DESIGN OF A DUTCH SUPERLEVEE

A CO-PRODUCTION BY CIVIL ENGINEERS & URBAN PLANNERS, WATERBOARDS & MUNICIPALITIES

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Preface

This report is the product of my thesis project, final part of my Master of Science study Systems Engineering, Policy Analysis and Management. The research has been carried out at ARCADIS division Water from November 2008 to May 2009.

Without prior knowledge of the concept I have started this research on the Superlevee. Immediately, I was enthusiastic about this innovative concept that can be a solution for so many problems. During my research this enthusiasm was slightly tempered by the amount of issues that I came across and the practical difficulties of designing this “super” levee. The reality turned out to be somewhat more complex than I suspected at first sight. Not only did I run into a web of different definitions for identical dike concepts and identical definitions for different ones. Also, I had to give myself a crash course in urban design and the design of water barriers. While my understanding of the field of study and of the actual design challenges grew, my enthusiasm was completely restored. Therefore, I would like to introduce my report with the enthusiasm that I have started and finally completed my thesis study. This is best illustrated by the following quote of Pier Vellinga (in: Visiebeeldboek 02 Klimaattijdijk).


I would like to thank those who helped me during my research. The working sessions, brainstorm storms, advice and enthusiasm of my thesis committee, Tineke Ruijgh, Paulien Herder Wil Thissen have contributed severely to the quality of my research and the joy with which I have executed it. Furthermore, I would like to thank all colleagues from ARCADIS, and especially Iris de Jongh, for the assistance and input, for involving me in (other) inspiring projects and for the fun I had during the completion of my thesis project. Finally, I would like to thank my family, friends and Chris for listening to my ‘individual brainstorm storms’, for being a second reader and for providing me the needed distraction.

I hope you will enjoy reading this report.

Carlijn van der Sande
May 29, 2009
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Summary

Climate change is forcing the Netherlands to reconsider the safety level of its flood protection system. Meanwhile, population growth, economic activities and increasing spatial pressure require urban expansions in heavily urbanized areas. The innovative Japanese concept of a Superlevee is presented to be the solution for both challenges. Combining the two problems into one Superlevee will require the integration of the flood protection function and the function of urban development into one design process.

General design theory provides insight into the differences between various design approaches, and more specific between architectural and engineering design approaches. It does not provide any methods to deal with these differences. Existing literature on multiple land use mainly focuses on the process and the role of process management during design and implementation of multifunctional projects. These studies are mostly based on examples of past multifunctional projects and no general conclusion on the design challenges of such projects is given. Two currently running studies on the Superlevee concept have significantly contributed to knowledge development on this topic. Additionally many knowledge gaps and questions for further research have been formulated. These need to be dealt with in order for the concept to become truly applicable. These knowledge gaps are mostly practical in character and do not address the underlying reasons and background of these questions. A knowledge gap thus exists on how should be dealt with differences in general design approach between functions - that are to be combined within one artifact - and what the role should be of content related uncertainties.

In this absence of available theory it has been decided to conduct a separate and symmetric analysis of the two functions based on the general TIP design methodology for complex technological problems. The goal of this research is twofold. The first goal is to increase the understanding of the background and content of the difficulties in design of a bifunctional Superlevee and to contribute to the actual applicability of the concept in the Netherlands. The second, more theoretical, goal is to contribute to the development of a more systematic approach for the design of projects that apply the concept of multiple land use. With this research is tried to connect general design theory with the literature on process management of multifunctional project. Therefore the following research question has been formulated: How can a better understanding of the design process of the two functions flood protection and urban development improve the applicability of the Superlevee concept?

This analysis has lead to the conclusions that the design approach of a flood protection system and the design approach of an urban area are different in multiple ways. Additionally the actors involved in both functions have a different vision on the definition of a Superlevee, about the need for a Superlevee and about the added value (Win) of a Superlevee. The consequence is that both sides have different starting points for the design process. Moreover, the analysis shows that the main difficulty for the co-production of a Superlevee is the realization of a joint design process. The attitude of the Waterboard regarding a Superlevee is determined by the absence of a need for a Superlevee, the lack of financial resources, the technical and institutional effects plus uncertainties and their problem focused design approach that prevents a focus on the Win of a Superlevee. This
attitude contains the risk for a Waterboard that the design process of the Superlevee continues without them. The outcome of such a separated design process could be the implementation of a design variant that is experienced to be a deterioration compared to the existing situation.

To support the Waterboard in adopting a pro-active and opportunity oriented attitude towards the Superlevee concept, an action plan has been drawn up. The starting point of this action plan is the fact that the Waterboard should focus on the main goal of its water barriers - providing safety against flooding – and should not focus on the (institutional) instruments and obstacles for managing the water barrier. Regarding the safety level, the Win of a Superlevee could be that the barrier is made burst- and climate proof. The effects of surface and underground constructions on the safety level of the barrier should be assessed on a conceptual level. In depth discussions about design criteria such as costs of a Superlevee, manageability and others are advised to postpone. The outcome of this action plan will serve as input for the co-production design process of the Superlevee.

This study has contributed to an increase in understanding of the background of design difficulties of a Superlevee with regard to the combination of the functions flood protection and urban development. Furthermore, this study has delivered a plan that should assist in overcoming these difficulties and thus contributes to the general applicability of the Superlevee. The conducted research also shows that understanding of the separate design approaches of functions - that are to be combined into one design process - provides a great amount of understanding about the design challenges and their effect on the potential of a co-production. The attitude of involved actors can be better understood; consequently it becomes easier to steer a co-production process. This approach is suggested to be useful in other multifunctional design dilemmas and this study intended to contribute to the filling of the identified theoretical knowledge gap. Finally, the applied design methodology that integrates the technological, institutional and process design (TIP) has proven to be very useful. With this framework it becomes possible to generate a structured comparison of the design approaches of the multiple functions. It provides clear understanding of the differences between them and thus of the background of existing difficulties. This insight can be used to solve these difficulties.

With the growing scarcity of space in the Netherlands the pressure for multiple land use will ever increase. This leaves a very interesting field of study for research on multifunctional design theory and multiple land use. Regarding the applicability of the Superlevee, additional research will be needed. This study has focussed on a bi-functional Superlevee and in practice more functions will be possible to combine. A waterfront is very interesting for nature development and recreation; the combination of these functions with flood protection should be further elaborated on.
CHAPTER 1

Introduction

The Netherlands are facing a huge challenge concerning flood protection. The country has a history of floods from the sea as well as from the main rivers. Approximately 65% of the country would be flooded during high sea and river levels in combination with absence of the dunes and dikes. The population is ever growing and most of the economic activities are concentrated in the lower areas of the country (Huisman, 2004). Moreover, uncertainties concerning our water barrier system are increasing due the currently running discussion about climate change and the possible effects. Sea level rise, increasing fluctuations in the river discharges, drought and a needed fresh water stock will ask for reconsideration of the safety level of our water barriers.

To deal with this challenge the cabinet has asked an independent commission, the Delta commission, to advice them on a long term vision on how the Netherlands should guarantee water safety in the future and how it should deal with the effects of climate change. The commission’s advice has been presented in September 2008. Amongst other aspects, the advice contained the strategy to increase the safety level by a factor 10 and to stimulate the construction of Delta dikes that would be so high, strong or broad that the possibility of sudden collapse would become negligible. In December 2008 the Ministry of Transport, Public Works and Water Management has presented the new National Water Plan which will become the official framework for all aspects of Dutch water management. Concerning flood protection it presents a new safety philosophy. In former times the focus in flood protection has mainly been on the prevention of floods. With the new plan, flood protection will be divided over three layers: flood prevention, sustainable spatial planning and disaster management.

Besides the cabinet other public and private actors are meanwhile investigating potential new safety strategies for our water barrier system. October 2008 a study was presented on how the existing dikes could be made burst proof (Silva et al, 2008). This concept is not new, already in 1953, shortly after the great storm flood, the idea has been introduced (Elderman, 1954). But the study shows a first estimation on the costs and the feasibility of implementing this idea. Another development that is currently being studied is the levee that is able to withstand water that is overtopping the dike (Comcoast, 2009). All these developments provide new ideas about how we could improve the design and construction of water barriers to keep them safe enough, no matter what the future brings.
Frame 1: Superlevee in Japan

According to the Japanese Foundation for Riverfront Improvement and Restoration (2008) a Superlevee is "a river embankment with a broad width which can withstand even overflow, so that destruction by a dike break and its resultant flooding can be prevented". But in the Japanese examples of a Superlevee the levee is not only able to withstand overflow. It is dimensioned in such a way that multifunctional use of the dike-body becomes possible. For example the lower reaches of the Arakawa River in Japan are very flood-prone areas. The number of natural disasters has increased in the recent years and both the local and the national governments are currently taken various measures to safeguard against flooding. One of these measures is the Superlevee (Arakawa-Karyu River Office, 2007). An impression of the Japanese concept of a Superlevee is given in Figure 1.

The Netherlands and Japan experience great differences in geographical location and meteorological conditions. Japan counts 200 volcanoes and more than 70% of Japan is covered with mountains. The Netherlands are rather flat with a highest point of only 322.5 meters above the mean sea level. Japan is situated in the East monsoon region and is affected by 30 typhoons a year. In large contrast, the Netherlands is situated in Western Europe and does not experience any monsoon seasons or typhoons. The average precipitation in the wettest month is only 80 millimeters (Graaf et. Al 2008). Based on these huge differences it is remarkable that the Japanese and Dutch have applied similar approaches of pluvial and fluvial flood control throughout the centuries (Stalenberg et al., 2007). And - even thought the Netherlands have very different meteorological conditions - the combination of an extra strong and multifunctional Superlevee could be a good solution to multiple problems.
The Netherlands is facing a huge challenge with regard to spatial planning. The country has a population of approximately 16.5 million people (CBS, 2009). The surface area for this population is 34,000 km$^2$. The population is still increasing and thus the spatial need for locating these people as well. Not only housing is a task in this spatial planning. Other functions like working, recreation, nature development, economic activities, energy production, flood protection, etc. ask for space. Only for living and working already 120,000 to 190,000 hectares will have to be developed in the coming decennia (VROM, 2009).

Whereas in previous times most of these functions were separated, the lack of space urges to combine functions. To structure these space-demanding functions the Ministry of Housing, Spatial Planning and Environment is assigned to set up national spatial plans. On a lower level provinces and municipalities implement these plans. In these plans the available land is divided amongst the different functions. The water barriers with the main function of flood protection are becoming more interesting for the embedding of other functions.

Already on multiple locations water barriers are being combined with other functions like farming (grazing stocks of cattle on dikes), recreation, nature development (bio-diverse vegetation in dunes and on dikes) etc. These examples however do not suggest that a combination of functions is an easy task. Combining these functions requires clear agreements on responsibilities, financial resources, maintenance etc. Examples of the combination of housing and flood protection exist as well. Some of these have grown historically, like the old city centre of Dordrecht, and others have been developed more recently (Min V&W, 2003). Either way, the combination contains difficult aspects for design as will be reflected on further in this report.

Despite the difficulties, new concepts have been and are being developed to improve multifunctional use of water barriers. The label “Multifunctional Water Barrier” that is being used, clearly states this intention. A relatively new term that expresses the multifunctional aspect of water barriers is the “Water Retaining Landscape”. This term suggest the integration of all functions into one landscape instead of dividing these functions over the landscape.

New ideas that combine the increasing challenge of water safety with the challenge of spatial pressure have been developed as well. Currently a platform is active that promotes the idea of a Climate Dike. The Climate Dike is a collective term for forms of water barriers that are so robust that it will not burst even when water overflows the barrier. And it contains a multifunctional, robust protection zone that fits the environment. It can be shaped in different ways like a very broad dike, as a terp-dike or as another innovative solution. The goal of the platform is to change the way of thinking about flood protection as a monofunctional system. Simultaneously a knowledge program is running and a knowledge network is being established between all interested parties, public and private (Hartog et al, 2009). Additionally the concept Superlevee is being used. The name originates from Japan were it has been the solution for urban water safety in combination with extreme weather conditions. Very broad and urbanized riverbanks are being constructed that provide sustainable safety and appealing areas for living and working. In Frame 1 an introduction is given to the Japanese idea of a Superlevee. Taking the definition of the Climate dike, the Superlevee can be seen as the broad variant of the Climate levee.

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1. Amongst others used during meeting Platform Climate dike (April 2, 2009)
2. Initiated during at a meeting of dep. Deltas & Rivers, Division Water, ARCADIS (January 29, 2009)
Frame 2: Designing on the interface of Water and Space

“Projects that affect both water and space will exceed the administrative borders. Per definition that places more emphasize on design and on research about designing. In conventional plans the public manager determines the rules of the plan, while a designer designs within that sets of rules. Designing on the interface of water and space requires a different approach. By approaching water and spatial challenges on the scale of the entire area it will become possible to combine spatial and water challenges and find an integral solution that serves both aspects. A designer will not only be expected to deliver a spatial plan, but his plan should serve as a guide or inspiration for the managerial and legal design”. The above is the vision in the booklet Designing on the Interface of Water and Space that VROM has published March 2009. General rules of advice have been formulated.

Figure 2: Location of waterfront development (VROM, 2009)

More practical is the part with the examples that explain what can be learned from previous projects. One example is given on the combination of flood protection and housing, the Waterfronts of Walcheren, see Figure 2. The main challenge for flood protection has been enforcing the weak spots in the boulevards to the required safety level. The challenge for urban design has been the development of the boulevards of Vlissingen, Zoutelande and Westkapelle into attractive areas for inhabitants, visitors and investors. The learning points from this project have been summarized as follows:

- Do not think according to the safety norm, but learn to deal with uncertainties.
- The speed of sea level rise is uncertain, therefore phase the safety measures.
- Put long term challenges on the agenda, now is the time to start thinking about this
- Involve a quality team.
- Coastal defence is development of the area, an integral approach will be the most supported one.
- Do not plan coastal defence ahead, but act now. This way it will be easier to fit in spatial plans.
Focus
This research focuses on the concept of a Superlevee and the combination of the two functions flood protection and urban development. As this study will show, many small and larger differences exist in the meaning of the term Superlevee that is being used by different people. Therefore a few remarks need to be made about the demarcation of the research:
A Superlevee is approached as a broad ground construction that allows for multifunctional use. Concerning the function flood protection and the potential locations of a Superlevee the focus of this research has been on primary water barriers that do not already have an urban function. Examples that answer to the earlier mentioned definition of a Climate Dike in combination with urban development can already be found in densely urbanised areas (see website platform Climate Dike). The very broad Superlevee currently does not exist as such in the Netherlands. A very strong and broad Superlevee could be interesting for many functions, for instance for the improvement of natural/ ecological environment or the development of a recreational area. This study only focuses on a combination with the function urban development. This means the development of an urban neighbourhood in an area that has not had an urban function before. Main reason for this demarcation is the fact that urbanization will be likely to have the largest additional value with regard to the financial feasibility of a Superlevee. On the other hand it will be one of the most difficult functions to integrate, due to the number of actors, the interests and the political power.

1.1 Motivation for Research
Due to pressure for urban development on the water barriers of Flevoland and the introduction of the concept of a Superlevee, the Waterboard Zuiderzeeland decided to start a study on the applicability of the Superlevee in the province of Flevoland. ARCADIS has supported this study and at this moment (May 2009) the study is about to be completed. During this study possible design variants of a Superlevee have been analyzed, difficulties have been identified, follow-up research questions have been formulated and three possible ways to continue the process have been determined.
The platform Climate dike is also continuing with knowledge development and has recently (April 2009) published a first document on the Climate Dike in cooperation with the program Knowledge for Climate (Hartog et al, 2009). In this document the already available knowledge has been bundled and questions concerning the implementation of Climate dikes that need further research have been identified.

The conducted studies have been very useful for the development of knowledge on the Superlevee and show a rather complete overview of the aspects that are uncertain and unknown about the Superlevee/ Climate dike. The number of identified knowledge gaps shows that much information is needed before real implementation of one of these concepts becomes possible. The combination of flood protection and urban development in a Dutch variant of the Superlevee seems to be more difficult than the examples in the Japanese Superlevee Guidebook would suggest. However, these studies do not specifically address the background of the questions and uncertainties and the underlying philosophy of both designer worlds.
Besides these studies on new, safer and multifunctional dike concepts also a study has been conducted on the philosophy of and the need for designing on the interface of water and space. In March 2009 the Ministry of VROM has brought out a booklet in which the importance of a shared design process between water designers and spatial designers is being emphasized. Both functions are space demanding and the philosophy of VROM is therefore that both functions should be approached in combination with each other instead of in a mono-functional way. The booklet contains examples of projects with a water-space design combination and based on these examples some rules for shared design are set up. The link with this research is mainly the example on the design of the enforcement of weak spots in the flood protection system combined with the challenge of developing an attractive area for inhabitants, visitors and investors. In the second half of Frame 2 this project is explained in more detail. The advice that is given based on this example mainly refers to the design principles for flood protection. The recommendations suggest adjustments to the core of the design process for flood protection. How these changes would have to be accommodated is unfortunately not discussed.

In the next section more will be said about the theoretical underpinning of this research. At this point should be explained that the three studies above have lead to the following starting points for the conducted research:

1. Bringing together the two functions into one artifact, the Superlevee, asks for **design** on the interface of water and space. The Superlevee design process will become a shared process, rather than a combination of two existing design processes.
2. A shared **design process** will not only imply the combination of functions that needs to be designed, but also the people that design, the method of designing, the applicable legislation, the financing structures, the philosophy behind these financing structures etc.
3. The studies at Zuiderzeeland and the platform Climate Dike have taken the Superlevee/ Climate Dike as point of departure and have identified the difficulties and uncertainties for design. With this approach the intended (designed) situation is compared to the existing one; this assumes that the two functions have the same **vision** about what that intended situation is and how to get there. Based on initial interviews and the outcome of both studies, this assumption of a shared vision appeared to be difficult to confirm.

### 1.2 DESIGN OF MULTIFUNCTIONAL SPACE USAGE

Considering the three starting points above, this paragraph explains which theory is available on design and on the process of projects that apply the concept of multiple land use. Also it explains how and why these theories can be used in this study on the design of a Dutch Superlevee. Accordingly the goal of the research is explained and the research questions are presented (1.3) followed by an explanation of the research methodology (1.4), the research methods (1.5) and a clarification of the structure of the report.

#### 1.2.1 GENERAL DESIGN THEORY

As introduction to design theory and to increase the readability of this paragraph a few terms about design and characteristics of design have to be specified. The definitions given
here are based on Mingers and Brocklesby (1997). They are not claimed to be the only and correct definitions but are the ones used in this report. A paradigm is a very general set of philosophical assumptions that define the nature of possible research and intervention. A methodology is a structured set of guidelines or activities to assist people in undertaking research or intervention. A design methodology therefore is a structured set of guidelines or activities to assist in the undertaking of the design activity. A methodology will generally develop within a particular paradigm and will embody the philosophical assumptions and principles of that paradigm. A technique is a specific activity that has a clear and well-defined purpose within the context of a methodology. With regard to design in general and the activity of designing two major design paradigms, multiple methodologies and a great amount of techniques can be identified.

Two major paradigms are generally distinguished by design theorists. This distinction is made between the Rational Problem Solver paradigm and the Reflective Practitioner or Reflection-in-action paradigm (Joseph, 1996). Drost and Dijkhuis (1999) describe how the systems for describing design processes have developed over the years. They compare the two paradigms and show the main differences in the position of designer, design problem, process and knowledge. Achten (2005) provides comparable insight in the so-called ‘conflict’ between the two paradigms. Table 1 shows this conflict by Achten between the Rational Problem Solver paradigm and the Reflective Practitioner paradigm.

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<th>Rational Problem Solving (Simon, 1967)</th>
<th>Reflective Practice (Schon, 1983)</th>
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<td>Design is a way of problem solving</td>
<td>Design is a dialogue between design and designer</td>
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<tr>
<td>Design can be divided into sub-problems</td>
<td>A designer names, frames, moves and evaluates without strict pre-division of the problem</td>
</tr>
<tr>
<td>Quality of a design is measurable</td>
<td>A designer reflects during and about the action and on the delivered work</td>
</tr>
<tr>
<td>Strong theory, weak connection with real life</td>
<td>Weak theory, strong connection with real life</td>
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Table 1: Paradigm conflict within the two design paradigms

In the choice for a design methodology many options exist. As mentioned in the definition, the design methodology is related to the design paradigm that it is developed within. Between the two design paradigms thus different methodologies are used. Methodologies are mostly related to the goal of the design process, in other words, the (passive) element that is being designed. This can vary from the design of an information system, to the design of new legislation, to aircraft design, to the design of a decision making process, to the design of an entertainment game for the computer and so on. Depending on the purpose of the specific design technique, the phase in the design process, the applied methodology and so on, a great variety of design techniques are possible. Drawing maps, developing scale models or holding a group discussion on the objectives of a process/system/product are all design techniques that can be used during a design process.

The design of the Superlevee should become a combination of the design that is made with regard to its function flood protection and on the other hand the design that is made for the function urban development. Thus the design paradigms, the methodologies and techniques for spatial and landscape design and architecture as well as those for the design of flood
defence elements and systems, dikes and dike rings, are relevant in the design of a Superlevee. For a successful design process of the Superlevee it will not be possible to take all elements of both and mingle them into the design process. Choices will have to be made regarding design methodology and design techniques; these will have to answer to the requirements for designing a flood protection system (e.g. take into account technical constraints) as well as designing an urban area (e.g. leaving space for creativity and originality). Moreover, both sides should support and understand the used methodology and technique.

Achten (2005) distinguishes between Architectural and the Engineering design methodologies. He relates these to the two paradigms and explains how the different methodologies work. He explains that architectural design methodologies have a very conceptual design phase, that the design is based on the individual designer skills and that they take a normative position. He links the Architectural design methodologies to the Reflective Practitioner design paradigm. This link is also described by Dorst and Dijkhuis (1995). Engineering design methodologies split up the design problem in sub problems according. They use a specific design method per activity and the package of these methods is the overall design strategy. Moreover, a lot of attention is given to structure and overhead. Evidently the link is made with the Rational Problem Solver paradigm. At first site urban design is more linked to the architectural methodology and design of a flood protection system more to (hydraulic) engineering.

Thus, we have reason to assume that the design of the functions flood protection and urban development differ from each other and that combining them into one artefact - the Superlevee - could become a difficult process. The major challenge of designing a Superlevee will be to integrate and combine the different design methodologies and techniques. Unfortunately, literature on combining design paradigms, methodologies or techniques of two different functions into one artefact is not abundantly available. Roozenburg and Cross (1991) underline the gap between the paradigms and their design methodologies and the growing distance between the two. They emphasize the importance of integrating the two paradigms more. How this gap could be closed in case it involves two very different functions is not part of the discussion and other authors in design theory do not address this issue as well.

**Conclusion general design theory**
Based on the existing knowledge of design methodologies of engineering and architecture, can be assumed that the two functions - that are combined within a Superlevee - will likely have great differences in design approach (paradigm, methodology and techniques). The available design theory is mostly descriptive and does not prescribe any methods for design and for dealing with the differences in design paradigm when combining multiple approaches. It is helpful in the understanding of differences but not directly helpful in the shaping of a design process of the Superlevee.
1.2.2 DESIGN IN A BROADER PERSPECTIVE

Design theory provides insight in the overall design approach. But to come to a design of the Superlevee it is important to look at all aspects that need to be designed. For a structured understanding of what design of a Superlevee includes, the general methodology of this research is based on the integrated TIP design methodology for complex technological systems. In this framework, see the left picture in Figure 3, a distinction is made between Technological design, Institutional design and Process design. The design of a water barrier as well as the design of an urban area is a process with many actors, sometimes opposite opinions, an important role for technical elements and a complex legislative and financial structure. Both can be thus characterized as a complex, technological system. “These technologically complex systems require besides the design of the technological component an institutional structure that coordinates the positions, relations and behaviour of the parties that own and operate the system. And in view of the complexity and multiactor nature of technologically complex systems, a design cannot be a ‘blueprint’ created through an intellectual process by a designer behind a desk. Mostly, designs appear to have been established during a historical process of incremental steps. Process design is thus concerned with designing the design process” (Koppenjan and Groenewegen, 2005).

Because the design of complex technological systems can be divided into these three relatively separate elements, the design of a Superlevee can be as well, see right picture in Figure 3. Because the Superlevee integrates two functions, the separate elements of these functions will have to be combined: the technological design for flood protection will have to match the technological design as well as the institutional design for urban development and vice versa. Moreover, the two design processes will have to be synchronised as well. The previous section already concluded that on the combination of the two upper blocks literature is not available. With regard to the combination of the two process designs the field of study of multiple land use<sup>3</sup> provides interesting publications.

<sup>3</sup>In Dutch: Meervoudig Ruimtegebruik
1.2.3 CO-PRODUCTIONS AND MULTIPLE LAND USE

Multifunctional space usage has become a specific field of study in 1999 when the knowledge centre Habiforum was established. The goal of this centre is to develop, bundle and spread knowledge on innovative spatial concepts and increase the awareness regarding the advantages of multifunctional use of space. Within this platform studies have been conducted on methods of process management and cooperation processes for these types of developments (Teisman, 2001). A Superlevee would evidently match the concept of multiple land use and the available literature on this topic is studied in search of elements that could be useful for the design of a Dutch Superlevee.

The concept of a co-production is clearly explained by a descriptive study of Teisman and others in assignment of the Dutch Organization for Scientific Research (NOW) and the Knowledge centre Large Cities (2004). The authors distinguish between three forms of co-production and explain the main problems for each variant. The term is mostly used for the indication of a co-operation between the government and inhabitants or between public and private partners. An underexposed aspect of co-production is the cooperation between governments. The main dilemmas for this third type of co-production are the feeling of hierarchical authority instead of a co-operative attitude; the ongoing ‘battle’ between different layers within public organizations and between for instance municipalities and provinces; and the complicated question of how public organizations can be held responsible when they apply the concept of co-production and how they can create a clear yet effective regulation structure. These problems are generally known, but no effective methods exist so far to overcome them. Edelenbos and Teisman discuss the effect of a (private) process manager in such a public co-production project and the importance of the generation of a win-win solution based on the example of the case Sijtwende (2005). In Frame 3 this case is explained in more detail.

