should not be understood as the ability to control transitions as the term 'management' might imply. From early on, the complexity and uncertainty in transitions have been acknowledged and therefore the highest ambition is to *influence* transitions in terms of pace and direction by creating the conditions under which transformative change may occur. An important aspect of TM is experimentation with a set of alternative options and to organize multi-actor coalitions around such experiments and to let them mature. Meadowcroft (2007) argues that while the literature on transition management is clear about keeping alternative options open, it is less clear about how to choose among options in a later stage. If decisions need to be made among alternatives, one enters the realm of politics and democratic legitimacy. He points out that transition management literature is lacking a good account of the politics involved and therefore he concludes that transition management is especially "good at opening up stable systems".

Transition management attempts to do so by organizing a so-called *shadow track* next to the normal policy process (Rotmans et al., 2001) in which there is 'room' for long-term anticipation and experimentation. Within the shadow track the intention is to explore sustainable alternatives. The initial idea to organize TM as a shadow-track was born from the experience that long-term sustainability issues could not be adequately addressed within 'normal' policy arenas (Rotmans, 2003). Therefore, transition scholars argued that long-term sustainability issues required so-called 'transition arenas' as a counterpart to normal short-term policy arenas. A transition arena can be defined as "informal group of frontrunners" (Rotmans et al., 2001, Loorbach, 2007) who "reach consensus with each other about the need or opportunity for systemic change and coordinate amongst themselves to promote and develop alternatives" (Loorbach and Van Raak, 2006).

This is close to what Olsson et al (2006) found in their synthesis of five case studies about transformation in social-ecological systems. They showed that a successful transformation of local governance networks was associated with 'shadow networks'.

According to them, such informal networks were important in exploring new system constellations. Gunderson et al (2006) refer to these groups of people as 'arenas for discourse'. In this dissertation we refer to these spontaneously emerging arenas as *policy niches,* because these type of niches aim to develop a new policy perspective. The actual policy change is due to the interplay between these people and an enabling regime context (Brown and Clarke, 2007). Transition management suggests ways as to how to deliberately organize such arenas (Van der Brugge and Van Raak, 2007). Although this dissertation is primarily concerned with the dynamics of transition, we will address the implications for transition management and we will make recommendations.

1.5 Research questions

The main objective of this PhD-research was described earlier as to generate insight into the dynamics of transitions and more specifically to generate insight into the transition of Dutch water management. Now we can be more specific as to what is needed to fulfil this objective.

As we have seen, the multi-level concept, the multi-phase concept and the multi-pattern concept are important starting points to study transitions. These concepts address different aspects of a transition, but they also have limitations. The multi-level-concept is a static concept and not a dynamic concept showing how the system moves from one state to the next. In addition, there is an underlying assumption that the regime is rigid and inhibits transformative change. The multi-phase concept is in its current form too generic and abstract and essentially describes only one pattern of transformative change. This limitation is partly addressed by the multi-pattern concept. However, the identified patterns are still rather generic and abstract and there is a need to empirically ground them.

Furthermore, these patterns describe *how* a regime might transform, but they do not describe *which* kind of regime structures are changing during the process. However, in order to explain transition dynamics it is crucial to understand what actually is changing. We therefore argue that the question of which structures are changing should be an integral part of the multi-pattern concept. A more refined objective of this research is therefore to generate insight into the kind of structures that are changing and to further develop the multi-pattern concept. The overall hypothesis is that if we know which structures are changing and as a result of which kind of dynamic pattern, we may better explain how transitions unfold. This leads us to the following main research question:

Can we describe and explain transitions by identifying the different structures that are changing and by identifying the underlying patterns of transformative change?

In order to answer this question, we will further develop the multi-pattern concept and develop a new transition analysis approach that allows us to analyze the structures that are changing during a transition and to analyze the underlying patterns of transformative change that give rise to these changes. Applying this approach to the transition in Dutch water management will generate insight into the dynamics of this transition and will contribute to our understanding of transition dynamics in general. The main research question can be subdivided into the following four sub-questions. The first question is:

Sub-question 1: How can we further develop the multi-pattern concept?

The first step in this research is to further develop the multi-pattern concept. To this end, we will use insights of resilience theory. Resilience theory (Holling, 1973, Gunderson and Holling, 2002, Folke, 2006, Walker et al., 2004) - like the transition framework - represents a way of thinking about structural change, renewal and re-organization (Folke, 2006). The resilience theory is concerned with a specific type of system, namely a social-ecological system (SES), which is comprised of a societal and ecological dimension. Berkes and Folke (1998) started to use the term 'social-ecological system' to emphasize that the delineation between social and ecological is artificial and arbitrary. In this dissertation we focus on Dutch water management, which may be perceived of as a social-ecological system (i.e. the water system and the water governance system). The social and the ecological dimensions co-evolve, and cannot be understood independently from one another (Norgaard, 1994).

The resilience theory consists of a conceptual framework of four underlying concepts: stability domains, the adaptive cycle, panarchy and adaptive management. In the remainder of this dissertation we refer to this conceptual framework as the resilience framework. The concept of stability domains refers to the idea that the (deep) structure and the function of a system can be maintained only within certain boundaries (that of the stability domain) (Holling, 1973, Scheffer et al., 2001). Crossing these boundaries results in a structural transformation. The adaptive cycle is a concept that describes the evolution of ecosystems as a cycle of exploitation, conservation, release and reorganization. The panarchy concept is a further elaboration of the adaptive cycle adding multiple levels of organization and cross-scale interactions. Although these concepts are originally ecological concepts, they now are used to describe and explain the dynamics of social-ecological systems as a whole (Gunderson and Holling, 2002). The last concept is adaptive management, which is an ecosystem management approach concerned

with continuously monitoring the ecosystem dynamics and adapting the management strategies.

We will explore the resilience framework as to how it may enrich the transition framework. This synthesis will lead to a conceptualization of the phenomenon of transition grounded in systems theory and a further elaboration of the multi-pattern concept. An additional outcome of this exploration will be a comparison of the resilience and the transition framework. Both frameworks are gaining importance in the field of sustainability, so it is important to understand how both frameworks are related from a scientific and from a policy point of view, and to understand how both communities can benefit from each other. We will deal with this in chapter three.

Sub-question 2: How can we translate the multi-pattern concept into a generic approach to analyze transitions?

Since the field of transition studies is relatively new, there is not yet a validated method on how to analyze transitions (Genus and Coles, 2008). Therefore, the second step in this research is to translate the developed multi-pattern concept into a generic approach for a transition analysis. This approach should enable the analyst to identify the changes in the structures of the regime and to identify the patterns of transformative change that give rise to them. In order to identify the regime changes, we will need to develop a new regime conceptualization that is able to differentiate between different actors, processes and regime structures and provides insight in how actors may influence them. Therefore the first part of the approach will consist of a generic method for a regime analysis, which can be applied to analyze the regime of a specific system of interest. The second part of this approach focuses on the dynamics and should enable the researcher to analyze the pattern of transformative change in terms of the actors involved, the key-processes influenced and structures changed. We will deal with the development of this approach in chapter four.

Sub-question 3: If we apply this transition analysis approach to the transition in Dutch water management, does it generate insights into what is changing during a transition and how these changes come about?

In order to 'test' this approach we will apply it to the transition in Dutch water management. The Dutch water management has changed fundamentally over the past four decades, providing a good opportunity to study transition dynamics. The shift can be understood as the transition from a technocratic and sectoral water management towards integrated and interactive water management (Van Ast, 2000). De Wit (2000) labeled this shift as from "stemming water" to "embracing and accommodating water". The transition involves two major policy shifts. The first policy shift is towards integrated water management, which integrates water quantity and water quality. This

shift emerged as a result of increasing environmental awareness. The second shift is towards the water policy of the 21st century, which focuses on enlarging the space for water retention in anticipation of climate change. By applying the transition analysis approach we will generate insight into the patterns of transformative change that gave rise to the changes in the regime structures. In doing so, the patterns will be empirically grounded and we will gain a deeper understanding of how this transition unfolded. We will deal with this in chapter five.

Sub-question 4: Can we identify essential aspects of niche-regime dynamics?

The fourth sub-question is concerned with niche-regime dynamics. The niche-regime dynamic is an important aspect of the transition dynamics and so it is crucial to improve our understanding of how this works. In chapter four we will elaborate and redefine the regime and niche concept and develop the so-called double-loop concept for understanding niche-regime dynamics. We will apply and test the concept in case study two and three (chapter six and seven) which will lead to a more detailed understanding of their dynamic. In the case study of Amstelland, a region in the mid-west of the Netherlands, we will analyze the niche-regime dynamics in which the niche is created by the regime itself (chapter 6). In the case study of Rotterdam, the second largest city in the south-west of the Netherlands, we will analyze the niche-regime dynamics in which the niche comes from outside the regime (chapter 7). Both the case studies are concerned with Dutch water management and show how the new Water policy for the 21st century is currently implemented and illustrate the gap between the ambitions on the one hand, and the complex reality on the other.

In chapter 8, we will reflect on the developed multi-pattern concept, the developed approach for a transition analysis and what we have learned about the transition dynamics. In addition, we will reflect on what this means for transition management and how this approach can be used in a transition management process. Finally we will draw the main conclusions of this research and provide recommendations for future research.

Chapter 2

Methodology

2.1 Introduction

This chapter outlines the research methodology that was used to address the research questions formulated in chapter one. This research consists of four parts. The first part deals with the theoretical synthesis of the resilience framework and the transition framework in order to develop the multi-pattern-concept further (section 2.4). The second part deals with translating the multi-pattern concept into a new approach for analyzing transitions (section 2.5). The third part consists of a transition analysis of the Dutch water management sector by applying this approach in order to generate insight into the dynamics of this transition (section 2.6). The fourth part is concerned with a more detailed analysis of niche-regime dynamics.

Before we outline these four parts in more detail, we will address two methodological considerations concerning this research. The first is about the explorative nature of this research (section 2.2) and the second about using complex systems science and the resilience framework as a point of departure (section 2.3).

2.2 The nature of this research

Before we outline the four research steps, we should address the explorative nature of this research. The field of transition studies is relatively new and is therefore still relatively open and unexplored. The transition framework, as described in chapter one, is considered to be a theory-in-development. The literature on transitions is predominantly descriptive and moreover, the concepts in the transition framework themselves are provisional and need to be further developed before specific hypotheses can be formulated and tested. Working with provisional concepts means that they can only be 'tested' in a relative sense by applying them and adjusting them during the research process (Glaser and Strauss, 1967). Testing thus takes place through a combination of pattern identification (i.e. reconstructing historical events and developments in a chronological order and tracing the change processes) and pattern matching (i.e. comparing empirical transition patterns with theoretically expected transition patterns) (Rotmans *et al.*, 2004). According to Maxwell (2005), this kind of qualitative research often involves a continuous cycling back and forth between the different components of the design (i.e. goals, theoretical framework, research questions, methods and validity).

According to Rotmans et al (2004), the transition framework cannot be falsified in the strict 'Popperian' sense in this stage of development. Popper ((1959) argued that theories are not truths, but are simplified models of reality that help people to solve problems. According to him, there was no rational way to verify or confirm a scientific theory. Single instances do not mean that the theory is right; for instance, because the sun rises

every day it does not mean that tomorrow it will rise too. Instead Popper argued that only counter examples are logically decisive in showing the theory is false. However, in order to falsify a theory a set of causal mechanisms or theoretical propositions should be formulated which explain certain phenomena or predict certain outcomes. These kinds of claims have not yet been found in the transition literature. On the one hand, this is due to the field being so young, but on the other hand, it is the due to the nature of the field, which deals with complex issues that are inherently uncertain and defy simple explanations or predictions. In the next section we will deal with this further.

In this research, we have further explored the field of transitions by combining the approach of pattern matching with the approach of pattern identification in the empirical case studies. This PhD-dissertation is the result of this exploration.

2.3. Complex systems science and the resilience framework

2.3.1 Complex systems science

Studying transitions means dealing with open systems in which the dynamics are non-linear and are the result of interacting actors in response to different developments at different scales. Therefore, the starting point of this research was that we could not comprehend transition dynamics by using a reductionist approach and that we needed a systems perspective. Reductionism generates knowledge and understanding of phenomena by breaking them into smaller parts and by studying these single parts in terms of cause and effect. In contrast, system theorists argue that phenomena are emergent properties of the interrelated whole and that valid knowledge and meaningful understanding comes from building up whole pictures of phenomena and not by breaking them into parts (Flood, 2001). The first system approaches emerged during the 1950s as a criticism on reductionism.

At the most fundamental level a 'system' is a unit made up of organized elements. Hall and Fagan (1956) define a system as a set of objects, together with relationships between the objects and between their attributes. This definition discriminates between the set of objects that can be related in many ways and the system of interest that is built from that set of objects but with specific relations (Marchal, 1975). A systems approach enables an observer to deal with elements of a different nature in coherence.

However, applying a systems approach to society, that is, defining a societal system in terms of objects, relations and system boundaries, is inevitably controversial (Checkland, 1981). In addition, Churchman (1997) argued that all such boundary judgements are essentially based on the value judgements of the observer. In this respect, system approaches should be perceived as a way to facilitate debate among stakeholders using

subjective system models to capture the possible perceptions of the world, instead of as a way to model the objective 'truth' (Churchman, 1997, Flood and Jackson, 1991). Senge (1990) and Midgely (2000) therefore use the term 'systems thinking'. Flood and Jackson (1991) argue that systems thinking can help us to deal with the complex reality.

The origins of the systems approach can be traced back to Ludwig von Bertanlanffy (1956) who argued that science had no theory of organization and in response developed a General Systems Theory (GST). GST assumes that systems of many kinds share common characteristics that can be described mathematically (Von Bertalanffy, 1956). Using GST, one can study systems as general phenomena obeying general laws, which can be applied to different kinds of systems (i.e. biological cells, society, planetary systems), which generates insight into the specific functioning of such systems.

In the 1960s and 1970s system dynamics arose as a technique for dealing with systems composed of many entities and feedback loops (Forrester, 1969). In system dynamics a key distinction is between state variables (stocks) and rate variables (flows). Stocks represent the state of a system at an arbitrary point in time and they change relatively slowly. Flows represent processes that relate the various stocks to one another and change relatively fast. A system is a composition of interrelated stocks and flows. The first system dynamics models were highly deterministic and purely quantitative. In the 1970s and 1980s integrated systems theory became an important field, focusing on the integration of social, economic and ecological processes (Rotmans, 1990, Hordijk, 1985). An integrated systems approach aims to integrate physical, economic, sociocultural (and sometimes financial) stocks and flows. Gradually the integrated systems approach came to address the uncertainties more explicitly. During the 1980s, the 'soft' systems approaches emerged, taking a qualitative approach rather than a quantitative and mathematical approach, mostly applied to companies and organizations (Senge, 1990). During the 1990s the field of Integrated Assessment (IA) emerged, in which an integrated systems analysis is embedded in a participatory process to inform policy makers. Advancements in the studies of participatory methods within the IA community suggested that Integrated Assessments required different kinds of knowledge, not only expert knowledge but also tacit knowledge of stakeholders. IA-models captured only a part of complex reality and should be complemented with narratives and process knowledge to better represent the complex reality (Weaver and Rotmans, 2006).

Complexity theory, or complex systems science, was introduced in the 1990s as well. Complex systems science is an interdisciplinary field of science that studies the nature and dynamics of complex, open systems (e.g. Cilliers, 2005, Stacey et al., 2000, Prigogine and Stengers, 1984). A societal system can be seen as a specific kind of complex system, namely a complex adaptive system (CAS). In a CAS, the constituents are agents who can adapt to changing circumstances by choosing among a set of strategies. Complexity theory has attracted a great deal of attention and has many applications in diverse re-

search fields: in biology (Kauffman, 1995), economics (Arthur, 1999), ecology (Gunderson and Holling, 2002, Kay et al., 1999), public administration (Kickert, 1991, Teisman, 2005, Geldof, 2002) and policy analysis (Rotmans, 2005).

Complex systems science, however, is not clearly defined. We identified four broad categories in which it manifests itself, which are: (1) formalized and computational modeling approaches, (2) a set of 'understandings' of the behaviour of complex systems; (3) a metaphorical use of complexity concepts to describe social phenomena; and (4) philosophical considerations about the ontology and epistemology of complex phenomena. This dissertation primarily falls under the second and the third category. Murray (2003) argues that complexity theory has three potential impacts in the social sciences: as a mathematical model, as a metaphor and as an explanatory narrative. However, Rosenhead (1998) argues that complexity theory in the social science still has to pass the level of metaphor.

In this research, we have used the complex systems perspective primarily to structure our own thinking about societal systems. Van der Brugge and Rotmans (2007) identified the following general characteristics of complex adaptive systems (based on (Holling, 1987, Prigogine and Stengers, 1984, Holland, 1995, Kauffman, 1995):

- *Complex adaptive systems are open systems*. They interact with their environment via continuous exchange of matter, energy and information.
- *Complex adaptive systems have many and diverse components*. Some of these components are agents. Agents interact with each other in a network. Agents are able to respond to their environment by changing strategies.
- *Complex adaptive systems change in a non-linear fashion*. Positive and negative feedback loops give rise to amplifying or dampening effects.
- *Complex adaptive systems may have multiple attractors with stability domains. Dynamic* systems evolve towards attractors. The stability domain (or the basin of attraction) gives rise to resilience: the ability of the system to absorb disturbances and return to the same attractor.
- *Complex adaptive systems have an evolutionary or co-evolutionary drive of variation and selection.* Agents co-evolve with the system as a whole. This may lead to irreversible pathways as well as to the creation of new attractors.
- *Complex adaptive systems exhibit self-organization*. The structure of the system is the result of internal dynamics (i.e. agent-interaction) and not the result of an external power imposing that particular organization, like in a machine.
- *Complex adaptive systems may have emergent properties.* A complex adaptive system may have different levels of organization. Higher levels are comprised of components which themselves are complex adaptive systems. Higher levels can exhibit properties that do not exist at the lower levels.

Some scholars have argued that with the rise of complex systems science a new scientific paradigm is emerging, emphasizing the end of Newtonian determinism and the end of certainty (Prigogine and Stengers, 1984). Complex systems science has important epistemological implications, especially with regard to the kind of societal systems we are dealing with in this dissertation. It emphasizes the following limitations to our knowledge and scientific practice:

- *Ignorance*: it is impossible to know or understand the whole system;
- *Perspective*: understanding of the world is limited by one's own individual mental frame;
- *Structural uncertainty*: it is impossible to know what we might learn in the future;
- *Measurement*: there is always a measurement error.

Essentially, this means that no single model is capable of capturing the complexity of reality to its full extent. Cilliers (2005) therefore, calls for modesty in the claims the researcher can make. Complexity requires a multitude of different models, all capturing different dynamic features. We agree with Cilliers' statements and in this research we therefore do not claim that we can capture the full complexity of transition dynamics, but that we can only attempt to capture some essential aspects of the dynamics.

There is a long tradition of using insights from other kinds of systems to understand societal dynamics (for instance, the clockwork, the machine and the human body). However, according to Sawyer (2005), these earlier attempts were inadequate because the models and formalisms were originally developed for natural systems. One of the main concerns of a systems approach which is built on understanding of the natural systems is that it places too much emphasis on structure and function (Flood, 2001). Mittleton-Kelly (1997) argues that while behaviour in natural systems may be governed by laws, the very awareness of such laws in human systems may generate change behaviour. Vickers (1983) argued that in human systems, the subsystems may be in conflict with the wider system which makes human systems fundamentally different from natural systems.

Sawyer (2005) argues that the more recent complexity theory, with its focus on emergence from agent interaction, is more suitable for a social systems theory. The view presented by complex adaptive systems can link the macro-level sociology concerning the societal structures (functionalist view) with the micro-level sociology of agency and motives of individuals (interpretative sociology). It is also more in line with Giddens' Structuration theory (1984), which states that social practice has both a structure and an agency component. The structural environment constrains and enables individual actions, but it is also created and reinforced through these actions. Agency and motives can lead to the creation of new social structures, which makes new social practices possible. This 'duality of structure' can, at least to some degree, be simulated in complex

adaptive systems, in which agent interactions lead to global structures that influence local agent interactions.

One important criticism of complexity theory is that the insights are mostly generated by simple computer simulation models and that it lacks empirical grounding (Horgan, 1995). These models use a too simplistic representation of the agents and the structures for understanding the complex reality of societal systems. Rotmans and Loorbach (Forthcoming) propose to complement the key elements from complex adaptive systems theory with key elements from the field of Integrated Assessment. They refer to this as a complex, integrated systems approach, which attempts to combine a more realistic account of the physical, institutional and infrastructural elements with heterogeneous actors. This dissertation puts forward some suggestions in this direction.

2.3.2 The resilience framework

In this dissertation we deal with water management. Water management can be understood as a social-ecological system (SES). As described in chapter one, SESs are systems comprised of an ecological part and a social part and since both parts co-evolve they cannot be dealt with independently (Norgaard, 1994). The interactions in these human-environment systems are complex and unpredictable. Indeed, Ostrom et al (2007), in the context of the governance of social–ecological systems, warns us to not fall in the trap of a panacea. A panacea refers to a blueprint for a single type of governance system, or solution that is applied to all environmental problems. In a comparative study of local common pool resource management systems, Ostrom discovered no specific blueprint of successful common-pool resource management, however, what she did found was that maintaining clearly defined boundaries and collective efforts to monitor inappropriate behavior repeatedly presented themselves in successful common-pool resource regimes (Ostrom, 1990). Therefore, the governance systems in an SES should be adapted to the specific context as a polycentric institutional arrangement and multi-actor decision making unit (Ostrom, 1996).

The resilience framework is a leading framework to understand the dynamics in SESs, but according to Holling (2001) and Folke (2006) the resilience framework is also a sophisticated framework for understanding and dealing with the dynamics of complex adaptive systems more generally. The framework has been initially developed by ecologists during the 1970s and 1980s, but during the late 1990s and early 2000s they shifted their attention towards the social realm, e.g. to social-ecological systems. Although this community might be considered to be a different scientific community than the community studying complex adaptive systems, many of the concepts, such as attractors, stability domains and hierarchies (Allen and Starr, 1982, Levin, 1992) are used in both

fields. Therefore, the resilience framework can be seen as a part of complex system science.

The resilience framework is based on a specific view of complexity. According to Holling (2001) there are two approaches in dealing with complexity. The first view of complexity is that it is anything we do not understand because the numbers of interacting elements is too large. The appropriate way then is to embrace the complexity and uncertainty by analyzing subsets from different perspectives. An alternative view, which is adopted by the resilience community, is that the complexity is the result of a smaller number of controlling processes. These processes establish a persistent template upon which a host of other variables exercise influence. These subsidiary variables or factors can be interesting, relevant and important, but they exist at the whim of the critical controlling variables (Holling, 2001). In this dessertation we take this second approach as a way to deal with complexity.

Much of the early resilience literature is about ecosystems and their capacity to absorb shocks (i.e. ecological resilience) (Holling, 1973). Only recently is the resilience framework applied to *social*-ecological systems and used in the field of disaster management and vulnerability assessment. In this respect, it is still a hypothesis as to what extent the framework adequately describes the dynamics of the social subsystem (Gunderson and Holling, 2002). In this way, Folke (2006) portrays a modest stance by arguing that the resilience framework represents a 'way of thinking' about the relationship between sustaining (desirable) system structures, renewal of undesired system structures, disturbances and the possibilities these disturbances open up for innovation.

We found the resilience framework a promising starting point, which in our view falls under the banner of complex systems science. The framework can provide us with insights into the dynamics of social-ecological systems. The resilience framework puts forward a way of thinking about the interaction across scales and so helps to interpret the multi-level concept. It is concerned with the capability of SESs to adapt to a changing environment through continuous re-organization and in this sense provides insight in how regimes re-organize during transition and how this may be improved. As such, the basic research question of the resilience community and the transition community are closely related, namely to understand how complex adaptive systems sustain and renew themselves and how and to what extent this can be managed. By integrating the insights from the resilience framework and the transition framework we could contribute to both frameworks and strengthen their theoretical base. We will come back to this in section 2.4.1.

2.4 Research Methods and Approach

In this section we will further outline the research method, which consisted of four parts (fig 2.1). In part A we have further developed the multi-pattern concept by integrating the resilience framework and the transition framework. In part B we have developed an approach to analyze transitions based on the multi-pattern concept. In part C we have applied the approach to the transition in Dutch water management. In part D we have studied niche-regime interactions in more detail.

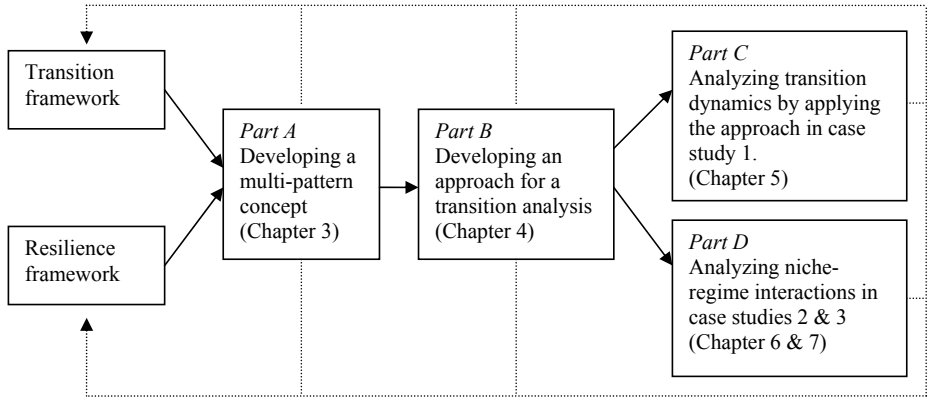


Figure 2.1 Overview of the research method.

2.4.1 Part A: Developing the multi-pattern concept further

The first part of this research was concerned with a theoretical exploration of the resilience literature. The objective of this part of the research was to develop the multi-pattern concept further. The multi-pattern concept aims to provide insight into the nature of change and attempts to generate insight into how transitions come about by identifying what the underlying dynamical patterns are. The hypothesis was that the resilience framework could contribute to our understanding of the dynamics of transitions.

We have used the resilience framework in the following way. We have first elaborated on the four concepts that together comprise the resilience framework. These concepts are (a) stability domains, which help us to understand the stability of a SES system; (b) adaptive management, which addresses the adaptive capacity of a SES system, (c) the adaptive cycle which helps us to understand the dynamics and (d) panarchy, which helps to understand the cross-scale interactions. Then we have compared these concepts with the concepts of the transition framework (i.e. the multi-level concept, the multi-phase

concept, the multi-pattern concept and transition management). This allowed us to identify the commonalities and the differences. Based on this comparison we have attempted to synthesize the two frameworks by postulating ten starting points. These starting points were then integrated with the four general phases of transition, generating a new conceptualization of the phenomenon of transition and the dynamics during the course of a transition. This indicative conceptualization distinguishes between six general types of patterns of how transformative change may unfold. Therefore, the concept is called the multi-pattern concept of transitions. This part of the research is described in chapter 3.

2.4.2 Part B: Developing an approach for a transition analysis

In this part of the research we have translated the multi-pattern concept into a generic approach for a transition analysis. To this end, we have developed a new conceptualization of the regime, which differentiated between the different regime elements. This was required because the existing conceptualizations were too aggregated and too abstract to identify which kinds of regime structures change during a transition. We used Giddens' Structuration theory (1984) and the theory of complex adaptive systems (e.g. Holland, 1995, Kauffman, 1995, Gell-Man, 1994) to develop this conceptualization and distinguished three dimensions: actors, processes, structures. This new conceptualization of the regime allowed us to analyze regimes by identifying how the main actors initiate processes in order to influence certain regime structures. We defined niches in the same scheme as the regime conceptualization. Based on this we developed the so-called double-loop concept, which describes three critical aspects of the niche-regime interactions. This concept has been further developed in part D of this dissertation.

In the next step we translated the regime concept into a method to identify and analyze the Dutch water management regime. The three regime dimensions are used as qualitative variables to describe the regime. The method consists of five steps during which the system boundaries are defined and the actors, processes and structures are identified that are to be taken into account. We used the five main actor types as described by Rotmans et al (2001) to identify the relevant organizations. We identified the main categories of structure while using the different regime definitions that are used in the transition literature (Rotmans and Loorbach, 2007, Schot, 1998a, Geels, 2006, Berkhout et al., 2004, Nelson and Winter, 1977). The key- processes in the regime are general processes derived from the responsibilities and tasks of the actors.

The second part of the approach was concerned with the identification and analysis of the different patterns of transformative change developed in chapter three. The method is used to analyze these patterns in terms of same three variables used for the regime analysis (i.e. actors, processes and structures). The method encompasses five steps dur-

ing which the involved actors are identified, the key-processes are identified that have been influenced and the regime structures that have changed are identified. The final step is to analyze the transition as a whole with regard to the changes in the regime structures and the sequence of the patterns of transformative change. The approach for transition analysis is linked to a reconstruction of the historical developments of system of interest. We decided to use the multi-level concept as an heuristic to describe the history by discriminating between (a) developments in the regime, (b) niches at the micro-level and (c) long-term trends at the macro-level. We also decided to take the changes in the regime structures as the indicator for transition. This means that the classification of whether a system is in transition or not is based on the observed changes in the structures and not in the actors or processes. We found that this dimension gives the most relevant information with regard to the actual changes. However, since they are three dimensions of the regime, the structural changes are reflected in changing actors and processes.

2.4.3 Case study research: The transition in Dutch water management

In parts C and D of this research, we have carried out three longitudinal case studies. A case study can be understood as an empirical inquiry that investigates a phenomenon within its real-life context (Yin, 2003). Case study research involves an in-depth, longitudinal examination of a single instance or event: a case. By doing a case study one may gain a better understanding of why the instance occurred as it did and consequently use it to describe, understand and explain certain phenomena. In general, case studies can be qualitative as well as quantitative (Yin, 2003). In this PhD-research the case studies are qualitative.

Maxwell (2005) argues that in practice, qualitative research often does not have a linear design. It is often an ongoing research process that involves cycling back and forth between the different components of the design, assessing the implications of the objectives, theoretical framework, research questions, methods and validity for one another. Therefore, he argues that conducting qualitative research requires a continuous assessment of how the design works during the process and how to make adjustments.

A common criticism to case study research is that the research findings cannot be simply generalized to other cases. Yin (2003), however, argues that research findings can be generalized to theory. It can generate new theoretical propositions, but it can also be used to test or validate a theory. However, one must be careful in generalizing the conclusions beyond that single case. Case studies thus lend themselves to both generating and testing hypotheses, but also to generating insight into what might become important to look at more extensively in future research (Flyvbjerg, 2006). Case studies

are therefore especially effective when the researcher investigates a new topic that is relatively unexplored.

The three case studies carried out in this research are concerned with Dutch water management. The Dutch water management sector is an example of a social-ecological system in transition. Over the past four decades the paradigm and practice of water management has changed significantly (Van Ast, 2000, Bosch and Van der Ham, 1998, Disco, 2000, De Wit, 2000, Van Leussen, 2002). Therefore, the developments in the Dutch water management sector provided us with the opportunity to analyze how transitions take place in social-ecological systems. This was an interesting addition to the field of transition studies, since the majority of case-studies in the transition literature, focused on transitions of socio-technical systems, such as energy, (Verbong and Geels, 2006), transport (Schot *et al.*, 2000), aviation (Geels, 2006) and waste management (Parto, 2007). In the water sector, the co-evolution between the ecological subsystem and the societal subsystem is an important driver of change and it is not clear whether a transition in this type of system has similar dynamics as seen in a socio-technical system. Although the Dutch water management sector has many features of a socio-technical system, for instance the water infrastructure is a large network of technological artifacts, there are indications that social-ecological transitions are driven by disasters, and changes in the mindset, or paradigmatic changes (Olsson *et al.*, 2006). The analysis of social-ecological transitions will improve our insight into transitions in different kinds of systems.

The three case studies were single case studies with different objectives. The first case study had a long time frame (1970 – 2005) and the objective was to study the long term dynamics of a transition and to test the developed approach for transition analysis. The second and the third case studies have a shorter time frame. The objective of these case studies was to study patterns of niche-regime dynamics in more detail and to test and refine the double-loop concept. The fact that the case studies do not have the same time scope makes it difficult to compare them and to make statistical generalizations about transition dynamics. Therefore we will limit ourselves to analytical generalizations to theory and generating new hypotheses. Case study two and three have a similar time frame and thus can be compared. However, with regard to statistical generalizations the number is small. In addition, it is especially problematic to generalize the findings to other sectors than the Dutch water sector. In the next sections, we will discuss these case studies in more detail.

2.4.4 Part C: Applying the approach to the transition in Dutch water management

In part C we have applied the approach developed for a transition analysis to the transition in Dutch water management. This case study had two objectives. The first objective was to apply the approach in order to investigate to what extent it enabled us to analyze

a transition. The second objective was to generate insight into the dynamics of the transition in Dutch water management.

The method we used in this case study was the following. We first applied the method for regime analysis in order to define the system and to identify the actors, processes and regime structures. The second step dealt with a reconstruction of the history of Dutch water management between 1970 and 2005. We have used the multi-level concept to guide the data collection, which distinguishes between (a) long-term trends at the macro-level; (b) developments in the regime; (c) innovations at the micro-level. The reconstruction is based on a synthesis of multiple data sources. The primary data involved recording oral histories of individuals involved with water management and individuals involved first hand in some of the crucial periods. The interviews were carried out because of two additional strengths: they were targeted, so specific or missing information could be retrieved, and they provided insight into the way different events are related. The average duration of these interviews was 90 minutes. The secondary data was based on a literature survey with regard to the history of Dutch water management (e.g., 2002, Bosch and Van der Ham, 1998, De Wit, 2000, Dicke, 2001, Disco, 2000, Van Heezik, 2007) and relevant policy documents. Thirdly, we made use of an electronic newspaper archive to verify some of the data. An important starting point for reconstruction was the ecological disaster in the Haringvliet estuary in the province of Zeeland in 1970. The disaster triggered the sectoral and technocratic regime to adopt a more ecologically oriented, integral water management approach. We therefore start the reconstruction at this point in time. In the third step we have applied the method for pattern analysis (chapter four) in order to analyze the dynamics in this transition. We have subdivided the historical reconstruction into seven episodes during which a certain characteristic transformative change occurred. The periods were identified on the basis of interviews and the literature. For each period we analyzed the three variables: which actors were involved, which key–processes were influenced and which of the elements of structure changed. In the final step, we interpreted the changes in regime structures and discuss to what extend we might consider it a transition. Secondly, we analyzed the dynamics in terms of the sequence of the patterns of transformative change and identified the dominant patterns.

2.4.5 Part D: Analyzing niche-regime dynamics

In this part, we have zoomed in to generate insight into the patterns of niche-regime dynamics. We have used the double-loop concept developed in part B to analyze three critical aspects of this dynamics (see chapter 4). The first aspect of this concept is concerned with how the niche is formed. The second aspect is concerned with what kind of reframing occurs in the niche and how this leads to the development of a new policy

perspective. The third aspect is concerned with how the niche influences the regime. In the case studies, we have analyzed two different patterns of niche-regime dynamics in order to identify different phases of the niche-regime dynamics and to identify the management strategies. An additional objective of these two case studies was to illustrate how the transition in Dutch water management currently manifests itself at the regional and local level.

2.4.5.1 Case study 2 Niche-regime interactions in Amstelland

In this case study we have studied the development of the so-called river basin plan for the Amstelland region, a region between the city of Utrecht and the city of Amsterdam. In 2000, the Dutch government declared a new national strategic water policy, referred to as the 'Water policy for the 21st century (WB21), which is concerned with climate change adaptation. One of the important characteristics of this policy is that water should be a guiding principle in the spatial planning of a region. The first step in the implementation process was the development of a spatial adaptation plan for the river basin. In total, 17 of such river basin plans have been developed by the various provincial governments and district water boards. We have analyzed the Amstelland river basin plan for practical reasons. Via the NeWater-research programme (see chapter 1.7) there were contacts with the people of Amstelland. However, this case study is illustrative for the development of the other river basin plans as well. This case study provided the opportunity to study the pattern of niche–regime dynamics in which regime actors themselves formed a niche to develop a new policy perspective with regard to climate change adaptation.

The method consisted of three steps. The first step was concerned with defining the 'Amstelland system' and to identify the actors that are relevant for this case study and the main water-related problems. In the next step, we have described the changing context by identifying relevant developments. In the third step, we have made a historical reconstruction of the development of the river basin plan and how it influenced the regional water policies and regional development policies for the period 2001-2007. We have used the double-loop concept in the analysis of the niche-regime dynamics and identified the phases and the management strategies that were used to influence the interaction.

This reconstruction is based on in-depth interviews with the participants of the project and individuals at senior level who were related to the project indirectly, but directly to what was adopted in the policy processes. The duration of the interviews was 90 minutes on average. We analyzed relevant policy reports and the minutes of the meetings.

2.4.5.2 Case study 3 Niche-regime interactions in Rotterdam

The third case study was concerned with urban water management in the city of Rotterdam in the southwest of The Netherlands. In this case study we have investigated

the development of a climate adaptation strategy for the city of Rotterdam. This case study provided the opportunity to study a pattern of niche-regime dynamics in which the niche came from outside but influenced the water management regime. The objective of this case study was twofold. The first objective was to analyze whether similar phases and management strategies could be identified as in the pattern of niche-regime dynamics in the Amstelland case study. A second objective was to analyze how a large city like Rotterdam prepares itself for climate change. This case study is a good example of how the integration of water managers and spatial planners can be successful and how water can become guiding in the spatial planning. According to the Ministry of Transport, Public Works and Water management the developed vision was an example for a new generation of urban water plans.

In order to analyze how urban water management in Rotterdam has changed, we first made a reconstruction of its history and analyzed the paradigm shift and the institutional changes. Secondly, we studied the niche-regime interactions by focusing on the same three critical aspects of niche-regime dynamics: how the niche was formed; the reframing in the niche; and how the innovative design influenced the regime. We applied the different phases identified in the pattern of niche-regime dynamics in the Amstelland case study in order to test whether these phases could describe the pattern of niche-regime dynamics adequately in this case. In addition we have identified the most important management strategies.

With regard to the data collection, we used local water policy documents, urban planning documents, internet resources and project plans. We participated in two field trips and an interdisciplinary design workshop and we carried out sixteen in-depth interviews with the project participants and key individuals that were indirectly related to the project. These individuals were affiliated with district water boards, social housing corporations, consultancy firms or several departments of the municipality at middle or senior level positions (executives, project leaders, or senior advisors).

The case study differs from the Amstelland case study in the following four ways. The first difference is that this case was concerned with an urban context. Secondly, this niche was not part of an obligatory implementation process, but emerged as a result of an architecture design contest. Thirdly, the niche emerged four years after the niche emerged in the Amstelland case, and during those years, both water managers and spatial planners became more familiar with and accustomed to the idea of 'water as guiding principle in spatial planning', which was postulated by the Water policy for the 21st century in 2000. In the fourth place, this case study focused on the local scale, while Amstelland had a regional focus.

Figure 2.2 shows an overview of the three case studies. In principle, the three case studies can be read as one long and coherent story. The first case study represents the long-term

transitional change in the Dutch water management sector. This allows us to analyze the structural changes in the regime and the sequence of the underlying patterns of transformative change. The Amstelland and Rotterdam case studies zoom in and focus on the niche-regime dynamics, but they also show the dynamics of implementation and the barriers in the current phase of the transition. We decided to focus on regional and urban water management, since they receive less attention than the transformation of the large rivers.

The three case studies may have been subject to three kinds of biases. Applying the multi-level concept to develop historical reconstructions may have introduced a selection bias (Yin, 2003) towards the role of niches. With regard to the interviews, the two most important biases to consider were recall bias and reflexivity bias. Recall bias may have resulted in inadequacies due to poor recollection of historical events (Yin, 2003) and since these cases go back in time (especially the first case study), this may have been the case. We attempted to reduce recall bias by sending the interviewees the list of questions prior to the interview so the interviewees could refresh their memory and secondly, by responding to the answers of the interviewees in order to stimulate recollection of details. This may have resulted in reflexivity bias, which means that the

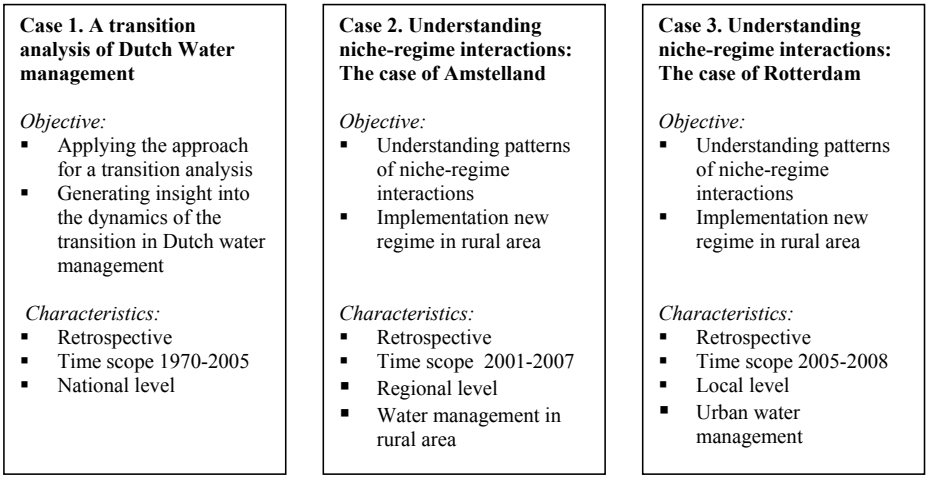


Figure 2.2 Overview of the case studies in this research.

interviewee gives the answer the interviewer wants to hear. In order to reduce reflexivity bias, the questions focused on factual events as much as possible.

2.5 Synthesis

In this chapter we have discussed the methodological aspects of this PhD-research. In our experience, explorative research is a process of continuous searching and learning and adjusting the direction of the research. This may be partly explained by the fact that the topic was so new and that the concepts in the transition framework changed as a result of new insights. In addition, this research is concerned with a large and complex topic, namely the dynamics of structural change in social sectors over a period of 30-50 years. Being aware of this complexity, we are aware that there is much more to transitions than dealt with here. However, we do expect to contribute to the understanding of what transitions are how they unfold. By combining the insights of the transition framework and the resilience framework, and by analyzing the structures that are changing during transitions and the underlying patterns of transformative change, we expect to generate new theoretical and practical insights with regard to the dynamics of transitions. In addition, the transition analysis approach developed during this research is a new way of analyzing transition dynamics in a structured way. Ultimately, we hope these insights may help to facilitate or manage transitions to more sustainable systems. In chapter eight, we will address how this research may help to improve transition management.

Chapter 3

Theoretical framework: the multi-pattern concept

3.1 Introduction

This chapter is concerned with the conceptualization of the phenomenon of transitions using a systems theory perspective and the further development of the multi-pattern concept. The multi-pattern concept makes a distinction between different patterns of transformative change and attempts to describe the nature of the changes during a transition (Rotmans *et al.*, 2004). In chapter one, we have argued that there are two approaches that may be associated with the multi-pattern concept. The first approach is the typology of transition paths of Geels and Schot (2007) and the second approach is the Pillar theory of De Haan (2007) and De Haan and Rotmans (forthcoming).

In this chapter we will attempt to contribute to conceptualization of transitions and the multi-pattern concept by using insights from the resilience framework. The resilience framework (Holling, 1973, Gunderson and Holling, 2002, Folke, 2006, Walker et al., 2004, Scheffer et al., 2001) is a sophisticated conceptual framework for understanding change in social-ecological systems (SES). The resilience framework is - similar to the transition framework - concerned with how systems adapt in a changing social or bio-physical environment via structural changes, innovation and re-organization. Therefore, the hypothesis of this chapter is that insights from the resilience framework may improve our understanding of transition dynamics. In this chapter, we will suggest how to synthesize the insights from the resilience framework and the transition framework and show what this means for the further development of the multi-pattern concept.

Current thinking on resilience is the product of theoretical constructs and practical applications. Especially in the field of ecology, the resilience framework has been further developed as a way to understand and deal with social-ecological systems. The resilience framework is a conceptual framework consisting of four interlinked concepts: stability domains, adaptive management, the adaptive cycle and panarchy. We will explore how these concepts can enrich the transition framework.

Although there are different definitions[1] of resilience, the resilience of a social –ecological system is currently understood as (1) the amount of disturbance a system can absorb; (2) the degree to which a system is capable of re-organization; and (3) the degree to which a system can increase the capacity for adaptation through learning (Folke, 2006). The growing importance of the resilience framework in the field of disaster management (Manyena, 2006) is reflected by the adoption of the concept by the United Nations International Strategy for Disaster Risk Reduction (2005). In this field, a reduction of resilience is associated with the increasing probability of collapsing into an undesired system state (UNISDR, 2005). In highly resilient systems, disturbances may create the opportunities for renewal (Adger, 2006).

1 For a good overview, see Manyena, S. B. (2006) The concept of resilience revisited *Disasters,* **30,** 433-450.

An additional outcome of this chapter will be a comparison between the resilience framework and the transition framework. Both the frameworks are gaining importance in the field of sustainability, however, the linkages between the two have not yet been sufficiently explored, which is necessary from a scientific as well as from a policy viewpoint. In doing so, we also seek to embed the transition framework in the resilience framework and vice versa.

We have taken the following approach. First, we have studied the resilience framework and the underlying concepts of stability domains (section 3.2.1), adaptive management (section 3.2.3), the adaptive cycle (section 3.2.3) and panarchy (section 3.2.4). In the next step, we have made a comparison between the concepts of the resilience framework with the concepts of the transition framework in order to understand how both frameworks relate to each other (section 3.3). During the final step we have made a synthesis of the insights, which has resulted in a generic multi-pattern conceptualization of transitions. In section 3.5 we will draw the main conclusions and address the question of what is needed in order to apply the multi-pattern concept empirically.

3.2 The Resilience framework

In this section we will outline the resilience framework. The resilience framework is not undisputed and may be considered to be a theory-in-development as well, especially with regard to the more recent application to social-ecological systems (Gunderson and Holling, 2002). Much of the early resilience literature is on ecosystems and their capacity to absorb shocks, but the attention has shifted from single ecosystems to interlinked social and ecological systems, or social-ecological systems. One of the reasons why the concept of resilience is not so straightforward is that the meaning of resilience has changed as well. These new insights did not replace the older definitions but added new dimensions to it. Currently, the resilience framework represents a 'way of thinking' about social-ecological systems. According to Gunderson (2006) it might be used to understand a broad range of complex adaptive systems, since the concepts in the resilience framework (i.e stability domains, adaptive management, the adaptive cycle and panarchy) are generic. In the next sections we will describe each of these concepts.

3.2.1. The concept of stability domains

Originally, resilience had a rather specific meaning in systems ecology. It referred to the time required for an ecosystem to recover from external disturbances (Holling, 1973). Systems ecology studies ecosystems in terms of population growth, species interaction (e.g. predator-prey dynamics), and resource availability. System ecologists assumed that

population growth was a linear function of population size and resource availability (e.g. food, water, sunlight, nutrients) and that the maximum population size, the so-called 'carrying capacity' was more or less fixed. Consequently, after a disturbance the populations would recover and stabilize at the initial equilibrium. This specific form of resilience is now known as *engineering resilience* and was measured as the time required for the ecosystem to return to the initial equilibrium (Holling, 1973, Folke, 2006).

A new meaning of resilience was introduced by C. S. Holling in 1973 when he studied the relationship between structure and functioning of ecosystems (Holling, 1973). One of his major contributions was showing that ecosystems could exhibit multiple equilibria or basins of attraction (or stability domains) - and that ecosystems may shift from one basin into another if certain key ecological process are inhibited. Such a shift is associated with an alteration of the structure and functioning of the ecosystem, in terms of the dominating organisms and biochemical processes (Scheffer *et al.*, 2001). Holling (1973) argued that the size of the basin of attraction was another measure for the resilience of an ecosystem. This form of resilience is called *ecological resilience* and is defined as the ability to absorb disturbances and still retain essentially the same structure and function, (Holling, 1973, Walker et al., 2004). Highly resilient ecosystems can cope with disturbances without being pushed out of the basin. It is now assumed that a range of different ecosystems exhibit multiple basins of attraction (Gunderson and Holling, 2002). The two forms of resilience capture two different aspects of stability. Engineering resilience captures the stability of an ecosystem in terms of its populations, whereas ecological resilience captures stability in terms of the structure and functioning of an ecosystem (Holling, 1987).

Figure 3.1 illustrates an ecosystem with two domains of attraction. Each basin represents an alternative attractor domain. The black dot represents the current state of the system in state space (thus in terms of the values of the variables). The dotted line represents the boundaries of the basins. Walker, Holling, Carpenter, & Kinzig (2004) argue that ecosystems follow a trajectory within the boundaries of the attractor domain. Although they do tend to move towards the attractor, they never actually reach it, because disturbances, stochastic events and decisions of human actors constantly move the system off the attractor. The general idea is that when the system approaches the threshold, smaller disturbances may be able to push the system into another attractor domain than when there is a considerable distance to these thresholds. The shift from one basin to another is thought to be the consequence of a slowly changing variable (for instance fishing or nutrient loading) pushing the system towards the threshold or changing the threshold; and small disturbances (storms, fires, etc) that push it over the threshold (Scheffer et al., 2001, Holling, 1987, Cumming et al., 2006).

Resilience combines three interrelated dimensions (Walker *et al.*, 2004). The first dimension is latitude, or the size of the attractor basin. The second dimension is the depth

of the basin, which reflects the resistance of the system to be moved within the basin. In a deeper basin, more effort is needed to change the system because of strong feedbacks that pull the system back. The third dimension is the actual distance to thresholds and is called precariousness. In general, pushing a system to another regime is harder when the basin is large, resistance is high and the system is far away from thresholds. The concept of basins of attraction offers a way to understand why ecosystems are able to absorb disturbances and why sometimes only small shocks cause sudden, un-proportional or non-linear responses.

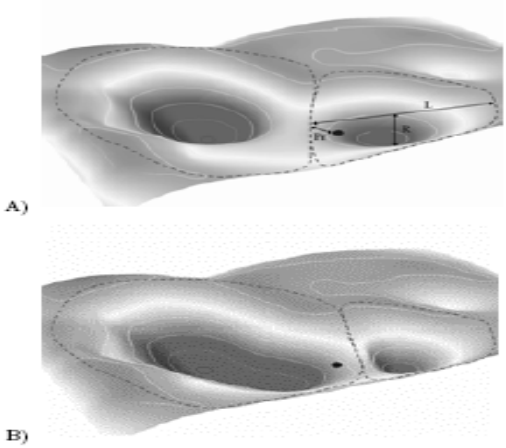


Figure 3.1 Landscape containing two basins of attraction. The dot represents the current system state; the edges represent thresholds. L=width of the basin, R=depth. P= distance to edge. Source: (Walker *et al.*, 2004).

3.2.2 Adaptive management

The concept of stability domains has had a major impact on ecosystem management. The dominant ecosystem management strategies shifted from fishing quota and the stabilization of populations towards maintaining ecological resilience, which may involve letting populations fluctuate in order to maintain the ecosystem dynamic (Holling, 1973). This kind of ecosystem management is called adaptive management. Adaptive management requires constant monitoring of populations, assessing the thresholds, evaluating ecological resilience and developing new strategies to increase ecological resilience (Walters, 1986, Holling, 1973). Managing resilience means keeping the ecosystem at a safe distance from thresholds so they can absorb disturbances without catastrophic change (Scheffer *et al.*, 2001). Typical adaptive management strategies are setting small, controllable fires to forests in order to prevent the ecosystem from larger, more devastating fires.

Adaptive management suggests a continuous learning approach, because ecosystem managers will always be partially ignorant about the complex dynamics of the ecosystem (Holling, 1987, Lee, 1999). There are two forms of adaptive management: active and passive. Active adaptive management is geared to systematic learning and might involve consciously disturbing the ecosystem and monitor its response (Lee, 1999). Passive adaptive management is concerned with monitoring and assessing if the ecosystem approaches thresholds (Lee, 1999). It is argued that knowledge and experiences from local communities is valuable and must complement the formal, mathematical models of the ecosystem (Folke *et al.*, 2005). Olsson et al (2004) and Folke et al (2005) suggest that adaptive governance is concerned with: (a) developing knowledge and understanding of the resources and the ecosystem dynamics; (b) developing practices that interpret and respond to ecological feedback; (c) creating flexible institutions; (d) building adaptive capacity in order to deal with uncertainty and surprise.

Early work on resilience focused on ecosystems and their capacity to tolerate disturbances without collapsing into a different qualitative state. This ability to cope with disturbances is understood in two ways. The first way is by keeping the system away from thresholds. The second way is by increasing the capacity to recover from the disturbance and re-establish normal functioning. It is important to mention here that each ecosystem system is unique and that recovery will never lead to exactly the same system. Therefore, the term recovery has been replaced by regeneration, renewal or re-organization. This is crucial, because it points to the other side of resilience, which is about the opportunities for innovation and adaptation, which are opened up by disturbances.

