Coping with the consequences of climate change in River Basins

A comparative analysis of the adaptive capacity of water management regimes in Portugal, Hungary, Ukraine, and the Netherlands

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1 Introduction

This paper is related to the EU-NeWater project (New methods for adaptive water management under uncertainty, www.newater.info).[1]
This paper contains an assessment and comparative analysis of the current water management regimes in four sub basins: Upper Tisza in Hungary, Zacarpathian Tisza in Ukraine, Alqueva in the Lower Guadiana in Portugal, and Rivierenland in the Netherlands. The following overall research question is central to this paper: what are the conditions under which adaptive and integrated water resources management arrangements have been or are likely to be critical to success in the study basins? Success is defined as the performance of each case-study in water resource adaptation to climate change.

According to the 2003 United Nations World Water Development Report, between 1991 and 2000 over 665,000 people died in 2,557 natural disasters—90% of which were water-related and 97% of the victims were from developing countries (UNESCO, 2003). The recorded annual economic losses associated with these disasters have grown from US$30 billion in 1990 to US$70 billion in 1999. According to the International Panel on Climate Change (IPCC, AR4, 2007) these problems will

[1] The NeWater project is an Integrated Project in the 6th Framework Programme of the European Union. The total funding from the European Union is 12 Million Euro over a duration of 4 years (begin January 2005). The project will closely cooperate with another European IP AquaStress (Mitigation of Water Stress through new Approaches Integrating Management, Technical, Economic and Institutional Instruments) following a similar paradigm of adaptive and participatory water management.

become even worse due to the impacts of global climate change. 'By 2080, it is likely that 1.1 to 3.2 billion people will be experiencing water scarcity; 200 to 600 million will suffer from hunger; and 2 to 7 million more per year will be victimized by coastal floodings' says the IPCC (AR4, 2007).

This paper addresses the present and future challenges of water resources management related to climate-related extreme events in river basins. The number of disasters caused by weather-related phenomena such as hurricanes, floods and droughts has more than doubled over the past decade, from 175 in 1996 to 391 in 2005.[2] This paper will start with an introduction on the challenges posed by climate change, and how we are currently dealing with these challenges in water resources management.

This paper tries to make a contribution to the development of a knowledge base for Adaptive and Integrated Water Resources Management. The objectives and questions of this paper will be explained in more detail in the paragraph 3 and 5.

2 Coping with the impacts of climate change in river basins

Despite all the recent attention for climate change, it has been merely focusing on the causes, and the observed and projected changes in climatic conditions, and solutions for mitigating or preventing further climate change. For example, the last IPPC report (IPCC, AR4, 2007) has been focusing on policies, measures and instruments to mitigate climate change itself, in particular focusing on the so-called 'mitigation potential', a concept which has been developed to assess the scale of greenhouse gas reductions that could be made (IPPC, AR4, 2007).

However, the issue which has been profoundly neglected is how we are going to deal with the consequences of climate change, such as an increased intensity and frequency in storms, droughts, extreme precipitation events, circulation changes and heat waves. Even if we are able to stabilize the emissions of greenhouse gases today, increases in temperature and the associated impacts, including water availability and flooding, will continue for many decades to come (EEA, 2007). Even worse, instead of stabilizing greenhouse gas emissions today, with current climate change mitigation policies and related sustainable development practices, global greenhouse gas emissions will continue to grow over the next few decades (IPPC, AR4, 2007).

The challenges posed by climate-related extreme events to river basins are manifold. Especially since water resource issues interact with a wide range of environmental and socio-economic sectors including health, public safety, agriculture, biodiversity, industry, navigation, and tourism.

An increase in the surface temperature of water, and changes in the hydrological cycle could result in changing rainfall patterns over the region. Some areas may experience intense rainfall resulting in heavy floods, while other areas may witness less rainfall, and also frequent droughts.

Moreover, mortality is expected to increase as a result of more and intense heat and cold spells (Haines *et al*., 1993; Kalkstein, 1993; IPCC 1996, WG II, Section 18.2.1). For example, the heat wave of 2003 in Western Europe killed almost 20,000 people throughout Italy (Istat, 2007), approximately the same amount in France (From: Terra Daily, June 27th, 2007), and between 1400 and 2200 lethal victims in the

[2] International Federation of the Red Cross and Red Crescent Societies' World Disaster Report 2006, p 211.

