Rutger van der Brugge
D.R.I.F.T - Dutch Research Institute for Transitions
Erasmus University Rotterdam,
Faculty of Social Sciences
P.O. Box 1738
3000 DR Rotterdam
The Netherlands
VanderBrugge@fsw.eur.nl

Transition Dynamics: the case of Dutch water management

Abstract
In this paper we want to further develop transition theory with insight from complexity theory and illustrate transition dynamics with a case study in which the driving forces and changing interaction patterns in Dutch water management policies and strategies are analyzed. The changing patterns are viewed as transition dynamics from a technocratic water management regime towards integrated water management. Based on this case study we have gained insight in how transition dynamics work and how a multi-phase and multi-level approach can be used to describe and analyze transitions of society. We have investigated if the historical developments in Dutch Water management can be characterized as a transition between two management attractors, from the 'water will follow' attractor to the 'water as a guiding principle'-attractor. Our research indicates that this transition is currently in the take-off stage, but near the acceleration stage. There are still major barriers for the transition to shift into the next phase as long as there is not enough alignment between the strategic macro-vision, actor configurations and practical implementation at the micro-level. The formation of a transition arena could help to align the strategic, tactical and operational levels.

Keywords: transition, complexity, water management

Introduction

Recently, Rotmans et al. (2000) have introduced the concepts of transitions and transition management as integration framework into the field of sustainability and governance (Rotmans et al. 2000). This framework is rooted in complexity theory (Progogine, 1984; Kaufmann, 1995; Holland, 1995) and post-normal science (Ravetz, 1999), integrating theories about the behavior of complex adaptive system (CAS) with insights from the field of governance (Sabatier, 1999), evolutionary economics (Nelson and Winter (1982) (Arthur, 1988) Innovation studies (Smits & Kuhlman, 2004) and technological transitions (Kemp, 2000) (Geels & Kemp, 2000). Rotmans et al. (2000) define a transition as 'a continuous process of societal change, whereby the structure of society (or a subsystem of society) fundamentally changes'. Transitions can be illustrated by an S-shaped curve (Figure 1). Although this is a very simple aggregated curve, the underlying transition dynamics are complex interaction processes between markets, networks, institutions, technologies, policies, individual behavior and autonomous trends in the economic, socio-cultural and ecological domain. From a systems perspective, transitions are system transformations from initial equilibrium dynamics through a period of instability and rapid developments reverting to relative stability again (Rotmans, 1994). In between the two equilibrium states there is a period of rapid change in which the system undergoes irreversible change and re-organization.

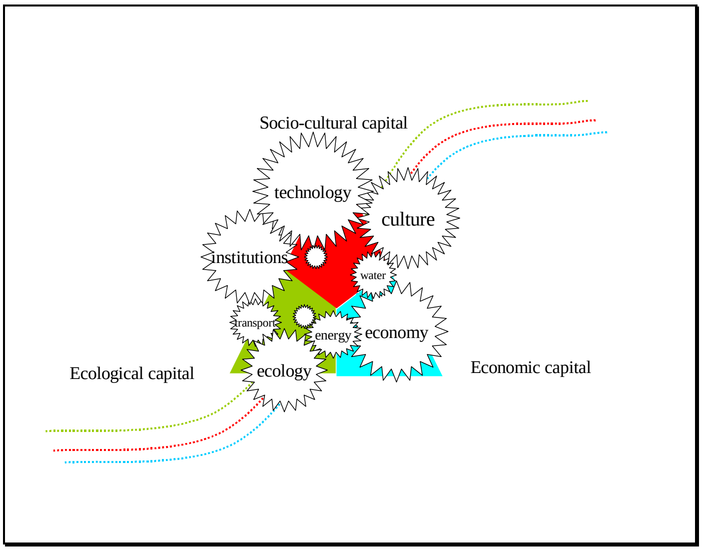

Figure 1. Transition as a complex set of reinforcing societal cogwheels (Martens & Rotmans, 2002.)

According to Rotmans et al. (2004) the current state of knowledge about transitions dynamics in societal systems is still limited. In order to strengthen the scientific knowledgebase with regard to both transitions and transition management, the

‘Knowledge network on System Innovation and transitions’ (KSI) has been established. In the coming six years this network will carry out a scientific research program on historical transitions, current transitions and the management of transitions (Rotmans et al, 2004). Three analytical tools are central to the program for pattern recognition and explanation of transitions dynamics:

(1) A transition is a sequence of the following four phases: the predevelopment, the take-off, the acceleration and the stabilization (multi-phase concept).
(2) A transition is the result interacting developments at the macro-, meso- and micro-level (multi-level concept).
(3) In a transition there are different types of change (multi-change concept.)

According to Rotmans et al. (2000) the general pattern in these four phases is the following. In the pre-development phase the system dynamics do not visibly change but variables (stocks) are slowly changing. In the take-off phase, the structure of the system begins to change, which is manifested by new emerging variables and relations (flows) and destruction of existing patterns. Thresholds may be reached and the system state becomes increasingly vulnerable. Than in the acceleration phase structural change takes place. At the system level new patterns of system dynamics emerge as a result of accumulation of socio-cultural, economic, ecological and institutional changes innovations that reinforce each other. And eventually in the stabilization phase the new pattern of system dynamics reaches a new dynamic equilibrium.