Over time the focus of the resilience debate shifted towards the social domain. It was then argued that resilience in social-ecological systems also involved the added capacity of humans to anticipate and plan for the future (www. Resalliance.com). Folke et al. (2005) argue that resilience of social-ecological systems (SES) has in fact the following three dimensions: (1) the amount of disturbance an SES can absorb; (2) the degree to which a SES is capable of re-organization; and (3) the degree to which an SES can increase the capacity for adaptation through learning. Taking these three dimensions into account means that disturbances in a resilient social-ecological system have the potential to create opportunity for innovation and reconfiguration, while in a less resilient system small disturbances can have dramatic social consequences (Adger, 2006).

Resilience is based on the idea that nature is inherently unpredictable and that disturbances can occur, which cannot be anticipated but which might have dramatic consequences (Manyena, 2006). Highly resilient SESs are less vulnerable to environmental or social variability and extremes. In this respect, a distinction is made between specific resilience and general resilience. Specific resilience means that a system is able to cope with specific disturbances which to some extent can be expected to happen. Since these disturbances might be more or less anticipated, the system can be made more resilient

to cope with them. General resilience is the ability to cope with all kinds of different disturbances, including unanticipated surprises. An important aspect to increase general resilience is diversity, which lessens the dependence on one single functional aspect of the system. The underlying rationale is that if a particular function is disturbed, there are alternative ways to provide the same functions. This redundancy is an important aspect in coping with unexpected societal and environmental extremes.

Another important aspect of resilience in a SES is the adaptive capacity. Adaptive capacity is the capacity of a system to adapt if the environment of the system is changing (Holling, 1987, Holland, 1995, Kauffman, 1995). In social-ecological systems, adaptive capacity means that the structures can be changed in order to maintain the functions in the SES. Recently, Walker (2004) suggested taking into consideration that the functions of the social-ecological system can be changed as well, for instance by transforming an agricultural SES into a nature preservation or recreational area. He refers to this as transformative capacity. According to Gunderson et al (2006) adaptive capacity and transformative capacity are only contrasted in the degree of change. Adaptive (or transformative) capacity is the ability to design and implement effective adaptation (transformation) strategies (Adger, 2006).

Considerable attention has been devoted to the identification of determinants of adaptive capacity, however, the determinants that influence sensitivity and constrain local systems to cope with hazards or stresses are context specific (Smit *et al.*, 2000). A distinction can be made between a coping range for the short term and adaptive capacity for the long term. (Smit *et al.*, 2000). Depletion of resources may lead to a diminished coping capacity, while economic growth, technological improvement or institutions may lead to an increasing adaptive capacity. In general, SESs can cope with a normal amount of variation and deviations, but extreme events can lie outside the coping range. The coping range itself is also flexible and depends on the specific local and social conditions.

Pahl-Wostl et al (2005) argue that the adaptive capacity of the water management regimes in Western Europe will increase when they shift (1) from hierarchical, narrow stakeholder participation to polycentric, horizontal, broad participation; (2) from separate analysis of sectors to cross-sector analysis; (3) from river (sub)basin scale to a multi-scale approach; (4) from fragmented to integrated comprehensive information management; (5) from centralized infrastructure to a diversity of infrastructural designs at appropriate scales; and (6) to a diversification of financial resources through public and private investments.

Hence, there is no definite consensus about a generic set of the determinants of adaptive capacity, however, adaptive capacity is thought to be enhanced by taking into account a diversity of perspectives from groups of stakeholders to inform adaptive strategies (Folke *et al.*, 2005). In addition, the adaptive capacity of a social-ecological system

is associated with the learning ability of networks; the flexibility of institutions and a sufficient amount of capital in terms of people and trust, the availability of knowledge and the amount of financial resources (Folke *et al.*, 2005).

The realization of adaptive or transformative capacity - the actual adaptation or transformation - may be frustrated by stakeholders who have vested interests and at a local or regional level barriers may take the form of national regulations or economic policies that hinder the freedom of actors to act or that make certain adaptive strategies unviable (Adger, 2000). The existing culture, institutions, and infrastructure play an important role by determining which adaptations and transformations are feasible. Therefore, it is argued that adaption and transformation requires flexible institutions.

In summary, we perceive the resilience in social-ecological systems as a combination of adaptive capacity and diversity (fig 3.2). Both aspects reduce the vulnerability to disturbances. Adaptive capacity is needed in order to adapt to changing circumstances. Diversity is needed to reduce the dependence on one particular way of fulfilling a function and so reduce the vulnerability for devastating shocks. Three important features of adaptive capacity are the ability for learning, institutional flexibility (as opposed to rigidity) and innovation capital in terms of amount of people that work on R&D, the level of knowledge and the financial resources that are spend on R&D. Two important aspects of the diversity component are the variety of alternative systems in order to have redundancy in the way a societal function is fulfilled and the variety of different perspectives of the people in the SES, which prevents uniform group think and blind spots.

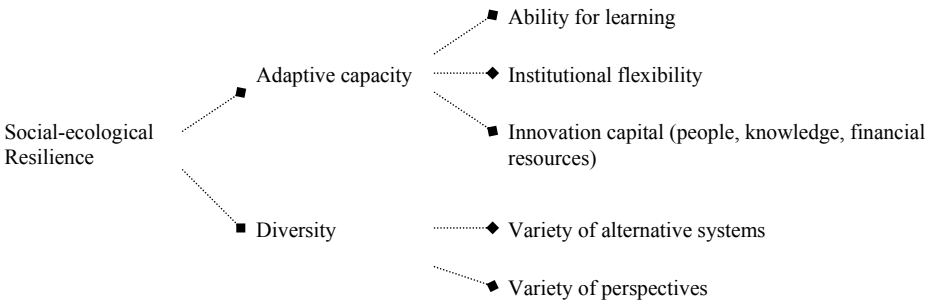


Figure 3.2 Aspects of social –ecological resilience.

3.2.3 The adaptive cycle

The third concept in the resilience framework is the adaptive cycle (Holling, 1987). The adaptive cycle was an attempt to develop a simple conceptual model to understand the complex behaviour of ecosystems. The adaptive cycle is based on research into the dynamics of budworm outbreaks in the boreal forests of Canada (see textbox 3.1) and has

been applied to many other types of ecosystems since (Gunderson and Holling, 2002). The adaptive cycle distinguishes four general phases in the evolution of an ecosystem, each phase having a specific evolutionary function (fig 3.3 and table 3.1). During the first phase the key function is *exploitation* in which there is a rapid colonization of recently disturbed areas. During the second phase - the *conservation* phase - energy and material is accumulated and stored. These two phases form the so-called front loop, during which biomass accumulates and connectedness increases. As a result, the attractor domain is formed and resilience increases. At the end of the conservation phases, resilience declines because the ecosystem becomes too rigid due to specialization, increased interdependencies and reduced redundancy. Small disturbances can trigger the *release* phase, in which the accumulated biomass and nutrients are released. During the fourth phase – the *reorganization* phase - soil processes prepare nutrients to become available for the next cycle. The release and the reorganization phase are part of the so-called back loop.

Although the adaptive cycle suggests that ecosystems cycle through these four phases, they can 'pause' for a long time in the conservation phase, if the basin of attraction is relatively large and deep and the thresholds are far away.

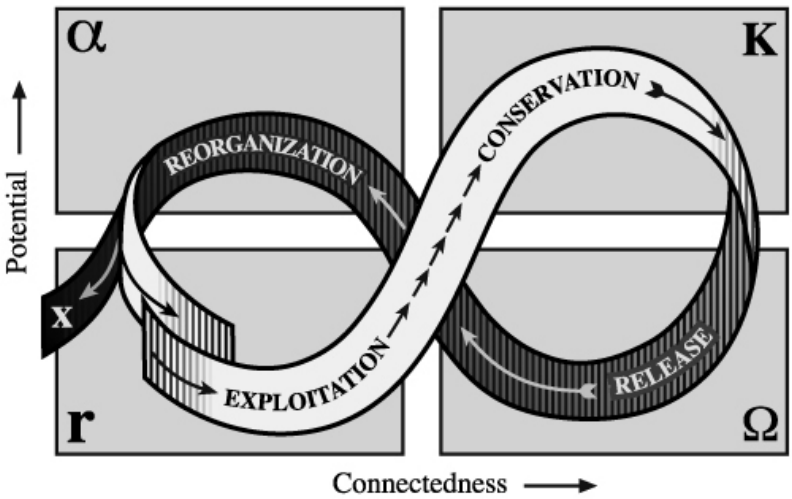


Figure 3.3 Hollings Adaptive cycle (Gunderson and Holling, 2002).

Textbox 3.1 Budworm outbreaks

Holling derived his idea of the adaptive cycle on his studies of budworm outbreaks in boreal forests in Canada. Holling described the ecosystem dynamics by four populations (budworm, fir, spruce, birch). Fir has a competitive advantage over spruce

and birch. Consequently, the fir accumulates and the density (connectedness) of fir increases. Since budworms forage on fir, the accumulated fir and high density create the potential for a budworm outbreak. When the fir is largely destroyed (release phase), the budworm population declines. In the absence of fir, spruce and birch are able to grow, but the remaining fir slowly builds up (exploitation) and will eventually suffocate spruce and birch populations. The accumulation and connectedness (conservation) of fir create the potential for budworm outbreaks. The ecosystem portrays an adaptive cycle. If not for budworm outbreaks destroying a lot of fir, spruce and birch would disappear. The ideas of Holling had a significant impact on the field preservation strategies and initiated a shift from protecting population quantities towards protecting ecosystem processes.

Table 3.1 Functions and mechanisms in the adaptive cycle.

Phase in ecosystem adaptation	Function	Mechanism
Exploitation	Rapid colonization of recently disturbed areas	Succession
Conservation	Accumulation and storage of energy and material and connectivity	Reproduction, growth
Release	Release of nutrients	Disease, fire, plague
Reconfiguration	Preparation for exploitation	Soil processes bounding nutrients

The basin of attraction emerges as a result of succession during the front loop. Succession refers to the more or less orderly stages in the build-up of ecosystems with regard to the species composition (i.e. stages in colonisation of a disturbed area) (Clements, 1916). Generally, a distinction is made between the so-called r-strategists and K-strategists. During the early succession stages, r-strategists (e.g. bacteria, insects, weeds, small mammals) colonize the area. The r-strategists are competitive in unstable environments and exploit empty niches. Generally, they have small body size, high fecundity and the ability to disperse offspring widely. During later stages of succession, K-strategists (generally larger organisms such as elephants, whales, humans) enter the scene. K-strategists are strong competitors in crowded niches and stable environments. During the front loop, K-strategists slowly replace the r-strategists. While connectivity increases and biomass accumulates a situation is created where disturbances like disease and fire can spread rapidly. Resilience declines and release is 'waiting to happen'. During the reorganization phase there are two possibilities: the ecosystem will either recover by progressing through succession stages towards the same attractor, or progress through different succession stages towards another attractor. After release the opportunity of

shifting into another attractor domain is highest. In figure 3.3 this shift is represented by the x-escape.

3.2.4 Panarchy

The panarchy concept (fig 3.4) is in fact a further elaboration of the adaptive cycle, but includes multiple scales and the interaction between slower and faster adaptive cycles. Panarchy is a response to Hierarchy theory (Allen and Starr, 1982) which suggests that fast processes at smaller levels are constrained by larger and slower processes at higher levels. Panarchy counters this implication of top-down dynamics by adding the bottom-up interaction: dynamics at lower levels could cascade upwards to change dynamics at higher levels. Thus, the interaction between levels is both bottom-up and top-down. The panarchy framework suggests that during some phases of the adaptive cycle, the system is more resilient than in other phases and as a result more sensitive to developments at higher or lower levels.

During the shift from conservation to release (K-to-Ω), when the resilience is low, the system is extremely sensitive to smaller cycles in the release phase. This cross-scale interaction is known as *revolt*: the smaller cycle in the release phase disturbs the slower cycle in the K-phase in such a way that the slower cycle shifts into the release phase as well. An example of revolt is when a local ignition of fire spreads to the crown of the tree, from there to a patch in the forest and to a whole stand of trees, etc. The probability of release at a higher level of scale might increase when a number of smaller adaptive cycles synchronize and go into release simultaneously (Walker *et al.*, 2006).

After the release phase (or the collapse) and the reorganization phase, the smaller cycle is sensitive to the higher level. This interaction is understood as *memory*. If the larger adaptive cycle is in the K-phase it provides 'memory' for the faster cycle in the form of available seeds in the ground and air, which allow the faster cycle to recover. The memory function is strongest during the conservation (K-phase), therefore, the possibility of shifting into another stability domain is most likely to occur when this memory function is weak, i.e. when the higher level cycle has not progressed too far into the conservation phase, or has shifted into the release phase.

The panarchy concept modifies the adaptive cycle in terms of the role of collapse after crossing a threshold. First of all, subsystems at lower levels have thresholds too. Crossing these thresholds may lead to partial collapse and not collapse of the whole system. Secondly, these thresholds crossings also provide the opportunity for a partial renewal. In this way there can be a continuous partial collapse and renewal in the system.

Cumming and Collier (2005) have argued that the adaptive cycle is a heuristic model or metaphor which provides a general understanding of ecosystem dynamics. It also inspired others to apply the metaphor to business organizations (Hurst, 1995) and to

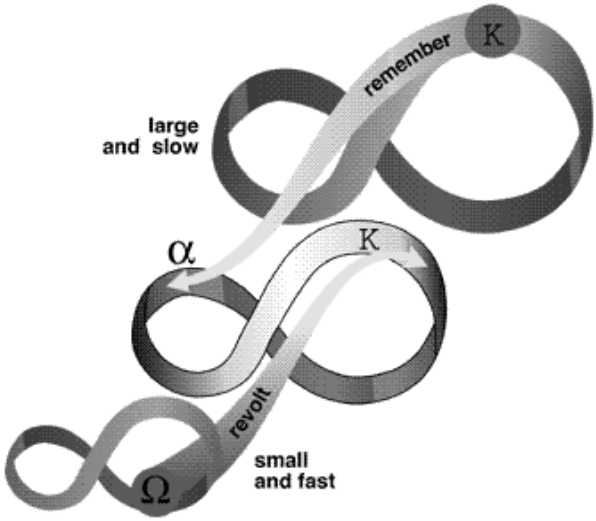


Figure 3.4 The Panarchy concept.

apply it to social-ecological systems. In the book "Panarchy: Understanding transformation in human systems" Gunderson and Holling (2002) and others have illustrated how panarchy can be used to interpret transformations in social-ecological systems. For instance, they showed how a sequence of ecological disasters in the Everglades in Florida, USA, initiated new configurations of water management institutions. They argued that these alternative institutional configurations can be thought of as alternative attractor domains of the social system (Gunderson and Holling, 2002). The institutional configuration provides new responsibilities and resources for the actors to carry out measures.

In addition, Holling (2001) argued that social-ecological systems can become trapped in so-called pathological states. The first is called the poverty-trap, which can occur if the SES is in the exploitation phase of the adaptive cycle. The SES then lacks capital (financial capital, human capital) to build up the system. The second is called the rigidity trap, in which the SES has become too rigid to adapt.

To pursue the analogy further, Gunderson and Holling (2002) compared r-strategies, or pioneer species, to Schumpeter's 'entrepreneurs' who are driven by the exploitation of new opportunities. After a disturbance, these entrepreneurs exploit new opportunities, which can be thought of as creative destruction (Schumpeter, 1942). In latter phases of the succession (the front loop), they suggest that the entrepreneurs are slowly replaced by larger corporations or institutions because they are the better competitors in terms of human capital, financial resources and power (Gunderson and Holling, 2002).

It is however necessary to take the more unique characteristics of human systems into account in order to provide a more balanced understanding of these dynamics. There are at least five critical differences which are considered crucial since they might

influence or alter the dynamics suggested by Panarchy. This list of five is not exhaustive; it is but a first attempt to explore how human characteristics influence these dynamics.

- *Reflexivity*. Human beings are self-conscious and aware of their own actions and position in society. They are aware of social structures and intentionally develop strategies to change the system. This property alters dynamics in such a way that processes of structural change in human systems might be driven internally rather than by external disturbance, as tends to be the case in ecosystems.
- *Foresight and expectations*. Humans are capable of foresight. Compared to ecosystem dynamics, this may alter the dynamics in such a way that future thresholds may be anticipated and disasters may be prevented. This can stabilize the boom-and-bust character of the adaptive cycle because a myriad of entrepreneurs identify future risks and opportunities. The adaptive cycle would apply only to those who gamble on a certain future, but not to the economy as a whole (Gunderson and Holling, 2002).
- *Intellectual capability & communication*. The intellectual ability of humans generates innovation and communication can lead to rapid distribution across a wide range of indirectly related local subsystems. Baumgartner and Jones (1991) argue that events or calamities can also be used in a strategic way to create new policy images which may trigger the inclusion of groups of people who were not included in the debate before. As a result, the policies can change quite rapidly initiating a shift towards a new basin.
- *Use of technology.* Humans have cognitive capabilities that enable them to create artifacts and allow them to adapt to changing circumstances. Societal systems, like transport or water management, may consist of a wide network of technological infrastructures (such as roads, bridges, dikes). Once this infrastructure is in place, it can remain there for decades. Consequently, this kind of rigidity may also create path dependence and decreases the ability to adapt.
- *Power and representation.* Human systems exhibit authority systems in which rights to control resources are transferred to representative institutions. These authority systems have the power to initiate or impose change as well the power to block change (Gunderson and Holling, 2002).

Features like technology, institutions and infrastructure enable the management of the social-ecological system, however they can also introduce rigidity and constrain new innovative ways of dealing with the system. This may be countered through features like reflexivity, foresight, intellectual capabilities and communication which enhance the ability to change the system consciously. Stimulating these features may thus enhance the adaptive capacity of a social–ecological system.

3.3 How do the resilience framework and the transition framework relate?

In this section we will compare the resilience framework and the transition framework. We will identify commonalities and differences between the frameworks and compare the underlying concepts. This provides us with a good foundation to understand how both frameworks are related to each other, which paves the way for the synthesis in the next section.

We have distinguished four general commonalties between both frameworks. In the first place, both frameworks are rooted in complex systems science and attempt to develop generic concepts about the dynamics by distinguishing different phases and different levels. Secondly, these concepts are used to inform management as to how to deal with the system. Thirdly, both frameworks are based on the idea that complex systems cannot be fully understood, which means that the management should involve a continuous learning, by introducing new perspectives, monitoring and actively experimenting. Fourthly, both frameworks make a distinction between 'normal' changes and more 'fundamental' changes, like regime shifts.

At the level of the underlying concepts, we have identified the following commonalties and differences. The concept of stability domains refers to the idea that an SES maintains the same structure and function as long as it remains within certain thresholds (that of the basin of attraction) (Holling, 1973, Scheffer et al., 2001). If we translate this to the regime concept in the transition framework, we may argue that a regime is a particular manifestation of an SES in a certain basin of attraction. The regime thus has resilience and can cope with internal and external disturbances without transforming fundamentally. In the resilience literature, the stability domain is associated with the institutional structure (Gunderson and Holling, 2002). In the transition framework, the basin would correspond to dominant culture, institutions and infrastructure. In this view, a transition would resemble the creation of and the shift of the SES into a new basin of attraction and thus a different kind of culture, institutional structure and infrastructure.

Adaptive management and transition management share many aspects. They both take the system dynamics as the starting point for developing strategies and emphasize that continuous monitoring, learning and anticipation are crucial in order to develop successful management strategies. The most significant difference however is that adaptive management is primarily focused on preserving a social-ecological system (by continuous adaptation), whereas transition management is primarily focused on transforming a system. We will come back to this at the end of this section.

The concept of the adaptive cycle – like the multi-phase concept - distinguishes four phases in how a system adapts to a changing social or bio-physical environment. However, both concepts emphasize a different path. The adaptive cycle is essentially a collapse and renewal cycle and thus emphasizes the collapse of the system, before

a new regime can be built up. The multi-phase concept suggests a different transition path, namely a regime shift as a result of innovations and re-organization. In this respect, the so-called release phase should rather be interpreted as a tipping point, or a take-off phase, of a shift towards a new basin of attraction. The take-off phase would correspond to crossing the boundary between two basins. This would mean that during the predevelopment there is a buildup of critical mass leading to a tipping point after which the SES shifts into a different basin.

Adaptive management, the adaptive cycle and the panarchy-concept suggest that in order to take the transition path of regime shift, a SES requires a certain level of adaptive capacity. However, a SES can be in the so-called rigidity trap, which means that the system is too rigid to renew and reorganize itself. In addition, an SES may also be trapped in a poverty trap, which means that the system is lacking the capital to renew and reorganize itself. In these cases, the SES is trapped in its basin and the system should increase the adaptive capacity as a precondition for the path of regime shift.

The panarchy concept and the multi-level concept both make a distinction between different scales. In the multi-level concept, the levels are not explicitly related to spatial-temporal scales as in the panarchy concept and it suggests that a regime can be detected at each level and that the niche represents a smaller deviating subsystem. In the panarchy-concept, this would correspond to the following view, namely that a niche would be a deviating subsystem, which operates one level below the regime level.

Both the panarchy concept and the multi-level concept emphasize that transformative change can be bottom-up as well as top-down. The top-down dynamic means that changes at the higher level drive the lower levels to transform. De Haan (De Haan, 2007) and De Haan and Rotmans (forthcoming) refer to the top-down pattern of transformative change as *re-constellation*. The bottom-up dynamic means that the changes at the lower levels drive higher levels to transform. This dynamic is essentially concerned with niche-regime interaction. We can make a distinction between two different bottom-up patterns of transformative change. This first pattern is called *niche-absorption* in which a niche emerges and the developed idea is adopted by the regime. According to De Haan and Rotmans this dynamic is part of the adaptation pattern. The other bottom-up pattern is *empowerment* in which a niche emerges. However, the niche is not taken up by the regime, but it grows into a niche-regime which coexists and co-evolves with the regime (and eventually takes over the incumbent regime).

In the panarchy-concept, the niche-regime interactions would reflect the following dynamic patterns. The regime would be in the conservation phase of the adaptive cycle. The niche represents a sub-system at one level below progressing through the exploitation phase. In the niche-absorption pattern, the niche is adopted by the regime, which corresponds to the pattern suggested by panarchy. At the lower levels of scale, new ideas are invented and the successful experiments are conserved at the higher levels of

scale (Gunderson and Holling, 2002). In the empowerment pattern the niche progresses into the conservation phase to become a niche-regime, co-existing and competing with the incumbent regime. The patterns of niche-regime dynamics are different from what panarchy refers to as "revolt". Revolt is the interaction between a regime in the conservation phase, and the lower level adaptive cycle in the release phase. This pattern refers to the possibility that collapse of a subsystem at a lower level can trigger collapse of the whole system.

Niche-regime dynamics have not yet received sufficient attention in the resilience literature, although recent literature indicates that this is changing. Gunderson et al (2006) and Olsson et al (2006) showed that the role of so-called 'shadow networks' or 'arenas for discourse' were important in transforming regional ecosystem management regimes. These shadow networks, or arenas for discourse can be perceived as niches, although this kind of niches focus on developing alternative policy perspective and not so much on technological innovation.

In conclusion, the resilience concepts emphasize different aspects of the dynamics of (social-ecological) systems than the transition concepts. The comparison suggests that we can understand the phenomenon of transitions as the shift from one basin of attraction to another. The resilience concepts emphasize that a sufficient degree of adaptive capacity is an important precondition for a regime shift. However, the framework provides little insight in how the process of adaptation or transformation actually works. The niche–regime dynamics is one of the mechanisms of how this takes place.

Now that we have compared the underlying concepts, we can summarize the main differences at the framework level. The first difference we should address is the different origin. The resilience literature originated in the field of ecological conservation. As a result, much of the resilience literature is focused on the ecosystem dynamics as the driver for change in the societal subsystem and the governance system in particular. In contrast, the transition framework originated in the field of sustainability and much of the literature is focused on the dynamics in the societal subsystem.

A second difference is the point of departure. The resilience literature is primarily focused on preserving the functioning of the social-ecological system, whereas the transition framework is applied to systems that are not functioning well or are considered to be unsustainable and therefore need to transform.

A third point, which is directly related, is the different focus. The resilience framework predominantly focuses on protecting the system against disturbances, whereas the transition framework focuses on building an alternative system. Since the focus of the resilience literature is on *coping with* or *absorption of* disturbances, it has been associated with a rather reactive stance. However, this is not always the case. It is too simplistic to perceive the resilience framework as purely reactive, because enhancing resilience may require a proactive building-up of diversity and adaptive capacity. In the vulner-

ability literature, for instance, resilience prompted a new way of conceptualizing risk by not focusing on reducing hazards, but by proactively creating resilience (Manyena, 2006). Nonetheless, the impulse for building resilience is in response to a possible threat in the near or far future.

A fourth point of difference is concerned with renewal. The resilience literature emphasizes renewal in the post-calamity or post-disaster period, when institutional 'memory' is temporarily weakened and creates the opportunity for renewal. In contrast, the transition framework emphasizes the need for renewal while the regime is still in place. Therefore, much attention is given to niche–regime dynamics.

All in all, the resilience framework and the transition framework are both concerned with structural change and renewal, but they appear to have a different focus. The resilience framework tends to focus on preserving the functioning of the social-ecological in the system and protecting it against external and internal disturbances. The transition framework focuses on transforming systems that are not desirable or sustainable. In both cases, this may give reason to deliberately change the structures of the system. Both frameworks put forward a proactive management concept, although they do tend to emphasize different aspects. Adaptive management (or adaptive governance) attempts to build highly resilient SESs in order to be less vulnerable and does so by enhancing adaptive management and increasing diversity. Transition management attempts to build more sustainable and desirable systems and does so by building a growing multi-actor network that is directed towards changing the system. Together, the resilience framework and the transition framework cover a wide spectrum of dealing with a SES, ranging from building resilience in order to maintain desired functions to reforming undesired systems into desired systems.

3.4 Synthesis: a multi-pattern concept of transitions

In this section we will attempt to synthesize the concepts from the resilience framework with the concepts from the transition framework. We will do so by formulating ten starting points.

(1) The regime;

A social-ecological system operates under a certain regime, represented a basin of attraction, or stability domain. Each basin of attraction represents a different regime and the SES operates under a certain regime (fig 3.5). The SES has resilience, so it is capable of dealing with external and internal variability, without shifting into a different regime. However, the SES becomes more susceptible for a regime change when it approaches the boundaries of the basin of attraction. In chapter four we will address what we mean

by the regime in more detail. For know, we suffice to say that the regime can be understood as the set of dominant actors, processes and structures.

Figure 3.5 The black ball represent the state of the system. The basin represents the stability domain of the regime.

(2) A transition is the creation of and the shift towards another basin of attraction;
Transitions can be understood as the creation of a new basin of attraction and the shift of the SES into the new basin of attraction (fig 3.6). Such a shift involves fundamental changes in the structures of the SES. This perspective allows us to make a conceptual distinction between 'normal' change within the basin of attraction and 'transitional' change from one basin to another. It also allows us to distinguish between two generic transition paths: (1) collapse and renewal: a collapse of the SES and a build up of a SES in a new regime; or (2) regime shift: a transformation of the structures of the SES (i.e. fig 3.6).

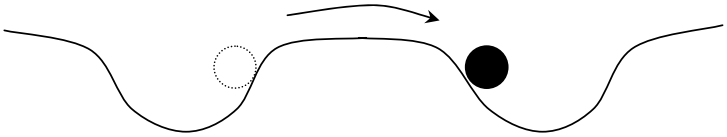


Figure 3.6 The shift towards another stability domain (i.e. regime).

(3) A social-ecological system with sufficient adaptive capacity is able to renew and reorganize itself;
A SES with sufficient adaptive capacity is able to change its structures when necessary and to maintain its functions. The actors are capable of renewal and reorganization. Three important aspects of adaptive capacity are: the ability to learn, flexible institutions and capital. A high adaptive capacity is represented by a shallow basin (figure 3.7). A shallower basin means that the SES can get out of the basin easier and shift into another basin.

Figure 3.7 A shallow basin represents a high level of adaptive capacity.

(4) A SES with insufficient adaptive capacity is incapable of renewal and reorganization;
A SES with low adaptive capacity is less capable of changing the necessary structures and to maintain its functions. In this case, the actors do not have enough adaptive capacity to change existing structures. There are two manifestation of this: too much rigidity (rigidity trap) or too little capital (poverty trap). In figure 3.8 we represent this with a deep basin. A deep basin means that the system cannot get out easily.

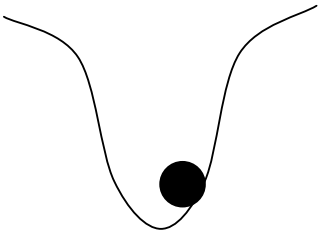


Figure 3.8 A deep basin represents low adaptive capacity.

(5) A precondition for regime shift is that SES must have enough adaptive capacity;
If an SES is lacking adaptive capacity, it cannot change its structures and is locked into its basin. Therefore, the amount of adaptive capacity should be increased as a necessary condition for the transition path of regime shift (fig 3.9).

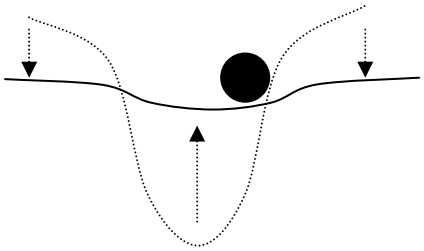


Figure 3.9 Increasing adaptive capacity is a precondition for shifting to another basin. The basin should become shallow.

(6) Tipping point;
In the shift from one basin to another, the SES crosses a certain threshold that marks the boundary between the two basins. If the SES crosses the 'tipping point' it shifts into a new basin. (fig 3.10). The tipping point is associated with a reform of the institutional structure.

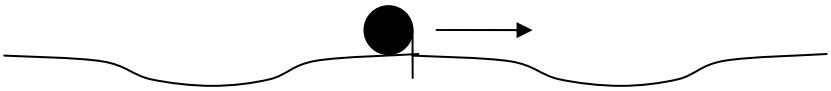


Figure 3.10 The regime crosses a tipping point which marks the boundary between to basins of attraction.

(7) Macro-trends and events may disturb the incumbent regime;
Developments at macro-level may slowly reduce the ability of a regime to fulfill societal functions. This means that they pressurize the SES to change its structures. This top-down dynamic is referred to as re-constellation.

(8) Niches;
Niches can develop innovations and make suggestions as to how to change the structures in order to fulfill existing societal functions or suggesting new societal functions. If these niches grow, they build up a certain critical mass and push the SES toward the tipping point. There are two variants of this bottom-up dynamic. The first is niche-absorption in which the niche-innovations are adopted. The second is empowerment, in which the niche itself grows and expands and competes with the regime.

(9) Patterns of transformative change;
During the course of transition, different patterns of transformative change may unfold along which structural changes are realized. The three above mentioned patterns can be driven endogenously, thus driven from within the SES, or exogenously driven, thus initiated somewhere outside the SES that is under consideration. This leads to the following six patterns of transformative change:

1. Endogenous niche-absorption: a niche is created by the SES and is successfully adopted and incorporated into the regime.
2. Exogenous niche-absorption: a niche emerges spontaneously or is created somewhere outside the SES and is successfully adopted and incorporated into the regime
3. Endogenous empowerment: a niche is created by the SES itself, grows and is able to sustain itself. It forms a new SES in a separate basin of attraction, called a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
4. Exogenous empowerment: a niche emerges spontaneously or is created somewhere outside the SES, grows and is able to sustain itself as a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
5. Endogenous re-constellation: a powerful actor in the SES imposes a transformative change top-down, for instance a national government imposing a large scale reform policy.

6. Exogenous re-constellation: a powerful actor outside the SES imposes a transformative change top-down, for instance a global institution or an international agreement.

(10) Calamities;

Calamities, or disasters, create a sense of urgency. In response to calamities, some of the constraining structures may be released (i.e. loss of memory) and thus provide opportunities for innovations to emerge or breakthrough.

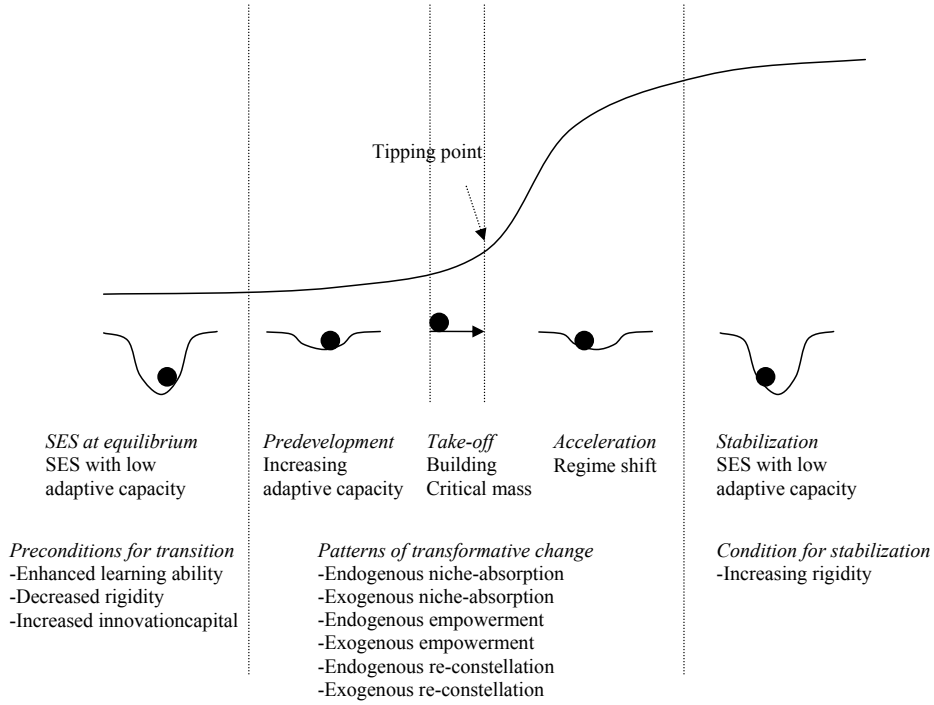


Figure 3.11 A generic multi-pattern concept of transition based on the resilience – transition synthesis.

If we link these ten starting points to the multi-phase concept of transition, the following general multi-pattern representation of transition emerges (fig 3.11):

- At dynamic equilibrium, there are only minor changes in the SES. This system state represents a state before the predevelopment phase. The SES is in a deep basin.
- The shift from dynamic equilibrium to the predevelopment phase is marked by a growing tension, or mismatch, between the SES and its macro-environment. In order to adapt, the adaptive capacity should increase. Niches emerge suggesting to adapt certain structures (cultural, institutional or infrastructural).

- In the shift from the predevelopment to the take-off, there is a buildup of critical mass and more structures change.
- The shift from the take-off the acceleration phase is marked by a tipping point. There is enough critical mass to make the SES shift into another basin of attraction.
- In the shift from the acceleration phase to the stabilization phase, the adaptive capacity decreases. This may be the result of an increasing rigidity of the new regime and is reflected in the basin becoming deeper.
- During the course of the predevelopment, take-off and acceleration phase, the SES is able to renew and reorganize its structures. Underlying these structural changes are the six patterns of transformative change.

In summary, the resilience-transition synthesis has provided us with a theoretical conceptualization of the phenomenon of transition and important conditions for transitional change. Furthermore, is has provided us with six types of dynamic patterns that may push a transition forward.

However, based on this theoretical deduction, we are not yet capable of saying which patterns of transformative change occur during which phase, or whether different systems portray different dominant patterns. In chapter five we therefore will attempt to identify which of the patterns occurred during the transition of Dutch water management.

Secondly, we are also not yet capable of telling which kind of structures in the SES are changing during transition, let alone capable of telling which structures need to change in order to reach a tipping point and which structures change afterwards. In order to increase our insight in this respect, we will need to differentiate between different kinds of regime structures that can change during transition. In the next chapter, we therefore will focus on the regime and what we mean by the regime structures. Furthermore, we will develop a new approach for a transition analysis which will allow us to link changes in the structures to the different patterns of transformative change. This approach will then be applied to the transition in Dutch water management (chapter five). By doing this, we hope to learn which structures have changed during the course of transition and through which patterns of transformative change.

3.5 Conclusion and discussion

In this chapter we have attempted to synthesize two frameworks that are used to understand fundamental systemic changes. An important result of this synthesis is that it grounds transition theory in the complex systems theories and more specifically in the resilience theory. It also provides a new conceptualization of transitions in addition to

the debated S-curve. This conceptualization however does not replace the S-curve it rather enriches the concept with a system-theoretical explanation.

The synthesis contributes to the transition theory in the following ways. First, it has provided us with a generic understanding of the phenomenon of transition as a shift from one basin to another. The basin of attraction metaphor enables us to make a conceptual distinction between normal change and transitional change, that is, change within the basin or change from one basin to another. The synthesis also suggests two different transition paths: a collapse and renewal pathway and a regime shift pathway. Interestingly, the transition literature focuses primarily on the path of regime shift, while the resilience literate focuses primarily on the collapse and renewal path. An important determinant for which path is chosen is the adaptive capacity of the SES. An SES with a high level of adaptive capacity is more likely to go along the path of regime shift than an SES with low adaptive capacity, which is more likely to go trough a collapse and renewal pathway since it cannot adapt sufficiently to changing circumstances. In this respect, there is a whole literature on the downfall of civilizations, which should be analyzed more thoroughly.

Secondly, the synthesis provides us with a more dynamic notion of the concept of regime. A system operates under a certain regime, but this regime is not fixed. The transition literature tends to attribute rigidity to regimes, which does not necessarily have to be the case. An SES can be in a shallow basin, which allows the system to shift from one regime into another. Rigidity is not a fixed value but a variable. In addition, the system can also be more or less 'susceptible to regime shift' if it is closer to or further off a tipping point. Therefore, an important lesson for transition research is that we should focus our attention more to the regime as a unit of analysis to understand its adaptive capacity.

The question that arises is how these basins of attraction manifest themselves in reality and whether their boundaries might be identified. Do social systems have attractors equivalent to those that have been shown for ecological systems (Walker et al., 2006)? In ecology, the structure of a regime is described by the population dynamics and underlying ecological processes, such as predation, growth and reproduction. Although some of these mechanisms are also present in societal systems, they do not represent what we have in mind when talking about social structures. In the social sciences, the term structure refers to things like culture and institutions. Hence, the structure of societal systems is described with different variables. The question also arises whether there is such a thing as a grand structure in a societal system with clear thresholds. In conclusion, we cannot simply translate the ecological theory directly into a social theory, before we have elaborated further on the concept of regime and regime structures. We will do so in the next chapter.

In the third place, the synthesis resulted in a further elaboration of the multi-pattern concept. The resilience framework supports the different patterns of transformative change that are distinguished in the transition framework and emphasizes the niche-absorption pattern and re-constellation patterns. Interestingly, it does not give much attention to the co-called empowerment pattern, which suggests that this pattern may not be encountered much in ecology. Unfortunately, the resilience framework does not deal in detail with the dynamics of how innovations, or niches, lead to regime re-organization.

We should warn the reader to interpret this multi-pattern concept of transitions only as a heuristic conceptualization of how transitions might unfold. The different nature and structure of ecosystems and social systems raises critical questions about the assumption that the ecological insights can be transposed to the social domain and we should deal with this theoretically. In the next chapter we will attempt such an exploration. However, we may use the patterns heuristically, as a sort of initial templates to mirror societal dynamics. We should develop them further and link them to conditions about when they occur. For instance, under certain conditions a possible variation may be that of a system pausing in the predevelopment phase and not shifting into a take-off because some of the patterns are hampered. In addition, we can also imagine that if a system is able to keep up a high level of adaptive capacity, it does not have to shift into a stability phase and can remain in a continuous transitional state of renewal and reorganization.

In this chapter we have been primarily concerned with the concept of transition and we made an attempt to identify different types of patterns of transformative change that describe *how* an SES might change its regime. However, we did not discuss *what* is changing and the related question of what we mean by the regime structure in societal systems. Thus in order to understand and explain transition dynamics, we should first make clear what we mean by societal structures and then identify which kind of structures are actually changing during the shift from one basin to another. In the next chapter, we therefore will develop a transition analysis approach which enables us to identify the structural changes that occur and the underlying patterns of transformative change. In chapter five, we will apply the approach to a case study.

Chapter 4

A generic approach to analyze transitions

4.1 Introduction

In this chapter we will further develop the multi-pattern conceptualization of transitions and focus more specifically on the regime and niche concepts. The objective of this chapter is to translate the multi-pattern concept into a generic transition analysis approach which could be used to analyze transitions in different fields. As discussed in chapter one, there is not yet a clear and validated method to analyze transitions. This hampers the further development of the theory on transitions and to compare different case studies of transitions. In this chapter we will make a start to develop such a method.

Broadly speaking, transitions are currently analyzed by applying the multi-level concept, (see Geels, 2002, Geels and Schot, 2007) and by applying the multi-phase concept (see Parto, 2007, Van der Brugge et al., 2005) and by analyzing the functions of innovation systems (Smits and Kuhlmann, 2004, Hekkert et al., 2007). We will build further on the multi-level analysis and multi-phase analysis and add what we might call a multi-pattern analysis. The main idea of the multi-pattern analysis is that by analyzing the patterns of transformative change that occur during a transition and by analyzing the sequence in which they occur, we will improve our understanding of the transition dynamics.

The transition analysis approach we will develop consists of two parts. The first part is a generic method how to analyze a regime. Therefore we will first develop a new conceptualization of the regime which consists of three dimensions: actors, processes and structures. This regime concept forms the basis for the second part, which is concerned with analyzing patterns of transformative change in terms of actors, processes and structures.

In next section (4.2) we will first explain why there is need for a new regime conceptualization and how we can differentiate between different regime dimensions. In section 4.3 we will develop a generic method to analyze a regime. In section 4.4 we will elaborate further on the different patterns of transformative change and develop the double-loop concept to understand niche-regime dynamics. In section 4.4 we will develop a method to analyze the patterns of transformative change empirically. In section 4.5 we will reflect on the developed approach.

4.2 The regime concept

4.2.1 The regime concept and the need for further differentiation

In the transition literature, the concept of *regime* is used to address the dominant set of interconnected elements. In essence, the concept implies that existing regimes cre-

ate barriers for innovations that are not compatible with that regime. The concept is thus used as an explanation of why societal systems tend to develop along incremental trajectories, instead of via radical, transitional trajectories.

As chapter one showed, there are many definitions of the regime, but in general we can distinguish two different conceptualizations[2]. The first is used to describe socio-technical systems (Schot, 1998a, Geels, 2002, Berkhout et al., 2004, Nelson and Winter, 1977, Dosi, 1982, Rip and Kemp, 1998) and the second is used to describe societal systems (i.e. sectors or regional entities) (Rotmans, 2005, Loorbach, 2007, De Haan, 2007, Van der Brugge et al., 2005, Van Raak, 2006). These two schools of thought do not exclude each other, rather their differences are in focus and tradition.

The origin of the socio-technical regime conceptualization can be traced back to Nelson & Winter (1977). They use the term 'regime' to emphasize that technological advance is to a large extent shaped by the cognitive frames of actors. Dosi (1982) refers to this as a technological paradigm, pointing to the existence of certain "rules", "heuristic methods" or "principles" that define the boundaries of thought and action, such as the nature of the problem and the set of possible solutions. One consequence of mental frames is that efforts to advance the performance of technologies are often focused in specific directions building on past achievements, ideas and knowledge. Dosi (1982) suggests that for this reason they have powerful exclusion effects; possibilities and solutions that lie outside the dominant technological paradigm are rarely explored. Hence, innovation tends to proceed incrementally along certain trajectories, rather than along radical and discontinuous trajectories.

Compatibility is a second reason why regimes are inclined to continue progressing along incremental trajectories. From an economic perspective, Arthur (1989) argues that there are benefits from being compatible with a particular network of interdependent technologies, infrastructures, economic and institutional structures that 'work together'. When a particular network increases in size, its attractiveness to potential users will increase as well. These are the so-called network-externalities. Compatibility-networks raise barriers for the entry of innovations that are not part of the dominant cluster. With regard to technology clusters, this creates a technological lock-in (Arthur, 1989). According to Metcalfe (1997), any attempt to introduce a technology that is incompatible with existing technologies and infrastructures will require corresponding changes to the rest of the technological system in order to make it fit (Metcalfe, 1997). Compatible technologies are thus adopted more easily than technologies that are less compatible. In principle, a lock-in can occur in any kind of cluster of compatible elements and is not limited to technology clusters. The interlinked elements form a structure which enables specific practices. At the same time, these structures impose constraints on the

2 See also chapter one section 1.4.1.

actors. They form the selection environment for social practice and reduce the degrees of freedom of actors. One way of escaping this selection environment is via the creation of niches (section 4.2.3). The niche is a protected space which allows innovations to mature.

The second regime conceptualization focuses on societal systems in relation to sustainability. Although this conceptualization shares the main idea that the interconnection and interdependence between the elements constrains radical innovations, it somewhat emphasizes the cultural and institutional elements more than the technological artifacts. The focus of this approach differs from the socio-technical approach in the sense that it does not take a particular technological system as the point of departure, but focuses on the un-sustainable aspects of a societal regime. In this view, the regime is particularly seen as the 'deep' structure of the societal system (Loorbach and Rotmans, 2006)(see also chapter 1). Following this, De Haan and Rotmans (forthcoming) argue that the regime and the niche may be understood as two societal subsystems, each portraying a different culture, structure and practice and they can interact in a competitive, symbiotic or co-evolutionary way.

Both regime conceptualizations offer a way to address the whole (i.e. the regime), without needing to deal with every individual actor. This has had a large advantage in understanding and approaching the phenomenon of transitions theoretically, however, this abstract representation falls short if we want to analyze transitions empirically. The concept of regime implies a rather homogeneous and static entity, while in reality a regime consists of a variety of different actors and structures. Consequently, the internal dynamics are ignored. Furthermore, the regime is often associated with rigidity, inertia and resistance to change, however, as shown in the previous chapter, this is not always true. Increasing the adaptive capacity of a regime may facilitate the ability to change.

Hence, there is a need for a more differentiated, more dynamic concept of the regime if we want to analyze transitions empirically. The current, abstract representation of regime remains too much of a 'black box' and hides what is inside and how the elements are internally related (see also Holz *et al.*, 2008) and the internal dynamics. Since we are interested in which kind of structures are actually changing during transition, there is need to break open the black box and develop a more differentiated concept of the regime. In the next section we will deal with this.

4.2.2 Differentiating the regime: Actors – Processes – Structures

As we argued in the previous section, there is a need for a more refined conceptualization of the regime concept. In this section we will use Giddens' Structuration theory (1984) and Complex Adaptive Systems theory (Holland, 1995, Gell-Man, 1994, Kauffman, 1995) to develop such a new regime concept.

According to Giddens (1984) social practice has a structural and an agency component. The structural environment both constrains individual behaviour and makes it possible, but the structural environment is also created and reproduced through these social practices. Giddens (1984) refers to this as the 'duality of structure'. Agency and motives can lead to the creation of new social structures (i.e. the structural component of the niche), which makes new social practices possible. This duality is an important factor that we must take into account while considering the regime. Complex adaptive systems theory suggests that actors continuously select strategies out of a range of possible strategies. As a result, structures emerge at a higher level, which in their turn influence the selection of strategies. The actors thus co-evolve with the system as a whole (Kauffman, 1995, Allen, 1998).

So the three basic dimensions that these two theories put forward to describe a regime are the following: (1) the actors, who have agency; (2) the structures, which enable and constrain certain practices; and (3) the processes, or social practices, which change or reproduce the structures. In figure 4.1 we illustrate how we can use these dimensions to represent the regime. We will now elaborate further on each of these dimensions.

A. Actors

The first dimension is that of the actors. With actors we mean real individuals, who can act autonomously and have their own perspective. However, they are also representatives of an organization. They often participate in projects because of their home-organizations and so they are bounded by their rules. As such, we cannot separate these two levels from each other and therefore we use a two-level actor model, which distinguishes between a primary level – the individual – and a secondary level – the

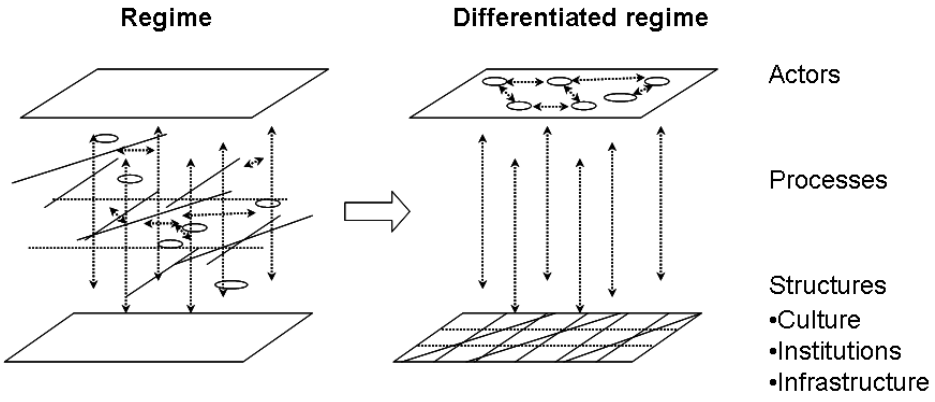


Figure 4.1. The regime contains entities of a different nature. Differentiating the regime concept provides the opportunity to analytically order the regime into three dimensions: actors, processes and structures.

organization. At the secondary level, we distinguish between five different types of organizations actors: (1) governments; (2) companies; (3) non-governmental organizations (NGOs) (4) expert centers (universities, consultants); and (5) the end-user (Rotmans et al., 2001). These organizations have different goals, ambitions or visions and different formal responsibilities (in the case of governments, and NGOs).

We should be aware that individual actors are not always rational and that their rationality is bounded. Simon (1955) argued that the rationality of decisions made by human actors is bounded in terms of knowledge restrictions. Any decision is a choice between alternatives and a rational decision would require a listing of all the alternatives, a listing of all the consequences of the alternatives and knowledge about the accuracy of these consequences. Simon argued that humans can not comply with these requirements and instead reduce the complexity by making assumptions and simplified models of the world. In addition, (Kørnøv and Thissen, 2000) argue that there are also other factors involved in decision-making, such as behavioural biases, ambiguity and variability of preferences and norms, distribution of decision-making over actors and in time and negotiation. A third aspect we should be aware of is the fact that human actors can anticipate future events or threats, which influences their decisions. Grin en de Graaf (1996) argue that the actions of individuals are guided by the following four aspects: the evaluation of solutions, the problem definitions and the meaning of solutions, the empirical and normative background theories, and the normative (ontological) preferences.

B. Structures

The second dimension is that of structures. Sewell (1992) argues that the term structure itself is 'frustratingly underspecified', even in the work of Giddens. Giddens (1984) defines structures as "rules and resources, recursively implicated in the reproduction of social systems". The term structure however, is often posited as structuring; thus it should be regarded as a process, not as a steady state. The social structure is a continually evolving outcome of social processes (Sewell, 1992). In this way, social structure only exists in the "memory traces" and according to Giddens they have a more or less "virtual" existence.

The term structure is used differently in distinct sociological disciplines. Some sociologists tend to contrast structure to culture; structure being 'hard' or 'material', referring to rules or infrastructure, and culture being the 'soft' or 'mental' structuring aspects. Anthropologists however, tend to use the term structure to refer to the realm of culture (Sewell, 1992). Culture is a term contested as well. Originally used by Edward Barret Tylor (1874) as a synonym for civilization, in later centuries it acquired the meaning of implicit and explicit patterns of behavior (Kroeber and Kluckhohn, 1952). Behind these patterns of behavior are sets of values, beliefs, ideas, knowledge and skills. Bordieu (1977) showed

that these soft mental structures (or schemas) were inherently related to the hard structures (the world of objects). They influence each other and co-evolve as it were.

Consequently, there are many different kinds of social structures and we have identified the following three main types of structure: culture, institutions and infrastructure. These three types are abstracted from the various definitions of regimes as described in chapter one (Rotmans et al., 2001, Geels, 2002, Schot, 1998a, Berkhout et al., 2004). Each type of structure can be subdivided in different elements of structure, or social elements that are 'structuring' (fig 4.2). The first type of structure is the culture, or the 'soft' structure, which consists of the following elements: the paradigm (i.e. the perception of the system and the problems and solutions), the discourse (the lines of reasoning behind policies and the argumentation), values (what is deemed important?) and the knowledge base (the level of knowledge that is available). The second type of structure is the institutional or formal structure, which contains the following elements: regulations of responsibilities, legislative norms, official policies, budgets (allocation of resources) and official contracts and permits. The third type of structure is the physical infrastructure, which encompasses the following elements: the network of roads and channels, the water infrastructure (i.e. dikes, bridges), land and water use, buildings for occupancy and residency and technological artefacts (like machines).