Teisman has also studied the characteristics of existing decision making and management methods and the degree to which these contribute or impede with the application of multiple land use (2001). He concludes that multiple land use is guided by an accumulation of ambitions and desires of multiple actors, but that a summary of these ambitions does not necessarily lead to multiple land use. True and profitable participation of multiple actors is needed. With that Teisman emphasizes the importance of the process between actors. He also addresses the main fields of problems which are the fragmentized steering by the government, the fragmentation of the market and the poor interaction between governments, civilians and companies. Additionally, Habiforum has asked scientists from nine universities to make an inventory of the main drivers and obstacles for multiple land use (Volkers, 2001). They concluded that the wish for multiple land use is generally present, but the institutional framework hinders implementation. The main obstacle they identified was the relation between institutions that steer the spatial processes on the intermediate level. Impulses for cooperation are lacking and the conditions for co-production are far from optimal. The involved team of scientists argues that follow up research should focus on methods to optimize the decision-making structure for multiple land use that rises above the existing fragmentized decision-making. This field of study they call process management.
Frame 3: Case Sijtwende

The Sijtwende project has a very long history. The plan was initiated in 1938 by the Ministry of Transport, Public Works and Water Management. The aim was to construct a Highway that would connect Highway 4 (currently the A44) and the Highway 4a (currently the A4). The Municipality of Voorburg and the Ministry of Transport, Public Works and Water Management has been in a conflict over this road for more than 50 years. These two actors had a very different vision on the goal of this road and were not able to come to an understanding for a long time. The Ministry emphasized the problems of traffic jams and congestion on The Hague ring road that this Verlengde Landscheidingsweg (VLW) was meant to solve. The Ministries’ problem was thus in terms of accessibility. The Municipality of Voorburg highlighted the problems of nuisance that the intended road would cause and the interference with the spatial plans of the Municipality to construct houses in that area. The Municipality would only agree on the construction of the road in case it would be located underground. The Ministry however, preferred the much cheaper variant without a tunnel. (Edelenbos and Teisman, 2005).

Eventually the private consortium Sijtwende BV has been able to combine the interests of the actors and pushed forward the concept of a ‘hollow dike’. This variant finally had a multiple win-win character and was accepted by the Municipality as well as the Ministry. The project comprehended the construction of a tunnel for road traffic (main interest for the Ministry), a tunnel for the high-quality public transport system (interest of Haaglanden) and the construction of 700 houses - including apartments, individual houses and one-household-houses.

The above is a short and simplified presentation of the Sijtwende project, but illustrates the effect of conflicting interests between different governmental layers. It shows the disability of the actors to combine these into one solution. The application of multiple land use has only become possible after intervention of a private actor who was not only able to manage the process successfully (procedures concerning adjustment spatial plans, environmental assessments etc.) but was also able to connect the different interests into one solution and create a win-win.
De Bruijn and others have continued with the investigation of the process of “the development and realisation of (yet separated) spatial interventions that are being combined” (2004). Based on fifteen cases the authors describe several dilemmas that managers of multifunctional design processes are being confronted with. One of these cases is again the case of Sijtwende. They explain how the implementation of the project has stagnated for more than 50 years due to the impossibility of the involved actors to come to a design that contains a win for all parties. Eventually a (private) process manager has intervened and was able to come up with a design that did contain a win-win for all involved. The main difference between this case and the Superlevee is the fact that with the latter the multifunctional solution concept - for the problem regarding safety as well as the problem regarding urban pressure – already is available. The Superlevee concept is present, but does not seem to be linked to the problems of all the actors.

The studies above have been rather general and not directly related to projects that include a water-related function in the multiple land use. Goossen and others have documented on the practical experiences with such water-related multiple land use projects (2002). Unfortunately, this study only focuses on projects in which water is the space demanding function and puts other functions under pressure (e.g. water storage). Regarding the Superlevee urban development will be the pressing function. Space for flood protection has already been safeguarded. Despite this elementary difference an interesting conclusion of this study is that the multi functionality or plurality in water related projects is often achieved concerning the goals of a multifunctional project, but that the spatial implementation mostly shows a separation of functions. They wonder if in that case the project can still be assigned as a multifunctional one.

**Conclusion theory multiple land use**

Literature on multiple land use focuses on the management of projects and the importance of a solid process management. The studies are mostly based on existing cases and descriptive of character. Factors are identified that have determined failure or success in past multifunctional projects, but according to de Bruijn et al. these findings should not be applied one on one in other cases. Each project is unique and asks for an individual process design. A returning element in most case studies is the importance of a win-win potential. Case studies on multifunctional use of space related to water exist as well, but refer to the need of space for water purposes. The Superlevee does not match this situation as will be explained further in this report.

1.2.4 CONCLUSIONS ON DESIGN THEORY

Based on the previous sections and the conclusions on the usefulness of the available literature on design theory and on the design of multifunctional land use the following two starting points are added to the three points that were introduced in paragraph 1.1

4. The questions and difficulties in the design of a Superlevee are (partly) caused by the **differences** between the two design techniques and methodologies for flood protection and urban development and perhaps even due to a difference in design paradigms. More insight in these differences will provide better insight is how the process can be steered to overcome these difficulties.

5. For a successful co-production of a Superlevee in the design process will have to contain the potential of a **win-win** outcome for the actors involved in flood protection on the one side and the actors on urban development on the other side.
1.3 GOAL AND RESEARCH QUESTION

Based on the five starting points the philosophy of this research is to start with a thorough analysis of the existing design approach of the two (currently separated) functions regarding their technological design, their institutional design as well as their process design. Accordingly will be identified from both sides why, how and who is interested in the new concept of a Superlevee. With this insight

- it becomes possible to identify from both sides the design opportunities and challenges as well as the vision and attitude towards the Superlevee concept,
- it becomes possible to portray how these attitudes pose challenges on the further co-production design process of a Superlevee,
- it becomes possible to draw up an action plan that assists in overcoming these challenges and increase the potential of a co-production design process of a Superlevee.

The goal of this research is twofold. Regarding the Superlevee the aim is to increase the understanding of the background and content of the difficulties in design of a bifunctional Superlevee and to contribute to the actual applicability of the concept in the Netherlands. The second, more theoretical, goal is to contribute to the development of a more systematic approach for the design of projects that apply the concept of multiple land use. With this research is tried to connect general design theory with the literature on process management of multifunctional project. The main research question is:

How can a better understanding of the design process of the two functions flood protection and urban development improve the applicability of the Superlevee concept?

The research question is split up in several sub questions. The answers to these sub questions will lead to an answer to the main question.

Understanding of design:
1. What does design for the function Flood Protection generally consist of?
2. Which challenges is Flood Protection currently facing?
3. How would a Superlevee fit the design and these challenges?
4. What does design for the function Urban Development generally consist of?
5. Which challenges is Urban Development currently facing?
6. How would a Superlevee fit this design and these challenges?

Difficulties in co-productive design of a Superlevee:
7. Which difficulties can be identified concerning a shared design of a Superlevee?
8. Which difficulties can be identified concerning the two functional artifact of a Superlevee?

Increase the applicability of a Superlevee
9. How can best be dealt with these difficulties?
The research contains three phases as can be concluded from the sub questions. This structure is visualized in Figure 5. Started is with a separated and symmetric analysis (phase 1), this leads to conclusions about the applicability of the Superlevee concept (phase 2) and finally results in the drawing up of an action plan for the Waterboard (phase 3). From left to right the figure suggest a chronological order. This order is true for the structure of the research. However it does not pronounce anything about a chronological order with regard to an implementation process of a Superlevee. The blocks in the figure explain the content of each research phase. The arrows show how the different elements lead to the others. A quick view on the index shows the symmetric composition for the analysis of flood protection and urban development.

Figure 5: Structure of the research
1.4 METHODOLOGY FOR RESEARCH

The analysis focuses on understanding the design process of both the function flood protection as well as the function urban development. To come to a complete analysis of the two design approaches, the previously introduced TIP design methodology for complex technological systems will be used. For both functions the three different aspects of design are being analyzed. Figure 6 below shows how this analysis has been conducted.

![Figure 6: Analysis according to the TIP method.](image)

Because the two functions have very different (technical) artifacts that are subject of the design process a rather general framework has been used for the analysis of the technological design instead of a specific urban or civil technological design framework, see Figure 7. This Metamodel gives a straightforward description of the steps that need to be made in general in order to arrive at a design. Moreover, the model is easy communicable with designers from every kind.

![Figure 7: TPM Metamodel (Koppenjan, 2005, derived from Herder and Stikkelman, 2004)](image)

The model distinguishes between the development of the goal, objectives, constraints, design space and tests and the activity of testing and selecting a design variant. The definition of design goal depends of the definition of the system and on the demands that this system needs to meet; the requirements. These requirements can be divided into objectives - a factor with a normative value - and constraints - an objective with a boundary value-. An objective should thus be optimized and a design constraint should not be
exceeded. Requirements can be functional; directly related to the main goal of the system or they can be more general; related to other aspects that fall inside the systems but are not directly related to the main goal. Furthermore, the design space is the sum of all possible design variants that meet the requirements (objectives and constraints).

For the analysis of the institutional design of both functions the four layer institutional model of Koppenjan and Groenewegen (adapted from Williamson, 1979, 1998) is used. This model distinguishes between four types of institutions. For the analysis the institutional arrangements (layer 2), the formal legislation (layer 3) and the culture, values and norms (layer 4) have been analyzed.

![Figure 8: Four layer model adapted from Williamson for (Koppenjan and Groenewegen, 2005).](image)

For the analysis of the process design a framework has been searched that allows for a symmetric yet complete analysis that highlights all important elements from both sides. This framework was found in the 3D-method of Rijsberman (Eijck et al, 2000), see Figure 9.

![Figure 9: Dimensions and aspects of the 3D-method (Ven van de et al., 2005)](image)

This framework has been developed to support evaluation of planning processes of urban water plans. It is thus related to the combination of water and urban design. The 3D method is a way of looking at the development of a vision of functional design and provides vocabulary in the communication with interested actors. It distinguishes between four elements of a process: The concept, the field of actors, the role of knowledge and other aspects. The Concept is the idea behind a solution that is developed during the plan process.
The concept makes statements about the character of the solution; it provides direction to the design choices and excludes design variants. The **Field of Actors** contains all issues about who plays a role in the process and who does not. With the field of actors choices are made specific about the role and interdependencies between themes, actors and areas. The dimension **Knowledge** describes the origination of knowledge in the dialogue between actors, the verification of results of the process and the documentation of process and results. **Other aspects** that could play a role are the Process phasing, Continuity, System approach (actors’ perception of the system) and the ground approach (Approach from which actors act).

### 1.5 RESEARCH METHODS

Different methods have been applied during the research. For the theoretical grounding of this research a literature study has been conducted. In the analyses phase literature study and interviews have been combined to gain understanding of the different design approaches. The style of interviewing has been relatively open in order to gain understanding of the reasoning and philosophy of the actors involved. These interviews have contributed significantly to the understanding of differences between the designer approach for flood protection and the approach of urban designers. Also several informal conversations (with colleagues from ARCADIS, stakeholders from other projects of ARCADIS, and visitors of the seminar on Innovative Multiple land use) have been used to test findings from literature study and discuss differences in vision and design approach. Where these conversations have contributed to the analyses, it will be denoted in the text. In Annex 5 an overview of the interviews can be found together with an explanation of the purpose and the outcome of each interview. The conclusions of the analysis have been presented and discussed at a meeting of the Platform Climate Dike. The discussion and comments as result of the presentation, combined with the outcome of the analysis phase and more interviews have been input for the design of the action plan. The concept of the action plan has been discussed with the Waterboard Zuiderzee and the final plan has been adjusted based on the input during this meeting.

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1 For more information on the presentation is referred to the Website of the Platform Climate Dike/Pilots: [www.klimaatdijk.nl](http://www.klimaatdijk.nl)
1.6 STRUCTURE OF THE REPORT

The structure of the report is based on the structure of the research.

1. Phase one consists of the Chapters 2 and 3. These chapters contain the symmetric analysis of the technological, institutional and process design of the functions flood protection and urban development and explain their vision on the concept of a Superlevee.

2. Phase two consists of Chapter 4 and 5. Chapter 4 summarizes the main findings from Chapter 2 and 3, compares them and draws important conclusions on the effect of combining and integrating the two processes. Moreover, it presents the visions on the Superlevee of both sides and the attitude towards a co-production design process of a Superlevee. The chapter ends with concluding remarks about the potential of a co-production. Chapter 5 relates the findings from Chapter 4 to the project in Flevoland and draws conclusions on the potential of a co-production in this specific case study.

3. Phase 3 consists of Chapter 6 and 7. The first contains the action plan for the Waterboard that should lead to an increase in the potential of co-producing a Superlevee. Chapter 7 summarizes the conclusions and recommendations and reflects upon the conducted research. In the final Chapter 8 shows an overview of the used literature and documentation.
CHAPTER 2
Design of a Primary Water Barrier

Phase 1 starts with the analysis of the design process of the improvement of a primary water barrier from the perspective of the function flood protection and from the viewpoint of those who are responsible for flood protection. Evidently not every dike improvement will follow exactly the same process, with the same stakeholders, the same design requirements and the same design challenges.

The first section therefore contains a general description of the design process of a dike improvement project. The aim is to gain an understanding of the design process and be able to compare this process to the design process of an urban development project. The second section explains which developments in the design environment have taken place that make a dike designer look at the concept of a Superlevee. This chapter concludes with section three on the vision on the Superlevee from the function Flood protection. The current design process is linked to this vision and dilemma’s are identified that might obstruct against the implementation of a Superlevee.
2.1 ANALYSIS OF THE DESIGN PROCESS

Dike improvement and the design of such a project are related to the policy on Water safety / flood protection. Flood protection is task of the government.

2.1.1 ANALYSIS OF THE TECHNICAL DESIGN

This section elaborates on the technical design of a primary water barrier. The design goal, the objectives and constraints will be discussed accordingly.

**Goal**

According to the Expertise Network on Water barriers (ENW) and the information website of Rijkswaterstaat, Helpdesk Water a primary water barrier is defined as “a barrier that provides safety against flooding either by belonging to the network surrounding a dike-ring area (with or without elevated land), or by being positioned in front of a dike ring area”. The main goal of a primary water barrier is providing protection against flooding from the North Sea, Wadden Sea, the rivers Rhine, Meuse and Western Scheldt, the Eastern Scheldt and the IJssel lake.

The Guide on River Dikes⁵ (2007) and the Guide on Sea and Lake Dikes⁶ (1999) are the official documents to assist designers of water barriers in the (process of) functional / technical design of the dike. The legal status of this document will be discussed in the next paragraph. The Guide on River Dikes identifies four aspects that should be addressed during the functional design phase. These aspects are Safety, Spatial quality, Robustness, Management / maintenance. All these requirements have an effect on the spatial dimensioning of the barrier (height, length, slopes, berms and location) but not all are directly related to the main goal of flood prevention. Safety is evidently directly related to the main goal, Robustness deals with meeting the functional requirements over a longer period of time and Management / maintenance is related to guaranteeing the meeting of requirements during plan period of the design. Spatial Quality is not directly related to the functional requirements regarding the goal flood prevention and will thus not be discussed in this chapter. In Chapter 3 on urban development this aspect will be treated more thoroughly.

**Design constraints for Safety**

For better understanding of the design constraints on the dimensioning of a water barrier concerning its safety level, a few important terms have to be explained (TAW, 1998):

- *(Safety) Norm:* All the dike rings in the Netherlands have been appointed a certain safety norm. This norm is laid down in the Flood Defence Act and the actor responsible for the water barrier is responsible to maintain this safety level and improve the water barrier is case it does not fulfill this norm anymore. Different regions in the Netherlands have different norms based on the type of flood and the magnitude of potential damage in that region. A norm of 1/4000 means that the water barrier should just be able to withstand a water level with the probability of occurrence once every 4000 years.

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⁵ In Dutch: *Leidraad Rivieren*
⁶ In Dutch: *Leidraad Zee- en meerdijken*
- **Normative High Water level**: To be able to design a barrier according to the norm in that region, the Normative High Water Level is set up (MHW). This level is binding for the testing of a barrier, but also leading for design. It is the water level on which designer should design the water barrier. This level also varies between different areas in the Netherlands.

- **Plan period**: An artefact, like a water barrier, is being designed to last a certain period. For a water barrier this period represents the period for which the foreseen changes in conditions are included in the design. For water barriers that consist of a ground construction this plan period is usually 50 years and if the barrier contains other structures that have a water retaining function the period is 100 years.

The main design constraint for a primary water barrier is that the barrier is able to withstand the Normative High Water level (related to the Safety norm in that region). This includes retaining the water level and is thus related to the **height** of the barrier and indicates that the designed barrier is strong enough to withstand the force of the water against the barrier and is thus related to the **strength**.

Direct inundation of the hinterland will occur in case the dike is not high enough, inundation of the hinterland caused by erosion or breach of the dike will occur in case the dike is not strong enough. Both have to be prevented. The plan period for design is important because it determines which scenario’s for the design environment (e.g. potential water level rise) are taken into account and thus directly influences the needed height and strength.

**Design variables**

A water barrier consists of multiple elements that all need to be designed in order to make the barrier high and strong enough, the design variables. Figure 10 below shows how these elements shape the water barrier.

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7 In Dutch: Maatgevende Hoog Waterstand, MHW
Design models
The method of designing the separate elements in relation to the overall functioning of the barrier is based on the factors that could make the barrier fail in this water retaining task. A failure can be caused in multiple ways and the ways by which a barrier can fail are called failing mechanism. These mechanisms play an important role in the design and judgement of the safety of a levee. For the different failing mechanisms, different rules for design have been developed. These mostly mathematical rules are applied on the local conditions, the given MHW and with that it is possible to calculate how the water barrier could and should be dimensioned minimally (Haan et al, 2001). Figure 11 shows the failing mechanisms for a dike that are taking into account during design and they are explained in more detail below (TAW, 1998).

Figure 11: Failing mechanisms of soil structures (TAW, 1998, page 58)

A. Overflow (Overlopen) is the phenomenon by which the dike ring area is inundated by a combination of high water level and wave overtopping without the collapse of the defence structure.

B. Wave overtopping (Golfoverslag) occurs when water overtops the flood defence by waves.

C. Sliding (Afschuiven) is the instability of the (inner) slope due to either infiltration of the overflowing water in a combination of high water level and wave overtopping, or water pressure against the defence and increased water pressure in the subsoil.

D. Shearing (Wegschuiven) of a soil body is also caused by water pressure against the defence and the increased water pressure in the subsoil.

E. Sliding of the outer slope occurs by a rapid fall in the outside water level after high water.

F. Micro-Instability is the instability of the inner or outer slope by existing seepage water through the soil body analogous to mechanism C. but at lower water levels.

G. Piping is the phenomenon by which a hollow pipe-shaped space originates under the flood defence because the erosion process of a sand boil does not stop.

H and I. Erosion of the outer slope or the toe and foreshore occur by current or wave movements

J. Settlement (Zetting) is the sinking of soil; mainly due to an upper load, own mass and/or the exit of water.

K and L. Drifting ice and Collision (Aanvaring) of a vessel are treats that cannot be planned but need to be taking into account.
The fail-tree in Figure 12 shows how the mechanisms can cause a dike failure/ collapse. Important note to make here is the fact that failure does not necessarily mean the complete loss of the water retaining function. Overflow and wave overtopping is seen as failure mechanism as well. These failures may lead to loss of functionality and collapse. Thus a difference exists between direct inundation due to overflowing water and inundation after dike erosion or breach (TU Delft, 2009-1, 2009-2).

It would be too much in detail for this moment to explain how each failing mechanism specifically influences the dimensioning and which mathematical methods are used to calculate the minimal measures (based on the overall constraint). Moreover, failing mechanisms influence each other as well which would make an in-depth explanation very complex. In short can be stated that height is directly related to the Normative High Water Level (MHW) and the plan period for design combined with at least the failing mechanisms of overflow, wave overtopping and settlement. Strength is more complex to determine and related to more of the failing mechanisms. Evidently the collision of a ship or shifting ice can damage the slopes of a dike or even the crown which negatively affects the strength. But also a storm can cause wave overtopping that affects the inner slope. The material and state of this slope will determine how stable this slope will stay. Furthermore the occurrence of piping can cause inner erosion that weakens the dike.

**Design objectives for Management & Maintenance**

A barrier can be designed high and strong enough, but it has to remain high and strong enough for a longer period of time. Besides the constraints on design from a flood protection viewpoint, the dimensioning of a water barrier is also influenced by objectives set for the Management of that barrier. The Flood Defence Act provides some basic requirements on how management and maintenance should be arranged by the Waterboard. Moreover, the Waterboard has a few legislative tools to ensure solid management. These tools and requirements do not constrain the specific dimensioning of a dike. The responsible Waterboard will have to decide how its objectives with regard to management will influence the dimensioning.

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The objectives regarding Management can be divided in different groups:

- **Expendability:** In case the dike is tested insufficient, is it easy to reinforce?
  
  Example: As little constructions / houses in de dike as possible, no constructions close to the dike

- **Vulnerability:** How vulnerable is the dike for damaging?
  
  Example: No trees / constructions in the core zone, type of slopes.

- **Reach ability:** How easy can a maintainer reach a damaged spot?
  
  Example: Access and maintenance roads, steepness of the profile

- **Test ability:** How easy is it to test whether the dike still meets the requirements?
  
  Example: Possibility of accessing the dike body, recognisability of the dike body

- **Costs:** How expensive will management and maintenance be?
  
  Example: Minimal (but safe) dimensioning of the dike, integration of other functions paid by others

### 2.1.2 ANALYSIS OF THE INSTITUTIONAL DESIGN

For an analysis of the institutional design of the flood protection system the recently published first version of the National Water Plan should be addressed. A division is made between three layers of the water safety policy (Rijksoverheid, 2008):

- **Flood prevention**
- **Sustainable spatial development**
- **Disaster management during flood**

Historically the main focus in water safety has always been on the prevention of floods. The other two aspects will be implemented in when the policy will become official in 2009.

For the institutional analysis of a primary water barrier a division should be made over the different phases in the life span of this barrier:

- **Design**
- **Construction**
- **Management & Maintenance**
- **Testing**

All these phases have different institutional consequences. Per each of these phases the most import informal institutions, the formal institutions and the (in)formal arrangements are explained according to the four layer model of Williamson.
The main legislation on flood prevention is the Flood Defence Act. This act also decides on the writing of legally binding supporting documents during all phases of the lifespan. Figure 13 shows an overview of these documents. This figure is adopted from a shared study that ARCADIS has conducted on a comparison of the Dutch and the Belgian Water Safety Policy (Waterwegen en Zeekanaal, 2006).

Most likely in 2009 a new Act will come into being: the Water Act. This Act will combine eight currently existing Acts. The description here is based on the current situation and the different Acts are therefore treated separately.

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* In Dutch: Wet op de Waterkering
Informal institutions

The design of a water barrier is, as described in the previous paragraph, for great deal institutionalized. The process is not so much based on creativity but much more on technical constraints and efficient spatial use. The design culture for the function flood protection is a rather technical one with a few companies that have the knowledge. How the different Waterboards deal with other objectives depends on the attitude of the Waterboard.

Formal institutions

Flood Defence Act: The safety norms as introduced in the previous paragraph are laid down in the Flood defence Act and are determined according to an overload approach per dike section. The Ministry of Transport Public Works and Water Management is responsible for the provision and supply of technical support documents for the design, the construction and the management of primary water barriers. The latest version of such a support document is the Guide on River Barriers from 2007. It is not obligatory to apply the information in these documents in design. The Water authority (mostly a Waterboard) is responsible for the improvement of a barrier in case it has been disapproved in the tests. The Waterboard does not have to design the dike itself, but is responsible that the dike will at least be restored to the minimal safety level. The province is enforced to (dis)approve with a suggested design.

Spatial Planning Act: Drawn up by the Ministry of Housing, Spatial Planning and Environment, this Act is the basis for other zoning plans by the central Government, Provinces and Municipalities. In a zoning plan the function of a water barrier is appointed hydraulic. When (re)designing a barrier, the design has to comply with the existing plans or these plans have to be adjusted.

Environmental Management Act: The Dutch Environmental Management Act is adjusted to the European Legislation and specifies the conditions of a project under which an Environmental Impact Assessment (in Dutch mer) has to be fulfilled. The execution of an EIA is obliged for the (re)design and construction of a sea levee or delta levee in case it involves a change or expansion over the length of this levee of 5 kilometres or more, or a change of the profile of 250m² or more. With a river levee an EIA is obligatory in case the change or expansion takes place over the length of 5 kilometers. The obligation to conduct an EIA involves many process-steps that will influence a dike reinforcement project.

Expropriation Act: This Act regulates the legal procedures for ground acquisition, needed for improvement works, in case it is not possible to reach an amicable agreement.

Formal and informal arrangements

Every year the Secretary of State of V&W adapts the High Water Protection Programme (HWBP). Within this program the improvement of primary water barriers that are rejected in the testing round, is financed by national funds. Criteria to decide which improvement project will become part of the HWBP are determined in cooperation with the Ministry of V&W and the Union of Water boards. The State will also finance the costs for enforcements of primary water barriers in case these measures are needed because: The safety norm has changed/ the document ‘Hydraulic Preconditions’ for testing has changed/ the document ‘Prescription on Testing Safety’ has changed. Elements in the design of a water barrier that have a different function than flood protection and are not part of the necessary improvements of a barrier will have to be financed by another party than the responsible Water Authority.

Table 2: Institutional Analysis for the Design of a water barrier

10 The Dutch names of the different Acts, in chronological order: Wet op de Waterkering/ Wet ruimtelijke ordening/ Wet Milieubeheer/ Onteigeningswet
11 In Dutch: Hoog Water Beschermings Programma
12 In Dutch: Unie van Waterschappen.
The construction of an enforcement project of a dike can cause hinder for the surrounding area, the inhabitants, etc. Participation in the design procedure will prevent barricades in the construction phase of a barrier.

