**Controversies in water management: frames and mental models**

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**Abstract**
In a specific EIA case in the Netherlands the frames and mental models of stakeholders were elicited to explain controversies. The case concerns the construction of a storm surge barrier to comply with national regulations on short term. Long term plans are initiated to improve the water management in the region. Complicating factor is the interaction between national dike safety norms and local water management problems. Revealed controversies mainly concerned disputes between an administrative and a technical perspectives. But also disputes on distribution of responsibilities between different institutes, legal and political liability, and funding issues, involving persons of both perspectives, existed.

Political feasibility appeared to be the decisive factor. Technical factors were discussed extensively, but had limited effect on the final decision. The EIA report was completed several years after the intended deadline, an integrated problem solution was not reached. The solution was limited to the well structured part of the problem by deliberately separating it form its broader context. The case reveals a lack of possibilities to search for an integrated solution involving all levels of authority, and possibilities for discussing the additional problems that were raised by the integrated approach in the initial phase of the EIA project.

**Contents**

## 1 Introduction

The challenge of learning to live with risk of floods (and other risks) implies three activities: becoming aware of extreme events and their risk (sources of risk), estimating the effects of extreme events, and building resistance or resilience against extreme events. For the latter, a shift from pure engineering towards a more integrated (flood management) approach is needed. Such an approach can only work when it is embedded in a theoretical framework that can adequately describe the problem situation from an integrated perspective. An integrated approach demands not only integration between scientific disciplines, but also integration between the diverse steps of the problem solving cycle (e.g. problem analysis, plan preparation, decision making and implementation) in close cooperation with other relevant land use functions and their associated stakeholders. Dealing with multiple stakeholders in a multifunctional system also means dealing with unstructured problem situations, where values are debated and knowledge is uncertain. These elements should therefore be included in the theoretical framework. In addition to the theoretical framework methods are also needed to analyse the elements of the framework and to promote integration of instruments for flood damage reduction. Such methods should stimulate awareness of the different frames of perception in operation by the stakeholders, offer techniques for frame reflection and the construction of new common frames, and should recognise institutional and personal barriers for integration. In our research we drew upon knowledge from the social and cognitive science disciplines to promote communication and learning between individuals and their organisations through frame reflection (Kolkman 2005).

Traditional problem solving approaches are directed at control and remediation, identifying acceptable protection levels, and management of uncertain risks. In contrast to these "end of pipe" approaches, an integrated problem solving approach aims at finding new, less hazardous alternatives to reach the intended principal goals, in order to prevent risk when possible. Integrated problem solving consists of gathering, synthesising, interpreting, and communicating knowledge from various expert domains and disciplines, and is aimed at helping responsible decision makers and participating stakeholders to think about a complex problem and to evaluate possible solutions. The early phases of problem articulation and system analysis are especially important to guide the process towards a truly integrated problem solution. The philosophy behind integrated problem solving is that transparent and open communication about the problem from all perspectives involved can result in a decision that is more optimal than the solution attained from the perspective of a single actor. In this paper we will look upon integrated problem solving as a process of production, transfer and interpretation of information. Interpretation in complex problem situations takes place from different perspectives. These perspectives might limit the possibilities of turning the available information into usable knowledge, and cause controversy and dispute, disregard and misuse of knowledge, delay and failure of projects, and decline of public trust.

The purpose of SEA is to show a range of potential options, and an integrated (environmental, social, economic, political) assessment of these options. The Netherlands Commission for Environmental Impact Assessment (NCEIA) defines Strategic Environmental Assessment (SEA) as a way to bring people together in planning processes, and structure and feed their debate on the environmental consequences of strategic choices. More concrete, they consider SEA to be a tool to:

1. structure the public debate in the preparation of policies, plans and programmes;
2. feed this debate through a robust assessment of the environmental and, if and when required, other consequences;
3. ensure that the results of the assessment and the debate are taken into account during decision making and implementation.

According to the NCEIA this means that public participation, transparency and good quality information are key principles – SEA can be a tool to enhance good[1] governance and to contribute to sustainable development. The method developed in (Kolkman 2005) may serve the purposes of SEA.

[1] Good governance means, in the author's practice, firstly the strict adherence to the legal procedure in order to prevent court appeals to be successful. Secondly it means the construction of an argument which is defendable and acceptable in for the decision makers involved.

The main question for this IAIA2005 workshop is whether effective improvement of policies in the water sector can be reached by using new approaches to public consultations and participation in impact studies. This paper claims that such improvement is potentially threatened by institutional, political and social resistance to use available knowledge as decision arguments. The limits of democratic decision making can be revealed by frame reflection.

We will show, by means of a case study, how controversies may become persistent when conflicting opinions on an issue are shaped by different perspective types. Such a perspective types are, in turn, shaped by the personal and institutional context of the individual stakeholders. Each stakeholder constructs a preferred solution alternative within his perceived range of uncertainties, which are both technical and administrative in nature. Open communication appears to be an insufficient condition for resolving controversies. Also needed is the individual willingness to change existing regulations or their interpretations, and the willingness to break through institutional communication patterns and distributions of responsibilities, in order to creatively redefine the problems on a higher level of aggregation and to find new solution spaces. Therefore, addressing the above aspects of decision making might improve SEA methods.

A method for frame reflection using mental model mapping offers a new approach that can address these aspects. The approach starts from the premise that an analysis of mental models in use by stakeholders will identify communication barriers, by revealing the experiences, perceptions, assumptions, knowledge and subjective beliefs that a "mental model user" draws upon to reach his conclusion about some issue. Mental model analysis assesses tacit knowledge, broadens the narrow understanding of a problem by confronting one decision maker's, stakeholders' or scientist's map with the map of others, brings to light alternative perspectives on the problem, encourages negotiation and helps to reduce destructive conflict. The basic idea is to elicit a person's knowledge and consequently open it up to discussion. The results will be useful for helping decision makers, but also for scientists and stakeholders. The material presented in this paper is based on research presented earlier in Kolkman (2005).

## 2 Case description

### 2.1 Catchment area

The case study concerns part of the catchment of the river Overijsselse Vecht, see **figure 1**. The insert in figure 1 shows the river Vecht which transfers into the Zwarte Water (at point no.3 downstream of Zwolle) and debouches into the Lake Zwartemeer. The Lake Zwartemeer is separated from the lake Ketelmeer (which is in open connection with Lake IJsselmeer) by the Ramspol storm surge barrier. The Ramspol barrier is the first line of defence against storm induced high water threats (Van der Schrier 2000). The dikes behind Ramspol (nrs 1, 2, 3, 4, 5 and 6 on the insert in figure 1) have been subject to a process of improvement which should make them compatible with the legal guidelines according to the Water Defences Act adopted in 1996 (WWK96). Design flood levels (MHW's) have been specified for the dikes along this system by the "Hydraulic Preconditions for Primary Flood Defences" ("Hydraulische randvoorwaarden", in Dutch, TAW 1996a), which are updated every five year. The presence of the Ramspol barrier reduces the MHW's upstream along the Zwarte Water that are required to reach the specified level of protection (which ranges from 1/1250 to 1/2000 per year). Part of the WWK96 are the "Guidelines for safety assessment" ("Leidraad Toetsen op Veiligheid", in Dutch, TAW 1996b) which defines the framework to assess the safety conditions of a dike. When the resulting condition is not described as "good", a dike improvement process will be started according to the, at that time applicable, TAW-documents Guideline for Designing River Dikes ("Leidraad voor het ontwerpen van rivierdijken", in Dutch, TAW 1985, 1989). The case is concerned with two parts of the above water system: the Sallandse Weteringen and the canals in the Zwolle city centre (nos. 1 and 2 in the insert, respectively).

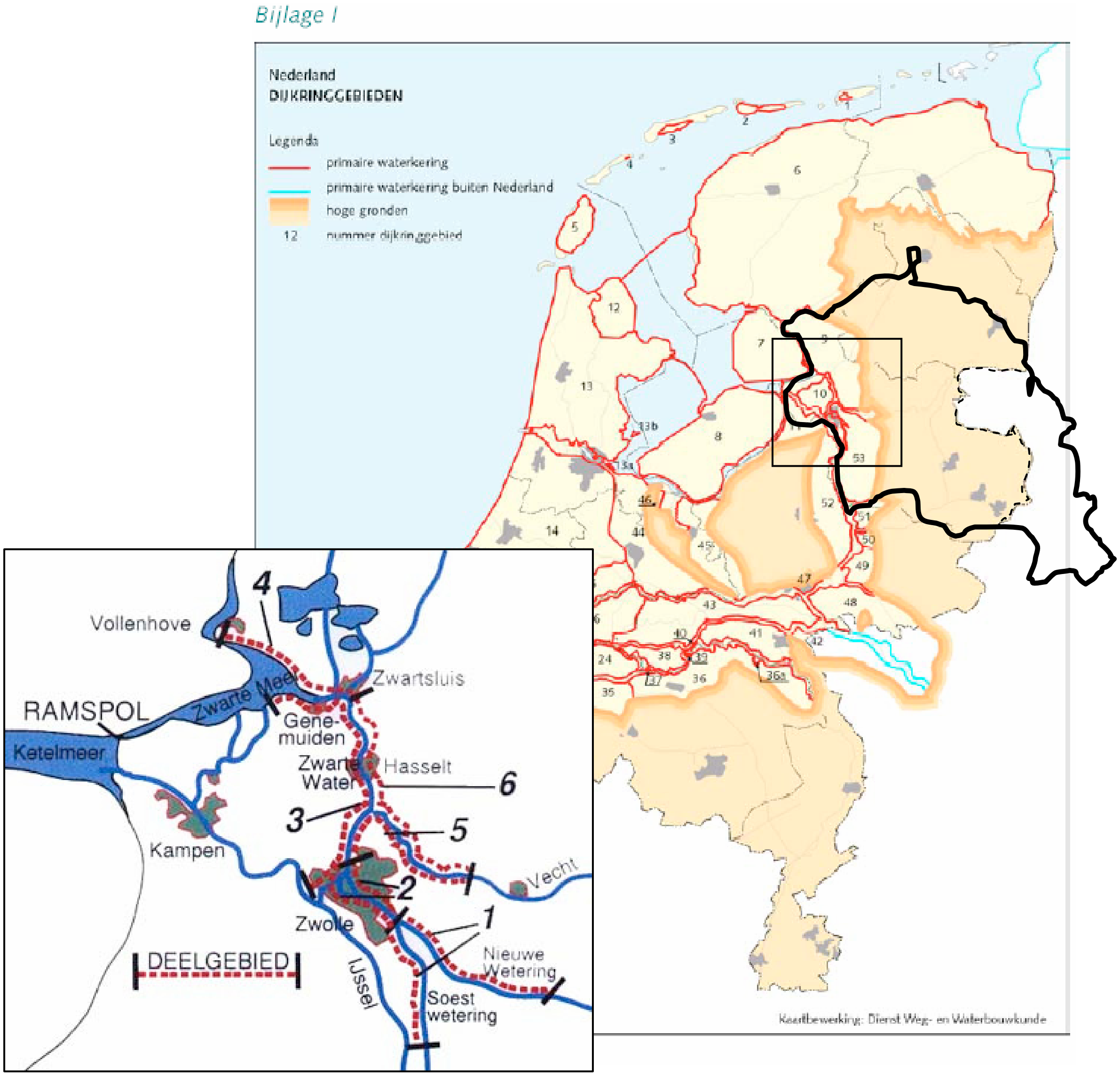



**Figure 1:** Map from appendix 1 from the "Wet op de waterkering", showing the dike-ring areas. The marked area represents the river Overijsselse Vecht cachment area (630.000 ha). The insert shows the case study area around the city of Zwolle (figure copied from the Groot-Salland water board website http://www.wgs.nl/ ). The case concerns the improvement of sections 1 and 2 of dike ring 53, as required by the act "Wet op de Waterkering 1996".