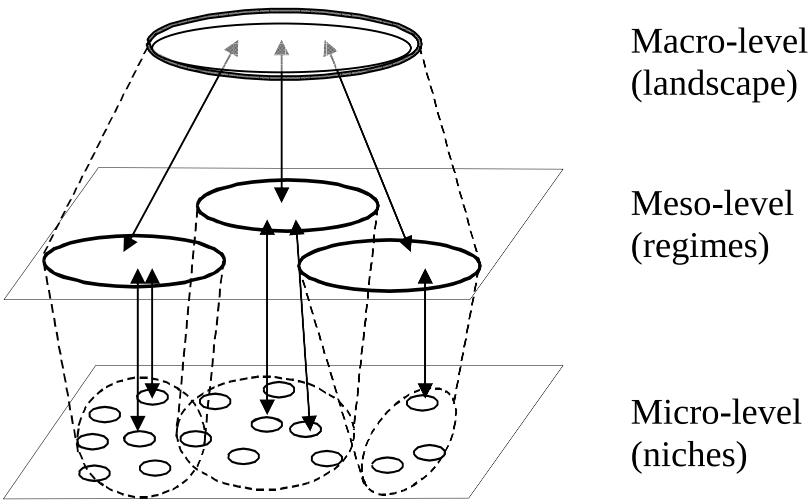

Figure 2. Interaction between different scale-levels (Geels and Kemp, 2000).

Transitions only unfold when developments at the macro level, meso-level and micro-level ‘move into the same direction’ (Rotmans, 2002) (Geels and Kemp, 2002). This mechanism is called modulation (after the musical phenomenon of moving to a different key). Geels and Kemp (2000) use a multi-level perspective to describe and explain the diffusion of technological innovations, but it is also useful to describe and explain transitions (see Figure 2). At the macro-level the socio-technical landscape is determined by changes in the macro economy, politics, population dynamics, natural environment, culture and worldviews. This level responds to relative slow trends and large-scale developments. At the meso-level there are patterns of artifacts, institutions, rules and norms assembled and maintained to perform economic and social activities to which is referred to as the regime (Berkhout et al. 2003). At this level the dynamics are determined by their dominant practices, rules and shared assumptions, social norms, interests, rules and belief systems that underlie strategies of companies, organizations and institutions and policies of political institutions which are often geared towards preserving the status quo and thus towards optimization and protecting investments rather than system innovations (Rotmans et al. 2000). At the micro-level (niche-level) there are individual actors; alternative technologies and local practices. At this level, variations to and deviations from the status quo occur as a result from new ideas and new initiatives and innovations, such as new techniques, alternative technologies and social practices (Kemp, Schot & Hoogma, 1998).

When the macro–level landscape changes, agents at the micro-level will respond. The regime as a whole is not capable of doing this. The deep structures, e.g. those that are deeply embedded in the social interactions in the regime, are hard to break because of strong interdependencies. This constitutes path dependency at the regime level and limits radical and fundamental change induced by the regime. The regime thus (initially) tries to reduce the effects of the changing landscape through optimizing its existing structures. Eventually, pressure from both macro–level and micro-level cause the regime to change these structures in order to adapt to the changing outside world.

In order to learn to recognize the generic dynamic patterns in each transition phase there is need of further development of the theory. In this paper we want to further develop transition theory by describing and the driving forces and interaction patterns that took place since the 1970's in Dutch water management policies and strategies. The shift that took place can be illustrated as a transition from a scientific technocratic water management regime to integrated water management (Van der Brugge, 2005) (Bosch & Van der Ham, 1998). Based on this case study we will gain insight in how transition dynamics work and how a multi-phase and multi-level approach can be used to describe and analyze societal transition processes. Before moving onto the case study, we will first go into some general issues concerning complex adaptive systems and transitions theory. We will present an ideal typical 'transition trajectory', which will be our heuristic framework for the case study.

Transitions

Rotmans and Kemp (2000) have introduced the concept of transition into the field of sustainability and governance (Rotmans et al. 2000; Loorbach & Rotmans, 2004). Transitions are studied from a complex adaptive system (CAS) paradigm, linking CAS-properties to the dynamic behavior of societal systems, such as mobility, energy and agriculture, and the management of transitions. Rotmans et al. (2000) define a transition as ‘a continuous process of societal change, whereby the structure of society (or a subsystem of society) fundamentally changes and has the following characteristics (Rotmans, 2000):

- It concerns large scale technological, economical, ecological, socio-cultural and institutional developments that influence and reinforce each other;
- It’s a long term process that covers at least one generation (25 years);
- There are interactions between different scale levels (niche, regime, landscape).

Properties of Complex Adaptive Systems
– Complex systems consist of many and divers components and interactions between them. The components may be agents, as well as physical or social entities. The components are organized in a network configuration.
– The system is open, so there is exchange of matter energy and information with the external environment pushing system away from thermodynamic equilibrium
– There is non-linearity in the system. Over time small causes can have large effects.
– There are positive and negative feedback loops in the system, resulting in respectively reinforcing or dampening effects.
– The system is adaptive because (part of) the components in the system respond to change in their environment.
– The system is nested, so we can observe different organizations at different levels
– There is co-evolution: through interaction patterns certain developments become irreversible. Components push each other over thresholds beyond which there is no way back.
– There is emergence: novelties and new patterns at higher levels of organizations spring into being as a result of component interactions.
– There is more than one qualitative different attractor (relative stable equilibrium state) possible to which the system may develop.
– Each attractor has a certain stability domain, constituted through thresholds.