Netherlands (From: Algemeen Dagblad, June 9th, 2006). Moreover, worldwide migration patterns clearly indicate that people increasingly are occupying regions exposed to extreme events (MA, 2005). As a matter of fact, 90% of the world's population is currently living in river basins (World Bank, 2006).
For the past two decades, new, more integrated approaches to water management have been developed and are being implemented to address perceived shortcomings in earlier approaches. During the last decade, the principle of Integrated Water Resources Management (IWRM) has, for example, been used as a framework for the implementation of such integrated approaches to water management (GWP-TEC, 2000). The IWRM concept is being defined as '*a process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*.' (GWP-TEC, 2000).

This paper recognizes the value of highly integrated solutions, although it argues that the concept of integrated water resource management (IWRM) needs to be strengthened, because IWRM is immature as a management tool (Pahl-Wostl, C & Sendzimir, J., 2005). As a review article stated: '*There is still a long way to go to achieve a common understanding of IWRM and to develop and refine approaches for its successful implementation*.' (Jonker, 2002. p. 719). More recently, adaptive management has been introduced as a concept that may complement missing elements of current approaches to IWRM (Pahl-Wostl, C & Sendzimir, J., 2005).

3 Research objectives

The characteristics of adaptive and integrated water resources management (AIWRM) are to be regarded as working hypotheses, since the change towards AIWRM is yet slow and empirical data and practical experience thus limited. One possible reason for this lack of innovation is the strong interdependence of the factors stabilizing current management regimes. One cannot, for example, move easily from top-down to participatory management practices without changing the whole approach to information and risk management. Hence, research is urgently needed to better understand the interdependence of key elements of water management regimes and the dynamics of transition processes in order to be able to compare and evaluate alternative management regimes and to implement and support transition processes if required.

This paper tries to contribute to developing this knowledge base by assessing and comparing current water management regimes in four European sub catchments, located in 3 transbroundary river basins (Tisza, Rhine, and Guadiana), in order to identify the level of adaptive and integrated water resources management, the internal coherence of different elements, the similarities and differences between the case-studies. This paper is taking a multi-level governance approach, focusing on conditions and processes at the sub-basin level, but being embedded in a wider context

In summary, this paper takes a first step towards strengthening the conceptual foundations and practical value of AIWRM approaches by assessing the conditions under which adaptive and integrated water resources management arrangements have been or are likely to be critical to success in the study basins.

4 Research questions

Based on the research objectives described above, the following overall research question is central to this paper: what are the conditions under which adaptive and integrated water resources management arrangements have been or are likely to be critical to success in the study basins?

Based on the overall research question the following research questions will be addressed:

1) What is the level of Adaptive and Integrated Water Resources Management in dealing with climate-related extreme events in each case-study? Are there any relationships between different elements? And how could these relationships be explained?
2) What are differences and similarities between the case-studies? And how could these similarities and differences be explained?
3) Are there any general patterns in the characteristics of AIWRM based on comparative analysis?

5 Analytical framework

The analytical framework for this paper (see figure 1) can best be described as a framework in which adaptive and integrated water resources management (AIWRM) is embedded in an institutional setting of formal rules, such as the Water Framework Directive or national and regional Water Law(s). This institutional setting is created to respond to the demand for governance related to climate-related extreme events. AIWRM in combination with its institutional setting can be described as a water management regime. The most commonly used definition of a regime in political science is that of Krasner (1983): "*implicit principles, norms, rules, and decision-making procedures around which actors' expectations converge in a given area*". Principles are beliefs of fact, causation, and rectitude. Norms are standards of behaviour defined in terms of rights and obligations. Rules are specific prescriptions or proscriptions for action. Decision-making procedures are prevailing practices for making and implementing collective choice. Regime theory strives to explain the formation, properties and consequences of these (international) regimes (Mayer *et al*., 1993). Due to the high interconnectedness and internal logic, it is assumed that individual elements of the regime cannot be exchanged arbitrarily.