**Surface Water Pollution Act**: For construction activities at the dike it is often necessary to move or replace ground. In case this ground is polluted and could this Act sets restrictions on the activities.

**Environmental Management Act**: Materials used in flood defences must fulfil the Building Materials Decree from this Law. If it does not fulfil this, a permit must be requested based on this EMA. The conditions under which a EIA is obligatory has been explained in Table 2.

The type of contracts for the execution of dike improvement projects has changed throughout the years. Integrated outsourcing like Design & Construct contract, Public Private Partnerships are getting more popular.

The construction phase of a barrier involves requesting a great deal of permits. The Province is responsible for providing the permits for earth removal, groundwater abstractions etc, in case these are needed. The Water authority is responsible for the provision of permits in case another function has a request for activity within the area surrounding the barrier (the area defined in the Data-base). Other obligations are the request of a building permits, the adjustment of the destination plan of municipality of province, nature protection legislation, cultural heritage protection legislation.

**Table 3**: Institutional analysis of the construction of water barrier

**Figure 14**: Visualization of the zoning in of an area surrounding a water barrier (TAW, 1998, page 72)

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13 The Dutch names of the different Acts, chronologically: Wet Verontreiniging Oppervlakte Water/ Wet Milieubeheer
For the management of a barrier the same is true as for design; the attitude differs per Waterboard. In a highly urbanized area, a Waterboard is more used to allow multifunctional use of its barriers and search for widely accepted solutions compared to locations where the barriers have been kept rather mono-functional. Waterboards do acknowledge the fact that besides their responsibility for flood protection they have a social function. However, because of their (legal) responsibility for the first function it can be difficult to combine the two.

<table>
<thead>
<tr>
<th>Institutional Arrangements</th>
<th>Management &amp; Maintenance of a Primary Water Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal institutions</td>
<td>For the management of a barrier the same is true as for design; the attitude differs per Waterboard. In a highly urbanized area, a Waterboard is more used to allow multifunctional use of its barriers and search for widely accepted solutions compared to locations where the barriers have been kept rather mono-functional. Waterboards do acknowledge the fact that besides their responsibility for flood protection they have a social function. However, because of their (legal) responsibility for the first function it can be difficult to combine the two.</td>
</tr>
<tr>
<td>Formal institutions</td>
<td><strong>Flood Defence Act:</strong> The Ministry of Transport Public Works and Water Management is responsible for up to date information about (high) water levels and declares alarm water levels. The Water authority is obliged to construct maps, a Data-base, a By-law and a management register. In the Data-base a description is given of the minimal design requirements of the barrier concerning shape and size, direction and zoning of the area surrounding the barrier. In the By-law, the Water authority sets up binding regulation regarding activities on or close to all water barriers in their region. This is related to the zoning in the Data-base. Financial punishment structures are set up to guarantee compliance to this regulation. This includes the power of undoing damage due to activities at costs of the initiator. The management register shows the actual status of the barrier. Figure 14 shows how the area around the dike is divided into different zones in the Data-base. Other elements that play a role in the management of a primary water barrier are (TAW, 1998, page 71): The Assessment Profile: A theoretical minimum profile of defined dimensions that must fit inside the actual profile. This profile may generally not be crossed by non-water retaining objects and must guarantee that damage to the flood defence as a result of presence of the object will not lead to immediate failure of the flood defence. The Profile of free space: space to be kept free for the continued realisation of the water retaining function of the flood defence. <strong>Water Board Act:</strong> This act defines the official role and responsibility of a Waterboard. Also, it explicates the fact that the inhabitants who pay for flood protection (see below) are allowed to join the decision-making process if (s)he wishes. Concerning the By-law this Act outlines how the By-law should be adjusted in case this is needed.</td>
</tr>
<tr>
<td>Formal and informal arrangements</td>
<td>The costs for Management and Maintenance of a primary water barrier are the responsibility of the Water authority (mostly the Water board). The income of the Waterboard comes from tax amongst the inhabitants.</td>
</tr>
</tbody>
</table>

Table 4: Institutional analysis of the management of a water barrier

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14 Conclusion based on discussions between different Waterboards during the “Versnellingssessie Nota Waterkeringen” Waterboard Rijnland facilitated by ARCADIS (24 maart 2009)
15 In Dutch: Overzichtskaarten, Legger, Keur and Beheersregister
16 In Dutch: Beoordelingsprofiel and Profiel van Vrije Ruimte
17 In Dutch: Waterschapswet
Testing of a Primary water barrier

<table>
<thead>
<tr>
<th>Informal institutions</th>
<th>The responsibilities and procedure of testing and reporting on the conducted tests is laid down in legislation (see below). It is a formal procedure that does not leave space for many informal institutions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal institutions</td>
<td>Flood Defence Act: In the preparation of a test round the DG Water of the Ministry of Transport Public Works and Water Management sets up the Hydraulic Preconditions (HR2006) and the Prescription of Testing the Safety of Primary Water barriers (VTV2006) every five years. In these documents is explained which methods the responsible Waterboard has to apply for testing its Primary water defences. The DG Water also prepares the planning (testing rounds), format for reporting and is responsible for communication about the testing process. During the five yearly testing rounds, the responsible Waterboard tests its water barriers and reports to the Province about the state of the flood defence system. The province (Gedeputeerde Staten) is responsible for monitoring of the Waterboard during the testing and afterwards for reporting to the responsible Minister about the testing. The Ministry has the responsibility to combine the provincial reports into one document and report to the Second Chamber about the national results.</td>
</tr>
<tr>
<td>Formal and informal arrangements</td>
<td>Each Waterboard is responsible for the execution and the costs of testing its own primary water barriers. The province is financially responsible for the monitoring and the bundling of reports, as well as the Ministry one higher level.</td>
</tr>
</tbody>
</table>

Table 5: Institutional analysis of the testing of a water barrier

The most important conclusions from the institutional analysis can be summarized as follows:

- The main focus is on flood prevention. Each Waterboard is responsible for the state of barriers within their territory and should manage and test these barriers. The Waterboards’ income is based on tax.
- The State mostly finances the needed enforcements to restore the required safety level.
- Primary water barriers are subject to intensive legislation in all phases of its life span.
- Future water safety policy will focus on a three layer safety, the effects of this are not yet clear.

2.1.3 ANALYSIS OF THE DESIGN PROCESS

Evidently not each dike design process will be the same; different actors will participate, the (local) political situation will differ, the local environment will be different, other knowledge is available, etc. The Guide on River barriers is the document on design that has been updated most recently (2007). Evidently this guideline is set up specifically for the design of River dikes; however, the current design philosophy of the design of other dikes will not be very different. The dimensions and aspects of the 3D model (see Part A) will be applied to analyze the process of a regular dike improvement project. A water barrier is being redesigned in two cases:

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18 In Dutch: Hydrulische Randvoorwaarden en Voorschrift Toetsen op Veiligheid Primaire Waterkeringen
1. The barrier has been rejected during the obligatory test round and needs to be heightened and/or strengthened in order to meet the required safety level again.
2. The intention exists for development of another function in the area close to the water barrier. The existing shape of the water barrier constraints this development too much, thus a suggestion is made to adjust the barrier.

**Concept**

The starting point for the design project of a primary water barrier is the (legally) required safety level of the barrier. This is true in case the safety of a water barrier is insufficient and the barrier needs to be enforced and in case adjustments to the barrier are desirable caused by the development of other functions in the barrier-area. The safety level is designed based on mechanisms that could make a barrier fail. The starting point for design is the prevention of failure, thus the process is *problem driven*. With enforcement projects the starting points for design are the aspects on which the dike has been rejected (for instance an insufficient height or unstable slopes). The idea behind those projects is to find design solutions that meet the legal requirements in the easiest form possible. After design space is reserved to assure that future expansions will be possible in case needed. An image of such a minimal dike concept is presented in Figure 15.

*Figure 15: Design concept of a water barrier (Zuiderzeeland, 2008)*

During design other factors will be taken into account besides the issue of flood protection. The Leidraad Rivieren specifies the following: Safety, Sustainability / Robustness / Expandability, Spatial quality, Costs, Use of material and availability, Construction, including planning and methods, Management and maintenance. Although these factors are taken into account, a design concept that makes statements about the general character of the solution is mostly not defined. For the different factors, different goals are set and the leading factor in this process is clearly Safety. For spatial quality the preservation of LNC values can the ambition. The choice between the safe alternatives will depend on these other ambitions (ARCADIS, 2003).

**Field of actors**

A dike improvement project is mostly shaped around different groups of actors with all a different role (ARCADIS, 2003 and discussions with ARCADIS colleagues\(^\d\)): The *core team* consists of representatives from the responsible Waterboard and mostly of representatives of at least one engineering company that supports in the process planning and the technical input. A *project team* is developed that includes the core team together with actors that have a direct interest in the dike improvement. This could include: representatives from the Province, the regional Rijkswaterstaat department, representatives from municipalities, and representatives from residents or other interest groups. A *steering group* that consists of the Dijkgraaf of the Waterboard and Wethouders from the municipalities is informed about the progress and can provide input to the process. Other input during the project can come

\(^{19}\) K. Versmissen (March 16, 2009), R. Hoijink (April 16, 2009)
from a *klankbord-group* or an *advisory group*. For instance local companies can safeguard their interests in the latter. The specific set up of actors and their input moments depends on the project. In case an EIA (mer) is required the process and input from different actors is relatively determined. The application of a Superlevee will most likely ask for a mer procedure, thus it is interesting to look at this. In case no EIA is needed participatory moments are included as well. The final option for disagreeing actors is to object to the project after completion of the plan (beroep).

The Table 6 below shows a more structured insight in the involved actors. A distinction is made between critical or non-critical. This gives an idea of the importance of involving the actor in the project based on its resources and power to influence the project. As already mentioned this section gives a very general insight into the process of a dike design project. The position of different actors may vary each project due to a change in interest and change in resources to influence the project.

<table>
<thead>
<tr>
<th>Involved actors</th>
<th>Critical</th>
<th>Non-critical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shared perceptions, goals, interests</strong></td>
<td>Waterboard, Municipality, Province, Engineering company, Regional Rijkswaterstaat department</td>
<td>Inhabitants in the protected region, Industry, Companies</td>
</tr>
<tr>
<td><strong>Opposite perceptions, goals, interests</strong></td>
<td>Municipality, Province, Interest groups (environmental/ inhabitants/ industry etc.)</td>
<td>Inhabitants close to barrier, Environmental action groups, Industry and companies, Infrastructure companies/ owners</td>
</tr>
</tbody>
</table>

**Table 6: Scan of the involved actors in a dike design project**

*Critical:* The position of the involved municipalities and the province will depend on their interests in the project. When a suggested enforcement design conflicts with the municipal or provincial spatial plans their position is on the second row. Is the core team able to come up with a design that integrates all interests, they will be in upper row. They both however are critical for the process. Waterboard mostly do not have all the technical expert knowledge that is needed to structure a dike design process (see below). An engineering company will assist in this and can thus not be left outside the process. The financial resources with regard to a dike-enforcement will come from the State. Control over these financial resources is mostly done by regional departments of Rijkswaterstaat. Interests coming from the region –inhabitants, industry, infrastructure, environmental groups – are included in the process, but can cause delay and hinder when the interests are opposite. At the beginning of a process the interests should therefore be framed.

*Non-Critical:* The row in which inhabitants and companies are located depends on the local interests in the project. A company with infrastructure running through the barrier would be in the lower row in case the situation causes disadvantage compared to the existing situations. For inhabitants the same is applicable: concerning flood protection the objective is clear for all inhabitants (a safe environment). But when this affects their personal interests they may move over to the lower row. As mentioned above the critical or non-critical positioning will depend on the power to influence the process.
Knowledge
The main knowledge concerning the motive of a dike improvement project and the starting points for design (concerning safety) is present within the core team, the Waterboard and at least one advisory company. This knowledge is mostly very specific knowledge and based on cause-effect relations; Technical safety requirements of the barrier, local conditions and the way failing mechanisms determine the dimensioning of the barrier that needs improving. The set up of alternatives is based on this knowledge. The actors with less knowledge on the functioning of barriers (have to) rely on the knowledge brought in. Other factors that are taken into account like spatial quality are more open to discussion since less specific knowledge is required. Discussion about and documentation on the design is mostly done in text, images and comparable tables.

Aspects of the process
The motive for a design process is either the development of other functions, or a restoration of the required safety level. Especially in the second case the phases in the process are regulated by legislation. Multiple procedures have to be executed and this requires strict planning and management: For the enforcement of a dike it can be obligatory to do an Environmental Impact Assessment, the rejected dike can be part of the High water Protection Programme (HWBP) and some other rules are applicable with regard to the SNIP. In the Leidraad Rivieren can be found how these procedures fit into the actual design process and how they should be followed in order to reach the goal.
For the EIA it is obligatory to develop different alternatives for the enforcement. In the first phase a start-notitie is developed that contains a description of the problem, the current situation and the vision on how to deal with the problem. The alternatives are being described and based on first estimations of the applicability and feasibility is made. The alternatives that are already judged to be not feasible will be left outside the process (Waterwegen en Zeekanaal NV, 2006).
2.2 CHANGING DESIGN ENVIRONMENT

As discussed in the previous paragraph, the Waterboard is the main actor and problem owner of a (re)design project of a water barrier because it legally responsible for the safety level of its barriers. In this section will be described how the design environment of the different elements of the design process has been changing or will change in the (near) future and how this affects the existing design process. This enhances rather sudden developments that cannot be anticipated on beforehand as well as changes that are the result of an ongoing (political) discussion. The timeline of these developments varies, and so will their effect and the design of a water barrier. Because design is based on a certain plan period (mostly 50-100 years) all described developments are relevant to be aware of. In section 2.3 the connection will be made with the concept of a Superlevee.

2.2.1 CHANGES IN TECHNICAL DESIGN ENVIRONMENT

Climate change

In the ongoing discussion about climate change, flood protection is an important issue. About the scale of changes still many uncertainties exist. Based on the latest KNMI estimations (2006)\(^2\) the following issues will be important in dike design:

For coastal barriers the main issues are a change of peak water levels as a consequence of sea level rise combined with a change of wind setup and a change of wave loading. These directly affect the needed height of the barrier. Also the possibility of extreme weather events and/or droughts can affect the strength of the barrier. For river barriers also a change in the height of peak water levels is expected caused by heavier rainfall in winter and less rainfall in summer. The speed of changes in the water level caused by extreme rainfall will change and wave loading might change. For the barriers of the IJsselmeer the changes in discharging rivers will have an effect on the lake water level and increase of the sea level will affect the possibility for discharging of the IJsselmeer into sea. Figure 16 below shows how these factors affect the Hydraulic Forces on a barrier.

![Figure 16: Causal diagram of the natural factors that influence the ‘hydraulische belasting’](image)

The uncertainties on climate change and the size of its effects on the hydraulic force on a water barrier are large. Moreover, next to natural effect of climate change also political decisions can influence the technical requirements. For instance the IJsselmeer water level might be needed to increase in order to safeguard the availability of fresh water. But also discussion about closure of the Rijnmond has a great effect but is still very uncertain (bron). All these uncertainties have to be taken into account in the design process.

**Innovation**

A second issue that makes the process of dike design more interesting is the multiple innovations that are being done in this area. For years dikes and dike enforcements have been a rather standard procedure. However, partly due to the discussions on climate change, many research and studies have been conducted in how to make barrier stronger, better, higher and how dikes can be used for other functions besides flood protection. Such an initiative is the Platform Climate Dike derived from the Water INNovation program (Rijkswaterstaat). Another example is the concept of burst proof levees and the Quick Scan that was conducted on the possibilities of designing a water barrier that is not able to break. The Superlevee evidently is also one of these innovations. Result is that new technologies become available and instead of the standard dike profile, Waterboards will be able to choose.

**Robust design**

In the latest version of the Leidraad Rivieren the increase in uncertainties has been underlined and to deal with that the concept of robust design has been introduced. The definition of robust design according to the Guide on River Barriers is the following [1 p.62].

“During design taking into account future developments and uncertainties in such a way that the design will keep functioning during plan period without heavy and costly adjustments becoming necessary and in such a way that the design will be expendable in case that is economically feasible”

For the design of water barriers this gives a reason the redefine the goal of the water barriers. An important uncertainty regarding robust design however is the availability of financial resources. It is doubtful whether the State is able to provide additional resources for robust water barriers.

### Changes in Institutional Design Environment

**Safety norms**

The current safety norms are expressed in the probability of the water level and wave loading that the barrier is just able to withstand. However, new norms are under development and will most likely be applicable in the next testing round for primary water barriers in 2011 (ENW, 2008). These norms will be based on a Cost-Benefit analysis and a number of potential victims. Also new insights in the level of safety norms and a needed increase of these will be taken into account (Delta commission, 2008). Most likely these safety norms for primary water barriers will be stricter than before. This will affect the design height of the water barriers and they possibly need to be heightened to meet the new safety level.

**Three levels of Safety**

As mentioned in the institutional analysis a new water policy and more specific water safety policy is being developed (National Water Plan). Besides flood prevention more attention
will be given to sustainable spatial planning & development and disaster management in case a flood does occur. This is mainly due to the increase in economic value and number of inhabitants in the vulnerable regions. The role of water barriers has always been on the first level, the prevention level. The discussion is being held whether the barriers could have a role in the other two levels as well. It is yet uncertain how these two other safety aspects will affect the design process. A broader and higher dike could be integrated in the emergency plans for disaster management and could also be interesting for spatial planning.

2.2.3 CHANGES IN PROCES DESIGN ENVIRONMENT

**Spatial pressure**
An important aspect that forces Waterboards to take into account the factor of Spatial Quality is the increasing pressure on the available space. Whereas dikes used to be only dikes, the area has become increasingly interesting for other functions. The most relevant issue in this research is the pressure the Waterboard is feeling by spatial developers and municipalities. In the case of Waterboard Zuiderzeeland this example is very clear. In this case the national spatial policy document assigns the water line the function of developing a new waterfront. Waterboards will have to deal with this pressure while safeguarding the main function of a barrier, flood protection. Different actors bring different objectives and a different shaping of the process.

**Internal consensus**
Not all people within the Waterboard might agree on the need for extra robust design or the allowance of urban development on top of the dike. Based on the project for Zuiderzeeland can be concluded that some people take a progressive position and are enthusiastic about integrating functions within a flood protection system. Others take a more defensive attitude towards the innovative concepts.
Frame 4: Project exploration Superlevee Flevoland

The region of Flevoland is developing in many ways. The concept of a Superlevee could be a very interesting solution for the spatial challenges it faces: water safety as well as demands for living, working and/or recreation. While the existing dike functions as a barrier between water and the urban areas, the Superlevee could create a visual connection between housing and water, due to the enormous breadth and urban redevelopment of the waterfront. Besides, the Superlevee could offer safe high grounds in case a flood would occur. The region of Flevoland is well suited for this type of innovative urban and rural development. The landscape is still young and the province has a young image. Spatial innovation would fit the image of this province and enough space is available for a Superlevee. The polder is characterized by its size, openness and long sightlines (Flevoland, 2009).

From a flood protection point of view, the dike will have to ensure safety now and in the future, has to be manageable and it should be possible to test the dike. From a spatial planning point of view the Superlevee is interesting because it offers opportunities for multiple land use, new possibilities for living with water and experiencing of water. In the project the following definition of a Superlevee has been used: “A Superlevee is a water barrier that is dimensioned and designed in such a way that multiple use of the space becomes possible and sustainable flood protection is guaranteed”.

The project has resulted in a comparison between five design variants and some conclusions about the potential of all variants. The variant that shows the most similarities with the Japanese idea of a Superlevee appears to be the most interesting alternative.
2.3 VISION ON THE SUPERLEVEE

To deal with the changes in the design environment from paragraph 2.2, a Superlevee might be a good concept. However, important is to start with what exactly is meant by a Superlevee and how the design of a Superlevee will be different than the design of an ‘ordinary’ levee. Thus, the goal of this chapter is to identify the effects that the changes in the design environment in paragraph 2.2 will have on the design of a Superlevee compared to the ‘normal’ design.

2.3.1 DEFINITION OF A SUPERLEVEE

Based on the conducted interviews and conclusions from the Project with Zuiderzee land can be concluded that actors involved or interested in the concept of the Superlevee from the viewpoint of Flood protection have the following vision on a Superlevee:

A Superlevee is a dike that is broad enough to be burst proof and in height it is able to deal with the changing water level related to climate change and political decisions. Due to the way in which the barrier is over-dimensioned, it will become possible to integrate other functions. However, the first incentive to dimension a water barrier that way is the increase in safety.

Some of the interviewees also mentioned that the height of the crest should be high enough to prevent every form of water overflow (direct overflow or wave overtopping) at every water level. Others underlined the fact that in case the dike is dimensioned to burst proof, wave overtopping could be allowed. From the perspective of the Waterboard no overflow of any kind would be preferred.

2.3.2 CONSEQUENCES OF SUPERLEVEE ON TECHNICAL DESIGN

Figure 19: Elements of a dike cross section

Goal

Concerning the strength of the Superlevee the goal becomes burst proof design. The design of a Superlevee thus has to be connected to the climate and political uncertainties. Concerning the height the goal could be to prevent wave overtopping at any water level. Because the Superlevee is extreme robust that way, it will be possible to provide possibilities for urban development. It might also be possible to connect the goal of a Superlevee to the two other levels of Safety according to the new National Water Plan (Rijksoverheid, 2008). A burst proof levee could be an element in disaster management and related to sustainable spatial planning. However, this has to be studied in more detail. Which of the above elements will actually become (part of the overall) goal of the Superlevee is a decision of the
Design constraints

The requirements on the primary water barrier for safety that are discussed before will not directly change (excluded possible changes in the safety norm). Still the starting points for design will be the aspects of the dike that were tested insufficient and failing mechanisms will be applied to come to the minimally needed design. The goal of a burst proof dike can be set, but this is a design choice that is not supported institutionally (yet). It can thus be seen more as an objective for design instead of a constraint and will be treated in the next section.

A very broad ground construction will demand a great amount of material. Before deciding on the dimensions of a levee, the availability of this ground has to be assured. In the construction of a dike settlement always has to be taken into account. In case of weak undergounds (as is the case in Flevoland) ground improvements below the dike body might be needed or already exist. For a Superlevee this improvement would be even more important seen the additional weight of the ground material and the weight of potential constructions. When an extra broad Superlevee will be constructed this could form extra difficulties.

For a Waterboard the allowance of urban development on top of the Superlevee could be a sub goal, but the Waterboard is not the actor who is able to set clear objectives on the dimensioning of urban development. Since the Waterboard is the responsible actor for water safety, it should be able to set constraints on what is possible concerning safety and what is not. This is a difficult problem, especially in combination with the uncertainty about what elements of safety will be taken into account in the specific goal of a Superlevee (see above). When discussing the options for integration of other functions in a barrier, mainly risks are identified. For example the Waterboard of Zuiderzeeland has written a policy statement on Constructions close to Water Barriers (2008). In this statement only risks are being discussed of buildings and how they can affect the strength of the dike. A selection of these risks is given below:

- During construction the vibrations can cause ground mechanical instabilities of the slopes. This could cause extra water tension that affects the stability of the entire barrier.
- By digging off or drilling in the closing slopes or by closing off of the deeper layers, unintended groundwater streams trough and under the barrier can cause an outflow or ground.
- By perforating a closing layer with foundation piles the seepage length is shortened and piping can occur.
- Buildings close to or on the dike can obstruct future needed extensions.
- The presence of buildings mostly is accompanied by cables, tubes and other infrastructures. Besides the risk of a damage in case of a cable break, also the risk exists of uncontrolled maintenance on these infrastructures
- With existing buildings adjustments or internal building elements can noticed to late (for instance basements under need buildings)
- Due to the surface occupation of buildings surface water flows will cause erosion around the buildings.
- On the side of walls, floors etc, seepage can occur that can cause piping.
If the Waterboard is not convinced of the fact that one of these risks will not appear during an activity or construction, it will not allow the activity. An actor that wants to develop on top of the dike will have to prove that these risks will not occur.

**Design Objectives**

Currently research is being done on how a water barrier can be made burst proof. Statistically it is not possible to design and construct a dike in such a way that it gives a 100% certainty of never bursting. In the “Quick scan on burst proof levees” (Silva et al, 2008) burst proof has been defined as: a probability of failure of a levee due to piping or inside macro instability that is a 100 times smaller than is currently required.

The translation of burst proof into failing mechanisms provides dike designers the possibility to calculate the minimal dimensions. In short the following issues will play a role:

- **Piping** is the phenomenon by which a hollow pipe-shaped space originates under the flood defence because the erosion process of a sand boil does not stop.
- The minimal width of a dike section to prevent piping can be determined by dividing the Height (m) by the Width (m). This should be smaller than \( 1 / c_{creep} \) (=Creep factor). The creep factor depends on the used material and varies between 18 and 5. (ex. Height=5m and c=5, than min Width=25m). A decrease in the probability of piping can thus be accomplished either by changing the used material or enlarging the width of the dike.
- **Macro-instability** is the instability of the (inner) slope due to either infiltration of the overflowing water in a combination of high water level and wave overtopping, or water pressure against the defence and increased water pressure in the subsoil.
- It is determined by the inner ‘slide circle stability’ of the talud. In the Netherlands the Bishop method is being applied to calculate this stability.

Main conclusion on burst proof design with regard to the concept of a Superlevee is the fact that a dike does not have to be extremely wide in order to become burst proof, see figure Figure 20. The extreme wide variant however will probably be more interesting with regard to the potential of combining an (urban) function.

![Figure 20: Visualization of a normal dike, a burst proof levee and a very broad (Super)levee](image)

The objective to prevent water overtopping can mainly be translated into a required height. The responsible Waterboard will have to choose how this objective is translated into the dimensioning of a Superlevee; Height can be a fixed design requirement (referred to as ‘robust’) that should be resistant to the identified uncertainties during the plan period and preferably much longer. Or the height is approached as a flexible factor that can be adjusted in case new insights show the need for this. Spatial reservation will be needed in the latter case.