The Sallandse Weteringen originally were brooks that discharged into the River IJssel, which have been gradually reconstructed into canals in the Middle Ages to drain the Salland region near the city of Zwolle into the Zwarte Water. Reconstruction and improvement took place again in the period 1960-1970. The canals operate under free flow under all circumstances (Van der Schrier 2003a, personal communication), which means that there is no discharge sluice to prevent downstream water to enter the canals (like there is in polder discharge systems near the coast). The canals transfer into the Zwarte Water just downstream the Zwolle city centre, and join the Vecht (at point 3 on the insert in figure 1). Although the naming is confusing, the canals and their extension called Zwarte Water, are in fact a tributary to the river Vecht.

The Weteringen and city canals are not real rivers because of their artificial construction, and have a comparatively small size, but nevertheless their flood defences are denoted in the WWK96 as primary. The latter fact makes them subject to the dike improvement process started by the WWK96. The safety assessment of the DAR-2 dikes in the city of Zwolle concluded that on some parts their height was below the required design level, and the assessment of the DAR-1 dikes along the Weteringen concluded that in many places these dikes were below the required design level.

Together the improvement of the six dike sections mentioned above comprise the "Dijkverbetering achter Ramspol" (DAR) project. Parallel to the construction of the Ramspol barrier (which was completed in 2002), the DAR project was started to improve the dikes upstream of Ramspol. Because of the Ramspol barrier, these dike improvements could be limited compared to a situation without the Ramspol barrier. The DAR project started in 1997 with the production of the "Nota van uitgangspunten" (Grontmij_Projectbureau_DAR 1997a) and the separate "Startnotities" for DAR1 and DAR2 (Grontmij_Projectbureau_DAR 1997b, c). Afterwards dike sections 1 and 2 were combined in a single project DAR-1+2, for which an environmental impact assessment (EIA) has been performed (EIA-report 2001). The use of information in the decision network involved in producing the EIA-report has been the object of research in the case study.

## 2.2 Flooding history

In the event that high discharges from the river Rhine through the river IJssel into Lake IJsselmeer continue for a long period, this can affect the water level in Lake IJsselmeer. Because of the (still) limited discharge capacity of the "Afsluitdijk" sluices, the water level in Lake IJsselmeer can rise above its design level and thus limit the discharge capacity of the Zwarte Water. Consequently higher water levels in the Zwarte Water, Vecht, Zwolle city canals and Sallandse Weteringen can result. In case a storm surge on the North Sea happens in this period, this situation is aggravated through the further limitation of Lake IJsselmeer discharge capacity and wind induced raise of water levels on the Zwolle side of the Lake IJsselmeer and Zwarte Water. The worst case scenario takes place when, added to the above two events, also a high discharge occurs on the river Vecht and the Sallandse Weteringen. In that case the water in the Zwolle city centre canals may reach high levels. Historically, such situations have caused flooding inconvenience in the city centre in e.g. 1825 (a major national flooding disaster), 1877, 1883, 1895 (NCEIA 1998), 1916 (a national flooding disaster which initiated the planning of closure of the Zuiderzee), 1925, and 1930. After the closure of the Lake IJsselmeer with the "Afsluitdijk" in 1932, high water levels in 1954, 1956, 1960, 1965, and 1987 caused less flooding inconvenience.

The city of Zwolle was founded around 800 A.D. The name Zwolle comes from the word *Suolle*, which means "hill". Zwolle was founded on a hill between the three rivers surrounding the city, IJssel, Vecht, and Zwarte Water. The hill was the only piece of land that would remain dry during the frequent flooding of the rivers. Of old, the city of Zwolle has learned to cope with high water situations. Already in the early middle ages, a storm surge entering the Vecht river system from the former Zuiderzee would pass through Zwolle to find its way into the low lands of Salland. The low lands acted as a natural inundation area, and resulted in a relative lower (0.5 to 1 meter) water level in the city of Zwolle compared to e.g. the city of Genemuiden further downstream the Zwarte Water. The city of Zwolle has carefully maintained these inundation areas, even up to the 20$^{th}$ century. In the second half of the 19$^{th}$ century the railway tracks from Zwolle to the North and East were constructed on dikes in the low areas, and large openings were provided in these railway dikes to ensure unrestricted flow of the storm surge water. Until the closure of the Zuiderzee (in 1932) the dikes along the Weteringen were to resist these storm surges, and one polder (Sekdoorn) had an emergency spillway to mitigate the highest water level in the Weteringen by inundation of this polder, and, by a further emergency spillway, the adjacent polder Lierderbroek in case the Sekdoorn capacity was exceeded.

Only after the closure of the Zuiderzee with the "Afsluitdijk" in 1932, this inundation principle was released, resulting in the major reconstruction of the area in the years 1960-1970. On this occasion, the emergency spillway along the Weteringen was removed. At the current time the former inundation areas are protected against high water by the dikes along the Sallandse Weteringen (see **figure 2**). But in extreme precipitation events they are at risk of being flooded again. The threat of the city of Zwolle being flooded does not so much result from a storm surge, but rather results from high precipitation events in the Salland en river Vecht region. The effects of a storm surge will be limited because of the protection offered by the Ramspol barrier. Calculations show that the MHW of 1.75 m+NAP in Zwolle is determined by the 1/1250 per year discharge peaks on the river Vecht and Weterningen (HKV_Lijn_in_water 1996b), (HKV_Lijn_in_water 1999). The lowest part of the Zwolle city canals quays lies at 1,65 m+NAP. The EIA-report (2001) mentions 1,75 m as maximum and 1,40 m as desirable target MHW level. The level of 1,40 m is substantiated because this was the highest water level measured after 1960, on which occasion no damage was observed. Even at a MHW level of 1,80 m+NAP no safety problems will occur in the city centre, but water hindrance in cellars and through sewer system backflow is possible. Only limited parts at the edge of the city centre will inundate with insignificant water depth, and water hindrance there will be prevented by future municipal housing plans. The situation in the city of Zwolle is unique with regard to the varying water levels due the open connection with Lake IJsselmeer and the Zwarte Water. But with regard to its location at the downstream point of a regional water system discharging into a larger stream, comparable situations exist in other cities in the Netherlands, e.g. Den Bosch (Dieze into the Maas), Amersfoort (Eem into Gooimeer), Meppel (Mepperdiep into Zwarte Water).

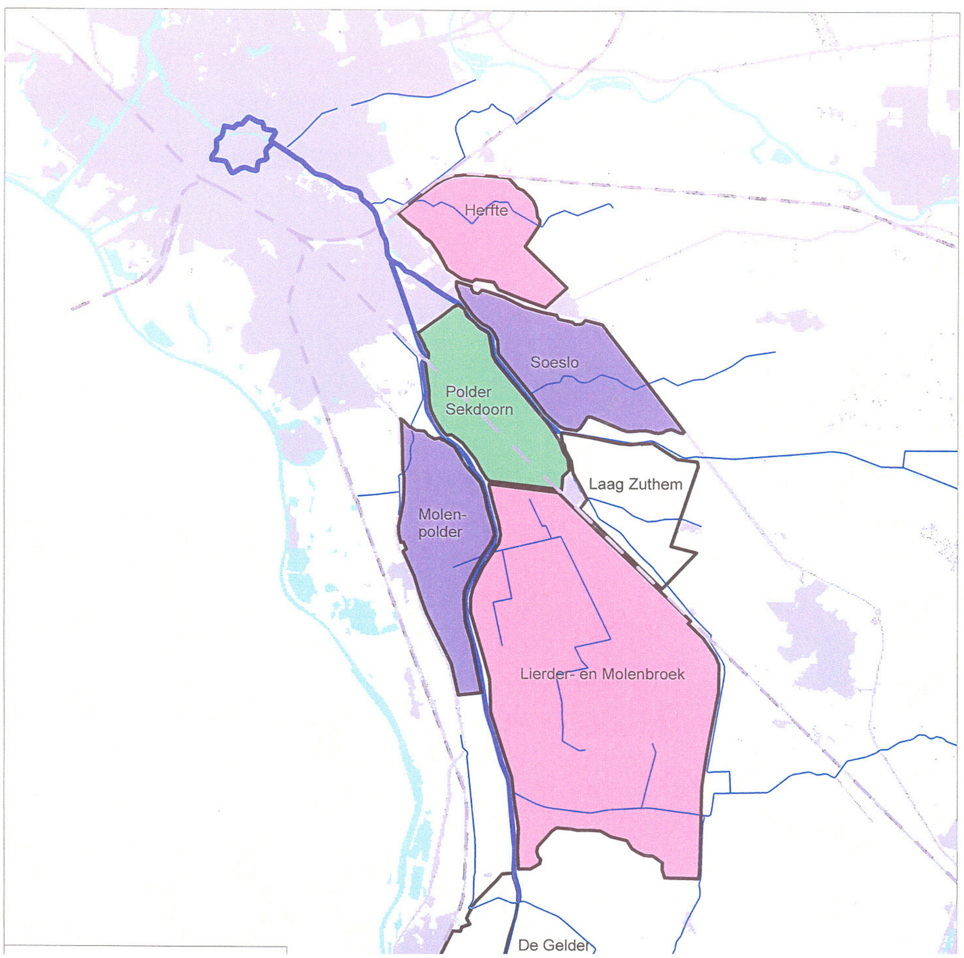
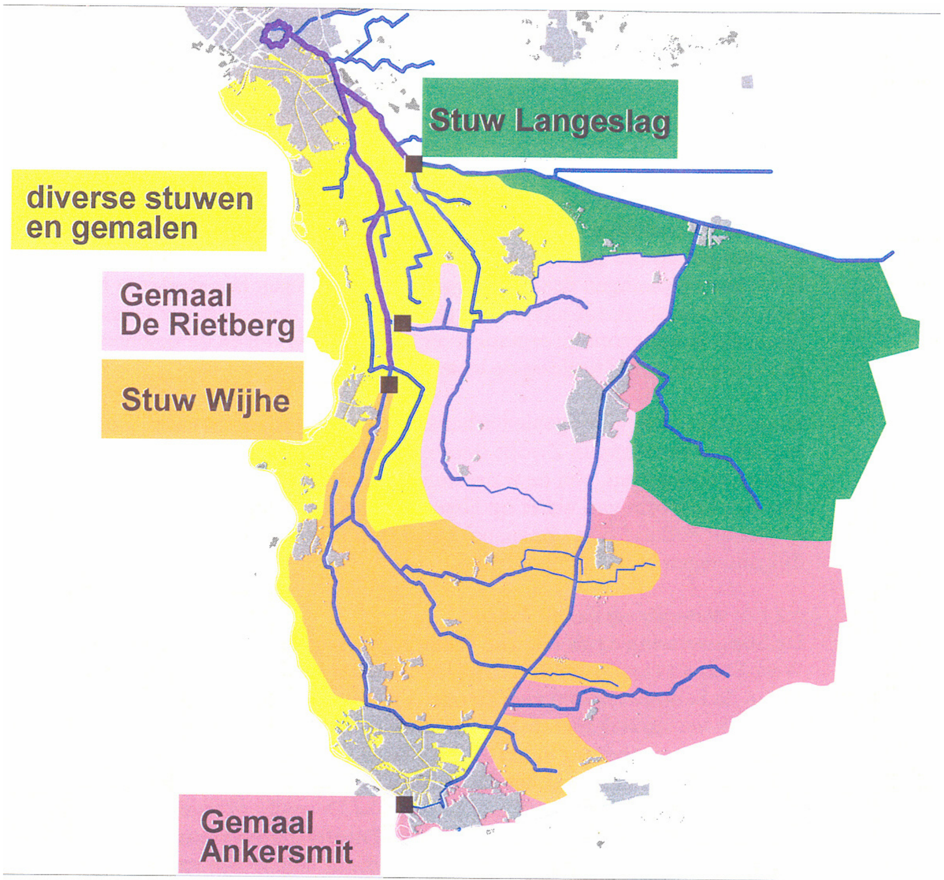



**Figure 2:** The marked five inundation areas of old are now protected against high water by the dikes along the Sallandse Weteringen. Within the EIA-project they were considered to perform this function again in several of the alternative solutions. (figure reproduced from (EIA-report 2001) Annex III "Waterberging in Salland").