Perceiving the structure dimension of a regime in this way makes it problematic to think of one single 'grand regime structure', rather it we should think of it as a multitude

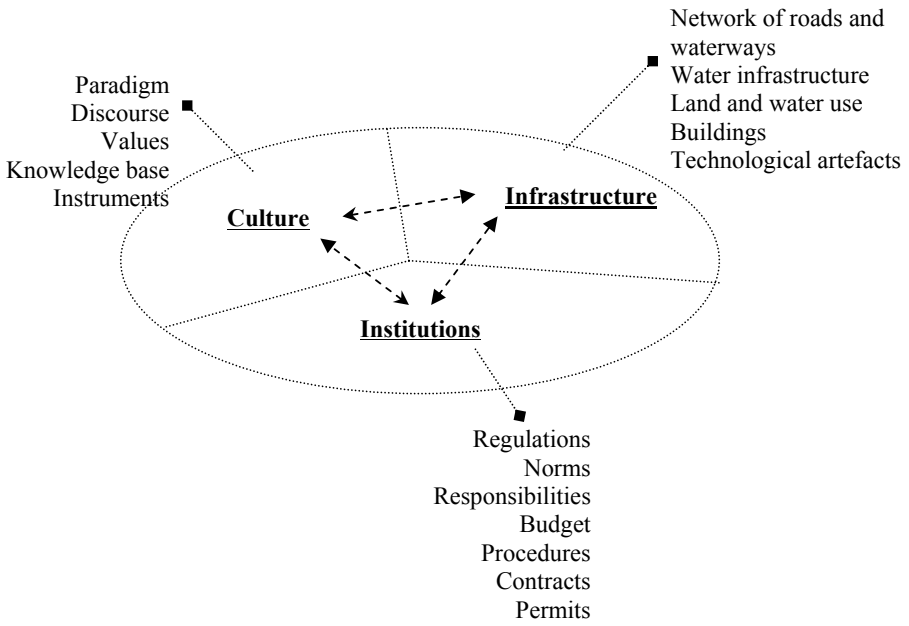


Figure 4.2 Elements of structure in a regime.

of structuring elements. Among and within these clusters, the elements of structure that comprise the regime are of a very different nature and may operate on different time and spatial scales and in this respect, may some elements be more structuring than others.

C. Processes

The third dimension is that of the processes. We view the dimension of processes as connecting the sphere of actors to the sphere of structures. Processes, such as the policy process or the construction process, are clusters of social practices. With social practices we mean activities carried out in a specific way (Spaargaren et al., 2002). Figure 4.3 illustrates a scheme of how actors, processes and structures are related. Actors initiate processes to achieve their goals, ambitions, visions or formal responsibilities. Via these processes they are able to change the regime structures. The changed structures influence the actors, which may then lead to a reformulation of their strategies, goals, ambitions or responsibilities. The actors may initiate new processes in order to change the structures etc. We thus may perceive this actor – process – structures scheme as a cycle.

If we take into account the most relevant actors, the regime dynamics can be understood as actors who engage in one or more processes, in order to adapt to and change the structures. In reality, many different cycles run simultaneously and each process is unique. Each process:

- Runs for a certain period;
- Requires knowledge input;
- Delivers output;
- Involves different kinds of activities;
- Encompasses strategic behaviour of participants;

The continuous interaction between the cycles can be understood as co-evolution and gives rise to a shared direction of the regime as a whole.

Based on these three dimensions we can define and analyze a particular regime of interest. In the next section we will present a generic method how to analyze a regime. In chapter five we will apply this method to the Dutch water management regime.

4.3 A method for regime analysis

In this section we will develop a generic method for regime analysis. This method is founded in the above developed regime concept. The method guides the analyst through five steps. By going through these five steps the different elements of the regime are identified and linked to each other. In this way, the individual regime elements are made

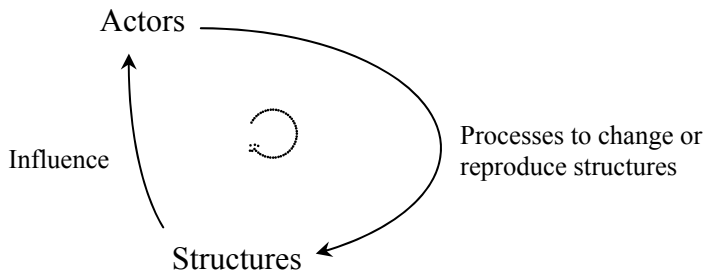


Figure 4.3 Three dimensions of the regime. The regime can be understood as a set of actors, engaging in different kinds of processes to change existing structures and simultaneously influenced (enabled or constrained) by existing structures. The inner circle merely indicates that these processes are self-repeating although the specific content and shape changes each time.

explicit, as well as the way in which the regime is organized. Applying this approach will improve our understanding of the dynamics in the regime.

Step 1 Define the system.

The first step is concerned with defining the system and the system boundaries in order to clarify what the unit of analysis is. This means that decisions should be made about which aspects are taken into account. In principle, there are no general inclusion or exclusion rules, so what is included depends on the problem the analyst wants to address. To characterize the system we can make a distinction between:

- societal systems ,
- social-ecological systems,
- socio-technical systems,
- public management sectors
- private sectors
- etc.

Step 2 Identify the actors

The second step is concerned with the identification of the main actors in the system. As a guideline, five different types of actors may be identified: government, business corporations, knowledge experts (scientists, consultants) and non-governmental organizations (NGOs) and the end users. The most relevant actors can be identified by carrying out stakeholder or expert interviews.

Step 3 Identify the main processes.

The third step is concerned with the identification of the main processes the identified actors initiate. This can be done by identifying the goals of the actors. One way of doing this is by looking at what their formal responsibilities are in the case of governments or NGOs. In the case of companies, where there are no formal responsibilities, one may look

into the mission statements. The goals of actors may also be identified by carrying out stakeholder or expert interviews.

Step 4 Identify the main elements of structure

In this step the main elements of structure should be identified. We have identified three general types of structure:

- Culture
- Institutions
- Infrastructure

These structures consist of various different elements of structure. In figure 4.3, we have identified the main elements. Each of these elements can be made specific for the regime of interest. This can be done by literature and by carrying out stakeholder or expert interviews.

Step 5 Integrate the actors, processes and structures

This step is concerned with understanding how the different elements are internally linked. This means that we have to identify which actors may influence which kind of structure elements. We are able to identify this by looking at the processes that actors initiate and at how these processes are related to the different elements of structure. The actors, processes and structures can be linked in one table to provide an overview.

Step 6 How is the regime organized?

This last step is concerned with understanding how the regime is organized in order to understand the internal dynamics. If there is a certain hierarchy, it is possible to identify which processes are initiating others. If there is no clear hierarchy, one may be able to identify which actors are in control or leading and which actors are following.

This method developed for regime analysis can be used as a starting point for a further transition analysis. Based on this method, the analyst can clarify the system boundaries, the regime elements, the organization of the regime and the dominant dynamics in the regime. This forms the basis for identifying the changes in the regime structures. In the next section, we will focus on the second part of the transition analysis: the method for pattern analysis.

4.4 The patterns of transformative change

In this section we will elaborate on the multi-pattern concept developed in chapter three by using the regime concept presented here. In chapter three we have made a

distinction between the bottom-up pattern and the top-down pattern of transformative change. In addition, we have made a distinction between whether the pattern emerges within the regime (endogenous), or is initiated somewhere outside the regime (exogenous). We have identified two variants of the bottom-up pattern: niche-absorption and empowerment. The top-down pattern was referred to as re-constellation. This led to the following six patterns of transformative change.

1. Endogenous niche-absorption: a niche is created by the SES and is successfully adopted and incorporated into the regime.
2. Exogenous niche-absorption: a niche emerges spontaneously or is created somewhere outside the SES and is successfully adopted and incorporated into the regime
3. Endogenous empowerment: a niche is created by the SES itself, grows and is able to sustain itself. It forms a new SES in a separate basin of attraction, called a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
4. Exogenous empowerment: a niche emerges spontaneously or is created somewhere outside the SES, grows and is able to sustain itself as a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
5. Endogenous re-constellation: a powerful actor in the SES imposes a transformative change top-down, for instance a national government imposing a large scale reform policy.
6. Exogenous re-constellation: a powerful actor outside the SES imposes a transformative change top-down, for instance a global institution or an international agreement.

In this section we will elaborate further on these patterns of transformative change.

4.4.1 The bottom-up pattern of transformative change

In this section we will deal with the bottom-up pattern of transformative change, which describes how transformation in the regime is triggered by niches. In the previous chapter, we have argued that we should focus more on the niche-regime interaction, so we will elaborate further on what a niche is and how it interacts with the regime.

We view niches and regimes not as antagonists; rather we view them as contrasted in the degree of the radicalism of innovation. Neither are niches isolated from the regime. Over the last decades, institutional theories and evolutionary economy theories have challenged the notion of the linear model of innovation coming from science, research and technology (Smits and Kuhlmann, 2004). Instead, innovation is now thought of as a product of social and economic processes. Freeman and Lundvall (1988) point out to the numerous interactions between users and producers in innovation processes and argue that organizations as such are not innovating in isolation, but in a broader con-

text, a so-called innovation system. Freeman (1987) defines innovation systems as the network of institutions in the public and private sectors who activities and interactions initiate import modify and diffuse technologies. The performance of innovation systems depends on the structure of the system, in particular the mutual tuning of subsystems, such as R&D, users, intermediaries and supportive infrastructure (Freeman, 1987). More recently, the attention shifted towards the activities performed within an innovation system (Hekkert et al., 2007). Galli and Teubal (1997) distinguish between hard functions, such as R&D activities and the scientific and technical services to business and public administration and soft functions, such as diffusion of information, knowledge and technology, policy making, design and implementation of patents, laws and standards, diffusion of scientific culture and professional coordination.

The term 'niche' was introduced in the field of transition studies by Rip and Kemp (1998). They saw a niche as an experimental space for a new technology before introducing it to the market. In their view the niche is a protected space, which can be actively modified, so that the product can survive more easily. Within the emerging niche, different niche-experiments are carried out (Raven, 2007). Based on Giddens (1984), we argue that such niche-experiments have both a structural component (the niche-structure) and an agency component, which is represented by the group(s) of people that are operating in and shaping the niche (the niche-group).

Recently, there is growing evidence that niches may also be important in the policy domain by developing innovative new policies. Based on a comparative analysis, Olsson et al (2006) showed that a successful transformation of social-ecological systems was associated with the existence of so-called 'shadow networks'. Gunderson et al. (2006) refer to them as 'arenas for discourse'. They state that "successful transformation toward adaptive governance seems to be preceded by the emergence of informal networks […] where new ideas arise and flourish […] and because the members are not always under scrutiny of their obligations they are freer to develop alternative policies". An important feature of these networks is that they extended beyond the scientific community and into the management and political arenas. Nooteboom (2006) refers to these groups as 'adaptive networks' which are "self-organizing groups of policy makers who enable joint fact-finding and visualization in a direction towards improvement". One feature of such adaptive networks is that the members reside in so-called power networks, but try to break away from the policies developed in power networks and participate in adaptive networks to develop new, more effective policies, which they then plug into power networks. In our view, power networks are adaptive too, however, the distinction between the formal, established groups in power versus the informal, emerging groups proposing change is an important theme raised by these various scholars.

In this dissertation, we refer to such groups as *policy* niches, to make clear that they can be regarded as niches, but that they are not technological niches. Hall (1993) defines

this type of social learning as the "deliberate attempt to adjust the goals or techniques of policy in response to past experience and new information". He distinguishes between three orders of policy learning. First order learning concerns learning at the level of policy instruments, for instance changing the interest rates, or taxes. Second order policy learning concerns a change of the instruments, which are usually applied in a particular setting. Third order policy learning concerns a change in the policy paradigm, which is the "the framework of ideas and standards that specifies the goals of policy the instruments, but also the nature of the problems they are meant to address". He argued, drawing on Kuhn, that a policy paradigm is likely to be preceded by anomalies, experimentation with new forms of policy and policy failures and a shift competing factions. Oliver and Pemberton (2004) argue that third order change occurs through a complex interaction of first order and second order changes over decades, also involving an ideological battle. They also argue that in a change of the policy paradigm outsiders often play a key-role and that it often requires an exogenous shock that destroys confidence in the existing policy framework. Grin and Loeber (2007) therefore argue that the policy subsystem is continuously under construction, also because learning at the individual level has effect on the aggregated level in an organization (Argyris and Schön 1978). Learning is more than only a cognitive factor, the learning process is situated in the social interaction. Wenger (1998) refers to this interaction as communities of practice. A community of practice is an identifiable group of people who interact regularly in regard to some shared concern or passion and who learn from their mutual engagement about how to improve their practice.

Policy niches provide the opportunity to explore new and innovative policy perspectives. One important condition for innovation is reframing. Frames are "schemata of interpretation" that allow individuals or groups to locate, perceive, identify, and label events and occurrences, thus rendering meaning, organizing experiences, and guiding actions (Argyris and Schon, 1978). Reframing thus refers to the act of re-creating new schemata, and consequently opportunities for innovation. Argyris and Schön (1978) distinguish between single-loop and double-loop learning. In single-loop learning, individuals or groups modify their actions according to the difference between expected and obtained outcomes, but in double-loop learning, the values and underlying assumptions are modified (Argyris and Schon, 1978). The confrontation between individuals with different perspectives may stimulate reframing and an informal sphere may improve creativity and the sharing of knowledge (Stacey *et al.*, 2000).

Summarizing these insights leads to the following conceptualization of niches (see table 4.1). The niche can be seen as an emerging field, which deviates from the regime (i.e. a modified environment). A niche may involve one or more groups of people. Each group has a structure component (niche structure) and an agency component (niche-group). The niche-structure provides an escape for individuals from the formal day-to-

day organizational constraints. It thus provides room for individuals to come loose from their role as representative of the organization and provides the opportunity to engage in a reframing process and seek for innovative solutions. We thus may interpret a niche as a shadow process, running parallel to regime processes attempting to influence the regime by developing innovative perspectives.

Figure 4.4 visualizes this idea of a shadow track next to the regime. This concept is called the double-loop concept. The inner loop represents the regime cycles. The outer loop represents the shadow track attempting to influence the regime. This double-loop concept represents a way of thinking about niches and regimes and distinguishing between different variants. The concept is directing our attention to three aspects of niche-regime dynamics:

- The formation of the niche
- The reframing during the shadow track
- How the alternative influences the regime

We will discuss these aspects now in more detail.

Table 4.1 Lessons from different theories.

Theories	Lessons for conceptualizing niches
Innovation theory	Niches are contrasted in the degree of radicalism of innovation Niches are small innovation systems
Technological innovation studies	Niches as modified selection environments
Policy learning	Policy learning occurs in social interaction Anomalies and outsiders may trigger paradigm changes
Organization theory	Formal and informal realm. Creativity resides in the informal realm.
Social-ecological systems theory	Informal network precondition for transformation Leadership is needed in building trust and seizing opportunities
Adaptive networks	Professionals in power engage in adaptive networks to influence power networks
Transition management	Counterpart of normal policy-arena Selection of front-runner participants
Organizational learning	Reframing Double-loop learning

The formation of the niche

We may distinguish between two variants with regard to the emergence of the niche. In the first variant, the actors in the regime create the niche themselves. We have called these niches endogenous niches. There may be various reasons for regime actors to create a niche. For instance, the actors may keep each other in a deadlock due to different stakes or goals and they create a niche in order to come up with solutions to remove the deadlock. Another condition for niche formation may be the awareness of new opportunities to be explored by the niche. A third condition for the formation of a niche may be the occurrence of a disaster which makes clear that a new solution is necessary to prevent a second disaster.

The second variant is that the niche is not created by the regime at hand, but somewhere outside the system, i.e. in another sector. We have called these niches exogenous niches. Exogenous niches may present alternatives that could influence the actors in the regime.

The reframing during the shadow track

In principle, there are two variants with regard to reframing during the shadow track. The first variant is that a radical reframing takes place. This may be the result of a confrontation between people of widely diverging backgrounds (Beers, 2005), or the incorporation of previously neglected elements, etcetera. The second variant is that the reframing is less radical, adjusting former ideas only marginally.

How the alternative influences the regime

Niche-groups can influence the regime by finding ways to adjust regime processes; timing and convincing actors to cooperate is important. Generally, we may assume that a process may be more receptive to new ideas in the beginning if the process is still open and alternatives are explored and studied than in a later stage when selections are made between the alternatives and the process will continue along the selected path. This means that the *windows of opportunity* for plugging in innovative ideas are present before the decision-making phase and that there an increasing *resistance to renewal* when the decisions are made. In more complex decision making processes there may a number of such decision rounds (Teisman, 1995). The windows of opportunity are close to policy windows as described by Kingdon (1984/1995). Policy windows provide the opportunity to put alternative policies on the political agenda, however, we refer to opportunity to introduce innovative ideas to the actors in the regime who may adopt the ideas and develop them further.

We have distinguished two variants. The first variant is that the idea of the niche is adopted by some actors in the regime. The niche finds a window of opportunity and the ideas are adopted. We have referred to this as niche-absorption. A second variant is that

the niche further expands into a niche-regime. We have referred to this as empowerment. We may expect that the probability of this variant increases in the case of radical reframing. The new ideas may be too far off the daily practice of the regime actors for them to see the added value.

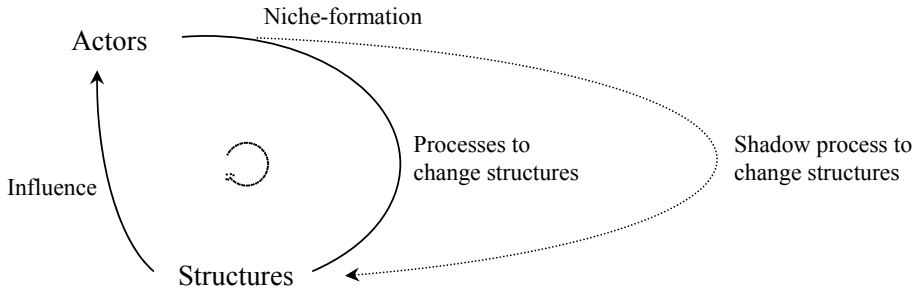


Figure 4.4 The double-loop concept visualizes the niche-regime dynamics. The inner loop represents the actors, processes and structures in the regime. The outer loop represents the shadow process of a niche. The niche runs through a shadow process and attempts to influence the regime structures.

4.4.2 The top-down pattern of transformative change

The top-down pattern of transformative change describes how transformation is driven top-down. We distinguish between two top-down patterns of transformative change. The first one is exogenous re-constellation. This top–down pattern refers to a transformation in the regime, which is triggered by an external force which operates at a higher level. This force can be a trend, like globalization or climate change, or a global market conjuncture, or international agreements, like the directives from the European Union, of the World Trade agreements etc. These forces can initiate a regime transformation top-down.

A second type of top-down transformation is endogenous re-constellation. This kind of transformation is top-down, but driven from within the regime. A strong authority in the regime may have the power to impose such a reform. Generally, this may be the National government, but in a market–oriented sector this may also be the market leader, or a monopolist. Both patterns have a top-down drive, forcing the regime to transform, either through external macro-force, or imposed top-down by the government (or another actor in power).

The six patterns of transformative change are ideal-typical, but can be used as templates in order to recognize which kind of pattern is giving rise to a certain structural regime change. In the next section we will present a method which enables us to analyze these patterns of transformative change empirically.

4.5. A Method for Pattern analysis

In this section we will develop a generic method for pattern analysis. The method consists of three steps and enables us to analyze the patterns of transformative change. This method should be used in combination with the method developed for regime analysis. The rationale of this method is to specify which element or elements of structure are changing and to analyze which pattern is giving rise to that transformative change. The method for pattern analysis is developed to analyze historical transitions, so the first step is to describe the history of the system.

Describe the history

The first step is concerned with describing the historical events and development in the regime. To this end, the starting point and the end point of the period should be defined. The multi-level concept can be used to reconstruct the history, by identifying the:
(a) developments in the regime,
(b) niches at the micro-level and
(c) long-term trends at the macro-level.
The most important regime changes can be analyzed between the start of the period and the end in order to obtain a general understanding of the transition. In order to analyze the dynamics in more detail, we suggest the following steps.

Step 1 Choose an episode in which a certain change occurred.

Choose a period during which a certain characteristic transformative change occurred. Hints for tracking important episodes of transformative change are:

- Disaster, calamities
- Policy changes
- Niches
- Events
- Etc.

These change episodes could be identified using literature, interviewing experts or analyzing newspapers.

Step 2 Which element or elements of structure change during the episode?

Specify which kind of element of structure is actually changing during this period and in what way. The changes in the elements of structure can be identified using literature, interviewing experts or analyzing newspapers.

Step 3 Which actors are involved and how?

Identify which actors are relevant and how they are involved.

Step 4 Is there a niche formed? Which process did it influence?

Investigate whether a niche or niche-regime was formed. Identify who created the niche. Is the niche endogenous or exogenous? Which processes did it influence?

Step 5 Interpret the answers and match them to the pattern templates and identify the pattern

This step is concerned with identifying the pattern of transformative change.

- *Is the transformation a bottom-up or a top-down dynamics?*
- *Is the transformation endogenously or exogenously driven?*

Step 6 Analyze the sequence of patterns

In order to interpret the transition as a whole, the sequence of the patterns can be analyzed. Which patterns are present? Is one pattern or a sequence of patterns dominant? What kind of structural change do they give rise to?

The method developed for pattern analysis can be used to analyze the dynamics of transition in more detail. In the next chapter we will apply this approach to the case study of Dutch water management. In doing so, we will analyze in detail which elements of structure have changed in the water management regime. In addition we will analyze how these structural changes have come about, e.g. which kind of pattern of transformative change can we recognize and which actors were involved and influenced which kind of key processes? Hence, by analyzing these changing structures and the underlying patterns we will generate insights into the dynamics of that transition.

4.6 Conclusions and discussion

In this chapter we developed a generic approach for a transition analysis. The approach is based on a new conceptualization of the regime concept and enables us to analyze the six types of patterns of transformative change with three variables: actors, processes and structures. In this way, the method allows us to identify which elements of structures change during the course of a transition, who were involved and which processes were influenced. By analyzing these dynamic patterns individually and by analyzing the sequence of patterns and which of the patterns is dominant, we may generate insight into how a transition unfolds.

We argued that the current regime conceptualization was not sufficient for empirical research and therefore, we have developed a new regime conceptualization. This new regime concept contributes to transition theory in the following ways. First of all, it provides the regime concept with a theoretical grounding in the social theories, especially to (parts of) Structuration theory. Important consequence of this regime conceptualiza-

tion is that it becomes difficult to think of *the* regime structure, as if there is one 'grand structure'. Instead, the regime consists of a multitude of structuring elements of very different nature. For our conceptualization of transition, this means that a regime shift should also be understood as resulting from a multitude of changing elements that add up. This has also implications for how we define transitions and what we may classify as transitions or not. For instance, do all the elements of structure need to change, or will a limited set suffice? And do different elements have different weights in such a classification? In our view, these questions cannot be addressed objectively a priori. They can only be set by consensus, which requires a large data base of transition studies involving a clear listing of which structures have indeed changed. The next question which arises is whether we are able to identify at what point in time during the course of a transition is which element of structure changing? The method for pattern analysis is an attempt to explore exactly this question. By applying the method, we might learn what is changing when, how actors can influence the structures and how these patterns of transformative change unfold. This will be done in chapter five.

Secondly, this new view of the regime contributes to transition theory through a new understanding of niche-regime dynamics. The double-loop concept describes the niche-regime dynamics by pointing to three critical aspects: the formation of the niche; the reframing during the shadow-process; and the influence of the niche on the regime. The niche-structure allows for a reframing process which we have called the shadow track running parallel to the regime processes. Niche-groups may attempt to influence the regime via windows of opportunity. The window of opportunity and the resistance to renewal depends on the phase of the process in relation to the developed idea. The concept shows a number of possible variations in the dynamic. First of all, the niche can be created by regime actors as well as by actors in another system and secondly, a niche can be incorporated into the regime, but can also develop into a self-sustaining niche-regime.

What we also learn from the double-loop concept is that there is an immanent tension in niche-regime interactions: on the one hand, one needs to stimulate reframing and 'out of the box' thinking in order to innovate; on the other hand, the more radical these innovations are, the less compatible they might be with the regime. This requires a careful balancing between reframing and securing adoption through alignment with the regime. In chapters six and seven we will study niche-regime interactions in more detail.

Chapter 5

A transition analysis of Dutch water management

5.1. Introduction

This chapter deals with the changes in Dutch water management sector during the period 1970-2005. The objective of this longitudinal case study is to identify the changes in the regime structures and to generate insight into the underlying dynamics. To this end we will apply the transition analysis approach developed in chapter four.

The Dutch water management sector has changed quite fundamentally during this period. In the 1970's the water management regime was *technocratic* and *sector-oriented,* while contemporary water management is much more *interactive* and *integrated*. In the sectoral and technocratic regime, the water engineers had obtained a broad mandate based on their expertise and as a result of this, the sector could operate almost autonomously, that is, relatively independent of the other sectors (Van Lente and Schot, 2003). The technocratic water management regime had a strong belief in its ability to control the water system by technical means. Van Ast (2000) argues that the current water management regime is much more integrated and interactive. It is integrated, because the regime needs to integrate water management with related policy fields, such as nature preservation, spatial planning, agriculture and industry; it is interactive, because it involves a continuous monitoring of the water system and a continuous interaction with relevant actors. The current regime has more modest stance with regard to its ability to control nature and understands there is a need to continuously adapt to changing ecological, physical and social circumstances.

Others, such as De Wit (2000), symbolically summarized this shift as *"from fighting the water to accommodating the water*[3]*"*. This quote emphasizes a shifting perception of seeing water as a ´enemy´ that needs to be mastered with technical means towards a perception of the water system as part of a continuously changing social-ecological system. The water management sector should therefore increase its adaptive capacity, for instance to cope with climate change. One important consequence following from this perception is the need to create local water retention zones. Abundant water can be stored there temporally and released in times of drought.

This kind of thinking has emerged slowly over time, but was reinforced in 2000 by the declaration of a new water reform policy by the Dutch government. This new water policy was called "Water policy for the 21st century" (WB21). WB21 anticipates the effects of climate change in the future, arguing to expect a sea level rise, more extreme river run offs and more extreme precipitation patterns. In order to deal with the extra amount of water, there is a need for transforming land use patterns and to create additional water retention areas. This requires a quite radical change in the culture of Dutch water management, as well as in the existing institutional and infrastructural structures.

3 In Dutch: "Van water keren, naar water accommoderen" (de Wit, 2000).

In this chapter, we thus focus on how the interactive and integrative regime emerged. One of the questions addressed is whether this shift may be understood as a transition. A part of this analysis has been published earlier (see Van der Brugge *et al.*, 2005). In this article, we used the multi-level concept and the multi-phase concept to analyze these changes. Although that study generated insight into the transitional dynamics within the water sector, it also made clear that the two concepts alone were not sufficient. The concepts do not make analytical distinctions between different kinds of regime structures that change during the course of transition, which makes it difficult to pinpoint the exact structural changes. In the previous chapter, we argued that there is not so much as one single 'grand' structure of the regime; rather the regime contains a multitude of different elements of structure. Consequently, if a multitude of different elements of structure is changing, it might add up to a transition. The transition analysis approach enables us to identify these changes and thus to be much more specific about which of the elements of structure have changed in the Dutch water management regime. This analysis provides us the basis for discussing to what extent we might classify these changes as ´transition´. In this case study, we perceive a ´transition´ only if there are changes in each of the three types of structure: culture, institutions and infrastructure. We mention the infrastructure explicitly, since changes in culture and institutions are less tangible and do not necessarily mean that the practice on the ground indeed has changed. In this sense, changes in the infrastructure, corresponding to the cultural and institutional changes, are the physical proof of a different regime.

In addition, the multi-level concept and the multi-phase concept were also insufficient to generate specific insight into how these structural changes came about. Therefore it is necessary to make a distinction between different patterns of transformative change. A pattern of transformative change describes how specific elements of structure changed during a certain period. We use three variables to describe such a pattern: the actors, the key–processes and the elements of structure. In this case study we will analyze the dynamics using the six types of patterns of transformative change identified in chapter three and four.

In section 5.2 the research approach will be outlined. Is section 5.3, we will address the historical background shortly. In section 5.4 we apply the method for regime analysis to the Dutch water management regime. In section 5.5 we will present a historical reconstruction of the transition. In section 5.6 we will analyze the changes and the dynamics by applying a multi-level and a multi-pattern analysis. In section 5.7 we will address and discuss the main findings of this case study and interpret the observed changes. We will draw conclusions with regard to the dynamics of this transition and the approach used and we will reflect on what this means for our understanding of transitions.

5.2 Research Approach

The research approach for this case study consists of four steps. The first step was concerned with defining and characterizing the Dutch water management regime by applying the method for regime analysis. This involves the identification of three types of variables: regime actors, key–processes and elements of structure. We have used literature and interviews to identify the actors and the structures and we have identified the processes through looking at the formal responsibilities of the actors.

The second step dealt with a reconstruction of the history of Dutch water management between 1970 and 2005. We have used the multi-level concept to guide the data collection, which distinguishes between (a) long-term trends at the macro-level; (b) developments in the regime; (c) innovations at the micro-level. The reconstruction is based on a synthesis of multiple data sources. The primary data involved recording oral histories of individuals involved with water management and individuals involved first hand in some of the crucial periods. The secondary data was based on a literature survey with regard to the history of Dutch water management (e.g. , 2002, Bosch and Van der Ham, 1998, De Wit, 2000, Dicke, 2001, Disco, 2000, Van Heezik, 2007) and relevant policy documents. Thirdly, we made use of an electronic newspaper archive to verify some of the data. An important starting point for reconstruction was the ecological disaster in the Haringvliet estuary in the province of Zeeland in 1970. The disaster triggered the sectoral and technocratic regime to adopt a more ecologically oriented, integral water management approach. We therefore start the reconstruction at this point in time.

In the third step we have applied the method for pattern analysis (chapter four) in order to analyze the dynamics in this transition. We have subdivided the historical reconstruction into seven episodes during which a certain characteristic transformative change occurred. The periods were identified on the basis of interviews and the literature. For each period we analyzed the three variables: which actors were involved, which key–processes were influenced and which of the elements of structure changed.

In the final step, we interpreted the changes in regimes structures and discuss to what extend we might considered it as a transition. Secondly, we analyzed the dynamics in terms of the sequence of the patterns of transformative change and identified the dominant patterns.

5.3 Previous transitions in Dutch water management

In this section we will provide the reader with a short overview of the history of Dutch water management. Based on Van Ast (2000) we can identify three earlier transitions in the history of Dutch water management. During the medieval ages, life in the low

lands of Holland was threatened by the rivers and the sea and the inhabitants protected themselves by living at higher grounds and by building small dikes. During the first transition, water management shifted away from a primitive way of flood protection to a more organized form of water quantity management. This transition was initiated by the emergence of the windmill (and during the 19th century replaced by the steam engine) and can be characterized by the land reclamations for agricultural purposes. In the 20th century, water management became more important as a result of the growth of water dependent sectors such as shipping, agriculture and the drinking-water industry. A water management sector emerged and during this transition the regime developed its scientific and technocratic stance (Bosch and Van der Ham, 1998). Large interventions in the water system were needed to secure flood protection and shipping. Meandering rivers were straightened and new river channels were created. The scientific-technocratic mode emerged when engineers started to study water dynamics in scale models, which enabled the hydraulic engineering and hydrological modeling (Disco, 2000, Linsten and Ten Horn-van Nispen, 1998). In addition, new materials were used for the construction of water infrastructure, such as steel, concrete and electronics. Leussen (Van Leussen, 2002) points out that sectoral water management was primarily concerned with (1) controlling water; (2) solving problems with technical interventions; and (3) dividing land and water to support land-use demands.

The *Delta Works* reflect the sectoral-technocratic regime at its height. The Delta Works are one of the most complicated hydraulic engineering programmes in the Dutch history, consisting of 14 dams which close off the estuaries in the province of Zeeland in the southwest of The Netherlands. The Delta Works were initiated in response to the 1953 sea-flood, which killed 1835 people. The construction works started in the mid 1950s and were finished in 1997, when the last dam was completed. Although these hydraulic constructions have made the Dutch Water sector famous across the world, they also initiated change towards a more ecological oriented water management approach.

In the 1970s, a new transitional period started as a consequence of growing environmental awareness and the understanding that water quality and water quantity were inherently related and an integral part of an ecosystem and a society (Saeijs, 1991). Currently this is known as *integrated water management*. The adverse ecological effects of the storm barriers of the Delta Works triggered public protest. With hindsight, the ecological problems in one of the estuaries, the Haringvliet, were important triggers for the shift towards integrated water management. Slowly, the inward-looking, autonomously operating sector changed into an open sector, interacting with related policy fields (Disco, 2000, Van Heezik, 2007). This process is denoted as the "socialization of water management" (Van Leussen, 2002). During this transition, the traditional powerful role of agriculture in water management became less important and the role of nature preservation and spatial planning became more important. In addition the emphasis

on technological solutions reduced. Van Ast (1999, 2000) labels this transition the shift towards *interactive water management*, during which the water managers start to continuously monitor the water system and interact with relevant actors more frequently. This shift is far from being completed.

This chapter is concerned with the shift from the sectoral and technocratic water management regime to the integral and interactive water management regime. Before we present a more detailed reconstruction of this shift, we will first describe the Dutch water management regime.

5.4 The Dutch water management regime

The method for regime analysis developed in chapter four distinguishes between three dimensions in the regime: actors, processes and structures. In this section, we will define the system and demarcate its boundaries and describe the regime by these three variables. Thus we will apply this method and identify the most relevant actors, processes and structures in the Dutch water management regime and analyze how these three dimensions are organized.

Step 1: Define the system.

In general, water management cannot be seen independently of the water system. Water managers continuously respond to changes in the water levels, the water flows and the ecological and chemical balance and do interventions. Their interactions makes it pointless to separate the social part and the ecological part but to perceive it as a social-ecological system (see chapter 1 & 3). The social part includes the water usage and governance system and the ecological part includes the water system in terms of its hydrology, morphology and biodiversity.

In this case study we focus on the Dutch water management sector. The social part of the Dutch water management sector includes a high level of technological assets, such as dikes, bridges, pumping stations and sewerage and may therefore be seen as a socio-technical system. The intensification of land-use during the last century has demanded huge engineering efforts. A second important feature of Dutch water management is that it is a public management sector. By law, water quantity and water quality management is the responsibility of different governmental water management authorities. Private companies do not have such responsibilities, but are often contracted to co-develop water management plans and to do research. In contrast, the drinking water companies are private companies responsible for purification of wastewater and distribution of

drinking water to the consumer. The main functions of the water management sector can be summarized as follows (Huisman, 2001):

- Protection of people and their properties against water related dangers;
- Enabling the use of water resources;
- Securing and maintenance of clean water reserves;
- Setting and maintaining norms for surface water and groundwater quality;
- Waste water treatment;
- Protection of the natural circulation of water against adverse effects;

The Dutch water system can be subdivided into three main types of water ecosystems: the coastal zone, the main water system (the large rivers) and the regional water system (Huismans, 2001). The coastal zone contains salt water ecosystems. In the estuaries in the South-West in the Province of Zeeland salt and freshwater are mixed, creating a brackish environment with specific biodiversity and ecological dynamics. The main water system contains four large European rivers, the Rhine, the Meuse, the Scheldt, and the Ems and the large fresh water lake IJsselmeer. Each river has its own characteristic run off pattern, morphology and biodiversity. The regional water ecosystems show a large variety, from rural area, to nature preservations, to urban water systems. More than 60 % of the Dutch land lies beneath sea-level and is pumped dry to allow agriculture, industry and housing. There are over 3000 of such polders, which are essentially man–made water units.

Norms for the ecological quality of these water systems are largely determined by the European Water Framework Directive (WFD). The norms go beyond maximum allowed concentrations, but focus on the ecological status of the water system. This includes biodiversity and population numbers. The ecological status is classified according to a WFD-classification system. Norms for safety are determined nationally and differ per area. The safety norms are based on the flood probability. In the densely populated West, the norm is 1 / 10,000 years, meaning the area is protected against extreme water levels that occur only once in 10,000 years. For the South-west delta area and the North, the norm is 1 / 4,000. For the Brabant and Gelderland regions the norm is 1 / 2,000 and in Limburg 1 / 1,250. The dikes are tested against the norm every six years, but there is a significant delay. The so-called 'primary dikes' protect the people against the sea and the rivers. These dikes divide the land into 57 regions (fig 5.1). Within these 57 regions, the 'secondary dikes' protect the land from flooding by the smaller channels. The norms for these regional water systems are related to land-use. Flood frequencies are allowed to be higher in rural grassland than in urban areas. In most cases, water levels are maintained at a fixed level. These levels are the outcome of negotiations between the users and the water management authorities.

In this case study we decided to focus on the changes that have occurred in water quality management and water quantity management of surface water in the coastal,

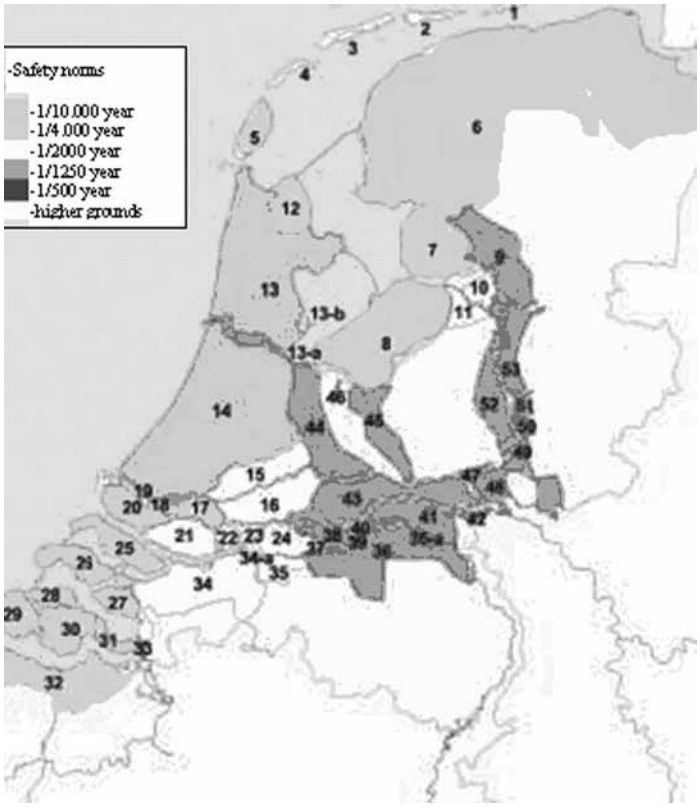


Figure 5.1 Safety norms for each of the 57 regions.

river and regional water system in The Netherlands. In the next steps we will proceed with identifying the most relevant actors, key-processes and structures of this regime.

Step 2: Identify the actors

Eighteen different types of organizations are involved in Dutch water management (see appendix A). Of these eighteen organizations, four are supra-national actors and are therefore not included in this analysis. Although these organizations are quite important, they are considered to be part of the macro-level landscape. This is a direct result of the multi-level concept which creates distinctive levels of scale. As we attempt to identify the regime at a national level, this automatically means that organizations at a international level are not included in the regime. However, they are included as actors at the macro-level and thus of influence to the national regime.

Since our focus is on surface water management, drinking water companies are excluded as well. These are primarily concerned with the drinking water supply chain, rather than directly involved with surface water management. Citizens and farmers are

important stakeholders in the playing field. Their influence is primarily through the number of seats in the boards of the regional water management authorities, or district water boards. As such, their role as actors is taken into account indirectly via the district water boards. Insurance companies are also indirectly related to water management and are therefore not taken into account as regime actor. Currently, individual insurance against flood damage is not possible, although the debate has started. If it would be included, we may expect the insurance companies to become of more influence to water management, for instance in relation to safety norms and location based insurances.

The remaining twelve organizations are directly related to surface water management and are considered to represent the actor-dimension of the regime. The selection criteria are based on the responsibilities, role and influence in water management. The selection of these twelve regime actors is based on the identification of legal responsibilities, expert-interviews and literature. Of these twelve regime actors, three actors are part of the national government. Most important actor at this level is the Ministry of Transport, Public Works and Water management. The Ministry of Housing, Spatial planning and Environment is involved in water management through spatial planning policies. The Ministry of Agriculture, Nature and Food quality is involved though the agricultural policies and nature preservation policies. At the regional policy level the Provincial Government is in charge of formulating regional water policy (especially the department of water management and the department of spatial planning). The district water boards are primarily involved in the execution of local water management, but are consulted in formulating policy. Aside these government actors, five other types of actors are perceived to be regime actors, because of their influence on water management. First of all, the engineering offices, which have a specific, often high-level of technological expertise. Secondly, scientists, who do specific research and develop new methods and concepts. A third type of actor is the consultancy agent who can be hired for instance to do research or co-operate to develop water policy plans. Fourth type of actor is the project-developer, who is important in the actual management and construction of water infrastructure. And the fifth type of actor is the non-governmental organisation (NGO), who has as important role in research and agenda setting.

These twelve types of regime actors are organizations with different roles in surface water management. In the actor dimension of the regime we use a two-level actor model: the level of the organization and the level of the individual. The organization is a collective agent, which means that it exists of individuals. The individuals are representatives of the organization. The individual has its own mind and expertise, but is also bounded by the rules and strategies of the organization. As such, these two levels cannot not separated. A second remark we should make is that the representatives of the different organizations often cooperate in consortia and participate in all kind of networks. In that sense their roles are distinctive, but they share knowledge and influence each other.

Thirdly, within the different actor categories there can be large differences as well. For instance, different NOG's have different issues and management styles and there are large differences between water boards or the expertise of engineering offices.

So, although we have identified the regime actors in terms of the organization, we should be aware that the real actors are individuals representing the organization.

Step 3: Identify the main processes.

In order to get grip on the process dimension of the regime, we have attempted to identify what kind of activities the actors are carrying out. We make a distinction between the key-process and secondary processes. The primary process concerns the prime function of the organization. The secondary processes are those activities that are supportive of the key-process. To this end, we have first identified for each of the organization what their main role or function is. The line of reasoning is that in order to fulfil their function, an actor initiates a certain process. In this way, we can link every actor to a certain key-process. In the case of the different government water management authorities, the responsibilities are clearly formulated in legislation and so their role can be simply deduced (see also appendix A). We have used literature and interviews to identify the roles or tasks of the other types of actors (see appendix A). We have taken these tasks as point of departure and translated them into the type of process that is initiated in order to fulfil their responsibility or task.

In table 5.1 we have translated the tasks of the actors into the key-processes they initiate or participate in. If actors cooperate in the same type of process in order to fulfil the tasks, we have clustered them and linked them to one single key-process. This resulted in seven key-processes. The seven key-processes give a simplified overview of the different dynamic cycles that are going on in the regime. These key-processes are continuously initiated, gone through and repeated. Although each repeating cycle has the same theme, each repeating cycle has a new objective and different time and spatial scope. As such, each cycle will realize a different outcome as we will show later.

Looking closer into the different key-processes, we may identify different phases during the process (figure 5.2). The phases are clusters of activities done in a certain way (a practice). Although these phases are not empirically pinpointed, they represent more or less the expected, logical order of the process. The organizations, of course, do not initiate processes of random activities, but have some sort of process design upfront, which is in some case regulated into formal procedures and in some cases based on past experiences. However, in practice al kinds of variations exist, for instance the phases are not that linear as suggested here, phases might run parallel and phases might be skipped or repeated. Thus in reality these processes are fuzzy, somewhere in between randomness and the strict order represented here. However, what is useful about iden-

Table 5.1 Key processes in the Dutch water management regime and the actors who initiate them.

	Actors	Key processes
1.	Ministry of Transport, Public Works and Water management Ministry of Agriculture, Nature and fishery Ministry of Housing, Spatial planning and Environment	National water policy
2.	Provincial Government, -department of water management District water board	Provincial water policy
3.	Provincial Government, -department of water management -department of spatial planning	Attuning water policy and spatial planning
4.	District water boards	Local management
5.	Project-developers Engineering offices	Construction
6.	Scientists, Consultants, NGOs	Research
7.	All	Knowledge exchange

tifying these different phases is that each phase requires different kinds of (knowledge) input, which means that along the run of the process there are windows for different kinds of knowledge input. This is an important characteristic of the process-dimension (see chapter four). This characteristic can be used to change the outcome of the process. However, it must be said that due to the fuzziness of the process, these windows are not always easy recognizable.

Step 4: Identify the main elements of structure

The structure dimension of the regime involves three different types of structure (see also chapter four). The main elements of structure are shown in figure 5.3. The first type is the cultural structure, or the set of soft, mental structures. In the field of water management important elements of culture are the dominant paradigm, the discourses, the values and the knowledge base. The dominant water management paradigm is the

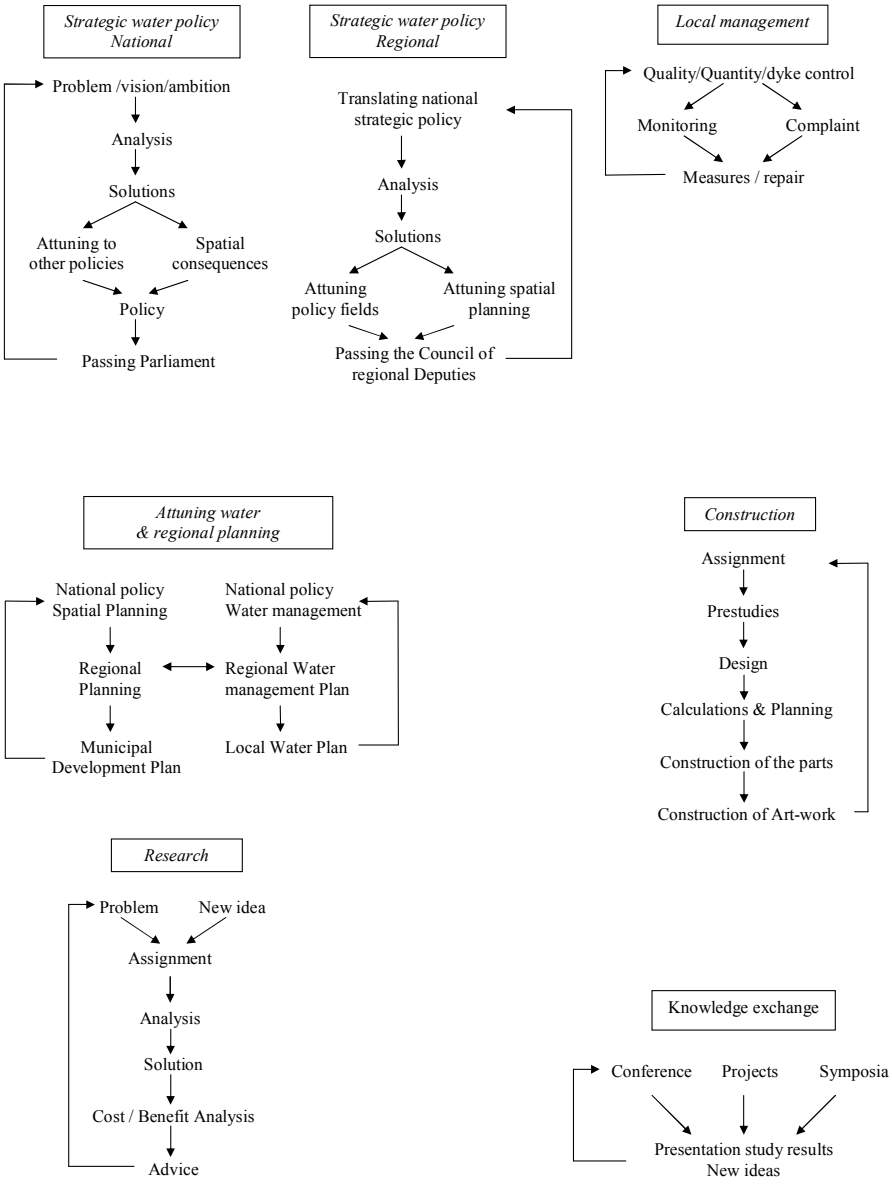


Figure 5.2 a-g. Activities and practice during the key-processes. Different activities take place during the various phases in the process. In reality, these phases are not altogether linear and confined as may be suggested here.

set of shared assumptions about the workings of the water system and consequently of how water related problems can be solved. The dominant water management paradigm also contains a view about the relationship between humanity and nature in terms of the degree of control and utility. A second element of culture is the policy discourse. The water policy discourse contains an argumentative line of reasoning why a certain policy is desired and required. Often there are rivalling discourses competing for support. In addition, new discourses can emerge as a result of events, future threats or increased knowledge base. A third element of the water culture is the shared values, such as safety or ecological quality. If these values are threatened, it will be perceived as a problem. Hence, water related problems are directly related to the values we deem important. The fourth element of culture is the knowledge base. The level of water expertise and hydrological engineering enables the prevention of problems and expansion of solution space to solve problems if they occur. The four elements of culture are strongly interlinked. They might reinforce each other, but new knowledge can cascade into a new discourse or even trigger a paradigm shift.

The second type of structure is the institutional structure, or the set of formal structures. The first institutional element of structure is legislative regulation. This set of laws regulates the water management sector in terms of formal responsibilities of authorities and accountability. A second element of institutional structure is the determination of norms. Safety norms are based on a flood probability and need to be evaluated every now and then. Norms for water quality in terms of maximum allowed concentrations exist formally since the Law on the pollution of surface water appeared in 1970. A third element of institutional structure is the water policy plan. There are many types of water

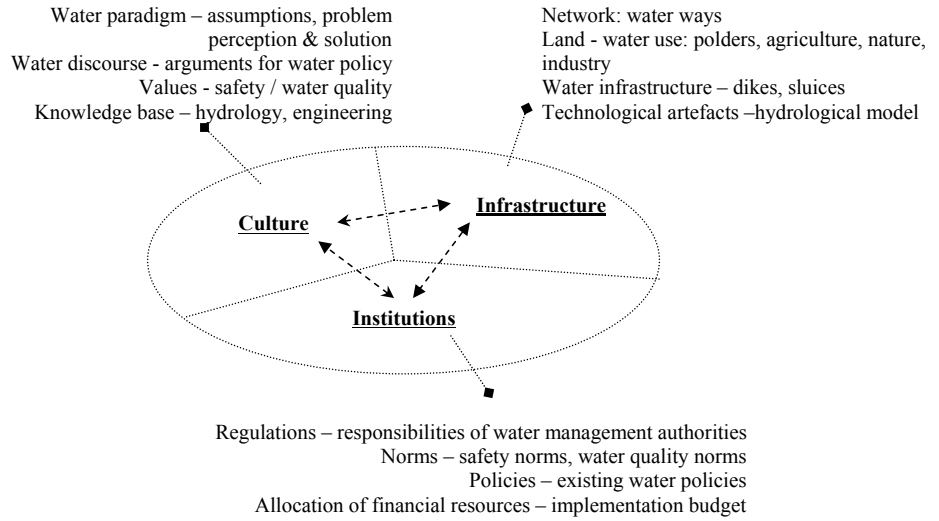


Figure 5.3 Elements of structure in the Dutch water management regime.

policy plans, ranging from the national level to the local level and from water quantity management to water quality management. Water policy plans need to be attuned to other policies, for instance the regional development plans. A fourth element of institutions is the allocation of financial resources. Priorities between controlling safety and water quality norms and implementing polices are determined by available budgets. The four elements of institutional structure are internally aligned.

The third type of structure is the infrastructure, or the actual physical structure. Amongst this type of category we locate the water itself, or the network of connected water ways. A second element of the infrastructure is the land use and water, including the polder systems, in terms of agricultural, nature preservation areas or industry. These differences in land use require different amounts of water supply and have different flooding norms. A third element of the infrastructure is the water infrastructural artefacts, like the dikes, the sluices, the pumping stations and sewers. These artefacts are expensive and often have a long time span. A fourth element of infrastructure is what we refer to as technological artefacts. We mean by this the smaller technological artefacts, such as the hydrological computer simulation models, by which the effects of measures can be calculated. The four different elements of infrastructure have a strong spatial orientation and so there might be large differences between localities.

Step 5: Integrate the actors, processes and structures

In this step, we link the three dimensions of actors, processes and structures to each other. The core of the regime concept is that these three dimensions are interrelated. Change in one dimension is reflected in the other two. For instance, changing regulations (structure) with regard to responsibilities, directly affect the organizations involved and will be reflected in the processes they will initiate and participate in. Although the regime is thus the emergent outcome of the interplay between the actors, processes and structures, each of the actors has the capacity to change one or more specific elements of structure to a certain extent. Table 5.2 links the identified regime actors and key-processes to the elements of structure they can influence.