The factors which are considered important in Adaptive and Integrated Water Resources Management (AIWRM) have been developed based on working hypotheses of the NeWater-project (Pahl-Wostl *et al*., 2005). Some structural requirements for a system to be adaptive have been summarized in the following table. Two different regimes are contrasted as the extreme, opposing ends of six axes.

Table 2: Different regimes and their characteristics (From: Pahl-Wostl *et al.*, 2005)

Dimension	Prediction, Control Regime	Integrated, Adaptive Regime
Governance	Centralized, hierarchical, narrow stakeholder participation	Polycentric, horizontal, broad stakeholder participation
Sectoral Integration	Sectors separately analysed resulting in policy conflicts and emergent chronic problems	Cross-sectoral analysis identifies emergent problems and integrates policy implementation
Scale of Analysis and Operation	Transboundary problems emerge when river sub-basins are the exclusive scale of analysis and management	Transboundary issues addressed by multiple scales of analysis and management
Information Management	Understanding fragmented by gaps and lack of integration of information sources that are proprietary	Comprehensive understanding achieved by open, shared information sources that fill gaps and facilitate integration
Infra-structure	Massive, centralized infrastructure, single sources of design, power delivery	Appropriate scale, decentralized, diverse sources of design, power delivery
Finances and Risk	Financial resources concentrated in structural protection (sunk costs)	Financial resources diversified using a broad set of private and public financial instruments

Using these working hypotheses as a starting point, the factors considered important in adaptive and integrated water management have been operationalised, based on relevant literature, which resulted in an analytical (sub-)framework for AIWRM (see green box in figure 1), consisting of nine different categories of variables:

A) Agency
B) Awareness Raising & Education
C) Cooperation (maybe split in stakeholder and citizen participation & networks)
D) Policy development & implementation
E) Information management & sharing
F) Finances and cost recovery
G) Risk management
H) Effectiveness of (international) regulation

An important assumption in this analytical framework is that effective AIWRM is able to facilitate a change in rule configuration, as being an adaptation to climate change. As such, there is a reciprocal relationship between the institutional setting and AIWRM. Moreover, my assumption is that this relationship is reciprocal only in a situation of bottom-up governance, including real participation of non-governmental stakeholders, but also from different government sectors, lower levels of government, and downstream stakeholders. This bottom-up process is emerging from partnerships and networks (Geels *et al*., 2004). In a hierarchical mode of government, merely including top-down processes, this relationship will have a unilateral character, instead of a reciprocal one.

In turn, the analytical framework describes the physical intervention in the river basin, being defined as adaptation measures within the context of flood protection and drought/low flow protection (see figure 1, yellow box). In principle, this could be measures which have been implemented very recently or more than 50 years ago. Moreover, it should be taken into account that each regime could be currently in a process of policy development or –implementation as regards its adaptation to climate-related extreme events. The results presented in this paper are therefore being analyzed from this perspective.