When consensus has been reached on the goal of a Superlevee and its safety requirements, it has to be decided for which plan period the requirements will be designed. The normal plan period of 50-100 years might be too short in case true robust/ climate proof design is the intention. An option would be to keep the plan period, but make the design very flexible.
and adjustable. However, the intention to allow urban development on top of the Superlevee could limit this flexibility. Moreover, the plan period for urban development might differ. Ones houses have been constructed on top of the levee, it might be rather difficult to adjust or maintain the levee below these houses.

2.3.3 CONSEQUENCES OF SUPERLEVEE ON INSTITUTIONAL DESIGN

The current legislation on dike design does not object to the construction of a burst proof Superlevee. Moreover, in the Leidraad Rivieren is being proposed to over dimension a dike in order to make it more robust. An interesting issue is the financial responsibility for the extra robust part. The National program for dike enforcement (HWBP) is not always willing to pay for over dimensioning. And as long as no actor is willing to take the costs for the robust design, the levee will be designed and constructed according to the minimally required dimensions (safety constraints)\(^2\). Documents like the Delta report of the Commission Veerman and initiatives like the Platform Klimaatdijk and others do stimulate to look for possibilities to make dike designs more robust. But as long as it is unclear how much extra costs for the ‘robust part’ or the extra height (ground material, settlement, etc) will be, it is difficult to discuss the financing structure. Moreover, financially it could be attractive to search for multifunctional use of the dike.

Another important issue concerning the Superlevee is the way that a Waterboard manages its water barrier. As explained before the Waterboard is obliged to set up documents like the **Data-base**, policy register and a **By-law**. In these documents restrictions are laid and even financial punishments structures to prevent damage on the barrier caused by activities, buildings, etc. When a very broad Superlevee is constructed and the same Data-base and By law would be applied as is currently done, still nothing is allowed on top of the Superlevee. Moreover, the region inlands of the Superlevee will also be part of the restricted area. Conclusion should be that management methods and plans have to be revised, but it is unclear yet how this should be done.

The Waterboard is responsible for conduction the five yearly **tests** and report on this. The methods for testing are known and formulated by the DG Water of the Ministry of V&W. A Superlevee might ask for a different approach and since no Superlevee exists already in the Netherlands, some creativity will be needed. The ENW will be the obvious actor to find a solution for this.

2.3.4 CONSEQUENCES OF SUPERLEVEE ON PROCESS DESIGN

On first sight the process of improving an existing water barrier into a normal levee or a Superlevee does not have to be very different. The Waterboard stays responsible for the safety level of the barrier and another actor is responsible for the urban development. However, some difficulties can be identified.

**Concept:**
Whereas the approach of a dike improvement project has always been very problem focussed, the design of a Superlevee (with or without extra height) will have to be approached in a different way. Still the failing mechanisms lead to the dimensioning of the

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\(^2\) Interview Hans Niemeijer (Feb 4, 2009)
barrier. When burst proof is set as the goal for the safety level this can be translated into the minimal dimension that are needed to make the barrier burst proof. In that sense it is comparable to the existing method of design. But instead of focussing on the minimally needed safety level, the goal becomes ‘safer than the minimal safety level’. This asks for a change in mindset. The Waterboard however, needs to be given an incentive to change this mindset. With all barriers complying with the safety norm, no need exists to adjust them again. This incentive is also related to the issues of financial resources and the willingness (of the State) to invest in ‘safer than minimal safety’ design of barriers.

Concerning urban development the Waterboards have always had the ability to prevent activities on the dike. This position was needed to be able to safeguard the dikes safety level. A Superlevee provides great opportunities for urban development and many employees from Waterboards underline this in case you ask for their personal opinion22. It is however difficult from a professional attitude to be very exited and open minded about urban construction on top of a water barrier that has always been only a barrier. Too many uncertainties exist about how the Superlevee affects all four phases of the lifespan of a barrier and with that the functioning of the Waterboard.

Field of Actors:
The setup of a dike improvement project with a core team and project team will most likely not be applicable in the same way when designing a Superlevee. The first problem that needs to be overcome is the timing of the process. The initiative can come from different actors:

1. The Water board has to adjust its existing dikes and wishes to make a more robust design. In order to make a robust design financially feasible the Water board searches actors that would be interesting to invest. The municipality and/or developer could be interested. This situation is not the most likely variant because many dikes have recently been improved and will not need adjustments very soon.

2. The Municipality (possibly supported by the Province or National government) wishes to develop an urban area close to the waterfront and approaches the Waterboard to talk about the possibilities of integrating flood prevention with urban development. The water board has to discuss the effects of urban development on the safety level of the dike. The Superlevee comes in sight. Important is whether the pressure is supported by the province and national government and whether the possibility exists that the urban development get pushed through. (example: Flevoland Superdijk)

3. An urban developer sees great opportunities in an area close to the waterside and decided to invest in the area. The developer together with a design bureau starts to investigate the options within the region. At a certain point they visit the Waterboard to ask about the restrictions and requirements for flood protection. When they have a flashy design they visit the municipality to promote their idea. (example: Almere Haven).

In any of the three situations more actors will have a larger role in the dike-design process than is currently the case. Interesting to notice is that the attitude of the Waterboard towards the idea will most likely be influenced by the initiator. In the first situation the Water board starts the process and is able to steer it in a certain direction. It has time to start thinking about the issues described in the technical and the institutional effects and may be able to

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22 Meeting Platform Klimaatdijk, April 2 2009. Sigrid Hafkenscheid, Municipality of Kampen.
form an opinion already. In the second situation, the Water board is able to notice the urban pressure and probably has time to think about what they want with the situation. However, the municipality will already have ideas about what they would like and how. In the third situation, the water board could be surprised by a sudden interest for urban development. The developer will have a wild vision and would like clear design constraints from the water board concerning safety so he can make a feasible design and promote this at the municipality.

Knowledge
The idea of robust design, burst proof construction etc, are not concepts that have been figured out completely yet. Whereas the normal design is based on much specific but available knowledge, for the design of a Superlevee many things need to be sort out. The most logic attitude for the Waterboard would be to wait with the concept until more knowledge is available. Additionally, knowledge from urban designers will have to be given a place the design process.
CHAPTER 3 Urban Development Design

This chapter starts with the analysis of the design process of an urban development project. With this is meant the development (from design to construction to use) of an area that did not have an urban function before and is being transformed into an urbanised area. Evidently not every urban development project will follow the same process, with the same stakeholders, the same design requirements and the same design challenges. The first section therefore contains a general description of the design process of an urban development project comparable and symmetric to the analyses in Part B on a dike improvement project. Again the analyses are based on the TIP design approach of Koppenjan (2005). The aim of this is to gain an understanding of the design process and be able to compare this process to the design process of a dike improvement project. The second section explains which developments in the design environment of such a project have taken place that makes the concept of a Superlevee an interesting one for urban development. This chapter concludes with section three on the vision on the Superlevee from the function of urban development. The current design process is linked to this vision and dilemmas are identified for a real implementation of a Superlevee. These visions and dilemmas will be taken to the next Part D where the two functions and their way of designing will be compared and conclusions of the applicability of a Superlevee will be made.
3.1 ANALYSES OF THE DESIGN PROCESS

Urban development is defined as the activity of developing an urban area on a location where no urban activities have taken place before; in other words a new urban location.

3.1.1 ANALYSIS OF THE TECHNICAL DESIGN

Goal
It is difficult to determine one general goal for urban development projects since each project is completely different than another. The goal of a development project could be to attract a wealthier segment to the edge of a city. This could be translated into objectives for design to develop low density of comfortable low-rise one-household houses with the atmosphere of living in a green area. The goal of a project could also be to increase the availability of low priced houses because the stock of this housing type is insufficient. This could be translated into the objective to develop high-rise multi-household buildings in an area. These are great differences and the goal depends on the spatial plan of the municipality and the type of houses that are needed. But with an urban development project, the goal will always be to construct buildings in a certain area. How this translates into objectives and constraints for design completely depends on the choice of the specific function, the local situation, politics, inhabitants etc.

For a better understanding of how an urban design is being made a little more detail is given on the approach for spatial development projects in the Netherlands. Currently the keystone for spatial development is the three layer approach in which a distinction is made between the Subsurface/Foundation layer, the Network layer and the Occupation layer. Figure 21 and Figure 22 below shows these three layers (Ruimtexmilieu, 2009).
The Foundation layer is divided into three subsystems that describe the elements and functioning of the subsurface and the water system. The water system on this level deals with ecological value of the system, water experience and the safety against/ functionality of water. The latter includes the scarcity of water and also the protection against water. The issue of flood protection takes place in this layer. The natural system of water barriers, dunes and high grounds along rivers belong in this layer. The second layer, the network layer describes the networks of infrastructure, traffic, green networks, energy and also the network of artificial water barriers. The system of dikes and dike rings in the Netherlands can be seen as a network for flood protection. The third layer describes which functions a certain area can have like living, working, agriculture, recreation.

Concerning the division in layers it is important to notice that the third layer of occupation will play an important role in the design process of an urban development project. The goals that are set will be drawn out in this layer and an urban and/ or landscape designer will therefore mostly focus on this layer. The infrastructure from the second layer consists of the existing networks in the area that should be taken into account and also the needed new infrastructures like roads and electricity. Connections between existing infrastructures and new ones are important as well. The elements in this layer can have a constraining effect of the design. For instance a river running through the developing area or an energy network will limit the possibilities. Most networks are characterized by very high investment costs (Sunk costs) and an adjustment to such a network will be very expensive as well. This is also applicable for a (part of the) network of dikes in case it is located in the developing area. Besides the high costs for relocating the network, (legal) constraints exist about what is allowed and what is not. The third layer is not directly part of the urban design process in the sense that it assist in achieving the set goal. It will mainly set constraints on the occupation and networks layer. These constraints can be physical (borders of an area) as well as legal (nature protection legislation).
Besides the different functional layers an urban/landscape designer needs to involve different scale levels in his design. The Urban Design Association (New York, 2003) identifies five scale levels that are important in this case.

1. Regional scale
2. Village, town, district scale
3. Neighborhood scale
4. Blocks and Lots scale
5. Individual Buildings scale

**Design Objectives**
The translation of the goal of an urban project into design objectives can vary greatly. The following general objectives are mostly translated into more specific project related objectives:

- To make **optimal** use of the available space: The challenge for a designer is to maximize the objectives of the involved actors as much as possible within the area that is available. In the example of the low-rise valuable houses the building density will be much lower than in the second example. This does not mean that the space is being used less optimal.

- Create **additional** value for the area: A new urban development project does not stand alone. This issue is directly related to the different scale levels explained before. Because a design that seems suitable on a local scale might not fit the surrounding area. The design should fit the environment and create added value to it instead of being an isolated area.

- Keep **diversity** in design: Of course the degree of diversity is negotiable, but the general idea is not keep variation into design.

The comparison of different design variants is based on indicators that say something about the degree to which the objectives are being realized. The following can be identified:

- **Spatial Quality**: The quality of space is a very subjective factor and difficult to quantify. An element that is loved by one can be hated by some one else. It is mostly related to the objective of creating additional value for the area, but the spatial quality of a design depends on the opinions of the designer, the residents, the municipality etc. To generate a design that is supported by the decision makers the design process is rather iterative.

- **Financial feasibility**: of the project has to do with the probability that the project will actually be implemented. Financial feasibility is related to the optimal use of space and relevant for the owner of the project. The feasibility of the design depends on how the costs for implementation will be compared to the benefits that can be gained by the project. Costs will involve the costs for a developer to gain the needed surface and the costs for allowance of the implementation (permits). Also the building material will add significantly. The benefits depend on the type of houses and the profit that can be gained by the developer. The financial feasibility is more important in case a private actor is investor compared to a project with a municipality as main investor.

- **Resident interests**: The focus and goal of the project will vary each time. They depend on the wishes of the spatial planner, the municipality, the wishes of the developer and the input from other actors involved. In general an urban/landscape designer (-bureau) does not design individual buildings on scale 5. However, this might be

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23 Interview Renzo Veenstra (march 9, 2009)
possible. But during process the designer has to switch between the different layers of design. An individual building has to fit within the design of the blocks and lots and these have to fit in the neighborhood and so on.

Important note to make before moving on to the constraints for urban design is the fact that the objectives as well as the criteria are mostly related to the Occupation layer, layer 3.

During the design of an urban area the plan period does not play a very important role. The philosophy of an urban designer is much more to create an artifact for a certain area, not specifically for a certain time period. On average the decrease in value of building takes 50 years. The average time between delivery of a building and demolition is approximately 110 years (Ekkers, 2002). But the demolition of a building mostly does not result in a change in the function of an area. Once an area is assigned an urban function, this mostly stays like that for a longer period than only the lifespan of a building. Therefore, the plan period does not plan a real important role during an urban design project but much more during spatial planning.

**Design constraints**

The constraints for the design of an urban development project exist on all three layers. Again the type of constraints will vary per project.

**Occupation layer:**

On a regional to a block level (level 1. to 4.) the design is mostly based on the project specific conditions; to goal and objectives (eg. high-rise versus low-rise), but also preferences from politics, (future) resident and of course the creativity of the designer. Some requirements exist on for instance the maximum inhabitant density, number of houses, etc. These requirements are often set by the initiator of the project (municipality or developer). General technical design requirements as they can be identified in Part B, Flood Protection is difficult. On the scale level of individual buildings constraints do exist and these have been institutionalized by the Bouwbesluit (2003). This act specifies five aspects on which constraints are posed;

- Safety (entries, exits, fire, electricity, gas, etc.),
- Health (sounds, water, materials, etc.),
- Usability (division into rooms, reachability, surface, etc.),
- Energy use (isolation, energy frugality),
- Environment

These aspect also vary based on whether it involves a new building or an existing one and it depends on the specific function of the building: Living / Meeting / Emprisonment / Health / Industry / Office / Vernight / Education / Sports / Shopping / Other. However, an urban/ landscape designer will most likely not go into such a detailed analysis of the design of individual buildings. This will be left to the architect and the constructor.

**Network layer:**

The already existing network in the area will have to be taken into account in design and potentially needed adjustment will have to requested in time. This will also ask for financial reservations while. A new urban area will also ask for the installation of new infrastructures. For example electricity, gas, telephone. Restrictions concerning the installation of these will evidently constrain the urban plan as well.
Underground layer:
With regard to the underground layer constraints can be identified concerning violation of the natural system. Many natural legislation prevents development in areas that are important for the preservation of for certain species (e.g. Natura2000, European Bird & Habitat Directive), for the guarantee of water quality (Water Framework Directive) or others. The type and characteristics of the underground will determine the possibilities for occupation.

3.1.2 ANALYSIS OF THE INSTITUTIONAL DESIGN

Concerning urban development two institutional aspects can be identified that are important: Spatial planning and Housing. These sectors are very interrelated and both are positioned under the responsibility of the Ministry of VROM (Ekkers, 2002). Spatial planning deals with the division of the available surface over the different existing functions a landscape can have. Housing deals with the supply and quality of accommodation of the inhabitants of the country. For insight in the legislation and regulation of these sectors the same scales can be applied as before. However, one level will have to be added to this list; the national level. Moreover, the list is based on the system in the USA and for the understanding of the Dutch system we rephrase scales 1 and 2 into Provincial and Municipality scale.

0. National
1. Regional
2. Village, town, district
3. Neighborhoods
4. Blocks and Lots
5. Individual Buildings
Spatial planning is an essential task for the government. The scale level on which is being planned determines which authority is involved. However, local government can be involved in national planning processes and vice versa. The input of experts and other actor is needed to gain support for a certain spatial plan.

**Spatial Planning Act (Wro)** This Act deals with the responsibility of setting up spatial plans that arrange how the country is shaped and how this should be done in the future. The latest adoptions on this Act were made in 2006. In 2008 this new version came into being. Not all existing spatial document are already written according to this new law. (PkB’s, Streekplannen etc.) The Wro divides the responsibility for spatial planning over the governments on the first three scale levels, nation, province, and municipality.

Setting up a National Structure Vision (Structuurvisie) that includes the headlines of spatial developments in the country. The national government is not obliged to make a more detailed spatial plan. However, in case national interests are at stake they can set up a Rijksinpassingsplan. The municipality will have to adjust its Bestemmingsplan on this provincial plan.

Setting up a regional Structure Vision that includes the headlines of spatial developments in the Province. In cooperation with neighboring provinces a shared Vision can be set up.

The province is not obliged to make a more detailed spatial plan. However, in case provincial interests are at stake the province is enforced to set up an Inpassingsplan. The municipality will have to adjust its Bestemmingsplan on this provincial plan.

Setting up a local Structure Vision that includes the headlines of spatial developments in the Municipality. In cooperation with neighboring municipalities a shared Structure Vision can be set up. The municipality has to set up a Destination plan (Bestemmingsplan) for all the surface of its area for a period of ten years. This plan should contribute to the realization of the policy goals that are defined in the Structure Vision. In this document the municipality lays down the rules and regulations according to the typology of destination.

<table>
<thead>
<tr>
<th>Formal Institutions</th>
<th>Spatial Planning Act (Wro)</th>
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<tbody>
<tr>
<td></td>
<td>This Act deals with the responsibility of setting up spatial plans that arrange how the country is shaped and how this should be done in the future. The latest adoptions on this Act were made in 2006. In 2008 this new version came into being. Not all existing spatial document are already written according to this new law. (PkB’s, Streekplannen etc.) The Wro divides the responsibility for spatial planning over the governments on the first three scale levels, nation, province, and municipality. Setting up a National Structure Vision (Structuurvisie) that includes the headlines of spatial developments in the country. The national government is not obliged to make a more detailed spatial plan. However, in case national interests are at stake they can set up a Rijksinpassingsplan. The municipality will have to adjust its Bestemmingsplan on this provincial plan. Setting up a regional Structure Vision that includes the headlines of spatial developments in the Province. In cooperation with neighboring provinces a shared Vision can be set up. The province is not obliged to make a more detailed spatial plan. However, in case provincial interests are at stake the province is enforced to set up an Inpassingsplan. The municipality will have to adjust its Bestemmingsplan on this provincial plan. Setting up a local Structure Vision that includes the headlines of spatial developments in the Municipality. In cooperation with neighboring municipalities a shared Structure Vision can be set up. The municipality has to set up a Destination plan (Bestemmingsplan) for all the surface of its area for a period of ten years. This plan should contribute to the realization of the policy goals that are defined in the Structure Vision. In this document the municipality lays down the rules and regulations according to the typology of destination.</td>
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**Table 7:** Institutional analysis for Spatial Planning

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24 In Dutch: Wet Ruimtelijke ordening
### Housing

<table>
<thead>
<tr>
<th>Informal Institutions</th>
<th>Housing Act[^25]</th>
</tr>
</thead>
<tbody>
<tr>
<td>After initiative the project will have to be designed. Many small and larger design companies exist that have specialized in landscape architecting, urban development or areas related. The approach and creativity of the designer are important for the final result.</td>
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<tr>
<td>This Act originates from the year 1901 and was originally set up to prevent bad quality houses and promote good quality houses from being constructed. The rules and regulation in this law thus have an impact on the lowest scale level, the individual buildings. Moreover, this act obliges the municipality to set up a Welstandsnota. Under this law three AMvB’s are added. The Building decision[^26] is the most important one in this perspective. In this section the technical prescriptions for constructions are laid down. These prescriptions have been discussed under design constraints.</td>
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<table>
<thead>
<tr>
<th>Formal Institutions</th>
<th>Environmental Management Act</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing is a market. The market consists of a stock of houses that can not only be seen as consumption good but also as an investment good. Because it is a market it consists of demand and supply. Both are heterogenic which means that the demand and the wishes for housing varies per household (depending on income, location etc.) and therefore the supply does as well (Ekkers, 2002). For the development of an urban area an investor is needed. A municipality can take the role of investor in order to safeguard the housing supply. It is also possible that the investment is done by an investing company. This changes the perspective and the objectives of the project. Before a project can actually be implemented, permits will have to be acquired at the responsible authorities. This can be the municipality but also the Waterboard. Acquiring these permits can take a long time (up to a few years)</td>
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<table>
<thead>
<tr>
<th>Formal and informal arrangements</th>
<th>Table 8: Institutional analysis for Housing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept</td>
<td><strong>3.1.3</strong> ANALYSIS OF THE DESIGN PROCESS</td>
</tr>
<tr>
<td>Generally in urban design not an existing problem is the motive for the project, but much more the opportunity that is identified to develop a certain area. The specific reason will vary based on which actor is the initiator. For a municipality the reason for a project can be the need for housing. A developer will invest in an area because he sees a (profitable) opportunity in the area. In both cases leading principles for design will be; creating added value for the area, making optimal use of the available space and sometimes adding diversity in design. The challenge for the urban/ landscape designer is to create a design</td>
<td></td>
</tr>
</tbody>
</table>

[^25]: The Dutch names of the different Acts, chronologically: Woningwet, Wet milieubeheer
[^26]: In Dutch: Bouwbesluit
that maximizes the potential of the designated area as much as possible. Because most objectives are qualitative, a designer will have the role to convince the municipality of developer that his/her design in fact answers to all objectives. The decision is partly based on esthetical values. Figure 23 shows two examples of how a designer designs an urban project.

![Figure 23: Impression of urban design (RROG, 2009)](image)

**Field of actors**

The process of an urban development project can be initiated in two ways:

1. Either spatial planners, mostly the municipality has set up a spatial plan and based on this plan they search for developers who are interested in a certain project. The municipality might also function as developer but mostly other (private) parties are involved. These developers decide to invest in the project and have their own designers in service or search urban/landscape designers that could help them to make the project successful.

2. Or urban developers see a great opportunity in a not yet developed area and decide to invest in this. With the preliminary ideas they approach the municipality and try to gain support for the idea. The developer needs approval of the municipality in order to start a project. In case the developer is on the territory on the Waterboard, the municipality will send the developer to the Waterboard.

**Table 9:** Scan of the involved actors in a dike design project

<table>
<thead>
<tr>
<th>Involved actors</th>
<th>Critical</th>
<th>Non-critical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shared perceptions, goals, interests</strong></td>
<td>Municipality, developer, financer, designer (bureau) Surrounding municipalities Province, National government (Waterboard)</td>
<td>Inhabitants, lobby groups of industry and companies</td>
</tr>
<tr>
<td><strong>Opposite perceptions, goals, interests</strong></td>
<td>Environmental groups Inhabitants Competitive developers, other municipalities (Waterboard)</td>
<td>Inhabitants, interests groups</td>
</tr>
</tbody>
</table>
Critical: The municipality is the main actor in an urban development project. It is responsible for setting up the local spatial plans and the local housing policy. In the latter it has the responsibility of safeguarding a sufficient housing stock, supervising the quality of houses and providing or neglecting permits for project (Ekkers, 2002). It can also function as developer of a certain project, but mostly this is a different (partly) public developer or a private actor. The actor responsible for the actual design is mostly a different one, an urban/landscape designer. This can be a designers company or an individual. The province is responsible for the provincial spatial plans as well as the national government for national planning. Also the province has a coordination role for the spatial developments of and between neighboring municipalities. The position of the involved municipalities and the province will depend on their interests in the project. When a suggested enforcement design conflicts with the municipal or provincial spatial plans their position is on the second row.

Non-Critical: The position of inhabitants will depend on the opinion with regard to a development project. This can be related to the construction and the fear for hinder during this phase, but also to the fact that inhabitants do not like the idea of a new development. Inhabitants have a saying in the establishment of spatial plans, but once this plan is determined, objection against development projects will become more difficult. Interest groups of any kind (tourism, industry, etc.) could see the project as an opportunity to link their interests with. Lobby groups might support the project with the intention to gain something for themselves. On the other hand the project could conflict with their interests. Evidently the actors will then shift from the upper row to the lower row.

Knowledge
An urban design process will start with strategic knowledge that is rather easy to share with non-experts. That basic understanding generates support for the generation of knowledge during the process. For instance the need for housing in an area and the explanation why can be communicated in a rather simple way. When the actors involved have agreed on the location for housing, the design can be generated with those actors during the process. Other needed knowledge on design will mostly be factual knowledge and location specific, for instance the number of (future) inhabitants, measures of the area, natural/ecological situation, or is related to the financial aspects of the project. However, not much of the input for design will be based on specific technical knowledge like is the case in dike design. Rather on the opinion of actors, the objectives of a developer and/or municipality and the creativity of the designers. Discussion about and documentation on the design is mostly done by sketches, maps and images. The way that constraints and objectives lead to a final design is thus completely different than is the case in the improvement of a water barrier. The first steps are much more based on identifying the possibilities and the wishes of actors instead of a first focus on the minimal constraints to guarantee safety.
Aspects of the process

According to R. Veenstra\(^{27}\) the process of urban design is a very iterative process. At first an understanding is needed of the assignment and of course the area. The second phase of actually developing design variants is less straightforward. This is also explained by the qualitative character of the design objectives. To the Urban Design Associates (2003) describes this phase as an exploration phase in which ideas are being tried out and alternatives are being explored. The design techniques that are used are not very structured and phased. According to Achten(2005) an urban design process contains four different phases that each designer fills in a different way (Naming, Framing, Moving, Evaluating). In case private actors take part in the project, the continuity and speed of the process will be more affected by the financial situation and the market conditions. In a solid or growing market investors and developers will be more capable and willing to invest in new urban development projects then in case the market is not functioning well. Thus, although spatial planners have decided on the development of an area, financial resources could influence the progress.

3.2

CHANGING DESIGN ENVIRONMENT

The process of urban development is a fuzzy one. The municipality is the main actor when it comes to connecting spatial planning and housing assignment to the actual development of neighbourhoods. However, developers could take initiative as well. This section will describe how the design environment has been changing or will change in the near future. This is important in order to understand the viewpoint of urban developers and designers on the conditions under which a Superlevee is an interesting concept.

First more general remarks are made and this is illustrated by the explanation of spatial developments in the province of Flevoland, the Randstad region and the municipality of Almere.

3.2.1

CHANGES IN TECHNICAL DESIGN ENVIRONMENT

As explained in the previous section, urban development is not very bound to technical constraints\(^{28}\). Only on the level of individual buildings strict requirements are posed but these are not directly relevant for an urban designer. The specific goal of a project depends on the local situation and urban designers adjust to this by creating new, innovative and creative designs.