## 2.3 The Salland water system

The current Salland water discharge system (starting with local drains and ending in the Weteringen, see figure) was designed to deal with a 1/10 per year rainfall situation. The maximum possible discharge in the Weteringen is 68 m3/s (corresponding to a 1/100 per year situation). About 23 m3/s of it originates from the pumping stations in the Salland polders, the rest originates from the higher parts of Salland. Because of the artificial construction of the water system – limited capacity of pumping stations and the relatively small size of the Weteringen canals upstream the Wijhe weir – this maximum discharge cannot be exceeded.




A 1/100 per year rainfall situation, however, will theoretically produce a peak discharge of 100 m3/s just upstream Zwolle. The excess discharge will remain in the polders (a situation represented by one of the cover pictures), and will overflow from the Weteringen upstream the Wijhe weir into the adjacent area. In this way excess precipitation will cause local flooding in Salland, both in the lower and higher parts. For the same reason retention measures in the higher parts of Salland upstream the Wijhe weir will not necessarily reduce the actual peak discharge from the Weteringen (Annex I of EIA-report 2001). (Grontmij_Projectbureau_DAR 1997b) adds that water overflowing upstream of the Wijhe weir can partly find it way into other downstream areas along the Weteringen, which will aggravate the water hindrance in the lower parts of Salland. Below we will summarise the relevant information from the EIA documents.

The high water safety norm for dike ring 53 is 1/1250 per year (WWK96), which is also applicable to part of the Weteringen dikes.. (Grontmij_Projectbureau_DAR 1997b) presents the proposed MHW for Zwolle before (2,55 m+NAP) and after (1,90 m+NAP) the construction of the Ramspol Barrier. These values originate from a study performed in the context of the Ramspol barrier project EIA report (Ramspol 1995). The closure of the Ramspol barrier reduced the MHW in Zwolle. The calculated MHW's for Zwolle and the Weteringen are based on the physical maximum possible discharge over the Wijhe weir increased with the maximum pumping rates of all the pumping stations discharging into the Weteringen. This maximum discharge corresponds to a 1/100 per year event ((Grontmij_Projectbureau_DAR 1997b). Initially, a maximum Weteringen discharge of 99 m3/s was used for the calculations (HKV_Lijn_in_water 1996a). During the DAR1+2 project this maximum Weteringen discharge was adjusted to 68 m3/s (Annex I of EIA-report 2001). The corresponding MHW in Zwolle was recalculated to be 1,75 m+NAP (HKV_Lijn_in_water 1999). (Grontmij_Projectbureau_DAR 1997a) mentions that the proposed MHW's for Zwolle and the Sallandse Weteringen were not yet submitted to the Minister for approval. Grontmij_Projectbureau_DAR 1997b) adds that one of the reasons for this delay was the uncertainties in the model calculations.

High water level calculations have been performed for the Sallands Weteringen within the Ramspol EIA-project, using the model system SOBEK. The same model system has subsequently been used to quantify several high water scenarios for the DAR-project (HKV_Lijn_in_water 1996b). This report concludes that a closed Ramspol barrier will reduce high water levels in the DAR1+2 area to such a low level that the discharges of the river Vecht and the Weteringen now determine the 1/1250 per year design water level, instead of the storm surge. Water levels above 1,65 meter +NAP in the city of Zwolle will very likely be caused by high discharge of the Weteringen. Because the uncertainty in the boundary conditions (water levels and wind), however, no conclusion can be made with regard to the design water levels. For this purpose a probabilistic analysis of the interdependency between boundary conditions would be needed. For example high discharge of the river Vecht may not occur simultaneously with a high N-W wind episode and/or a high water level on Lake IJsselmeer. The maximum discharge scenario used in a subsequent study (HKV_Lijn_in_water 1999) presumes a co-occurrence of the discharge peaks of the river Vecht and the Weteringen. The correlation between the high water boundary conditions is subject to discussion and therefore is one of the sources of uncertainty in the calculated high water levels. Other reported sources of uncertainty are values of the boundary conditions, the model schematisation, and the value of the wind hiding coefficient. The uncertainties resulted in reported MHW-values ranging from 1.40 to 1.90 m +NAP.

One of the boundary conditions is the Weteringen discharge. (EIA-report 2001) states that the Weteringen design discharge is based on a frequency of 1/1 (one or two days a year on average), resulting in a discharge of 49 m3/s. (EIA-report 2001) also states that the 1/100 per year Weteringen discharge is about 68m3/s. This discharge is the calculated maximum value that can be delivered by the Weteringen at the given boundary conditions (1/1250 per year MHW discharge of 470 m3/s at the Vecht and a IJsselmeer water level on NAP +0,28 m (which is a 1/10 situation). The discharge capacity of the Weteringen is limited by the geometry of the Weteringen channels and weirs.
Annex I of (EIA-report 2001) states that the maximum discharge precipitation sequence would theoretically result in a calculated peak discharge of 100 m3/s, which can not be accommodated by the Weteringen and therefore will cause the Weteringen quays upstream to overflow in the adjacent area.
Annex II of (EIA-report 2001) uses a worst case scenario for the water levels in which the discharge peaks of the river Vecht en the Weteringen coincide. It states that in the Weteringen a discharge wave with a peak of 68 m3/s will result in a water level corresponding to the proposed MHW's. It also states that the precipitation sequence resulting in such a discharge wave will have a frequency of occurrence less than 1/1000 per year.
Other considerations, presented in Annex IV of (EIA-report 2001) argue that the rapid reaction of the canalised Salland water system will result in Weteringen discharge peak which precedes the discharge peak of the river Vecht. Annex IV of (EIA-report 2001) also suggests that there may be other worst case scenarios conceivable, e.g. 1) considerable (300 m3/s) discharge on the Vecht and a NW-storm at a high level of the Lake IJsselmeer, 2) MHW (470 m3/s) discharge on the Vecht and lower discharge (20 m3/s) on the Weteringen, and 3) higher than MHW discharge on the Vecht (future scenario) at 40 m3/s at the Weteringen.
The maximum measured discharge of the Weteringen was 45 m3/s in the 1998 high water episode (EIA-report 2001).
The original reference to the designed Weteringen discharge is found in (HKV_Lijn_in_water 1996a) which refers to (Janssen 1993), who gives 55 m3/s for 1/10 per year, and 99 m3/s for 1/100 per year.

A closed Ramspol barrier will cause the upstream water level to rise in the Zwarte Water because of the blocked discharge (less, however, than an unprotected storm surge). Subsequently, water levels in the river Vecht and in Zwolle and on the Sallandse Weteringen will also rise. The maximum closure time of the Ramspol barrier is expected to be about 15 to 20 hours, related to the characteristics of an extreme N-W storm event (Grontmij_Projectbureau_DAR 1997b:82). The calculated MHW's take the barrier closure into account (HKV_Lijn_in_water 1996b). The maximum closure time of the Zwolle barrier is estimated to be about 4 to 5 days, depending on the discharge peak on the river Vecht and a closure water level of 1,40 m+NAP, see Annex I of (EIA-report 2001:5). These closure times have been used in the model calculations performed in (HKV_Lijn_in_water 1999). In case of closure of the Ramspol barrier, the blocked discharge can be stored in Lake Zwartemeer and the Zwarte Water, and also emergency inundation are available on the Lake Zwartemeer side of dike ring no. 10. in case of closure of the Zwolle barrier, storage in the Weteringen is very limited (calculations performed in (HKV_Lijn_in_water 1999) show a very quick rise of the water level in Zwolle even with low discharge conditions of 6 m3/s on the Weteringen), and inundation areas are not established.

Summarising, the high water safety issue in the Zwolle and Salland area is rather confusing due to inconsistent use of information, and complicated because of the combination of different, correlated sources of danger, viz. a N-W storm surge, a high water level in Lake IJsselmeer, a high discharge from the river Vecht, and a high precipitation runoff discharge from the Weteringen. Adding to this complexity is the man-made water management system of Salland, which at present cannot adequately deal with extreme precipitation events. Furthermore, the Zwolle city centre did not, at the time this case study was performed, come under the protection of the WWK96, which deprived the centre from a protection against flooding under the WWL96[2].

[2] By letter dated 6 July 2004 from the secretary of state of the ministry of V&W informed Parliament of her decision to shorten dike ring 53 as a result of the construction of the Zwolle barrier. This decision was published in the "Staatsblad" 2004, 234. It brings the Zwolle City Centre within dike ring 53. At the same time the status of the Weteringen dikes and Zwolle quays has been changed from primary into secondary status.

## 2.4 History of water management organisations involved

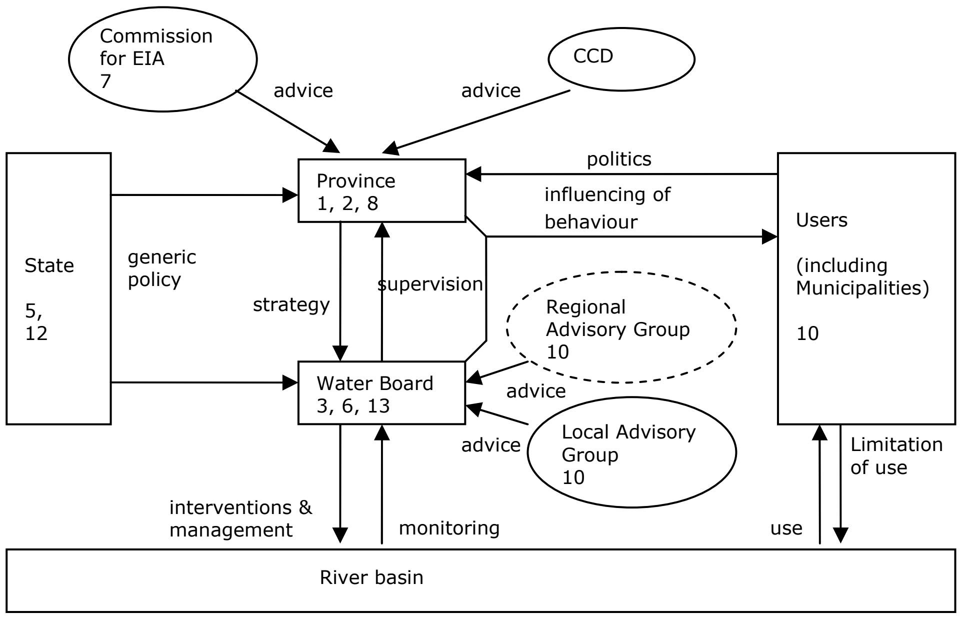



**Figure 3:** Model of parties and relationships involved in the control of regional water management, adapted after van Slobbe (2002:110). Compared to the original (blocks), several parties have been added (ellipses) that are related to the formal planning procedure for dike improvements. The code numbers of some of the informants in the case study have been added to their organisations.