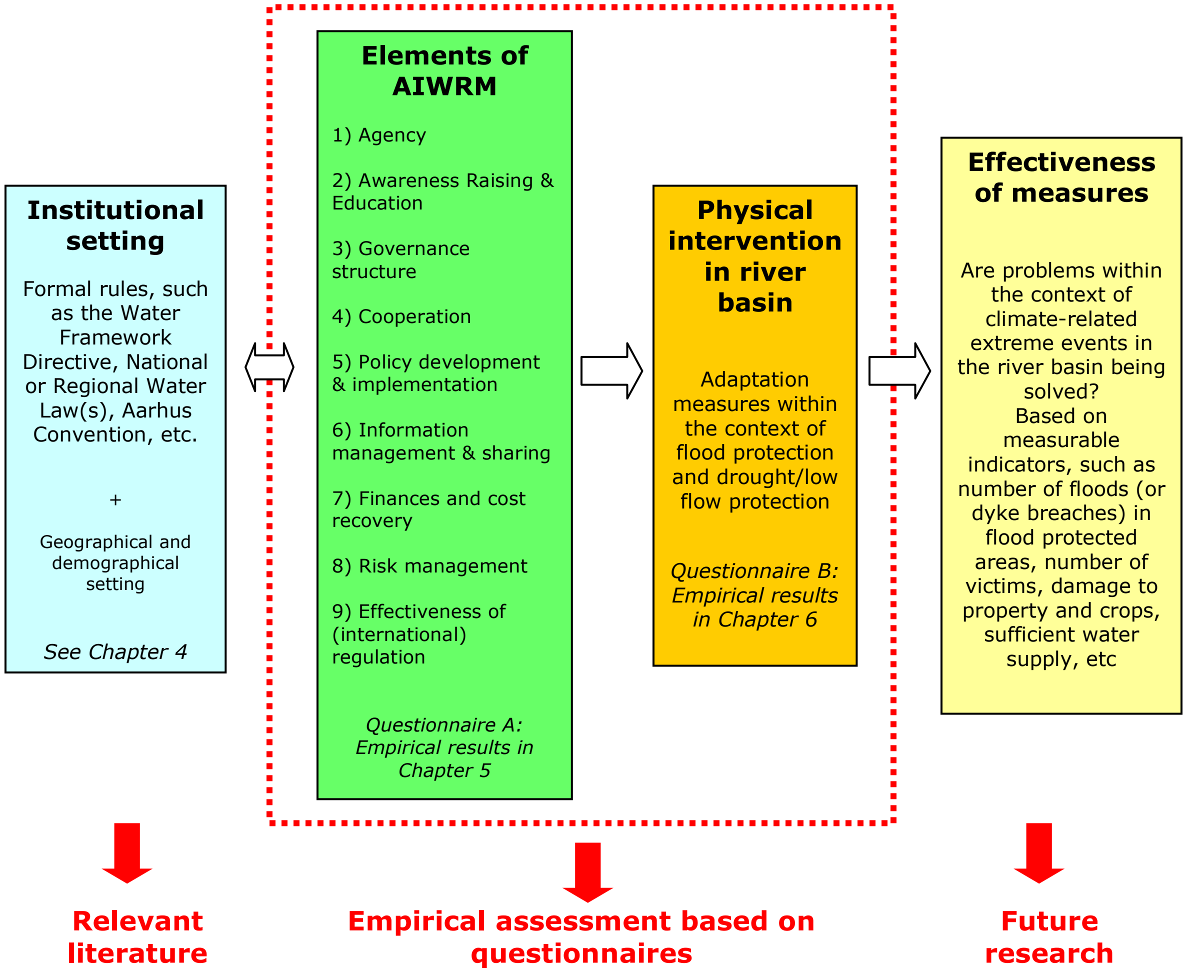

Figure 1 – Analytical framework for explorative research in this paper

Although this paper is focusing on adaptation to climate-related extreme events, instead of adaptation to climate change, it is useful to take a look at the definition of 'adaptation to climate change' as defined by Adger *et al.*, (2005, p.78):

> *"An adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities. Adaptation can involve both building adaptive capacity thereby increasing the ability of individuals, groups, or organisations to adapt to changes, and implementing adaptation decisions, i.e. transforming that*

capacity into action. Both dimensions of adaptation can be implemented in preparation for or in response to impacts generated by a changing climate."

The adaptive capacity to deal with changes is similar to the level of Adaptive and Integrated Water Resources Management (AIWRM) in this paper (see green box in figure 1).

In the analytical framework described above this paper is focusing on two dependent variables:

1) The adaptive capacity / level of AIWRM (see green box in figure 1), and;
2) The physical intervention in the river basin, being defined as adaptation measures within the context of flood protection and drought/low flow protection (see orange box in figure 1).

A calibrated approach (standardized questionnaire, expert judgement and reinterpretation of outcomes by means of relevant literature) was used to compare the state of affairs in water management in the selected case-studies.

By combining in-depth case studies with more extensive and formal comparative analysis we can to some extent use the strengths of one to compensate for limitations inherent in the other. This paper has taken the research problem, rather than a favorite methodology, to determine the research approach, and both the quantitative and qualitative aspects can be used in a consonant manner (Leon, P. de, 1998). As such it is possible to combine the qualities of the case-oriented approach with the qualities of the variable-oriented approach (Ragin-Rihoux, 2004 in Journal of Qualitative Methods).