Table 1. Aspects of Complex Adaptive Systems

Complex Adaptive Systems

Transition theory is based on the properties of complex adaptive systems (Prigogine, 1984; Holland, 1995; Kaufmann, 1995) and applies it to change processes in societal systems (table 1.). Complex system properties give societal systems the ability to self-organize, e.g. to be able to spontaneously adapt to changing environmental conditions without external control. The process of change itself is punctuated; jumps between equilibrium states[1] that are qualitative different in terms of system structures. Equilibrium states are not static, however, there is a stable organization of the dynamics because they remain within a certain variation range (stability domain) as result of feedback mechanisms that keep the system organization on the attractor. According to C.S Holling (1987) (Gunderson & Holling, 2002) the dynamics are dominated by a relative small number of interacting variables, which he calls the attractor. Transition from one attractor to another require system perturbations of some kind (crisis, or innovations) that are able

[1] The late scientist Stephen J. Gould referred to this jump-wise evolution as ‘punctuated equilibrium’ evolution and is seen in biological evolution.

to break the existing attractor organization. Combining the properties of complex adaptive systems with multi-phase and multi-level yields the following dynamic pattern:

Fase 1. Predevelopment → Approaching criticality
At each system level dynamics are determined by lower level components and constraint by higher levels. Components perform a certain function in certain organization. The (repeating) interaction patterns of components constitute a relative stable organization (attractor dynamics). At the meso-level, the dominant practices of major stakeholders and their artifacts form the attractor. This is the regime. Around each attractor there is a stability domain. The size of the stability domain is a measure for the resilience of the system to stay on the same attractor and thus maintain its organization. Stability domains are formed through thresholds. In the predevelopment phase the system interdependencies increase and as a result the regime organization becomes increasingly dependent from events taking place somewhere else (criticality).

Fase 2. Take off → Triggering change & Build up of the new attractor
In the take off two co-evolving mechanisms are at work.
→ Triggering change
As the system becomes increasingly 'critical', probability increases that somewhere in the organization the thresholds of the stability domains are exceeded. Exceeding the thresholds of stability domains can be the result of calamities or penetrating innovations. The result is a system crisis. The attractor-dynamics collapse when certain functions fall away because components are no longer able to perform their function adequately and there is functional substitution preformed by other components.
Emergence of alternative (innovative) activity is generally constrained by the attractor dynamics at higher system levels. Thus for alternative behavior to evolve and diffuse (or emerge at higher system levels), it seems a prerequisite that higher-level attractors develop into unstable networks before it is possible for alternative dynamics to break through. For alternative behavior to move up system levels thus has to be radical enough to break the (slower) aggregated attractor dynamics at higher levels.
→ Build up of the new attractor
Simultaneously there is build-up of alternative behavior. Innovations (idea, concept, theory of technology) may act as assimilation nuclei around which a new network of (positive) feedback interactions - the new attractor – emerges. In order to survive and assimilate it needs access to resources, like for example money and knowledge (e.g. the societal equivalents of nutrients and energy needed by biological systems to maintain their organization). When the assimilation nucleus grows to become a self-sustaining attractor that is able to maintain its own organization[2] it has survival advantages as opposed to assimilation nuclei that are not capable of doing that. According to Arthur, increasing returns to adoption may lead to sub-optimal solutions, meaning that the outcome of the competitive nuclei may depend on the ability to be incorporated in the regime, while technically it is not the most superior option (Arthur, 1988).

[2] This phenomenon that biological networks of components are able to reproduce their own organizations is referred to as autopoiese. The sociologist Niklas Luhmann has applied the same concept to societal systems (1984).

Depending on co-evolution of developments in the regime on the one hand, and the 'survival fitness' of the available attractors on the other, there can be three pathways (Figure 3.): (1) there remains a co-existence of more competing attractors (lock-in), (2) there is only one attractor which is reinforced by sub-attractors which enable the attractor to grow (acceleration), or (3) the attractors are all weak and compete for same resources. This is a chaotic world where systems come and go (system breakdown).

Fase 3. Acceleration → Cascading effects

In the acceleration it is becoming clear which of the attractors has the best 'fitness' to survive. Fitness is a relative term, referring to the survival chances of the attractor in a co-evolving world. Thus while the attractors compete for resources with each other, they simultaneously are influenced by the regime developments. Co-evolution in the end determines the outcome as a result of recursive developments between the macro developments, regime developments and attractor growth at the micro-level.

When the attractor is not able to outcompete other attractors it can't grow further. When it is able to outcompete other attractors - for instance by blocking a component access to a resource in another attractor - the strongest attractor grows in volume. When weaker attractors fail to find functional substitution they have no chance of survival and they will collapse. This may cause again other attractors to collapse. It may also initiate the emergence of new attractors.

Fase 4. → Stabilization

In the stabilization the attractor stops its exponential growth and slowly settles into equilibrium of needs and resources. When this equilibrium is not reached, the attractor can still breakdown (backlash).