**Figure 3** presents an extended general model of institutional parties and relationships involved in Dutch regional water management. General institutional parties are: National authorities, Province, Water Board, Municipalities, Citizens, NCEIA. Furthermore, the province can install a CCD Advisory Group and the Water Board must install a Local Advisory Group. The EIA procedure identifies the institutional stakeholders involved in this specific case. In addition to to the general model the Water Board installed a Regional Advisory Group. Another institutional stakeholder is the external engineering company called Grontmij. The Grontmij project group already conducted the preceding dike improvement projects 3, 5 and 6 within DAR for the WGS. The applicable legal system governing the decision making process is mainly determined by the Flood Defences Act ("Wet op de waterkering" - WWK) 1996 and its accompanying Guide on Safety Monitoring( "Leidraad Toetsen op Veiligheid") and Hydraulic Preconditions for Primary Flood Defences ("Hydraulisch Randvoorwaardenboek) 1996. The latter is updated every five years. Figure 1 shows the map from appendix 1 of the WWK that defines the dike-ring areas. Furthermore, some ten other acts and regulations are relevant for the process of permitting, mainly on the level of Municipality and Province. In the following we will briefly describe the main institutional actors, and some of their stakes in the specific case of the Zwolle barrier project.

On the national level, the ministry V&W's primary role is policy development (e.g. the dike ring approach and establishment of safety norms). Further more, it is the third institution in the line of responsibility (super-supervisor). In the latter role it is responsible for a timely delivery of the dike improvement projects defined in the WWK96 before 1 January 2001. Also the State is directly responsible for water management issues that are of national importance, such as the dikes along the North Sea, the Wadden Sea, and the large rivers. Rijkswaterstaat (the Directorate-General of Public Works and Water Management) carries out the necessary work.

Based on article 133 of the Dutch Constitution (Staatsblad 1983, no.70), and the Water Boards Act ("Waterschapswet") 1992, the Province is supervisor to the District Water Board, and as such the second institution in the line of responsibility. In addition the WWK96 gives the Province a coordinating task. The coordination concerns the combined handling of all relevant permitting procedures (WWK article 17 and 19), but also the stimulation and, when necessary, demanding or even enforcing of the cooperation between stakeholders. Furthermore the WWK96 gives the Province a governing task, in that it must approve or reject the plans made by a Water Board (e.g. the storm surge barrier plan). Also the Province handles the financial flows from the National level to the Water Board. The Province of Overijssel requested, within the DAR-project, to evaluate the inundation risks of the Zwolle city centre for a water level corresponding to the 1/1250 safety norm. The objective of this evaluation was to decide whether a safety norm was required for the Zwolle city centre. Such a norm was lacking at the time of the case, because the city centre is situated outside the dike and therefore the WWK dike ring protection is not applicable.

The District Water Board Groot Salland, as part of their water quantity task, is the first responsible institution for the maintenance and safety assessment of the dikes in the case area. It is the third layer of government. The District Water Board is organised in a General Council ("Algemeen Bestuur") consisting of elected members, an Executive Council ("Dagelijks Bestuur") consisting of members chosen from the General Council, and a chairman chairing both councils (the 'dijkgraaf' - the dike warden). The relationship between water board and province is governed by the Water Boards Act ("Waterschapswet") 1991. Starting from about 1992, the many small water boards existing up to that time were in the process of merging into larger scale water boards. These Water Boards new-style had, compared to the old situation, extended administrative and knowledge capacities, which are transferred from the National authorities and Provinces. The responsibility for some national waters is also transferred to the regional Water Boards (e.g. the river Overijsselse Vecht). Starting from 1992, the Water Boards have faced major changes of organisation and responsibilities. These changes required them to find a new equilibrium in their relationship with the Province. On top of this the high water episodes in 1993 and 1995 resulted in new legislation, the Major Rivers Act ("Deltawet Grote Rivieren") 1995 and the Flood Defences Act ("Wet op de Waterkering" - WWK) 1996 on the national level, which forced them to start major, large scale dike improvement projects (most of which were already identified many years before but were not taken into execution because of time consuming administrative procedures. When a safety assessment reveals a dike section not to be up to the legal standard defined by the WWK96, a dike improvement procedure is started by the Water Board, which includes an EIA. According to the WWK96, dike improvements governed by it must be completed before January 1$^{st}$ 2001.

The municipalities played a role through their presence in the regional and local advisory groups. Furthermore, they are the responsible authorities for licensing the barrier building plans, together with any necessary change of the prevailing zoning plan. The municipality of Zwolle was visible in press publications concerning the barrier, mainly because the turmoil cause by questions asked in the city council and their delay of the building permitting procedure.

In addition, in the province of Overijssel a separate permanent regional advisory group, called "Coördinatie Commissie Dijkverbetering Overijssel" (CCD), existed where the dike improvements were also discussed. This CCD was established already during the planning phase of the Ramspol barrier.

The Regional advisory group ("klankbordgroep", in Dutch) is a regional committee which is established by the Water Board for all of the DAR-projects together, with the purpose of advising the Water Board from a regional perspective (Grontmij_Projectbureau_DAR 1997b:4). The regional advisory group operates on an administrative level. In contrast, the local advisory group operates on a public participation level. Both local and regional advisory groups are temporary. All municipalities involved in DAR participated in this advisory group, as wel als regional interest groups e.g. GLTO Overijssel, Natuur en Milieu, Kon. Schippersverenigng Schuttevaer, Bond Heemschut, Stichting Het Overijssels Landschap, Vereniging tot behoud van natuurmonumenten in Nederland.

The Local advisory group ("adviesgroep", in Dutch) is a local committee which was established by the Water Board for each of the DAR-project separately (Grontmij_Projectbureau_DAR 1997b:4). Its purpose is to supply local information and advise the Water Board on the presented alternatives (Grontmij_Projectbureau_DAR 1997b:3). Several local interest groups participated in the advisory groups, e.g. LTO-Heino, LTO-Wijhe (these two represent the local farmers), Landschap Overijssel, Bond Heemschut, Vrienden van de Stadskern Zwolle, Bewonersverenigigng binnenstad (EIA-report 2001:97).

Apart from the formal stakeholders described above, the consulting engineers firm Grontmij acted as DAR project manager and coordinated the production of the EIA report.

## 3 Case analysis using SEA elements

### 3.1 The decision making cycle

The EIA procedure is governed by the Dutch law on EIA, which was passed in 1987. In this law the Netherland Commission for Environmental Impact Assessment (NCEIA) was given an important role in the EIA procedure (see e.g. NCEIA 2005). The NCEIA advises decision makers – government ministers and provincial and municipal councils – on the environmental aspects of plans and projects. The Commission can draw on a pool of independent consultants to advise on the scope of EIAs (what are the relevant impacts and alternatives?) and prepare advisory reviews of the content of environmental impact statements (is all necessary information present and correct?). The Commission remains outside political decision making and does not express a preference for one alternative or another. It acts as an independent expert watchdog to improve the quality of the EIA's. The NCEIA advises the government authority responsible for the decision, usually twice during the procedure. First the NCEIA advises scoping guidelines (with regard to which topics should be covered in the EIA), second it performs an advisory review of the completed EIA (with regard to whether the essential environmental information for decision making has been presented). The decision making cycle in the case situation is mainly described by the legal procedure along which the EIA is conducted, **see figure 4**. Public consultation and participation is also governed by the legal procedure.

An inventory of events and documents produced in the EIA-procedure leads us to distinguish between four major phases in the EIA-procedure. In the first phase solution alternatives were explored, presented to the public, and subjected to advise e.g. from the NCEIA. In the second phase research was performed on a few selected alternatives, and some types of alternatives were rejected. In the third phase the selection was narrowed down to the barrier alternative against the full scale dike improvement alternative, the EIA report was written, presented to the public, subjected to advise, and finally approved by the Province. In the fourth phase objections and appeal to court against the approval were made. Preceding the first phase, the dikes of dike ring 53 in Zwolle and Salland have been tested against the applicable TAW guidelines. This test established that the dikes failed to comply to the WWK96, and consequently a dike improvement procedure has been started, which includes the EIA procedure. Following the last phase, the implementation of the dike improvement plan was started, which included the construction of the Zwolle barrier. The construction was completed in June 2005, and on September 14, 2005 the barrier was officially opened.

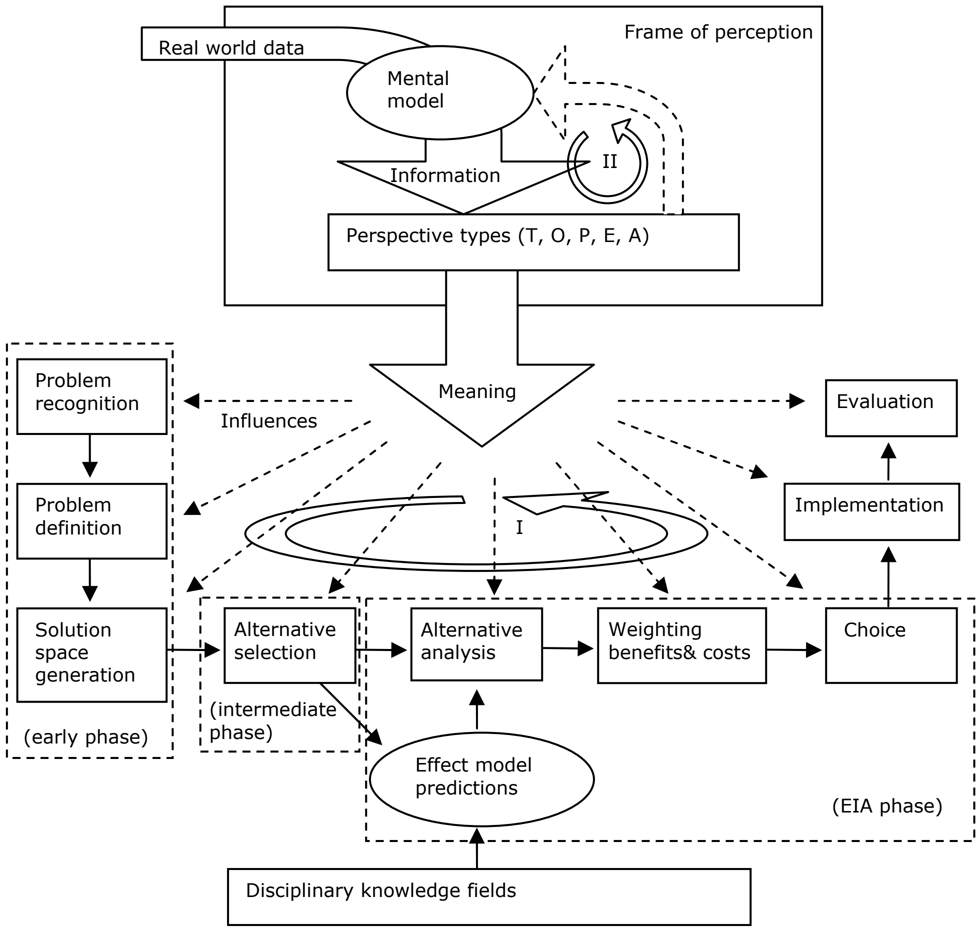



**Figure 4:** The theoretical framework used in the case study. It shows the frame with its mental model en perspectives in the upper part, the decision making cycle in the middle and the use of disciplinary models in the lower part. Disciplinary knowledge enters the decision making process through the effect models used. The decision making cycle is influenced by the frame of perception and, indirectly, by the mental model. The mental model acts as a 'filter' that selects information from the 'real world', which is subsequently interpreted from specific perspective types to produce meaning for the problem situation at hand. Perspective types can induce changes in the mental model by second order (II) learning processes. First (I) order learning is also indicated, and does not involve frame changes. Solution of complex problems need second order learning. Several phases are identified in the decision making cycle. In general, an environmental impact assessment (EIA) concerns a limited set of steps from the cycle. In the preceding (intermediate) phase the number of alternatives to be studied in the EIA is reduced. In the early phase of the cycle the possible alternatives are limited by setting restrictions for the solution space.