Concerning the objectives for design a slight change can be notified. The topic of Climate change has pushed politicians to discuss about the consequences and how can be dealt with these. For landscape and urban designers a new market appeared for climate proof living, living with water, etc. The concept of a Superlevee fits this market.

\(^{27}\) Interview Renzo Veenstra, design bureau RROG (March 9, 2009)

\(^{28}\) R. Veenstra / M. Spits
3.2.2 CHANGES IN INSTITUTIONAL DESIGN ENVIRONMENT

**Housing**

Already for a longer period of time the housing market has been under pressure. The supply side of the market is not flexible enough and unable to deal with the increase in demand (VROM, 2006). Due to a number of reasons like individualizing, obsolescence and the number of divorces, the demand for (single person) households will keep increasing even fast. Planning, designing and actual construction of new homes is therefore an important target on the agenda of the Ministry of VROM (VROM, 2008).

**Spatial Planning**

Besides the need for homes, the new Nota Ruimte has emphasizes the importance an certain areas. For the international position of a few important regions urban expansion has to be realized. This is explained better by the example of Flevoland.

3.2.3 CHANGES IN PROCES DESIGN ENVIRONMENT

The focus on living with water, supported by national and regional policy leads to innovative design on, next to and over the water barriers. But the function of the barrier should not be endangered; Safety requirements will have to be added as design requirements in design. The Water board will start to play an important role.

Based on discussions with multiple urban designers\(^2\) can be concluded that cooperation with the Waterboard can be difficult. When normally a developer has plans for the region around the dike he visits the section of Permits to ask for permission to develop something on the Waterboards’ territory. The “No, unless…”- attitude is most common. This is understandable since the Waterboard is responsible for the safety. It does however make cooperation rather difficult.

When the plans for waterfront development will proceed something will have to be done about this communication.

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\(^2\) Based on interview R. Veenstra and informal conversation with K. Batterbee & M. Spits
Frame 5: Urban Pressure in Flevoland

In the National Spatial Policy (Nota Ruimte) (VROM, 2006) the Randstad is one of the regions that is given specific goals (of national importance): For the north wing of the Randstad the goal is to expand the urban area between Amsterdam and Almere in order to cope with the increasing demand for housing within the Randstad and to be able to maintain the internationally competitive position of the Randstad. The Almere waterfront towards Amsterdam has been assigned the function: new waterfront development. (See the red line on the Westside of Almere in Figure 19).

Meanwhile the Province has set up its spatial plan (Provincie Flevoland, 2006) in which they seek a way to switch from a “no, unless”-policy to a “yes, because”-policy for waterfront development. With that, the province emphasizes the importance of urban development in Flevoland. For Almere the province identified three possible directions. One is on the west side towards the waterfront. (See the red arrows is Figure 20)

In the Structure-vision Randstad (Structuurvisie Randstad, 2008) the cabinet has translated the goals from the Nota Ruimte into the ambition to construct 60,000 new homes in Almere before 2030 (Almere Schaalsprong).

On request of the cabinet, the municipality (together with municipality of Amsterdam, the Province, The Water board ZuiderZeeland and Communal Development Company (Gemeenschappelijk Ontwikkelings Bedrijf, GOB) has started three studies to the possibilities of urban expansion in Almere. One of these is on the west side in the area Almere Pampus. Innovative designs like constructions outside the dikes, islands or small polders in front of the coast line are circulating in this discussion. The output of this cooperation has been the document Masterplan Almere Pampus (2008) in which three possibilities are described for development. Two of three include the water barrier in their design. A solution for this could be a Superlevee.
3.3 VISION ON THE SUPERLEVEE

To deal with the changes in the design environment from paragraph 3.2, a Superlevee might be a very interesting concept. However, important is to start with what exactly is meant by people involved in Urban Design with a Superlevee and how the development of an urban area on top of a levee differs from a ‘normal’ urban development design. Thus, the goal of this paragraph is to identify the effects that the changes in the design environment in paragraph 3.2 will have on the design of a Superlevee compared to the ‘normal’ design.

3.3.1 DEFINITION OF A SUPERLEVEE

Based on an interview with a Landscape architect/urban designer, the conclusions from the Project in Zuiderzeeland and the discussions during the meeting of the Platform Climate dike can be concluded that people involved or interested in the concept of the Superlevee from the viewpoint of urban development have the following vision on a Superlevee.

A Superlevee is a dike that will enable developments on top of the levee in such a way that the connection between housing and water is restored. Moreover, a Superlevee could form a link between urban areas within the dike ring and outside (eg. on the water). Evidently the protection level of the hinterland should still be guaranteed. Preferable the Superlevee will be high enough to withstand every water level, but wave overtopping could be dealt with by creative design.

The Municipality who is responsible for the urban planning is the most important actor in the context; however a developer will have an interesting role in the process as well and a designer will have to translate the wishes of municipality, developer and other into a realistic design. The Waterboard becomes a needed actor, but how this will fit the process needs to be studied.

3.3.2 CONSEQUENCES OF SUPERLEVEE ON TECHNICAL DESIGN

Design constraints:
This shift in location-focus to the dike areas has as a consequence for the focus of the design. Normally the Occupation Layer is the main layer for the urban designer. The network layer sets a few constraints but by taking these into account the urban design process can focus on maximizing the design objectives. In a Superlevee the constraints from the network layer will play a much more important role. The design space for the occupation layer will be constrained by the design requirements of the flood defence network. The aspects that are taken into account will thus be:

- Spatial quality
- Financial feasibility
- Residents interests
- Safety
- Ecology

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Interview Renzo Veenstra, Design bureau RROG (March 9, 2009)
Design Objectives:
The given vision on the Superlevee does not specify any characteristics besides that it will be multi functional. The design will depend on the specific wishes in that situation. Important characteristics of the design space from the occupation and network layer can already be identified:

- **Type of buildings**: High-rise versus low rise blocks. The first will be more interesting for the developer since they are more profitable, the second will have less impact on the dike body, since the weight is less. From the workshops in Flevoland can be concluded that High rise is necessary in order to make it an attractive concept.

- The planting of trees can be a decisive element in the attractiveness of a neighborhood. Trees in a dike will become a point of discussion, since currently trees are prevented as much as possible by the Water boards. They have an effect on the stability, especially in case the tree falls over during a storm and the roots take out a part of the dike.

- Sufficient parking space is a requirement. This aspect needs to be taken into account when designing the Superlevee and especially in relation to High rise buildings. Using the surface around a High rise building for parking does not contribute to the attractiveness of the location. Underground parking is definitely preferred. Underground will imply in this case; inside the dike body.

- Potentially difficult issues with from the network layer could contain: Cables, sewer systems, electricity and gas infrastructures, roads, pathways, etc.

3.3.3 CONSEQUENCES OF SUPERLEVEE ON INSTITUTIONAL DESIGN

The Spatial planning policy documents not only promote but really steer for the development of urban waterfronts and more specific in Flevoland. A Superlevee is one of the options that fit this policy. It is however not the only possibility.

A Superlevee will however ask for great investments and is an innovative concept with many uncertainties. To make first estimations of the financial feasibility more knowledge is needed on a few topics:

- What are the costs for the land on and around the dike? And how will the Water board and the municipality/developer deal with the ownership of these grounds.

- A Superlevee needs a great amount of ground material. This will have to be available (in close distance) from the construction site in order to create the transition from barrier to urban waterfront.

- The amount of ground that needs to be delivered and the division of these costs between the Water board and the developer.

- The construction costs for houses could be comparable to the normal construction material and methods. Possibly other, more expensive methods and material are required.

- For the Municipality/Developer it is easiest the keep the management of the water retaining part of the barrier in hands of the Water board.

- How can be assured that benefits cover the costs? Is living at the waterside as interesting as everyone is thinking? Market research and input from real estate agents should give more information on this topic.
3.3.4

CONSEQUENCES OF SUPERLEVEE ON PROCESS DESIGN

Field of actors
In the field of actors evidently the Water board will take a more prominent role. The Water board is the actor with the knowledge of safety design and is the authority of the dikes. In the normal situation when a municipality or developer would like to undertake activity on the area of the Water board a permit has to be requested at the department of permits in the Water board. This will probably not be the way when the intention is to construct a Superlevee. Cooperation with the Water board will be needed. On which level inside the organisation has to be found out. The current tendency in the design of innovative urban waterfronts is to not involve the Waterboard in the process\textsuperscript{31}.

Aspects
The decision making on this topic is political. That could provide great opportunities; elements that cannot be agreed on via the permit department of a Water board, might become possible in case the topic comes to the board. For instance, the Dijkgraaf signed the document Master plan Almere Pampus in which of the three possibilities for development of Pampus two include a development on the dike.

However, a political process could also be a drawback. The process will become fuzzy and the outcome will not per definition be the most suitable solution. The implementation of a Superlevee, once decided that it should be implemented, might take longer than an urban development project already does.

An urban development process is as mentioned before an iterative process where the designer gets back to the different involved actors during the process. He uses maps and visualizations to investigate the wishes of people involved and adjusts his design based on the input on these visualizations. These maps are used to investigate the people’s wishes and are rather conceptual instead of a detailed analysis/design of the specific conditions\textsuperscript{32}. In a way these maps can be seen as art (Carton, 2007). In communication with the water board it might a different approach might be needed.

\textsuperscript{31} Informal conversation with Kevin Batterbee, company INBO (March 27, 2009)
\textsuperscript{32} Interview Renzo Veenstra, designers bureau RROG (March 9, 2009)
CHAPTER 4  Effect of a bifunctional design

In the introduction of this report has been justified my is chosen for a separated yet symmetric approach for the two functions of flood protection and urban development. When combining two functions in one artefact - that have not been combined in that artefact before - one should realise that the technical design, the institutional design and the design process will have to be combined as well (see Figure 3). The previous Chapters 2 and 3 have provided a better understanding of the design processes of a primary water barrier and that of an urban development project. This chapter summarizes and compares the findings from both chapters and draws conclusions about the consequences for a (shared) design process of a Superlevee. In the previous two chapters references have been made to all used literature, the input from interviews and the input from (informal) discussions. These references will not be repeated here. The several tables that are used in this chapter present a schematic overview of the findings from the previous chapters.

First the existing design processes of the two functions and the changes in both design environments will be compared. Also the two visions on the concept of a Superlevee will be discussed. The goal is to understand the main difficulties in combining these design processes in a Superlevee. Next the main issues and questions concerning the design from both sides are discussed.
4.1 COMPARISON OF THE DESIGN PROCESSES

For the function Flood Protection the main goal of a design process is to guarantee the legally required safety level for the required plan period (50-100 years). This is true in case the safety level of a water barrier is tested to be insufficient and the barrier needs to be enforced as well as in case adjustments to the barrier are desirable because of developments of other functions in the barrier-area. In both situations the starting points for design are the ways in which the barrier could fail. Based on these failing mechanisms it can be determined how the barrier should be dimensioned minimally in order to prevent these failing mechanisms to occur. Expert knowledge is needed to translate these failing mechanisms into design alternatives. The process for design is determined, structured and organized. Methods and procedures are laid down in legislation. The water board is the responsible actor for the state of the water barriers. The income for a Waterboard is based on taxes amongst inhabitants. The State provides financial resources for the restoration of the required safety level of a barrier in case it has been rejected and is part of the High Water Protection Program. Adjustments due to developments of other functions are paid for by other actors.

The main goal of an urban development project is to develop a new urban area. The constraints and objectives for design vary per project. They depend on the local conditions, the involved actors and they can be negotiable. Legal constraints only exist on the level of individual buildings. Knowledge is more linked to experience and creativity than to technical knowledge of the construction of buildings. The main intention is to develop the area in such a way that the potential is fully used. The municipality is the main actor concerning spatial planning and is responsible for housing quality and supply. Financial resources can come from public as well as private actors like project developers. Housing is market-related and development mostly has a profit intention. The urban design process is an iterative one and shifts between different scale levels (regional level, block level, local level, etc.).

<table>
<thead>
<tr>
<th></th>
<th>Flood Protection</th>
<th>Urban development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical design</strong></td>
<td>Main goal is guaranteeing the (minimally) required safety level</td>
<td>Main goal is developing a new urban area</td>
</tr>
<tr>
<td></td>
<td>Leading constraint is safety of hinterland</td>
<td>Constraints vary per project (eg. # of houses)</td>
</tr>
<tr>
<td></td>
<td>Design objectives are related to managing safety or to other functions</td>
<td>Design objectives depend on wishes of municipality/ developer/ inhabitants etc</td>
</tr>
<tr>
<td><strong>Institutional design</strong></td>
<td>Constraints are institutionalized</td>
<td>Constraints are mostly negotiable/ politic</td>
</tr>
<tr>
<td></td>
<td>Costs: Public actors pay for safety (non-profit), other interests are paid for by others</td>
<td>Costs: Public and Private actors (profit intention)/ Housing is market-related</td>
</tr>
<tr>
<td><strong>Process Design</strong></td>
<td>Design is Problem-focused (based on failing mechanisms)</td>
<td>Design is Opportunity-oriented (new development, maximize objectives)</td>
</tr>
<tr>
<td></td>
<td>Waterboard is responsible for safety</td>
<td>Municipality is responsible for housing</td>
</tr>
<tr>
<td></td>
<td>Expert knowledge is important</td>
<td>Knowledge is mostly negotiable</td>
</tr>
<tr>
<td></td>
<td>Structure process is institutionalized</td>
<td>Iterative and fuzzy process</td>
</tr>
</tbody>
</table>

Table 10: Comparison of the design processes
4.2 CHANGING DESIGN ENVIRONMENT

Both for flood protection as well as for urban development the design environment has been and is currently changing. New challenges arise that could make the concept of a Superlevee more interesting. Table 11 summarizes the changes.

<table>
<thead>
<tr>
<th></th>
<th>Flood Protection</th>
<th>Urban development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical design</td>
<td>Effects of climate change (sea level rise, fluctuations in river discharge, rise in lake level for fresh water stock) pose future challenges on the flood protection system.</td>
<td>Demand for living at/with water</td>
</tr>
<tr>
<td></td>
<td>Innovative concepts besides the basic dike profile become available.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intention of over dimensioning (robust design) is suggested as method to deal with uncertainties</td>
<td></td>
</tr>
<tr>
<td>Institutional design</td>
<td>Change in the type of safety norm</td>
<td>Need for the development of houses</td>
</tr>
<tr>
<td></td>
<td>Three level safety policy</td>
<td>National support for waterfront development</td>
</tr>
<tr>
<td>Process Design</td>
<td>Political pressure for waterfront development (in Flevoland)</td>
<td>Safety becomes a constraint for design</td>
</tr>
</tbody>
</table>

Table 11: Changes in the design environment
4.3 VISIONS ON THE SUPERLEVEE

Both functions and the actors involved in the design processes for both functions have developed a vision about the Superlevee; what it should do in order to be ‘Super’, what the added value could be of a Superlevee and how ‘needed’ a Superlevee currently is. Table 12 and Table 13 below show these three elements for both functions.

<table>
<thead>
<tr>
<th>Flood protection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition of a Superlevee</strong></td>
</tr>
<tr>
<td>A Superlevee is a dike that is broad enough to be burst proof and high enough to deal with changing water levels related to climate change and political decisions. Due to the way in which the barrier is over-dimensioned, it will become possible to integrate other functions into the Superlevee. However, the first incentive to over-dimension a water barrier in such a way is the increase in safety level.</td>
</tr>
</tbody>
</table>

| **Added value of a Superlevee** |
| The added value of a Superlevee compared to the existing state of the barriers would be the increase in safety level for a longer period of time. This could involve less effort for maintenance of the dike and less effort for testing and reporting every test round. Assuming that solid agreements can be made about the location where urban constructions are allowed the management and provision of permits could be more straightforward than it currently is. The Waterboard will be able to liberalize their attitude because the conditions for developments are clear. A more balanced relationship with the municipality might occur. |

| **Need for a Superlevee** |
| From the perspective of flood protection there is no real need to develop a Superlevee. The primary water barriers are being or have recently been enforced and space has been reserved for future expansions when needed due to changes in the design environment. This free space and the restrictions for other functions are laid down in the Data-base and in the By-law. For developments close to or on top of (primary) water barriers most Waterboards have even set up a policy with guidelines for developers and restrictions for constructions. The possibility to raise the ground level and develop on top already exists. Even in the situation in which the drive for the Superlevee would be the potential added value, no financial resources will be available. |

Table 12: Vision about a Superlevee from the perspective of Flood Protection

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33 Discussion with Marco Veendorp (May 6, 2009)
34 This is true with the Waterboard Zuiderzeeland: Beleid bouwen nabij PW (2008). See also Chapter 5
35 Investments in barriers that are safer than the safety norm are very difficult to finance. The state will probably not be willing to invest, because the barriers already comply with the existing safety norms. In case the Waterboard would be forced to finance the Superlevee on its own, this in turn will lead to an increase in taxes and presumably resistance from local inhabitants.
Urban development

A Superlevee is a dike that will enable developments on top of the levee in such a way that the connection between land and water is restored. Moreover, a Superlevee could form a link between urban areas within the dike ring and outside (e.g., on the water). Evidently protection of the hinterland against flooding should be guaranteed. Preferable the Superlevee will be high enough to withstand every water level, but wave overtopping could be dealt with by creative design.

The added value of a Superlevee is the possibility to create a new urban area on a highly attractive location for living, working, etc. This development is not possible/feasible under the currently existing restrictions of the Waterboard. The Superlevee is interesting from the inland towards to waterside, by restoring the connection between land and water. Also it could be interesting for the connection between housing within the dike ring and outside, for example on the foreland or on islands in front of the shore.

On multiple locations housing is needed. On those locations where housing is needed close to a water barrier, waterfront development will have to take place. The Superlevee is one of the possibilities to develop the waterfront and might be a very attractive one if a (financially) feasible business case can be constructed.

<table>
<thead>
<tr>
<th>Definition of a Superlevee</th>
<th>Added value of a Superlevee</th>
<th>Need for a Superlevee</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Superlevee is a dike that will enable developments on top of the levee in such a way that the connection between land and water is restored. Moreover, a Superlevee could form a link between urban areas within the dike ring and outside (e.g., on the water). Evidently protection of the hinterland against flooding should be guaranteed. Preferable the Superlevee will be high enough to withstand every water level, but wave overtopping could be dealt with by creative design.</td>
<td>The added value of a Superlevee is the possibility to create a new urban area on a highly attractive location for living, working, etc. This development is not possible/feasible under the currently existing restrictions of the Waterboard. The Superlevee is interesting from the inland towards to waterside, by restoring the connection between land and water. Also it could be interesting for the connection between housing within the dike ring and outside, for example on the foreland or on islands in front of the shore.</td>
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</tr>
</tbody>
</table>

Table 13: Vision about a Superlevee from the perspective of Urban Development

Based on the comparisons in Table 10, Table 11, Table 12 and Table 13 it can be concluded that a shared design process might become difficult. The role of technical constraints and the importance of (technical) knowledge are very different. An urban designer is used to a negotiation process revolving around objectives, whereas for flood protection constraints are strictly regulated by legislation. This could lead to communication and co-operation problems. Secondly, flood protection is a common good while housing is a market-oriented sector. The combination of these two into one artefact requires a clear division of responsibilities. The design processes that both sides are used to differ most significantly in the fact that flood protection is used to start the design from a problem perspective, whereas an urban designer tries to fully utilize the possibilities of a certain opportunity.

The characteristics of the design processes in combination with the difference in vision lead to some additional remarks. In case a municipality or urban developer identifies an opportunity for waterfront development, it will try to maximize the potential of the area. The expected attitude of the Waterboard (based on the above) will be rather defensive. With the ongoing enforcement projects (High Water Protection Program) there is (mostly) no problem regarding the safety level of the water barriers. The By-law of the Waterboard states what a developer is allowed to do and what not to do. The reason of the By-law and the reason why the Waterboard is legally empowered to set up a By-law are to prevent negative effects on the strength of the barrier or on the future possibilities for expansion. Exceptions on the By-law will therefore not be allowed easily. Moreover, no need exists for the Waterboard to change the existing rules, especially when doing so could potentially risk the safety level of the water barrier. The added value of a Superlevee would be an increase in the safety level, but no financial resources will be available for this over-dimensioning. Thus for the Waterboard the most convenient situation is the existing situation in which the dike is empty without constructions on top.
Although the first conclusions above on a shared design process of a Superlevee are not very optimistic, two other aspects are important to state as well:

Firstly, most Waterboards are very willing to look beyond the task of flood protection and the care for water barriers. The Delta Commission and the National Water Plan support the idea of a Delta dike and Climate dike. And also the booklet on shared design (VROM, 2009) emphasizes the importance of approaching flood protection from a regional viewpoint instead of sectoral one. Waterboards underline this.

Secondly, Waterboards are experiencing a pressure for urban development. In the example of Flevoland and more specific the needed expansion of Almere, the national government supports the idea of waterfront development (Nota Ruimte, 2006). It has not been articulated that this development should be a Superlevee, but for the Waterboard of Zuiderzeeland it has been the reason to start investigating the possibilities of such a levee. Based on these two issues it is realistic to further investigate the Superlevee and the challenges that is poses on the technical, institutional and process designs of urban development as well as flood protection. Table 14 shows the questions that a Waterboard will have to address and which issues it will have to deal with concerning the dimensioning of a Superlevee and the design process. Table 15 shows the comparable issues and questions from the perspective of the Municipality. These issues and questions are partly based on the project in Flevoland, but also on discussions with other Waterboards and the Platform Climate dike.

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36 Based on informal conversations during the ARCADIS Project “Kustnota en Nota Waterkeringen” for the Waterboard of Rijnland. Present were: representatives from Waterboard Schieland en de  
Krimpenerwaard, Delfland, Hollandse Delta
### Table 14: Issues for design of a Superlevee from Flood Protection viewpoint

<table>
<thead>
<tr>
<th>Elements of design</th>
<th>Issues/ questions for design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical design</strong></td>
<td></td>
</tr>
<tr>
<td>Existing constraints concerning safety</td>
<td>What is the effect of surface and underground constructions (buildings and infrastructure) on the functionality of the levee?</td>
</tr>
<tr>
<td>Objectives/ constraints concerning robust design</td>
<td>Strength: burst proof. What are the effects of constructions on the strength? Height: Preferable no overtopping/over flow. What should be the plan period for design?</td>
</tr>
<tr>
<td>Objectives concerning Management</td>
<td>How will constructions on the levee influence management possibilities (maintenance, testing etc.)?</td>
</tr>
<tr>
<td>Urban objectives</td>
<td>When is the concept interesting for developers (assuming that the current possibilities are not interesting enough)?</td>
</tr>
<tr>
<td>Plan period</td>
<td>Which plan period is suitable to deal with the uncertainties and to match with urban development?</td>
</tr>
<tr>
<td><strong>Institutional design</strong></td>
<td></td>
</tr>
<tr>
<td>Management structure and policy</td>
<td>The existing management structure (By-law, Data-base) on constructions does not match the new concept.</td>
</tr>
<tr>
<td>Ground construction is preferred. What would be the effect when including constructions in the water barrier?</td>
<td></td>
</tr>
<tr>
<td>Methods for design</td>
<td>Existing design methods will be less applicable on the design of a Superlevee.</td>
</tr>
<tr>
<td>Financing structure</td>
<td>Who will pay for which aspects of the robust design? How much is a developer willing to invest?</td>
</tr>
<tr>
<td><strong>Process design</strong></td>
<td></td>
</tr>
<tr>
<td>Waterboard is responsible for main constraints (= safety)</td>
<td>What will be the position of Waterboard in the process compared to a municipality/developer?</td>
</tr>
<tr>
<td>Current safety level</td>
<td>Currently there is no need to adjust the existing levees, but the Municipality is interested at this moment. Will this lead to political/managerial pressure and what will be the effect?</td>
</tr>
<tr>
<td>Technical knowledge about the effect of constructions</td>
<td>Which and how much knowledge is needed to start the process?</td>
</tr>
<tr>
<td>Process based on the concept of a Superlevee</td>
<td>Which design variants are possible? Does this match with the approach of an urban designer?</td>
</tr>
</tbody>
</table>
Table 15: Issues for design of a Superlevee from Urban development viewpoint

Based on Table 14 and Table 15 and the previous notes, the following conclusions can be drawn about a shared design of the Superlevee.

- Currently the Waterboard has no safety problem and there is no immediate need for a Superlevee. The existing situation is safe, manageable and testable. The Waterboard has the instruments to make sure the barrier will be expandable when required. Therefore it is difficult to create a sense of urgency or to gain consensus about the specific goal of a Superlevee in terms of Safety.

- Discussions about the goal of a Superlevee for the Waterboard are tended to become a discussion about the negative effects on the instruments to guarantee safety, for instance manageability and testability, instead of safety itself (height and strength of the dike). This “No, unless” attitude can be directly related to the task of the Waterboard and the existence of for instance a By-law, but it leads to a reserved attitude towards constructions on the dike and thus towards the concept of a Superlevee.

- When talking about the goal of a Superlevee in terms of safety words like robust, climate proof and sustainable are being used. As long as these words are not translated into clear objectives for design (for instance burst proof) and subsequently into
dimensioning of alternatives (height etc.) there will not be a clear understanding among those involved about the issues at hand. Creating consensus will thus be difficult.

- As noted before, expert knowledge is important in the design process of a water barrier. With regard to a Superlevee, still uncertainties still exist about the effect of constructions - especially underground- on the strength of the barrier. Moreover, it is not yet clear what urban developers have in mind concerning surface and underground constructions and what is needed to make the Superlevee financially feasible for them. The lack of such specific knowledge forces the Waterboard to take a very reserved position in order to protect their dikes from unforeseen and negative future effects.

- Concerning the needed height of the Superlevee, uncertainties exist about how climate change and political decisions affect the water level and thus the design requirements. A robust\(^3\) design could be made by taking the ‘worst case’ of the existing scenarios. However, the design period is an important factor here. The plan period of constructions on top should run parallel to the plan period of the design height of the levee; otherwise it will be very difficult the increase the height when this is necessary for the safety level.

- All the aspects above combined with the earlier conclusions on the characteristics will prevent a fast and considered reaction from the Waterboard to the currently existing urban pressure.