With regard to the cultural elements of structure, we might ague that all the actors are of influence. Each actor contributes is his own way to the water paradigm, discourse, values and knowledge base. With regard to the institutional structure, not all actors have the same amount of influence. Regulations and norms are formulated by the Ministry. The national, regional and local policies are formulated by respectively the Ministries, Provincial governments and district water boards. With regard to the elements of infrastructure, the project developers and the engineering offices have much influence by manifesting the actual physical changes. Although each organization has an influence, it is a different influence on different elements of structure.

Table 5.2 The output of key-processes that can influence regime elements.

	Actors	Key process	Influences element(s) of structure
1.	Ministry of Transport, Public Works and Water management Ministry of Agriculture, Nature and fishery Ministry of Housing, Spatial planning and Environment	National water policy	Water-related paradigm Values (safety, water quality) Water discourse Knowledge base National water policy Land and water use Regulations Norms Responsibilities Allocation of financial resources
2.	Provincial Government, -department of water management District water board	Provincial water policy	Water-related paradigm Values (safety, water quality) Water discourse Knowledge base Regional policy Network of water ways Land and water use Allocation of financial resources
3.	Provincial Government, -department of water management -department of spatial planning	Attuning water policy and planning	Water-related paradigm Values (safety, water quality) Water discourse Knowledge base Regional water policy Allocation of financial resources Network of water ways Land and water use
4.	District water boards	Local management	Water-related paradigm Values (safety, water quality) Water discourse Knowledge base Local water policy Allocation of financial resources Water infrastructure
5.	Project-developers Engineering offices	Construction	Water-related paradigm Values (safety, water quality) Water discourse Knowledge base Water infrastructure Technological artifacts
6.	Scientists, Consultants, NGOs	Research	Water-related paradigm Values (safety, water quality) Water discourse Knowledge base
7.	All	Knowledge exchange	Water-related paradigm Values (safety, water quality) Water discourse Knowledge base Regulations Norms Policies Allocation of financial Water ways Land - water use Water infrastructure Technological artefacts

We should however be aware that in reality these distinctions are not that simple and clearly demarcated and the following four aspects should be take into account. In the first place, as table 5.2 shows, different organizations may participate in the same key–process and the involved organizations need to cooperate. In some cases however, they can keep each other in a deadlock because they have opposing stakes. Secondly, these processes can influence more than one element of structure. For instance the key–process of developing *National water policy* has an impact on many elements of structure: among other things it influences the water paradigm, it influences which of the values are deemed most important, it formulates new strategies and even designates water defence works for certain locations. In the third place, the scale of influence differs per process: the key–process of *National water policy* for instance has a wider range than the key–process of *Local management*. In the fourth place different processes may influence the same element of structure. An example of this is land and water use, which is influenced by *National water policy*, *Provincial water policy, Attuning water policy and spatial planning* and *Construction*.

Taking these consideration into account, we see that actors can both influence some elements of structure directly and some indirectly via influencing other actors. In the next step we will attempt to show how the regime is organized by interrelating the different process.

Step 6: How is the regime organized?

The last step of this method is to analyze the dynamics in the regime by viewing how the regime is organized and how the various processes relate to each other. In the Dutch water management regime this can be understood as follows. The organization in the regime is rather hierarchic. At the top level of the hierarchy is the *National water policy process.* This process leads to tangible outputs, such as national policy documents. The 12 provincial governments respond by initiating the *Provincial water policy* process and the process of *Attuning water policy and spatial planning*. There is a recursive interaction between both processes, which means that mutations in the one have a direct consequence for the other. These policies set the constraints for *local management* carried out by the district water boards and the municipalities. The other processes primarily support the policy processes and although they are not a formal part of the policy hierarchy they are closely related. The *Construction* process is concerned with the construction of water infrastructure and as such is important during the actual implementation of policy. *Research* and *Knowledge exchange* can influence the policy processes by providing them with appropriate and up-to-date knowledge, but also new knowledge.

In summary, we have defined the Dutch water management regime by three variables: the actors, the key–processes and the structures, taking into account water quantity and water quality in coastal water management, river basin management and regional water management. The identified organizations have different responsibilities or tasks and initiate different kinds of processes in order to change or influence different elements of structure. They can do this directly or indirectly. The policy hierarchy is an important feature of the regime and creates a dominant top–down dynamic. However, local initiatives and innovations can influence the policy bottom–up.

Social–ecological systems, like water management, are complex and messy (Ravetz, 1999). Inherent to their nature is that they cannot be known to their full extent and therefore the analyst is always bounded to simplify reality into a conceptual model of the system (Cilliers, 2005). Decisions about what is taken into account are not value free (Checkland, 1981). Here we have attempted to develop a conceptual model of the Dutch water regime that allows for a more differentiated understanding of the internal elements and dynamics, since these two aspects often remain hidden in the transitions literature.

Being aware of the complexity, we have sought for a balance between a too simplistic and a too complex representation. In reality, the regime is much more complex and heterogeneous than is represented here. There are many organizations within in each actor type, which may portray a large variety. In addition, the activities of actors are not solely determined by their formal responsibilities, but actors are reflexive and anticipative. Furthermore, we have left the secondary processes out of the analysis, for the same reason of reducing complexity.

In the next section, we will use this regime definition to understand how the regime changed between 1970 and 2005. We will first start by characterizing the elements of structure in the sectoral and technocratic regime around 1970. Then, we will present a historical reconstruction of the regime and analyze which elements of structure have changed.

5.5 A history of Dutch water management between 1970 and 2005

In this section we will present a history of Dutch water management during the period between 1970 and 2005. We have used the multi-level concept to reconstruct this history by identifying niches, regime changes and developments at the macro level. We will start with a characterization of the elements of structure in the sectoral technocratic water management regime of the 1970s.

The culture of the water management regime could be characterized as technocratic. In terms of the underlying elements of structure, the water management paradigm

was one of strong belief in the human ability to control the water system by technical means and so the water problems were approached as engineering problems requiring technical solutions. The main values underlying water management were the necessity to optimize flood protection and freshwater distribution for agricultural purposes. The main discourse with regard to safety and distribution was to reinforce dikes, to redirect the water, or to increase the pumping capacity. The scientific knowledge base was dominated by the engineering disciplines, as most of the professionals working in the sector had been trained at technical universities.

The institutional structure can be characterized as sectoral, operating rather independently of other sectors. In terms of regulations, the sector was hierarchically organized and the Ministry of Transport, Public Works and Water management was the most powerful authority. At the regional level, there were about 800 local water management authorities, or district water boards (IJff, 1993). Traditionally, these water boards were responsible for local water quantity management. The norms for flood protection were already established almost two decades earlier, but the norms for water quality had just appeared with a new law in 1970. The national memorandum on the national water household had appeared in 1964 and was further translated to the provincial and local level.

With regard to the infrastructural elements, the water system had become a sophisticated system of connected water systems and sluices. The water level was often set at specific level, to allow for specific land use, such as housing, agriculture and industry. The meandering rivers had been ´normalized´ for the benefit of shipping and the floodplains were also used for agricultural exploitation. The Delta works were being build, changing the estuaries in the province of Zeeland. Technological artifacts, like computer models, emerged, which were being used to understand the hydrology and morphology of the water systems.

5.5.1 The emergence of Integrated water management

Many of these structures started to change from the 1970s. Some of the first regime changes emerged as a result of the execution of the Delta Works programme in the province of Zeeland in the southwest of the Netherlands. The Delta Works were constructed in order to protect the people of Zeeland. However, by closing off the estuaries a number of ecological disasters occurred, which triggered a more ecologically oriented, integrated water management approach.

5.5.1.1 The Zeeland-Estuaries

In 1970, the storm surge barrier that closed off the Haringvliet estuary had been finished. The barrier caused significant ecological problems because it stopped the tidal dynam-

ics and turned the brackish water into a fresh water lake. The biodiversity in the region diminished and the local fisheries collapsed, which triggered a large public protest. As a result, the plans for closure of the next estuary - the Eastern Scheldt – were controversial and a protest action group *"Against closure of the Eastern Scheldt"* was raised. In the political climate of the 1970s the plans became a target for massive opposition (Disco, 2002).

The macro-landscape was also changing. It was a time of growing environmental concern. The influential 'Club of Rome' emphasized that explosive population growth and economic development would lead to overexploitation and depletion of natural resources and increasing environmental pollution. Their alarming report "Limits to Growth" (Meadows et al. 1972) sold over one million copies in the Netherlands. The Law on Surface Water Pollution appeared in 1970. During the 1970s as many as 600-700 environmental action groups were formed (Van Lente and Schot, 2003). People started to associate the Ministry of Transport, Public Works and Water management with large concrete infrastructure and landscape degradation. Not surprisingly, the 1973 elections resulted in a center-left coalition with environmental protection as one of the core issues. Within this landscape, Prime Minister Den Uyl promised to re-evaluate the closure of the Eastern Scheldt.

A committee was appointed to investigate the feasibility of a semi-permeable storm surge barrier. The committee had seven members, with - unconventionally - only two civil engineers. The chairman was a lawyer; the other members had backgrounds in economics, biology, fishery, environment and regional planning (Disco, 2000). In 1974, the committee reported to the National government that a closed dam was undesirable from an environmental as well as an economic perspective. This raised the question about the design and technical features of the barrier, which should not alter tidal dynamics to such an extent that the ecosystem dynamics would be irreversibly affected.

Against this background, two studies were carried out to investigate alternative designs for storm surge barriers with different apertures. The results were presented to Parliament in the so-called *Blue report* and *White report* in 1976 (Westerheijden, 1988). The white report was based on the detailed POLANO-study (Protecting an Estuary from floods - Policy analysis of the Eastern Scheldt) carried out by the RAND-corporation. The study compared three alternatives for the storm barrier: a closed barrier; a semi-closed barrier; and an open barrier with additional dike reinforcements. For the first time, next to evaluation criteria of costs/benefits and safety, a third criterion was added: ecology. Although the POLANO-study did not advise pro or against a closure of the Eastern Scheldt, in response Parliament decided to build the semi-open storm surge barrier. The Eastern Scheldt storm surge barrier was eventually completed in 1986 and now epitomizes the new approach in coastal engineering: a hybrid construction serving safety, economy and ecology.

The Eastern Scheldt case influenced the regime in two ways. First, the POLANO-study provided a framework to integrate ecological criteria next to costs/benefits and safety. The underlying systems approach was based on energy inputs, throughputs and outputs of nutrients cycles and a small number of species. This systems approach provided a language that aligned with the scientific language of the civil engineers at the time (Disco, 2000). The second regime influence was that the Eastern Scheldt case paved the way for the entry of ecologists, chemists and biologists in the water sector. In 1971, the Delta Department – the department of the Ministry of Public Works, Transport and Water responsible for the construction of the Delta Works - hired its first biologist, H. L. F. Saeijs, to manage the new fresh-water lakes and to alleviate the ecological effects of the new dams. By 1975, this department[4] was renamed "Department of Environmental Research and Facilities" and 21 of the 33 employees had a biological or ecological training background. The ecologists can be seen as the second niche. In 1985, the unit was split up into a *land ecology* unit and a *water ecology* unit. Disco (2000) pointed out that the influx of ecologists stagnated from that point on, but he argues that the ecological approach continued to spread because new cohorts of civil engineers had become interested. The ecosystem approach would be more a matter of rules and routines, than of people and disciplines.

Another important triggering event was the 1976 dry summer, during which the availability of fresh water supplies had run short. The government commissioned RAND and the Hydraulic Laboratory in Delft to carry out a policy study of fresh water distribution. The influential study *Policy Analysis for Water management in the Netherlands* (PAWN) took six years and made an inventory of fresh water availability for different consumer categories. In the meanwhile, Saeijs was appointed head of the *Department of the Water household* of the Ministry of Public Works, Transport and Water management and was responsible for developing a policy for the so-called national *water household*. The water household concept referred to the management of water levels, safeguarding water quality and cooperation of water authorities. Saeijs revitalized the concept by redefining water quality in terms of ecological parameters, in addition to the norms in terms of concentrations of chemicals. In 1984, the 2nd Policy memorandum on the water household appeared. It was the first attempt to articulate an integrated systems approach whereby groundwater, surface water, water quantity and water quality were viewed in their mutual relationship on a national scale.

5.5.1.2 Regional water management

In 1970, the Pollution of surface water Act established norms for water quality. The provincial governments were held responsible but they could delegate this task to

4 It was first called: Department of Water management, Ancillary Works, and Facilities Delta Lakes

the existing water boards[5], or to newly founded 'purification institutions' (in Dutch: zuiveringschappen)(IJff, 1993). On a large scale, this initiated the construction of water purification facilities and the development of a tax system, administration and a system of permits. The new organization was built up rapidly and required new engineers, ecologists, legal officers, etc (IJff, 1993). The execution of the new Act started in 1974 (Dicke, 2001).

In the same year a state-committee[6] was installed to re-evaluate the organization of the water boards. A debate had arisen about the democratic nature and role of the water boards. The committee concluded that the water boards should continue to exist but that the boundaries of the districts should be administered to the natural boundaries of the water system, which required a new Act for Water boards[7] (Havekes *et al.*, 1995). In addition, the water boards should take into account recreation, nature preservation and landscape issues. The committee argued that a merger was necessary to increase the scale of the water boards. In 1978 a new policy memorandum passed Parliament about this new organization of the water boards. At that time there were 678 water boards (IJff, 1993). The merger continued and the integration between water quantity and water quality management slowly took shape.

5.5.1.3 The rivers

The ecological approach also became important in river basin management. During the eighties a large public debate was going on with regard to a new programme of dike reinforcements along a stretch of 600 km to guarantee the safety norm of 1/1250, which programme was to be completed in 2004. The dikes had to be elevated by 100-150 cm on average and broadened by 20 meters (Van Heezik, 2007). These plans, however, were contested for a number of reasons. First, the historian Bervaes claimed in March 1991 that all recorded large floods in the history of the Meuse were caused by the formation of ice-dams and not by high river discharges, so dike reinforcements would not solve this problem. It triggered a debate in Parliament about the 2 billion Dutch guilders (approx. 0.9 billion euros) that were necessary to continue the programme. Secondly, the inhabitants feared a loss of the cultural identity of the landscape. In the newspapers, the Ministry was often compared to a bulldozer. Typically, a journalist wrote: "The dikes have destroyed more houses than a flood would have". The environmental movement had suggested to investigate the environmental impact in the so-called Environmental Impact Procedure (MER). The union of district water boards agreed but in the meanwhile the programme for the 600 km dike reinforcement was subdivided into smaller sub-projects of only 5 km for which no MER was required. Two members of parliament asked

5 Only to those who were equipped to carry out this task
6 The so-called "Diepdelvers-commissie"
7 This act was formulated and presented to the parliament in 1987 and enforced in 1991.

the minister of Transport, Public Works and Water Management Mrs Maij–Wegge to secure the MER for the remainder of the programme, especially for contested projects.

The second debate was about landscape geography with regard to agriculture, nature reserves, cultural identity, infrastructure and recreation in the river region between Arnhem, Nijmegen, Den Bosch (this region is also called the River region). In 1985 a new law was passed in Parliament providing in a new re-allotment, which included the river floodplains. In the floodplains, agricultural production was 30% less compared to other areas in the region. Approximately 350 farms depended on these grounds. In addition, high river run-offs had damaged the harvest during the summers of 1986 and 1987. Although there was great need for the re-allotment, the process stagnated because of the planned dike reinforcements. According to one of the interviewees the reason for this was that: "*The ministries of agriculture and water management kept each other in a dead-lock, because Agriculture had its re-allotment and Water management had its River law".* Against this background, The Netherlands Institute for Spatial Planning (In Dutch het Ruimtelijk Plan Bureau) was preparing the 4th memorandum on spatial planning. In order to generate ideas that could solve the dead-lock in the river region, the *E.O. Wijers Institute* - a think-tank - organized a national contest.

The awarded plan was titled "*Ooievaar"8*. Four out of the six authors worked for the Institute for State Forestry Management (in Dutch: Staatsbosbeheer), an institute involved in the execution of the stagnating re-allotment. This contest provided the opportunity to present their ideas without the frustrations of the re-allotment planning. One of the interviewees explained: *"We opted for a process-oriented approach, instead of an engineered plan. Within the administrative organization there was no room for that. When suddenly the opportunity appeared by means of a contest, we decided to tell what we really thought about it […].* The fifth author was an expert on river morphology and the sixth was a biologist working for the Ministry of Agriculture, Nature and Fishery.

In retrospect, this group of people can be considered to have been an important policy niche. Plan Ooievaar proposed a new spatial design for the river region by separating agricultural activities and designating land for spontaneous nature development. They argued that not all the grounds in the floodplains were suited for agriculture; instead they could better be used for wild nature and recreation. The authors were inspired by the "Oostvaardersplassen", a wetland in the region of Zuid-Flevoland, where a wild-life ecosystem had spontaneously developed during the 1970s. With Ooievaar, the concept of 'Nature development' became an important policy objective in flood plain management. It challenged beliefs about agriculture supporting nature development, since this inhibited the spontaneous development of ecosystems. One of the interviewees explained how they came up with the idea: "*We asked ourselves: 'What did the (Waal-)*

8 The Dutch word for a stork

river look like in the past?' That appeared to be totally different than expected. It turned out that it was not only about water management, but it was also about spontaneous nature development. […] From that we derived the most important aspect of the plan: disconnection of agriculture and nature". The design separated the region into three zones. The land between the rivers (the so-called bowls) had good conditions for agricultural exploitation. The floodplains would be reserved for spontaneous nature development. Between these two extremes there would be a mixed zone (i.e. the river dike), which would remain as it was.

The plan has had a large influence on floodplain management, in particular on how river basin management and spontaneous nature development in the floodplains could be used as an alternative way of flood protection. We can identify three ways of how the Ooievaar-ideas were distributed. The first one is probably the most significant one in explaining Ooievaar's success. Sijmons, one of the authors, was the coordinator of the Ganges river basin plan and told the deputy minister of Transport, Public Works and Water management Mrs. Smit-Kroes about Ooievaar during a visit. When a couple of months later, she had to attend an ecologist conference she presented the Ooievaar-principles to show that the Ministry was engaged in nature preservation. A journalist attending the conference wrote the story in the newspaper, focusing on breaching the summer dike in order to allow the river to overflow the floodplains for ecological benefit. Later that evening it was a topic on the eight o'clock news, which triggered a public debate and farmers and local governments asked for copies of the plan. The second distribution pattern is that the authors themselves started their own consultancy offices. This was important for the continuity of the ideas that had been developed. Three years later, three of the authors founded the consultancy office *H+N+S landscape architects*. Another founded *Bureau Stroming,* a consultancy office concerned with nature development. The third distribution pattern was via the 4th memorandum spatial planning in which Ooievaar's principles served as input. The memorandum designated different zones for land use and appointed the rivers as important ecological zones. *H+N+S landscape architects* contributed by preparing the chapter *Setting a course for the countryside* in an additional memorandum, called the 'VINEX' (in Dutch: Vierde nota extra), which appeared in 1991. The second window was the NURG (in Dutch: Nadere uitwerking riveriengebied) that appeared in 1991 as well. The NURG was an extra policy report linked to the 4th memorandum on spatial planning concerning the river region, and initiated 19 experiments based on the ideas put forward in plan Ooievaar[9]. *Bureau Stroming* played an important role in the execution of most of these experiments.

An important regime development during the late eighties was that political attention slowly shifted from the country side to the urban area and that agriculture became

9 These experiments were carried out in the following regions: Gelderse Poort, Blauwe Kamer, Duursche Waarden, Forst St Andries, Noordoever Nederrijn, Millingerwaard.

less important, which paved the way for a nature preservation policy. In 1989, the Nature Policy Plan presented the so-called *Ecological Main Structure* (in Dutch: ecologische hoofdstructuur), a national network of connected ecological zones, in which the rivers had a prominent role. An important catalyzing event had been the Sandoz-crisis in 1986. Due to a fire in the Swiss chemical concern of Sandoz, large amounts of chemicals leaked into the Rhine which caused massive fish-mortality. In response, a European *Rhine Action Program* was launched under the title *Salmon back into the Rhine,* which raised the awareness for ecological repair of both the Rhine and the Meuse. During that period the notion of *"nevengeul"* was introduced. The *nevengeul* is a small side channel in the floodplain which does not run as fast as the river and is therefore suited to provide a habitat for fish and other species. These small channels had disappeared during the past century and restoring them would enable the return of fish populations.

The year 1989 was an important policy tipping point, because all these lessons came together in the 3rd Memorandum on the water household. This year reflects the breakthrough of integrated water management. Based on a slide show from Saeijs presented to a number of high-level officials, a policy report called 'Dealing with water' (1985) was published in 1985. This report was the foundation for the 3rd Memorandum which appeared four years later and proposed integral water management as the new water management philosophy. It perceived water as an integral part of an ecosystem and a community. Three new directions were introduced by important niches (1) integrating water quality and water quantity (2) the water systems approach, and (3) spontaneous nature development. The 3rd Memorandum on the Water household stimulated the merger between the water boards and argued that integrated water management required the cooperation with the purification institutions and suggested that they merge into so-called all–in, or integrated, water boards (IJff, 1993). This re-organization contributed to the institutional build-up of a new regime.

The Dutch NGO of the World Wildlife Fund (WWF) took up the idea of Ooievaar and *nevengeulen* (side channels). The Dutch WWF-office was founded in 1990 and as a part of its launching campaign it published a report called 'Living Rivers' (in Dutch: Levende Rivieren). The report emphasized the restoration of the side channels in order to stimulate biodiversity and repair the broken food chains. It argued that other European rivers, such as the Donau and the Weichsel still had those side channels.

The report had a major impact since the heated debates about dike reinforcement were still going on. The cooperation with the Hydrology Laboratory in Delft was extremely important because they had run computer-simulations of the hydro-morphological consequences and suggested that digging up the clay layers along the rivers would create extra room for the rivers and therefore would lower the water levels so that reinforcements would no longer be necessary (WWF, 1992). Therefore, the WWF could present the report as an alternative flood protection strategy, which served the

additional goal of wild life preservation. In this respect, the report also played a crucial role in the emergence of the room for the river strategy as part of the Water Policy for the 21st century, which will be described in the next section. The first *nevengeul* appeared in the Leeuwense Waard in 1994.

5.5.2. The emergence of Water Policy for the 21st century

During the winters of 1993 and 1995 the rivers Meuse and Rhine had extreme run-offs. In 1995, over 200,000 people had to be evacuated because parts of the winter dike were about to give in, which in the end did not happen. Although a real flood disaster had been prevented, most of the floodplains including a number of small villages did flood. This near-flood disaster made instantly clear that it was not safe behind the water defence line. In fact, people were living in a bathtub, which would flood quickly if a dike gave in. The floods captured the attention of the whole nation and the international community. This period reflects an important turning point in the debate about dike reinforcement among the experts. During the summer of 1992 the minister of Water management had appointed the Boertien Committee to test whether the criteria for dike reinforcements were still appropriate. The committee saw no reason for a new alternative flood protection strategy. After the 1993 flood, the Boertien Committee was reappointed to give advice on measures for the Meuse. In December, Boertien-II advised that alternative flood protection strategies were indeed necessary, such as lowering the summer riverbed and giving the rivers more room.

5.5.2.1 Safety first: dike reinforcements

The near-flood disaster had a large impact on the feeling of safety and increased support for the dike reinforcement programme. The Delta Plan Rivers, named after the Delta plan for the Zeeland region after the 1953 flooding, was immediately launched and a new law was passed to accelerate the start-up of the most urgent projects by limiting public participation procedures and environmental impact assessment procedures. During the first phase the dikes were reinforced along a stretch of 148 km and another 143 km of river banks were improved. During the second phase, which was executed in the years 1996- 2000, an extra 450 km of dikes were reinforced, but the new law did not apply to these projects. At first sight, this period seems to reflect a backlash to the traditional engineering approach, since it was dominated by execution of the dike reinforcement programme.

In the meanwhile there were four other important responses. The first one is that from 1996 on it was prohibited to start new non-river related activities in the floodplains under the new policy *Room for the River*. On the other hand, nature development was also being criticized for slowing down river run-off. The second response was that the floods

triggered further international collaboration. France, Germany, Luxembourg, Belgium and The Netherlands made a treaty to deal with risks involving the Rhine and the Meuse, which led to international Action Plans for High Water for the Rhine and the Meuse, the International committee for the Protection of the Rhine (IPCR), for the Meuse (IPCM) and the Scheldt (IPCS). The EU supported the cross-border plans with the IRMA-programme (Inter-regional Rhine/Meuse Activities). A third response within the Ministry of Transport, Public Works and Water Management were attempts to improve the link between water management and spatial planning. One of the directors, Mr. G. Verwolf, started an interdepartmental platform concerned with Strategic policy for Public Amenity (in Dutch: Strategisch Omgevingsbeleid). It was an informal platform which was a cross-cut of the seven participating departments and consisted of directors who exchanged ideas about the integration of policy fields. This was input for the 5th National memorandum on spatial planning. The fourth response was the start of the preparation for the *4th Memorandum on water management*. This was the first open public participatory planning process. It took three years and offered a platform in which all kinds of discussions took place. Just after it was finished in 1998, heavy rainfall flooded the horticultural sector in the West and damage claims were sent to the government which had passed the bill (after the floods in the 1990s) to provide funds in case of damage due to accidents or calamities (in Dutch: Tegemoetkoming Schade bij rampen en ongevallen). In response to the damage claims, Parliament questioned the performance of the water management sector. In six weeks time, the director, Mr G. Verwolf and colleagues wrote the report *Aanpak water Overlast,* which proposed ways to deal with flooding and recommended to appoint a new committee to evaluate the current water management.

5.5.2.2 Climate change and Water policy for the 21st century

The ensuing Tielrooy-Committee completed its task in 2000 and concluded that the water management sector was not sufficiently prepared to meet the challenges of the 21st century. The awareness and knowledge with regard to climate change had increased substantially as a result of the hydrological models of the Rhine and the Meuse which had been developed during the nineties. The committee emphasized the effects of anthropogenic climate change in the future on the one hand, and the continuous reduction of the room for water retention on the other hand. Therefore, the committee proposed to stop this trend and to enlarge the room for water retention. To this end, it recommended a new strategy known as the triple strategy of retention, storage and drainage, which means that retaining water in the same area is preferable, but if that is not possible, it should be stored somewhere else; and if that is also impossible, then the water should be transported to the main water system. In general, the committee argued that the condition of the water ought to be the guiding principle in spatial planning. To this end the *Water Test* was presented, which obliged project initiators to include water

experts in project development. In summary, the Tielrooy-committee (1) formulated a new strategy: water should be the guiding element in planning; (2) suggested a new instrument: the Water Test; (3) provided an action perspective for the water manager: retention, storage and drainage; and (4) and articulated a sense of urgency and inevitability due to climate change.

Parliament supported these conclusions and issued a decree under the title "Dealing differently with Water" as a reference to the report "Dealing with Water", which had triggered integral water management in 1985. This policy is now referred to as *Water Policy for the 21st century* (WB21). This policy started the so-called key-planning decision *Room for the River*. The key-planning decision (in Dutch: Planologische Kern Beslissing; PKB) is a spatial planning instrument of the national government to decide on the designation of strategically important spatial projects. This key-planning decision would guarantee safety norms by 2015, via broadening and deepening of the river bed. This was based on two studies (Room for Rhine branches & Integral exploration of downstream river systems). The PKB-Room for the River had the following objectives:

- In 2015, all Rhine branches can cope with river discharges up to 16,000 M^3/s;
- The measures taken should improve the quality of the areas surrounding the rivers;
- Reserving extra room for the river is safeguarded with respect to climate change;
- Measures for the Rhine branches (Waal, Nederijn-Lek, IJssel and further downstream);
- In the PKB - Room for the River there are general descriptions of the measures, detailed studies are executed for implementation.

The *PKB Room for the River* consists of 40 projects to enlarge the room for the river[10]. In the philosophy of learning-by-doing, six initial pioneer projects were appointed, followed by six additional projects some time after. The EMAB-procedure is an exception to the general rule of not building in the floodplains. The fifteen EMAB-experiments are concerned with innovative building (i.e. floating houses) in the river bed, provided that they create extra room for water.[11]

With regard to regional water management, the relevant water management authorities signed a petition (in Dutch: Startovereenkomst) in 2001 to commit themselves to WB21. The provincial governments were appointed to coordinate the implementation process, because of their appropriate scale and responsibilities in spatial planning. The implementation process started with the development of 17 long-term river basin plans, to explore and anticipate the possible water-related problems of climate change and to develop spatial strategies (see also chapter 6). In 2003, the 2001-petition was upgraded

10 In short these measures are: *Waal:* Removal of obstacles; *Nederrijn:* Lowering of floodplains; *Lek*: Reinforcement of the dikes; *IJssel:* Lowering of floodplains, reallocating of dike and side channel; *Downstream:* water retention in polder systems Noordwaard en Overdiepsche polder.

11 In 2006 the PKB was passed in the Senate.

into the National Treaty on Water management (in Dutch: *Nationaal Bestuursakkoord Water*). This Treaty encompassed procedural agreements with regard to the so-called water challenge. The water challenge refers to the extra amount of water (in m^3)that can be expected as a result of climate change, which is then often translated into the extra amount of space (in m^2) required for the purpose of water storage.

Currently, the Dutch water management sector is primarily occupied with the implementation of WB21 (i.e. the National Treaty on Water management) and the implementation of the European Water Framework Directive (EC, 2000). The water framework directive (WFD) obligates all Member States to secure a "good ecological status" before 2015 and reflects the integration between ecological thinking and water management at the European level. The implementation process of the WFD is a complex process which required the categorization of water systems into four classes, ranging from natural systems to artificial systems. Each class was given different ecological standards. The WFD is a legislative framework. Member States are fined when the objectives for 2015 are not met without adequate argumentation. In order to pave the way for implementation a Common Implementation Strategy (CIS) was developed. Currently, the EU has also formulated a high-water directive, which reflects increasing awareness of climate change and the consequences for water management.

Overall, the Dutch water management regime changed from a relatively 'closed' regime in 1970 to a relatively 'open' sector in 2005, which is more integrative and interactive (Van der Brugge *et al.*, 2005). The historical reconstruction essentially describes two major policy shifts and the question is whether we can classify them as transition (fig 5.4). In this section we will reflect on this question.

The first policy shift was the shift from sectoral water management towards integrated water management. Fuelled by a growing ecological concern, it started out with innovations in the estuaries of Zeeland and in the river region. Increasing scientific knowledge and practical experiences led to more ecologically oriented water management approach. Although the water quality of the rivers had improved significantly, water quantity and water quality management were still institutionally separated. The tipping point was around the year 1990 when the 3rd Memorandum on the national Water household declared Integrated water management as the new policy. The memorandum set in place the necessary institutional structures, after which the regime shifted into a new basin of attraction. A few years later, the floods of 1993 and 1995 shifted the focus back towards flood protection and the ecological perspective was given a lower priority as compared to the dike reinforcement program. This may be thus interpreted as a temporal backlash. However, in the longer run it became clear that nature development in the floodplains and flood protection would reinforce each other. Hence, in the longer run, the floods

stimulated the further integration of water management and nature development, paving the way to a second policy shift.

The second policy shift took place as a result of the ongoing integration between water management and spatial planning. This shift was fuelled by the near flood-disasters and climate change. The first seeds for this shift already emerged in the late eighties and early nineties as innovations in river basin management (i.e. Oievaar, WWF). As these ideas were being adopted, river basin management and spatial planning became more interconnected, resulting in the Room for River policy. The tipping point was around the year 2000, by the declaration of the Water policy for the 21st century, which applied the concept of water as guiding principle in spatial planning to the whole water system, including the regional water systems. Currently, much effort is going into the implementation of the WB21. The new institutions, like the PKB-Room for Rivers, the water test and river basin plans, should enable the actual interventions in the physical infrastructure. However, the path from planning to digging is long and extremely complex, so that the actual physical changes only have taken place marginally.

Although we can see these two policy shifts as separate in time, we cannot see them independently of each other. The first paved the way for the second and the second reinforced the first.

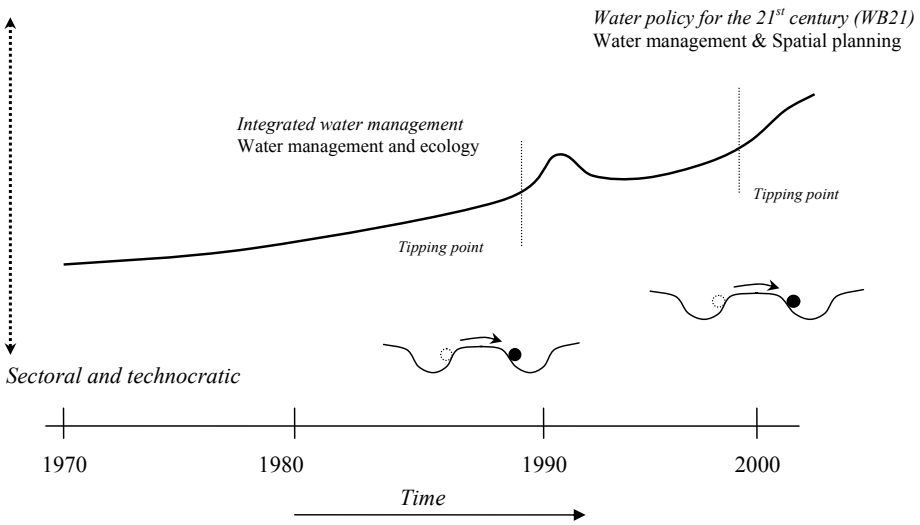


Figure 5.4 The two policy shifts in the transition from the sectoral and technocratic regime to the integrated and interactive regime. The first policy shift was towards integrated water management. The second policy shift was to water policy for the 21st century.

We argued that transitions should involve changes in culture, in the institutions as well as in the infrastructure. In table 5.3 the most significant differences between the sectoral and technocratic regime of the 1970s and the integrated and interactive regime of 2005 are shown. In terms of cultural elements of structure, we may argue that there has been a paradigmatic change from an *optimization* paradigm to an *adaptation & anticipation* paradigm. The belief in the human ability to control and master the water system is being replaced by a paradigm of adaptation and anticipation. In this paradigm, the world is perceived as dynamic, complex and inherently uncertain and consequently water managers have to continuously adapt the water system and anticipate the future. In addition, within this paradigm water is understood as an integral part of a social–ecological system. The most important water related value is still safety, but the ecological quality is deemed much more important than during the sectoral technocratic regime. Nature development has become more important and agriculture somewhat less. In addition, seeing water as an integral part of social–ecological system also means that water is an important asset which can be used to develop a region. The discourse has changed in two rather fundamental ways. The first one is that water quantity and the water quality are inherently linked and cannot be separated as in the sectoral technocratic regime. Secondly, flood protection is no longer only a technical challenge of raising dikes, but also the spatial challenge of creating water retention zones. The knowledge base is becoming much more interdisciplinary, integrating engineering, ecological and social aspects.

With regard to the institutional structures, the current regime is less hierarchical and centralized. The actors have become more interdependent. The water system approach has made water managers more aware of the trade-offs between different water systems and consequently they are cooperating across multiple scales, from the local to the international. Water related projects are often carried out in consortia. The sector operates less autonomously and interacts with other policy domains, like spatial planning, nature preservation and agriculture. The responsibilities for water quality and water quantity are institutionally integrated in the water district boards. The main flood protection policy is a combination of creating additional room for water retention and dike reinforcements. The spatial measures require that the water manager and the spatial planner should interact more extensively. The main institutional instrument to empower the water manager is the *Water Test*. The Water Test is a relatively new instrument, which obligates spatial planners and project developers to consult the water expert early in the design process.

With regard to the infrastructure, many of the real physical changes of the room for water discourse are yet to come. The *PKB- Room for the Rivers* has just started, but will result in major changes in the river system, broadening of the river beds and new channels to enlarge the room for the incoming amount of water. At a regional level, water

retention is realized by transforming agricultural land into wetlands. However, these plans are confronted with resistance (see chapter six and seven). In the upcoming years, however, the planned interventions will further change the landscape.

In conclusion, the transition in Dutch water management sector is still ongoing. Its history might be read as a progressing integration between the water management sector and related policy fields, first nature management and later spatial planning. Looking at the structures that have changed, we see that the cultural elements of structure have changed quite fundamentally. The institutional structures have been adapted and set in place to enable the implementation of this new way of water management. However, up till now, the physical infrastructure has not been altered much, although many policy plans that have been formulated are being prepared for implementation. Therefore we must conclude that this transition is not yet completed. The sector shifted into a new cultural and institutional regime, but the shift has not yet manifested itself physically.

This means that the transition is in a crucial phase a the moment. Many of the infrastructural changes are expected to manifest themselves in the next 5 – 15 years, but there are many barriers still to overcome. However, these barriers are often thrown up not by the water management sector, but by related policy fields and by the people living in those areas. In chapter six and seven we will illustrate the complexity and barriers of the implementation process.

So, whether the sector will stabilize in this basin of attraction is not yet clear. At a more fundamental level, the adaptation paradigm argues that a social-ecological system should never sink too deep into one domain of attraction, but should remain adaptive to be able to shift when it is necessary. As discussed in chapter three, the adaptive capacity of a social-ecological system is reflected in the ability for learning, institutional flexibility and a high level of innovation capital in terms of people, knowledge and money. In the case of Dutch water management, the learning ability is quite high, but still focused mainly on technical knowledge and so there is a need for social learning. A part of the innovation capital should be re-allocated to the domain of the social sciences and practice. Clarity on the institutional structures is necessary in order to implement physical measures, but institutional flexibility at a more experimental level may offer the opportunity to test an develop innovations.

In the next sections we will analyze the dynamics in more detail by applying the method for pattern analysis developed in chapter four. This will allow us to generate insight in what kind of dynamical patterns gave rise to these policy shifts.

Table 5.3 Most important structural changes between the sectoral and technocratic vs. integrated and interactive water management regime. Adapted from (Van der Brugge *et al.*, 2005)

Elements of structure	Sectoral and technocratic	Integrated and interactive
Water paradigm	-Technocratic, optimization	-Adaptation and anticipation
Water discourse	-Separate water quantity / water quality management -Reduced safety is technical problem	-Integral water management as part of social-ecological system -reduced safety is technical & spatial problem
Values	Flood protection Water provision for agriculture	Flood protection Nature preservation Water provision for agriculture Water as an asset
Knowledge base	Engineering disciplines	Interdisciplinary: engineers, biologists, public managers, spatial planners
Regulation	-Centralized, -Top down	-Centralized -Interdependent consortia, public participation
Responsibilities	Water quantity management	Water quantity and water quality management
Flood protection policy	Dike reinforcements	Retention, room for water Dike reinforcements
Land and water use	Interaction with planners at end of design process	Interaction with planners at start of design process due to the Water Test
Water network	-Agricultural exploitation in floodplains	-Broadening river beds -Regional water retention areas

5.6 Analyzing the transition dynamics

In this section, we will analyze the dynamics of this (ongoing) transition in more detail. First, we will analyze the most important developments at the macro-level, regime-level and the niche level. Then, we will further analyze dynamical patterns of transformative change by applying the method for pattern analysis.

5.6.1 A multi-level analysis

Figure 5.5 presents a schematic overview of the events and developments, which are categorized to the macro-level, the regime and the niches. At the macro-level, we have identified four developments that have played an important role in this transition. The first development was the emerging environmental concern of the Dutch population, reflected in the growing number of environmental protection groups and protests against measures of the Ministry of Public Works, Transport and Water management. This has had a large impact on the regime actors, especially on those who worked in the estuaries in Zeeland. Secondly, societal trends like population growth, urbanisation, economic growth, increasing agricultural land use, increasing traffic and expanding

	System state 1970	Events	System state 1980	Events	System state 1990	Events	System state 2000
Macro Supranational		-Growing environmental awareness -Economic growth -Limits to Growth				-Climate Change -Sea level rise -EU Water Framework Directive	
National		-Delta Works Calamities (ecological impact)		-1st National - Environmental Policy Plan -1st Nature Policy Plan -Floods (’93, ’95)		-National Environmental Policy Plan 2, 3, 4 -Environmental Management Act	
Regime	*Sectoral Technocratic water management*		*Integrated water management*		*Integral water management*		*Integrated & Interactive water management*
	-Engineering approach -Hierarchical organization Priorities: Safety Agriculture	-Delta Works -2nd National Policy - Memorandum Water Management -Protests against water management approach	-Engineering approach -Hierarchical organization Priorities: -Safety -Agriculture -Ecology	-3rd National Policy Memorandum Water Management (’89) -Re-organization Rijkswaterstaat -Re-organization Regional water boards -Decentralization	Room for Water Stakeholder participation Priorities: -Safety -Nature development -Agriculture	-Delta Plan Rivers -4th National Policy Memorandum Water Management (’98) -WB21 (’99)	Adaptation and retention Participatory Policy process Priorities: -Safety -Attuning with Spatial Planning -Nature development -Agriculture
Niches		-Environment dept. in Delta Department -POLANO -PAWN		-Plan Ooievaar (’87) -Living Rivers (’92)			

Figure 5.5 Scheme of developments at three levels of scale (macro, meso, micro) that have influenced the system state of water management in the Netherlands over a time period (1970-2005). System states are described in terms of management concept, approach and priorities (1970, 1980, 1990, 2000). Based on (Van der Brugge et al., 2005).

infrastructure had reduced the room for water retention which had led to a unsafe situation as shown by the floods in the early 1990s. The third macro development was the national trend of decentralization and privatization during the 1980s. As a result, the power of the Ministry reduced and the sector became less hierarchical, resulting in an increasing role of private engineering offices and consultancy offices, which was an important condition for opening up to other policy fields. The fourth macro-development is climate change, which has been an important trigger to integrate the water policy and the spatial planning policy and to create the room for water retention.

In chapter four, we defined a niche as an alternative subsystem, or an emerging field, that deviates from the regime. A niche contains (partially) alternative structures compared to the regime (i.e. the structural component) and one or more what we have called niche-groups developing these new structures further (i.e. the agency component). In this case study we have identify two types of niches that have eventually resulted in the two policy shifts described in the historical reconstruction. The first niche that emerged was that of ecological water management, which was a new perspective within the sectoral technocratic regime. In retrospect, we can identify a number of influential niche-groups, who stood at the basis of that niche and who have shaped it. Two of those niche groups were operating in the province of Zeeland. The first one is the unit of environmental research and facilities of the Delta Department. The second niche-group was the group of researchers of POLANO. Both niche-groups have contributed greatly to the development of ecological water management by developing a water system approach. Two other important niche-groups we have identified operated in the river areas: the authors of Ooievaar and the authors of Levende rivieren. These two niche-groups laid the foundation for ecological focus of river basin management (table 5.4).

Around 1980 a new niche started to emerge in which water management was being integrated with spatial planning. One of the important niche-groups that gave the initial shaping of the niche was the PAWN-research team. They developed a national water system approach in which the water system was spatially linked to land use functions. In addition, authors of Ooievaar and Living river also had an important contribution in shaping this niche further, as they led the foundation for a new spatial design in the river regions. In doing so, these two niche-groups have in fact linked both niches and thereby shaped their parallel growth. We will further elaborate on theses niches in the multi-pattern analysis in section 5.6.2.

The macro level developments created fertile soil for the niches to grow and influenced the regime. The sectoral technocratic stance was no longer viable and the priorities changed. The role of agriculture in water management became less important in favour of nature development and the interaction with spatial planning has become much more self-evident. The reorganization of the Ministry of Transport, Public works and

Water management, including the Delta Department was an important mechanism for scaling up the ecological approach in the Ministry as the ecologists were placed in strategic positions within the Ministry. The merger of the water quantity and purification institutions into integrated water boards was yet another mechanism for scaling up and institutionalizing the ecological approach. The implementation of the water test, which enables water managers to participate in the spatial planning process at an early stage is an important mechanism to scale up the spatial niche. The water test requires that for each project plan with a spatial claim a water expert is consulted. All the mechanisms have contributed to the cultural and institutional establishment of a integrated and interactive water management.

In the next section we will analyze these dynamic in more detail by applying the method for pattern analysis.

Table 5.4 Niche-groups that have played an important role in the water transition

	Water and Ecology	**Water and spatial planning**
Coastal (Estuary) management	Unit of environmental research and facilities (1970-1980) POLANO-researchers (1976)	
River management	Authors of Ooievaar (1986) Authors of Living Rivers (1992)	Authors of Ooievaar (1986) Authors of Living Rivers (1992)
Regional water management		PAWN-researchers (-1980)

5.6.2 A multi-pattern analysis

In this section we will apply the method for pattern analysis to gain a deeper insight in the dynamics of change in the water sector, in terms of *when* specific elements of structure changed and *how* they changed.

The basic rationale of the method for pattern analysis is the distinction between six different types of patterns of transformative change, which are described in chapter three and four. We distinguished between a bottom-up and a top-down pattern of transformative change. There are two variants of the bottom-up pattern. The first pattern is the niche-absorption pattern, which describes the emergence of a niche-group, which is adopted by the actors and incorporated into the regime. The second pattern is the empowerment pattern, which describes the emergence of a niche, which is not incorporated into the regime, but that expands into a self-sustaining niche-regime alongside the incumbent regime. The top-down pattern of transformative change was called the re-constellation pattern in which the change is imposed top-down upon the regime. In addition, we have made a distinction between endogenously and exogenously driven patterns: endogenously meaning from with in the water management regime, exogenously meaning from outside the water management regime.

Seven key episodes in the historical reconstruction were identified based on the literature and the interviews. The method contains five steps, which are repeated for each period. We used three variables to describe the patterns of transformative change: the actors involved, the key–processes that have been influenced and the elements of structure that changed. For each of these periods, we identified which of the patterns of transformative change was at work and the conditions that initiated the pattern. After having described the seven episodes, we have analyzed the sequence of the patterns.

Episode 1: The foundation of the Unit for Water management, Ancillary Works and Facilities Delta Lakes

1) *Choose an episode in which a certain change occurs.*
The first crucial episode of change we want to address is the foundation of the unit of Water management, Ancillary Works and Facilities Delta Lakes as a response to the ecological problems after the closing of the Haringvliet estuary. This unit had the task to do research and to manage the newly formed freshwater lakes. The unit developed an ecologically oriented water management approach and in doing so, it has laid the foundation for what later came to be known as integrated water management.

2) *Which element(s) of structure change(s) during the episode?*
The elements of structure that changed during this period were:
- Knowledge: the unit developed and introduced a new kind of knowledge with regard to dealing with the ecological aspect in water management
- Discourse: a new discourse emerged about the importance of integrating water quality (and ecology) and water quantity.
- Water system: the Delta lakes improvement with regard to the ecological quality

3) *Which actors are involved and how?*
- The Delta Department, which was responsible for the construction of the Delta Works programme and the management of the Delta-lakes.
- The unit for Water management, Ancillary Works and Facilities Delta Lakes, which was part of the Delta Department
- Local protest groups, who directly suffered from the ecological problems.

4) *Is there a niche-group formed? Which process did it influence?*
We consider the unit for Water management, Ancillary Works and Facilities Delta Lakes to have been a niche-group for the following reasons. The first reason is that they were the first group of ecologists that introduced the ecological perspective on water management into a world which was dominated by civil engineers. This niche was created

by the Delta Department itself in response to the ecological problem and we therefore interpret the niche as endogenous.

During the early years the unit expanded quickly, which suggest that it transformed into a niche-regime. However, as Disco (2000) pointed out, the growth of the number of ecologists stagnated. Their ideas, however, inspired many engineers and were adopted broadly. In this way, the niche influenced the key processes such as research and local management.

5) Interpret the answers and match it to the pattern templates and identify the pattern

The most important elements of structure that have changed during this period were the knowledge base, the discourse and the local water system. These changes in the elements of structure were the result of a bottom-up process initiated by the unit for Water management, Ancillary Works and Facilities Delta Lakes. We may perceive this research unit as an endogenous niche. The niche initially grew into small niche-regime, suggesting the pattern of empowerment. However, in a later stage the growth of the unit stagnated and the ideas were absorbed by the Delta Department and the Ministry and spread throughout the sector. Therefore we conclude that the pattern of transformative change was *endogenous niche-absorption*. In figure 5.6 we have summarized this pattern with the double-loop concept.

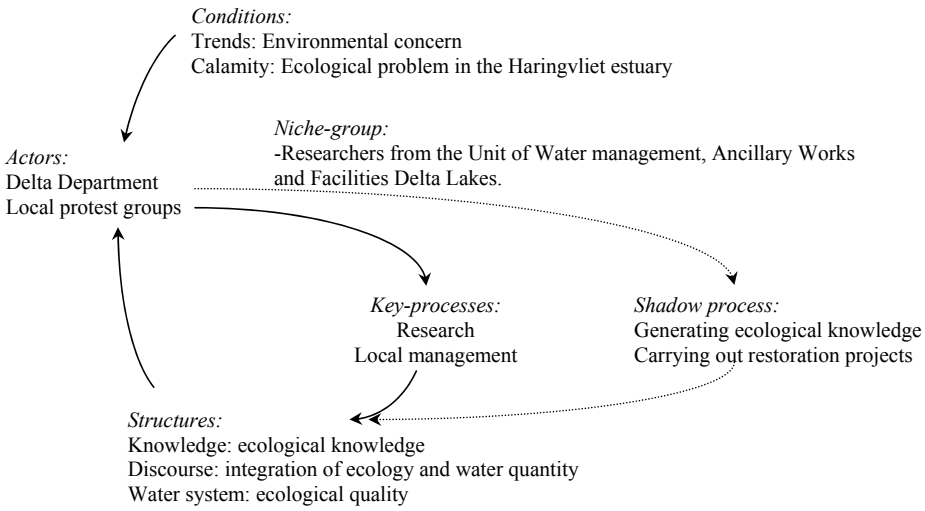


Figure 5.6 The pattern of endogenous niche-absorption, initiated by the unit for Water management, Ancillary Works and Facilities Delta Lakes

Episode 2 The new design of the Eastern Scheldt storm-surge barrier: The POLANO-study

1). *Choose an episode in which a certain change occurs.*
The second crucial episode of change we address is the re-evaluation of the closure of the Eastern Scheldt estuary in the POLANO-study. This study developed ecological criteria to take into account in the of design of the planned storm surge barrier.

2) *Which element(s) of structure change(s) during the episode?*
The main elements of structure that changed during this period were:
- Knowledge: in the POLANO study, a new approach was developed how to include ecological criteria in decision making
- Discourse: a new discourse emerged that argued that ecological criteria were important in hydraulic engineering
- Norms: criteria for ecological quality in decision making were introduced

3) *Which actors are involved and how?*
- The Ministry of Transport, Pubic Works and Water management
- The Delta Department, responsible for the construction of the Delta Works
- The Unit for Water management, Ancillary Works and Facilities Delta Lakes
- RAND-corporation, who had expertise on the systems approach
- Local protest groups, fighting against closure of the Eastern Scheldt

4) *Is there a niche formed? Which process did it influence?*
We may consider the researchers involved in the POLANO study to have been a niche-group. They developed a new approach, which made it possible to incorporate ecological criteria in decision making. The researchers were employees from RAND-corporation – an actor from outside the water sector – who cooperated with the Unit for Water management, Ancillary Works and Facilities Delta Lakes. Since the niche was initiated by the Ministry of Public Works, Transport and Water management, we perceive it as an endogenous niche.

The POLANO-study compared three alternatives: an open barrier, a closed barrier and a semi-open barrier. Based on the study, Parliament decided that the semi-open storm barrier was the most desirable. The closure of the Eastern Scheldt was off. These conclusions affected the key-process of local management in the estuary and the Delta Department started with the construction of a semi-open storm surge barrier in the Eastern Scheldt.

5) Interpret the answers and match it to the pattern templates and identify the pattern

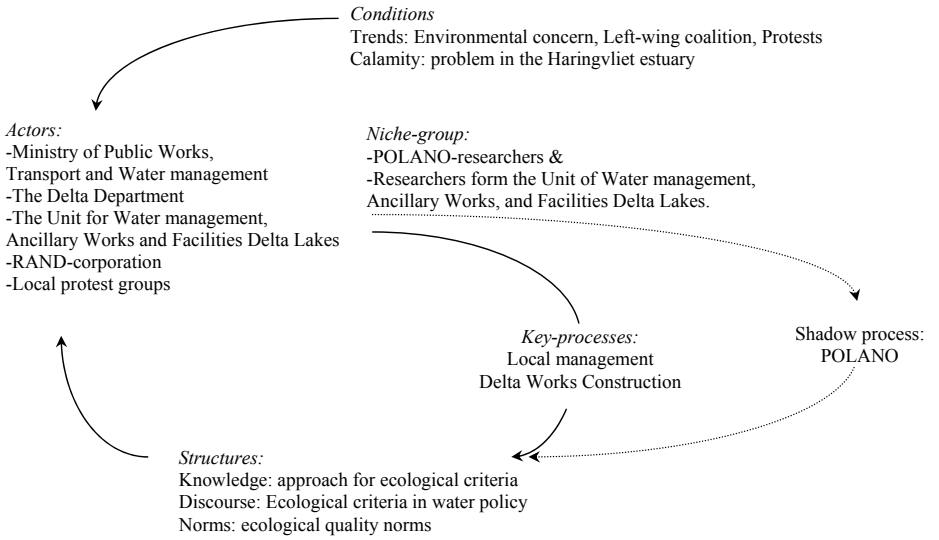


Figure 5.7 The endogenous niche-absorption pattern, initiated by the POLANO-study.