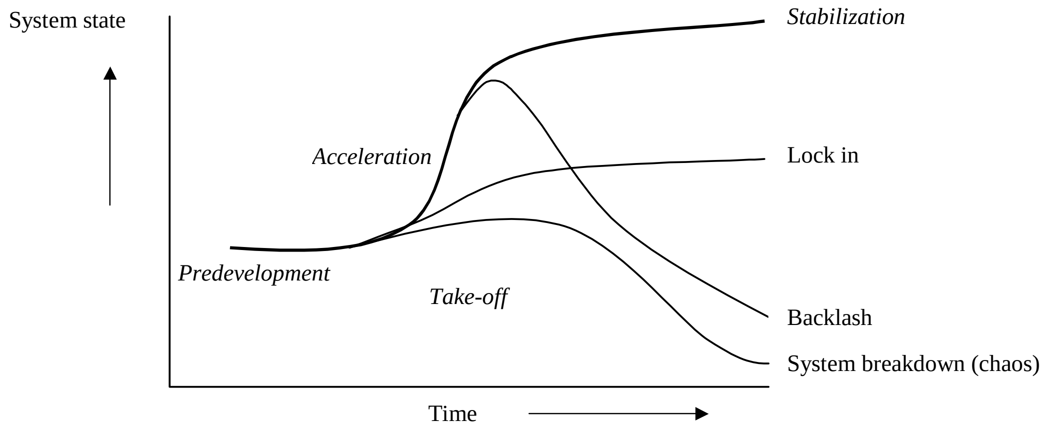

Figure 3. Possible system pathways

Case Study: The Transition in Dutch Water management.

In this chapter we will apply the above transition model in order to describe the observed water management shift in the Netherlands over the past four decades; the transition from the scientific technocratic water management regime towards the integrated water management regime (Van der Brugge, et al., 2004). The changing nature and scope of water management is reflected in subsequent National Policy Memoranda on Water Management (Rijkswaterstaat, 1964, 1982, 1989, 1998). During this period the scientific technocratic water management regime, that had a major focus on the physical and hydrological processes from a technocratic policy paradigm, started to change towards what is now called 'integrated water management'. Integrated water management (Saeijs, 1990) perceives the (context-specific) water system as a whole, integrating social, ecological and physical components of the water system.

The predevelopment phase

Water-related problems traditionally were solved with technological means. The dominant attractor was controlled by a scientific technocratic regime that reigned throughout the 20th century (Bosch & Van der Ham, 1998; Van der Ham, 1999; Lintsen, 2002) and can be sketched as the 'Water will follow' attractor. The attractor emerges out of interaction between regime actors that perform their tasks in specific ways. At the macro level, the attractor pattern becomes somewhat like this: growing economic development, increasing population density and changing life-styles are leading to an increasing spatial claim of agriculture, industry, traffic, housing and infrastructure. Water management is occupied in meeting these societal needs. Water managers engineered the water system to meet the needs and the water followed. By doing that, water mangers were draining redundant water, canalizing rivers and constructing dams. Through the significant interventions in the water system, the water engineers fabricated an unnatural, engineers' design that could only be controlled and maintained by continuing the technological mode of operating (path dependency). The problems were perceived as singular technological problems. The right solutions were engineering solutions. Problem perceptions and solutions were being transferred to next generations, for instance in educational settings.

Eventually this led to a decrease in land cover destined for water. So while the volume of water discharge did not change (moreover extremes are more likely to occur as a result of climate change) water surface decreased. Thresholds thus, were bound to be exceeded at some point in time. And so they did. All kinds of problems manifested themselves: floods, droughts, financial damages and diminishing water quality. As water management tried to control them and performed brilliant things in doing so, it did not solve the problem on a fundamental level as it remained in the familiar realm of the approved attractor.

Take-off → Triggering change

After the floods in 1993 and 1995 of the rivers Meuse and Rhine, increasing numbers of people started to understand that the 'water will follow' attractor had resulted in an unsustainable water system and that the problems were symptoms of the system exceeding its thresholds. The floods were followed by high regional water levels in 1998 and flooding in the small village of Wilnis in 2003. Also within the regime the perception of flood protection and safety changed. The regime could no longer defy that the engineering approach as long-term strategy was not viable any longer.

The Tielrooy-committee claimed that 'Dutch water management is not sufficiently prepared to meet the challenges of climate change effects in the next century' (CW21, 2000). The continuous subsidence of soil, the rising sea level and the decreasing capacity to retain water due to loss of nature will cause serious problems in the future. Climate change will contribute by extreme events and higher frequencies of relative high and low discharge levels. On the whole, water managers began to understand they had to go back to a natural water system and acknowledge the spatial claim of water because the current design was not capable in meeting future threads. What in fact the Tielrooy-committee proposed was a new management strategy based on a new attractor. This attractor we call the "Water as guiding principle" attractor. From now on, the committee said, should our water management approach be a strategy of retaining, storing, and draining water where and when needed. Solutions are to be found spatially, not technologically. From than on, water management was an important guiding principle in spatial planning.

Take-off→ Build up of the new attractor

Many developments have ultimately led to the proclamation of the new attractor by the Tielrooy-committee. This already started in the 1970's as has been illustrated in Van der Brugge et al (2004).

The emergence of ecological orientation

In order to prevent another crisis such as the 1953 "waternoodsramp", Rijkswaterstaat (the Dutch ministry concerned with water management) started the construction of the Delta Works in the 1960's. Although very successful in its initial goal of enhancing safety, the Delta Works also had some profound adverse effects for nearby ecosystems. Salt water ecosystems transformed into fresh water ecosystems, leading to dramatic consequences in local biodiversity (Interview Saeijs, van der Kleij, 2002) (Bosch & Van der Ham, 1998). To prevent this form happening again, the Delta Dienst, the formal institute responsible for the construction of the Delta Works, raised an environmental department concerned with ecological research. Head of the environmental department at the time was H. L. F. Saeijs. A biologist himself, he brought in over a hundred fellow biologists into the engineers dominated world of water management. The research activities performed by the Delta Dienst led to a number of restoration problems. In 1985, important elements of the ecological approach in water management appeared in the policy memorandum 'Dealing with Water' (RIZA, 1985). The report reached a wide audience, partly due to the ecological calamities evoked by the Delta Works. The systems approach advocated in this document represented a new perception proposing water as an integral part of an ecosystem in relation to its community (Saeijs, 1991, Interview Saeijs, 2002).