- The levee and the idea of a Superlevee do not require for large adjustments in the urban design process. As in other projects design constraints and objectives depend on the actors involved.

- From a spatial planning perspective the area of a Superlevee will have the function of flood protection and thus the urban development area on top on the levee will as well. The Waterboard is the actor responsible for safety and is empowered to constrain activities in the designated areas. The Waterboard will therefore have to provide the constraints for design. The existing constraints (By-law) do not provide sufficient possibilities for development. To make the concept of a Superlevee realistic, the Waterboard will have to revise its policies.

- (Financial) feasibility will be an important challenge in this design process. A great deal of ground will need to be supplied and this is expensive. Also the design constraints concerning safety will ask for creative and probably more expensive solutions. To be able to make estimations of this feasibility, more information is needed about what is and what is not possible on top of a dike.

\(^3\) Meaning here: over-dimensioned
4.4 EFFECT OF THE WATERBOARDS ATTITUDE

With these issues and questions in mind and the urban pressure that is being practised, the Waterboard will have to decide which attitude it will take. Two variables are especially important in this.

**Re-active attitude versus Proactive attitude:**
The wish for urban development comes from a different actor then the Waterboard. The Waterboard could wait for more information to become available or for the municipality to come with a design variant. The function of the Waterboard in that situation will be to provide or neglect permits for development. A Waterboard could also take a pro-active attitude and start the discussion with municipality and others and become part of the process.

**Problem-focused versus Opportunity-oriented approach:**
The idea of a Superlevee can be approached as an issue and the implementation of this issue will bring about many problems. Or the Superlevee could be a possible solution to deal with the challenges of climate change and to construct a dike that is stronger than the safety level while providing opportunities for development as well.

With these two variables, four scenarios are possible. A short explanation of these is given below.

**Re-active and problem oriented**
The Waterboard remains at the background of the discussion about waterfront development and/or a Superlevee because they experience no urgency and no need to actively participate. The existing By-law and Policy are the guidelines for allowance of constructions in the area of the barrier and these documents are legally binding. The effect of this attitude will be that urban developers will not approach the Waterboard early in their design process and that the input of the Waterboard is limited. However, with waterfront development as a political goal (in the case of Flevoland the national policy is waterfront development, see also Frame 5, page 61), they will have to enter the discussion at a certain point. This can at be on an administrative level or at a managerial level. For the municipality every development is an improvement, for the Waterboard – when adopting the problem oriented attitude – every development is a deterioration compared to the existing situation. In case the municipality is able to presents a design variant that can be proven to comply with the safety level during the entire plan period, the decision could be made to implement that variant. For instance, different constructions than a ground construction could be the result.

**Pro-active and problem oriented**
The Waterboard acknowledges the opportunity for urban developers and is willing to participate in the discussion from an early stage. However, the Waterboard will still focus on the negative effects – the potential problems - that constructions might have on the strength of the barrier. The process will mainly be guided by the progressive approach of the urban designers and the role of the Waterboard will still be to prevent constructions that affect the safety level of the barrier in such a way that it does not comply with the safety norms. Again this can take place at an administrative as well as a managerial level. This scenario is comparable to the already existing situation in which Waterboards receive a request for adjusting a water barrier because of development of other functions. The final

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39 Based on: Platform Klimaatdijk, Situation in Kampen/ Interview R. Veenstra/ discussion K. Batterbee
design of the waterfront development might contain elements that the Waterboard will experience as deterioration compared to the existing situation in which the barriers are free from constructions\(^{39}\). The result concerning the dimensioning of the Superlevee could eventually be comparable to the result in scenario 1. Because the adjustments to the barrier are driven by other functions besides flood protection, the financial resources will come from this developing party.

**Re-active and opportunity oriented:**
The Waterboard translates the objectives for urban development into an added value for safety. However, the Waterboard does not actively seek contact with the municipality. It will thus become difficult to realize this added value. This scenario will not be very likely. In case the Waterboard is able to adopt an opportunity oriented approach it is not likely that it will not also take the step to actively join the process with the municipality. The focus on the opportunity will probably lead to a more pro-active attitude.

**Pro-active and opportunity oriented:**
The Waterboard acknowledges the urban pressure and the intention of waterfront development. It actively seeks contact with urban developers and is from the beginning an active participant in the design process together with the municipality and developers. Moreover, the Waterboard is able to communicate the added value for safety of a Superlevee and communicates this to the urban designers. The process can result in a win-win situation due to the fact now that both sides actually have a win to gain.

### 4.5 CONCLUSIONS

The starting point for this study was the design of a Superlevee as a co-production between the functions flood protection and urban development. This co-production includes a synergy in:

- The technical design; in the final design the existing design objectives and constraints of both sides are being met.
- The institutional design; the final design complies with all existing legal obligations, the responsibilities are divided clearly and the needed financial resources are covered.
- The process design; for the design of a Superlevee agreement is found on the win for both sides and both sides are represented equally in the process.

True synergy in the design process is only realized when the design process contains the potential for a Win-Win outcome. The generation of a Win-Win requires a pro-active attitude from the Municipality but also from the Waterboard. Moreover, in case the Waterboard does not show a pro-active attitude the result might be a situation that is less preferred by the Waterboard than the existing situation.

However, the previously drawn conclusions show that the existing situation does not provide many incentives for a Waterboard to adopt a more pro-active attitude. Too many uncertainties exist and there is no urgent need regarding safety.

Concluded must be that the Waterboard needs to alter its attitude to an opportunity-oriented and pro-active one to prevent that the design process of a Superlevee becomes an deterioration compared to the existing situation and to make use of the potential added value of the Superlevee concerning the safety level of the flood protection system.

\(^{39}\) Based on discussion with R. Hoijink ARCADIS (April 16, 2009) / Discussion with Waterboard Zuiderzeeland (April 21, 2009)
In this report many references have been made to the project of Waterboard Zuiderzeeland which is investigating the possibilities of a Superlevee in the province of Flevoland. The conclusions in Chapter 4 are based on the two general design processes and therefore generally applicable. To illustrate the findings from the previous chapters, Chapter 5 will discuss the situation regarding a Superlevee in Flevoland and the current vision of the Waterboard Zuiderzeeland.

5.1 EXISTING SITUATION

The Waterboard of Zuiderzeeland is responsible for 265 km of water barriers surrounding the polders and protecting the province of Flevoland against water from the IJssellake, the Marker-lake, IJ-lake and other lakes. Figure 26 shows the region that is the responsibility of Waterboard Zuiderzeeland.

Figure 26: Water barriers of the Waterboard Zuiderzeeland (Zuiderzeeland, 2007)
The objectives of the Waterboard of Zuiderzeeiland concerning the primary water barriers with a direct water retaining function (Category A), have been defined in the Water Management plan 2007-2011 (Zuiderzeeland, 2007):

Objectives 2007-2011:
All primary water barrier Category A (direct retaining function) meet the legal safety norms now and in the future.

Currently all primary barriers category A in Flevoland are in order. All enforcement projects have been completed at the end of 2005 so now they all comply with the safety norm. The next Hydraulic Preconditions Guide will probably increase the test level with 10-30 cm for the Zwarte meer and the Waterboard expects that the Zwartemeerdijk will therefore not pass the next test round in 2010 (Zuiderzeeland, 2007). The State will pay for the needed enforcements as the reason for possible disapproval is a change in the safety norm.

In the Water Management plan 2007-2011 Zuiderzeeland also defined a vision regarding the use of a water barrier for other functions: A dike is an element in the environment of Flevoland and the Waterboard would like to participate in the improvement of the quality of this environment for inhabitants and recreates in Flevoland. The barrier could therefore have an additional value in recreational possibilities (pathways for pedestrians or cyclists), nature or living. However, the primary function of the barriers is and will always be retaining water. This function should never be in jeopardy, but the Waterboard has to define how this main function can be combined with other functions.

In 2008 the Waterboard has adjusted its By-law and the policy regarding constructions close to primary water barriers. Figure 27 shows the zoning of the area surrounding the water barriers. The restrictions regarding activities in the different zones are explained below.

Figure 27: Zoning of the cross section of a primary water barrier in an urban area (Zuiderzeeland, 2008)

Core zone:
The core zone is the central zone of the dike. It is defined as such in the Data-base and contains the space that the dike needs for the coming 100 years.
In this zone no construction activities are allowed. The only exception to this rule regards re-constructing of an existing building. However, the possibilities for re-construction are limited as well.

In Dutch: Waterbeheersplan 2007-2011
In Dutch: Kern zone
**Inner protection zone**

The inner protection zone exists on both sides of the core zone of the dike. It is mostly defined in the Data-base but when not, the zone should be assumed to be maximally 20 meters in length. The Waterboards policy states that in this zone construction activities are not allowed except in situations where it entails reconstructions of existing buildings or new constructions and/or expansions of existing constructions behind the line of the existing constructions with an open space between existing constructions of maximally 100 meters.

**Outer protection zone**

The outer protection zone is located after the inner protection zone on both sides of the dike and is 80 meters on the landside of the dike and 155 meters on the waterside. The policy in the outer protection zone is less constraining than is the case in the inner protection zone: No restrictions are stated regarding construction activities, with the exception of activities that involve digging or that hold a risk of explosion.

When this existing By-law is linked to the intention to construct a Superlevee the following image could be drawn.

![Figure 28: Result when connection the existing By-law to the concept of a Superlevee](image)

As explained before the added value of an urban development on top of the levee would be the connection between living and water, the possible connection between urban areas outside and inside the dike ring. Another important design criterion for a developer is the financial feasibility. With the existing restrictions a great deal of soil will have to be delivered to raise the inner side of the dike. But this ground can only be used for certain from the point were the outer protection zone starts. The inner protection zone might be possible as well, but depends on the activity. The soil that is used for raising the core zone cannot be used for development (the shaded area in the picture). Conclusion is that the existing restrictions constrain the design and construction of a Superlevee to much and will have to be adjusted.

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\(^{51}\) In Dutch: Binnen beschermingszone

\(^{52}\) In Dutch: Buiten beschermingszone
Now that the final report is about to be delivered something can be said about the results of the investigation project to the possibilities of a Superlevee in Flevoland. The main conclusion is that a Superlevee would be applicable in Flevoland under four conditions: Guarantee of Safety level/ Availability of space for implementation/ a need for spatial development/ a business case can be made. The Waterboard Zuiderzeeland states that in case these conditions are met, the potential applicability is proven and the Waterboard will be willing to actively co-operate.

The report also defines in which case a Superlevee would be a success according to the Waterboard: The Superlevee is a success in case the safety against flooding is guaranteed now and in the future and the costs are lower compared to the costs of a normal water barrier.

Additionally, the final (draft) report (April 28th 2009) defines some issues that need specific attention and some research questions that will need to be studied in more detail.

**Issues:**
- Because the future is uncertain the design should be flexible. In case flexibility is not a real option, the design should be high and strong enough during the entire lifespan of the buildings.
- Because functions will be combined in a Superlevee a clear division of tasks and responsibilities is needed regarding activities, management, maintenance, etc.
- The existing management policy needs to be revised.
- Agreements for the (very) long term are needed regarding potentially needed adjustments to the levee.
- Legislation regarding the preservation and development of natural areas could be a constraining factor.
- To come to a financially feasible project a high density of development is needed.

**Research questions:**
- What should be the plan period of the Superlevee and can this be signed up?
- Which management method provides the best tools to guarantee safety and manage spatial development?
- How can be dealt with ownership of the Superlevee and how will the Waterboard deal with this?
- How can the Superlevee be financed? Which financing structures are possible?
- When is it possible to allow underground parking garages regarding the strength of the Superlevee?
- When is it possible to allow underground parking garages regarding the strength of the Superlevee?
- What could be the role of the Superlevee in disaster management measures?
- How should be dealt with (temporal) nature development?
To answer these research questions the Waterboard has defined three possibilities to continue the investigation process about the possibilities of a Superlevee:

- An exploring study with the interested municipalities
- A Pilot Project on a potential location
- An excursion to the Superlevees in Japan, the exchange of knowledge with the Japanese variant of a Waterboard

With regard to the urban pressure one could say that Zuiderzeeland takes a pro-active attitude. The report identifies difficulties and research questions, but it also states when the Superlevee would be a success for the Waterboard. The approach could be seen as a combination of both problem-focussed and opportunity-oriented.

With regard to the possible next steps, a few remarks will have to be made:

- **An excursion to Japan** would be a nice way of creating enthusiasm within Waterboard for the concept of a Superlevee. Apparently the Japanese have succeeded in constructing multiple Superlevees which shows it is possible. However, it may be doubted whether many of the research questions will be answered during such an excursion. Two of the questions are related to the technical functioning of the dike and the rest is mostly linked to the institutional or the process design. The Japanese example might serve as an inspiration, but will not be one on none applicable in the Netherlands and does not change anything about the Dutch situation. The main risk is that the excursion will be nice but expensive and less useful as expected.

- **The intention to start an exploring study with the municipality** shows a very pro-active attitude of the Waterboard. However, it does not change anything about the knowledge questions that still need to be answered and the fact that these answers will mostly need to come from the Waterboard or from external technical experts. For instance, the effect of underground garages and foundations on the strength of the levee will affect what can be allowed on which location. That on its turn will affect which management method would fit best. The municipality will have most of the information about their design objectives and constraints available and needs input from the Waterboard to further investigate the possibilities and feasibility. As long as the Waterboard is not able to provide this input, the municipality will not be able to move much further than it already could without the Waterboard. Moreover, for the Waterboard it is important that the outcome of the process will not be legally binding.\textsuperscript{4}

The municipality will probably like to move faster. To illustrate; for Almere the assignment is to develop 60.000 houses between 2010 and 2030.\textsuperscript{5} The positive aspect about a joint study is that mutual uncertainties – for instance the needed plan period for design - can be discussed and an increase in understanding of each others dilemmas and positions will take place. However, the risk of this situation is the risk that is described in the second scenario in paragraph 4.3 (page 70): The municipality (and the potentially involved developers) might get frustrated about the little progress that is made and will try to influence the speed of the process in a different way. Political pressure is not unthinkable. The developers could also come up with a design that is safe enough but perhaps not desirable for the Waterboard. Yet it could become a management decision within the Waterboard to implement that variant because its strength is proven and it serves the wishes for urbanization of the levee.

\textsuperscript{4} Presentation at the Waterboard of Zuiderzeeland (april 21\textsuperscript{st}, 2009)

\textsuperscript{5} Masterplan Almere Pampus
5.3 CONCLUSIONS

Although the Waterboard Zuiderzeeland does not feel the need for the implementation of a Superlevee it is willing to investigate the possibilities. This shows a pro-active attitude. Nevertheless, the suggested next steps contain some risks (see above). The main issue is that the Waterboard still has many questions about the safety of a Superlevee and the answers to these questions are interrelated. This implies that it is difficult for the Waterboard to make design choices. Furthermore, the Waterboard will have to decide on the attitude that it wants to take in a joint exploring study or a pilot project. Their attitude will affect the attitude of the municipality and others. Based on the scenario sketch in chapter 4 the following advice could be given to the Waterboard Zuiderzeeland:

- Regardless whether is chosen for a joint exploration study or a pilot project, the Waterboard should try to focus on the opportunity of a Superlevee. This will probably be the only way to guarantee that the outcome of a Superlevee does not contain a loss compared to the existing situation.

In a way, Zuiderzeeland has defined its opportunity. The report specifically states when the Superlevee would be a success for the Waterboard: The Superlevee is a success in case the safety against flooding is guaranteed now and in the future and the costs are lower compared to the costs of a normal water barrier.

The focus on costs in this perspective is evident. Dike enforcement projects to restore the safety level are paid for by the State, but currently no actor in the flood protection management system, is willing/able to take the costs for the additional safety that a Superlevee could provide. Sufficient financial resources are a criterion that needs to be met in order for the Superlevee to become feasible. The opportunity however for the Waterboard does not lie at a decrease in costs. The win for a Waterboard would be the increase in Safety and accompanying advantages (see Table 12 on page 68).

The existing management policies and restrictions are instruments to guarantee safety. These do not directly influence the safety level and thus stand apart from the win of a Superlevee. Moreover, they can be adjusted. How they should be adjusted can only be determined after is decided on the safety-win can be dimensioned inside a Superlevee.

- For the suggestion to start a pilot study the previous comments are applicable as well. The Waterboard will be confronted with a lack of knowledge and will need time to structure this and to find answers.
CHAPTER 6

Action plan for the Waterboard in preparation of co-production

The findings in chapter 4 led to the main recommendation for the Waterboard to adopt a pro-active and opportunity oriented attitude. The analysis in Chapter 2 however showed that the normal approach of a Waterboard mostly is problem focussed. To support this needed change in attitude this chapter contains an action plan that should assist the Waterboard in taking that pro-active and opportunity-oriented approach.

The chapter starts with a comparison of the findings from phase 1 and phase 2 with the related theory as discussed in Chapter 1. Next, the practical positioning of the action plan related to the design process of a Superlevee is presented based on the used TIP methodology. The goal of the plan is discussed as well as the usability and the validity of the plan. Each step of the plan is clarified in more detailed explaining what the Waterboard should do, how this is related to the possibilities for the urban planners, the possible output of each step and potential pitfalls that should be prevented. The chapter closes with some general remarks for the further design of the co-production design process of a Superlevee.
6.1 THEORETICAL GROUNDING

Design theory describes the differences between the two main design paradigms and the relation with design methodology and techniques. Based on the conducted analysis the problem of combining the different design approaches of urban planners and civil engineers has become clear. Unfortunately design theory does not provide prescriptive tools that could assist in integrating different design paradigms into one artefact. The importance of bringing the two closer together is mentioned, but for a successful Superlevee design no prescriptive tools are available from design theory.

The literature on multifunctional use of space has given the insight that many more successful and unsuccessful examples exist of combining different functions into one area. Designing the process of such a co-operation process is given much emphasis in these studies. But, from the analysis can be concluded that not only the process between Waterboard and Municipality needs to be designed at this stage. The (technical and institutional) substance that needs to be dealt with during the design process asks for attention as well (especially from the Waterboard). According the theories on process management in relation to multiple land use the design of a Superlevee should contain a Win for the Waterboard and a Win for the Municipality / Developer.

The design process of the Superlevee evidently should lead to the design of a Superlevee, see Figure 29. Chapter 4 and 5 showed that the existing combination of the technological and institutional design for flood protection do not lead to a situation in which the Waterboard is able to formulate a Win regarding flood protection. Consequently it is not possible to establish an overall Win-Win situation. Thus, in order for a design process of a Superlevee to become successful, should be focussed on the technological and the institutional design of the Waterboard, in other words, the substance of the design process.

Figure 29: Design process of a Superlevee according to TIP design methodology
6.2 SET UP OF THE ACTION PLAN

The goal of the action plan is to make it possible for a Waterboard to adopt an opportunity oriented approach regarding a Superlevee. This means that following this action plan should allow the Waterboard to determine the Win regarding flood protection and become able to approach a co-operation design process of a Superlevee with the aim of establishing a win-win situation.

By focussing on the main requirement of the technological design - the safety level - this plan aims to postpone problem-focussed discussions about the instruments and the impossibilities regarding existing management policy or existing financing structures as long as possible. It focuses on the opportunity for the Waterboard to gain a safer flood protection system while at the same time allowing regional development.

With the output of this plan the Waterboard will be capable to start an actual co-operation process with the interested municipalities. The outcome should be a definition of the choices that could be made and should be useful for the Waterboard to prepare itself on later negotiations. Preferable this plan leads to an overview of design variants and the potential for urban development. It is not the intention of this plan to generate one design variant as output of the action plan and input for the shared design process. One design variant will limit the shared design process very early in the process.

For the process architecture of the design process is referred to the available literature on multiple land use by Teiman, de Bruijn and others. A detailed description of the process architecture does not fall within the scope of this research. Nonetheless a few remarks can be made about it:

- The consulted literature on multifunctional land use and more specific the Sijtwende case study (see Frame 3) showed the importance of a solid process management. On the one hand process management is argued to be essential for shaping the interactions between actors, gaining and keeping support, enthusiasm and trust; on the other hand project management is essential to keep a structured focus on the realisation of the project. In Sijtwende a private actor was able to take the role of process manager when the public actors were not able to manage the process. For a Superlevee design process this might be an interesting thought. Anyhow, the (private) process manager should have understanding of both designer worlds.

- During the design process the Waterboard and municipality and probably other involved actors will start negotiating about the design constraints, objectives and the design variants. The actors connected to an urban development project will be much more used to such a negotiating process because it is linked to their natural way of designing. During the action plan already multiple aspects are described that will probably become part of the negotiation process. By following the plan the Waterboard can prepare itself for these negotiations. Additional issues – that are treated in the plan – can still become part of the negotiation process, for instance the ownership of land.
### 6.3 ACTION PLAN

#### ACTION PLAN for the Waterboard

<table>
<thead>
<tr>
<th>Input form Municipality</th>
<th>Action step</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intention for urban development</td>
<td>1</td>
<td>Define vision &amp; goal regarding flood protection</td>
</tr>
<tr>
<td>Superlevee</td>
<td>2</td>
<td>Determine the Win for floor protection</td>
</tr>
<tr>
<td>Plan period for design</td>
<td>3</td>
<td>Translate Win into design objectives</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Determine criteria for the final design</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Translate design objectives into design variants</td>
</tr>
<tr>
<td>Information on occupation requirements</td>
<td>6</td>
<td>Determine effect of surface occupation</td>
</tr>
<tr>
<td>Information on occupation requirements</td>
<td>7</td>
<td>Determine effect of underground occupation</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Decide on constraints for occupation</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Test design variants on criteria</td>
</tr>
</tbody>
</table>

![Diagram](image_url)

*Figure 30: Nine step action plan*
Step 1  Vision and goal concerning Safety

→ What to do
To prevent discussions about the possible problems of a Superlevee, the Waterboard should start the discussion on the highest strategic level; the overall mission statement of the Waterboard and its main vision about how they would like to manage water in their region. Mostly, this vision is translated into several goals related to the different responsibilities of the Waterboard: Water quality, water quantity and water safety. The Waterboard should (re)define its main goal concerning water safety. This way it will be possible to relate further discussions about the Superlevee to the overall vision and the goal concerning water safety. Most Waterboards already have a vision and goal on water safety. This step therefore does not have to take a great deal of time.

→ Relation with municipality
This first step can be done relatively independent from any urban and other spatial development or opinions and objectives of municipalities. Whether a great deal of urban development takes place in a certain area or not could play a role in the definition of the overall vision, but this might influence the discussion negatively (see potential pitfall). However, the overall vision is very general and will not be one on one applicable on individual cases. In case the vision states that the Waterboard would like to facilitate as much development as possible, this does not have to result in fully urbanized flood protection system. This depends on the practical realization of ‘as much as possible’.

On the other hand, a municipality has spatial plans and has a vision on how it would preferably develop a certain area. This vision is very relevant were it touched upon the territory of the Waterboard. In the next step more will be said about this.

→ Possible outcome:
As example of a vision definition and goal description the statements of Zuiderzeeland are presented below:

Vision: Waterschap Zuiderzeeland is een overheidsorganisatie die middenin de samenleving staat. Het is de waterautoriteit in Flevoland, met een toegespitst apparaat, teneinde de belangen van het water goed te kunnen behartigen. Het waterschap zorgt voor een veilige woonomgeving en streft daarbij naar duurzaam waterbeheer. Water is een belangrijk ordenend element in Flevoland en draagt bij aan de kwaliteit van onze leefomgeving. Het waterschap wil hieraan bijdragen en samen met de omgeving werken aan een optimale inrichting. Het waterschap maakt maatschappelijk verantwoordelijke keuzes. Het besteedt de publieke gelden op een verantwoorde, efficiënte en effectieve manier, en probeert op die manier zo veel mogelijk van zijn ambities te bereiken. De besluitvorming van het waterschap gebeurt open, transparant en integer. Zo is het waterschap controleerbaar en kan het zijn plaats middenin de samenleving waarmaken.

Goal water safety: De dijken in Flevoland moeten sterk en hoog genoeg zijn om het water tegen te houden. En niet alleen hoger dan de hoogste waterstanden. Maar zo hoog dat bij de zwaarste stormen de golven er niet overheen slaan.

6 Website: Zuiderzeeland.nl/ons_waterschap/missie_visie
Potential pitfall
Flood protection is not a single issue discussion. Especially when it comes to combining functions within this flood protection system. In case a Waterboard is experiencing urban pressure, employees of various departments within the Waterboard (eg. permits) might experience this as a negative issue. In that situation, it will not be unthinkable that a discussion about the safety vision and goal will be driven by the current issues into a problem-focused discussion. This way the determination of vision and goal can take a long time. The goal and vision should be kept on a high abstraction level and no practical effects should be discussed.

Step 2 Determine the WIN for flood protection from a Superlevee and No-loose

What to do
With clarity about its overall vision and goal concerning water safety, the Waterboard should define what the added value could be regarding of the concept of a Superlevee with regard to vision and goal. This step is very important because without clear understanding of the potential Win, it will be much more difficult for the Waterboard to keep the opportunity-oriented approach during a co-production design process. Also the Waterboard should think about the aspects of a Superlevee that could contain a loss compared to the existing situation and define what the boundaries will be for this. Again important is that this no-loose is related to the vision and goal and not to existing instruments that are tools to achieve the goal.

Relation with municipality
An important aspect in this step is that this action plan assumes that the intention is to create a Superlevee. From the perspective of urban development another concept might be interesting as well or even more interesting. The intentions of the urban developers and designers are therefore important to use as input for this step. When for instance a more stepwise levee concept or a development outside the dike ring is preferred, this is important to take into account. In this plan is assumed that the municipality and developers are aiming towards the concept of a very broad construction of (water retaining) ground that allows an urban area on top.

Possible outcome
The Win can consist of various elements, but the most important aspect is the increase in safety level. A Superlevee can be made higher and stronger which will result in a longer period in which safety is guaranteed, less hinder for inhabitants due to less adjustments that are needed and less enforcement projects. But also an improved relation with municipalities could be a part of the Win for a Waterboard in case the Waterboard is able to tolerate more activities on their territory.