The most important elements of structure that changed were the knowledge base on how to include ecological criteria, the discourse that ecological criteria were necessary and the introduction of these criteria in decision making. These changes were also the result of a bottom-up process. Although the niches consisted of people from outside the water management regime, the niche was created by the regime itself, and it is therefore considered to be endogenous. The Delta Department adopted the conclusions and adjusted the construction plans. Hence, these regime changes were the result of an *endogenous niche-absorption* pattern. (fig 5.7).

Episode 3 Revitalizing the concept of the "water household": the PAWN-study

1) *Choose an episode in which a certain change occurs.*

The third significant episode we address is the revitalization and further development of the concept of the national water household by the PAWN-study. The PAWN-study was a large scale policy analysis in response to the drought of 1976 which had resulted in water shortages. During the study, using a systems approach was developed which focused on freshwater distribution at a national level.

2) *Which element(s) of structure change(s) during the episode?*

The main elements of structure that changed during this period were:

- Knowledge: PAWN had developed a new instrument based on an integrated water systems approach
- Discourse: a new discourse emerged to integrate water quantity, quality and societal functions

3) Which actors are involved and how?

- The Ministry of Transport, Public Works and Water management; Department of the Water household.
- RAND-corporation
- The research institute Hydrology Laboratory-Delft (HL-Delft)

4) *Is there a niche formed? Which process did it influence?*

We consider PAWN researchers to have been a niche. They introduced a new perspective, which linked freshwater requirements to consumer categories, identified possible conflict areas and made policy suggestions, which was a new and integrated approach that revitalized the concept of the national water household. The niche was formed by the Ministry of Transport, Public Works and Water management and is therefore considered to an endogenous niche.

This niche influenced the key process of strategic national water policy, since the 2nd Memorandum on national water household drew heavily on the PAWN-study.

5). Interpret the answers and match it to the pattern templates and identify the pattern

The most important element of structure we see changing here is the knowledge base and the discourse. These changes were the result of a bottom-up process. The niche was endogenously created, but was also partly exogenous (i.e. researchers from RAND-corporation). The ideas of PAWN were adopted by the Ministry of Transportation,

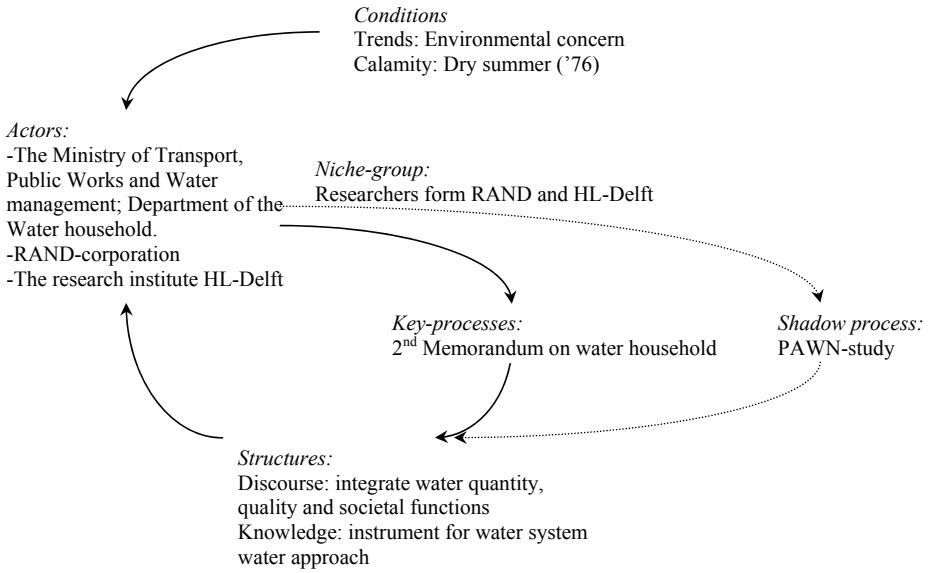


Figure 5.8 The pattern of endogenous niche-absorption initiated by the PAWN-study.

Public Works and Water management in the 2nd Memorandum on water household. We conclude that during this episode the underlying pattern of transformative change was *endogenous niche-absorption* (fig 5.8).

Episode 4 A new vision for the rivers: Ooievaar

1) *Choose an episode in which a certain change occurs.*

The fourth important episode, was the development of plan Ooievaar, which introduced new ideas about the relation between agriculture and nature preservation in the river region. The plan had had major impact for agriculture in the floodplains, which were better suited for nature development.

2) *Which element(s) of structure change(s) during the episode?*

The elements of structure that changed during this period were:

- Knowledge: Ooievaar introduced a new plan on floodplain management, by linking land use functions to the river dynamic and stimulating spontaneous nature development
- Discourse: a new discourse was developed that argued that the floodplains should not be used for agriculture, but for nature development.
- Water system: pilot projects were set up.

3) *Which actors are involved and how?*

- The Ministry of Transport, Public Works and Water management.
- The Ministry of Agriculture, Nature and Food Quality
- Institute for State Forestry Management
- The E.O. Wijers Institute, a think thank for spatial planning policies

4) *Is there a niche formed? Which process did it influence?*

We consider the authors of Ooievaar to have been a niche. They suggested a radical departure from the traditional way of looking at nature management, water management and agriculture and presented as new vision for the river region. The niche is essentially created by a contest organized by the E.O Wijers institute, an institute concerned with spatial planning. In this regard, the niche is considered to be an exogenous niche. The authors were professionals from the Institute for State Forestry Management, the Ministry of Agriculture, Nature and Food Quality and only one of them worked for the Ministry of Public Works, Transport and Water management.

The plan influenced the key process of strategic national policy trough three different policies: the 3rd Memorandum on the water household, the *4th National Planning Memorandum* with regard to the river policy (via the NURG). It also influenced the *1st*

Nature Policy Plan in which the rivers and floodplains were seen as important corridors in the ecological main structure.

5) Interpret the answers and match it to the pattern templates and identify the pattern
The most important elements of structure that have changed are the knowledge base and the discourse with regard to floodplain management. The changes were the result of a bottom-up pattern of transformation and the niche was exogenously created. It was adopted by 3rd Memorandum on the water household, the *4th National Planning Memorandum* and the *1st Nature Policy Plan*. The pattern that gave rise to these change have been *exogenous niche-absorption* (fig 5.9).

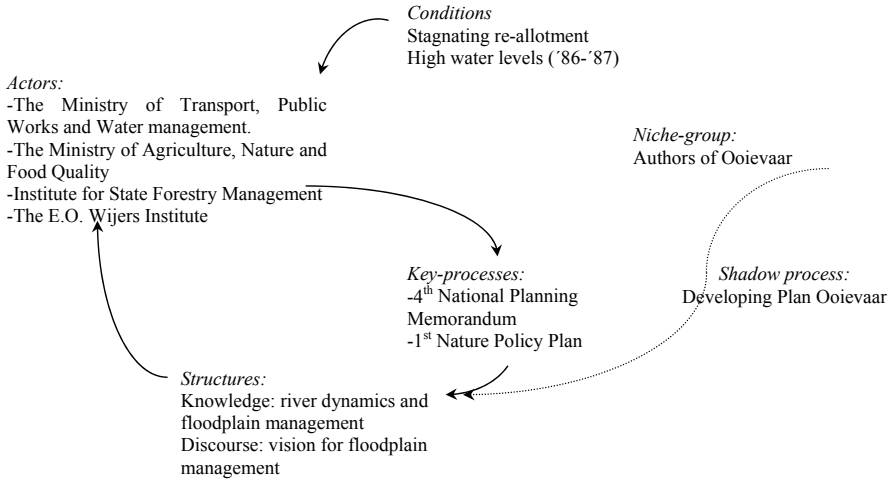


Figure 5.9 The pattern of exogenous niche-absorption initiated by Ooievaar. The niche is considered to be an exogenous niche, which is here visualized as coming from outside the regime.

Episode 5 The declaration of the Integrated water management policy
1). *Choose an episode in which a certain change occurs.*
A firth important episode was the development and appearance of the 3rd Memorandum on the water household, which declared the new policy of integrated water management. This memorandum may be interpreted as the culmination of the new ideas with regard to ecology and water management into one integrated approach. This declaration gave integrated water management a formal status and obligated the water management authorities to implement it. It was shaped institutionally by a large scale merger of the water quantity boards and purification institutions into integrated water quality and water quantity boards

2) *Which element(s) of structure change(s) during the episode?*

The elements of structure that changed during this period were:

- Paradigm: a new water management paradigm started to emerge which integrates ecology, water quality, water quantity and societal functions.
- Policy: a new policy was declared: Integrated water management
- Responsibilities: The new integrated water district boards were responsible for both water quality management and water quantity management.

3) *Which actors are involved and how?*

- The Ministry of Transport, Public Works and Water management. Department of the Water household
- The quantity water management boards
- The water purification institutions

4) *Is there a niche formed? Which process did it influence?*

During this period of transformative change there was no formation of a niche. The 3rd Memorandum on the National water household was translated and implemented by the various water management authorities. Although the trend of mergers was already ongoing, the Ministry of Transport, Public Works and Water management stimulated the mergers between the water quantity boards and water purification institutions into integrated water quantity and quality boards as a way to implement integrated water management locally.

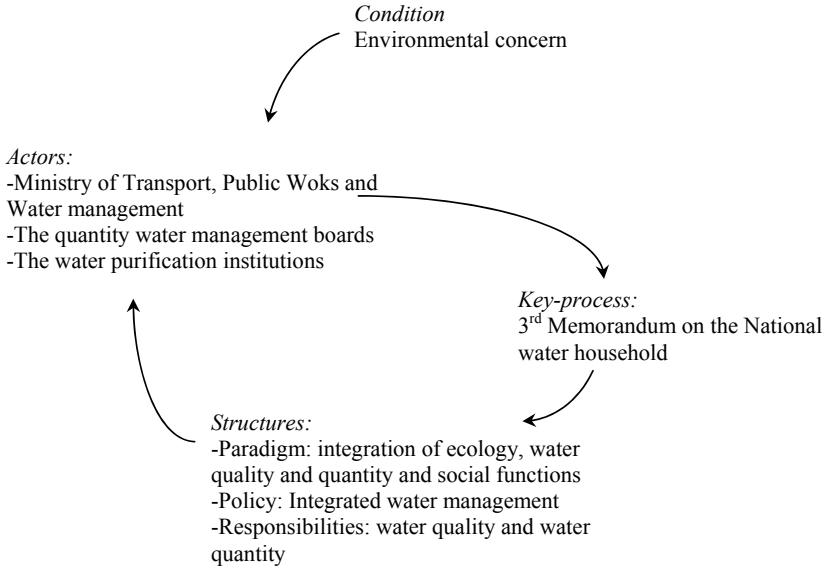


Figure 5.10 The pattern of endogenous re-constellation as a result of the 3rd memorandum on the water household.

5) Interpret the answers and match it to the pattern templates and identify the pattern
The element of structure that started to change during this period was the paradigm with regard to integration of water quantity, ecology and social functions. In addition, the national policy changed and the responsibilities of the water boards. The new ideas that were introduced in the period before had culminated into a new paradigm in which water quantity, quality, ecology and societal function were combined into one integrated approach. The 3rd memorandum on the water household gave it formal status which triggered implementation by the provincial and local lower level governments and the district water boards. This transformation was more or less imposed by the Ministry of Transport, Public works and Water management. We therefore interpret this pattern as an *endogenous re-constellation* pattern (fig 5.10).

Episode 6 A new flood protection strategy: Living Rivers
1) *Choose an episode in which a certain change occurs.*
The sixth episode of importance was the development and appearance of the WWF –Living rivers, which formulated a new perspective on flood protection: broadening of the river bed and digging small channels in the floodplains. The Dutch world wildlife fund argued that river bed broadening and small channels in the floodplains would provide an alternative flood protection strategy and in addition, it would restore the natural habitat of the fish.

2) *Which element(s) of structure change(s) during the episode?*
The elements of structure that changed during this period were:
- Discourse: small side channels and excavation of clay layers along the river stimulates the biodiversity and is an alternative flood protection strategy.

3) *Which actors are involved and how?*
- World Wildlife Fund
- The research institute Hydrology Laboratory-Delft (HL-Delft)
- The Ministry of Transportation, Public Works and Water management

4) *Is there a niche formed? Which process did it influence?*
We consider the WWF to have been a niche, since it introduced a new perspective that would stimulate biodiversity, but would also serve as a new flood protection strategy. The WWF is not directly considered to be part of the water management regime and therefore we argue that this niche was exogenous. However, there were also researchers from the water research institute HL-Delft involved, so the niche was partly endogenous.

The niche influenced strategic national policy. Especially due to the flood disasters of the Rhine and the Meuse of 1993 the idea of broadening the river bed was taken as a serious alternative flood protection strategy. The Ministry of Transportation, Public Works and Water management adopted the idea when the appointed Committee Boertien II suggested that the river Mheuse was to be broadened at several places. Important was that after the 1995 flood, the national Room-for-River policy was initiated to investigate where such interventions in the river bed were necessary and possible.

5) Interpret the answers and match it to the pattern templates and identify the pattern
The most important element that has changed during this episode was the discourse to broaden the river bed as flood protection strategy. This was due to a bottom-up process. The WWF initiated this study and therefore we consider this to be an exogenous niche. The ideas were adopted and have now become an integral part in the Room for the River policy. So, this change in the discourse was the result of an *exogenous niche-absorption* pattern (fig 5.11).

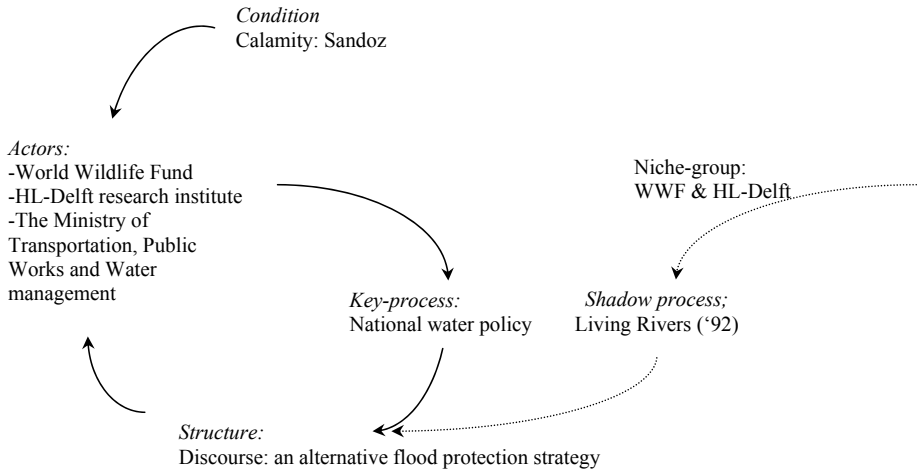


Figure 5.11 The pattern of exogenous niche-absorption initiated by the World Wildlife Fund and HL-Delft.

Episode 7 Formulation of Water policy for the 21st century
1) *Choose an episode in which a certain change occurs.*
The final period of transformative change we want to address is the declaration of the Water policy for the 21st century (WB21). This policy explicitly includes the role of water in spatial planning policies. It argues that the room for water retention should increase and that this requires extensive cooperation between water managers and spatial planners.

2) *Which element(s) of structure change(s) during the episode?*

The elements of structure that changed during this period were:

- Policy: WB21 was a new policy to deal with climate change and should be translated into regional river basin plans
- Regulation: a new instrument was introduced, the water test, to secure the evaluation of the water related aspects of spatial plans.
- Responsibilities: Agreements were made between the water management authorities on how to implement WB21 in the National Treaty on Water management.

3) *Which actors are involved and how?*

- The Ministry of Transportation, Public Works and Water management
- Provincial governments as coordinators
- Municipalities
- District water district boards

4) *Is there a niche formed? Which process did it influence?*

WB21 obligated the provincial governments to develop river basin plans in order to develop regional water policy. It also gave rise to the Water test, which is an important instrument in local water management. In addition, it triggered a National Treaty on Water management, which was signed the water management authorities in which agreements were as to how to implement WB21 locally.

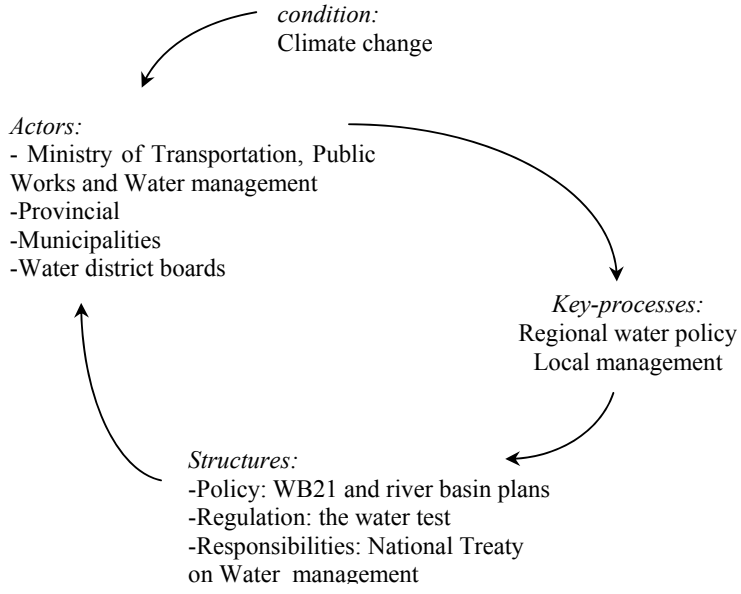


Figure 5.12 The pattern of endogenous re-constellation as a result of the Water policy for the 21st century.

5) Interpret the answers and match it to the pattern templates and identify the pattern
The most important elements of structure that have changed were the policy, the instrument and the responsibility in order to deal with the effect of climate change. These changes were imposed by the national government, when it declared a new policy. It triggered a top-down process of regional and local implementation by the lower level authorities and we interpret this pattern as an *endogenous re-constellation* pattern (fig 5.12).
Reflecting on this multi-pattern analysis, a number of aspects should be addressed. We observed that the pattern of endogenous niche-absorption and exogenous niche-absorption were both present, meaning that niche-groups from inside as well from outside the water management regime influenced the course of the transition. These niche-groups have played a significant role, primarily by developing new knowledge and contributing to the new discourse. In the endogenous niche-absorption patterns, the regime itself played an active role in shaping the niche by creating a niche-group. Some of the niche-groups were installed as a direct result of a calamity, for instance in response to the ecological problems in the Haringvliet, or the water shortages during the summer of 1976. Other niche-groups emerged more or less spontaneously as a result of a deadlock, for instance in the case of Ooievaar where the re-allotment stagnated and the *E.O Wijers Institute* organized a contest to invite people to come up with new ideas. An explanation for the success of the exogenous niches may lie in the fact that they were familiar with the problems of the water sector, but approached the problems differently because of their different background.

In addition, some of the niche-groups influenced each other heavily and shared insights. For instance, in the POLANO-study, the researcher from RAND-corporation and the researchers from the unit for Water management, Ancillary Works and Facilities Delta Lakes worked together. In addition, niche-groups may build upon the insight from other niche-groups, for instance, the authors from WWF-plan Living Rivers were inspired by the plan Ooievaar, which appeared five years earlier. In these ways, niche-groups may influence and reinforce reach other and by sharing knowledge or by elaborating further on earlier niches and adding new insights. In doing so, the niche-groups were shaping and developing the niche further.

Looking at the pattern analysis as a whole, we see the following general picture emerging. Initially the patterns of endogenous niche-absorption and exogenous niche-absorption emerge, introducing new kinds of knowledge and discourses (figure 5.13). At some point in time, we see that these different ideas 'come together' and are being formulated into a new and coherent policy. The endogenous re-constellation pattern then emerges in which the national government initiates the implementation of the new policy. We may interpret this as a tipping point from one basin of attraction to the other. It coincides with a flip from the bottom-up pattern to the top-down pattern of

transformative change. The institutional settings are set in place so that the infrastructural changes can be implemented.

Based on our regime analysis, we might not find this so surprising, considering the fact that the water sector had a rather formal top-down policy hierarchy. When the national government formulates a general strategy, the provincial governments, water boards and municipalities are obligated to translate this further into regional policies and local water management. The tipping point is an important phase in a transition, because the institutional structures are being built up that enable the actual implementation.

On the other hand, we should not overestimate the role of national government and the declaration of a new reform policy. Even if there is sufficient support, it may still be difficult to implement the policy, which is the case in the Water policy for the 21st century. Calamities, such as the near-floods of 1993 and 1995, can trigger backlashes and the reform policy itself can throw up new and unforeseen barriers. Nonetheless, such an policy shift is a necessary condition with regard to the institutional establishment of the new regime.

As we have shown in the multi-pattern analysis, different kinds of structures need to change before the regime approaches a policy tipping point. The elements of structure that are changing before the policy tipping point appears to predominantly the knowledge base and the discourse. An important condition for tipping seems to be that the new insights ought to be integrated into a coherent policy, which will only be done if there is enough critical mass. We saw that the buildup of critical mass was the result of a growing number of actors who adopt the new ideas and who carry out pilot experiments. This may lead to the further buildup of a wider and more accurate knowledge base and the development of instruments with regard to how to apply the new knowledge. If these experiments are successful, they may stimulate other actors. If there is enough knowledge and experience, the new insights and experiences may be integrated into a coherent, new paradigm, challenging the old paradigm. An important condition for this seems to be the presence of a spokesperson in the right position. For instance, in the first regime shift, H. L. F. Saeijs had such a role, who strongly promoted integrated water management, and as the head of the department responsible for the 3rd Memorandum on the Water household he was able to scale it up to a new national policy. In 2000, the committee Tielrooij has had a similar role. After the policy tipping point, the institutional structures change, and a re-constellation pattern emerges. The elements of structure that change are responsibilities and financial allocation. This may trigger new niche-groups that translate the policy to the regional and local level and implement infrastructural change measures.

The above implies that during the course of a transition different regime structures change at different points in time. This leads to the hypothesis that the different patterns of transformative change may be associated with changes in specific elements of

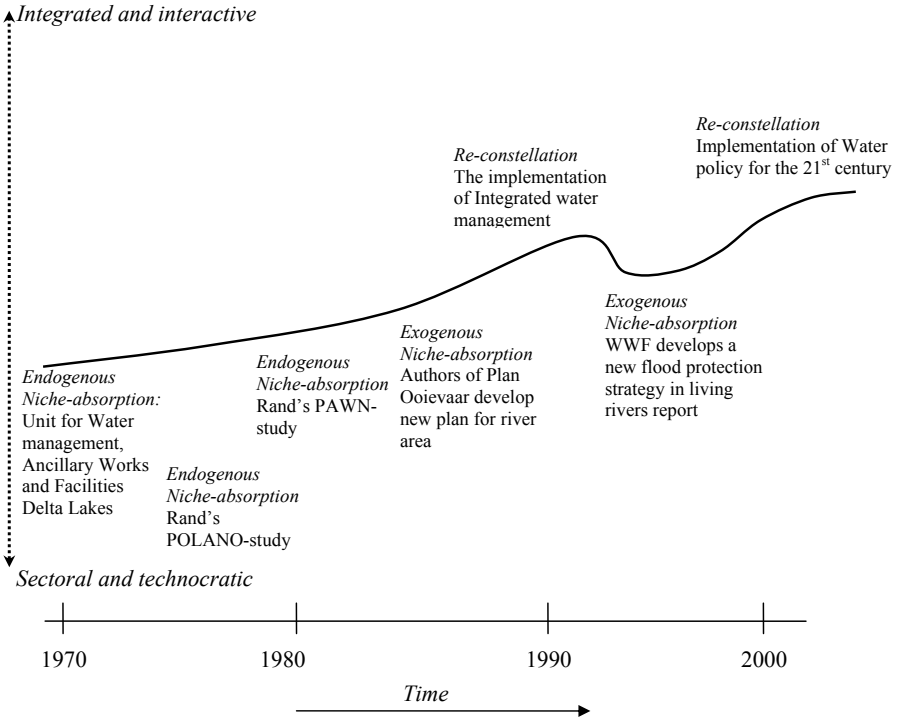


Figure 5.13 Patterns of transformative change in the Dutch water management regime.

structures and so each of these patterns has a different function in the buildup of a new regime. Exploring this line of reasoning, we may associate the niche-absorption patterns primarily with influencing the cultural elements of structure, especially the knowledge base and the discourse. These patterns build up a kind of knowledge that is abstract and that represents a new way of thinking about a specific problem, solution or opportunity. The function of the niche-absorption patterns may be understood as providing the knowledge and argumentation for a new direction in which the regime could develop.

Furthermore, we may associate the endogenous re-constellation pattern with the institutional elements of structure and primarily with new policies, norms and responsibilities. This pattern appears to build up new institutional structures, like the integrated water boards, the Water test and the National treaty on water management. These new institutional structures enable the implementation. The actual implementation leads to a buildup of more local knowledge and knowledge as to how to deal with local stakeholders and residents. In this respect, the function of the re-constellation pattern may be understood as to institutionally establish the new regime and to enable implementation and interventions in the physical infrastructure.

The pattern analysis also shows that the empowerment pattern played no significant role. The literature, however, often suggests this to be a rather important pattern. We did not come across this pattern. It may be so that this pattern is just not so common in Dutch water management. This may be true, since it seems not so obvious that a new niche-regime would emerge next to the incumbent water management regime. This seems to be more naturally related to market-oriented sectors in which a new market can be created alongside the existing markets. In the water management regime the ideas of the niche-groups were absorbed rather quickly and the niche groups were not so much competitive. However, they were rather new and unfamiliar and therefore it took time for the ideas to become mainstream. This suggests that niches and regimes are indeed not always antagonistic.

5.7 Conclusions and discussion

The objective of this chapter was to generate insight into the dynamics of the Dutch water sector. In this section we draw the most important conclusions on three different levels:

- Is the Dutch water management sector in transition?
- Does the method of pattern analysis work and what are the lessons we learn with regard to the dynamics.
- What do we learn about transition management?

Is this a transition?

The transition we have investigated is that from a sectoral-technocratic water management regime to an integrated and interactive water management regime. In order to get grip on the regime changes, we have characterized the regimes of 1970 and 2005 in terms of the cultural institutional and infrastructural elements of structure and we have analyzed which elements have changed. This raises the question whether these changes add up to be classified as a transition. We thereby argued that a completed transition involves changes in the all three types of structure: culture, institutions and infrastructure.

Overall, the cultural and institutional elements of structure have changed quite fundamentally. The water management paradigm changed: there is a broad acknowledgement that the water system can not be fully controlled and requires a continuous adaptation. The water can not be managed only by technological means, but the spatial measures necessary and a new discourse emerged that water should be more guiding in spatial planning. There has also been a shift in the values, that is, safety is still most important, but the ecological status of the water system is also important. In addition,

water is seen an asset to improve the quality of a region and to stimulate economic development. Institutionally, the sector became less hierarchic. The responsibilities of the district water boards change as they became all-in water boards. The water test now secures the position of the water boards in the spatial planning. The PKB-room for the river is currently being executed. As such, the institutional structures are adjusted in order to implement the new water management policy. With regard to the infrastructure, many of the planned infrastructural changes are in the start-up phase; however, none of them are actually finished. The cultural and institutional changes are not yet manifested physically. What does this mean in terms of transition? Considering all the changes in the elements of structure, both the cultural and the institutional structures of a new regime are in place, but the physical infrastructure is lagging behind. In the coming years, however, the infrastructure will change especially in the river bed. Therefore we conclude that Dutch water management is indeed in transition, however, the transition is still ongoing.

The policy shift that took place around 2000 is now being implemented, which implies that we are beyond the so-called take-off and somewhere in the acceleration phase. However, the acceleration phase should not be seen simply as a quick implementation process, rather as the physical manifestation of the cultural and institutional changes. The term acceleration and the associated steep slope of the S-curve is somewhat misleading in this respect. They suggest that the change process goes faster, however this is not necessarily the case since the infrastructural projects tend to take years or decades to be build. The conceptualization of transitions as the shift from one basin of attraction to another may therefore be a suitable alternative for the S-curve, since it does not per se presuppose an acceleration during course of transition. That the water sector is shifting into a new basin of attraction does not mean that the future of the sector is straightforward and the direction a run course. There are still many barriers yet to be overcome and there is always the chance of backlashes. In the next two chapters we further explore the how the change process after the policy tipping unfolded.

Characterizing a certain regime change as transition is inherently subjective. The very notion of *fundamental change* used in various definitions (e.g. Rotmans, Schot and Kemp et al) to distinguish transitional change from non-transitional or normal change is in the eye of the beholder, which means that there are no objective criteria possible *a priori*. Two reasons are at the heart of this subjectivity. The first reason has to do with defining the system boundaries, which by definition are subjective. Secondly, if the system is defined, then still decisions about what kind of change is considered to be 'fundamental' is subjective. Should all elements of structure change in order to consider it as a transition, or it is enough that one element of structure changes? And to what extent should they change? And if all structuring elements change only a little bit, do we still consider it to be a transition? These questions make research into transitions complex and slippery.

However, since there are no a priory criteria of what transitions are, the implicit criteria we use are socially constructed by the database of earlier studied transitions. In this case study we therefore attempted to be more specific about what kind of structures actually changed.

The method for pattern analysis and what do we learn?

First, of all, the developed approach for transition analysis enabled us to analyze transitions in a structured way. The regime analysis helped to make explicit which actors, processes and elements of structure should be taken into account. The patterns analysis enabled us to identify and analyze the patterns of transformative change in terms of the involved actors, key-processes and structures changed over various time slots.

There are also some shortcomings of the method. The method unravels the different elements of structure, while in reality they are internally related. Discriminating between them is useful and clarifies what is actually changing in the regime, however, these structures cannot change independently. If one structure is changing, other elements of structure follow. In this sense, the method makes the occurred changes explicit, but it may represent a too mechanistic view where it should be co-evolutionary.

Secondly, it remains difficult to identify niches and niche-groups. Unfortunately, the literature is not clear on how innovative, or how deviating or how large or small a niche should be in order to call it a niche. There are no objective criteria available and so distinctions between niche and regime are therefore trivial. However, we do consider these notions useful, especially for providing a language to discuss what is going on. In this case study we used the selection criterion for a niche in terms of its deviating policy perspective compared to mainstream policy. The niche-groups that we have identified shaped these niches significantly. However, other important niche-groups may have been missed. The reason for this might be due to recall bias of the interviewees or that such niche-groups have not been recorded into the history books. This may be the case of those who have failed to influence policy. This also brings us to the differences between doing research into historical or contemporary transitions. Historical research has a bias to the successful niches and niche-groups. In contemporary cases it is impossible to predict whether such groups of people will be successful. In contemporary cases one may find all kinds of innovative change agents which means that there are all kinds of deviating policy perspectives present and so the border between niches and regimes is much more fluent. Historical transition studies thus tend to overstate the distinction between niches and regimes.

For instance, the Dutch water management sector has a tradition of appointing official state research or advisory committees to bring out advice in all kinds of policy related issues. It is not clear whether to refer to them as niches or not. Often, these committees do not present new ideas, but they analyze and evaluate already existing ideas and we

therefore did not label them as niche-group. The advisory committee Tielrooij however is in this respect debatable. The committee based its advice on things that were already heard of and discussed, but it also gave it a 'twist' of its own, for instance by suggesting that water should have a more guiding role in the spatial planning and that the role for provincial government should be more prominent.

Taking into account these shortcomings, what can we learn form this method with regard to transition dynamics? First of all, by applying the method for pattern analysis, we learned that transitional processes involve more than one pattern of transformative change. In identifying the patterns that gave rise to the two policy shifts, we first saw various bottom-up patterns of transformative change emerge, which were then followed-up by a top-down pattern of transformative change. The analysis suggests that we may interpret a tipping point as a flip from the bottom-up pattern to the top-down pattern of transformative change and which corresponds to the installment of new institutions. In contrast, the bottom patterns (endogenous niche-absorption as well as the pattern of exogenous niche-absorption) primarily influence the cultural aspects of water management).

Secondly, the dominant patterns of change were the niche-absorption and re-constellation pattern and we did not come across the empowerment pattern. These findings suggest that indeed the regime and the niche are not 'opposites', standing next to each other and competing, but that niches and regimes are much more intertwined and that the ideas developed in the niche are adopted by the regime. Furthermore, they suggest that the transition dynamics should be better understood as a continuous niche-regime dynamic: the regime creates a niche, the niche-groups influences the regime; the regime change triggers new niche-groups, etcetera.

These findings also suggest that the regime is actively involved in shaping niches by creating niche groups. We should therefore nuance the view sometimes seen in the transition literature that regimes are too rigid to adapt. This is not always true, rather the adaptive capacity of a regime is a property that can be influenced and improved. Regime actors create niche-groups to explore opportunities and to keep up with other actors. This implies that within the regime there are many innovative change agents present, but that they do not always get the opportunity to innovate. A niche provides such an opportunity.

Thirdly, what is interesting is that this transition was predominantly driven by changes in the cultural dimension of the regime. New ideas grew out to become new discourses, which grew out to become a new paradigm. Underlying the changes in the water sector, we can recognize the shift from an *optimization* paradigm to an *adaptation & anticipation* paradigm. To some extent this stands in contrast to the literature on socio-technical transitions, in which the technological innovation is often perceived as the major driver. Perhaps, this is due to the fact that nature of social-ecological systems is somewhat dif-

ferent from socio-technical systems. Disasters, or calamities, have been important in the policy shifts as well, however, they can trigger different responses. In the case of ecological problems in the Haringvliet, the disaster had been the reason for the development of a new approach. In the case of the near-flood disaster of the mid 1990s, it triggered an initial backlash and re-triggered a new direction. In another case, for instance the pluvial flooding in the horticultural sector in the late 1990's created momentum to formulate new policy.

Lessons for transition management

An interesting question is whether transitions can be managed? On the basis of this transition analysis of the Dutch water management regime, we may answer this question with yes and no. Some niches have been actively created, which means that the formation of niches can be at least partially managed. We might argue that the transition was partly managed in terms of up-scaling, for instance, the ecologists were deliberately allocated to strategic positions within the Ministry after the Delta Works were finished. On the other hand, most of the knowledge has been built up in a distributed fashion, meaning that many organizations adopted the new ideas and applied it to their own context, contributing to a rather autonomous buildup of critical mass. After the tipping point and during the implementation process, the change process has been heavily managed. Policy plans at regional levels, such as the river basins plans (see also chapter six) have been formulated and translated into implementation plans and the water test was implemented. However, these processes cannot be fully controlled by one actor, for instance by the Ministry of Transport, Public Works and Water. Hence, we may conclude that a transition as a whole cannot be managed, but that certain aspects of transitions can be managed, at least to a certain extent.

So what does this teach us about the management of transitions? First of all, we have seen that many different elements of structure need to change. In principle these structures are often in alignment with each other. This means that if one element changes, then others should change as well. Hence the change process is a co-evolutionary process, in which related elements are adapted. This also means that elements themselves are barriers as well as leverage points to change other elements. Through analysis, one might be able to identify which of the elements of structure is holding back others. By definition, changing these structures then requires multiple actors. Those organizations should be involved that can influence the particular elements of structure and these actors should work simultaneously on the different related elements. Within such multi-actor processes there should be some kind of coordination, so that they all work into the same direction and that the new structures align, in stead of constrain one and another. One way of doing so is by creating a long term vision which binds the involved organizations to each other.

Second what we might learn from this case study in terms of management is that we should intentionally initiate patterns of transformative change. We should not let them emerge spontaneously, but we should actively organize them and facilitate them. We should be more conscious about which kind of organizations should deliver representatives in order to change specific structures and which kind of processes they need to influence. The key for transition management is to stimulate patterns which go into a desirable direction This triggers the question how to find the change agents who are willing to innovate? Does that mean that one should involve people with vested interests in the current system or only people that have much to gain by a new kind of system, or a mixture of both? In addition we should improve our knowledge how to facilitate such process and which kinds of activities are successful. In chapter six and seven we attempt to identify management strategies that would facilitate such processes.

In the third place, we learn that we should increase the adaptive capacity of the regime. In the transition management literature and also in the strategic niche management literature the focus is predominantly on developing niches and much less on the regime itself. However, if niches and regimes are more intertwined as we suggested, then the focus should also be on the regime. As we discussed in chapter three, the adaptive capacity of a system can be understood as the ability to adapt to changing circumstances. Adaptive regimes as such do not get locked in deep basins of attraction, but they are capable of shifting to a new basin if necessary. Adaptive regimes score high on the following aspects: the ability for learning, institutional flexibility and amount of capital in terms of people, knowledge and financial resources that is directed towards innovation. Increasing these three determinants would thus improve the adaptive capacity. The ability to learn for instance could be enhanced by interdisciplinary collaboration and the confrontation with different perspectives. The flexibility of institutions, for instance, can be enhanced by creating so-called experimentation locations (Loorbach 2007) in which temporarily certain rules may be altered. Finally, personnel, knowledge and financial resources can be reallocated to improve R&D. One way of shaping the adaptive capacity is by stimulating the formation of niches and facilitate the dynamic interplay between niches and regimes.

In the next two chapters, we will analyze the dynamics of niche-regime patterns in more detail.

Chapter 6

An analysis of niche-regime dynamics in Amstelland

6.1 Introduction

In the previous chapter, we have seen that niche-regime dynamics are an important aspect of the dynamics in a transition and that is therefore necessary to increase our understanding of how this interaction works. The objective of this case study is to generate insight into this dynamic. The hypothesis is that the double-loop concept developed in chapter four captures the crucial aspects of the niche-regime dynamic and therefore we have applied the double-loop concept to increase our understanding of niche-regime interactions and how these interactions can be managed.

A second objective of this case study is to illustrate how the transition in the Dutch water management sector is manifesting itself regionally. The case study illustrates the implementation process of the 'Water policy for the 21st century' (WB21, 2000), which was declared by the Dutch government in 2000. As described in chapter five, the WB21 was a national water reform policy to prepare for the adverse effects of climate change. An important objective of the WB21 is to enlarge the room for water retention in order to cope with water abundance as well as shortages. A second characteristic is that the water system should have a guiding role in the spatial planning of a region. We argued that the declaration of WB21 reflected a tipping point in the shift towards a new institutional regime. The implementation process started in 2001 with the development of so-called river basin plans. These river basin plans consisted of assessments of the water related effects of long-term climate change, an examination of the spatial consequences and a long-term programme of necessary measures. However, a policy shift does not necessarily mean a successful shift into another basin of attraction. This case study illustrates the gap between the ambitions of WB21 on the one hand and the complex reality of implementation on the other.

In this case study, we have focused on the development and implementation of the river basin plan in the Amstelland-region, a region in the mid-west of the Netherlands between 2001 and 2007. We saw this case study as an opportunity to study the interactions of a policy niche and the regional water management regime. We contrasted a policy niche to a technological niche to emphasize that the niche develops a new policy perspective instead of a technological artifact. In chapter four we developed the double-loop concept as a way to understand the dynamic interplay between niches and regimes conceptually. The niche goes through a so-called shadow track, which operates alongside and at a certain distance from the regime, which allows for reflection and reframing. The double-loop concept points to three critical issues of niche-regime interaction. The first aspect is that of how the niche is created. The second critical issue is the reframing that occurs during the so-called shadow process, which leads to an alternative perspective; and the third aspect is how this niche influences the regime. There are different patterns of niche–regime interaction possible. In this case study we have focused on the pattern of endogenous niche-

absorption. In this pattern of niche-regime dynamics, the niche is created endogenously, which means that the actors in the regime are involved in the creation of the niche. The niche develops a new perspective which influences the regime. In this case study we will further investigate these three different aspects of niche-regime interaction.

In the next section, we outline the research approach. In section 6.3, we will define the Amstelland system. Section 6.4 we will present a historical reconstruction of the development of the river basin plan and how it influenced the regime. In section 6.5 we will reflect on the niche-regime interactions and the strategies. In section 6.6 we will draw the main conclusions.

6.2 Method

In this case study, we have carried out the following three steps. In the first step, we have defined and characterized the 'Amstelland system'. We have used the regime analyses of the Dutch water management regime of chapter five as a starting point and consider the Amstelland-regime as a regional manifestation of that regime. We will point out additional regional characteristics, the main water related problems and identify the relevant actors for this case study. In the second step, we have a made a historical reconstruction of the development of the river basin plan and how it influenced the regional water policies and regional development policies. This reconstruction starts in 2001, with the formation of the niche and ends in 2007. We have focused on the three aspects of niche-regime interaction pointed out by the double-loop concept. The first aspect is how the policy niche has been created. We have made a distinction between the structural component and the agency component of the niche and have used the term niche-structure to refer to the structural component and the term niche-group to refer to the people (agency). Therefore, we focused on the regime developments that created the niche-structure and on how the participants of the niche have been selected. The second aspect of the double–loop is the development of a new policy perspective. We have focused on the kinds of reframing that have occurred during the shadow process and that have rendered the new policy perspective. The third aspect of the double-loop is concerned with how the niche influenced the regime. We have focused on two different aspects, namely the political support the river basin plan received and the adoption of this policy perspective in policy processes. In the third step we have analyzed the strategies that influenced the niche-regime interaction.

This reconstruction is based on in-depth interviews with the participants of the project and individuals at senior level who were indirectly related to the project. We have analyzed the relevant policy reports and the minutes of relevant meetings.

6.3 The Amstelland river basin

In this section we will describe the 'Amstelland-system' in terms of the regional characteristics, the water related problems and the relevant actors.

6.3.1 The region

The Amstelland river basin in the mid-west of The Netherlands (fig 6.1) spans the province of Noord-Holland south-east of Amsterdam, the province of Utrecht and a small part of the province of Zuid-Holland. Amstelland river basin is a part of the Rhine basin, which splits up in five Rhine-branches[12]. In the west, the region primarily involves polder systems. These areas consist of clay and peaty soil and require relatively high water levels to prevent subsidence of the soil. These areas are mostly agricultural. In the eastern part is the 'Utrechtse Heuvelrug' – a range of hills created by glaciers during the last ice-age. This area is predominantly agricultural and recreational. Water from this area is

Figure. 6.1 The Amstelland-region. This region falls under the jurisdiction of three provincial governments, those of Utrecht, Noord-Holland and Zuid-Holland. Two district water boards are active in the area. The Provincial borders do not correspond with the district borders of the water boards.

12 Lek, Oude Rijn, Kromme Rijn, Hollandse IJssel and Amsterdam-Rijn canal.

transported through the aquifer to the west where it becomes infiltration water. Some parts of the region are urbanized. The main cities in the region are the city of Utrecht and a part of the city of Amsterdam.

6.2.3 The water-related problems

The water related problems in the area are rather persistent because they are rooted in existing land-use patterns. There are three main categories of problems (Schaafsma *et al.*, 2002). The first problem category is that of ongoing soil subsidence in the western part of the region. The polder systems in these parts consist of peaty soil. Peat has the property to oxidize when exposed to oxygen, which leads to soil subsidence. The farmers in the region require water levels of 40-70 cm below ground level for their crops. Since farmers have a large vote in regional water management, these water levels have been lowered every now and then, which stimulated further oxidation. On average, the speed of subsidence is 50-100 cm per 100 years and the system is more or less trapped in a self-reinforcing loop. Most of these soils are used for agriculture. In addition, the different speeds of subsidence led to a fragmented water management because of the large differences in local water levels, and so the costs of water management and maintenance increased. A second category of problems is the poor water quality. Some of the polder systems are so deep (5-6 meters below sea level) that water from the immediate surroundings flows in. This water is generally of a poor quality, because it is rich in sulphur and salt and leads to agricultural and ecological problems. The third category of problems is that of fluvial flooding due to climate change. This is especially the case along the Rhine branches, the lakes (e.g. Gooimeer and IJmeer) and nearby urbanized areas with a high population density. Climate change is expected to lead to a higher frequency of flooding along the Rhine branches, in urbanized areas (e.g. Oude Rijn, Amstel, Gravelandsevaart) and the deep-polder systems in the west (e.g. Groot Mijdrecht, Noorderlegmeer and the peaty-grasslands in north of Woerden).

6.3.3 The Water governance system

The main actors in the water governance system of Amstelland are the two regional water management authorities (i.e. water boards), the three provincial governments and the various municipalities (see fig 6.1). The water boards are responsible for the regional water system and the maintenance of dikes and pumps. The districts of the two water boards together form the borders of the Amstelland region. The Amstelland region falls under the jurisdiction of three different Provincial governments, those of Utrecht, Noord-Holland and Zuid-Holland. Since the Provincial government of Zuid-Holland has only a very small share in the region, it has played a marginal role in the development

of the river basin plan and is therefore left out of the analysis. Other important water management actors are the regional directory of the Ministry for Transport, Public Works and Water management and the municipalities in the region.

Various laws ensure that water policies and spatial planning policies align (Groothuijse and van Rijswick, 2005). At the national level the *Law on the Water household* prescribes the development of policy memoranda on the national water household and the memorandum takes into account the spatial consequences. At the provincial level, the water policy and the spatial planning polices are aligned reciprocally, which means that mutations in the Provincial water plan must be translated directly to the regional development plan and vice versa. Both plans need to be approved by the Provincial Council of Aldermen. At the local level, the water boards and municipalities are obliged to consult each other. Water boards can safeguard space for water infrastructure, which is arranged in the law called the 'Keur'. This law discriminates between three restriction zones for non-water-related activities. The core zone restricts almost all activities; in the protection zone certain harmful activities are restricted while others are allowed; in the third zone the restrictions are marginal. The Keur and the municipal development plan are hierarchically equal and so conflicting stakes are resolved depending on the context. The spatial planning regime is a planning hierarchy. The national PKB is translated to the regional development plan and the municipality development plan. This planning hierarchy suggests that planning is done systematically and rationally, but in practice the planning process is the outcome of stakeholder negotiation (Wolsink, 2003).

Although the formulation of water policy and spatial planning is formally reciprocal, in practice, the spatial planning regime has the initiative. In general, water is not a high priority in the agenda of the spatial planners. With the declaration of the Water policy for the 21st century this started to change.

The Water policy for the 21st century (WB21) flagged a turning point in Dutch water management. One of the most profound characterises of WB21 is that the water conditions should be guiding in the spatial planning of a region. This means that the water conditions should be taken into consideration to a greater extent than before when determining land use. This shift from water *following* spatial planning to water *guiding* in the spatial planning required a new kind of interaction between the water manager and the spatial planner. In box 6.1, the main points of the WB21-policy are summarized.

The WB21 is based on the advice of the Tielrooy-committee, which had been appointed in 1999 to investigate whether the Dutch water management sector was ready for the challenges of the 21st century. The committee argued that the room for water retention had to be enlarged in order to cope with the effects of climate change by appointing locations for water retention. This should serve two purposes: to store excess water temporarily and to use it in times of water shortages. The committee emphasized that these areas for water retention should be sought for within the regional water system.

The effects of climate change are expected to lead to a reduced safety due to water excess, but also to extended periods of drought. According to the regional climate change scenarios of the Royal Dutch Meteorological Institute[13] (Van den Hurk *et al.*, 2006), the winters will become softer and the summers will become warmer by the year 2100. During the winter, there will be more precipitation in general and there will be an increase in the frequency of extreme rainfall. The summer will be dryer on average. The number of rainy days is expected to decrease, while the frequency of extreme rainfall will increase. The scenarios project a rising sea level of 35 to 85 cm by the end of this century. The river discharges will increase during the winter.

Since so much emphasis was placed on the interaction between spatial planning and water management, the provincial government appeared to be the logical coordinator of the implementation process of WB21. The main reason for this is that the provincial government is officially responsible for attuning water policy and spatial planning policy. The first step in the implementation of WB21 was the development of so-called river basin plans. These river basin plans were to form the basis for so-called *regional agreements* (Schaafsma, 2003) between relevant authorities and therefore ought to be developed in coalitions of relevant authorities. The most important objective of these river basin plans was to make an assessment of the so-called water challenge. The water challenge refers to the extra amount of water which can be expected based on climate change scenarios. This was then to be translated into the extra square meters required for the purpose of water storage and to be translated into implementation measures.

Box 6.1 Main points of WB21

- Continuation of the Room-for-River policy
- The triplet priority principle: (1) retention of water within the area; if this is not sufficient; (2) storage of water elsewhere; if this is not sufficient, then (3) transport of water to the main water system.
- Water needs to be the guiding principle in regional planning.
- The implementation strategy is to be coordinated by regional government.
- The development of long-term river basin management plans.

6.4 Niche-regime interactions in Amstelland

We will now turn our attention to how the Amstelland river basin plan has been developed and how it influenced the water policies and the spatial development policies in

13 This institute is an authority in the field of weather forecast and climate change. These regional scenarios are based on the global IPCC-scenarios.

the region. Figure 6.2 illustrates the pattern of niche-regime dynamics we have analyzed in this case study. The inner loop refers to the regional water management regime as described in section 6.3.2. The development of the river basin plans represents the shadow process. In the next section, we will present a historical reconstruction of how the niche and the regime have interacted. We have identified five different phases, which will be discussed below. The first two phases are concerned with how the niche was formed. The third phase describes what happened during the shadow process. The fourth and fifth phase deal with how the new policy perspective has influenced the regime.

6.4.1 Phase 1: Formation of the niche-structure

The first phase in this pattern of niche-regime dynamics can be characterized by the formation of the structural component of the niche. As we have argued in chapter one and four, a niche has a structure component and an agency component (e.g. the group of people). The structural component can constrain and enable certain practices, and so new structures create the opportunity for developing new kinds of practices.

The most important development that created the structural component of the niche was the declaration and the implementation of WB21. WB21 created a new institutional structure in two ways. Firstly, it obligated the relevant authorities in the river basin to

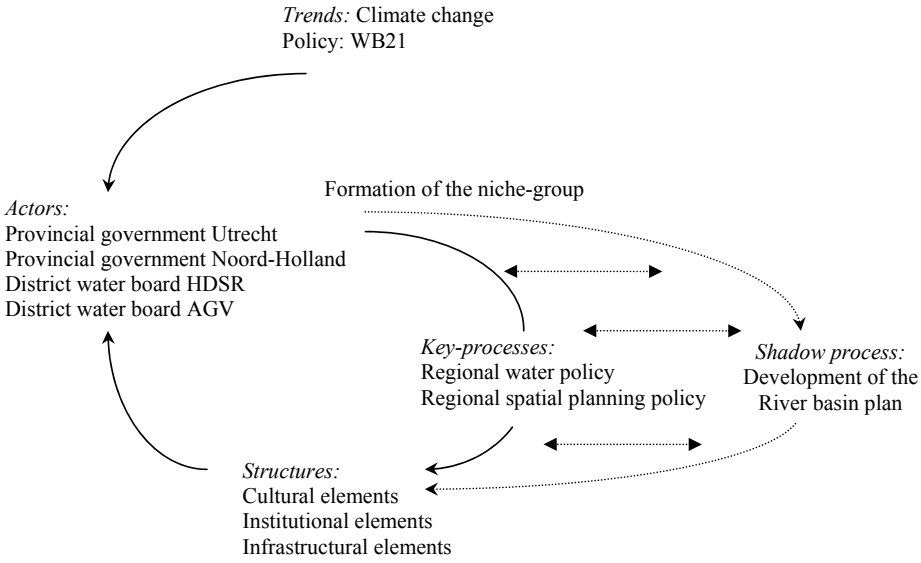


Figure 6.2 A double-loop representation of the niche-regime interaction in Amstelland. The niche involves the core team and a larger study group of representative from the Provincial governments, water boards, Rijkswaterstaat and Municipalities. The niche has developed a new policy perspective in a shadow process, which influenced the regional water policy and regional development policy.

develop a river basin plan together. Secondly, it appointed the Provincial government as the coordinating authority. In Amstelland, the Provincial Government of Utrecht was responsible.