Important reasons why the ecological perspective resonated at the meso-level were the growing number of biologists. During the construction of the Eastern Scheldt storm surge barrier the Environment Department of the Delta Dienst grew quickly to over one hundred biologists and confronted the regime with the consequences of their practice (Bosch & Van der Ham, 1998). In a huge re-organization process of Rijkswaterstaat in order to integrate water quantity and water quality policies, in order to integrate the Delta Dienst was officially removed and many former Delta Dienst biologists came into strategic positions (Interview van der Kleij, 2002). Cross-fertilization between biologists and water engineers ‘infected’ Rijkswaterstaat with new ideas (Interview Saeijs, 2002; van der Kleij, 2002; Overmars, 2002).

Another impetus towards the integration ecological considerations and water management was provided by the award-wining Plan Ooievaar (De Bruijn et al, 1987). The contest was called Netherlands – Riverland (organized by the E.O. Wijers Institute in the Netherlands) and invited people to come up with ideas about future water management. ‘Plan Ooievaar’ departed from decoupling agriculture and nature preservation, claiming that agriculture, instead of preserving nature, was damaging ecosystems (Interview Overmars, 2002). ‘Plan Ooievaar’ broke with prevailing beliefs and also defied the traditional influence of agricultural demand in water management. In short, Ooievaar came down to removal of agricultural land in the river flood plains and letting nature do what is does best. A number of experiments based on the Ooievaar principles started in different regions, e.g. the Duursche Waarden, in Rhenen and the Gelderse Poort (Bosch & Van der Ham, 1998).

The emerging link with spatial planning

The link between spatial planning and water management have always been around, but not until the end of the eighties conscious integration of the two policy fields was never serious attempt (Interview Saeijs, 2002). Meaningful in this respect is the World Wildlife Fund plan Living Rivers (WNF, 1992, ‘*Levende Rivieren*’) (Interview De Jong, 2002). Living Rivers elaborated on ‘Plan Ooievaar’ with a slightly different focus on the aquatic ecosystem and its flora and fauna. Wanting to restore broken food chains, Living Rives proposed the introduction of small channels in the river flood plains. A secondary aim, but not to be neglected, and maybe even more important in its success, ‘Living Rivers’ presented an alternative route for planned dike enhancements. Thus by means of spatial means, such as the channels themselves and the concurrent excavation of clay layered floodplains, it became possible to cope with expected discharge levels (Interview De Jong, 2002).

In that same period a small group within Rijkswaterstaat also explored possibilities of integrating water policy with spatial planning. The resulting report ‘Dealing with the Surrounding Area’ (Rijkswaterstaat, 1992 ‘*Omgaan met de Omgeving*’) initiated a number of informal interdepartmental meetings of top officials discussing the future of this path of integration.

Co-evolving mechanisms

The above-described innovations can be interpreted as foundations of the new attractor. The new attractor requires a totally different organization in terms of actors, responsibilities, tasks, technologies, regulations etc. There have been some up-scaling mechanisms as a result of co-evolving developments at the macro-level and meso-level that stimulated the emergence of the new attractor. First of al there was emergence of the environmental movement and the awareness it created about environmental pollution. The Eastern Scheldt storm surge barrier is one of the most significant signs of changing attitudes within Rijkswaterstaat, although it was forced form the outside. This was also one of the reasons why Rijkswaterstaat embraced the plans s of WWF that had broad support and sympathy among many civilians (Interview Verwolf, 2002).

Secondly, initial ambitions - and later the necessity - of integration of water practices and spatial planning grew rapidly. The major role of the floods is that they did not leave any doubt about the necessity of new strategies and aligned water managers, shifting from debate to collective search. The perception of flood risk had drastically changed.

Thirdly, there has been quite a shift in power-relations in the sector as a result of institutional re-arrangement. In general, Dutch policy has promoted decentralization and privatization since the 1980's. With regard to the water regime this has resulted in increasing proportions of tasks done by other parties than Rijkswaterstaat. This has had major consequences for its hierarchical position and consequently its top-down policy. Additionally, two quite huge re-organizations in the water regime led to the institutionalization of the integration of ecology and water quantity. The first reorganization was concerned with attuning water quality and quantity policies within Rijkswaterstaat. The Delta Dienst staff was replaced and scattered over several departments. The second re-organization - the merger of the water boards - is still going on. Both developments have had serious effects upon the institutional arrangements in the sector.

In summary, we may conclude that the emergence of the new attractor is based on two discourses that emerged – inherent relation between ecology and water management (water quality policy) and spatial planning and water management (water quantity policy) – that are now being institutionalized. Both integration processes have been reinforced by crises, such as the ecosystem damage induced by the Delta Works, and the floods of 1993 and 1995. This has resulted in re-organizations of the sector, thereby institutionalizing the discourses, and pushing the system into the new attractor trajectory 'Water as guiding principle'.

Acceleration?