## 3.2 Issue evaluation and choice

It is not a single issue that was at stake in the Zwolle storm surge barrier case. For one there was the legal obligation to improve the dikes along the Sallandse Weteringen canals according to the WWK96. Every stakeholder, however, agreed that this would result in an unnecessary and intolerable intrusion into nature, landscape and farmer properties, and that an alternative was wanted. From a wide range of alternatives that had been considered at one time or another (including detention of water in inundation polders), the Zwolle barrier prevailed and was presented in the EIA-report against the original full-scale dike improvement plan. It was the argumentation for the barrier alternative that presented the source of diverse conflicts. Furthermore, the issue of dike improvement made another issue to enter the agenda, namely the issue of water management in the Salland region, see e.g. the advice given by the Dutch Commission for EIA.

Selection criteria (and assumptions) are specified in the EIA-report (2001).The whole main EIA-report is, in fact, one big compilation of major and minor criteria, assumptions and effect scores. The EIA-report mentions a the barrier alternative to be favourable in case it can prevent large scale dike improvements along the Weteringen, guarantees safety and protection against water hindrance, and creates a controllable and admissible situation for water management. It also remarks that the most important bottleneck for the latter condition is constituted by the conflict between the discharge out of Salland versus the blocking of the discharge by a closed barrier. Furthermore, it mentions as additional goals the reduction of water hindrance in the city of Zwolle, and the reduction of water hindrance in the lower parts of Salland caused by extreme rainfall events. In a previous report "Startnotitie DAR1 Weteringen" (Grontmij_Projectbureau_DAR 1997b:54) special attention was asked for the barrier alternative in combination with buffering. In the final EIA-report two alternatives are presented, none of which contains buffering. The concluding chapter of the EIA-report presents a summarising qualitative overview of both alternatives.

The NCEIA does not explicitly specify the use of a decision method (e.g. Cost-Benefit or MCA). The method used in the case appears to be descriptive in nature and somewhat resembles the score chart method from (Hellendoorn 2001:41, 45-53), in that information on alternatives is not processed using a decision method but merely presented "as is" in a table. This table does not contain weights, and the table presents no judgement on the ranking of alternatives. The table is a structured presentation of qualitative scores of alternatives on criteria, with the exception of the costs which are quantified. In contrast with the score chart method, no qualitative ranking of alternatives for each of the criteria is given. For any further information on the meaning and consequences of the qualitative scores the reader must consult the text of the EIA-report and its annexes. An EIA is meant, by definition, to prove by the first responsible authority (the Water Board) that their argumentation for the preferred alternative is valid. This argumentation was ultimately accepted by the second responsible authorities (the Province).

## 3.3 Role of the NCEIA

The EIA-report was presented for advise (by the Province) to the NCEIA. This advice concerns the completeness and quality of the EIA, and also takes into account any remarks and recommendations connected to the EIA report. The advice (called "toetsingsadvies" in Dutch) contains some remarkable aspects. In the first part of the advice the NCEIA approved the EIA-report (NCEIA 1999:2). In the second part of the advice, however, the NCEIA made some critical remarks regarding the decisions made in the EIA-report, and advised to reconsider the barrier alternative by giving further consideration to the detention alternative (:4,5). The advice of the NCEIA indicated some important controversies. Firstly, based on the EIA report the discharge from the Sallandse Weteringen in extreme high water situations can hardly ever be blocked (e.g. by a barrier), therefore the NCEIA advised the Secretary of State to reconsider the principle that a dike ring must be closed. Secondly, the NCEIA concluded that the construction of the barrier would have little effect on the factual situation with regard to water management, because water nuisance frequency in the low area of Salland will not decrease and because the built area in the Zwolle city centre may experience more water nuisance. Therefore, the NCEIA advised to consider whether future water management plans for the area could by included in the barrier decision making process, especially the use of detention areas.

## 3.4 The actor network

The influences exerted by actors on the decision making cycle (see figure 4) are described on an institutional level in figure 3, and are detailed in **figure 5**. The actor network involved in dike improvement in Overijssel appeared rather stable, starting from the early days of the Ramspol barrier planning in the eighties, which was also confirmed by informant no. 13. Frequent informal contacts existed within this network. There appear to have been extensive informal contacts involving the Provincial Executive, the "Commisaris der Koningin", and the "dijkgraaf" at the administrative level, and at the civil servant level involving Water Board, Province and RWS. At the citizen participation level informant no. 13 mobilised persons in the Zwolle city council, the Province General Council and Parliament to promote his interests. Formal contacts within and between institutions existed along every available hierarchical connection, where the local visit of the NCEIA and the use of expert second opinions were quite remarkable. All things considered, the full range of administrative organisations in the Dutch society have been involved in this case.

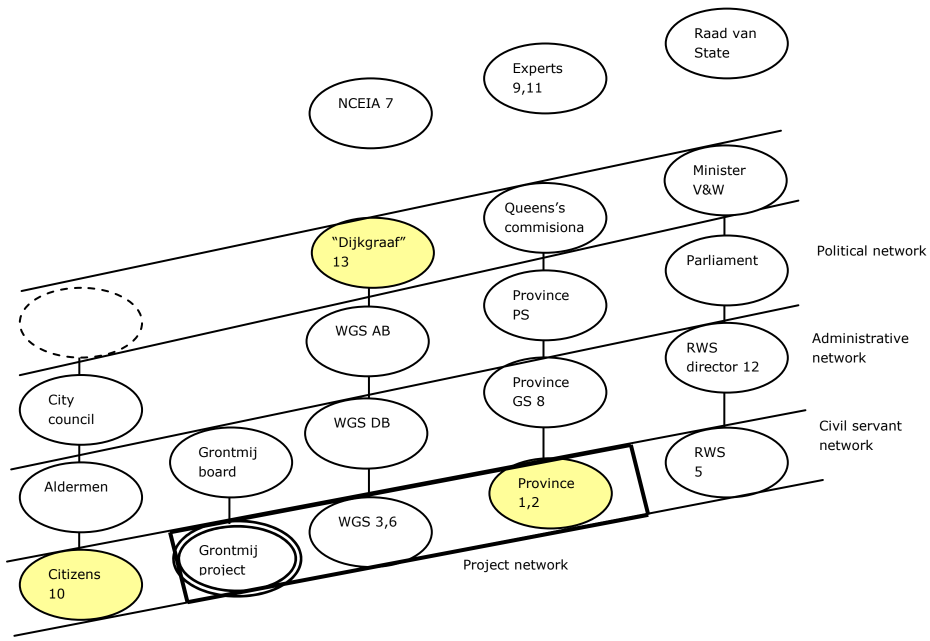



**Figure 5:** The actors involved in the case can be located on diverse hierarchical levels in their institutions, and cover almost the full range of administrative organisations in the Dutch society. Their involvement is based on their appearance in documents and interviews. The horizontal dimension indicates how institutions operate on different spatial scales. The vertical dimension indicates the hierarchical relationship within and between institutions. The "layers" indicate the various networks that appear from the interviews. The positions of the informants are indicated in this figure with their code numbers. The marked informants appear to have had a relatively large influence on the decision making process.

The two major institutional stakeholders, represented by persons of the water board WGS and province Overijssel, collaborated right from the beginning in the DAR 1+2 project group that was directed by the external engineering company called Grontmij. We mention the Grontmij project leader as the third major stakeholder, because of the interests such a company in general has with these kind of projects. Although the Grontmij project leader was supposed to follow the ideas of his principal the Water Board Groot Salland, his philosophy and leading and guiding capacities were of great influence on the project development, according to informants nos. 4 and 14. The Grontmij project group already conducted the preceding dike improvement projects 3, 5 and 6 within DAR for the Water Board Groot Salland, in changing team compositions depending on the exact nature of the specific project problems, but with always with the same major actors included. There had been, in fact, a build up during the DAR projects of a multitude of common experiences and emotions.

Opinions on the personal relationships differed greatly between informants and other observers, ranging from a good personal relationship that was under persistent functional stress in the DAR1+2 case, to a completely spoiled relationship already from the Ramspol project. Part of the relational stress was attributed to the change in distribution of both legal and informal responsibilities between Province, Water Board and National authorities after the introduction of the new large Water Boards starting from 1992. The Water Board expected their expertise to be taken seriously by the Province, and the Province had to give their technical and administrative expertise a new role in their broader responsibilities compared to the narrower water management and flooding safety responsibilities of the Water Board.

### 3.5 Conflicts between stakeholders

Based on the analysis of the field of actors and their interactions prior to the case (see section 2.4), frame conflicts could be expected on the issues of compliance to the TAW guidelines, distribution of legal tasks and responsibilities, and citizen's protests. From the analysis of the case documentation, the main conflicts appear to be the difference in opinion between the Technical and the Administrative perspectives with regard to the preferred solution alternatives. The limitation of alternatives to only those that fit within the Water Board policy, instead of a full argumentation that would also include other criteria (like technical), raised resistance among the "owners" of those other criteria. The approval advice given by the Dutch Commission for EIA contains some critical remarks regarding the choices made in the EIA-report, and advises reconsideration of the barrier alternative by giving further consideration to water detention. The case analysis reveals that some of the disputes, which were already present in the early case documents, grew into intractable controversies that were never resolved during the course of the EIA project, but were contested up to the highest administrative court in the Netherlands, the "Raad van State". Other disputes, like those on the distribution of legal tasks and responsibilities, were settled in the course of the EIA project.

In the early and intermediate phase (see figure 4) the Water Board supported the initiatives of the EIA project team and Advisory group to perform research on alternative solutions, albeit grumbling because of the extra financial costs and the delay of the project. But at the end of the "intermediate phase" the Water Board rapidly directed the decision process towards the barrier alternative, using their specific interpretation of the WWK (both with regard to dike improvement as well as to distribution of responsibilities), of the model calculations, of observation data and of future scenario's.

The most important opponent against the barrier alternative, representing a technical perspective, assisted cooperatively in the search for alternatives in the initial project phase. But after the approval of the EIA by the Water Board General Council this opponent applied every means available to express his arguments against the decision and to get the decision revoked. The opposition started in the Zwolle city council, continued in the Provincial General Council, was followed by a request to the "Commisaris der Koninging" to overrule the decision of the Province Executive Council, and culminated in the appeal to the "Raad van State". Up to the decision of the Provincial Executive Council some civil servants representing the Technical perspective, in diverse institutions, also opposed the barrier decision. Their arguments followed the same line of reasoning as the aforementioned opponent, but were overruled by the decision of the Provincial Executive Council, which at the same time terminated their opposition. The official document that prepared the Provincial Executive Council decision contained a personal policy opinion of the opposing civil servant.

From an Administrative perspective the broader legal responsibilities of the Province were defended against the limited responsibilities of the Water Board. The Provincial concern for participatory aspects of the EIA procedure were, by them, considered to legitimise project delay. The issue of distribution of technical responsibilities was ultimately decided in favour of the Water Board by the Province Executive Council (Provincie Overijssel 2003).