With only a small number of cases I do not expect major generalizations to suddenly emerge, but I do expect the contrasts to help refine the analyses and consideration of options in each sub-basin.
Not much work is available on comparative analyses of river basins including full range of a water management regime's complexity (Myint 2005; Wolf 1997). Many studies on IWRM are descriptive and limited to recording success or failure of single cases. The initial comparisons will help develop and test protocols (cf. Breimeier et al. 1996) that open the way for efforts at broader generalizations about options for institutional designs and procedures with a special emphasis on assessing what does and doesn't work well with respect to adaptive and participatory IWRM.

7 Towards a more precise understanding of Adaptive and Integrated Water Resources Management

Based on the empirical results of this research it is possible to describe general patterns, and the internal coherence of separate elements within these patterns, in order to explain the differences and similarities between water management regimes in European river basins. In general, water management regimes with a higher level of consensual (bottom-up) governance are also characterized by:

A) **More adaptive leadership**, which is characterized by the mobilization of allies, taking advantage of exogenous factors (e.g. when political climate is right or when new information becomes available), pro-active leadership (anticipating on problems), and an ability to formulate and articulate internally consistent policy preferences (high level of cohesion). A deviating aspect in this general pattern is the extent to which leadership is able to deal effectively with barriers. To a certain degree, barriers are causing (serious) delays or problems in all case-studies (which is no surprise, otherwise it wouldn't be called barriers). Another deviating aspect in the general pattern is the authority of agencies to act externally, in particular the legal competence in given subject matter. The level of authority is relatively low in the Upper Tisza, and relatively high in the other case-studies as compared to the general pattern.

In the case-studies dominated by hierarchical top-down governance, like Alqueva, the level of adaptive leadership is relatively low. This is no surprise since leadership on a sub basin level is not used to be involved in decision-making by higher level governments, meaning that the key functions of leadership in adaptive governance on lower hierarchical levels are much less required, or simply not authorized and therefore more risky, which results in less developed adaptive leadership.

B) **Higher levels of horizontal and vertical cooperation**, which is characterized by the inclusion of non-governmental stakeholders, the involvement of government bodies from different sectors and from different hierarchical levels, and higher levels of conflict resolution. A deviating aspect is the cooperation across administrative boundaries, in which downstream governments are involved in decision-making by upstream government and where international/ transboundary co-operation structures are in place. This transboundary cooperation shows no substantial differences between the case-studies, although in the neighboring Tisza case-studies there are different opinions on the success of transboundary conflict resolution. The scores in the upstream case-study (Zacarpathian Tisza in the Ukraine) are higher than the scores in the downstream case-study (Upper Tisza in Hungary). This is an interesting observation, since both case-studies are adjacent to each other, which means that upstream and downstream authorities are sitting at the same negotiation table. In other words, the resolution outcomes are more satisfactory for the upstream government than for the downstream government. Another deviating aspect is the level of legal provisions concerning access to information (Aarhus Convention and EU Directive 2003/4/EG), participation in decision-making (e.g. consultation requirements) and access to courts. Especially Portugal and Rivierenland are showing the highest scores here. This deviation is explained by the transposition of EU legislation into national law, which is lacking behind in both Tisza case-studies. A plausible reason is that Hungary became a member state only since 2004, and the Ukraine is not obliged to transpose EU legislation at all (although it shows incentives to do so).

C) **More adaptive and integrated policy development and implement-tation**, which is characterized by small-scale policy experiments, consideration of several alternatives and scenario's, and alternatives which include small and large-scale measures, structural and nonstructural measures, and finally by better developed monitoring and evaluation plans, including the establishment of process indicators, stress reduction indicators, and environmental status indicators. A deviation in the general pattern is the aspect of time horizon. An interesting observation in this research is that experts in the case-study with the most massive and centralized infrastructure, which is the Alqueva case-study in Portugal, indicate that the measures taken now or proposed for the near future, do not limit the range of possible measures that can be taken in the far future. The experts in other case-studies have a more negative opinion on this aspect in their case-studies. Moreover, experts in the Alqueva case-study also expect, at least more than in the other case-studies, that solutions for short term problems do not cause more problems in the (far) future (20 years or more). This deviation may be explained by the problem framing of the experts in the respective case-studies. Whereas centralized and large-scale and infrastructure is not seen as a problem in the Alqueva case-study, there is also no sign of a "paradigm shift" as regards the implementation of more small-scale infrastructure. However, in the case-studies where large-scale infrastructure is seen as a problem, there are also trends towards decentralization of infrastructure and more small-scale infrastructure, such as the current development of emergency reservoirs in the Rhine Basin and Tisza Basin.