Ideally, the acceleration phase is reached when the prevalence of one attractor becomes apparent. The question thus is whether we already can speak of a new attractor, which is on the one hand able to maintain itself, on the other hand able to compete with the old attractor regime. One of the strengths of the emergent attractor is the seemingly coherence of the concepts at the strategic level. There are however many practical hurdles and changes such as new institutions and debates cascading from the emergent attractor in which the coherence is not been found. Most important in this respect are the ‘water test’, debates about flooding polders and merging regional water management boards with provincial government layers. The transition thus still in a phase in which the new strategy is acknowledged, but the actual implementation is difficult. Therefore, one could argue that the water management system is not settled on the new attractor yet, it is only being envisioned, implying that currently the water management system is somewhere amidst the two attractors. In trying to move away from the ‘Water will follow’ attractor and onto to the ‘water as guiding principle’ attractor, numerous difficulties are encountered along the way since everything is still attuned to the old attractor. It means that interrelated subsystems have to flip into a new configuration, which requires alternative modes of operating, cooperation and regulation. Such sudden and rapid transformations are on the other hand very decisive in which configuration the system will end up in. The question is thus whether it is still possible to go back to the old attractor or that we can manage to get onto our envisioned attractor? When the debates are not solved, the pieces do not move and when the involved actors are not able to change their mode of operandi, a lock-in between the old en new attractor is also not inconceivable.

Water transition management

Table 2. shows five aspects that have changed over these past 40 years. First of all, problem perception has changed. The water problems are no longer seen as singular problems of technological nature, but as sets of interrelated problems, also depending what society wants. The water-related problems are symptoms of a deeper lying, fundamental problem that has emerged as a result of human interventions in the natural water system over the last centuries that have led to subsidence of soil and decreasing capacity to retain water due to loss of nature. Water engineers, in trying to meet societal demands, fabricated an intelligent branched, but unnatural water system built of canals, dikes and polders, draining redundant water to the sea and limiting the spatial demands for the entering water volume. The water problem viewed from this perspective is a ‘persistent’ problem. The persistence is caused by significant complexity and the structural uncertainty of the interactions of the societal demands and the impact of climate change that give rise to a multitude of plausible perspectives and the diversity of stakeholders with high stakes involved that give rise to governance problems (Dirven, Rotmans and Verkaik, 2002). The historically attuned institutionalized structures, social norms and economic mechanisms have now become the barriers for structural re-organization of the water management system.

Aspects of Water management	1970's	2000
Problem perception	Singular	Interrelated
Management perspective	Technological solutions	Spatial solutions
Competences	Disciplinary	Interdisciplinary
Staff	Engineers	Engineers, biologists, Public Managers, Spatial Planners
Institutional Organization	Hierarchical, top down	Networks, participation

Table 2. Changed aspects of water management in the Netherlands

The persistent water problem is a set of interrelated water problems, such as rising sea levels, groundwater problems, surface water problems or drinking water problems manifest themselves in different issues, such as demand and supply, water quality, waste-water treatment, or the alteration of hydrological cycles. Simultaneously, water serves important functions in our society: an *economic* function for navigation and agriculture, an *ecological* function for sustaining ecosystems, and a *social* function in terms of safety and drinking water supply. Water also represents different values: an *economic* value expressed as the utility value of water by using some kind of pricing mechanism, an *ecological* value expressed as the water regulation services for ecosystems, and a *social* value, indicating the cultural and emotional meaning of water.

Good water management practice thus requires an integrated approach addressing the multiplicity of water problems that are related through the underlying system structure. Water managers have to integrate management strategies at different scale levels in order to address the problems adequately. Considering the complexity of the water management system and the uncertainty of developments prevent clear-cut solutions to realize the envisioned future. Managing the transition towards the envisioned water management attractor is a matter of a joint search and learning process through coordinated multi-actor processes at strategic, tactical and operational levels. Transition management is based on four co-evolving activity clusters (Figure 4): (1) the establishment and development of a transition arena; (2) the creating 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 & Rotmans, 2004).

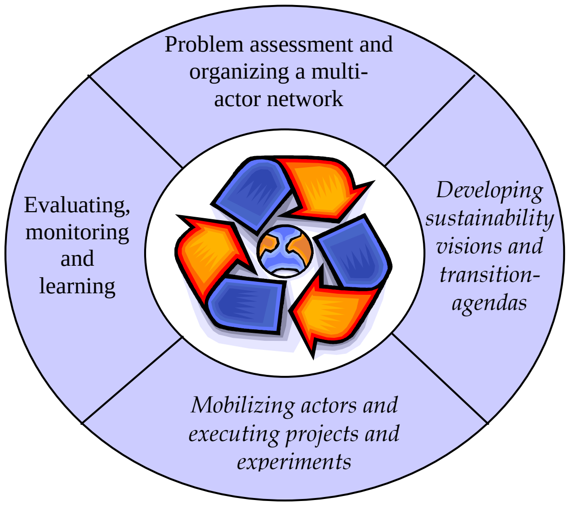

Figure 5. Activity clusters in transition management (Loorbach & Rotmans, 2004).

Initially the joint search- and learning process takes place in the transition arena. The transition arena starts with 10 to 15 people. The participants ought to have specific competencies like visionary thinking across domains, creativity and relevant knowledge of the field, innovative capability and network abilities. Important is that the transition arena has to be somewhat outside traditional institutional settings. The selected participants should join on personal account rather than representing their home organization or institution, in order to avoid a rather narrow focus on the short-term stakes and vested interests of their occupational background. However, the transition arena has to be of trans-disciplinary nature representing different but existing perspectives on the problem.