Three other developments co-shaped the niche-structure in terms of requirements that had to be included in the river basin plan. An important development in this respect was climate change and the assessment of the effects on the regional water system. Secondly, WB21 prescribed that the water conditions should be guiding in the spatial planning of the region and therefore it was required to investigate the spatial consequences. A third and related development was the increasing awareness of the need of interaction between water managers and spatial planners. A study[14] carried out a year earlier by the Rathenau Institute had shown that the collaboration between the water authorities and planners in the Amstelland region had been insufficient and that there had been a cultural difference between what the researchers called the 'creative design-oriented spatial planner' and the 'fact-seeking water expert' (Van Rooy and Sterrenberg, 2000), which suggested that the river basin plan should be developed in cooperation with spatial planners.

6.4.2 Phase 2: Formation of the niche-group

The second phase in this niche-regime dynamic is the formation of the niche-group, thus the individuals that participated in the development of the river basin plan, which reflects the agency-component of the niche. The process started in 2001 with the selection of participants of the core team. The project leader - a civil servant from the Provincial government of Utrecht – was responsible for this selection and she wanted to bring together a small core team of people she selected her self and a larger study group in which the representatives of the relevant institutes took place. According to her, successful projects depended on the people and not on the institutes they represented, so she spent sufficient time with the selection of the core team. She selected five individuals, each individual having a different role: the inspirer, the water expert, the spatial planner, the people manager and the work horse. This core team organized and prepared workshops and brainstorm sessions, but was also responsible for writing the final report.

An additional study group of nine people was formed which was invited for brainstorms and discussion sessions on a regular basis to provide local knowledge and water expertise. The project leader had less influence on the selection of these participants as the study group involved representatives of the relevant water management authorities. We may argue that the way in which the project leader initiated the process has been

14 This study was called "Het Blauwe Goud Verzilveren". (Van Rooy & Sterrenberg, 2000)

of significant influence for the course of the project. She had built a team which was a mixture of civil servants and consultants, of water experts and spatial planners.

Although the project leader herself did not participate in the process because she was pregnant at the time, she stayed in close contact with the core team and helped to write the final report at the end. The process of developing a river basin plan was new and the niche group had relatively much freedom to define and shape the process. They had only generic guidelines about what to include in the river basin plans (see box 6.2), and there was no example or standard set. The freedom with regard to the content and the diversity of the participants formed a good condition for reframing on the one hand and for realism about existing policies on the other hand.

Box 6.2 Main objectives of the Amstelland river basin plan (Schaafsma *et al.*, 2002)

The main objectives were to develop strategy to:

1. Guarantee safety
2. Reduce nuisance due to excess water or shortages
3. Prevent soil subsidence as much as possible
4. Turn the trend towards fragmented water management
5. Improve water quality
6. Deal with droughts
7. High quality experience of water

6.4.3 Phase 3: Reframing

The third phase we distinguished is concerned with an important aspect of the process, namely the reframing that occurred and which formed the basis for developing the new policy perspective. The process started out with formulating the main objectives and continued with developing an inventory of the current water-related problems and then extrapolated these over time using climate change scenarios.

The main sources for data were two studies, carried out earlier by the two participating water boards, Amstel, Gooi en Vecht (AGV) and Hoogheemraadschap De Stichtse Rijnlanden (HDSR). The first study was carried out by the water board AGV and was a report to re-orient their strategy after an internal reorganization. The second study was a report made by the second water board, HDSR. This study involved a detailed analysis of the problems in their district and the formulation of long-term strategies. Although this report was much more detailed, it focused primarily on water quality and largely disregarded the water quantity aspects in relation to the effects of climate change. The two studies were an important input for the discussions.

Based on the interviews, we have identified three kinds of reframing during the process. The first kind is concerned with how the participants perceived the water-related problems in the region. For them, this was the first exploration of climate change scenarios for the regional water system. As a consequence, they started to view some of the water-related problems as more fundamental and persistent than before. Figure 6.3 shows a map of the Amstelland region, which was developed by combining the water data and spatial data. This map summarizes the river basin plan in a single picture by marking the most important water related problems in a spatial context. The most problematic areas in this map are the 'search areas for water storage'. The areas had major water–related problems and solving them required structural transformation of the area in terms of land-use change. Five of such areas were appointed in this map (Groot-Mijdrecht, Bethunepolder, Horstermeerpolder, Ronde Hoep, Utrecht region) and were labelled *"search areas for new wetlands combined with peak-storage"*. Eight other areas were appointed in which additional peak-storage would suffice. Hence, the map suggests that these thirteen areas might be confronted with serious water problems in the future and that they possibly would need to be transformed into wetland areas or lakes. The zone along the river in the south is to safeguard possible additional water defence constructions in the future. In anticipation of the PKB-Room for the River, the two lines in the southwest show the planned broadening of two polder-rivers (i.e. the Oude Rijn and Hollandse IJssel). In the East, the natural fluctuation of the water level will be restored and in the West the area requires higher water levels to prevent oxidation. The two circles refer to the required improvements in the urban water systems of Utrecht and Amsterdam.

The second kind of reframing that occurred was concerned with learning to understand each other's perspective. The water experts learned how the spatial planners think and vice versa. One of the interviewees summarized it in the following way: *"I learned the difference in the way of thinking between the spatial planners and the water professionals. The spatial planners think in terms of processes and overlapping physical and societal layers, while water experts think in terms of plans and execution".* In addition, they had also learned each other's priorities and stakes. These learning experiences were important to improve the interaction.

The third kind of reframing we observed was with regard to management. The exercise made some of the participants realize that some of the problems could not be solved with current policies, but required new kinds of competences and strategies. This led to the distinction between three portfolios of measures. The first portfolio of measures consisted of urgent measures for the years 2002 -2015. These measures were urgent, but could be incorporated in existing policies. However, the second portfolio, which was labelled the "transformation portfolio", consisted of large and urgent interventions, which could not be matched with current policy plans. In addition, the third portfolio

included also large interventions, but which were less urgent (i.e. for the period of 2015-2050). With regard to the second and third portfolio, the participants started to recognize that these measures could not be implemented without public protest and an improved cooperation between water management and spatial planning. One of the interviews explained that "*it became clear to me that we had to carry on in a completely different fashion than we were used to; much more according to the new philosophy of the Area Development approach*[15]". This quote shows that the group experienced that the government could not implement these measures top-down, but that the residents and the people working in the areas needed to be involved. Therefore they approached the problems from two different angles. The first angle was to safeguard the area from irreversible and undesired developments. The second angle was to initiate bottom-up processes, in order to create enthusiasm and understanding and to mobilize the residents, to organize financial resources and to cooperate with the various authorities.

The first two points of reframing were important in the problem perception and in establishing the line of reasoning in the report, which was crucial for finding support as we will see in the next two phases. The third point of reframing was important in the implementation as to how to initiate such large transformation processes.

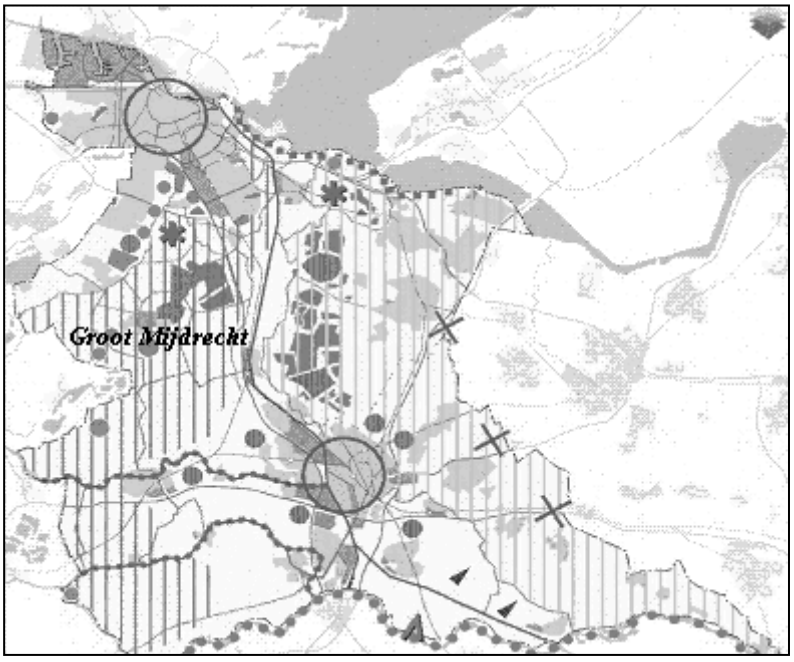


Figure 6.3 A map of the water- related problems in the region (source: Amstelland river basin plan).

15 Gebiedsgerichte aanpak

6.4.4 Phase 4: Passing the Council

The fourth phase in the niche-regime dynamics was concerned with how the river basin plan was received by the Provincial government. This phase is essentially a political phase since the Council of Aldermen of the Provincial government is democratically elected. By the end of 2002, the final report was presented to the Councils of Aldermen of the two Provincial governments.

The core team realised that the search areas for water storage were politically sensitive and that the proposed measures diverged quite radically from the current policy. As a tactical move, the core team decided to present the report as a sector based vision report. This was a significant decision because it meant that the report did not represent official policy, but was rather a vision of the water management department. One of the interviewees explained this decision: *"A sector-based vision made it possible to draw large 'search areas for water storage' on the map, despite the fact that other plans were already being executed. To us, it was clear that the river basin plan would not pass the Council as official policy, but it might pass the Council as a long-term vision, representing the optimal situation from a water management perspective".* The strategy turned out to be successful in the Provincial Council of Aldermen in Utrecht, where the Council approved of the river basin plan as a 'building block for the Provincial spatial development plan and the Provincial water policy plan".

In contrast, the Council of Aldermen in the province of Noord-Holland did not approve of the river basin plan. The Council thought it to be too radical and lacking public support. One reason for this was that the Provincial Government of Noord-Holland was also the coordinator for a river basin plan in the northern part of the province (Hollands Noorderkwartier). This plan was based on a participatory process which had made clear that large scale water storage had no public support. Therefore, the Council opposed the large search areas for water storage and preferred fine-grained and technical solutions. In addition, the council argued that decisions of this kind were of a political nature and not to be formulated in a sector-based water vision. Another aspect which may have played a role is the fact that some of the deputies happened to live in one of the areas that were proposed for storage. A follow-up report[16] was written by one of the members of the study group, which passed the Council in 2003. This report states that *"The river basin plan presented a general vision which was in some cases not sufficient for deriving integral measures and public support"* (2003) Balanced and fine-grained solutions had to be sought with regard to municipalities, inhabitants and stakeholders.

16 The report was titled "Evenwichtig omgaan met Water" (2003)

6.4.5 Phase 5: Influencing policy

This last phase is concerned with how this niche has influenced the policies. First of all, the river basin plan and the adjustments made in the follow-up report, had resulted in a regional water agenda, in which the provincial government and the water boards agreed to start with the implementation of the so-called action programme. The action programme consisted of 35 projects, subdivided into three categories. The first category of actions was related to integrating the measures into existing policy plans. The second category involved the execution of thematic projects, such as evaluating and testing safety norms, dealing with flooding, urban water management, water pollution prevention and projects with regard to soil subsidence. The third category contained projects with regard to the search areas for water storage, or the transformation areas. These actions required further research, creating public support and finding financial resources. Each project in the action programme was appointed to the most relevant authority.

Secondly, it is clear that the river basin plan influenced each participating organization in a very different way. Arguably, the river basin plan had the most effect within the Provincial government of Utrecht. The river basin plan was one of the inputs for the Spatial Development Plan of the Province of Utrecht. This was put forward during the inception phase by one of the core team members. In addition, there was also pressure from the water boards as with regard to the agreements in the regional water agenda. The Spatial Development Plan indicated the transformation areas as 'problem areas' which had to be safeguarded from any activities until the problems were understood better[17]. One of interviewees clarified: *"If something is written down in the Spatial Development Plan, it has direct consequences for the people. A spatial planner needs to know if it is valid to make statements, thus they require financial coverage, detailed research and argumentation".* Hence, in practice this triggered further research to study the precise details.

As we have seen, the Provincial government in Noord-Holland reacted quite differently to the river basin plan. In Noord–Holland all search areas were taken of the agenda unless before 2005, new studies proved that water storage was absolutely necessary. However, the water board AGV supported the river basin plan and was frustrated about the fact that the Provincial government of Noord Holland did accept the river basin plan. As a result a conflict arose. In the water board HDSR the river basin plan played only a marginal role according to one of the interviewees. The reason for this was that the water board had just developed its own long-term strategy in cooperation with the municipalities and was thus not eager to change the strategy. However, this strategy focused on water quality and the Amstelland river basin plan did trigger a re-evaluation and incorporation of water quantity issues, implying that its role might have been larger.

17 The polder *Groot Mijdrecht* area was safeguarded until 2004, the *Bethune* polder until 2005 and the *Oude Rijn*, the *Hollandse IJssel* and surroundings of the city of *Utrecht* until 2007.

Focusing on the so-called transformation portfolio, we have observed that most of the plans have been removed from the agenda. Initially, the river basin plan designated 13 areas in the transformation portfolio. Five of these areas were within the borders of the province of Utrecht, the remaining 8 within the borders of the province of Noord-Holland. Further research indicated that in three cases there was no direct need for large-scale water storage. In another case, (i.e. the Bethune polder) research indicated that the water-related problems were due to the neighbouring polder system (i.e. Polder Westbroek) and that the water problems in the Bethune polder could be solved by raising the water level[18]. In the province of Noord-Holland the search areas for water storage were removed from the agenda. In all, only one of the thirteen initially appointed search areas is currently viewed as a serious candidate for transformation: *Polder Groot Mijdrecht*.

Polder Groot-Mijdrecht is a deep polder system which lies on average 5-6 meters below sea-level. Because of its depth, the polder is confronted with infiltration water from the surrounding areas, which causes water shortages in these areas. Each second, approximately 1.5 m^3 of water is pumped into the main canal to maintain the water level. The costs involved in maintaining this situation are relatively high and will increase in the future. The eastern part consists of peaty soil, which oxidizes and causes soil subsidence, because agricultural land-use requires water levels of 40 cm below surface level. The soil subsides on average 70 cm per 100 years. There are also significant water quality problems. The water from the surrounding areas is of a poor quality due to chlorides, phosphates and ammonium and causes agricultural and ecological problems and according to the Water Framework Directive the concentrations are not allowed to increase. The area harbours 110 residents and a considerable part of the water taxes is used for only a small part of the district.

A direct consequence of the Amstelland river basin plan has been a re-evaluation of an existing covenant for Polder Groot Mijdrecht called '*De Venen*', which was signed in 1998 by 27 different parties. The covenant dealt with land-use changes in the polder and the parties had agreed to use the western part for agriculture and to transform the eastern part into a nature preservation area. The re-evaluation, which started 2004, included the water-related problems and resulted in six alternative strategies, ranging from a 'Doing nothing' strategy to a 'Transformation into a multi-functional lake' strategy in the Northern part (table 6.1).

The government official who initiated the Amstelland process was also in charge of this re-evaluation and involved the residents in the area. Although most of the residents recognized the water problems, they were not willing to leave. There was much local protest due to a lack of trust in the government and in the facts and figures presented

18 Currently, the provincial government and the water board are investigating whether this neighbouring polder requires land-use change.

by the various studies. The community is small and peer pressure made it hard for some of the willing residents to cooperate. On certain occasions they encouraged each other to invest in their estates so the government would not be able to provide them with sufficient financial compensation (Van Rooy *et al.*, 2007).

On February 5th 2007, the Council of Aldermen in the Province of Utrecht decided that the polder in its current form was unsustainable and set out a course of either the *Growing-along*-strategy or the *Lake*-strategy and thus excludes the two strategies of *Doing Nothing* and *Plan de Venen*. Both strategies involve a slow transformation from agriculture into lake or wetland area. A new study group was appointed to develop a strategy for the period after 2012 to be decided on in the summer of 2008. Recently, a research committee (Committee Remkes) was appointed to investigate the accuracy and completeness of earlier studies performed in the area. The committee argued that most of the studies and models were insufficient and lack independent expertise to secure the quality of these studies (Remkes *et al.*, 2007). The committee emphasized that the polder is not sustainable and creates undesirable side effects in the region, both economically and ecologically and if climate change requires large scale water storage, then the polder is a prime candidate.

In summary, this historical reconstruction shows how the water management regime in Amstelland has attempted to anticipate the Water policy for the 21st century in order to prepare for climate change. It shows the complexity of the current phase of transition

Table 6.1 Six strategies for Polder Groot-Mijdrecht (www.grootmijdrechtnoord.nl).

Strategy	Measures	Duration until
Doing Nothing	-Quit execution of Plan de Venen -No further lowering of water level	-
Plan de Venen	-Eastern part: nature park -Western part: agriculture until 2012 -Fixation of water level -Water treatment in some parts	2025
Technical measures	-Same as Plan de Venen -Additional circulation of inundation -Additional water treatment	2025
Growing Along	-Slow transformation of land- use -Raising water level by 2.5m in 2050	2050
Land raising	-New land-use -Nature park -Raising of land by 2.5m in 2050 -Raising of water level 2.5m in 2050	2040
Multi-functional lake	-Creation of a lake -Living next to the water -Nature park -Water recreation -Raising of water level by 2.5m in 2025	2025

and also the gap between the abstract ambitions and the complex reality of implementation. In the next section we analyze and reflect on the main changes in the Amstelland regime and the interactions of the niche and the regime.

6.5 Reflection

6.5.1. Changes in the Amstelland regime

In chapter four we distinguished between three kinds of regime structures (i.e. culture, institutions and infrastructure). If we take these three types as a starting point, we may argue that the main changes have occurred in the cultural and the institutional elements of structure (table 6.2). With regard to the cultural elements, we have seen how the knowledge base and the discourse have changed as a result of the reframing. The knowledge base changed primarily with regard to the regional effects of climate change. In addition, it made the consequences clear of WB21 and the conflicts with existing spatial planning policies. A crucial change in the discourse has been the recognition that in some cases the current water policy and regional development policy were not sufficient to solve the problem. With regard to the transformation areas, new policies were needed, which required a new approach, like initiating bottom-up processes and mobilizing the residents in the area.

With regard to the institutional elements of structure, the most significant and visible change was the regional water agreement and the action programme, which also increased the collaboration between the water management authorities and the spatial planning authorities (i.e. the provincial governments). The role of the provincial government as well as the water board changed and has become more pro-active. Another visible effect has been the readjustment of the policy to transform the polder Groot Mijdrecht after the re-evaluation process in 2004.

In the infrastructure, the most significant change has been the safeguard zone along the river Lek in the south. The search areas for water storage had been initially safeguarded from further spatial developments; however, additional research indicated that the water-related problems in the area did not require a fundamental land use transformation. Only in the polder Groot Mijdrecht this still remains an option, although the actual transformation is not yet taking place.

Hence, the most significant changes in the Amstelland regime have taken place in the knowledge base and in the discourse. Institutionally, an interdisciplinary network has been formed, in which the water managers and the spatial planners cooperate. In addition, the practice of water management has changed with regard to transformation

measures. The actual changes in the infrastructure have not yet taken place and reflect the inertia and the difficulties in the implementation.

Foremost, the policy niche has been important in translating the abstract principles of WB21 into a new policy perspective and strategy and as such it provided an important learning experience for the Amstelland water management regime. The ultimate consequence of the WB21 policy is indeed that areas are transformed into water retention areas and it was not clear in advance whether this was necessary in the region, and if so, how to implement such large interventions. This historical reconstruction shows the struggle of implementing WB21 at the regional and local level. Although the WB21 is coherent on an abstract level, when it is translated to lower levels, it becomes clear that reality is much more complex. An important aspect of this complexity was the multitude of spatial development plans in the region. These plans are politically validated and cannot be simply changed. The complexity was also a result of the diversity of authorities that were involved in the process. Each actor had a different interpretation of the problem and each actor had a different stake, strategy and internal procedures. In addition there was also much resistance of the local residents. These conditions make implementation of the WB21 a complicated and slow process.

Table 6.2 Effects of the river basin plan.

Cultural elements
- Knowledge base: the regional effects of climate change
- Knowledge base the conflicts between the water management polices and the spatial plans
- Discourse: solutions require large transformation
Institutional elements
- A regional water agreement (water action programme).
- Increased collaboration between actors and creating policy together
- A more pro-active role for Provincial government
- A more proactive role for the water boards
- Participation in local processes
- Policy: a re-adjustment of the transformation process in Groot Mijdrecht.
Infrastructure
- A safeguard zone along the river

6.5.2 Insights in niche-regime dynamics

Reflecting on this historical reconstruction, it has improved our understanding of the patterns of the niche-regime dynamics. We have distinguished five different phases in the niche-regime dynamics, which are summarized in table 6.3. Each phase has its own kind of dynamics and its own type of strategy that can influence the dynamics. We identified two different phases in the formation of the niche. During the first phase, the

structural component of the niche was formed. This formation of the niche-structure was primarily the result of the WB21. It was therefore more or less beyond the influence of the Amstelland-regime, so we have not identified strategies during this phase. The second phase was concerned with the formation of the niche-group, which was dominated by the selection of participants. In principle, this phase can be influenced by changing selection procedures and the selection criteria. The third phase was dominated by a process of understanding the problems and developing the solutions. This phase can be influenced by strategies to stimulate reframing, like brainstorming and confronting the participants with different perspectives. During the fourth phase, the dynamics were dominated by the interaction between the niche group and the regional politicians. This phase had its own political rules, however, it can be partially influenced by a strategic presentation of the plans developed. During the fifth phase, the developed plans were being adopted in the policy processes of the various organizations. Strategies to factually underpin the plans increase the probability of adoption and it is important to find

Table 6.3 Overview of phases and strategies in the Amstelland river basin plan project.

Phase	What happens?	Strategies
1. Formation of niche-structure	WB21 creates structure for a developing river basin plan in a multi-actor setting -WB21 appoints Provincial government as coordinator -Climate change and water as a guiding principle as two starting points	
2. Formation of the niche-group	-Selection of project team members and wider platform	-Selection on the basis of competences and roles
3. Reframing	-Long-term climate change led to understanding that problems were persistent	-Organize brainstorm sessions -Discussion between people with different background
	-Water expert and spatial planners learned how the other think	-Confront different policy fields Long term perspective
	-Measures for the transformation require different competences	-Translating the implications of to concrete strategies and measures -Develop different portfolios
4. Passing the Council	-Politicians approve or reject the plan.	-End-product should be strategically presented, with the appropriate status and detail.
5. Influencing policy	-The developed policy perspective is adopted in existing policies -Policy perspective influences each organization in a different way. -Local projects are set up.	-Factual underpinning of the policy plans -Secure continuation of strategy by network continuation and incorporation into other policy reports -Involve residents in the process.

the windows of opportunity and so timing is crucial. In addition, during this phase the niche dissolved, however, some of the participants continued having contact on a regular basis and were involved in the execution of projects defined in the action program.

A second insight based on this historical reconstruction is that both the niche-structure and the niche-group are of influence to how the shadow process takes place and how the new policy perspective influences the regime. We have been able to identify both the structure component and the agency component of this policy niche. The most important development with regard to the formation of the structural component has been the formulation and implementation of WB21. This policy created a new institutional structure by obliging the regional authorities to develop a river basin plan in a multi-actor setting. The agency-component was reflected in the way the project leader had selected the participants in the core team. On the one hand, the WB21 created the opportunity for re-evaluating the river basin and as such it determined more or less the assignment. On the other hand, the actual problem perception and the development of the measures were the result of the confrontation between different perspectives, knowledge and creativity and thus reflect the agency-component. In this case, the new structure allowed for sufficient degrees of freedom, which gave the niche-group the opportunity to shape its own process. The structure-component and the agency-component are also important in how the niche influences the regime. The formal status of the river basin plan made it easier to influence the relevant authorities and to find support. The agency side is reflected in the way the plans were presented and communicated.

A third insight with regard to this pattern of niche–regime interaction is that this policy niche has had a different influence on each participating organization The reason for this was that each organization had its own strategy, internal schedule and planning procedures. The developed river basin plan was a co-production of different authorities, but the plan did not always match with the strategy of the individual organizations. A second reason may be that some of the participants have better developed the competences to create enthusiasm and support in their own organization.

A fourth insight is that this pattern of niche-regime interaction has been actively 'managed'. The process was not managed in terms of full control, but in terms of smart strategies to influence the various aspects of niche-regime dynamics. We have identified the most important management strategies, which are listed in table 6.4. During each phase different strategies have been employed. Five aspects of the niche-regime management can be identified:

1. *Selection of participants:* the shadow process can be influenced by selecting participants that form the niche-group.

2. *Stimulate reframing:* Develop strategies to stimulate reframing during the shadow process by brainstorming and formulating starting points to approach the problem from a different angle.
3. *Communication:* Develop strategies as to how to communicate the developed perspective to politicians and regime actors.
4. *Distance to policy:* It is important to manage the distance between the policy niche and the regime. Managing this distance requires manoeuvring between keeping in touch with the colleagues and superiors, informing them and asking feedback, and simultaneously protecting the freedom with regard to the content.
5. *Timing*: Each organization has its own procedures and internal dynamics. It is important to help the participants find the right windows of opportunity and to develop strategies as to how to present the new perspective to these home-organizations.

Reflecting on this from a transition management perspective, we see that a number of these strategies is also part of the transition management approach (TM). The selection of the niche-group, for instance, which was based on competences, resembles the selection of members of the transition arena. Compared to the selection criteria of TM, this niche-group did not involve so-called 'frontrunners with innovative ideas', but consisted of experts. In addition, the selection criteria of TM prescribe a wider variety in backgrounds. Therefore, this niche-group was not a transition arena as described in the literature, but it has some characteristics. TM also focuses on reframing. One of the strategies to stimulate reframing is to approach the region (or a sector) as a system and to adopt a long term perspective. By identifying the long term trends that threaten the system and the innovations that provide new opportunities, reframing is stimulated (Loorbach, 2007). In addition, reframing is stimulated by asking the arena what they think is a sustainable and more desirable system.

We may argue that transition management attempts to develop governance principles to improve the various aspects of the niche-regime dynamics. One of the important ideas of TM is that the transition arena operates next to the normal policy arena. Managing this distance is done in two ways: first by developing institutional space to set up a transition arena and to carry out innovative experiments; secondly, by developing an expanding multi-actor network and by influencing financial allocation. Some of these strategies have occurred more or less spontaneously during this niche–regime pattern and an improved understanding of how these interactions work may therefore help to improve transition management.

6.6 Concluding remarks

This case study illustrates the subtle interconnection of policy niche and the regime in the pattern of endogenous niche-absorption. We have analyzed this pattern of niche-regime dynamics by applying the double-loop concept. Based on the historical reconstruction, we have been able to identify two phases in the formation of a niche. During the first phase, the structural component of the niche is being formed and during the second phase the niche-group is being formed. Based on this analysis, we may conclude that the formation of a niche is the result of a change in the regime structure and the deliberate selection of the participants. With regard to management, both the niche-structure as well as the niche-group, can be influenced to stimulate the process into a certain direction. An important implication of this is that the emergence of niches may be stimulated and partially shaped, for instance, by formulating new national policies.

The reframing during the shadow process is influenced by the niche-structure and the selection of the niche-group. The creation of a policy niche provides a learning opportunity for a regime. In this case study, an important function of the policy niche has been the translation of the abstract principles of WB21 into a policy perspective, which was essential to understand how to adapt to climate change and what it means to have water as a guiding principle in spatial planning.

An important aspect of this pattern of niche-regime dynamics was that the niche operates at a certain distance from the regime to stimulate the reframing. On the other hand, this distance should not be too large. The new policy perspective should be adopted by the organizations, which have not gone through the reframing process. Hence, an important part of managing niche-regime interaction is to develop a strategy how to present the developed policy perspective to the organizations. In our view, transition management has tools and instruments to facilitate this kind of niche-regime dynamics.

This case study illustrated the difficulties of implementing WB21. There is still a gap between the ambition of the new policy and the actual implementation. On an abstract level the new policy is coherent, but in practice there are still numerous barriers. The ultimate consequence of the WB21 is the designation of the search areas for water storage. However, the new policy measures have been down tuned quickly because of the political tensions, existing policies and local protests. If the water conditions are truly guiding in the spatial planning of the region, large interventions would be necessary in order to change the land-use patterns in these areas. In conclusion, the actual infrastructural changes that are suggested by the WB21 have not yet taken place and at the moment the only serious option of transformation in the region is the polder Groot Mijdrecht. In the next chapter, we will investigate how the transition is manifesting itself in the urban setting, where the room for water retention is even scarcer.

Chapter 7

An analysis of niche-regime dynamics in Rotterdam

7.1 Introduction

This chapter[19] illustrates how the city of Rotterdam in the south-west of the Netherlands is dealing with the ambition of the Water policy for the 21st century (WB21) to enlarge the room for water retention. WB21 proposed that water ought to be a guiding principle in spatial planning, however, in a densely populated area like Rotterdam the space is scarce and so innovative ways of water retention have to be developed.

The urban water infrastructure has a long life span (Hiessl *et al.*, 2001) and there are different points of view with regard to infrastructural investments (Wilsenach, 2006). One point of view is concerned with improving the current urban water system by developing technological innovation that improves functioning of the existing system. Another point of view is that alternatives can be developed that replace the current water management and sanitation systems. A third point of view is that there is a need to experiment with all kinds of alternatives including multi-functional systems. This last point of view is concerned with policy innovation of urban water management by linking water infrastructure to ongoing urban developments.

Currently, the water professionals in Rotterdam go one step further by arguing that urban water management can contribute to the quality of the social environment in the city. They argue that urban water management can contribute to the urban challenge of creating a vital economy and creating a higher diversity of social environments as formulated by the Rotterdam municipality (2007a). A higher quality of the social living environment would attract middle-class and highly educated people and so stimulate the economy[20]. This idea was first presented in a visionary urban design called *Rotterdam Water city 2035*. Although this niche came from outside the water management regime, it had a large influence on the water policy in Rotterdam.

The objective of this case study is twofold. The first objective is to generate insight into this pattern of niche-regime dynamics, thus how the *Rotterdam Water city 2035* - niche emerged and developed the vision and how it influenced the way of thinking about urban water management in Rotterdam. The hypothesis is that the five phases identified in the previous case study are also adequate to describe this pattern of niche-regime interaction. The second objective is to show that this vision did not stand on its own, but was part of a broader change process in the Rotterdam water management regime and that this is one of the reasons why the niche had so much influence. In addition, it signals a new direction in the transition in the Dutch water management sector.

19 This chapter is based on Van der Brugge, R. & De Graaf, R.E. (2009, forthcoming) *Linking Water Policy Innovation and Urban Renewal. Water policy.* Rutger de Graaf works at the Technical University Delft in The Netherlands.

20 The majority of the group of young highly educated persons is leaving the city as soon as they have finished their education.

In section 7.2 we will describe our approach in this case study. In section 7.3 we will give a short overview of urban water management in Rotterdam and water-related problems. In section 7.4 we will present a short historical overview of the changes in the Rotterdam water management regime over the past 15 years. In section 7.5 we will analyze the pattern of the niche-regime dynamics during the last three years. In section 7.6 we will reflect on this pattern. In section 7.7 the main conclusions will be formulated.

7.2 Method

The method in this case study consisted of three steps. First we have defined the 'Rotterdam system' by describing the regional characteristics, the water system in Rotterdam and the relevant actors. In the second step we have made a reconstruction of the history of the water management regime in Rotterdam in order to understand the changes that are going on in the Rotterdam water management regime. In the third step we analyzed the pattern of niche-regime dynamics by applying the five phases of niche-regime dynamics as identified by the Amstelland case study: a) the formation of the niche-structure; b) the formation of the niche-group; c) the reframing during the shadow process; d) finding political support; and e) influencing policy. We analyzed the dynamics and the management strategies during each of these phases.

To this end, we analyzed relevant policy documents, internet resources and project plans, participated in two field trips and an interdisciplinary design workshop and carried out 16 oral interviews with key-individuals. These interviewees were affiliated with water boards, social housing corporations, consultancy firms or several departments of the municipality at middle or senior level positions (executives, project leaders, or senior advisors). The majority of the interviewed persons participated in the *Rotterdam Water city 2035* project. The others were indirectly related to the project and were identified through policy documents and peer recommendations.

7.3 The Rotterdam water management system

In this section we will characterize the Rotterdam water management system. Rotterdam is the second largest city of the Netherlands and has the largest harbor in Europe. The city has almost 680,000 inhabitants and is situated in the South-west of Holland, in the province of South Holland (fig 7.1). The river New Meuse (in Dutch: Nieuwe Maas) in the Rhine and Meuse delta runs through the city, dividing it into a northern and a southern part. During the past decades the harbour has been reallocated out of the city toward the West, but many of the old docks are still present in the inner city; for these docks

Figure 7.1 The city of Rotterdam is located in the South-west of The Netherlands

new functions will be created (see also fig 7.2.) The city of Rotterdam is subdivided into 17 political districts.

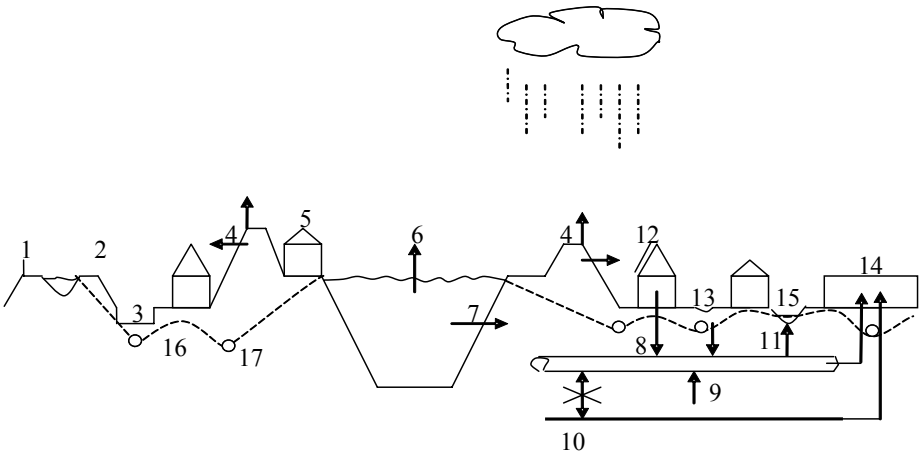
7.3.1 Urban water system

The urban surface water system of Rotterdam can be subdivided into three parts: the river bed, the polder water system and the regional canal system (fig 7.2). In figure 7.3, we have developed a schematic overview of the Rotterdam water system. The riverbed area itself is not protected by dikes; instead, flood control is achieved by artificial land filling, in some cases up to 5 meters above sea level. The average tidal movement of the river near the centre of Rotterdam is -0.25 to +1.15 m. The winter dikes near the city centre are on average +5.5 m above the mean sea level. The most important economic functions in this area are industry and port activities. The second part is the polder water system in

areas lying 1 or 2 meters below the mean sea level. These polders are protected by dikes and the surface water levels are artificially managed at fixed targets. In the southern part of Rotterdam, pumps transport water from the polder areas directly into the river. In the northern part the water is transported to the river via canals. The third part is the regional canal system, which consists of a series of canals that function as drainage medium for the polders. During dry spells, the water flow can be reversed. The river can then supply water to the regional canals and subsequently to the polder systems in order to maintain water quality and to compensate for evaporation. The water levels of the main canals are higher than the polder level.

The main sewage system is a combined system which transports urban run-off and waste water in single pipelines to the waste water treatment plants (WWTP). These pipelines do not have sufficient capacity to transport rainwater during intensive precipitation and as a result there are combined sewer overflows (CSOs) into surface water approximately three times a year. Due to the CSOs and stagnant water, urban surface water quality is poor. In newly developed urban areas and urban renewal areas, sewer systems are constructed to transport precipitation run-off to the urban surface water system and transport waste water separately to the treatment plant. However, due to transportation of the first run-off flush after a dry period, 70% of the annual run-off volume is still transported to the WTTP.

Figure 7.2 The Rotterdam water system. The river Meuse with the old city harbors separates the northern and southern polder systems. The thick line separates the riverbed area from the polders (Source: Municipality Rotterdam (2007b).



1. Pump
2. Sluice
3. Temporal Water square
4. Dike reinforcement
5. Building in Floodplain (land outside the dike)
6. River level
7. Saline water intrusion
8. Sewage capacity
9. Groundwater leakage
10. Disconnecting rain and sewage
11. Sewerage overflow
12. Green/water roof
13. Bio-retention system (wadi)
14. Purification plant capacity
15. Polder Canal
16. Ground water table
17. Subsurface drainage pipes

Figure 7.3 Schematization of the Rotterdam Urban Water system. The temporal water squares (3) and the green/water roofs (12) are innovations which are currently being studied.

7.3.2 Water problems

In general, many researchers consider contemporary urban water management unsustainable (e.g. Larsen and Gujer, 1996, Butler and Parkinson, 35, Zeeman and Lettinga, 1999, Ashley et al., 2003). The main reasons why current water systems are regarded unsustainable are: (1) waste water is mixed with cleaner urban run-off and groundwater; (2) nutrients are not recovered, causing accumulation of nutrients (eutrophication) and of synthetic chemicals; (3) the current water infrastructure is expensive; and (4) they are vulnerable to climate change (De Graaf *et al.*, 2007).

These problems are also present the Rotterdam water system. In addition, Rotterdam has some specific water-related problems. First of all, the water quality of urban surface

waters is poor because rain storms lead to sewer overflows, because the sewerage is a combined system for precipitation and waste water. Stagnant surface water reduces the ability for self-purification in the city canals. Secondly, the amount of surface water is limited and there is also limited room for water storage in the case of heavy precipitation. In the city centre only 1% of area is surface water, which is highly fragmented and disconnected. Thirdly, much of the sewer infrastructure was constructed in the postwar reconstruction period of the 1950s and 1960s. Groundwater leakage into these pipes causes a substantial groundwater flow to the WWTP. The exact amount, however, is unknown. If the sewer system is replaced, leakage will be reduced, which will lead to higher groundwater tables and higher probability of flooding.

Climate change is expected to have large consequences on the water system of Rotterdam (2007b). First of all, a rise of the sea level will lead to a higher level of the river and threatens the flood safety. In addition, the salt water intrusion complicates the intake of fresh water into the regional water system during droughts. Secondly, high intensity rainfall can lead to more frequent flooding because the sewer system and the surface water system have a limited capacity. Finally, climate change is expected to lead to dryer summer periods, with low river discharge, low precipitation, and high evaporation and thus longer and more severe droughts. Overall, the access and use of Rotterdam water resources will be affected by climate change in a number of ways. These expectations are the incentive to increase the water retention capacity in both the regional and the urban water system. Increasing this capacity could be effected by increasing the amount of surface water and allowing water fluctuation, rather than focusing on target levels. The increased storage capacity is a buffer for high intensity rainfall and during droughts.

7.3.3 Water governance system

The main actors in urban water management in Rotterdam are the district water boards and the Rotterdam municipality. The Rotterdam territory is divided into separate districts managed by a different water board; water board 'Hollandse Delta' in the South, water board 'Schieland & Krimpenerwaardi in the North east and water boards Delfland is responsible for a small part of the Rotterdam water system in the North-West. These water boards are responsible for water quantity and water quality management. The municipality is responsible for urban planning and in this way responsible for the amount of surface water, the sewer system and groundwater. Two departments are directly involved, the Public Works office and the Urban Design and Planning office. The department of Economic development is indirectly related. Another important actor is the Ministry of Transsport, Public Works and Water management who is responsible for flood protection along the river.

Table 7.1 Relevant actors in urban water management of Rotterdam

Actors	Abbr	Responsibility in Rotterdam	Activities
1. District water boards --Hollandse Delta -Schieland and Krimpenerwaard -Delfland	WS WSHD WSK WSD	- Water quantity management of main canal system and polder system - Water quality management including wastewater treatment - Flood protection	- Drawing up policy plans - Executing water assessments - Operation and maintenance of flood defense infrastructure and wwtp's
2. Municipality of Rotterdam	GR	- Urban planning	- Developing legally binding urban development plans
- Municipality of Rotterdam, department of Public Works	GW	- Sewer system - Public space - Urban infrastructure - Groundwater management (limited)	-Drawing up municipal sewer plan - Drawing up Waterplan Rotterdam - Operation and maintenance of sewer system and other infrastructure and public space - Collecting and transporting excess groundwater from allotment boundary
-Municipality of Rotterdam, department of Urban design and Planning	DS+V	- Spatial planning - Housing - Urban functions	- Designing and planning urban renewal projects and new urban areas - Drawing up spatial plans
-Municipality of Rotterdam, department of Economical development	OBR	- Project development - Economical development - Real estate management and development	- Developing new urban areas and urban renewal projects
3. Ministry of Transport, Public Works and Water Management	RWS	- Flood protection and water management of main river system - Supervision on implementation of European Water Framework Directive (EWFD)	Drawing up national water policy and legislation

7.4. The changes in water management in Rotterdam

The transition in Dutch water management as described in chapter five is also manifesting itself in Rotterdam. In this section we present a historical overview of urban water management in Rotterdam and the major turns in thinking that have occurred.

7.4.1 The first urban water plan

Traditionally, water boards focused on the rural area, however, in 1989, the 3rd National Memorandum on water management proclaimed that the responsibility for urban surface water management should be transferred from the municipality to the water boards and so the focus shifted to urban surface water. In Rotterdam, the first transfer attempt was made in 1996, though it failed due to a conflict over the price of the assets that were transferred, but succeeded the second time in 2001. However, in 1999

the municipality had developed the first water management plan (WP1) and already consulted the water boards. Before that, urban surface water management had received little political attention.

There were two reasons for developing the water plan: (1) the upcoming transfer of responsibilities for urban surface water management; and (2) the 40-year-old sewer system had to be replaced and renewed. During the preparation the municipality and the water boards carried out a full-scale inventory of the water system as the municipality did not have adequate knowledge of all channels under its jurisdiction. WP1 focused on water quality problems, addressing overdue dredging, sewer overflows and fish mortality. Based on these problems, strategies were formulated to improve water quality, remove polluted bottom-sediments, create ecological embankments and implement active biological management of fish populations. For example, in the *Bergse Plassen* the water quality improved significantly, in the *Zuiderpark* innovative technologies for dealing with excess water from rainstorms (bio-retention) were developed and ecological embankments and 14 hectares of additional water retention were created. In the northern part of Rotterdam, the old channels were significantly improved and sewer emissions into the river were successfully reduced. WP1 formulated for the first time future ambitions for the water system (i.e. green zone, the blue zone, red zone) in terms of water quality and ecological quality. The starting point was the improvement of the existing infrastructure, hydraulic functioning and water quality.

At the end of the 1990s, it became clear that the current water infrastructure was not sufficient. Pluvial flooding in 1998 in Western Holland - the Rotterdam districts included – triggered questions in parliament about the performance of the Dutch water system with respect to climate change. This led to the appointment of the committee-*Tielrooij* which argued that the limited water retention capacity was the main problem (Tielrooy-committee, 2000). In July 2003, the water management authorities signed the so-called National Water Treaty, which stated: *"In the nature and scope of the water issue, there appears to be a structural change happening. Climate change, sea level rise, soil subsidence and urbanization require a new approach to water-related problems".* The treaty is a formal declaration of intent to support WB21 and further specifies the objectives and the responsibilities of the individual authorities. For Rotterdam, this amounted to 600,000 m^3 of extra water retention capacity before 2015 and 900,000 m^3 in 2050. This amount of extra surface water could not be realized within the current infrastructure.

7.4.2 A new vision: Rotterdam Water city 2035

The envisioning project *Rotterdam Water city 2035* (in Dutch: Rotterdam Waterstad 2035) marked the first step towards a more adaptive and water sensitive urban design approach. This vision has had a significant effect on the course of urban water manage-

ment in Rotterdam. The *Rotterdam Water city 2035*- vision was developed by the Urban Design and Planning office, the Public Works office, two district water boards and the Municipal Development office. During this project a future vision on urban design was combined with a climate adaptation strategy in which the opportunities for water retention served urban development. The inducement for this envisioning project was the 2nd International Architecture Biennale Rotterdam (IABR). The IABR is a prestigious two-year architecture and design event. The 2005 theme was "The Flood". The assignment was to design and develop a scale model of Rotterdam city in 2035.

The *Rotterdam Water city 2035* design argues that surface water in the city can contribute to the urban challenge by creating a high diversity of social environments and by attracting better educated residents, thus contributing to the gentrification of degraded neighbourhoods. In addition, the water could improve the connection of the city with the surrounding areas and could contribute to an attractive city centre. This new vision was reflected in the following quote in the final report: *"The water challenge is the urban map of opportunities". The result is that not only the water challenge will be solved but that new qualities will be incorporated into the city too".* The actual urban design encompasses three images: *River city* in the city centre, *Water network city* in the South and *Canal city* in the North (figure 7.4). In River city, the river bed is transformed from an old port region to a vivid place with all kinds of economic initiatives combined with nature preservation areas and floating houses. There is an adaptive strategy: the possibilities to strengthen dikes must be safeguarded in the future, but will be built in accordance with the actual sea level rise. In Water network city, the southern part is transformed into an attractive living environment, rich in water and nature, attracting a diverse range of people. This part has relatively small variations in water levels, so water ways can be connected to an intricate water network and to the surroundings, contributing to the urban challenge as well as the water challenge. The Canal city design aims to improve and enlarge the existing water infrastructure of canals and polder outlets and exciting infrastructural innovations; squares are transformed into water retention squares to store excess water during periods of heavy rainfall; buildings with flat roofs have green sedum roofs which can be used for water retention and for capturing dust particles to improve air quality.

At the final symposium of the architecture biennale, The *Rotterdam Water city 2035* design was awarded the first prize and received much political and public attention from Provincial and local governments, water boards, and the Ministry of Public Works, Transport and Water management. Within the municipal council it led to the *Kuyper*-resolution, which proposed to develop a feasible programme based on the design and time strategy.

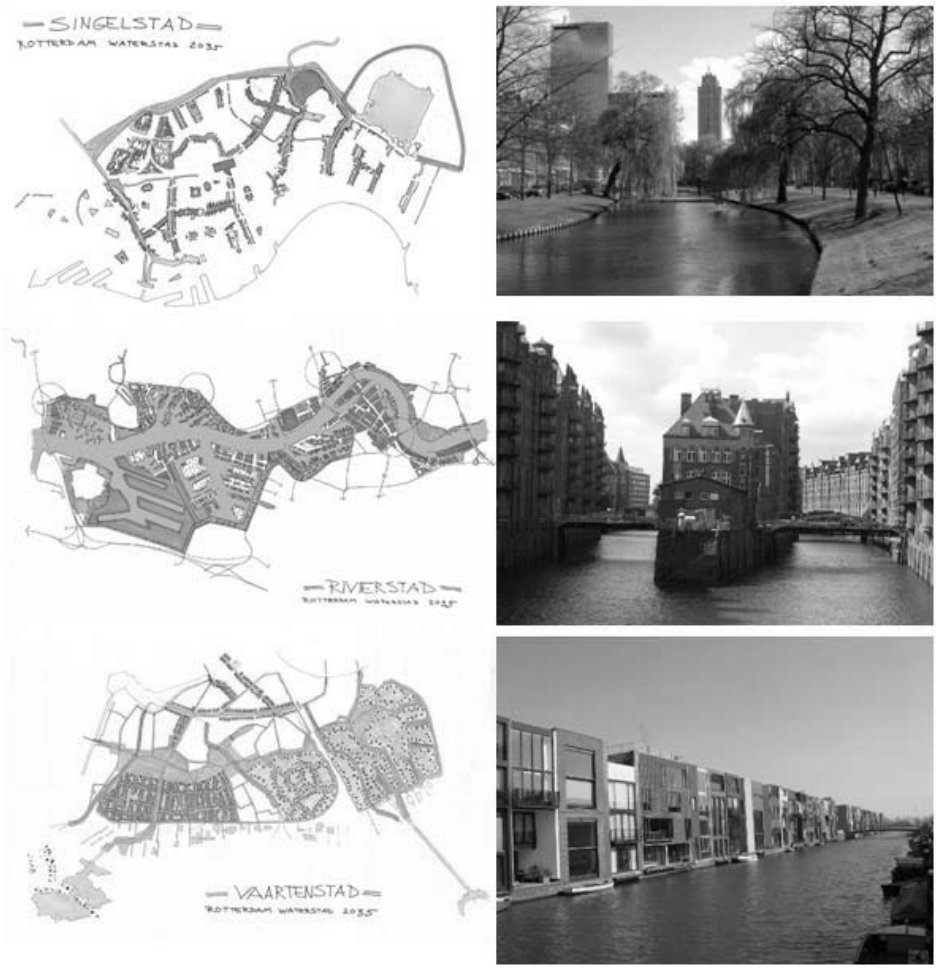


Figure 7.4 Future visions and reference images of Rotterdam Watercity 2035 for the northern part (top) river (middle) and the southern part. Source: (De Greef *et al.*, 2005).

7.4.3 The second urban water plan

The 2nd urban water plan (WP2) was developed in 2006/2007 and is more or less the response to the *Kuyper*-resolution. WP2 focused on water quantity and is a co-production of the three municipal departments (municipal works, design & urban planning and economic development) and the three water boards. As such it continued the cooperation which emerged during *Rotterdam Water city 2035,* adhering to the same philosophy. The WP2 (2007b) preface makes this clear: *"Water management and urban development are inherently linked. If we want to solve the water challenge, then we need to fit this in with urban design and city planning. In turn, the water challenge can give an enormous impulse to urban design and planning. A well-known example of this synergy is the Rotterdam*

Water city 2035". The main policy measures formulated in the 2nd Urban Water plan are (2007b):

- To create 600,000 m3 of additional water retention capacity to prevent pluvial flooding
- To apply risk based measures in order to secure flood safety of the riverbed area and polder area
- To accelerate sewer system renewal from 14 kilometers per year to 40 kilometers per year in 2010)
- To introduce flexible surface water levels against dry spells
- To develop water quality and measures to comply with the European Water Framework Directive

The historical reconstruction indicates that in less than ten years' time the urban water managers made a huge turn in thinking about urban water management. In figure 7.5 we represent this as a cascade of several turns in thinking, each turn triggering the next one. The cascade was triggered by the transfer of the responsibilities over urban surface water. This led to an inventory of the urban water system and the urban water plan. The second turn in thinking was due the acknowledgment that there are many conflicting stakes in the city. As a result, the water managers learned to link up with ongoing spatial development plans in order to achieve their own objectives. During the *Rotterdam Water*

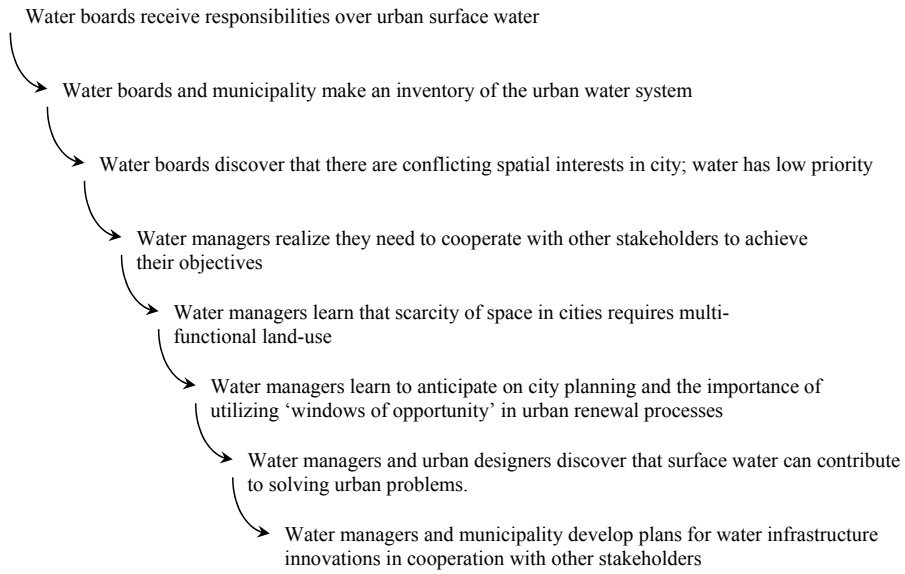


Figure 7.5 The urban water management cascade indicates the shifts in thinking towards a new approach in urban water management.

city 2035 - project another significant turn was made by learning that water can also add quality to the public amenity and can in this way contribute to the urban challenge. Hence, urban water management was not only about managing the water system and solving water problems, but it became an important pillar underlying urban development. It also became clear that additional water storage capacity in urban environments was not always possible without innovative solutions combining multiple city functions at one location. This triggered new ideas about new water infrastructure, such as green roofs and water retention squares, which are used as temporary water storage facilities in case of peak precipitation. One of the interviewees summarized the cascade in the following way: *"In the old approach we said: 'give us square meters and we will dig a water canal in a cost-effective way. In the new approach we are saying: 'we are open to water infrastructure innovations, such as water retention squares and green roofs'".*

The last three turns in thinking of the urban water cascade were made during the *Rotterdam Water city 2035* project. These turns in thinking were the result of changing regime on the one hand and the envisioning process that shaped and formulated a joint direction. In the next section we will focus on the last three steps in the urban water cascade and how the components of the innovative envisioning project were successfully adopted.