D) **More adaptive and integrated information management and –sharing**, which is characterized by joint/participative information production, interdisciplinarity, elicitation of mental models and critical self-reflection about assumptions, explicit consideration of uncertainties, broad communication, and updated decision support systems. On some aspects there are a few slight deviations from the general pattern, such as the relatively low level of consensual knowledge in the Upper Tisza in Hungary, compared to the other case-studies. Another deviating aspect is the utilization of information, on which Alqueva is scoring higher as can be expected by the general pattern. As regards the consideration of uncertainties the Zacarpathian Tisza is showing relatively high scores, which is noteworthy, because current water policy documents in the Ukraine do not include any climate (change) scenarios. This observation suggests that different respondents are thinking of different types of information while scoring the indicators. Future research should therefore define more specifically what type of information or uncertainty needs to be scored.

E) **Integrated risk perceptions** by formal expert judgement AND by stakeholders, followed by participative decision-making on what are acceptable risks.

Since the general patterns being observed in this research don't show any major deviations it is justified to conclude that there is a strong interdependence of the elements within a water management regime, and as such this interdependence is a stabilizing factor in current management regimes. One cannot, for example, move easily from top-down to participatory management practices without changing the whole approach to information management, risk management and cooperation, but also regarding the type of leadership. Additional limiting factors for moving towards adaptive and integrated water management regimes is a lack of funding and capacity in current water management regimes. Lack of capacity refers to a lack of adaptive leadership, limited number of water professionals who are familiar with AIWRM approaches, and limited public participation and stakeholder participation.

Within the general patterns and internal coherence as described above this research specifically provides empirical evidence for the positive correlation between horizontal and vertical cooperation, consensual knowledge production, and conflict resolution, leading to the conclusion that a lack of consensual knowledge is an important obstacle for cooperation. Cooperation and consensual knowledge is even more important when dealing with uncertainty and change. Several authors (Olsson *et al*., 2006; Stubbs and Lemon, 2001) argue that linking different networks and creating opportunities for new interactions are critical factors for learning and nurturing integrated adaptive responses to change. Therefore, mechanisms which facilitate social learning, such as cooperation structures or stakeholder platforms, are therefore posed in this paper as an important design principle for large-scale, complex multiple-use systems, such as river basins.

Finding a balance between centralized and decentralized river basin management

Although the general patterns as described above suggest that the more consensual (bottom up) governance the better the response of a water management regime to climate-related extreme events, it does not imply that (100%) decentralized river basin management is also the better and more effective strategy. However, it is obvious that current management regimes in Europe are moving towards more decentralized management approaches in order to improve their performance.
While some scholars argue for more public control in resources management (Carruthers and Stoner, 1981: 29), and others scholars for more decentralized, local management (Ostrom, 1990, 1992), this paper argues that an optimal performance of river basin management is achieved by a balance between centralized and decentralized river basin management, not only including mechanisms which facilitate social learning and consensual knowledge production (e.g. in cooperation structures and stakeholder platforms), but also arrangements for sharing upstream-downstream costs and benefits. This is supported by case-study Rivierenland, which is having the highest score regarding bottom-up governance, although the weighted averages on governance in Rivierenland suggest that there is much more top-down governance than could be expected from consensus-based decision-making, especially since the water boards in the Netherlands are well-known for its consensus-based decision-making (also called the 'Poldermodel').
What is clear is that bottom-up governance and decentralization is not a straight forward solution to water management problems. It is also true that some problem areas lend themselves more to decentralization than others. Local solutions to local problems such as water allocation within a small river basin will likely be found more easily under a decentralized system, but there will probably always be the need for a certain degree of centralisation, for instance in the area of transboundary problems, capacity building and the setting of standards.