A water transition arena for example consists of water policy makers, water engineers, ecologists, spatial planners, landscape architects, farmers, but also experts from other societal sectors that are related, such as construction sector (housing), urban planners etc. Confrontation between the different perspectives enriches the problem definition. It is helpful to structure the discussion by using a multi-phase and multi level system approach to give meaning to the direction of developments. Based on the joined representation of the water system sustainability visions for the water system can be formulated. The vision consists of a set of qualitative images that illustrate and visualize a future sustainable water system is (Dirven, Rotmans & Verkaik, 2002). These images should contain physical and spatial elements as well as elements of the new water management style, such as risk management in terms of anticipative and adaptive water management strategies, 'openness' towards other policy domains, institutional organization with regard to participation from stakeholders. Subsequently, the vision can be translated to the water system representation in terms strengthening or weakening existing relations and establishing new ones from which an integrated set of transition-experiments can be derived.

The current vision of water management is still rather implicit. There are no qualitative images that visualize what a sustainable water system really means. At the strategic level the concepts behind the new water management attractor are quite broadly accepted, but are not based on a shared vision of a sustainable water system. Furthermore at the tactical and operational level there are still numerous practical questions. The Tielrooy-committee proposed a retention-store-drain strategy and the committee encouraged the integration with spatial planning. This Tielrooy-strategy is a typical management directive based on the ‘water as a guiding principle’- attractor. Redundant water has to be retained and stored somewhere. In times of drought the water must be released again. Although the regional water management boards have agreed to the Tielrooy strategy, it does not tell them when, where or how the water is to be retained, stored or drained. The up-scaling of the boards means that water managers are increasingly confronted with other sector policies and regional policies. The long-term water basin visions are obligatory and have to be integrated in spatial development plans. An important instrument in the integration procedure is the so-called ‘Water Test’ that in theory should enable water management to participate in an early stage in the spatial planning process. Furthermore, the national ‘Room for Water’ policy designated a number of ‘calamity areas’ that will be flooded in case of high discharge levels. However, there is a vivid debate on the practical aspects of implementation, involving the financial, legal and democratic aspects.

As long as there are severe incompatibilities between the strategic level and the operational level, the transition hampers and can still suffer a severe backlash or remains stuck in a lock-in. At the tactical level there is this major barrier of the traditional way in which the water regime is still organized. Many consider the organizational structure of regional water boards old-fashioned. There have been proposals of a merger between the water boards and provincial government. Whether or not it happens, such a major institutional change could have serious reinforcing power for the transition when performed well. On the other hand, if ill-performed it can either seriously slow down the transition, or worse, even block the desired direction. It therefore is so important to act upon a shared vision of future water management.

Conclusions

The water problems in terms of floods, financial and ecological damage are symptoms of an unsustainable system structure in which the spatial demands of river basins, regional and urban waters have been structurally neglected. In order to cope with future threads such as climate change and soil subsidence, water management needed to change fundamentally.

The transition analysis shows that the shift from the ‘water will follow’-attractor towards the ‘water as a guiding principle’-attractor is in the take-off phase and near the acceleration phase. The new water management attractor principles, such as the retention-store-drain strategy, broadening of riverbeds, the designation of flood-areas and co-operation of water managers with spatial planners is being accepted. Nonetheless is the change of actual practices quite difficult. Unfortunately, there is still a considerable gap between the strategic, tactical and operational level, which is hampering shift towards the acceleration phase.

A water transition arena could help to improve the modulation between the three levels. The diversity of participants in the transition arena represents different perspectives on the water problem and the future of water management. As the participants have different societal stakes the future images they develop are of a different nature than traditional policy visions that reason from their governmental duties and bounded rationalities. Measures have to be realistic and may not contradict other policy fields. Both reasons limit the horizon of future possibilities. The transition arena operates at a distance from the traditional institutional settings and therefore has a much higher degree of freedom to explore the future of water management, including breaking away from path-dependent solutions. Niches such as Ooievaar and Living Rivers, for instance broke with reigning perspectives about river basin management. These niches (nuclei) can be considered transition arenas *avant-la-lettre* and are now basic underlying concepts of the 'water as guiding principle' attractor. However, the implementation at the operational level is surrounded with practical difficulties, related to questions such as where, when and how to store water and daily miscommunication between water managers and spatial planners. Important reason for this is that in between the strategic macro-vision and operational micro-level, parts of the old regime configuration are still present, despite the decentralization, reorganization and merger of water boards. At this tactical level new alliances and power relations have to crystallize and eventually institutionalize. Illustrative in this sense is the debate about merging the traditional democratic chosen water boards with provincial government and thereby cutting off an extra governmental layer. The water transition arena could take the lead in showing the direction of the transition by explicitly formulating the 'water as a guiding principle' attractor, providing the tactical level with a clear direction for institutional change, experimenting and practical knowledge production.

Important lessons for transition theory are that when innovations align and reinforce each other and are able to complement each other like pieces of the puzzle they might be able emerge as a serious and technically possible alternative attractor. Whether it will break through and replace the old attractor is a matter of co-evolving mechanisms in the whole system, that may of may not stimulate up-scaling mechanisms. The used transition trajectory heuristic is helpful to locate in which phase the transition process is and to understand in a very general way what the barriers are. Knowing this may lead to transition management strategies that push the transition into the next phase. The heuristic is also valuable because in views different organizational levels and how stable these organizations are. As a result, one is also stimulated to focus on system thresholds. Such a perspective may truly help us in the future to anticipate instead of reacting to problems we did not foresee.