Potential pitfall
The pitfalls that should be prevented are related to the existing problem-focused attitude. As explained before in Chapter 4, the existing financing structure of water barriers does not allow for great over-dimensioning. From a single function perspective a Win could thus be; highest protection against minimal costs for the Waterboard. But it should be kept in mind that it involves a co-production and that urban development is a social objective as well. In the case of Zuiderzeeland the vision declares “division of financial resources in a socially responsible, effective and efficient matter”, not minimal costs. Of each element of the Win
should be tested whether it truly matches the vision and safety goal or that it is a result of problems related to the existing design approach.

### Step 3 Translate Safety-Win into design objectives for the Superlevee

→ **What to do**

The safety level of a barrier is determined by its height and strength. In Chapter 2 the constraints of the design elements of a water barrier and the role of failing mechanism have already been discussed and these will not be repeated here. In this step the main goal of flood prevention will be approached as an objective rather than a constraint. Evidently, the constraint still exist and should be met in any case, but in step 3 the Win of the Superlevee is being translated into spatial dimensions of the dike that determine the height and the strength. Three very important aspects that are related to height and strength of a Superlevee are the following points. These points will come back later in the action plan.

- Plan period for design
- Expandability after plan period or when new insights regarding safety become available
- Design philosophy: over dimensioning or flexible design

→ **Possible outcome:**

**Strength:** The interviews during this study have lead to the conclusion that the win of additional safety could be translated into the objective of a burst proof levee. How this could be done is studied and an estimation of the investment costs has been made by Silva and van Velzen (2008):

Langs de zee, de grote meren en in mindere mate de estuaria voldoen de binnentaluds veelal aan de norm voor doorbraakvrije dijken. Dijken die recent versterkt zijn, kunnen het aangenomen kritieke overslagdebiet nu al weerstaan als het talud tenminste niet te steil is. De benodigde aanpassingen bestaan hier uit het versterken van de bekleding van het buitentalud (Silva et al, 2008).

### Drawing 1: Profile of a burst proof levee (based on image Silva et al)

**Height:**

The needed height of the (Super) levee in order to withstand overflow and wave overtopping during the entire plan period can be calculated. The outcome will depend on the scenario that is being used for the rise of water level, the subsidence of the underground, the potentially additional effects on the water level (political decisions for a rise of the IJsselmeer water level) etc. But evidently a very important factor for determining the design height is the plan period; whether the plan period is 50 or 200 years will have a great effect on the design height.

Klimaatbestendig: Aangenomen is dat dijken langs de zee, estuaria en grote meren een halve meter extra hoogte moeten hebben om gedurende 50 jaar berekend te zijn op zeespiegelstijging.
The goal of this step is really to come with design variants for the dimensioning of the dike in such a way that it is burst proof and in height climate proof. Different scenarios of the plan period and of a flexible or robust design can be used to show the effects of a shorter or longer period. This action plan will not describe the technical possibilities of how this dike could be dimensioned, but the examples in Drawing 2 below gives an impression of what it could look like. The grey upper part shows that the existing levee will be heightened. How the connection is made the heightening to the burst proof strengthening will have to be decided. This will probably have an effect on the urban potential in a later stage (see also step 7).

**Drawing 2: Optional profiles for a burst proof and climate proof dike**

→ *Relation with municipality*

For a decision on the plan period for design, communication with the municipality will be extremely important. Needed enforcement of the levee in the future will probably bring about demolition of the constructions on top of the levee. The plan periods of the two should therefore run as much parallel as possible. With input from the municipality on their (preferred) plan period for houses and the needed infrastructures, etc., the Waterboard will be able to draw up some design variants. These scenarios can be used to show the municipality what the effects could be of a longer or shorter plan period. Whether the levee is designed in a flexible way or a very robust/over-dimensioned way is on the one hand a choice of the Waterboard. On the other hand it could be part of the negotiation process with the municipality. An increase in height results in a greater amount of soil that needs to be delivered and this will also have financial consequences. The Municipality might prefer a one time over-dimensioned design in order to prevent hinder in a later stage. However, flexible design could be interesting with regard to the spreading of investment costs.

Another issue that should be discussed by the Waterboard but even more important by the Municipality is the issue of wave overtopping. Lowering the dike will naturally decrease the needed financial resources but will increase the risk of water overflowing the dike and flowing through the urban block. For an urban designer it could be a great challenge to incorporate the (prevention of) effects of wave overtopping into an urban design, but the municipality and Waterboard are the public actors responsible for the safety of the inhabitants. At this point in the action plan it is not necessary to actually start negotiations with the municipality on this topic. More important is it to realise the effect that decisions can have.
Potential pitfalls

The plan period for design is important for the dimensioning of the needed height. By opening the discussion with the municipality about this plan period the municipality will expect other information as well from the Waterboard. However, the Waterboard will not be able to give this information yet and this might frustrate further discussions. Important is to communicate about the stage of exploration and the further steps that will be taken.

Step 4   Determine criteria on the final design of a Superlevee

What to do

Besides the functional design requirements on the safety level of the barrier, some other requirements can be identified that will eventually have to be met. These requirements are mainly related to the (existing) institutional design. In this step the design criteria will only be formulated, they will not be used already to assess anything. It is important to define them in this phase to make it possible for everyone to not focus on them during the following steps 5 to 8. That would constrain the development of design variants too much.

Possible outcome

The additional criteria are especially related to the appointment of the Waterboard as responsible actor for the state of the water barriers (Flood defence act) and the financing structure of the Waterboard that is based on public taxes. Below four criteria are explained, but more can be appointed.

- A criterion for implementing a Superlevee is that the costs are covered. This includes costs for design as well as construction, management, maintenance and testing. The Waterboard only has a certain sum of money available and normally enforcements are paid for by the national government. At this point it is not needed to detail the division of costs specifically, but general expectations should be addressed and communicated with the municipality to prevent unpleasant surprises at a final negotiation phase. First estimations of the costs and some general numbers on investment costs are needed. By postponing this discussion more design options will stay in the running.

- The Waterboard is legally obliged to execute a five yearly test on its primary water barriers. Testability is therefore a requirement.

- To be able to test the water barrier it has to be defined. When it is not clear which elements have a water retaining function and which do not, it will be impossible to test the strength of the dike.

- In the situation that even the very strong and high Superlevee does not comply to the safety norms anymore, the levee has to be expendable is a certain way.

Relation with municipality

This step can be taken relatively independent from other parties. These design constraints of the Waterboard are mostly related to the existing institutional design of the flood protection system. The financial resources are a factor that will be part of the negotiations in the actual co-production design process.

Potential pitfalls

The criteria should only address the “What” question (e.g. the barrier should be testable) and should leave the “How” question (e.g. the crown and outer slope of the barrier should be visible) for a later stage. Focussing too much on the latter, could prevent innovative solutions for existing institutional restrictions to become applicable.
Step 5  Translate Design objectives into optional design variants of a Superlevee

What to do
When the design objectives regarding the WIN for safety have defined it becomes possible to connect these to the concept of a Superlevee. In step 2 it was brought up that this action plan focuses on the Superlevee. When other innovative urban-levee concepts are preferred this has been addressed in step 2. The burst proof and climate proof levee, as it is determined in step 3 should fit into the Superlevee and the water retaining part needs to be clear. But the location of the levee inside the Superlevee is a design choice.

Possible outcome
The output of this step does not need to be the choice of one of the design variants but more the realization that multiple variants are possible and the Waterboard could think of advantages and disadvantages concerning safety of the options. Below three possibilities have been sketched in Drawing 3 but probably even more options more exist.

Drawing 3: Potential profiles of a Superlevee and the position of the levee

The first variant is the simplest version in which the existing dike is expanded and filled up to form a Superlevee. The second variant was initiated during the platform Climate dike by the municipality of Kampen with the intention to generate new options on the waterfront (this is related to the existing restrictions in the by-law that no constructions are allowed in the core-zone; when the core-zone is moved, new possibilities arise). Somewhere inside the ground body of the Superlevee a certain part will be assigned to be the new dike. In the final design variant the entire ground body is assigned the Superlevee. This variant will probably bring about many arguments for being unpractical (it would difficult management under the existing management structure). However, the focus here should be on safety level, not on the instruments. The drawings show the water on the left side and the striped line shows the outer side of the part of the Superlevee that will be assigned the actual water retaining function. In the following steps the variants will be named ‘original location’, ‘in the middle’ and ‘the entire levee’. At this point should be realized that the third variant is truly different.
from the others because in this variant it is likely that functions are not only combined in relation to their goal but also in the spatial dimensioning\(^7\).

In the step the consequences of the different options in relation to the connection with the existing dike need to be elaborated on as well. Figure 31 visualized how a Superlevee and the appointed water retaining element will have to be connected to the parts of the dike ring (because a dike is part of the larger dike ring) that are not ‘super’.

![Figure 31](image)

**Figure 31:** Top view of the Superlevee, linking to the ‘normal’ levee and example of the positioning of urban blocks with regard to the levee

\(\Rightarrow\) **Relation with municipality**

At this moment direct contact with the municipality not absolutely necessary, but can be very useful in order for the Waterboard to generate alternatives that are actually interesting from a spatial viewpoint. The Waterboard should keep in mind that a choice of one of the three options can greatly affect the future possibilities for urban development.

\(\Rightarrow\) **Potential pitfalls**

No choice for one of the variants is made yet in this step, but the Waterboard should realize that other options indeed are possible than filling up the existing dike. The option to assign the damming function to the entire Superlevee is a very innovative one and might eventually contain more advantages for all actors compared to one of the two other options. Even if this appears to be the case, its innovative character and the accompanying uncertainties regarding (safety) management might frighten people off. To overcome this reserved attitude a solid process management is needed.

\(^7\) Reference should be made to Goosen et al. (2002) who concluded that multi-functionality in water-related projects is mostly achieved on the combination of goals but not on the spatial dimensioning of the project.
Step 6 Determine effect on safety of surface space occupying constructions

The goal regarding safety is now translated, but the motive of constructing a Superlevee in the first place was to enable urban development. This development can affect the factors of the barrier that determine the safety, **height** and **strength**. These negative effects can be determined based on the failing mechanisms (See chapter 2). The other three important aspects are repeated here as well.

- **Plan period** for design
- **Expandability** after plan period or when new insights are available
- Design philosophy: **over dimensioning** / **flexible** design

→ What to do

Both the occupation (layer 3 in spatial planning) and the infrastructure (layer 2 in spatial planning) can have an effect on the factors that determine the safety level. Moreover, a difference will exist in the occupation of the surface by buildings or the underground space that is needed. In this step the Waterboard has to make a first assessment of the effects of the surface occupation on the safety level of the water-retaining part of the Superlevee. Surface occupation of a Superlevee consists of the elements of an urban development project from the occupation layer and the infrastructure layers explained in Chapter 3. This will consist of the surface occupation from buildings (function living or working), infrastructure (traffic, electricity and other upper infrastructures), trees and vegetation.

Important factors that might affect the safety level are:

- Location of the occupation compared to location of the dike (water retaining part)
- Density of occupation

→ Possible outcome

**Original position:**

The potential effects of surface occupation on the height and strength of the barrier are:

- Effect of buildings on the overtopping-protection-layer and consequently on the stability of the dike in case of wave overtopping.
- During construction the vibrations can cause ground mechanical instabilities of the slopes. This could cause extra water tension that affects the stability of the entire barrier.
- Due to the surface occupation of buildings surface water flows will cause erosion around the buildings. This is only applicable in case overflow is allowed.
- On the side of walls, floors etc, seepage can occur that can cause piping.

The plan period of the occupation is important to guarantee possibility for expansion during plan period and after plan period.

![Drawing 4: Visualization of Surface occupation of a Superlevee](image)

**In the middle:**

The potential effects of surface occupation on the height and strength of the barrier are:
To a lesser extend: Effect of buildings on the overtopping-protection-layer and consequently on the stability of the dike in case of wave overtopping.

- On the side of walls, floors etc, seepage can occur that can cause piping.

The plan period of the occupation is important to guarantee the possibility for expansion during plan period and after plan period.

**Drawing 5: Visualization of Surface occupation of a Superlevee**

**The entire levee:**
Because the complete ground construction is assigned as water retaining part, the surface occupation of buildings and other will not have very negative effects and the strength of the barrier. However, this variant will probably bring about the most difficulties with regard to the plan period and the possibility for expandability during or after plan period. This is important to take into account in the negotiations later in the process with municipality.

**Drawing 6: Visualization of Surface occupation of a Superlevee**

The output of this step is not a decision on what is allowed where but an overview of which types of occupation might have a negative affect and why. Ideally the output of this step would be a small document that explains for each of the options in step 5 which types of surface occupation could be damaging and why. With such a document a discussion with the municipality will become easier and the understanding will grow.

> **Relation with municipality**

Input from municipality and developer is needed on general characteristics of urban blocks. For instance, first estimations on the number of houses that needs to be developed and their characteristics makes the Waterboard understand what the intention is. Insight is the future spatial plans of the municipality / province / national government need to discussed at this point. Probably some general figures will be needed from urban designers and the developer.
Potential pitfalls
This is the first step in which the Waterboard starts to combine its own Win with the Win for the Municipality. In this step and the next enough attention should be given to technical expertise. That way a solid argumentation can be made about why certain developments are not damaging the safety level although currently the existing instruments do not allow them. The focus needs to be on the effect regarding the Waterboards’ Win, not on potential problems for the existing institutional design.

Step 7 Determine effects on safety of underground space occupying constructions

What to do
This step is comparable to the previous one but now the effects of underground occupation in a Superlevee will be discussed. Underground occupation consists of the elements of an urban development project from the occupation layer and the infrastructure layers explained in Chapter 3 that are located below the surface. This underground occupation can consist of cables, pipes and tubes (and other infrastructures), the roots from vegetation, parking garages and foundations of buildings (and other elements that are related to the occupation layer). Underground elements will be able to have a more significant effect on the strength of the water retaining part than surface occupation because they can physically combined with the barrier. Moreover, the effect of different underground elements will not be isolated but cumulative. Important factors to determine the potential negative effects on safety are again:

- Location of the occupation compared to location of the dike (water retaining part)
- Density of occupation

And also the state of the elements is important to take into account:

- **Normal state** of the element: Cables and Tubes inside the barrier do not directly affect its strength/ Under the normal circumstances a tree is in an upright position and the roots of the tree do not directly affect the strength of the dike.
- **Failing state** of the element: For cables and tubes need maintenance digging will be needed in the dike or when a tube breaks and the content spreads through the dike, this could damage the structure and composition of the dike. The example of the tree will be explained below.
- **Construction/ placing** state of the element: During the construction of a building the foundation will have to be placed inside the dike. Construction works (digging, drilling) will affect the dike. More is said about this in Section 2.3.2.

Possible outcome

Original position

Figure 32: Visualization of underground occupation in a Superlevee variant ‘original position’
The effect on safety will depend on the location of the underground construction. In the situation without a Superlevee the positioning of trees on top the dike is not preferred (STOWA, 2000). This is related to the risk that tree might fall over during a strong and its underground elements, the roots, take out a part of the dike and the outer slope starts to slide. But the effects of these elements should be reconsidered in this new situation with a large ground body being positioned just after the water retaining part.

The effect of the different type of occupation will at least be related to the following failing mechanisms: Sliding outer slope (tree)/ Micro instability/ Settlement (additional mass/ non homogeneous composition of the body)

In the middle

[Figure 33: Visualization of underground occupation in a Superlevee variant ‘in the middle’]

With the water retaining part of the Superlevee more towards the middle the effect of underground occupation in the area in front of this part decreases. Legally this part in front becomes ‘outside the dike’. This will have institutional consequences. A decision on such a variant will therefore contain political decisions on how should be dealt with the safety level of this area, the responsibilities etc. Regarding the functional requirements (Safety level + Construction of Houses) this option could be very interesting.

The Waterboard will have to study the effects of the different type of occupation and at least in the relation to the following failing mechanisms: Micro instability/ Settlement (additional mass/ non homogeneous composition of the body).

Entire dike

[Figure 34: Visualization of underground occupation in a Superlevee variant ‘entire dike’]

In principal this variant is very strong due to the large body of ground. All underground elements will have an effect on the strength of the dike and thus all elements will have to be taking into account in the design (and testing) the safety level. What falls within the design constraints regarding safety and what does not is at this point relatively difficult to decide. The effect on strength will also be related to the density of occupation and the state of functioning of the occupation. Expert knowledge will be needed for more information on this topic.
The output of this step is again not a decision on what is allowed and what is not. The aim is to come up with an overview of which types of underground occupation might have a negative affect depending on the location of the dike and the location and density of the occupation. Also should be explained why this effect is important and how it is related to the extra stability that is provided by the additional ground body. Ideally the output of this step would be a small document that explains for each of the options in step 5 which types of underground occupation could be damaging and why. Again this document could be used in the discussion/ negotiations with a municipality (after completing the step plan).

**Relation with municipality**
Comparable to the previous step input from municipality and developer/designer is needed to make a realistic first estimation of the effects of underground occupation. This issue will probably become important in the negotiations with municipality due to the fact that more underground occupation will lead to an increase in financial feasibility. The area can be made more attractive in case space demanding functions like parking, cables etc. can be place below the surface. In the Superlevee design process the municipality will probably try to push as much as possible underground, thus the Waterboard should use this step to determine their opinion about the possibilities. These possibilities do not only include the effect of for instance one parking garage, but also the cumulative effect of multiple garages over the length of the entire Superlevee.

**Potential pitfalls**
A pitfall of this step could be to switch back to the problem focused attitude. Not all actors within the Waterboard will have full understanding of the technical impact of underground occupation. The safest option in such a case is to adopt a defensive attitude and restrict the elements that are unsure in order to be sure that it does not have a (too large) negative effect. Technical knowledge should be translated into understandable and communicable data and designs. Possibilities and impossibilities should be discussable, also in the further process with the municipality.

**Step 8 Decide on safety constraints for surface and underground occupation**

**What to do**
Based on the results in the previous two steps probably some first constraints concerning surface and underground occupation can be identified. In this step these two issues should be combined as well; e.g. the construction of a high rise with an underground parking garage will have a double effect on the expandability. Important is that the constraints should only be related to the safety level of the dike, not to any of the instruments!

**Possible outcome**
The result of this step will be an overview of the design variants of a climate proof and burst proof Superlevee with the possibilities that each variant has for urban development. This overview should be set up in such a way that it is communicable to the municipality. This communicability included the considerations why certain types of occupation are definitely not allowed, why others are allowed with reservation and others are allowed in any case. Also the effects of occupation that the Waterboard is unable to decide on its own should be explained.
Relation with municipality
For the municipality the output of this step is extremely relevant. With these design constraints an urban designer can start with actually making calculations of the financial feasibility of a project.

Potential pitfalls
Technical and expert knowledge is important to model the effects of occupation on the strength of the levee, but these insights will always contain a certain amount of uncertainty. The Waterboard will eventually have to decide on what will be allowed and what will not be allowed is a decision of the Waterboard.

Test the variants on the criteria

What to do
The final step of the action plan entails the testing of the variants on the criteria that were formulated in step 4. In this step the original problem focussed approach is allowed again to a certain extend as long the comments are related to the design variants that have been developed in step 5. In Step 6, 7 and 8 the constraints regarding safety have been identified and the design space has been narrowed down. The remaining variants can now be estimated on their ability to be tested, the ease of maintenance, the costs etc. Potential problems on these criteria should be

Possible outcome
The result of this step will be an assessment of the design variants in step 8.

Relation with municipality
The municipality will not have a major role in this step because at this moment the general constraints on which the variants are tested come from the Waterboard. On the other hand it would be very interesting to have contact with the Municipality on the reasons why certain constraints are not met in certain variants. In case the Waterboard is able to argue why this is the case the municipality / developer / urban designer can start thinking about ways to overcome this. This way space is left open for innovative solutions for at first site insolvable problems/ constraints.

Potential pitfalls
In case the Waterboard is unable to argue why certain constraints are absolutely needed and the reason why variants are thus not possible, no space is left for innovative solutions. In general for a successful outcome of this action plan it is important to provide clarity on constraints for design. However, the possibility for innovative solutions should not be cut down before they are even created. This could become a great frustration in the co-operation design process.
The action plan is presented as a very straightforward plan with a chronological order from one to nine. Naturally iterations between the different steps are possible to sharpen or loosen up earlier conclusions and decisions. For instance step 5 and 6 can be done parallel to each other. The testing on the criteria can also be seen as an ongoing and parallel running step during all other steps starting at step 4. Conclusions on these criteria should be postponed to the end in step 9, but an inventory during the steps might add to the completeness.
CHAPTER 7

Conclusions, recommendations and reflection

This Chapter summarizes the conclusions from the conducted research, followed by recommendations and a reflection. The goal of the research has been twofold and the conclusions and recommendations will be discussed accordingly. The goal regarding the Dutch Superlevee has been to increase the understanding of the background and of the difficulties in the design of a bi-functional Superlevee as well as providing a contribution to the applicability of the concept in the Netherlands. The second goal has been to contribute to the development of a more systematic approach to the design of projects that (wish to) apply the concept of multiple land use. General design theory has been linked to literature on process management of multifunctional projects with the intention to result in additional understanding of the role of the content in such projects. The main research question was formulated as follows: How can a better understanding of the design process of the two functions flood protection and urban development improve the applicability of the Superlevee concept?

7.1 CONCLUSIONS

With regard to the goal of contributing to an increase in the applicability of a Dutch Superlevee the research has led to the following conclusions.

The design approach of a flood protection system and the design approach of an urban area are different in multiple ways. The main differences can be found in Table 10 on page 66. The intention of a Superlevee is to integrate and combine the two design approaches into one design process. The existing differences will pose challenges on a co-production.

The actors involved in either the function flood protection or the function urban development have a different vision about the definition of a Superlevee, about the need for a Superlevee and about the added value (Win) of a Superlevee. The consequence is that both have different starting points for the design process. In order to realize a co-production, these differences need to be addressed.

The main difficulty for the co-production of a Superlevee is the realization of a joint design process. A co-production of Municipality and Waterboard on the design of a Superlevee is currently not self-evident. On the one hand, the municipality will need to take initiative by expressing a wish for urban development and a wish to cooperate with the Waterboard. On the other hand, the Waterboard has to be willing to co-operate with the plans of the Municipality. The latter seems to be the main difficulty. This can be directly related to the set-up of the technical, institutional and process designs for flood protection in relation to their vision about the Superlevee. The main difficulties to set up a joint design process are the absence of an immediate need for a Waterboard to construct a Superlevee – as most
water barriers comply with the safety norms - and the difficulties/ uncertainties regarding design and management. In the existing situation the role and responsibilities of the Waterboard are very clear, with regard to a Superlevee the Waterboard will have to re-define these. The absence of an urgent need combined with the many uncertainties leads to a reserved and defensive attitude of the Waterboard. To increase the likelihood of a co-production the reasons behind of this attitude should be considered.

The scenario analysis shows that a re-active attitude of the Waterboard, in fact, could result in a situation that the Waterboard will judge to be a worsening of the existing situation. Thus, the current absence of a need for a Superlevee poses a risk to the Waterboard. This risk is caused by the progressive and opportunity oriented design approach of urban developers, their vision on the Superlevee and the possibility that the decision process about the design of a Superlevee will be transferred to a political level: Decisions about (the need for) a Superlevee can be taken without the set up of a shared design process (consisting of designers from both sides). For the municipality a lack of co-production could result in suboptimal realizations of the urban development objectives. However, compared to the existing situation, every development can be seen as a positive effect.

With regard to the identified risk the Waterboard should consider the potential magnitude of this risk and decide whether they are willing and able to avoid it. In case they decide to avoid the risk, the Waterboard should take a pro-active and opportunity oriented approach.

To take this pro-active and opportunity oriented attitude towards the Superlevee concept the Waterboard has to define the potential “Win” of a Superlevee regarding the main goal of a water barrier: protection against flooding. This Win should then be translated into objectives for design and potential design variant. The Waterboard will need to investigate the effects of surface and underground occupation on safety to be able to start a co-production process with the municipality.

With regard to the scientific goal of contributing to the development of a more systematic approach for the design of projects that (wish to) apply the concept of multiple land use some additional conclusions can be drawn.

The available literature on design in general addresses the differences between design paradigms, methodologies and techniques. It does not provide prescriptive theories on how these differences should be dealt with. The available literature on multiple land use focuses on the process and the role of process management within projects that apply the concept of multiple land use. It does not specify the role of the substantive content within such a process. A knowledge gap exists in the role that should be given to the (differences in vision about) content of a design process in situations where multiple functions are to be combined into one artifact.

Conclusions 1, 2 and 3 on the design of a Superlevee lead to the conclusion that the content and the design approach – including the visions on this content of the separate functions that are going to be combined into one artifact - is very important. This substance can have a direct effect on the possibility to actually generate a co-production process. This is especially true in situations where functions are combined that experience large differences in design approach.
7.2 RECOMMENDATIONS

The Superlevee proves to be a very interesting concept for the Netherlands because it is able to deal with the challenges of flood protection and the challenges of urban planning simultaneously. To increase the general applicability of a Superlevee in the Netherlands the following recommendations have been formulated.

The conclusions 1 to 6 are all important when a Superlevee is to be realised by a Waterboard and Municipality. The potential of a Superlevee co-production is directly influenced by the way in which both parties deal with the differences in design approach and the consequences of these differences. Some Waterboards in the Netherlands will be more used to urban pressure than others, but that does not change the fact that a Waterboard should approach this pressure as an opportunity.

At the start of this research the most confusing aspect was the existence of multiple terms for identical or comparable concepts and identical names for different concepts. A general recommendation for all involved in one of the many innovative water barrier projects is to make sure that the terminology that is used is clear for all actors. This could be done by agreeing on these terms at the beginning of each project.

An element of the Superlevee that is experienced to be an important obstacle for implementation is the costs of implementation. The multifunctional Superlevee will require large investments and new financing structures. Potentially a link can be made with the implementation of the National Water Plan or the upcoming Delta fund. Either way, the actors involved have to be willing to search for solutions. Recommendations about the division of costs fall outside the scope of this research, but a final comment on the financing of a Superlevee is summarized in the following quote: "...Investments in multifunctional solutions are only feasible when all actors involved are willing to pay for solutions which do not fit seamlessly into their own budgetary frameworks and policy guidelines" (van Buuren and Teisman in Change magazine, 2009)

To increase the potential of a co-production design process with the Waterboard Zuiderzeeland and the Municipality of Almere on a Superlevee in Flevoland the following recommendation can be made.