7.5 Niche-regime dynamics

In order to understand this pattern of niche-regime dynamics, we have analyzed the dynamics in more detail by applying the double-loop concept (fig 7.6). The inner loop represents the Rotterdam water management regime and the outer loop represents the shadow track during which the Rotterdam Water City 2035 has been developed. The analysis is structured according to the five phases of the niche-regime dynamics. We analyzed what happened during each phase and what kinds of strategies have been employed.

7.5 1 Phase 1: The formation of niche-structure

The first phase in this pattern of niche-regime interaction is concerned with the formation of the niche-structure. Arguably, the crucial event in forming the niche-structure has been the Architecture Biennale. The biennale created a platform for participants to design and develop a scale model of the city and to re-think urban development and the opportunities for water management. The theme of the contest was "The Flood" because of the growing attention for climate change and water retention in urban areas. In this way, the biennale temporarily created a new institutional structure.

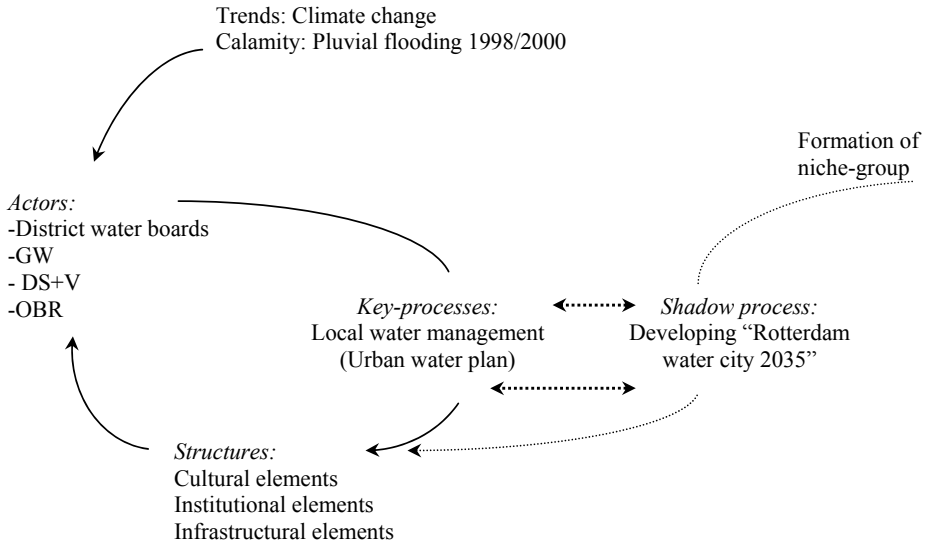


Figure 7.6 The double-loop diagram applied to the Rotterdam case study. The inner loop represents the regime and the outer loop represents the shadow process of the niche. In this pattern of niche-regime dynamics, the niche was formed outside the water management regime.

Another development that co-shaped the structure has been the assessment of the so-called water challenge. The water challenge translated the effects of climate change into the amount of extra room needed for water retention. In Rotterdam, the water challenge came down to the need for creating an additional 600,000 m^3 water storage before 2015 which could not be realized within the current water system. It thus required the cooperation between the water managers and the urban planners to re-think the urban water system with regard to a long-term urban climate adaptation strategy.

7.5.2 Phase 2: Niche creation; selection of participants

The next phase of the niche-formation was concerned with the formation of a team. Formally, *Rotterdam Water City 2035* was a project of the Urban Design and Planning office and the Public Works office. The niche-group, which consisted of a project leader, the participants and the moderators, was formed by a strict selection procedure and official job interviews. In addition, the selected project leader demanded a joint effort of the water management department, the department of economic development and the water boards in order to secure an integrated approach. Together with the department director, 15 project members were selected from various backgrounds: six designers, five water management experts, one member from the economic management department and three external members from the water boards. The different backgrounds of the members were expected to stimulate the cross-pollination of ideas. The selection of the moderator

was based on written acquisition proposals. Of the two selected moderators - or masters - one was a landscape architect and the other had a water engineering background.

The strict selection procedure raised the expectations. One of the interviewees said: *"It was a smart tactical move […] If you had been selected for the master case you were seen as one of the best […] During the project kick-off, the team was proud to have been chosen. But then you have to show your worth".* Hence, an atmosphere had been created of an prestigious project which motivated the participants. Three private companies were assigned to carry out three studies in advance to update the designers with regard to the water system and the engineers with regard to design and planning (box 1). One of the interviewees argued that *"participating in such a contest is a smart thing to do. If the project succeeds it can be used as policy, if it fails, it was just a nice project".*

Box 1 Studies carried out in advance of the Rotterdam water city 2035 project.

1. Water, History and Culture

Rotterdam city is a water city. Its history and identity is intertwined with the water and the development of the port. Rotterdam owes everything to the water.

2. Water and facts

Facts and figures about the Rotterdam water system. The report makes a distinction between the main water system, the regional water system and the urban water system.

3. Experience & Enjoy

This study presents five ideas, emphasising a different attitude towards water: not as threatening, but as providing opportunities:

Living levy: A city wall of 12 meters high in the city centre along the rivers. In the riverbed, urban districts are built that are flexible to the tidal movement.

Water living environments: Floating houses, locations for houseboats, city castles in the river, lagoons with houses on stilts

Water transportation network: Using the water system as a public transportation network

Rain feast: Rain as a public amenity (Raingardens, water storage in houses; green roofs, water squares)

Private initiatives along the Meuse: Private initiatives, tourist attractions, small businesses and recreation

7.5.3 Phase 3: Reframing

An important aspect of the double-loop concept is the reframing that occurs during the shadow process. Based on the interviews we identified three kinds of reframing. A

first kind of reframing occurred with regard to the problem perception. Climate change required additional room for water retention, but this room was not available in the city and thus required large infrastructural change. One of the moderator explained in an interview that: "*When you see climate change as a threat then it presents itself as an item of costs in your economic balance. But when you see it as an opportunity to adapt and to improve the city and to make it more attractive for its residents and companies, then it becomes an item of benefit in the economic balance*". Therefore, he stimulated reframing by introducing a climate change scenario with a six-meter sea level rise, which required enormous adaptive changes.

A second kind of reframing that occurred was with regard to the perspective of the water manager and the spatial planner. For instance, one of the water expert interviewees responded that: "*For the designers it was a discovery to see that the river bed is elevated compared to the rest of the city. The water engineer takes this for granted, but this image is not part of the designers' perception of the city*". On the other side, one interview indicated that: "*The water engineers learned what the social problems and challenges of the city are and how water can contribute to solutions*". In this respect, the reframing had a significant effect on the cooperation between water managers and designers. The designers were stimulated to design with water, which was a major shift as one of the interviewees indicated that urban designers considered water as 'one of the seven plagues' for the urban design. One of the designers reflected on this changing role of water in urban design: *"The urban planner is showing increased attention for water in urban design. This was in contrast to earlier experiences when water experts complained that the designers had forgotten about the water in their beautiful design".*

A third kind of reframing was concerned with the solutions and measures. The reframing with regard to the solution was that by creating room for water retention, the water management sector could contribute to a more attractive city for residency and entrepreneurs and could stimulate a high social diversity and strengthen the economy. Hence, more water retention would not only solve the water problems, but would also contribute to solve other urban problems. New solutions were developed as the result of combining the water challenge with the urban challenge. The measures developed focused on linking room for water retention to urban renewal projects. The moderators stimulated to translate the future images to strategies and measures and to develop a "philosophy in time" and to fit them in with the dynamics of urban development. This resulted in two main strategies. Since the harbour activities were removed from the inner city docks to new locations outside the city, there are opportunities for water-related entrepreneurial activities in the old docks. Secondly, urban plans for rebuilding deteriorated neighbourhoods could create opportunities for water retention. The additional water retention in neighbourhoods could upgrade the quality of the neighbourhood and lead to higher

economic returns for project developers. In this way, the shadow process resulted in a new perspective in which the water challenge and the urban challenge were integrated.

7.5.4 Phase 4: Finding support

The next phase in this pattern of niche-regime interaction is concerned with how the niche influences the regime. An important aspect of this is finding support. For internal support, some directors had been invited to visit the participants during the project. One of the interviewees explained that: *"it was clever to invite the directors over to our place, where work was clearly in progress […] and where the floor was littered with coffee cups and the walls covered with unfinished drawings. The directors thought they still had influence […] they felt ownership"* and so the invitation had been crucial in finding the support within the organization. A crucial factor in finding support outside the participating organizations was that the *Rotterdam Water City 2035* design won the Biennale award. The design was published in a book and the relevant politicians, including the directors of the water boards, signed the book as an informal way of approval and political commitment and so it received a lot of attention. An important factor was the way in which the book was written. It did not present a technical water story, but an emotional and cultural story, which was easy to identify with. It emphasized the identity of Rotterdam as port city, which owes its existence and success to the water.

7.5.5 Phase 5: Influencing policy

A new phase in the way the niche influenced the regime was triggered by the Kuyper-resolution, which suggested developing the vision into a plan. The preparation for the 2nd Urban Water Plan started and the line of reasoning, the integrated approach and long-term climate adaptation strategy combined with the urban challenge were adopted from the Rotterdam Water City vision. One of the interviewees explained the reason for this, he argued that: *"A mechanism had been initiated, which had to be continued. The WP1 was a good first inducement. Is there any better way than for the same organizations to elaborate further on WP1 and add the knowledge and inspiration from the Biennale? The water challenge is now so much better understood and so is the direction in which the city wants to go".*

WP2 is official policy and lists all the actions that are to be taken. In addition to the initiation of WP2, two other projects were started as spin-offs of the Water City project. The first is the green roof plan for Rotterdam (2005). The second one is the further technical development of water retention squares. The inter-departmental and inter-organizational network that emerged out of the *Rotterdam water city 2035* was an important condition for the integral development of WP2. It was not a coincidence that the WP2 project leader was also one of the members of the *Water City 2035* project. The

project founded the base for future cooperation and indeed WP2 is a true co-production of all the relevant authorities.

At least three barriers have so far been encountered in the implementation. The high property values are the most important. The social housing corporations together own almost 70% of the property. These properties have to be purchased in order to create additional water retention, which is too expensive. In addition, the corporations are not willing to destroy existing building stock. One the other hand, the corporations do see opportunities for water retention because they assume that water can be used to upgrade the neighbourhood and thus property value. The result is that these corporations determine the pace of revitalizing the neighbourhoods and thus the realization of water storage. Most of them are now directly cooperating with the municipal water management department and the water boards. A second barrier is that in the case of innovative water infrastructure, which combines different urban functions, it is unclear whose task or responsibility it is. For instance, one of the proposed innovations, the water retention square, is a public square and therefore should be the responsibility of the municipality, but since it serves as a water storage facility during heavy rainfall, the water board should be responsible too. It is not yet clear which party should do the maintenance and there is a need for institutional mechanisms to support the realization and maintenance of such multiple-stakeholder water facilities. A third barrier is the high investment costs for the construction of the facility and the risk of exceeding the budget.

7.6 Reflection

Although the Rotterdam Water City 2035 project was not an official policy process, it has influenced urban water policy in Rotterdam significantly. The most significant changes have occurred in the cultural and in the institutional domain. In the cultural domain, the main elements of structure that have changed are the knowledge base and the discourse. First of all, the process not only generated knowledge about climate change and the consequences, but the expertise of the water professionals and the designers has been integrated. The discourse has changed as the result of a collective understanding that creating additional water retention capacity in existing urban areas will only be realized if water management links up with the dynamics of urban renewal. The new discourse suggests that water retention can contribute to an attractive city for residents and companies and thereby contribute to solving other urban problems.

There have been two significant changes in the institutional domain. The main elements of structure that have changed are the responsibilities and the policy. The transfer of responsibilities for urban surface water from municipality to the water boards led to the full-scale inventory and WP1 – the first cooperative product - in 2000, and triggered

cooperation between the water department of the municipality and the water boards. This set the stage for the second change, the cooperation between water managers and urban planners, which emerged during the Rotterdam Water City 2035 project. The inter-organizational network continued to exist after the project was finished, which enabled the cooperation during the development of the official 2nd Urban Water Plan a year later.

In the infrastructural domain, most of the proposed changes are yet to come. However, the first green roof has been opened on the building of the *Municipal Archives*. The 2nd Urban Water plan is now further translated into concrete projects. However, the majority of actions falls under the category of 'further research' to understand specific technical features, locations, budgets and public-private partnerships and the next step is to define infrastructural projects.

Table 7.2 gives an overview of the five phases of the niche-regime dynamic. Like in the Amstelland case, there have been two phases in the formation of the niche. During the first phase, we observed the creation of the niche-structure, which in this case was created by an architecture design contest. The contest created a platform to rethink urban water management and to develop 'out of the box' ideas. An important difference with the Amstelland case was that the niche-structure was not created by the water management regime, but the spatial planning regime. However, the niche was co-shaped by the assessment of the water challenge, which required the cooperation between water experts and urban designers. During a second phase of the niche-formation, the niche group is formed. Similar to the Amstelland case, the niche-group was formed through a strict selection procedure.

In the next phase we identified similar types of reframing as in the Amstelland case (i.e. reframing with regard to the problem perception, the perspective and the solutions). In terms of the problem perception, the existing water related problems were linked to long term climate change and as such the problems were seen as more fundamental, but also as bringing new opportunities. With regard to different perspectives, the spatial planners learned about the water system and the water experts learned about the positive role of water management in the social problems of the city. Thirdly, with regard to the solutions, new strategies were developed which were based on the idea of how additional water retention could contribute to solving the urban problems, whereas the initial understanding of the urban water management was to solve water problems and to create additional room for water storage. The role of water is now seen as a means to add quality to the social environment and to contribute to solving urban problems. This is a radical shift in thinking, in which water management is no longer seen as an independent policy field, but as an integral part of city and as such has an important function in improving the city.

Two phases could be identified as to how the niche influenced the regime. The first phase created support and enthusiasm. The design received a lot of public attention,

including from the local politicians. Compared to the Amstelland-case, this phase was different since it was not a political phase. The niche had no formal status, and so the plan did not have to pass the municipal Council of Aldermen. During the second phase, however, there was a direct influence when the design triggered the Kuyper-resolution and was used as input for a new urban water management plan.

In conclusion, this pattern of niche-regime dynamics emerged as a result of an increasing need for cooperation between water managers and spatial planners and the Architecture biennale, which created the opportunity to shape a new direction. In turn, the *Rotterdam Water city 2035* vision reinforced these network relationships by formulating a common goal, which was the basis for the development of the 2nd Urban Water plan. This policy now triggers the opportunities for new niches to emerge, for instance more technologically oriented niches that experiment with green roofs and water retention squares.

In terms of management of the niche-regime dynamic, we have seen similar strategies as in the Amstelland case study, such as the selection of participants (table 7.2). An important difference was the process design. The process design during the Rotterdam Water city 2035 project was called a *master-case*, which was a short and intensive project

Table 7.2 Phases during this pattern of niche-regime dynamics and the management strategies.

Phase	What happens?	Strategies
1. Formation of niche- structure	-Architecture Biennale contest -Water challenge requires cooperation between planners and water experts	Organize a contest
2.Formation of the niche-group	-Selection of project groups members and moderators	-Select on ideas and competences -Select good moderators -Create responsibility and motivation
3. Reframing	-Water problems were linked to climate change -Water perspective and the spatial planning were integrated -Solutions were sought in combining the water challenge and the urban challenge.	-Stimulate discussion between disciplines, -Think in extremes -Develop time strategies. Link to ongoing developments in the city
4. Finding support	Presenting the plan and communication with relevant actors and public.	-Make plan concrete in a scale model -Connect to identity of the region and the emotion of residents
5. Influencing policy	Basis for 2nd Urban water plan Starting-up pilot projects Studies for indentifying right location and feasibility	-Secure continuation of strategy by network continuation -Incorporate ideas into official policy reports -Develop partnerships with organizations which dictate tempo

of approximately two or three days a week for a period of six weeks. The group consisted of 15 participants and two moderators (or masters) that guided and facilitated a certain case. The short duration helped to keep the participants motivated and to keep the energy level high.

Secondly, the case study shows the importance of developing a visual design. The attention that the project generated can be partially explained by the fact that it won the Architecture Biennale award, but also because the vision was translated into a scale model, which enables people to actually see what it means. Such a design should not be understood as a blueprint, but as a visualization exercise in order to make abstract visions more concrete. In the process, it serves as a reference point for further discussion and to inspire and mobilize people.

Thirdly, what this case study also shows it that it is important to develop a philosophy in time, or a transition path. In this project, the idea behind the transition paths was to link the water management measures with the upcoming plans about urban renewal. These projects provide the opportunity for water infrastructural renewal and the creation of room for water retention. Since the housing corporations and other project developers execute these plans, they determine to a large extent the opportunities and the pace of renewal and so it is important to involve them in developing the plans.

7.7 Conclusions

This case study illustrated how urban water management in Rotterdam made several turns in thinking as reflected in the urban water management cascade. We illustrated the role of the Rotterdam Water City 2035 and how it shaped the last three turns in the urban water management cascade. Currently, the 2nd Urban Water Plan continues this perspective by explicitly presenting water as a factor that adds quality to the city and can contribute to the urban challenge.

A first conclusion we draw is that the transition in water management requires a new approach in urbanized areas. There is insufficient room for water retention and therefore there is a need for new kinds of water infrastructure that is able to store water, like the green roofs or the water retention squares. If new water infrastructure serves a number of city functions the investments costs can be shared. In addition, the role of urban water management needs to change and the water management sector should transcend it own sectoral boundaries. This case study shows how water management can add quality to the city and that it can contribute to solving urban problems. This new discourse perceives water as an opportunity to improve the city and represents a new turn in thinking in the water transition.

However, there are also barriers, for instance it is not yet clear whether current co-operation mechanisms, such as public private partnerships, are adequate because the actors should commit themselves for several decades, considering the time scale of water infrastructure. Innovative, multi-functional infrastructure may require additional responsibilities of the existing authorities, or a new kind of authority for operation and maintenance of infrastructure developed by multiple stakeholders.

In addition, housing corporations and project developers need to be involved because they are large property owners. Although the housing corporations are not willing to destroy existing buildings, they expect rising values of the real estates as a result of new water canals in the neighbourhood, especially in the old and deprived neighbourhoods. Therefore, they have an interest in additional water retention in urban renewal projects. Some of these stakeholders are currently involved in follow-up plans in Rotterdam.

A second conclusion that we draw is that this pattern of niche-regime interaction could be described by the same phases as in the Amselland case study. This suggests that these five phases are rather generic phases of niche-regime dynamics and that the underlying double-loop concept captures crucial aspects of the niche-regime dynamics. Every niche is a unique combination of a niche-structure and the actual participants of the niche. The niche-structure may be shared by many niche-groups. In this case the formation of the niche-structure was exogenous, while the niche-group consisted of water experts and spatial planners. The reframing is partly determined by the niche-structure (it determines the direction of thought, so to say) and the interaction between the participants and in this way the niche further shapes the direction of a change. This case study supports the idea that transitions are the result of a continuous interplay between regimes and niches: regime developments create new niches; niches reframe the problems and challenges and discover new directions; the new directions adjust the direction of the regime; and then the cycle starts over again.

Chapter 8

Conclusions and discussion

8.1 Introduction

The overall aim of this dissertation is to generate insight into the dynamics of transitions. In this chapter we will reflect on the main findings and draw the main conclusions.

In chapter one, we have argued that the multi–level concept, the multi-phase concept and the multi-pattern concept are important for understanding and explaining transition dynamics, but that they are not sufficient. We have argued that these concepts address different aspects of a transition, but that they also have their limitations. The multi-level-concept distinguishes between different levels at which developments operate, but it is not a dynamic concept showing how the system moves from one state to the next. In addition, there is an underlying assumption that the regime is rigid and inhibits transformative change. The multi-phase concept distinguishes between different phases of a transition, but in its current form it is too generic and abstract and essentially describes only one pattern of transformative change. This limitation is partly addressed by the multi-pattern concept, which distinguishes between different patterns of transformative change. However, these patterns are still rather generic and abstract. Moreover, these patterns describe how the regime transforms, i.e. through a bottom-up or a top-down dynamics, but they do not describe what is changing, i.e. which kind of regime structure is changing during the process. Therefore we have argued that in order to describe and explain transitions, we should improve our understanding of what is changing and how these changes are realized.

A first contribution of this dissertation is the further development of the multi-pattern concept through a synthesis of the resilience framework and the transition framework, which resulted in a new conceptualization of the phenomenon of transition and the underlying dynamics. A second contribution is the development of an approach for transition analysis. Since the field of transition studies is rather new, there is no existing method to analyze transitions in a structured way and therefore we have attempted to develop such an approach. This approach consists of two parts: a method for regime analysis, and a method for pattern analysis. This generic approach enables the researcher to analyze transitions with regard to the changes in the regime structures and the underlying patterns of transformative change. In the third place, this dissertation contributes to our understanding of transition dynamics. We have applied the developed approach to the transition in Dutch water management in order to test the approach and analyze the dynamics of the transition. We have illustrated how the patterns of transformative change manifest themselves and how they gave rise to the changes in the regime structures. A fourth contribution is the development of the double-loop concept, which improves our understanding of how niches and regimes interact by capturing important aspects of their dynamic interplay.

In this chapter we will reflect on the main research findings. In section 8.2 we will deal with the main findings with regard to transition conceptualization, the multi-pattern concept and the double-loop concept and how they increase our understanding of transition dynamics. In section 8.3 we will focus on the approach developed for a transition analysis. In section 8.4 we will summarize the main findings with regard to the transition in Dutch water management and reflect on what we have learned with regard to transition dynamics. In section 8.5 we will reflect on the future of this transition. Section 8.6 we will reflect on how this dissertation may contribute to transition management. In section 8.7 we will summarize the main commonalities and differences between the resilience framework and the transition framework. In section 8.8 we will draw the main conclusions that follow from this research and in section 8.9 we will discuss to what extent they might be generalized. In section 8.10 we will suggest recommendations for future research.

8.2 Transitions and the multi-pattern concept

8.2.1 The phenomenon of transition

In this dissertation, we first addressed a more fundamental question about the nature of the phenomenon of transition. What do we mean by transitions and how can we distinguish between normal change and transitional change? The answer to that question is trivial. Transitions are associated with fundamental change in the structure of society, but what is deemed fundamental change is always subjective. At the heart of that subjectivity is the normative system demarcation and an evaluation of whether the perceived change is large enough to be classified as transition. This evaluation is not objective, but presumably based on earlier case examples of recorded transitions and so the definitions and demarcations of transitions that are currently used are to a large extent socially constructed.

Knowing that there is no way around this, we looked for clues in system theory to somehow – albeit on a conceptual level – distinguish between normal change and more fundamental change. Systems theory, and especially the resilience framework provides a way of understanding the nature of fundamental change. Theoretically, the difference between normal change and transitional change is respectively system changes within the basin of attraction, thus within the same regime structure, or system changes from one basin of attraction to another, accompanied by a change in the structure of the regime. The question then is: what are basins of attraction in societal systems, and how do they manifest themselves? And even more fundamental: what is a social structure and can we describe it?

In the resilience theory, the structure of an ecosystem is defined by the populations and their interactions and the basin of attraction is defined by the limits of when these interactions fall apart. A new structure, or dynamic regime, corresponds to a large shift in population numbers or even a new set of species. Analogue to this, we asked ourselves: what defines the structure of a societal system? The notion of social structure is heavily debated and in different social science disciplines the word is used differently. Sewell (1992) argues that although the word structure is often used, there is actually a lack of theorizing about what 'structures' are. Giddens (1984) argues that they are often virtual and only exist in the 'memory traces' of specific actions and decisions. He argues that structures are both the result as well as the medium for human action. Human actors are influenced by the social structures, but they can also change and re-create them. In this view structures are not seen as static but as *structuring* human processes and as such there are many different elements of structure of very different nature. This indeed complicates the whole idea of transitions as a fundamental change in *the* structure of a societal system. There is not such a thing as one objective 'grand structure' of a social system; rather, it is comprised of a multitude of structuring elements. So what does this mean for the phenomenon of transition? It means that a transition can still be seen as a fundamental regime change of a societal system, but that it results from a multitude of changing elements of structure that add up to a transition. The question then is, which elements of structure add up to constitute a transition and to what extent should they change?

Based on Giddens (1984) and on insights from the complex adaptive systems theories, we tried to come up with a new conceptualization of regimes that would address the idea of different elements of structure and link them to human action. We argued that a societal system is comprised of three dimensions: actors, processes and structures and in which the process dimension connects the sphere of actors and structures. The system operates under a specific regime and that regime could be described by these three (qualitative) variables, i.e. the actors, processes and structures. With regard to the actors, we perceive actors at two levels: organizations (aggregated entities) and individuals. The individuals are partly autonomous and have their own frame of reference and ideas, but we also see them as representatives from the organization, so they are bounded by the responsibilities and tasks of their organizations. With regard to the processes, we may discriminate between the key-process of an organization (i.e. its prime function) and the secondary processes that are supportive of the key-process. With regard to the structures, we found scattered traces of different elements in various regime definitions. Our regime concept categorizes the elements into three main types of structure: culture, institutions and infrastructure. The three categories are further differentiated into what we have called elements of structure. The three dimensions can be linked by describing how the actors influence the structures, and via which processes.

We argued a transition should at least involve change in all the three types of structure. This means that at least some of the cultural elements, some of the institutional elements and some of the infrastructural elements need to change in order to classify it as transition. Especially, the infrastructures are important to mention because they are the physical proof that the system shifted into a new regime. The infrastructure is the physical manifestation of the cultural and institutional changes. The institutional changes are important in setting the conditions for infrastructural change and as such could be interpreted as reflecting the tipping point between one basin of attraction and another.

This demarcation of transition is still broad and so we therefore suggest that this should be further specified. However, this is also ambiguous since there are no objective criteria possible *a priori*. Questions like: "Should all elements of structure change in order to consider it as a transition", or "it is enough that one element of structure changes?", or "to what extent should they change?" or "if all structuring elements change only a little, do we still consider it to be a transition?" make research into transitions complex and slippery. In this respect, all we can do is to expand the number of transitions studied and to be precise about what is changed and to let the demarcation emerge out of the database.

This theoretical exercise grounded the transition theory in systems theory. The synthesis of the transition framework and the resilience framework generated two important insights. In the first place, this synthesis provided us with more dynamic view of the regime concept. A regime has resilience, so it is able to cope with external and internal disturbances without transforming structurally, however, if certain thresholds are exceeded, the regime destabilizes and transforms. Hence there is a certain range between which the incumbent regime can hold on, but the susceptibility for transformation increases along the number of changes in the elements of structure change and push the system closer to a tipping point. In contrast, regimes with low adaptive capacity may get trapped into deep basins of attraction and locked in onto an incremental trajectory. These systems cannot adapt adequately and become vulnerable when the systems environment is changing. These systems are therefore more likely to follow a collapse & renewal transition path. Having a sufficient level of adaptive capacity is therefore an important condition for realizing transformative changes along the transition path of regime shift. The adaptive capacity of a regime may be enhanced by stimulating the ability for learning, creating flexible institutional structures and increasing the amount of innovation capital (knowledge, resources and people).

One point we should also address is the presumed normative character of the transition theory. The theory, especially the literature on transition management, is often linked to sustainability, assuming that the current system does not operate in a sustainable regime and therefore needs to change. This is indeed a normative stance. However,

what is considered unsustainable and sustainable is defined by the people participating in the transition management process and in this respect no different from any other policy process having a problem & solution structure. The part of the theory that deals with transition dynamics is much less normative. In principle, a new regime is not necessarily more desirable than the old regime. What we learn from investigating the dynamics is that a system might benefit from remaining adaptive and escaping lock-ins, so that its regime can be adjusted if necessary. What we learn on a generic level is that there is need to enhance the adaptive capacity of a system and on a more specific level how we might initiate the patterns of transformative change.

8.2.2 The multi-pattern concept

In this dissertation we also made a contribution to the development of the multi-pattern concept. Here we reflect on the concept and how we use it to improve our understanding of transitions.

First of all, what is the multi-pattern concept? The multi-pattern concept distinguishes between different patterns of transformative change. A pattern of transformative change refers to how a certain change in a regime structure is being realized. The multi-pattern concept can be used to describe a transition as a series of patterns of transformative change. The concept does not replace the multi-level and the multi-phase concept, but it adds two dimensions. The multi-level concept focuses on *where* (at which level) a change is occurring, the multi-phase concept focuses on *when* (in which phase) a change is occurring and the multi-pattern concept focuses on *what* kind of change is occurring and *how* this change is being realized.

The underlying hypothesis of the multi-pattern concept is that a transition can be explained by a limited set of different types of patterns of change. In this dissertation we identified six types of patterns of transformative change. Both the resilience framework and the transition framework explicitly distinguish between events at the micro-level that may lead to a bottom-up pattern of transformative change, and developments at the macro-level that may trigger a top-down pattern of transformative change. Based on the work of De Haan (2007) and the De Haan and Rotmans (forthcoming), we distinguished between two variants of the bottom-up patterns of transformative change. The first pattern is the niche-absorption pattern, which describes the emergence of niches which are adopted by the regime. The second pattern is the empowerment pattern, which describes the emergence of a niche which is not adopted by the regime, but grows into a niche-regime and co-evolves with the regime and eventually may even replace the incumbent regime. De Haan and Rotmans refer to the top-down pattern of transformative change as re-constellation in which a large-scale alternative is top-down imposed upon the regime. Although they argue that this pattern is always emerging

due to a force from outside the regime, we argue that the top-down dynamic can also be initiated from within the regime. We have referred to this kind of pattern as 'endogenous re-constellation'. We have made an explicit distinction between endogenously or exogenously driven patterns. We thought it necessary to make this distinction explicit because of the implicit assumption present in the transition literature that innovations emerge outside the system. Although this raises directly the question of system boundaries, theoretically it is important to distinguish all the possible variants and then to look empirically if they occur or not. This has resulted in the following six types of patterns of transformative change:

1. Endogenous niche-absorption: a niche is created by the SES and is successfully adopted and incorporated into the regime.
2. Exogenous niche-absorption: a niche emerges spontaneously or is created somewhere outside the SES and is successfully adopted and incorporated into the regime
3. Endogenous empowerment: a niche is created by the SES itself, grows and is able to sustain itself. It forms a new SES in a separate basin of attraction, called a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
4. Exogenous empowerment: a niche emerges spontaneously or is created somewhere outside the SES, grows and is able to sustain itself as a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
5. Endogenous re-constellation: a powerful actor in the SES imposes a transformative change top-down, for instance a national government imposing a large scale reform policy.
6. Exogenous re-constellation: a powerful actor outside the SES imposes a transformative change top-down, for instance a global institution or an international agreement.

We should perceive these patterns of transformative change as ideal-typical or as templates we may use to analyze transition dynamics. The patterns of De Haan and Rotmans play out on longer time scales than the patterns of transformative change identified in this dissertation. De Haan and Rotmans (forthcoming) argue that a sequence of two or three patterns gives rise to a transition path. The patterns described here play out on a smaller scale, which means that a transition path encompasses a much longer sequence of these patterns. However, these patterns are consistent with the patterns of De Haan and Rotmans, but they are less aggregated. They allow for a more specific, high resolution analysis of transition dynamics. The patterns can be described empirically by three variables. The first variable is that of the involved actors, the second is that of the key-processes that were influenced and the third is that of the elements of structure that have changed. Hence, the multi-pattern concept guides us in the analysis of transitions

by unraveling the complex dynamics into these patterns of transformative change. By analyzing which of the patterns occur and the sequence if these patterns we may generate understanding of how transitions unfold in the system of interest.

8.2.3 The double-loop concept

In this dissertation we have also attempted to conceptualize the dynamic interplay between niches and regimes. The bottom-up patterns of transformative change are essentially patterns of niche-–regime dynamics. The so-called double-loop concept describes this interaction. The double-loop concept represents the regime and the niche as two loops running parallel (the regime loop and the niche-loop). We defined a niche as an emerging field that deviates from the regime. Niches can be characterized according to the same scheme as we did for the regime (thus of actors, processes and structures). A niche may involve one or more groups of people. Each group has a structure component (niche structure) and an agency component (niche-group). The niche-structure provides an escape for individuals from the formal day-to-day organizational constraints and provides room for individuals to come loose from their role as representative of the organizations and to the opportunity to engage in a reframing process and seek for innovative solutions.

The double-loop concept does not represent niches and regimes as antagonists; rather they are contrasted in the degree of the radicalism of innovation. Groups of people working in a niche operate under a different set of structures. They generally have less structure constrains than the individuals working within the regime, since the field is not matured and fully established yet. The double-loop concept focuses thus on three critical aspects of niche-regime dynamics. The first aspect is the formation of the niche. During this formation a distinction should be made between the formation of the structural component (the niche-structure) and the agency component (the niche-group). The second aspect is the reframing that occurs within the niche-group and the developed innovation (for instance a new policy perspective). The third aspect is concerned with the mechanisms of how a niche influences regime structures through using windows of opportunity. The double-loop concept enables us to understand the basic pattern of niche-regime dynamics. Variations to this pattern are for instance the formation of a niche outside the system which influences the regime of interest, or that the ideas developed in the niche are not adopted by the regime either through deliberate resistance or simply due to a mismatch with regime structures. In these cases the niches may still be developed further to co-exist with the incumbent regime as a niche-regime.

The double-loop concept reveals an immanent tension in niche-regime interactions: on the one hand, one needs to stimulate reframing and 'out of the box' thinking in

order to innovate; on the other hand, the more radical these innovations are, the less compatible they might be with the incumbent regime. The double-loop concept shows interesting connections with the work of Grin and Sterrenberg (Sterrenberg et al., forthcoming, Grin, 2008a) on the design of system innovations. They argue that this requires a process of *Re*-structuration. Re-structuration is a term based on Giddens (1984) and refers to the development of new system structures. Grin and Sterrenberg indeed come up with a kind of dual-track governance, similar to the double-loop concept. The double-loop concept may be seen as one way of elaborating further on the concept of re-structuration through dual-track governance. Future research in this direction is crucial in order to understand how to improve and facilitate niche-regime dynamics (Van Raak and Van der Brugge, 2007).

8.3 A new approach for Transition analysis

This dissertation also attempted to contribute to the methodological aspects of transition studies. Since the field of transition studies is relatively new, there are no fully developed and validated methods yet as to how to analyze transitions. The majority of transition analyses are done by applying the multi–level concept (Geels, 2002, Verbong, 2006, Parto, 2007) and the multi-phase concept (i.e. Van der Brugge and Rotmans, 2007, Parto, 2007, Loorbach, 2007). This dissertation presents a generic approach for a transition analysis.

The approach developed for a transition analysis consists of two parts: a method for how to analyze a regime, and a method for analyzing patterns of transformative change. The method is linked to a historical reconstruction based on the multi-level concept. The rationale of this approach is that the system boundaries are defined and the regime of interest is further differentiated into actors, processes and structures in order to understand the regime organization. The method for pattern analysis guides the analyst to analyze the pattern of transformative change during certain episodes of the historical reconstruction with regard to the actors involved, which key-processes were influenced and which elements of structure changed. The regime and pattern analysis supplement the multi-level analysis and multi-phase analysis. In this way, transitions can be analyzed in a structured and more detailed way as a series of changing elements of structure resulting from different patterns of transformative change. In principle this method can be applied to any sort of system to analyze historical changes.

We concluded that this method for regime differentiation and the method for pattern analysis are valuable additions to the multi-level and the multi-phase analysis. By applying the approach, we were able to analyze some of the patterns of transformative change in the history of Dutch water management in more detail. The approach forces

the analyst to be explicit and specific about what is changing and in what way. The patterns of transformative change identified here are ideal-typical and we found some variations. For instance, a niche-group may be partly endogenous and partly exogenous if individuals from different sectors are involved.

The pattern analysis also generated two new preliminary hypotheses. The first is that a tipping point could be associated with the flip from a bottom-up pattern to a top-down pattern of transformative change, which is associated with the establishment of a new institutional regime. However, we should be aware of the fact that when the old regime and the new regime have little contrast, it may not be easy to recognize a tipping point. A second hypothesis is that the different patterns of transformative change may have different functions in the buildup of a new regime.

There are also some shortcomings of the method. The method unravels the different elements of structures, while in reality they are internally related. Discriminating between them is useful and clarifies what is actually changing, however, they often cannot change independently. If one structure is changing, other elements of structure follow. In this sense, the method makes things explicit, but it may represent a too mechanistic view, where it should be co-evolutionary.

Secondly, it remains difficult to identify niches and niche-groups. How innovative, or how deviating or how large or small a niche should be is defined nowhere in the literature. Again, distinctions between niche and regime are trivial and there are no objective criteria possible, however, we do consider these notions useful, especially for providing a language to discuss what is going on. In this case study we used the selection criterion for a niche in terms of its deviating policy perspective compared to mainstream policy, while in the socio-technical transition literature the niche is often linked to a new technology. There is also a difference between doing research into historical or contemporary transitions. Historical research has a bias to the successful niches and niche-groups and consequently less successful niche-groups are often not identified. The reason for this might be due to recall bias of the interviewees or that such niche-groups have not been recorded into the history books. In contemporary cases, however, it is impossible to predict whether groups of people will be successful. In contemporary cases, one finds innovative, change agents, distributed across the whole system. This means that there are all kinds of deviating policy perspectives present and thus that the border between niches and regimes is much more fluent. Historical transition studies thus tend to overstate this distinction.

8.4 Transition dynamics

In this section we will discuss what we have learned with regard to the transition dynamics. The empirical part of this dissertation was concerned with Dutch water management. We showed that in the long history of the Dutch water management there have been several transitions, each triggered by a different driving force. We focused on the most recent transition from a sectoral and technocratic water management regime to an integral and interactive water management regime.

One of the questions we addressed is whether this shift may be indeed understood as a transition. In this case study, we perceived the shift as a ´transition´ only if there were changes in each of the three types of structure: culture, institutions and infrastructure. This analysis provided us the basis for discussing to what extent we might classify the changes in the water management as ´transition´.

Our analysis suggests that overall the cultural and institutional elements of structure have changed quite fundamentally. The water management paradigm changed: there is a broad acknowledgement that the water system can not be fully controlled and requires a continuous adaptation. The flood protection discourse changed. Water can not be managed only by technological means, but spatial measures are necessary and therefore water should be more guiding in spatial planning. Also the values have changed. The ecological status of the water system is deemed much more important and agriculture somewhat less. The institutional structures are adjusted in order to implement the new water management policy. The responsibilities have changed. The district water boards are responsible for water quantity as well as water quality management. We have observed two major policy shifts, from sectoral to integrated water management and to water policy for the 21st century. With regard to the infrastructure, many of the planned infrastructural changes are in the start-up phase; however, none of them are actually finished.

So, what does this mean in terms of transition? Considering all the changes in the elements of structure, both the cultural and the institutional structures of a new regime are in place, but the physical infrastructure is lagging behind. Therefore we concluded that Dutch water management is in transition, however, the transition is still ongoing.

We argued that the transition is beyond the so-called take-off and somewhere in the acceleration phase, however, the acceleration phase should not be seen simply as a quick implementation process, neither that the future of the sector is straightforward and the direction already a run course. There are still many barriers yet to be overcome. The planned infrastructural projects tend to take years or decades to be built. Therefore, the term acceleration phase and the associated steep slope of the S-curve, is somewhat misleading. The conceptualization of transitions as the shift from one basin of attraction

to another may be a suitable alternative for the S-curve, since it does not per se impose such an acceleration phase onto the concept of transition.

In order to understand when a regime shift occurs or how to stimulate one, we need to improve our knowledge with regard to which kind of structures need to change. The analysis in Dutch water management showed us that during the first stage of the transition, predominantly the 'soft' cultural elements of structure, like the knowledge base and the discourse, started to change. We could therefore argue that the driving force of this transition was the changing mindset of the water professionals. In a latter stage, the institutional elements of structure changed. These institutional changes may be associated with the tipping point into a new basin of attraction. This institutional establishment enables the implementation of measures, so that the infrastructural elements can be changed to establish the new regime physically.

Although it seems to be a rather logical order that the mindset changes first, then the rules and the physical environment, we should be careful to interpret this in too straightforward a way. The different elements of structure are interconnected, which means that changes in the one have consequences for the others. It should rather be understood as a co-evolving whole: one changing element of structure may trigger change in another. The relative weight of these structures is also of importance. We pointed out that the regime has a certain resilience, which means that not every changing element of structure directly leads to a regime shift.

With regard to the dynamic patterns of transition, what have we learned? Our historical reconstruction shows that there have been two major policy shifts. The first policy shift was from a sectoral and technocratic regime towards an integrated water management regime, which integrated ecological quality, water quality, water quantity and the societal function of water. It tipped around the 1990s. However, during the implementation the system changed its course. The floods triggered a temporary backlash back towards the sectoral regime, but also initiated a new direction to incorporate the spatial dimension. The dominant policy of the regime tipped around 2000. Currently, the Dutch water management regime can be characterized as an integral and interactive regime in which nature preservation, spatial planning and water management are closely linked.

Our pattern analysis showed that both policy shifts started with various bottom-up patterns of transformative change (endogenous as well as exogenous niche-absorption patterns). After a period of building knowledge and experience (building critical mass) it was followed by the endogenous re-constellation pattern. We associate the flip from the bottom-up patterns of transformative change to the top-down pattern of transformative change with the tipping point and the shift of the system from the initial basin of attraction to another basin. This tipping point coincides with the establishment of new institutional structures.

The niche-absorption patterns primarily seemed to influence the cultural elements of structure, such as knowledge and discourse. These patterns build up a kind of knowledge that is abstract and that represents a new way of thinking about a specific problem, solution or opportunity. In this respect, we may understand the function of the niche-absorption patterns as providing the knowledge and argumentation for a new direction in which the regime could develop. The endogenous re-constellation pattern was associated with the institutional elements of structure. During this transformation pattern, new institutional structures were established, like the integrated water boards and their new responsibilities and in the second shift the WB21, the Water test and the National treaty on water management. Hence, we might understand the function of the endogenous re-constellation pattern as establishing new institutional structures to enable implementation and interventions in the infrastructure.

This transition analysis showed that a regime can be actively involved in creating niches. We may interpret this as evidence that regimes and niches are not antagonists. In reality, the borders between them are much more fluent. We also did not come across the empowerment pattern. Therefore, our findings suggest that the transition dynamics should be understood as a continuous dynamic interplay of niche-regime dynamics: the regime creates a niche, the niche influences the regime: the regime change triggers new niches, etcetera. This type of dynamics seems to resemble what Geels and Schot (2007) have called the re-configuration pathway. However, we may add that the re-configuration pathway can be driven by alternating bottom-up and top-down patterns of transformative change.

In order to improve our understanding of the niche-regime dynamics, we applied the double-loop concept to two case studies. Both in the case studies of Amstelland and Rotterdam, we found that there are actually two phases in the formation of a niche. The first phase was the formation of the structural component of the niche, for instance a new institutional structure. The second phase was the formation of the niche-group through the selection of participants. The second critical issue is the reframing in the niche. In both case studies the reframing occurred on three different aspects. The first aspect of reframing was with regard to how the problems were being perceived. The second aspect of reframing concerned the insights in each other's perspective. The participants learned how professionals with different backgrounds were thinking and what their goals were. The third kind of reframing concerned the solutions and initiated the development of different kinds of measures. The reframing occurred as a result of the confrontation between the different perspectives of the participants, which may increase if there is a wide variation of different backgrounds. This variety may be stimulated by a specific niche-structure, which requires inviting participants from the different authorities, like in the Amstelland case, but also by the selection of participants. The third critical point in the niche-regime interaction is the way in which the niche

can influence the regime. This aspect can be described by two different phases. The first phase was concerned with finding support. What is crucial (and this may be more specific for policy oriented niches) is that this phase includes the political game with its own rules and which means that the niche-group should be keen on how to present the alternative. The next phase was concerned with getting the ideas adopted in the regular process so that these processes are adjusted. Both case studies pointed out that it is important to use the windows of opportunity. The Amstelland case made clear that when the participants are representatives from different actors, the developed alternative will influence each organization differently. This is evident since the different actors each have their internal schedule and procedures.

We may draw an additional, but preliminary hypothesis that the dynamics observed in the cases emerge in a regime with sufficient adaptive capacity. Regime actors deliberately install niche-groups to explore new adaptive solutions. This implies that a regime may have a higher adaptive capacity than is generally assumed in the transition literature and that the assumption that regimes are too rigid to adapt is at least not always true. We might also formulate a tentative hypothesis that in less adaptive systems, the pattern of empowerment may be more prominent than the niche-absorption pattern. The regime actors might be too constrained to adopt the ideas of the niche-groups.

8.5 The future of Dutch water management

The question, of course, is whether the current water management regime will stabilize within this basin of attraction or will shift into yet another kind of regime. In this section we will reflect on the future of Dutch water management.

In 2006, the Directorate-general of water management of the Ministry of Public Works, Transportation and Water management published a visionary report called the 'Course of water 2' (in Dutch: Waterkoers 2 (2006)). This report used the transition framework as a guideline, which gives the impression that the Ministry acknowledges the necessity to think about the future of water management in a different and more integrated way. In 2007, a follow-up report appeared, presenting a vision for the long term (Ministry of Public Works, 2007), which will be further developed in the official National Water Plan due to appear in 2009. The vision report argued that there is a need for a re-evaluation and a new impulse to water management, because (1) there is updated knowledge with regard to climate change; (2) large programmes like the Room-for-the-River programme and the Water Framework Directive ask for a re-consideration with regard to the coherence within the sector; and (3) the current water system is not sustainable.

The vision for the Dutch water sector in 2050 is based on five pillars. The first pillar is concerned with climate change adaptation and the continuation of the current

programmes such as the Room for Rivers, and suggestions are made to shift from a flood-probability approach to a risk-based approach. The risk-based approach takes into account the possible damage of a flood, the slow internal degradation of dikes and human errors. This means that economically booming areas will be protected with higher dikes than for instance rural areas. The second pillar is that water should be a driver of the Dutch economy. The distribution of and the protection against water are important conditions for the functioning of economic sectors such as agriculture, fishery, industry, recreation, energy, shipping and for companies to settle here. In addition, the Dutch water management is seen as a high-tech sector which can stimulate the economy in terms of export of products to other deltas. The third pillar is the improvement of the ecological qualities of the water, resulting in cleaner water, wild nature areas with a high biodiversity and interesting landscapes. The fourth pillar is that water management can contribute to the Millennium Development Goals by sharing water knowledge and water education and by improving public water management authorities. The fifth and last pillar is that of involving the public. Climate adaptation is a big challenge, but it also brings opportunities for new landscapes, recreation, nature and economic activities. The awareness of water opportunities should be increased by communication and public participation.

Reflecting on what this vision means for water management in the future, that is, if all these pillars have been successfully implemented, then what would water management look like? First of all, water management would become more complex and plural. The complexity would be the result of an ongoing integration with the nature development and preservation sector, spatial planning, recreation, housing, agriculture, industry and energy, but also of interdependent governmental layers, tasks and responsibilities. The greater diversity of stakeholders involved in water management would lead to a greater plurality of different stakes and perspectives with regard to problems and solutions.

The physical landscape would contain more surface water than there is now. If the current plans continue, the river beds will be broadened and small channels will meander through the floodplains. Existing dikes will be re-allocated and the dike-compartments will be protected by a double set of dikes. In rural areas, some of the deep polder systems will be transformed from agricultural lands into wetlands, nature preservation areas and recreation areas. In the urban areas, there will be more surface water as well. Where this is not possible, one may encounter new kinds of water infrastructure, such as city squares, which would serve as water storage facilities in case of heavy rainfall, or green roofs planted with sedum to absorb rainwater, and there may be invisible water storage facilities underground. More people will be living in floating houses or be working in floating horticulture greenhouses.

The style of water management will be more interactive. In addition to securing safety and clean water, the task of the water authority will be to find ways as to how water

can contribute to the overall quality of the area. Multi-functional use of land and water can have financial advantages because costs are shared by the different authorities and participating private organizations. We see this shift already reflected in the notion of Area-development (in Dutch: gebiedsontwikkeling), which is supported by the new Spatial planning Act of 2008. In this approach, the stakeholders cooperate and develop plans in which economic, spatial and social policy is integrated. Tasks and financial resources are formulated in a specific arrangement that applies only to that area.

This would require different kinds of knowledge. The enormous infrastructural transformation requires technological knowledge of civil engineers. Secondly, interactive water management requires people trained to think in an integrated way. They will need to place water in the bigger context of Area-development and they must be able to look beyond the boundaries of the water sector. Thirdly, there is a need for process managers who facilitate the process and who include local residents. Finally, there is a need for more socially-oriented scientists to develop instruments how to integrate information, and to improve the design of area-specific institutional arrangements.

What is worth noticing is that climate change up till now has always been perceived as a threat, but this vision report emphasizes climate change as bringing opportunities as well. The focus has always been on flood protection since climate change threatens safety, but currently there is a growing awareness that the current experiences with climate change adaptation may become important export products in the future, when other delta areas will have to take measures as well. This may inspire designers and engineers to think about whole new types of water constructions and infrastructure, such as water retention squares to store peaks in precipitation. It also creates the opportunity to re-think land-use patterns and create high quality areas and wetlands with a high biodiversity.

These ambitions make clear that the current transition is far from being completed. Many of the changes, physically as well as institutionally, are still to come. The case studies of Amstelland and Rotterdam showed that there is still a wide gap between the ambitions of Water policy for the 21st century and the reality of implementing the new policy. One of the important barriers is that water managers are often not involved in the process of deciding where new development projects will be located, although there are examples of where this did happen. If water is to be truly guiding, this should be the case on a much wider scale. A second barrier is the uncertainty with regard to the impact of climate change. The uncertainties make it difficult to be exact about which measures are required, and this makes decision-making and re-allocating of financial resources complicated, especially when there are other high priority needs. Moreover risk perception and they ways of assessing risks differ among different institutional settings (Bouma *et al.*, 2005). In the Amstelland case we saw that an important barrier for large scale transformations is formed by the political stakes, public protests and a

de-alignment with existing policy fields. In the Rotterdam case, we saw that the high value of assets, especially in urban areas, presents a third barrier. The assets need to be purchased in order to safeguard room for additional water retention. In addition, investors purchase agricultural land, speculating that prices will rise as a result of the housing demand. This forces up the value of these lands and makes water retention even more costly. A fourth barrier is the lack of an institutional mechanism with regard to investments and maintenance of new infrastructures planned by multiple stakeholders. If new water infrastructure serves multiple city functions, the investments costs may be shared. More difficult, however, are the costs involved in maintenance. Who is responsible and in addition, who is responsible if anything goes wrong? Innovative, multi-functional infrastructure either requires additional responsibilities of the existing authorities, or a new kind of authority for operation and maintenance of infrastructure developed by multiple stakeholders. Current cooperation mechanisms, such as public private partnerships, may not be sufficient because the actors should commit themselves for several decades, considering the time scale of water infrastructure. This is one of the major challenges for realizing plans concerning multi-functional infrastructure plans, not only in Rotterdam, or in the Netherlands, but in general.

Taking these considerations into account, there are many different future scenarios possible. In figure 8.1 we have sketched three possible, rather generic scenarios. The first scenario is a successful transition scenario in which all the elements of the water vision

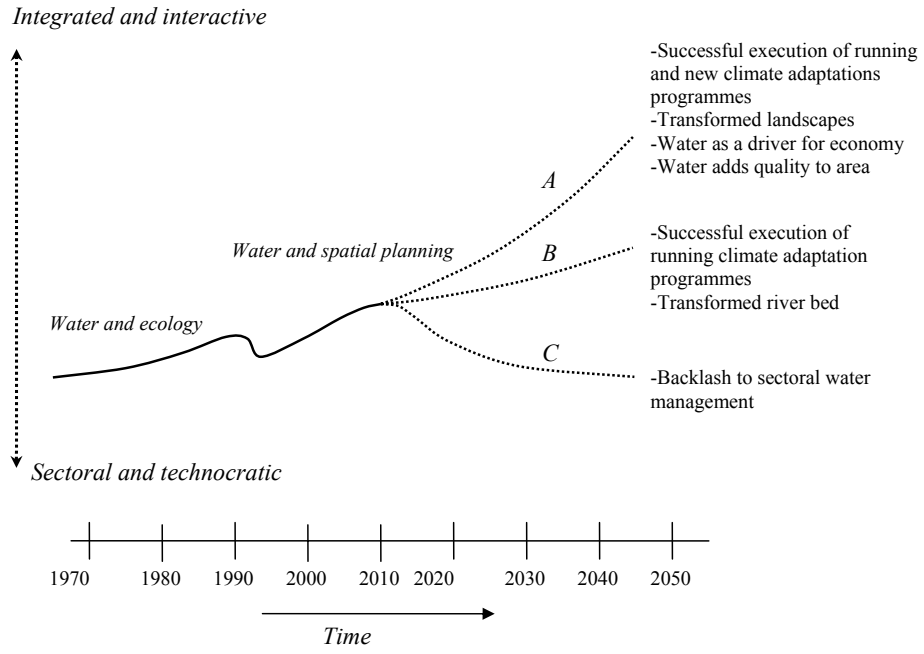


Figure 8.1 Three possible future scenarios for Dutch water management.

are implemented. There is a successful implementation of the current climate adaptation programmes and new more drastic landscape changes are executed successfully. Water technology has become an important expert product and water is also used to add quality to the region. Scenario B represents a more moderate scenario, in which the current climate adaptation programmes are successfully executed and the river beds are transformed. However, water is not used to add quality to the area, nor seen as an important driver of the economy. Scenario C represents a backlash to sectoral water management. It is not clear how the Dutch water management regime will evolve and it is therefore necessary to think about this as the report "The Course of Water" suggests.