Responsiveness of the case-studies to climate-related extreme events

The responsiveness of all case-studies to new information on the expected water stress in the near future, but also their response to severe drought events in the recent years, is very limited. Even the case-study with the most severe water stress, which is the Alqueva, is showing limited results in implementing physical adaptation measures for coping with these extreme drought events.
Extensive studies in the Netherlands (RIZA, Droogtestudie, 2005) indicate that droughts and heat waves are becoming a serious problem for many sectors, such as water transport, agriculture and nature. At the same time it is obvious that the political climate is not ready for a policy change with regard to extreme droughts and heat waves. This political climate is represented in the Dutch policy document on

National Safety (Ministry of Domestic Affairs, the Netherlands, 2006), which concludes that the situation with respect to mitigation and prevention of extreme droughts and heat waves is not as urgent as compared to other natural threats, such as pandemics (e.g. mouth and foot disease) and the threat of floods. As such there is no window of opportunity in the Netherlands to initiate new policy measures, since this would require that " *... a problem is recognized, a solution is available, the political climate makes the time right for change, and the constraints do not prohibit actions*" (Kingdon 1995).

This lack of an adequate response, especially in Rivierenland, but also in the other case-studies, is noteworthy, since droughts and heat waves have already caused enormous adverse social, economic and environmental effects in recent years (Della-Marta *et al*., 2007: 252), and it is expected that this will become even worse due to climate change (IPCC, 2007). For example, agricultural production in the Netherlands is reduced by 5 to 35 % because of water shortages (Ministry of Domestic Affairs, Netherlands, 2006). This means an average economical damage of 180 million Euros/year, and even 1800 million Euros/year in extreme years (*idem*). Damage to the Dutch water transport sector goes up to 800 million Euros in extreme years (RIZA, Droogtestudie, 2005). Moreover, estimates based on the statistical excess over mean mortality rates amount to between 22,000 and 35,000 heat-related deaths across Europe as a whole (Milligan, 2004). On the other hand, since 1998 floods in Europe have caused some 700 deaths, the displacement of about half a million people and at least €25 billion in insured economic losses (EEA, 2007). In other words, in Europe there are more lethal victims due to drought and heat waves than because of floods.

Nevertheless, this research concludes that in Rivierenland and both Tisza case-studies there is considerably more awareness on flood than on drought risk, and it is therefore justified to support Milligan's statement that droughts and heat waves are the developed world's hidden disaster (Milligan, 2004), and in this case Europe's hidden disaster.

In contradiction to the poor response to drought and low flow problems, all case-studies, except for Alqueva, seem to be more effective in terms of flood protection measures. In the Alqueva, respondents indicate that flood problems and flood protection is not an issue, although it was confronted with flooding events (notably in 1997 and 2006). Rivierenland shows the most advanced policy development and implementation regarding flood protection, although this policy was mainly the result of (the threat of) floods in 1993 and 1995. As such its policy is a response due to extreme events in the past. These extreme events created political momentum for developing new flood protection policy, including climate change scenarios and a pro-active preparation for the (future) impacts of climate change. Also in both Tisza case-studies recent floods have increased political momentum for planning new flood protection measures, although this has started a decade later, mainly due to the floods of 2005.

As regards flood protection policy Rivierenland is the most advanced of all four case-studies. Climate change (scenarios) and adaptation measures for flood protection are strongly integrated into the water policy agenda of Rivierenland. The Dutch water policy (Ministry of Transport, Public Works and Water Management, 2000) recognizes that in the coming years increasing water levels in the rivers and the accelerated rise in sea levels will mean that technical measures, such as raising dykes, will no longer be sufficient. The policy is to allow more space for water. In order to prevent floods, rivers are allowed to expand into side channels and wetland areas. Greater emphasis is also placed on managing water levels rather than keeping the water out. This paradigm shift can also be observed by the current implementation of non-structural measures such as flood insurance, flood zoning restrictions, land-use management, economic incentives, public information and community education. Non-structural measures are intended to modify flood susceptibility and flood impact. Also voluntary measures by land users are now starting to come into practice.

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