Salient controversies that are were revealed by mental model mapping include the following:

1. The barrier is unnecessary from an administrative point of view because the inclusion of the Weteringen dikes in dike ring 53 is both administratively disputable and technically unnecessary, and alternative administrative solutions exist in a risk approach within the context given by the WWK96.
2. The arguments for including the Weteringen dikes in dike ring 53 are based on financial considerations.
3. Water from outside the dike ring, in the sense of the Flood defences Act 1996 ("buitenwater", in Dutch) is supplied by the river Overijsselse Vecht.
4. Foreign objects in the broad quays of the Zwolle city centre are not permissible.
5. Norm differentiation for the dike sections along the Weteringen is not possible.
6. The barrier is ineffective from a technical point of view because the barrier closing scenario has a negligible frequency of occurrence.

7 The discharge of the Weteringen can be stopped by upstream measures to such an extent that the water level causing flooding of the Zwolle city centre will not be reached if the barrier is closed.
8 Multiple dike failures in rural Salland may cause backflow of Vecht water into Salland.
9 A Province may interfere on a technical level with a dike improvement project of the Water Board and associated Environmental Impact Assessment.
10 A Province may give due attention to procedural matters within an EIA also when this delays the EIA procedure.

In the end the issue appears to involve regional support and acceptability, as well as the distribution of responsibilities between Water Boars and Province. Informant no. 9 noted the opposition of the local farmers against the construction of inundation areas, which would have resulted in tremendous social pressure and resistance. In contrast, much less opposition would be expected from the urban areas, but the initiative of informant no. 10 raised opposition here also. The same informant also noted that the Water Board considered the behaviour of the Province to obstruct their responsibilities. Informant no. 13 confirmed this with this remark that the Water Board would have asked for a directive from the national authorities when the EIA should have been rejected, and perhaps even a decision from the "Raad van State".

Another important element in the case explanation is the delay of the EIA procedure caused by the discussions about diverse contested elements. In the opinion of informants nos. 9 and 13 the Province was not decisive enough in their role as approving authority. According to other informants, e.g. nos. 1 and 2, the delay was necessary to deal with the different opinions just because of this role. Some informants indicated that the minister would not accept much more delay in the EIA procedure.

The role of technical arguments has, according to some informants, been limited to the project level of civil servants, at the administrative level these arguments were considered to be not relevant.

Support and acceptability also played a role at the level of national authorities. According to informant no. 10 several solution alternatives have been rejected because these would cause a need for reinterpretation of the WWK and the dike ring principle by the minister of V&W. This opinion is confirmed by informant no. 12, who also expressed the concern within RWS for questions in Parliament that might harm the political position of the minister in case of a local (dike ring 53) subsidence of the WWK96 demands and possible future negative consequences thereof. According to informant no. 9 an exception made for dike ring 53 would have created a precedent for opponents of dike improvement project in other dike rings, or for civil servants that could use it to lower their budgetary demands, e.g. along the large rivers. The letter produced by REW clearly indicates that, at a national level, there was no willingness to change the appendix of the WWK with regard to the inclusion of the Weteringen in dike ring 53 without a strict adherence to the dike ring principle that a dike ring must be closed and have a uniform protection level.

Also an important aspect was the legal liability for flooding damage. According to informant no. 9 current social developments, starting from the high river levels in 1995, tend to hold the authorities responsible for any flooding damage that might be inflicted on citizens, and justice tends to honour their claims more and more. This caused Water Boards to be very cautious regarding any alternative solution that is not clearly based on the WWK96. Remarkably the Water Board (according to informant no. 13) considered the Province to lack courage to approve their EIA and dike improvement plan, where, at the same time, the Water Board did not want to use their administrative possibilities to construct their own interpretation of the WWK96 and accompanying guidelines. According to informant no. 9 a court, in a liability suit, will ultimately judge whether the decision arguments, including model calculations, are reasonably defendable. Any other criterion therefore would be irrelevant for the decision makers.

Remarkably actors with a Technical perspective not only presented their technical arguments against the effectiveness of barrier alternative, but also presented arguments to refute the arguments for its legal necessity presented by actors with an Administrative perspective. It seems that, where possible, the conflicting elements with regard to the WWK96 have been interpreted by the Administrative actors in such a way as to create as much a necessity for the barrier alternative as possible (see the bold marked elements from nos. 2 through 12 in the data matrix in table 5.1). The technical aspects appear to be countered with an appeal to uncertainty ("experts divided" and "complex situation cannot be modelled").

## 3.6 Participation

Stakeholders tried to exercise their influence in all steps of the decision making process, using every available means and with great personal dedication. This not only included the procedural opportunities, but to a large extent also a stakeholder's informal network.

A remarkable difference in the level of public participation appeared between the first and the third phase (see figure 4), the second phase denoting a kind of changeover. In the first phase the level of participation was relatively high, and was organised in the advisory groups, the public participation events prescribed by the EIA procedure, and in informal contacts. Parallel to the official EIA procedure, a more informal technical scientific discussion took place between actors in this case. Mainly within the project group at first, and subsequently in the advisory group. The stakeholders participating in the advisory group have discussed the concept (working) documents that were being produced by the project group for the formal procedure. These discussions had a very lively character, some of the aspects discussed resulted in additional research, which accounts for some part of the project delay. In this way the advisory group had direct influence on the EIA-report. Informant no. 7 described the atmosphere as remarkably open, and rules were creatively bended in favour of meaningful measures. The advisory group requested the search for solution alternatives against a large scale dike improvement, a possibility that was already indicated in the "Nota van uitgangspunten" (Grontmij_Projectbureau_DAR 1997a). The "startnotitie" concludes that such an alternative necessarily must be sought in a change of the legal status of the Weteringen dikes, and suggests to find such in solution in a more regional approach trough a combination of DAR1 an DAR2 (Zwolle) (Grontmij_Projectbureau_DAR 1997b).

The participation of public stakeholders within the advisory group had been difficult to arrange, because of lack of public interest. One of the participants, after some urging from the project leader, was informant no. 10 on behalf of the "Bond Heemschut" (a society for cultural heritage). Other participants were "Natuur en Milieu Zwolle" (a nature interest group) and the "LTO" (an agricultural organisation), and many others covering a broad range of local interests. To the opinion of some persons, few of the participants were seriously involved with the dike improvement problem, many were just guarding their own interests. The advisory group had been involved right from the start (already in the production of the "startnotities"), and had been consulted before the important decision events, especially at the selection between alternatives (EIA-report 2001:1, 119 and figure B 7.1). At the end, all but two participants of the advisory group agreed to the barrier alternative (EIA-report 2001:82). The exceptions, who claimed the barrier would have no functional value for the high water protection, were both civil engineers from profession. The input of the engineers made in the advisory group were not been seriously responded to, in their opinion.

This event marks the starting of the third phase. Informant no. 7 pinpoints the moment of changeover to be located between the intermediate advice given by the Commission EIA and the final EIA report. In this third phase the participation was limited to protest, objection and appeal, and the processes of construction and deconstruction described in the previous sections became dominant.

The problem solving style ultimately applied in the Zwolle storm surge barrier project (in the production of the EIA-report) can be labelled as "consultative", which is rather low on the participation ladder of Pröpper&Steenbeek (1998) and Pröpper (1999). In contrast the early style of participation (in the production of the "startnotities" and "tussennotities" can be labelled as "active cooperation and discussion and initiation of research", which is higher on the ladder.

## 3.7 Dealing with potential adverse impacts

According to several sources and informants the Zwolle barrier will, upon closure, quickly result in flooding because of the lack of discharge storage capacity in the Weteringen and Zwolle city canals, and because no collateral measures like detention basins or a pumping facility exist. Possibly because of the social disturbance to local residents and expected costs of construction of inundation areas this action was dropped from the barrier alternative action list. According to others informants this situation is only temporary, because the long term water management reconstruction plans will provide measures that will reduce the Weteringen discharge to almost zero, by stopping upstream drainage pumps and raising upstream weirs from the central barrier control unit. Moreover, in the event this situation should occur, despite the prevailing predictions, the barrier can be quickly lowered within 20 minutes to release the blocked discharge.

For the purpose of dealing with potential adverse impacts the storm surge barrier alternative defended by the EIA-report contains several actions (EIA-report 2001:83):

- Adaptation of weirs and pumping stations in the main Salland drainage system in order to enable remote control from the Water Board main office location in Zwolle; additional water level gauges and flow meters will be placed at typical locations.
- The formulation of an implementing program for the control of discharge under extreme rainfall conditions.

The account for the blocked discharge problem given in the EIA-report appears to be:

- The barrier does not necessarily have to be closed when in a specific storm situation the Weteringen discharge is larger than almost zero.
- But in the event that the barrier is closed, the Weteringen discharge can be reduced to almost zero by stopping pumps and raising weirs, because of the complete artificial reconstructed character of the water system in Salland. This will prevent the city of Zwolle to be flooded by regional discharge water.
- The consequences of stopping pumps and raising weirs will be subject of future studies.
- The result of which could be implemented in the long term WB21 planning.

## 3.8 Financial mechanisms

Several informants in the case study indicate that the inclusion of the Sallandse Weteringen in the definition of dike ring 53 can be considered rather peculiar from a technical perspective. They suggest financial motives to be the reason of the inclusion. One informant states that both the former Water Board Salland and the Province of Overijssel have cooperated in obtaining as much financial support from the central government in Den Haag as possible, in order to minimise the cost to the local citizen. According to this informant all actors were, at that time, pleased with the inclusion of the Weteringen in the WWK96. The opinions of an other informant confirm this statement, and added that the inclusion of the Weteringen in dike ring 53 was guided by whether or not a dike was included in the previous subsidy scheme from the national government. Yet another Informant mentions that in the 1968 reconstruction of the Salland water management system, the dikes along the Weteringen were given a height based on the influence of high water levels in Lake IJsselmeer, and that dike ring 53 has been fully based on information provided by the Province. This historical information indicates that the inclusion of the river Vecht and the Weteringen in dike ring 53 does not mean that their presence on the map in appendix 1 of the WWK96 denotes a high water safety problem of national importance. Local financial motives also played a role in designating them as primary water defences.

With regard to the cost of alternatives, the barrier alternative is presented in the EIA-report as cheaper. This statement is, however, only valid within the boundaries presented in the EIA-report. Costs of barrier and dike maintenance and catchment reconstruction are not included.

# 4 Case analysis results

## 4.1 Issues & controversies

Our analysis of the Zwolle storm surge barrier case reveals the following picture. In the period preceding the case problem (which started in 1997) a major dike strengthening operation in the DAR region (see figure 1) had been prevented by the construction of the Ramspol storm surge barrier. The administrative effect of the barrier was a lowering of the MHW's for the upstream region, according to the new WWK96 TAW-guidelines, compared to a situation without the Ramspol barrier. After the adoption of the WWK in 1996 the Water Boards were required to make a safety assessment of all dikes within their administration and, when needed, realise the required improvements before the deadline of 1 January 2001.

The dike safety assessment performed by the Water Board Groot Salland revealed (not unexpectedly) the problem of major shortcomings with respect to the WWK-TAW guidelines (Heidemij_Advies 1997a; b). The Water Board initiated a dike improvement procedure to remediate the shortcomings, using standard technical solutions according to the TAW guidelines. Immediately after the start of the procedure, the dike improvement plans appeared to lack support among all stakeholders involved. The safety of the dikes along the Sallandse Weteringen and the Zwolle city canals was not considered to be a major problem. Much more a problem was the local water management in the Salland system, the design of which is not adequate to deal with extreme precipitation events. At the same time the applicability of the WWK to the dikes along the Sallandse Weteringen was questioned. In this starting phase of the problem solving process the problem definition was broadened from the WWK demands for protection against water from outside to the more general problem of the water management in the Salland system.