- Arthur, B. W. (1988) Competing technologies. In: Dosi, G. (Ed.) *Technological change and economic development*. Printer, London/New York.
- Berkhout, F., Smith, A., Stirling, A. (2003) *Socio-technical regimes and transitions contexts*. SPRU Electronic Working Paper Series.
- Bosch, A., Ham, W. van der. (1998) *Twee eeuwen Rijkswaterstaat, 1798-1990.* (Two centuries Rijkswaterstaat, 1798-1990). Zaltbommel: Europese Bibliotheek.
- Bruijn, D. de., Hamhuis, D., Nieuwenhuijze, L. van., Overmars, W., Sijmons, D., Vera, F. (1987) Ooievaar: De toekomst van het Rivierengebied. (Ooievaar: the future of the riverland). Gelderse Milieufederatie. Arnhem, The Netherlands.
- CW21 (2000) *Anders Omgaan met Water. Waterbeleid voor de 21e eeuw.* (Dealing Differently with Water. Water management for the 21st century.). Committee Tielrooy, Ministry of Transport, Public Works and Water management /Union of Waterboards. The Hague, The Netherlands.
- Dirven, J., Rotmans, J. and Verkaik, A.P. (2002) *Samenleving in transitie, een vernieuwend gezichtpunt.* (Society in Transition: an Innovative Viewpoint). Essay, The Hague, The Netherlands.
- Geels, F. and Kemp, R. (2000) *Transities vanuit sociotechnisch perspectief* (Transitions from a sociotechnical perspective), Maastricht, The Netherlands.
- Gunderson, L.H., Holling, C.S. (2002), *'Understanding Transformations in Human and Natural Systems'*, Island Press, Washington DC, USA.
- Ham, W. van der. (1999) *Heersen en Beheersen, Rijkswaterstaat in de twintigste eeuw.* (Rule and Control, Rijkswaterstaat in the 20th century). European Library, Zaltbommel, The Netherlands
- Holland, J. H. (1992) Hidden Order. How Adaptation builds complexity. Perseus Books. Cambridge, Massachusetts. USA.
- Holling, C. S. (1987). Simplifying the complex: The paradigms of ecological function and structure. *European Journal of Operational Research*, 30, 139-146.
- Kauffman, S. (1995) *At home in the universe, the search for laws of self-organization and complexity*. Viking. London. U.K.
- Kemp, R, Schot, J, Hoogma, R (1998) *Regime shifts to sustainability through the process of niche formation. The approach of Strategic Niche Management.* In: Technology analysis and Strategic Management, 10(2): 175-195
- Lintsen, H. (2002) Two Centuries of Central Water Management in the Netherlands. *Technology and Culture*, 2002, 43.549-568.
- Loorbach, D. and Rotmans, J. (2004) *Managing transitions for Sustainable Development*. In: Wieczorek, A.J., Olsthoorn X. (eds) Industrial Transformation - Disciplinary approaches towards transformation research. Kluwer, The Netherlands. Forthcoming.
- Martens, P., Rotmans, J. (2002) *Transition in a globalizing world*. Swets & Zeitlinger B.V. Lisse, The Netherlands.
- Nelson, R. R., Winter, S.G. (1982) An Evolutionary theory of Economic change. Cambridge, Massachusetts. Belknap Press of Harvard University Press.
- Ravetz, J. R. What is Post-normal Science? *Futures*, 1999. 31: p. 647-653
- Rijkswaterstaat (1998) *Vierde Nota Waterhuishouding* (Fourth National Policy Memorandum on Water management). Ministry of Transport, Public Works and water management. The Hague, The Netherlands.
- Rijkswaterstaat, (1992) *Omgaan met de Omgeving* (Dealing with the surrounding area). Ministry of Transport, Public Works and water management. The Hague, The Netherlands.

- Rijkswaterstaat (1989) *Derde nota Waterhuishouding* (Third National Policy Memorandum on Water management). Ministry of Transport, Public Works and water management. The Haque, The Netherlands.
- Rijkswaterstaat (1982) *Tweede nota Waterhuishouding* (Second National Policy Memorandum on Water management). Ministry of Transport, Public Works and water management. The Haque, The Netherlands.
- Rijkswaterstaat (1964) *Eerste nota Waterhuishouding* (First National Policy Memorandum on Water management). Ministry of Transport, Public Works and water management. The Haque, The Netherlands.
- RIZA, (1985) *Omgaan met water* (Dealing with water). The Hague, The Netherlands.
- Rotmans, J. (1994) *Transitions on the move*. Global Dynamics and Sustainable Development. Rijksinstituut voor Volksgezondheid en Milieu (RIVM). Bilthoven, The Netherlands.
- Rotmans, J., Kemp, R. and van Asselt, M.B.A. (2000) *Transitions & Transition Management, the case of an emission-free energy supply*. International Centre for Integrative Studies, Maastricht, The Netherlands.
- Rotmans. J. (2003) *Transitiemanagement. Sleutel voor een duurzame samenleving.* (Transition Management. Key to a sustainable society). Koninklijke Van Gorcum. Assen. The Netherlands. .
- Sabatier, P.A (1999) Theories of the policy process. Westview Press Oxford, UK.
- Smits, R., Kuhlmann (2004) ‘The rise of systemic instruments in innovation policy’, in: *The International Journal of Foresight and Innovation Policy*, Vol. 1, no 1/2, p.4-32.
- Saeijs, H.L.F. (1991) Integrated water management. A new concept: from treating of symptoms towards a controlled ecosystem management in the Dutch delta. *Land and Urban Planning* 20, 245-255.
- World Wildlife Fund (1992) *Levende Rivieren* (Living Rivers). Zeist. The Netherlands.