8.6 Implications for Transition management

An interesting question is whether a transition can be managed. On the basis of our transition analysis of Dutch water management, we may answer this question by yes and no. We have seen how some niches have been actively created and managed. In addition, we might say this transition was partly managed in terms of distributing knowledge: the ecologists for instance were deliberately allocated to strategic positions within the Ministry after the Delta Department left off. On the other hand, most of the knowledge build-up was due to actors adopting the new ideas and applying them in their own context, contributing to the build-up of critical mass. After the tipping point, we see that the regime shift is heavily managed by the governmental authorities through coordinating the implementation process, though this was not fully controlled either. Hence, we may conclude that although it is impossible to manage the transition as a whole some aspects of the transition can be managed to a certain extent.

So, what can be done to stimulate transitions? We may distinguish between two broad strategies. First of all, one generic strategy should be directed to enhance the adaptive capacity of the regime. Enhancing the adaptive capacity may be done by stimulating the ability to learn, to create institutional flexibility and to increase the amount of innovation capital. Which one of these aspects should be stimulated depends on the specific context. Increasing the ability to learn is important in order to respond to early signals of change and to find solutions. By integrating different perspectives the adverse side effects may be limited. Creating flexible institutions is important, otherwise innovative initiatives may be blocked in early stages of development. Flexibility in this respect means dealing with existing rules in a flexible manner in so-called experimental gardens, for instance to allow a temporal exemption to certain rules. Innovation capital is important as a condition in order to actually make the change. Manpower, knowledge and financial resources are critical for realization. In general, this type of strategy receives little attention in the transition management literature and in our view it should. If we

view the regime as dynamic and heterogeneous, it is also clear that not every part of the regime is equally stable. Some parts may be more susceptible to change than others and so, the conditions for change may be more favorable in one subsystem than another. One of the challenges of transition management should be to learn to recognize these subsystems.

A second type of strategy should be directed towards initiating and organizing specific patterns of transformative change. Each of the identified patterns of transformative change has different leverage points for management. Recognizing these patterns in reality may help to identify strategies to stimulate or redirect the unfolding patterns. Currently, in the transition management literature there is much attention for the bottom-up pattern. Niches receive a lot of attention as the nuclei of innovation and strategies are developed on how to stimulate the growth of niches. In our empirical work we identified different strategies during the niche-regime dynamic. These strategies also support some of the crucial elements of transition management. We will discuss each of these aspects below.

- *Initiating a transition arena.* With regard to initiating a transition arena, much attention is focused on the selection of participants. Transition management emphasizes the need for the selection of a specific type of participants in the transition arena, namely frontrunners. This aspect of the selection of transition arena participants has raised the question of legitimacy. Who is making the selection? However, what we came across in the case studies of Amstelland and Rotterdam is that similar selection procedures already take place. The act of selecting participants as such is nothing new. We should mention here that the 'arenas' in Amstelland and Rotterdam, however, were not exactly the same as the transition arena with regard to group-composition. This also relates to the work of Van Raak (2006) who identifies different types of arenas. With regard to the process design, the so-called master case in the Rotterdam case study might be a promising process design to generate innovative ideas. In the master case, the duration of the process is short (i.e. six weeks), but intense (three days a week) whereas the transition arena sessions are on average held bimonthly. For the period in between the transition arena session, master cases can be set up to deliver new input or to investigate issues in more detail.
- *Envisioning processes as important learning opportunities.* Transition management emphasizes the role of an envisioning process to develop sustainability visions for a particular system. In both Amstelland and Rotterdam the envisioning process has been essential to understand the consequences of regarding water as guiding in spatial planning and how this is different from 'normal' water management. Based on the case studies, we might suggest that more attention should be given to translating the vision into a design. For instance, in the Rotterdam case the general vision was translated into a scale model, which enabled people to see what the vision

means, serving as a reference point for further discussion and as a communication tool. In addition the Rotterdam case study also illustrated how to develop transition paths that link up with ongoing dynamics. They explicitly linked water management measures with the upcoming urban renewal plans. These plans provide the opportunities and therefore determine the pace of the transition.

- *Balancing the distance to policy*. In the transition management literature, influencing the institutional structures is referred to as tactical transition management (Loorbach, 2007). With regard to the niche-regime dynamics, the cases illustrated the importance of finding a balance between the freedom to reframe problems and to seek for 'out of the box' solutions, and keeping a close link with the regime actors. The case studies showed that there is continuous interaction between the niche and the regime and that strategic behaviour plays a crucial role.
- *Timing and communication*. Transition management attempt to mobilize actors into engaging in a multi-actor innovation network. The Amstelland case showed that the impact of the river basin plan was different for each organization. These organizations have not gone through the reframing process, but they have to approve of the process. It is therefore of crucial importance to develop communication strategies about how the vision is translated to these organizations.

In conclusion, we may argue that transition management is primarily focused on facilitating the bottom-up patterns of transformative change, i.e. the niche-absorption patterns and the empowerment pattern and up till now the literature is much less concerned with the re-constellation pattern. As we have seen, the re-constellation pattern is important in two ways: in creating the institutional structures which form the basis for changes in the infrastructure and by triggering the emergence of new niches. In this respect, there is a clear role for the national government in the management of transitions by creating the institutional structure which defines the playing field. In this pattern we might expect to encounter managers and politicians. Their power positions enable them to influence institutional structures. What they need is instruments to change the rules, how to make exceptions to the rules, ways to change the existing money flows towards new projects. In the bottom-up patterns we expect to find entrepreneurs with innovative ideas. What they need is resources, support and experiment locations. Hence, to facilitate the bottom-up and top-down patterns require different approaches. This research suggests that each pattern of transformative change requires different transition management strategies, but that the strategies for the pattern of re-constellation have been explored insufficiently.

In principle, a transition management process should be based on a transition analysis of the system of interest. The approach for transition analysis here developed may be used as an instrument in such a process. The multi-pattern analysis provides insight into

which patterns of transformative change are present in a system and may provide a sense of the direction in which the system is heading. The identified patterns could then be the starting point for developing transition management strategies to stimulate, or redirect, these patterns.

8.7 The resilience framework and the transition framework

An additional outcome of this research has been the comparison of the resilience framework and the transition framework and we will summarize the findings here briefly and suggest how the communities can benefit from each other.

We have distinguished the following commonalities. In the first place, the resilience framework and the transition framework are both concerned with how systems adapt in a changing social or bio-physical environment via structural change, innovation and re-organization. Both frameworks are rooted in the science of complex systems and attempt to develop generic concepts about the dynamics by distinguishing different phases and different levels. Secondly, these concepts are used to inform management as to how to deal with the system at hand. Thirdly, both frameworks are based on the idea that complex systems cannot be fully understood, which means that management should involve in a continuous learning process by introducing new perspectives, monitoring and experimenting. In the fourth place, both frameworks make a distinction between 'normal' changes and more 'fundamental' changes, like regime shifts.

We distinguished four different focal points between the two frameworks. The first difference lies in the origin of both frameworks. Originally, the resilience framework was concerned with the dynamics and management of ecosystems (Holling, 1978). In a latter stage, the attention shifted to social-ecological systems (e.g. Folke et al., 2005, Olsson et al., 2006, Walker et al., 2006, Gunderson and Holling, 2002). The transition framework originated in the field of sustainability and environmental sciences (e.g. (Rotmans et al., 2001) and was embedded in the field of governance (Loorbach, 2007). The two frameworks also differ in their point of departure, which may be a direct result of their different origins. The resilience framework appears to be primarily concerned with preserving (i.e. protecting) the existing ecosystem and its functions for society, whereas the transition framework is primarily applied to undesirable systems that require fundamental changes.

A third point of difference is the focus. The resilience framework tends to emphasize the role of disturbances against which the system needs to be protected. Although this is often associated with a reactive stance, this is not necessarily the case because it can mean a pro-active building of resilience. In contrast, the transition framework is focusing on the development and build-up of a new, more desired system. This may also be in

response to a future threat, implying a certain reactive stance, but it is proactive in the sense of deliberately and consciously initiating envisioning processes, experimenting and developing multi-actor coalitions, directed towards the vision.

A fourth point of difference we may distinguish is the role of renewal in relation to collapse (or smaller calamities). Although both frameworks consider this relationship, the emphasis is different. The resilience framework primarily emphasizes the opportunity for innovations in the period after a disaster. It suggests that in the post-calamity period the institutional 'memory' may be weakened and this facilitates renewal. The transition framework is primarily concerned with innovation in niches and how this may lead to renewal in the regime. This means that much attention goes to how innovation breaks through when the regime is still in place. This kind of niche-regime interaction has received less attention in the resilience literature. In addition, the resilience framework suggests that the transition framework should focus more on the adaptive capacity of the regime and the vulnerability, or sensitivity, near tipping points.

We may conclude that both frameworks are fairly complementary. In a rather crude way, we could argue that the resilience framework is more focused on preserving systems and protecting them against disturbances, whereas the transition framework is primarily focused on transforming systems into an envisioned direction. Together, the resilience framework and the transition framework cover a spectrum of how to deal with an SES, ranging from building resilience in desired systems to reforming undesired systems into more desired systems. Both research communities are looking for how to understand and deal with the complex dynamics of social and social-ecological systems. Recently, the niche-regime interaction has gained attention in the resilience literature, for instance in the work of Gunderson et al (2006) and Olsson (2006), who suggest that so-called shadow networks, or arenas for discourse, are important in transformation processes of social-ecological systems. These networks are close to what we have called policy niches. Transition management attempts to formulate in a more prescriptive way how to organize such arenas and how to influence the regime. Hence, there is an opportunity for cross-pollination in both these frameworks and for contributing to a wider and improved understanding of complex adaptive systems (Van der Brugge and Van Raak, 2007).

8.8 Main conclusions

So, what kind of conclusions can we draw on the basis of this research? First of all, we should adjust our view of transition dynamics which is dominant in the transition literature. This view suggests that niches cluster, expand and that the incumbent regime is forced to transform as the result of increasing bottom-up pressure and top-down pres-

sure. However, this research suggests that regime actors are actively involved in creating niches and niches may be adopted more quickly. The general picture that emerges is that transition dynamics are the result of a continuous dynamic interplay between niches and regimes. Within the regime niches emerge. Regime actors actively create niche-groups; the niches initiate structure changes in the regime; these changes in turn trigger new niche-groups, etc. The developed double-loop concept captures these important aspects of the niche-regime dynamic. The concept shows a way forward how to investigate the niche-regime dynamics and how to manage the interplay.

Secondly, this research shows that the regime and the niche are not so much antagonists, but that they are contrasted in the degree of radicalism of innovation. We should view the regime as a dynamic and heterogeneous entity with adaptive capacity, comprised of actors, processes and structures.

Thirdly, this research suggests perceiving transitions as regime shifts. However, there is not one single grand regime structure, but rather a multitude of different elements of structure. During a transition, different elements of structure change, adding up to a transition. These structure elements are interlinked and impose constraints on each other, so the process of change is co-evolutionary. However, in the Dutch water sector there appears to be a rather general sequence of the cultural elements that change first, then the institutional structures and then the infrastructure.

A fourth conclusion is that the transition analysis approach we have developed has an added value since it enables us to carry out a multi-pattern analysis in addition to a multi-level and multi-phase analysis. This approach combines the aspect of how the regime is changing (i.e. the patterns of transformative change) with what is changing (i.e. the elements of structure). Currently, the regime is almost treated as a black box, not explicitly clarifying what is in there. In our view, the regime should be the main unit of analysis, especially since the regime appears to have a more proactive role than was often assumed. The regime conceptualization we have suggested in this dissertation is a first step into this direction. The approach allows us to be specific about which regime structures are actually changing during a transition and to analyze different patterns of change.

A fifth conclusion that we draw regarding the Dutch water management sector, is that the regime shift appears to be a result of various niche-absorptions patterns, which add up and eventually trigger a top-down pattern of transformative change. The flip from the bottom-up to the top-down patterns can be interpreted as tipping point and is associated with the establishment of new institutional settings.

A sixth conclusion that we draw is that the transition in Dutch water management is currently in an acceleration phase. Institutionally, a new regime is being established and the infrastructural changes are now slowly taking place. However, there are still many barriers and it is not clear whether this regime will stabilize in this basin of attraction. The

acceleration phase and associated steep slope of the S-cure are somewhat misleading, since the planned infrastructural programs take decades. Therefore the conceptualization of transitions as the creation of and the shift towards a new basin of attraction may be a suitable alternative. It does not imply acceleration, rather the physical manifestation of the cultural and institutional changes.

A seventh conclusion is that transition management should involve two generic strategies. The first is enhancing the adaptive capacity of the regime in order to create the right conditions. This can be done by stimulating the ability for learning, by the creation of experiment location with flexible institutions and by increasing the innovation capital. The second strategy is initiating and organizing specific patterns of transformative change. In the transition management literature, most of the attention has been focused on the bottom-up patterns of transformative change and much less to the re-constellation pattern. Each pattern of transformative change requires different transition management strategies. A multi-pattern analysis can be used as input for a transition management process. The analysis of which patterns are currently present in a system may provide leverages for transition management.

8.9 Generalization of the conclusions

This research was focused on Dutch water management and therefore we should be careful with regard to the generalization of these main findings to other cases. Thus, to what extent can we generalize these conclusions?

First of all, it is not clear whether the patterns of transformative changes found in the Dutch case would also be present in transition in water management sectors in other countries. The Dutch water management sector can be characterized as a public management sector, which is not always the case in other countries. Secondly, it is not clear whether other kinds of social-ecological systems have the same kind of dynamics, for instance, the Dutch agricultural sector is a private sector and we suspect that in more market-oriented systems other patterns might be more dominant in regime shift. For instance, the growth of organic farming in the agricultural sector is an example of the empowerment pattern in which a new niche grows into a self-sustaining niche-regime. We suspect that this pattern is more naturally related to market-oriented sectors in which the regime actors shield their markets, protect their investments and in which there is not a common goal as such. The multi-pattern analysis of the Dutch case showed that empowerment played no significant role. It may be so that this pattern of transformative change is just less common in Dutch water management since there is less competition between the actors and they share a common goal, which stimulates knowledge sharing. We suspect that in public sectors, where the government is primarily responsible

for managing a shared resource, this sequence of patterns may be more common. We hypothesize that, in general, social-ecological systems with a sufficient amount of adaptive capacity may show these patterns of transformative change, while less adaptive systems may show other sequences.

With regard to generalization of the findings to theory, we have the following considerations. The first consideration is that this research supports the work of De Haan and Rotmans (forthcoming) and Geels and Schot (2007) that there are various ways of how a transition may unfold, giving rise to different transition paths. The multi-pattern concept developed here distinguishes between six different patterns of transformative change. We did not come across all the patterns, and there may be other kinds of patterns of transformative change that we have not been able to identify with important functions in the build-up of a new regime. Secondly, the synthesis of the resilience framework and the transition framework strengthened the theoretical base. The frameworks complement each other in our understanding of complex adaptive systems.

This research also triggers new research directions, for instance that we should focus on the adaptive capacity of a regime and the vulnerability of the regime close to the boundaries of the basin. In addition, seeing a tipping point as the flip from a bottom-up pattern of transformative change to a top-down pattern is an interesting hypothesis to explore further. New research is also required to explore the function of these patterns in a regime shift.

8.10 Recommendations for future research

This PhD-research has attempted to contribute to the development of the transition framework. This dissertation only provides some pieces of the puzzle and has generated new insights which may form the basis for new research. Based on this research, we recommend that future research should focus on the following topics.

8.10.1 Attention for the regime

The first recommendation is that we should focus more on the dynamics within the regime. This means that we need to be more specific on which structures are changing and how. In addition, we need to develop new approaches to investigate how different subsystems are interacting. In our view, the regime should be the main unit of analysis, whereas currently, the focus is more on niches rather than on the regime. In addition, the regime should be treated like a dynamic web of actors, processes and structures.

The adaptive capacity as a property of the regime receives too little attention in the transition literature and there is a need to determine indicators for adaptive capacity.

Over time, a system can be more and less susceptible to transformative change. This requires a more thorough understanding of how we can detect this susceptibility and how we can ascertain for what kind of changes the regime is susceptible.

8.10.2 Causality with regard to the patterns of transformative change

A second recommendation is to investigate further the causality of the patterns of transformative change, that is, learning which kind of conditions create which kind of patterns. Although we saw that there were different causes for the niche-absorption patterns to emerge, like calamities or new opportunities, it is not clear whether these events will always trigger the same patterns. We should focus on the various conditions that create the different patterns of transformative change. In this respect we point to the work of De Haan (2007) and De Haan and Rotmans (forthcoming) who argue that conditions like pressure, stress and tension cause the different patterns to emerge.

8.10.3 The spatial dimension in transition studies

Currently, the spatial dimension is often not addressed in detail in the transition literature. However, based on our analysis we recommend taking this into account more explicitly. This dimension is especially important for social-ecological systems. Social-ecological systems are geographically bound to the ecosystem and the existing infrastructure, although the local SESs also share common features with regard to cultural and institutional changes. Geographically speaking, a transition manifests itself differently in different regions depending on the local context in terms of actual problems and opportunities, the land and water conditions, the network of infrastructure. Some regions may be at the front line, while other regions are lagging behind. Some regions only require adaptive changes in the structures, while in other regions the SES is no longer tenable in its current form and needs to be transformed. Local innovations may be communicated and applied to other regions, where they are implemented and attuned to the local context. In addition, these bottom-up changes may scale up to become adopted in national policy. A top-down pattern of change can emerge, forcing regional SESs to implement the new policy. In the next phase of stability the regional systems have adapted or are transformed. The cultural and institutional structures then enable the renewed practice.

8.10.4 Cross-comparison of different transitions

A fourth recommendation is to expand the current data base of descriptions of transitions and cluster them into different types of transitions. Although there are examples of tran-

sitions of socio-technical systems, of demographic transitions, of transition economies, of socio-technical and social-ecological transitions it is not exactly clear to what extent these different types of transitions have similar characteristics. In addition, we may link this to the transition typology of transitions developed by Rotmans (2005). Using the approach for a transition analysis we may shed light on the structure elements that are changing and the sequences of patterns of transformative change in different systems and to investigate whether additional patterns are needed which are not addressed in this dissertation. It may lead to an improved understanding of possible sequences that give rise to transitions and how to interpret tipping points in a range of different kinds of systems. In addition, it is not clear whether a transition in similar types of systems have the same kind of dynamics in different countries. Specific factors differ per country, for instance the economy (Van der Berg and Kemp, 2006), or the role of mass media and how this influences public opinion (Van Eijndhoven *et al.*, 2001). Performing cross-comparisons would provide a more solid empirical base for the transition framework.

8.10.5 Transition management

Our final recommendation regards transition management. We suggest that further research should focus on the development of transition management strategies for each pattern of transformative change. The key is to develop new approaches and instruments for each of these patterns. This should increase and improve the whole arsenal of transition management strategies and instruments, such as the transition arena (Loorbach, 2007, Loorbach and Van Raak, 2006), a method for transition scenarios (Sondeijker *et al.*, 2006), a method for transition experiments (Kemp and van den Bosch, 2006) and a method for transition monitoring (Taanman, 2008). Each of these instruments should be linked to the different patterns of transformative change. In addition, there is need to develop transition management strategies that focus on how to change the regime. On the one hand this means enhancing the adaptive capacity on the other hand this means initiating patterns of transformative change. In this way, we may better equip transition management to influence the transition dynamics into a more sustainable direction.

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Appendix A List of actors and tasks in the Dutch water management sector

Appendix.

Actors			Responsibilities / tasks
		Central Government	
1	Ministry of Transport, Public Works and Water management	-Dept. Water policy	-Formulating strategic national water policy
		-Dept. Rijkswaterstaat	-Management of main rivers
		-Dept. Transport	-Formulating strategic national shipping policy
2	Ministry of Housing Spatial planning and environment	-Dept. Spatial Planning	-Formulating strategic national spatial planning policy
		-Dept. Environmental policy	-Formulating strategic national environmental policy
3	Ministry of Agriculture, Nature, Fishery	-Dept. Nature management	-Formulating strategic national nature policy
		-Dept. Agriculture	-Formulating strategic national agricultural policy
		De-centralized government	
4	Provincial governments		-Formulating strategic provincial water policy -Formulating strategic provincial spatial planning policy -Coordination between water policy and spatial planning policy -Testing if plans of municipalities and district water boards are in line with spatial planning policy -Execution of ground water policy
5	District water boards		-Monitoring and Maintenance of water defense artifacts -Management of (surface) water quantity -Management of (surface) water quality
6	Municipalities		-Management of sewer system -Management of groundwater -Purification of (water) soil pollution
		Others	
7	Drink water companies		-Production of drink water -Distribution of drink water
8	NGO's		-Addressing issues -Protecting stakes
9	Engineering agencies		-Design of artifacts -Construction of artifacts
10	Research institutes		-Formulating advice

	Indirectly related actors	
11	Project developers	-Initiation and managing of spatial project
12	Citizens	-Consumers
13	Farmers	-Stakeholders
14	Insurance company	-Supply of insurances
	International actors	
15	European Union	-Water framework Directive
16	International committee for Rhine protection	-Negotiation political transboundary agreements
17	International committee for Meuse protection	-Negotiation political transboundary agreements
18	International committee for Scheldt protection	-Negotiation political transboudary agreements

Summary

Sustainable development is one of the great challenges of this century and it is increasingly recognized that it requires a fundamental, societal reform, or a transition. A transition may be defined as "*a long term continuous process of societal change during which the structure of society, or a sub-system of society, fundamentally changes* (Rotmans, 2001). In general, a transition is thought to occur as a result of increasing pressure from developments at the macro-level and innovations at the micro–level that force a societal system to change. However, it is not exactly clear how this kind of dynamics unfolds or how it may be stimulated or 'managed'. Therefore, the main objective of this dissertation is to generate more insight into dynamics of transitions and more specifically into the dynamics of the transition in Dutch water management.

There is no fully-fledged transition theory as yet; rather there is a conceptual framework of four interrelated concepts which forms the starting point for studying transitions (Rotmans et al., 2004). This conceptual transition framework should be perceived as a 'theory-in-development'. The first concept in the transition framework is the multi-level concept (Rip and Kemp 1998), which distinguishes between three levels of scale at which different developments operate. The concept may be used to describe transitions by unraveling (a) developments in the regime, (b) innovations at the micro-level and (c) long-term trends at the macro-level. The second concept is the multi-phase concept (Rotmans et al, 2001), which distinguishes between four phases in a transition and describes the dynamics during each of these phases. This concept can be used to recognize in which phase of transition a system is. The third concept is the multi-pattern concept, which distinguishes between different dynamical patterns of transformative change. A pattern of transformative change refers to how a structural change unfolds. The multi-pattern concept can be used to describe a transition as a sequence of different patterns of transformative change. The last concept is transition management. This concept is not used to explain transition dynamics, but attempts to understand how the pace and direction of a transition can be influenced.

These four concepts address different aspects of a transition, but they also have their limitations. The multi-level-concept is a static concept and not a dynamic concept showing how the system moves from one state to the next. In addition, there is an underlying assumption that the regime is rigid and inhibits transformative change. The multi-phase concept is in its current form too generic and abstract and essentially describes only one pattern of transformative change. Although this limitation is partly addressed by the multi-pattern concept, the identified patterns are still rather generic and abstract. Currently, two different approaches are associated with the multi-pattern concept. The first approach is the work of Geels and Schot (2007), who have identified four distinct transition paths based on a number of case studies. The second approach is the work of

De Haan (2007) and De Haan and Rotmans (forthcoming) who have identified three different patterns of change. Their approach is theoretical and based on complex adaptive systems theory and needs to be grounded empirically.

An underlying hypothesis is that transition dynamics can be explained by a limited set of patterns. However, the patterns describe *how* the regime transforms and not what is changing, that is, *which* kind of regime structures are actually changing during a transition. We argue that in order to explain transition dynamics, the question of which structures are actually changing is crucial and should be an integral part of the multi-pattern concept. This leads to the following main research question:

Can we describe and explain transitions by identifying the different structures that are changing and by identifying the underlying patterns of transformative change?

To answer this question we have carried out four steps. The first step was a theoretical step in order to develop the multi-pattern-concept further by using the insights from the resilience theory. The resilience theory (Holling, 1973, Gunderson and Holling, 2002, Folke, 2006 and Walker 2004) is a sophisticated conceptual framework for understanding change in social-ecological systems (SES). An SES is comprised of a societal and ecological subsystem. The conceptual framework consists of four underlying concepts: basins of attraction (or stability domains), the adaptive cycle, panarchy and adaptive management. In this dissertation we have referred to it as the resilience framework. We have explored these concepts as to how they may enrich the transition framework. This synthesis leads to a conceptualization of the phenomenon of transition and six types of patterns of transformative change. In the second step we developed a generic approach to analyze transitions since a validated approach did not yet exist (see also Genus and Coles, 2008). This approach is based on a new conceptualization of regime and niches and an adaptation of the patterns of change identified by De Haan (2006) and De Haan and Rotmans (forthcoming). In the third step we have applied this approach to the transition in Dutch water management in order to generate insight into the dynamics. The water management sector is a social–ecological system and offers the opportunity to investigate the resilience-transition synthesis. This case study allowed us to test the developed approach for transition analysis and to analyze the abstract patterns in more detail and to ground them empirically. In the fourth step we have analyzed the niche-regime interactions in more detail. Based on the new conceptualization of regimes and niches we developed the so-called double-loop concept, which describes their interaction. The second and third case studies were used to further refine this concept.

In this way, this dissertation aspires to contribute theoretically and empirically to the transition theory, by developing the multi-pattern concept further, by developing a new

approach for transition analysis and by grounding the different patterns of transformative change empirically in Dutch water management.

The first step in this research was to *further develop the multi-pattern concept of transitions*. The starting point for this step was to explore to what extent the resilience framework could provide new insights. The resilience framework and the transition framework are both concerned with how systems adapt in a changing social or bio-physical environment via structural change, innovation and reorganization. We distinguished the following commonalities. In the first place, both frameworks are rooted in complex systems science and attempt to develop generic concepts about the dynamics by distinguishing different phases and different levels. Secondly, these concepts are used to inform management as to how to deal with the system at hand. Thirdly, both frameworks are based on the idea that complex systems cannot be fully understood, which means that management should involve a continuous learning process by introducing new perspectives, monitoring and experimenting. In the fourth place, both frameworks make a distinction between 'normal' changes and more 'fundamental' changes, like regime shifts.

However, we also identified four different focal points. The first difference is a result of their different origins. The resilience-framework is primarily concerned with ecosystem management, whereas the transition literature is primarily concerned with sustainable development. Secondly, both frameworks differ with regard to their point of departure. The resilience framework is primarily concerned with preserving the SES, implying that the current system is desirable, whereas the transition framework is applied to systems that are considered unsustainable. A third point of difference is the focus. The resilience framework focuses on the ability of a SES to cope with internal or external disturbances, whereas the transition literature focuses on transforming the SES into an envisioned direction. This, however, does not mean that resilience should be associated with a reactive stance (as sometimes claimed), because improving the ability to withstand disturbances may require a proactive and deliberate changing of the system structures. The fourth difference is concerned with renewal. Whereas the resilience framework tends to emphasize the opportunity for renewal after a calamity or disaster, the transition framework focuses on innovation in niches to stimulate renewal in the regime in order to prevent calamities or disasters.

Despite these differences, we concluded that both frameworks are not contradictive, but rather complementary. In a crude way, we would argue that the resilience framework is more focused on preserving systems and protecting them against disturbances, whereas the transition framework is primarily focused on transforming systems into an envisioned direction. Together, the resilience framework and the transition framework cover a spectrum of how to deal with a SES, ranging from building resilience in desired systems to reforming undesired systems into more desired systems.

In our view, this was a good basis for an attempt to synthesize the resilience framework and the transition framework as a means to develop the multi-pattern concept further. We suggest the following synthesis.

First, the resilience framework suggests that the SES operates under a certain regime. This regime has a certain level of resilience and is thus able to cope with external and internal disturbances without transforming structurally. Its resilience is reflected in the distance between the SES and the boundaries of its so-called basin of attraction.

Secondly, we suggest that a transition might be interpreted as the creation of a new basin of attraction and the shift of the SES from the initial basin of attraction to the new basin. This perspective provides us with a conceptual distinction between 'normal' change, that is, change within a basin of attraction, and transitional change, that is, change that results in the creation and shift towards another basin of attraction.

Thirdly, we may distinguish between two generic transition paths. The first path is a 'collapse-renewal' path. This path is suggested by the adaptive cycle, which suggests that a new regime may be built up after the initial regime has collapsed. It emphasizes the role of collapse in the so-called 'release' phase and the opportunity for renewal in the period thereafter. The second transition path is a 'regime shift' path. This path is suggested by the panarchy concept, which emphasizes the ability of continuous renewal and reorganization through bottom-up innovations. This suggests a similar transition path as is indicated by the multi-phase concept, which emphasizes a regime shift as a result of renewal.

Fourthly, the resilience framework suggests that a prerequisite for a regime shift is a sufficient degree of adaptive capacity. A SES with insufficient adaptive capacity is incapable of renewal and reorganization, while an adaptive SES is capable of changing its structures through renewal and reorganization. The resilience literature suggests three important aspects of adaptive capacity: a) the ability for learning and anticipation; b) flexibility of institutional structures (in contrast to rigid structures); c) innovation capital, in terms of people, knowledge and resources. We interpret these three aspects as important preconditions for a SES to make a regime shift.

In the fifth place, the transition framework and the resilience framework point out that transformative change can be triggered by developments at higher scales as well as smaller scales. Therefore, we have made a distinction between a bottom-up and a top-down pattern of transformative change. Based on the work of de Haan (2007) and De Haan and Rotmans (forthcoming), we have distinguished two variants of the bottom-up pattern of transformative change. The first pattern is the niche-absorption pattern, which describes the emergence of niches which are adopted by the regime. The second pattern is the empowerment pattern, which describes the emergence of a niche which expands and co-evolves with the incumbent regime. De Haan and Rotmans refer to the top-down pattern of transformative change as re-constellation pattern in which

a large-scale alternative is imposed top-down upon the regime. In addition, we made a distinction between endogenously and exogenously driven patterns. The reason for this is that the transition literature suggests that innovation comes from outsiders who have a different background and perspective. Therefore, in the endogenously driven patterns, change comes from within the system (i.e. the water management sector) and in the exogenously driven patterns from outside the system. This amounts to the following six patterns of transformative change:

1. Endogenous niche-absorption: a niche is created by the SES and is successfully adopted and incorporated into the regime.
2. Exogenous niche-absorption: a niche emerges spontaneously or is created somewhere outside the SES and is successfully adopted and incorporated into the regime
3. Endogenous empowerment: a niche is created by the SES itself, grows and is able to sustain itself. It forms a new SES in a separate basin of attraction, called a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
4. Exogenous empowerment: a niche emerges spontaneously or is created somewhere outside the SES, grows and is able to sustain itself as a niche-regime. The niche-regime co-evolves with, or competes with the incumbent regime.
5. Endogenous re-constellation: a powerful actor in the SES imposes a transformative change top-down, for instance a national government imposing a large scale reform policy.
6. Exogenous re-constellation: a powerful actor outside the SES imposes a transformative change top-down, for instance a global institution or an international agreement.

These patterns of transformative change take place against the background of 'normal', incremental changes in the regime.

Finally, the last point of the synthesis is that a regime shift is the result of many smaller changes in the regime structures that together contribute to a build-up of critical mass and push the system towards a tipping point. The tipping point reflects the shift of the SES from the initial basin of attraction to the other basin of attraction.

These insights, combined with the multi-phase concept, suggest the following generic multi-pattern conceptualization of transitions:

- At dynamic equilibrium, there are only minor changes in the SES. This system state represents a state before the predevelopment phase. The SES is in a deep basin.
- The shift from dynamic equilibrium to the predevelopment phase is marked by a growing tension, or mismatch, between the SES and its macro-environment. In order to adapt, the adaptive capacity should increase. Niches emerge suggesting to adapt certain structures (cultural, institutional or infrastructural).

- In the shift from the predevelopment to the take-off, there is a buildup of critical mass and more structures change.
- The shift from the take-off the acceleration phase is marked by a tipping point. There is enough critical mass to make the SES shift into another basin of attraction.
- In the shift from the acceleration phase to the stabilization phase, the adaptive capacity decreases. This may be the result of an increasing rigidity of the new regime and is reflected in the basin becoming deeper.
- During the course of the predevelopment, take-off and acceleration phase, the SES is able to renew and reorganize its structures. Underlying these structural changes are the six patterns of transformative change.

In conclusion, an important result of this synthesis is that it grounds transition theory in the complex system theory and more specifically in the resilience theory. It contributes to a further theoretical conceptualization of the phenomenon of transition as a shift from one basin of attraction to another. Secondly, the synthesis provides us with a more dynamic notion of the concept of regime. Systems operate under different regimes, and their rigidity is variable. In addition, the system can also be more or less 'susceptible to regime shift' if it is closer to or further off a tipping point. Therefore, an important lesson for transition research is that we should focus our attention more to the regime as a unit of analysis to understand its adaptive capacity. In the third place, the synthesis resulted in a further elaboration of the multi-pattern concept. The resilience framework supports the different patterns of transformative change that are distinguished in the transition framework and emphasizes the niche-absorption pattern and re-constellation patterns. Interestingly, it does not give much attention to the so-called empowerment pattern, which suggests that this may not be a pattern encountered much in social-ecological systems.

In this part of the research we have been primarily concerned with the conceptualization of transitions and the identification of different types of patterns of transformative change that describe *how* an SES might change its regime. However, we did not discuss *what* is changing. Therefore we must further specify what we mean by regimes and which kind of regime structures are changing during the shift from one basin to another.

In part B, we *developed a new approach in order to analyze transitions with regard to the changes in the regime structures and the underlying patterns of transformative change*. This approach consists of two parts. The first part is concerned with how to define the regime in a particular system (regime analysis) and the second part is how to analyze the patterns of transformative change (multi-pattern analysis).

The regime analysis is based on a new conceptualization of the regime. For our purpose, current regime conceptualizations were too aggregated, too much of a black box and too static. Therefore, we developed a conceptualization that is much more specific

with regard to the elements that constitute the regime. This concept of regime is based on Giddens' Structuration theory and complex adaptive systems theory. The regime consists of three dimensions: actors, processes and structures. The rationale behind these dimensions is that the actors are influenced by the structures in the regime, but the structures are also changed by the processes the actors initiate. We perceive actors as individuals, who are partly autonomous and have their own frame of reference and ideas, but we also see them as representatives from the organization, so they are bounded by the responsibilities and tasks of their organizations. In this way, we use a two-level actor model. According to the same scheme, we defined niches as emerging fields that deviate from the regime. Niches are not antagonists of the regime, rather they can be contrasted in the degree of the radicalism of the innovations. A niche may involve one or more groups of people. Each group has a structure component (niche-structure) and an agency component (niche-group). The niche-structure provides an escape for individuals from the formal day-to-day organizational constraints and provides room for individuals to come loose from their role as representative of the organization and to the opportunity to engage in a reframing process and seek for innovative solutions.

Then, we developed the double-loop concept, which describes the interaction of niches and regimes. The double-loop concept represents the regime and the niche as two loops running parallel: the key processes in the regime and the shadow process. This concept focuses on three critical aspects of niche-regime dynamics. The first aspect is the formation of the niche. We made a distinction between the structural component (the niche-structure) and the agency component (the niche-group) of the niche. The second aspect is the reframing that occurs in the niche and how this leads to the development of a new policy perspective. The third aspect is concerned with how the niche-group influences regime structures through windows of opportunity.

The method for regime analysis encompasses five steps of how a regime can be analyzed with these three qualitative variables (i.e actors, processes and structures). The first step is about defining the system boundaries, which are inherently subjective and depended on the question the analyst wants to address (i.e. which transition is investigated?). Secondly, the main actors in the system must be identified. In the regime analysis, the actors are organizations, taking into account that the actual work is done by individuals. However, the reason why the individuals are at work is because of their membership to the organization and the responsibilities of that organization. With regard to the niches, however, the individual level is more informative. (We come back to this later in part D of this research.) The third step is to analyze the key-processes in the regime. We therefore should discriminate between the key-process of an organization (what is its prime function?) and the secondary processes that are supportive of the key-process. The fourth step is to identify the main regime structures. We used three main categories of structure, namely culture, institutions and infrastructure. The three

categories can be further differentiated into what we have called elements of structure. We found scattered traces of all these elements in the various regime definitions. In this regime concept, we link them with a clear rationale. The fifth step is linking the actors, processes and structures into one scheme in order to understand how the actors may influence the structures via which kind of key-process. In addition the organization between the organizations is analyzed to understand how one key-process triggers another.

The second part of the approach is concerned with the method for pattern analysis. The method is linked to a historical reconstruction of the development of the system. For this we can use the multi-level concept. The historical reconstruction should be subdivided into smaller episodes in which a certain characteristic change occurred. These episodes can be identified through literature or expert interviews. For each episode, the method guides the analyst to analyze the pattern of transformative change in terms of the involved actors, the key-processes that have been influenced and the elements of structure that have changed. These steps are interpreted and matched with the different types of patterns of transformative change. In the final step, the transition can be analyzed as a whole in terms of the regime change per episode, which of the patterns occurred, and the sequence of patterns. The application of this method thus allows one to analyze a regime shift in a more structured way in terms of what has changed (i.e. the changes in the regime structures) and how it has changed (i.e. according to which pattern).

We have *applied this approach in order to analyze the transition in Dutch water management* between 1970 and 2005. This transition can be understood as the shift from a sectoral and technocratic water management regime to an integral and integrated water management regime. One of the questions addressed is whether this shift may be indeed understood as a transition. In this case study, we perceive the shift as a ´transition´ only if there are changes in each of the three types of structure: culture, institutions and infrastructure. This analysis provides us with the basis for discussing to what extent we might classify the changes in the water management as ´transition´.

Our analysis suggests that overall the cultural and institutional elements of structure have changed quite fundamentally. The water management paradigm changed: there is a broad acknowledgement that the water system can not be fully controlled and requires a continuous adaptation. The flood protection discourse changed. Water can not be managed only by technological means, but spatial measures are necessary and that water therefore should be more guiding in spatial planning. The institutional structures are adjusted in order to implement the new water management policy. Many of the planned infrastructural changes are in the start-up phase; however, none of them are actually finished. Considering all the changes in the elements of structure, both the cultural and the institutional structures of a new regime are in place, but the physical

infrastructure is lagging behind. Therefore we concluded that Dutch water management is indeed in transition, however, the transition is still ongoing.

The policy shift that took place around 2000 is now being implemented, which implies that we are beyond the so-called take-off and somewhere in the acceleration phase. However, the acceleration phase should not be seen simply as a quick implementation process, rather as the physical manifestation of the cultural and institutional changes. The term acceleration and the associated steep slope of the S-curve are somewhat misleading. They suggest that the change process goes faster. However this is not necessarily the case since the infrastructural projects tend to take years or decades to be build. The conceptualization of transitions as the shift from one basin of attraction to another may therefore be a suitable alternative for the S-curve, since it does not per se impose an acceleration phase onto the concept of transition.

In addition, characterizing a certain regime change as transition is inherently subjective. The very notion of *fundamental change* used in various definitions (e.g. Rotmans et al., 2000; Geels and Schot, 2007; Rip and Kemp, 1998) to distinguish transitional change from non-transitional or normal change is in the eye of the beholder. Should all elements of structure change in order to consider it as a transition, or it is enough that one element of structure changes? And to what extent do they need to change? If all structuring elements change only a little bit, do we still consider it to be a transition? These questions make research into transitions complex and slippery. In this respect, all we can do is to expand the number of transitions studied and to be precise about what is changed and to let the demarcation emerge out of the database.

The developed approach for transition analysis enabled us to analyze transitions in a structured way. The regime analysis helped to make explicit which actors, processes and elements of structure should be taken into account. The patterns of transformative change enabled us to identify and analyze the types of patterns that occurred. By applying the method for pattern analysis, we learned that transitional processes involve more than one pattern of transformative change. In identifying the patterns that gave rise to the two policy shifts, we first saw various bottom-up patterns of transformative change emerge, which were then followed-up by a top-down pattern of transformative change. The analysis suggests that we may interpret a tipping point as a flip from the bottom-up pattern to the top-down pattern of transformative change and which corresponds to the installment of new institutions. In contrast, the bottom-up patterns (endogenous niche-absorption as well as the pattern of exogenous niche-absorption) primarily influence the cultural aspects of water management). Secondly, the dominant patterns of change were the niche-absorption and re-constellation pattern and we did not come across the empowerment pattern.

These findings suggest that indeed the regime and the niche are not 'opposites', standing next to each other and competing, but that niches and regimes are much

more intertwined and that the ideas developed in the niche are adopted by the regime. Furthermore, they suggest that the transition dynamics should be better understood as a continuous niche-regime dynamic: the regime creates a niche, the niche-groups influence the regime; the regime change triggers new niche-groups, etcetera. That the regime is actively involved in shaping niches by creating niche groups also means that we should nuance the view sometimes seen in the transition literature that regimes are too rigid to adapt.

There are also some shortcomings of the method. The method unravels the different elements of structure, while in reality they are internally related. Discriminating between them is useful and clarifies what is actually changing. However, they often cannot change independently. In this sense, the method makes things explicit, but it may represent a too mechanistic view, where it should be co-evolutionary. Secondly, it remains difficult to identify niches and niche-groups. Distinctions between niche and regime are ambiguous and there are no objective criteria available. However, we do consider these notions useful, especially for providing a language. In this case study we used the selection criterion for a niche in terms of its deviating policy perspective compared to mainstream policy. The niche-groups that we have identified shaped these niches significantly. However, other niche-groups may have been missed. The reason for this might be due to recall bias of the interviewees or that such niche-groups have not been recorded into the history books. Historical research has a bias to the successful niches and niche-groups, while in contemporary cases one finds all kinds of innovative, change agents and deviating policy perspectives. The border between niches and regimes is therefore much more fluent and historical transition studies tend to overstate the distinction.

To investigate niche-regime dynamics in more detail, we carried out two more case studies. The objective of these case studies was to identify different phases in the niche-regime dynamics and to identify the management strategies that were used to influence the interactions. An additional objective was to illustrate how the ongoing transition in Dutch water management was manifesting itself at the regional and local level: the Amstelland case focuses on the countryside and the Rotterdam case focuses on urbanized areas.

In the Amstelland case study *we investigated the pattern of endogenous niche-absorption in more detail.* In this case study we illustrated how the so-called river basin plan for the Amstelland region (a region between the city of Utrecht and the city of Amsterdam) was developed between 2001 and 2003 and how this policy niche influenced the regime thereafter. In order to analyze the niche-regime dynamics, we focused on the three critical aspects of niche-regime dynamics put forward by the double-loop concept developed in part B: niche-formation, reframing and regime influence.

In the case study, we identified five different phases in the niche-regime dynamics. The first two phases were concerned with the creation of the niche. In the first phase, the new Water policy for the 21st century created a new institutional structure, which may be interpreted as the formation of the structural component of the niche. In the second phase, the niche-group was formed through the selection of participants. The next phase was concerned with the development of the river basin plan. The reframing that occurred involved three different aspects. The first kind of reframing was related to problem perception. The water-related problems were perceived as more persistent than before. Secondly, reframing occurred with regard to the cooperation between water managers and spatial planners. Water managers learned how spatial planners were thinking and what their goals were and vice versa. The third kind of reframing was about the solution space, and the acknowledgement that solving some of the water problems in the region required more fundamental solutions and consequently new competences for the water managers. The fourth and fifth phases were concerned with how the niche influenced the regime. In the fourth phase, the river basin plan had to pass different Councils of aldermen, which was essentiality a political phase. The fifth phase was concerned with the adoption of the river basin plan in new and existing policies, which differed highly per actor as a result of internal procedures and strategies.

We concluded that the double-loop concept was a useful concept to understand niche-regime dynamics and provides the people engaged in such a process an action perspective. The five phases have different dynamics and different strategies were used to influence the dynamics. As such we argue that niche-regime dynamics at least to a certain extent can be managed. Strategies such as the selection of participants and the way in which the river basin plan was presented to the politicians have been crucial. In addition, the case study addressed the importance of balancing the 'distance' between the niche and the regime. On the one hand there is a need for freedom in order to develop a new perspective; on the other hand there is a need for keeping a close link with the regime in order to be able to influence. We also argue that the current literature on transition management (i.e. Loorbach, 2007) is actually more concerned with the 'management' of niche-regime dynamics than on the management of the transition as a whole.

An additional conclusion of this case-study with regard to the transition of Dutch water management is that the new water policy (WB21) is extremely difficult to implement regionally. The ultimate consequence of the policy is that land is transformed into wetlands; however, the case study shows that the complexity of the policy in terms of the multitude of overlapping plans, the lack of detailed data, the future uncertainties and the resistance of residents delay the execution of such plans enormously.

In the case study of Rotterdam we focused on the same three aspects of the niche-regime dynamics in order to investigate whether the same phases and strategies could

be identified. In this case, the niche was not formed by the water management regime but by the spatial planning regime and therefore allowed us *to investigate the pattern of exogenous niche-absorption in more detail*. This case study illustrated how the city of Rotterdam developed a climate adaptation strategy. In urbanized areas there is not much space available for water retention and the water issue has little political priority. This case study had the same design as the previous case-study.

We identified similar phases to the phases in the previous case. During the first phase, we observed the creation of the niche-structure, which in this case was created by an architecture design contest. Similar to the Amstelland case, the niche-group was created through a strict selection procedure of team members joining the contest. In the next phase we identified similar types of reframing that occurred in the niche. In terms of the problem perception, the existing water-related problems were placed in the perspective of long-term climate change. With regard to different perspectives, the spatial planners learned how the water experts think and vice versa. Thirdly, with regard to the solutions, new strategies were developed which were based on the idea how additional water retention could contribute to solving urban problems. In the Rotterdam case, we also observed two phases during which the niche influenced the regime. However, these two phases were different from the Amstelland case. The niche-group had no formal status like in the Amstelland-case, which means that there was no phase of formal approval. In this case, this phase was about creating enthusiasm. The design received a lot of public attention, including the local politicians. In second instance, there was a direct influence when the design was used as input for a new urban water management plan.

We may conclude that since similar phases were present as in the Amstelland case study, the double-loop concept captures some of the crucial aspects of the niche-regime dynamics. In terms of management of the niche-regime dynamics, we have seen similar strategies as in the Amstelland case study, such as the selection of participants and group facilitators. This case study showed the importance of developing an inspiring vision or a design and the importance of an adequate process design.

A conclusion with regard to how the transition is manifesting itself in urban water management, is that water managers are forced to link up with urban renewal developments in order to meet the quantitative water challenge. This requires of the water managers that they find ways not only to manage the water, but that they find ways in which the water adds quality to the area and contributes to the solution of urban problems of higher (political) priority, for instance by upgrading deprived neighborhoods. Secondly, innovative water infrastructures, such as green roofs and water retention squares, are alternative solutions to digging new water ways requiring less space. Since these infrastructures can combine different city functions the costs can be shared among the stakeholders, but it also requires new institutional cooperative structures.

The main conclusions we draw on the basis of this research are the following. First of all, we should adjust our view of transition dynamics which is dominant in the transition literature. This view suggests that niches cluster, expand and that the incumbent regime is forced to transform as the result of increasing bottom-up pressure and top-down pressure. However, this research suggests that regime actors are actively involved in creating niches and niches may be adopted more quickly. The general picture that emerges is that transition dynamics are the result of a continuous dynamic interplay between niches and regimes. Within the regime niches emerge. Regime actors actively create niche-groups; the niches initiate structure changes in the regime; these changes in turn trigger new niche-groups, etc. The developed double-loop concept captures three important aspects of this niche-regime dynamic. The double-loop concept shows a way forward how to investigate the niche-regime dynamics and how to manage the interplay.

Secondly, this research shows that the regime and the niche are not antagonists, but that they are contrasted in the degree of radicalism of innovation. We should view the regime as a dynamic and heterogeneous entity with adaptive capacity, comprised of actors, processes and structures.

Thirdly, this research suggests perceiving transitions as regime shifts. However, there is not one single grand regime structure, but rather a multitude of different elements of structure. During a transition, different elements of structure change, adding up to a transition. These structure elements are interlinked an impose constraints on each other, so the process of change is co-evolutionary. However, there appears a rather general sequence of the cultural elements that change first, then the institutional structures and then the infrastructure.

A fourth conclusion is that the transition analysis approach we have developed has an added value since it enables us to carry out a multi-pattern analysis in addition to a multi-level and multi-phase analysis. This approach combines the aspect of how the regime is changing (i.e. the patterns of transformative change) with what is changing (i.e. the elements of structure). Currently, the regime is almost treated as a black box, not explicitly clarifying what is in there. In our view, the regime should be the main unit of analysis, especially since the regime appears to have a more proactive role than was often assumed. The regime conceptualization we have suggested in this dissertation is a first step into this direction. The approach allows us to be specific about which regime structures are actually changing during a transition and to analyze different patterns of change.

A fifth conclusion that we draw regarding the Dutch water management sector is that the regime shift appears to be a result of various niche-absorptions patterns, which add up and eventually trigger a top-down pattern of transformative change. The flip from

the bottom-up to the top-down patterns can be interpreted as tipping point and is associated with the establishment of new institutional settings.

A sixth conclusion that we draw, is that the transition in Dutch water management is currently in an acceleration phase. Institutionally, a new regime is being established and the infrastructural changes are now slowly taking place. However, there are still many barriers and it is not clear whether this regime will stabilize in this basin of attraction. The acceleration phase and associated steep slope of the S-cure are somewhat misleading, since the planned infrastructural programs take decades. Therefore the conceptualization of transitions as the creation of and the shift towards a new basin of attraction may be a suitable alternative. It does not imply acceleration, but the physical manifestation of the cultural and institutional changes.

A seventh conclusion is that transition management should involve two generic strategies. The first is enhancing the adaptive capacity of the regime in order to create the right conditions. This can be done be stimulating the ability for learning, the creation of experiment location with flexible institutions and increasing the innovation capital. The second strategy is initiating and organizing specific patterns of transformative change. In the transition management literature, most of the attention has been focused on the bottom-up patterns of transformative change and much less to the re-constellation pattern. For this pattern other strategies should be developed. A multi-pattern analysis can be used as input for a transition management process. The analysis of which patterns are currently present in a system may provide leverages for transition management. Different patterns of change may require different transition management strategies in order to stimulate or re-adjust the changes.

Based on this research we recommend that future research should focus more on the role of the regime. In addition, we should investigate under which conditions which kind of patterns emerge and which kind of patterns can influence which kind of regime structures. Secondly, we suggest expanding the database with regard to this kind of transition analyses and to specify the structure changes, to find additional patterns of change and to learn to understand the sequence of patterns in other types of systems in transition. A third recommendation is to include the geographical dimension of transitions, which is currently lacking. Our final recommendation is with regard to transition management. We suggest that further research should focus on how to enhance the adaptive capacity of the regime and on the development of transition management strategies and instruments for each pattern of transformative change. In this way, transition management may be better equipped to influence transition dynamics into a more sustainable direction.

About the author

Rutger van der Brugge (1978) was born in Leidschendam, The Netherlands. He has a background in Environmental Health studies and Arts & Sciences. He has been a researcher at the ICIS-institute at Maastricht University from 2002 till 2004 where his main research area was on transitions, system Innovations, transition Management and sustainability. In 2004, he started to work at Drift (the Dutch Research Institute for Transitions) at the Erasmus University Rotterdam, where he finished his Ph-D dissertation "Transition dynamics in social-ecological systems. The case of Dutch water management". Rutger van der Brugge has been involved in a number of research programmes and consultancy projects concerning transition dynamics and transition management. His academic interests are transitions, resilience, complexity theory, water management, climate change and sustainability.

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