In the eary phase (see figure 4) a broad range of alternatives was generated (in the advisory group and project team) which tried to find an integrated solution for the external high water ("buitenwater") threat and the local precipitation runoff discharge ("binnenwater") problems. The alternatives ranged from technical measures for decreasing the extent of legally required dike improvement (including both dike construction principles to comply with the TAW guidelines in a minimal way, and detention and inundation schemes to lower the MHW's) to administrative measures to remove the legal obligation for dike improvement. In the intermediate phase, additional research projects were performed (with regard to MHW water levels and inundation depths) to investigate the feasibility of some of the technical alternatives. This research raised a multitude of further questions regarding details of alternatives. Additional research would be needed to solve these. At this stage of the problem solving process various conflicts arose between Technical and Administrative perspectives. The T's accused the A's of opportunistic argumentation to force a politically desired solution; the A's accused the T's of lacking insight into the complex administrative situation that supported their arguments. At the end of the intermediate phase the problem solution space was limited to those alternatives that were in accordance with the Water Board policy.

The problem solution process was, by now, taking much time, which was considered by the Water Board Groot Salland to be a problem because of the legal deadline of 1 January 2001. Furthermore the Water Board perceived the uncertainties present in the calculated lower MHW's resulting from some of the alternatives as insufficient guarantee for adequate safety. One of the major sources of uncertainty was the definition of the worst case high water scenario. the Water Board, in their role as first authority responsible, decided to choose a solution which with certainty would conform to their legal WWK obligations: a storm surge barrier downstream the Zwolle city centre. It is a technical measure that allows a subsequent administrative measure of changing the legal status of the Weteringen dikes from primary into secondary. This solution is presented in the environmental impact assessment (EIA-report 2001) against the alternative of the original full scale dike improvement. The other part of the problem, being the water management in the Salland area, would be dealt with in a long-term approach under WB21/KRW.

The controversies between the Technical (T) and Administrative (A) solution appeared to be irresolvable. The technical as well as administrative arguments of the T's were not accepted by the A's, and the administrative arguments of the A's were regarded as invalid by the T's because the T's could refute each of them as arbitrary interpretations of the WWK. All the way through the dike improvement procedure A's and T's have tried to convince each other and the first (the Water Board Groot Salland), second (Province Overijssel Executive Council) and third (Ministry of V&W) authorities responsible, using every available means. The power of the first administrator responsible ultimately forced a decision in favour of the barrier. This decision was subsequently contested by a single citizen stakeholder at the level of Province and Parliament, and brought before the highest Dutch administrative court, the "Raad van State" by several citizen stakeholders and interest groups. This court ruled the objections against the decision to be not admissible and unfounded. Subsequently the construction of the Zwolle barrier was started.

The objective of the barrier solution was to prevent flooding in the city of Zwolle and the polders in Salland. Ironically, the water management situation in Salland 1998 A.D. will already cause rural flooding in case of 1/100 per year extreme precipitation events. This flooding is a result of limited pumping capacity in the lower areas, and limited discharge capacity in the higher areas. Furthermore, excess runoff from the higher parts will cause flooding of the lower parts. The short term measures accompanying the barrier (stopping pumps and raising weirs) will aggravate the rural flooding. In the short term, the barrier, when closed, appeared to protect the inhabitants of the city of Zwolle at the expense of the inhabitants of the Salland polders. In the long term the WB21 reconstruction plans are to extend the local storage capacity. Currently some reconstruction projects are already in progress. The adequacy of the created extra storage, however, has yet to be calculated in a modelling project that was already announced as part of the barrier alternative and is currently under way.

The worst case external high water scenario for the WWK is a 1/1250 per year event. When the dikes along the Weteringen are not reinforced and raised up to the 1/1250 norm in accordance with the WWK guidelines, and the barrier would be absent, the lower parts of Salland could be flooded in a storm surge event in case water levels exceed the current 1/100 per year level of the Weteringen dikes. This could be the result of overflow of the existing dikes, or of a possible dike failure along the Weteringen. From a regional point of view such a flooding is considered acceptable, and emergency overflow sections could be constructed to guarantee dike integrity under such circumstances and mitigate the effects of the 1/1250 per year external event. Forcing an inundation by means of an emergency spillway in the Weteringen dikes would lower the MHW in the Zwolle city centre to an acceptable level (of 1,60 m+NAP, see Annex II of EIA-report 2001). Such an approach, however, would be against the WWK96 directives.

## 4.2 The use of research information

In the initial stage of the decision making process the advisory group was heavily involved, together with the project team, in finding alternative measures for a full-scale dike improvement of the Weteringen and Zwolle. In an intermediate stage the water board removed all solution alternatives which included inundation as a means of lowering the MHW's in the Weteringen, because of its administrative complications (of norm differentiation) and the uncertain effect on the MHW reduction (of technical measures). The same arguments also ruled out the alternatives with diminished dike improvement. Since a full scale dike improvement was considered not to be a feasible alternative, only a single alternative was left for consideration, viz. the barrier including accompanying measures to reduce the Weteringen discharge from the higher parts of Salland in the event of closure of the barrier. Fundamental questions remained, however, with regard to the safety of the Weteringen dikes, the damage resulting from a possible dike failure, and the socially acceptable inundation depths.

Remarkably, research performed in the initial project phase did consider the inflow of and inundation with water from the river Vecht to be unacceptable because of the 1/1250 safety norm (EIA-report 2001) and (see (Grontmij_Projectbureau_DAR 1997b:20). At the same time, however, it selected an alternative which implied the possibility of inundation with local Weteringen discharge and precipitation water. The report of the intermediate phase stated that a barrier downstream the Zwolle city centre would need administrative and social acceptance of water inconvenience in the lower parts of Salland. This could be regarded as the application of the "not in my backyard" principle to the city of Zwolle at the expense of the Salland rural area.

The reported low probability of flooding in the Zwolle city centre appears to contradict the barrier decision. At the same time, rejection of inundation alternatives in favour of the barrier is reported to hardly change the calculated damage of flooding in the Salland rural area. For both the safety of the Zwolle city centre and the Salland rural area, in case of a dike failure along the Weteringen, the presence of the barrier makes no difference.

The example of the Zwolle barrer case shows how our mental model mapping method for frame reflection is capable of surfacing contradictions in the decision making argumentation. The question now remains why actors, using this same expert information, reach a different decision outcome. The statement from the Administrators that they have a legal obligation to prevent water from outside ("buitenwater", in Dutch) entering the dike ring indicated a specific frame and which can be regarded as an explanation. The driving force for the entering process is a low water level on the Weteringen. This low level could result, in cases of higher Weteringen discharge, from the above mentioned dike failure. In this case the barrier, however, is reported not to be effective with regard to inundation damage. But the low level could also result from a low Weteringen discharge. The argument presented by the Administrators is that in combination with a high "buitenwater" level flow reversal could possibly occur. A low Weteringen discharge in combination with a high Vecht discharge is, however, contradicted by available research from the earlier Ramspol project (Burgdorffer 1992).

## 4.3 Actor integrity

Several informants made statements regarding personal integrity. According to informant no. 4, for example, no player has been dominating the decision game. This, in his opinion, had always been a group process with group responsibility. For some actors such a group responsibility offered safety compared to personal responsibility. In contrast, according to informant no. 13, it was the attitude of individual persons that decided the course of the decision process. Informant no. 7 indicated having had at one time a problem dealing with his personal conviction, objectivity and independency in the decision process, and ultimately decided that administrative considerations might very well balance the technical arguments without him being able to oversee the total picture.

Informant no. 9 illustrated the powerful position of technical advisors, because administrators are not in a position to judge the expert and therefore have to thrust his opinion. An administrative advice could be questioned and brought before court for a ruling to solve it, but the disregard of technical advice might have serious adverse effects which a court cannot decide upon. Therefore administrators can only function when trusting the integrity of technical advisors.

Another element of integrity is mentioned by informant no. 10, who stated that, once a decision has been taken within a certain group, a person is expected not to display doubts or even criticism in public, afterwards. In his opinion all resistance was in fact futile from the moment the Water Board Council approved of the EIA.

## 4.4 The decision making process

The central Technical issue in our case appears to be water detention in Salland, from either extreme precipitation or storm surge, and not the Zwolle storm surge barrier. The central Administrative issue appears to be the "closed dike ring" principle. Throughout the dike improvement procedure proponents of both perspectives have tried to convince each other and the first (Water Board Groot Salland), the second (Province Overijssel Executive Council) and third (Ministry of Transport, Public Works and Water Management) authorities responsible of their arguments. This controversy was not resolved in the case. The barrier solution ultimately allows and facilitates a further development of the Salland water management plans and the implementation thereof, over the next fifty years.

Although the decision making process can be described as rather turbulent, several years after this process ended (with the ruling of the "Raad van Sate" in 2002) almost all actors claim to be content with, or at least to acquiesce in, the decision outcome (the Zwolle storm surge barrier). One actor (taking a Technical perspective), however, maintains his opposition, because the storm surge barrier will never be closed as long as the need for discharge of the Sallandse Weteringen is not provided for by other means (like an alternative discharge route or detention in the polders). Some other actors, representing the Technical point of view, share his opinion but ultimately consider the Administrative arguments to be acceptable or inevitable. Most civil engineers agree that inundation will take place anyway, regardless of the operation of the barrier at the design event, because of the nature of the water system in Salland. The recently initiated long-term reconstruction of the Salland water system can alleviate this problem by retaining the precipitation locally. The presence of the barrier has allows a legal change of status to secondary of the Weteringen dikes and Zwolle quays, and consequently allows a very much reduced improvement of the dikes and quays that will not affect the LNC-values. Also the barrier has allowed the Weteringen dikes to be incorporated in the regional long-term WB21/KRW plans.

Despite the risk approach that was recently introduced in the State policy (the Flood defences Act 1996, in article 3.2, already allows for replacing the MHW safety norm by a probability on flooding caused by dike failure), in the present case a traditional safety approach was applied, based on the probability of water level exceedance. Dealing with uncertainties appears to coincide here with a "maximum safety" approach within the given legal framework, in order to secure responsibilities regarding the Flood defences Act and flooding liability.

## 4.5 Has the unstructured problem been solved in this case?

In section 1 we claimed:

> The solution of complex, unstructured problems in integrated water management is faced with controversy and dispute, unused en misused knowledge, project delay and failure, and decline of public trust in governmental decisions.

With regard to our case, the dispute[3] is visible in the debates between the Technical and the Administrative perspective, e.g. the technical arguments presented by informants nos. 2, 7, 10 and 11. Controversy[4] is visible in continuous separate efforts of Province and informant no. 10 to decide the conflict in accordance with their opinions. Unused knowledge is e.g. the unused data and research reports on high water peak discharges, and the estimated frequency of closure of the barrier. The presentation of a closure frequency of once a year, the disregard of the principle causes of inundation in Salland, and the specific interpretation of the distribution of responsibilities by the Water Board can be regarded as examples of misused knowledge. Project delay is cause by the additional research and deliberation started in the initial phase of the EIA project, the delay of the permitting procedure by the Zwolle municipality, and the objections and appeal to court by informant no. 10 and other citizens. Project failure is a matter of perception, but from the Technical perspective the barrier can not be closed currently, and the effect of future land reconstruction projects for discharge reduction is doubted. Decline of public trust in governmental decisions is visible in the publications of informant no. 10, the personal policy opinion of informant no. 2, the resignation of informant no. 7, and the careful criticism of informant no. 11. In the case the civil engineers, after having used every available means to oppose the administrative arguments, ultimately resigned in the primacy of the administrative (organisational + political) perspectives.
In the remainder of this section we will analyse the success and failure of the problem solution more in detail, by reflecting on the claim that complex unstructured problem situations require an interaction of the problem solution with the larger context, changing the definition of problem.

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[3] Dispute (m-w): to engage in argument : DEBATE; especially : to argue irritably or with irritating persistence. transitive senses 1 a : to make the subject of disputation b : to call into question <her honesty was never disputed> 1 : a discussion marked especially by the expression of opposing views.
[4] Controversy (m-w): 2 a : bitter sometimes violent conflict or dissension <political strife> b : an act of contention : FIGHT, STRUGGLE )

The initial problem of the DAR-1 and DAR-2 projects concerned the legal obligation for dike improvement along the Sallandse Weteringen and in the Zwolle city centre, respectively. In the course of the EIA project DAR 1 & 2 have been repeatedly joined and separated. The final decision implies a disconnection of the legal protection against external high water ("buitenwater") from the management of regional discharge high water, and marks a separated solution.
The quays in the city of Zwolle presented minor problems only. These problems concerned a few locations where the height was insufficient, and the use of the quays for cables and pipes and trees. The latter, although it had not been regulated, was considered not to present a real problem by experts. It was, however, administratively used as an argument in favour of the barrier, by claiming that all foreign objects would have to be removed from the quays. With regard to flooding damage legal liability would pose no problem because the city centre is located outside the dike.
The situation for the Weteringen dikes was different from Zwolle. The WWK96 demands on dike improvement would result in an enlargement of the dike body that was considered to be technically senseless and lacking social support. The Water Board, however, would be liable for flooding damage (mainly agricultural) when the dikes were not brought up to their legally required "delta" strength. This possible flooding damage has been problemised. For one by the farmers who claimed financial regulation in case of development of inundation areas. Remarkably, an other potential financial claim originated from a local electricity production plant, who had an existing agreement that their high tension masts should always accessible with heavy equipment, also in case of inundation.

The above exploration of the initial problem resulted in the generation of many alternative solutions in the initial project phase. At the end of the second project phase the Water Board decided for the barrier alternative, which would allow a withdrawal of the problematic dike sections from dike ring 53 and thus a change of legal status from primary into secondary.

A change of status would, in Zwolle, prevent a discussion about the installation of foreign objects tolerated for many years without any administrative control with regard to the primary status of the quays. Also the construction of a barrier would provide the Zwolle city centre with legal protection against flooding with water external to the dike ring. Remarkably, the probability of such flooding was estimated by expert to be lower than the 1/1250 per year level required by the WWK96 in the situation without barrier. Moreover, the barrier will not, and legally need not, protect the Zwolle city centre from flooding with regional discharge water.
A change of status would, along the Sallandse Weteringen, prevent full scale dike improvement. The dike can now be improved to comply with the regional demands of e.g. 1/100 per year. The barrier is considered to protect Salland against high discharge levels from the river Vecht in combination with a NW storm. The worst case scenario will occur when, under such conditions, several dikes along the Weteringen will fail and the Weteringen discharge will completely be diverted through the dike failures. In such event the water from the river Vecht may, according to model calculations performed by the Water Board, enter Zwolle and Salland, and the barrier will provide the legally required protection against "buitenwater". The same calculations show, according to technical experts, that the amount of damage will hardly change by the presence of a closed barrier. Furthermore the technical experts claim that the probability of flow reversal in Zwolle his highly unlikely. The flooding damage will be caused by regional discharge water, for which the Water Board is not liable, and has a probability of occurrence of 1/100 per year. The 1998 extreme precipitation event is an example of such an 1/100 per year event.

The above consequences of the barrier solution present new problems as well as considerable opposition. This is in accordance with the characteristics of complex unstructured problems, where problems and their solutions appear to be connected to the broader context. With regard to Zwolle we are now confronted with a barrier which can not be closed because of the lack of upstream discharge storage in the Weteringen. An additional solution is constructed through the integration of the storage problem into the long term WB21 land reconstruction projects. On the short term distance controlled shutdown of polder pumping stations and raising of weirs is considered to offer a first alleviation of the storage problem, in combination with a low closure level of the Zwolle barrier. New problems, however, lie ahead because model calculations have yet to prove the adequacy of this set of measures, which is already doubted by technical experts.

Also with regard to Zwolle, the barrier wil hardly ever close because the frequency of occurrence is estimated by technical experts to be very low. This argument is opposed with reference to climate change effects (sea level raise and extreme rainfall increase), which might change the frequency model. According to informant no. 7 such change would make a barrier inevitable in say 500 years from now. Before constructing a barrier, however, this informant considers the enlargement of the Zwarte Water storage basin area a preferable alternative.
With regard to the Sallandse Weteringen water system, the local storage in land and ditches is insufficient to allow shutdown of polder pumping stations and raising of weirs without local flooding. WB21 "Waternood" measures will only offer temporary relief, once the soil is saturated and the ditches are filled, the water will again discharge (under free flow or with pumps into the Weteringen) or, alternatively, cause flooding. For the higher parts of Salland, at such occasion the raised weirs will cause the water to flood the land adjacent to the Weteringen, and the flood will continue its natural course into the lower areas of Salland.

We can conclude that the Zwolle Barrier case situation poses an example that exhibits many characteristics of complex unstructured problems, also with regard to the embedding of the problem in its context. The initial problem formulation changed several times until it became a problem integrated in both its broader physical and administrative context. An integrated solutions has, however, not been reached within the EIA project. The Zwolle storm surge barrier appears to be more an end-of-pipe problem treatment.

## 5 Conclusions with regard to the workshop objectives

The workshop investigates the question whether policies in the water sector can effectively be improved by new approaches to public consultations and participation in impact studies.

From our analysis of the Zwolle barrier case we conclude that methods for such improvement are available. Improvement is, however, potentially threatened by institutional, political and social resistance to use available knowledge as decision arguments. The limits of democratic decision making can be revealed by frame reflection methods.

In our case, we found a very open and deliberate communication in the first phase of the decision making process. Scientists addressed the complexity of the physical system and revealed the uncertainties in their predictions. Many stakeholders have been involved in a rather high (for this type of decision making) level of participation, and discussed the problem and its alternative solution in detail. The involvement of all main actors in the dialogue did, however, NOT succeed in building mutual understanding and a shared vision on problems, objectives and alternatives. The persistence of the disputes in the later phases of the decision making process shows that open communication alone is not enough to prevent decision making barriers. Despite intensive communication between actors in this case, their different frame perspectives maintained different mental models and therefore different preferred solutions. Apparently institutional and personal perspectives ultimately play a dominant role. These perspectives determine the way in which actors deal with details that were exposed in the previous more open communication. These details are, for example, declared irrelevant (like a new interpretation of the Flood defences Act , distribution of responsibilities, and need for further research), or are not explicitly answered (e.g. the necessity of detention, and the low frequency of occurrence of the worst case scenario). In spite of the outcome of the EIA-process, the knowledge of the problem situation appears to have expanded considerably, through the efforts of the EIA project team, several research projects and critical members of the advisory group.

We conclude that, in the specific case analysed, the method developed to analyse mental models and perspectives that comprise the frame of an actor does indeed explain the persistence of controversies. It appears that the root of the issue lies in the unacceptability of the deployment of inundation areas for extreme high water events outside dike ring 53, where at the same time these inundation areas are effectively already operational for storage of excess local drainage water. The issue involved all levels of administration, from local residents (mostly farmers in the lower parts of Salland and inhabitants of the Zwolle city centre) up to the responsible Minister of Transport, Public Works and Water Management. A complicating factor was the uncertainty in the chosen worst case scenarios and in the calculated MHW's and expected inundation depths. The example of the Zwolle barrier case shows how our method is capable of surfacing experiences, perceptions, assumptions, and knowledge in the decision making argumentation.

Climate change parameters are incorporated in the Zwolle EIA through the way uncertainty is dealt with. Uncertainties in the calculated MHW-levels pressed the authorities to better-safe-than-sorry approach, in that they anticipated even higher water levels than resulted from model calculations. On the other hand they downplayed the risk of reconstruction plans to extend the local storage capacity not being capable of preventing local flooding in case of extreme precipitation events.

The principles for carrying risks. Despite the risk approach that was already introduced in the State policy, in the present case a traditional safety approach was applied, based on the probability of water level exceedance. Dealing with uncertainties appears to coincide here with a "maximum safety" approach within the given legal framework, in order to secure responsibilities regarding the Flood defences Act and flooding liability. The subject of compensation of flood damage has been avoided in the Zwolle barrier case. Two NIMBY's can be discerned in the Zwolle barrier case:

1) Building the barrier prevents additional land use for dike improvement at the expense of farmers' properties. Closing the barrier prevents the Zwolle city centre from flooding at the expense of flooding in rural areas (= same farmers). The question remains whether keeping the barrier open would have caused rural flooding also.
2) Building the barrier prevents a political discussion on national level about relaxation of the strict dike ring philosophy maintained so far (a national symbol!) and the associated political dangers, at the expense of local and regional political discussions (in the city council and

With regard to sustainable development, the Zwolle barrier case did not seize the opportunity to develop a long term high water safety solution in using the low polder areas for water retention. The need for formulating a new high water protection and water management strategy was made painfully visible in this EIA case. Many case aspects concern decision to be made on a strategic level. The Water Board's long term land use and water way reconstruction plans (WB21) will tackle these aspects over a 50 year period.

On the issue of dealing with different authorities, an integrated problem approach requires a willingness to cooperate in the fields of knowledge, legislation and economical consequences (long term costs, but possible future flood damage claims also). Also needed is the individual willingness to change existing regulations or their interpretations, and the willingness to break through institutional communication patterns and distributions of responsibilities, in order to creatively redefine the problems on a higher level of aggregation and to find new solution spaces. This needs present new responsibilities for the authorities involved. In the Zwolle Barrier case, the barrier construction conflicts with existing risk management and land use approaches. The EIA mainly served the purpose of achieving "good governance" in the definition given in section 1, which boils down to supporting the already made decision of constructing a barrier. Non-supporting information was removed from the line of argumentation or declared irrelevant.

The accountability of authorities in a democratic process in the Netherlands, at first glance, appears to be organised quite well in the applicable laws. In real-life project situations, however, the democratic principle has its limits and may get bogged down in the quicksand of personal and institutional interests – as was shown by our analysis of perspective types.

Discussion of the elicited mental model maps may promote communication and learning between individuals and their organisations involved in a case. Construction of a common mental model map of the problem situation (e.g. by the researcher) would allow the structuring of conflicting elements of diverse argumentation chains without immediately resolving the controversies, and may surface assumptions, interpretations and uncertainties (both technical and administrative) involved. The nature of the controversies could be discussed using the perspective types and their rooting in institutional and personal contexts. We hope that a means can be devised for overcoming frame differences also at the more abstract levels of national policy in the early stages of the problem solving cycle, where the problem is defined and the solution space determined. The data matrix tool also offers a way of discussing the decision making arguments with informants. The tool's results could be discussed with informants, separately and in a group. Such a discussion would potentially offer clarity on the meaning of and rationale of the conflicting positions, and thus contribute to open communication. Truth is relative to the frame in operation and therefore cannot be objective. Integrity, in the sense of Ravetz (2002), means recognizing the uncertainties in knowledge and the social and political construction of values. An integrated approach means a critical dialogue about conflicting interests and perceptions of both problem and solution. Frame reflection by mental model analysis can contribute to this goal.

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