The Waterboard of Zuiderzeeland has formulated the ambition to set up a pilot study or a study together with the municipality of Almere to explore the potential of a Superlevee in the region of Almere. First of all, the Waterboard should realize that their current position and vision on the Superlevee concept can be improved. The Waterboard should define what the added value of a Superlevee is regarding flood protection and use this as their starting point. The formulated action plan can assist in this. Secondly, the Waterboard should formulate clear goals for any pilot study or a shared exploration study. This goal should be communicated clearly to the municipality to prevent differences in expectations and frustrations.

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48 Referred is to the terms Superlevee, Deltalevee, Climate levee, Multifunctional levee, Water-withstanding landscape as well as the concepts like Robust, Sustainable, Climate proof and others
In addition to the recommendations 1, 2 and 3 one more recommendation needs to be made for the platform Climate Dike.

The Platform Climate Dike has explored a great deal of aspects of the Climate Dike/Superlevee and has contributed significantly to the knowledge about the design content on these concepts. This study showed that the attitude and vision of the Waterboard regarding these concepts is extremely important for generating a co-operation design process. As mentioned during one of the meetings: On a personal level, employees from a Waterboard underline the added value of a Superlevee. It becomes more complex when they have to take decisions on the topic from a professional viewpoint. Consequently, with this study the importance of ensuring participation of Waterboards in the platform Climate Dike is being emphasized.

Finally two more recommendations can be given with regard to further research.

The Superlevee is a very innovative concept with many uncertainties and many design challenges. The possibility exists to combine multiple functions. Urbanization is only one of them. Nature development, recreation, tourism, could all gain a position in (the design of) a Superlevee. However, this research specifically focuses on the combination of the functions flood protection and urban development. Especially a combination with the function of nature development could show difficulties in design (e.g. environmental legislation, financial responsibilities) and would be interesting to investigate.

Further research is needed on the role of content in projects that apply the concept of multiple land use. The existing literature on this topic uses many case studies to investigate the factors of failure and success for co-production. Comparable case studies could be conducted on the role of content in multifunctional design projects and on how this role influences either success or failure. The applied approach of starting with an analysis of the two separate functions to identify the attitude and starting points for co-operation can provide a great amount of insight in this.

7.3 REFLECTION

The initial goal of this study was to arrive at a program of requirements for the dimensioning of a bi-functional Superlevee. Unfortunately no theory was found to assist in this multi-functional design challenge. In the absence of theory the decision has been made to start the analysis phase in a symmetric and separate way for both functions involved. This approach has been chosen to gain an understanding of the design requirements from both sides, but it led to much more conclusions. Regarding flood protection a lot of information can be found on the design of a water barrier. However, these information sources seemed to be either, very general and not providing specific information in non-technical vocabulary, or, very specific but written for technical experts. The multiple open interviews with colleagues from ARCADIS as well as with employees from Waterboards and the Union of Waterboards have contributed severely to the understanding of all elements involved in designing a water barrier. An in depth discussion/interview with the urban designer involved in the project for Zuiderzeeland has accordingly equally clarified much on urban design and development. Together with two informal discussions during a
seminar on innovative multiple land use and the available literature on urban design the
differences in design, design methods and attitude between the two functions became
apparent. Hereafter, the research has focused on the side of flood protection and more
specific, the role of the Waterboard. This has led to important conclusions concerning the
potential of a shared design process (co-production) of a Superlevee and resulted in a
rephrasing of the research question and of the research approach. It would have been much
more difficult to arrive at these conclusions in case the functions had not been analyzed
separately.

The conclusions from the analysis phase have been discussed at a meeting with the Platform
Climate dike and with employees of the Waterboard Zuiderzeeland. Both have reacted
positive on the approach and on the overview of differences between the two functions and
the resulting design difficulties. Most conclusions were confirmed and based on the
feedback it possible to adjust a few others. For the drawing up of the action plan, an
important assumption - focus on safety, not on the instruments - has been discussed with an
ARCADIS colleague and former employee of the Waterboard Delfland. This focus indeed
prevented discussions about the problems regarding existing management structures
during a meeting at Zuiderzeeland and led to a discussion about the potential Win of the
Superlevee. Important aspect for the Waterboard appeared to be the financial consequences
of a Superlevee and their fear that a Superlevee would become very expensive (for the
Waterboard). Based on this insight, the formulation of criteria has been moved forward in
the overall action plan (step 4). At first was thought that the formulation of criteria should
be postponed as much as possible. The main reason for the change has been the realization
that formulation of the criteria (such as costs) will allow the involved people to postpone the
actual discussions about them.

The goal of this research with regard to the Superlevee was to contribute to the applicability
of the concept in the Netherlands. The studies of the Platform Climate dike and the
exploration in Flevoland have both investigated the difficulties with regard to the
Superlevee. Many of the defined questions and challenges are similar to the ones concluded
on in this study. Thus this research has a limited contribution to the definition of knowledge
gaps about the Superlevee. However, this research has provided much more insight in the
background of these questions. And as explained, knowledge about this background leads
to an understanding of how to deal with these knowledge gaps.

The value of this insight has been confirmed during a meeting of the Platform Climate dike
(Utrecht, April 2, 2009) and a discussion with the Waterboard Zuiderzeeland (Lelystad,
April 21, 2009). During the first meeting a presentation was given about the results of the
analysis. Reactions from the platform were enthusiastic, which can be illustrated by the
following quote from this meeting “Instead of focussing on how we can change the attitude
of the Waterboard, perhaps we should focus more on the reason why the Waterboard
adopts this attitude”. The slides from this presentation have been placed on the Platforms’
website. During a meeting held with Zuiderzeeland the results of the analysis as well as a
concept of the action plan have been presented and discussed. Concerning the results of the
analysis again the reaction was positive. The insight in the differences between the two
design approaches was found to be very useful. The usability of the action plan will have to
be proven in the future, but based on the initial reactions the prospects are promising.
The Waterboard Zuiderzeeland could use the plan in preparation of the planned pilot study
or exploration project with the Municipality.
For ARCADIS the research can be used as knowledge document on the Superlevee and on follow up projects on the Superlevee, Climate dike or other innovative dike concepts that combine the function flood protection with the function urban development.

The scientific goal of this research was to add to the development of a more systematic approach for the design of projects that (wish to) apply the concept of multiple land use. Based on the outcome of this research and the reactions from the people involved can be concluded that the chosen research method was successful. Understanding of the separate design approaches of functions - that are to be combined into one design process - provides a great amount of understanding about the design challenges and their effect on the potential of a co-production. The attitude of involved actors can be better understood; consequently it becomes easier to steer the process. This approach is suggested to be useful in other multifunctional design dilemmas. Consecutive research is recommended.

Finally, the applied design methodology that integrates the technological, institutional and process design (TIP) has proven to be very useful. With this framework it becomes possible to generate a structured comparison of the design approaches of the multiple functions. It provides clear understanding of the differences between them and thus of the background of existing difficulties. This insight can be used to solve these difficulties.

With a growing scarcity of space in the Netherlands the pressure for multiple land use will ever increase. This leaves a very interesting field of study for research on multifunctional design and multiple land use.
Chapter 8

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Annex 1: Initial research planning

During the Kick off meeting the research proposal has been discussed. In the research proposal a planning has been suggested. This planning is presented in

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*Table 16: Initial project planning*
## Annex 2: Interviews

### Aanwezig bij project Zuiderzeeland

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<td>TUDelft, CITG</td>
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<td>Prof. CITG Harde keringen</td>
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<td>Renzo Veenstra</td>
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<td>Judith Schoites</td>
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<td>UvW, Den Haag</td>
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<td>Projectmanager Superdijk ZZL</td>
<td>Zuiderzeeland, Lelystad</td>
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<td>Beleidsmedewerker waterkering</td>
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<td>van het financiële aspect van een Superdijk in de houding van het</td>
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Informal conversations:
- Nisa Nurmohammed (Waterboard Delfland): During ARCADIS project for the Waterboard of Rijnland.
- Harm Albert Zanting (ARCADIS, head of department Deltas and Rivers) ARCADIS. Feb 2, 2009.
- Marieke Spits (designers bureau, NexT).
Annex 3: Scientific paper
Multifunctional design - Design challenges of the Dutch Superlevee

C.M. van der Sande, Faculty of Technology, Policy and Management, Delft, University of Technology.

The innovative Japanese concept of a Superlevee is presented to be the solution for the Dutch challenges in flood protection in combination with the need for urban development. Designing such a Superlevee asks for the integration of two design processes, but design literature does not state how this should be done. Literature on multiple land use only addresses the process and emphasizes the importance of process management. The conducted research shows that an analysis of the separate functions and their design approaches provides a great amount of understanding regarding the attitudes towards the Superlevee concept and makes it easier to steer to design process. This approach is suggested to be useful in other multifunctional design dilemmas and suggested is conduct further research on this topic.

Keywords (3-6): Design theory, multiple land use, Superlevee, Multifunctional Design

The Netherlands are facing a huge challenge concerning flood protection. The country has a history of floods from the sea as well as from the main rivers. Approximately 65% of the country would be flooded during high sea and river levels in case of absence of the dunes and dikes. The population is ever growing and most of the economic activities are concentrated in the lower areas of the country (Huisman, 2004). Moreover, uncertainties concerning our water barrier system are increasing due the currently running discussion about climate change and the possible effects. Sea level rise, increasing fluctuations in the river discharges, drought and a needed fresh water stock will ask for revision of the safety level of our water barriers. A special Delta commission was asked to advice the cabinet on a long term vision. This commission concluded that the safety norms should be multiplied by a factor ten and that barriers will have to be made higher and stronger (Deltacommissie, 2008).

The Netherlands are facing a huge challenge concerning spatial planning. The countries population is approximately 16.5 million people on a surface area of nearly 34.000 km² (CBS, 2009). This population is still increasing and only for living and working already 120.000 to 190.000 hectares will have to be developed in the coming decennia (VROM, 2009).

In Japan a concept has been developed that combines the challenges for flood protection and urban planning: The Superlevee. This water barrier has a broad width that can withstand even overflow, so that destruction by dike break and its resultant flooding can be prevented. Moreover, on top of the dike an urban area can be constructed (Japanese Foundation for Riverfront Improvement and Restoration, 2008).
shows the Japanese concept of the Superlevee. The Superlevee is promoted to be the answer to the challenges in our flood protection system as well as the challenges in housing the coming years.

Figure 1: Profile of the Japanese Superlevee (Stalenberg, 2007, s.36)

I Superlevee in practice
The combination of two functions asks for design on the interface of water and space and will consequently result in the combination of the two existing design approaches. A shared design will not only imply the combination of functions that needs to be designed in the Superlevee (functional design), but also the people that design, the method of designing, the applicable legislation, the financing structures, the philosophy behind these financing structures and so on.

Currently two studies are running on the concept of a Superlevee and unfortunately the implementation of such an innovative dike concept appears to be more difficult than suggested. A platform has been established to promote the idea of a Climate dike\(^1\) (Klimaatdijk, 2009). The meetings of the Platform Climate dike and the knowledge exchange between participants have lead to a general document that bundles the knowledge about Climate levees (Hartog et al, 2009). The Waterboard of Zuiderzeeland has conducted a more practical exploration to the potential of a Superlevee in the province of Zuiderzeeland. The study was initiated due to urban pressure on the flood protection system.

Both studies have resulted in multiple questions for further research that are related to technical, financial, social and other aspects. From actors of both sides (flood protection as well as urban development) difficulties for in the design of a Superlevee have been formulated. At the platform Klimaatdijk an important question from the municipalities has been: “How can the attitude of the Waterboards be changed into a less defensive one regarding the Superlevee/ Climate dike?” At the Waterboard Zuiderzeeland a clear constraint for a shared design of a Superlevee was formulated as: “Spatial/urban developers should understand and have compassion for the flood protection task of the Waterboard”.

\(^1\)The Climate dike is a collective term for variants of water barriers that are so robust that they will not burst even when water overflows the barrier. Additionally, it contains a multifunctional, robust protection zone that fits the environment The Superlevee answers to this definition and can thus be seen as a variant of the Climate dike.
This article will first elaborate on existing literature on design, design methodologies and on the concept of multiple land use. The philosophy and approach of the conducted research will be explained followed by its results. The article will be completed with conclusions regarding a two-functional design approach of a Superlevee and more general considerations on the design of multiple functions into one artefact.

2 Design and multiple land use

For the readability of this article a few terms about design and characteristics of design have to be specified. The definitions given here are based on Mingers and Brocklesby (1997). They are not claimed to be the only and correct definitions but will be used as such in this article. A paradigm is a very general set of philosophical assumptions that define the nature of possible research and intervention. A methodology is a structured set of guidelines or activities to assist people in undertaking research or intervention. A design methodology therefore is a structured set of guidelines or activities to assist in the undertaking of the design activity. A methodology will generally develop within a particular paradigm and will embody the philosophical assumptions and principles of that paradigm. A technique is a specific activity that has a clear and well-defined purpose within the context of a methodology. With regard to design in general and the activity of designing two major design paradigms, multiple methodologies and a great amount of techniques can be identified.

Two major paradigms are generally distinguished by design theorists. This distinction is made between the Rational Problem Solver paradigm and the Reflective Practitioner or Reflection-in-action paradigm (Joseph, 1996). Drost and Dijkhuis (1999) describe how the systems for describing design processes have developed over the years. They compare the two paradigms and show the main differences in the position of designer, design problem, process and knowledge. Achten (2005) provides comparable insight in the so called ‘conflict’ between the two paradigms. Fout! Verwijzingsbron niet gevonden. shows this conflict by Achten between the Rational Problem Solver paradigm and the Reflective Practitioner paradigm.

<table>
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<tr>
<th>Rational Problem Solving (Simon,1967)</th>
<th>Reflective Practice (Schon, 1983)</th>
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<tr>
<td>Design is a way of problem solving</td>
<td>Design is a dialogue between design and designer</td>
</tr>
<tr>
<td>Design can be divided into sub-problems</td>
<td>A designer names, frames, moves and evaluates without strict pre-division of the problem</td>
</tr>
<tr>
<td>Quality of a design is measurable</td>
<td>A designer reflects during and about the action and on the delivered work</td>
</tr>
<tr>
<td>Strong theory, weak connection with real life</td>
<td>Weak theory, strong connection with real life</td>
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In the choice for a design methodology many options exist. As mentioned in the definition, the design methodology is related to the design paradigm that it is developed within thus between the two design paradigms different methodologies are used. Methodologies are mostly related to the goal of the
design process, in other words, the (passive) element that is being designed. This can vary from the design of an information system, to the design of new legislation, to aircraft design, to the design of a decision making process, to the design of an entertainment game for the computer and so on. Depending on the purpose of the specific design technique, the phase in the design process, the applied methodology and so on a great variety of design techniques are possible. Drawing maps, developing scale models or holding a group discussion on the objectives of a process/system/product are all *design techniques* that can be used during a design process.

### 2.1 A bi-functional Superlevee

The design of the Superlevee should become a combination of the design that is made with regard to its function *flood protection* and on the other hand the design that is made for the function *urban development*. Thus the design paradigms, the methodologies and techniques for spatial and landscape design and architecture as well as those for the design of flood defence elements and systems, dikes and dike rings, are relevant in the design of a Superlevee. For a successful design process of the Superlevee it will not be possible to take all elements of both and mingle them into the design process. Choices will have to be made regarding design methodology and design techniques; these will have to answer to the requirements for designing a flood protection system (e.g. take into account technical constraints) as well as designing an urban area (e.g. leaving space for creativity and originality). Moreover, both sides should support and understand the used methodology and technique.

Achten (2005) distinguishes between Architectural and the Engineering design methodologies. He relates these to the two paradigms and explains how the different methodologies work. He explains that architectural design methodologies have a very conceptual design phase, that the design is based on the individual designer skills and that they take a normative position. He links the Architectural design methodologies to the Reflective Practitioner design paradigm. This link is also described by Dorst and Dijkhuis (1995). Engineering design methodologies split up the design problem in sub problems according. They use a specific design method per activity and the package of these methods is the overall design strategy. Moreover, a lot of attention is given to structure and overhead. Evidently the link is made with the Rational Problem Solver paradigm. At first sight urban design is more linked to the architectural methodology and design of a flood protection system more to (hydraulic) engineering.

Thus, we have reason to assume that the design of the functions flood protection and urban development differ from each other and that combining them into one artefact - the Superlevee - could become a difficult process. The major challenge of designing a Superlevee will be to integrate and combine the different design methodologies and techniques. Unfortunately, literature on combining design paradigms, methodologies or techniques of two different functions into one artefact is not abundantly available. Roozenburg and Cross (1991) underline the gap between the paradigms and their design methodologies and the growing distance between the two. They emphasize the importance of integrating the two paradigms more. How this gap could be closed in case it involves two very different functions is not part of the discussion and other authors in design theory do not address this issue as well.
Based on the existing knowledge of design methodologies of engineering and architecture, can be assumed that the two functions - that are combined within a Superlevee - will likely have great differences in design approach (paradigm, methodology and techniques). The available design theory is mostly descriptive and does not prescribe any methods for design and for dealing with the differences in design paradigm when combining multiple approaches. It is helpful in the understanding of differences but not directly helpful in the shaping of a design process of the Superlevee.

2.2 Multiple land use

Multiple land use has become a specific field of study in 1999 when the knowledge centre Habiforum was established. The goal of this centre is to develop, bundle and spread knowledge on innovative spatial concepts and increase the awareness regarding the advantages of multifunctional use of space. Within this platform studies have been conducted on methods of process management and cooperation processes for these types of developments (Teisman, 2001). A Superlevee would evidently fit the concept of multiple use of space and the available literature on this topic is studied in search of elements that could be applicable on the design of a Superlevee.

The concept of a co-production is clearly explained by a descriptive study of Teisman and others in assignment of NOW and Knowledge centre Large Cities (2004). The authors distinguish between three forms of co-production and explain the main problems for each variant: The term is mostly used for the indication of a co-operation between the government and inhabitant or between public and private partners. An underexposed aspect of co-production is the cooperation between governments. The main dilemmas for this type of co-production are the feeling of hierarchical authority instead of a co-operative attitude; the ongoing ‘battle’ between different layers within public organizations and between for instance municipalities and provinces; and the complicated question of how public organizations can be held responsible when they apply the concept of co-production and how they can create a clear yet effective regulation structure. These problems are generally known, but no effective methods exist so far to overcome them. Edelenbos and Teisman discuss the effect of a (private) process manager in such a public co-operation project based on the example of the case Sijtwende (2005). In Frame 3 this case is explained in more detail.

Teisman has also studied the characteristics of existing decision making and management methods and the degree in which these contribute or impede with the application of multiple use of space (2001). He concludes that multiple use of space is guided by an accumulation of the ambitions and desires of multiple actors. However, a summary of these ambitions does not necessarily lead to multiple use of space. True and profitable participation of multiple actors is needed. With that Teisman emphasizes the importance of the process between actors. He also addresses the main fields of problems which are the fragmentized steering by the government, the fragmentation of the market and the poor interaction between governments, civilians and companies. Habiforum has asked scientists from nine universities to make an inventory as well of the main drivers and obstacles for multiple use of space (Volkers, 2001). They concluded that the wish for multiple use of space is generally present, but the institutional framework hinders the
implementation. The main obstacle they identified was the relation between institutions that steer the spatial processes on the intermediate level. Impulses for cooperation are lacking and the conditions for co-production are far from optimal. The involved team of scientists argues that follow up research should focus on methods to optimize the decision-making structure for multiple land use that rises above the existing fragmentized decision-making. This field of study they call process management.

De Bruijn and others have continued with the investigation of the process of “the development and realisation of (yet separated) spatial interventions that are being combined” (2004). Based on fifteen cases the authors describe several dilemmas that managers of multifunctional design processes are being confronted with. One of these cases is again the case of Sijtwende. They explain how the implementation of the project has stagnated for more than 50 years due to the impossibility of the involved actors to come to a design that contains a win for all parties. Eventually a (private) process manager has intervened and was able to come up with a design that did contain a win-win for all involved. The main difference between this case and the Superlevee is the fact that with the latter the multifunctional solution concept - for the problem regarding safety as well as the problem regarding urban pressure – already is available. The Superlevee concept is present, but does not seem to be linked to the problems of all the actors.

The studies above have been rather general and not directly related to projects that include a water-related function in the multiple land use. Goossen and others have documented on the practical experiences with such water-related multiple land use projects (2002). Unfortunately, this study only focuses on projects in which water is the space demanding function and puts other functions under pressure (e.g. water storage). Regarding the Superlevee urban development will be the pressing function. Space for flood protection has already been safeguarded. Despite this elementary difference an interesting conclusion of this study is that the multi functionality or plurality in water related projects is often achieved concerning the goals of a multifunctional project, but that the spatial implementation mostly shows a separation of functions. They wonder if in that case the project can still be assigned as a multifunctional one.

From the exploration on the issue of multiple land use can be concluded that this field of study focuses on the management of projects and the importance of a solid process management. The studies are mostly based on existing cases and descriptive of character. Factors are identified that have determined failure or success in past multifunctional projects, but according to de Bruijn et al. these findings should not be applied one on one in other cases. Each project is unique and asks for an individual process design. A returning element in most case studies is the importance of a win-win potential. Case studies on multifunctional use of space related to water exist as well, but refer to the need of space for water purposes. The Superlevee does not match this situation as will be explained further in this report.
2.3 Separate analysis of design approach

In this absence of available theory it has been decided to conduct a separate and symmetric analysis of the two functions based on the general design methodology that integrates technological, institutional and the process design of complex technological problems. The limited availability of theory has lead to the following two starting points for the analysis:

1. The questions and difficulties in the design of a Superlevee are (partly) caused by the differences between the two design techniques and methodologies for flood protection and urban development and perhaps even due to a difference in design paradigms. More insight in these differences will provide better insight is how the process can be steered to overcome these difficulties.

2. For a successful co-production of a Superlevee in the design process will have to contain the potential of a win-win outcome for the actors involved in flood protection on the one side and the actors on urban development on the other side.

The goal of the conducted research has been twofold. The first goal was to increase the understanding of the background and content of the difficulties in design of a bifunctional Superlevee and to contribute to the actual applicability of the concept in the Netherlands. The second - more theoretical - goal is related to the identified knowledge gap. The aim was to contribute to the development of a more systematic approach for the design of projects that apply the concept of multiple land use. The following research question has been formulated:

How can a better understanding of the design process of the two functions flood protection and urban development improve the applicability of the Superlevee concept?

This article tries to connect general design theory to the literature on multiple land use and hopes to show the reader that a knowledge gap exists between the two that is very relevant for the success of future multifunctional projects.

3 Results of the research

During the conducted thesis study the two functions and their way of designing have been taking as the starting point for design.

For the function Flood Protection the main goal of a design process is to guarantee the legally required safety level for the required plan period (50-100 years). This is true in case the safety level of a water barrier is tested to be insufficient and the barrier needs to be enforced as well as in case adjustments to the barrier are desirable because of developments of other functions in the barrier-area. In both situations the starting points for design are the ways in which the barrier could fail. Based on these failing mechanisms it can be determined how the barrier should be dimensioned minimally in order to prevent these failing mechanisms to occur. Expert knowledge is needed to translate these failing mechanisms into design alternatives. The process for design is determined, structured and organized. Methods and procedures are laid down in legislation. The water board is the responsible actor for the state of the water barriers. The income for a
Waterboard is based on taxes amongst inhabitants. The State provides financial resources for the restoration of the required safety level of a barrier in case it has been rejected and is part of the High Water Protection Program. Adjustments due to developments of other functions are paid for by other actors.

The main goal of an urban development project is to develop a new urban area. The constraints and objectives for design vary per project. They depend on the local conditions, the involved actors and they can be negotiable. Legal constraints only exist on the level of individual buildings. Knowledge is more linked to experience and creativity than to technical knowledge of the construction of buildings. The main intention is to develop the area in such a way that the potential is fully used. The municipality is the main actor concerning spatial planning and is responsible for housing quality and supply. Financial resources can come from public as well as private actors like project developers. Housing is market-related and development mostly has a profit intention. The urban design process is an iterative one and shifts between different scale levels (regional level, block level, local level, etc.).

Table 2: Comparison of design processes Flood Protection and Urban development

<table>
<thead>
<tr>
<th></th>
<th>Flood Protection</th>
<th>Urban development</th>
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</thead>
<tbody>
<tr>
<td><strong>Technical design</strong></td>
<td>Main goal is guaranteeing the (minimally) required safety level</td>
<td>Main goal is developing a new urban area</td>
</tr>
<tr>
<td></td>
<td>Leading constraint is safety of hinterland</td>
<td>Constraints vary per project (eg. number of houses)</td>
</tr>
<tr>
<td></td>
<td>Design objectives are related to managing safety or to other functions</td>
<td>Design objectives depend on wishes of municipality/ developer/ inhabitants etc.</td>
</tr>
<tr>
<td><strong>Institutional design</strong></td>
<td>Constraints are institutionalized</td>
<td>Constraints are mostly negotiable/ politic</td>
</tr>
<tr>
<td></td>
<td>Costs: Public actors pay for safety (non-profit), other interests are paid for by others</td>
<td>Costs: Public and Private actors (profit intention)/ Housing is market-related</td>
</tr>
<tr>
<td><strong>Process Design</strong></td>
<td>Design is Problem-focused (based on failing mechanisms)</td>
<td>Design is Opportunity-oriented (new development, maximize objectives)</td>
</tr>
<tr>
<td></td>
<td>Waterboard is responsible for safety</td>
<td>Municipality is responsible for housing</td>
</tr>
<tr>
<td></td>
<td>Expert knowledge is important</td>
<td>Knowledge is mostly negotiable</td>
</tr>
<tr>
<td></td>
<td>Structure process is institutionalized</td>
<td>Iterative and fuzzy process</td>
</tr>
</tbody>
</table>

Based on the comparison above and in Fout! Verwijzingsbron niet gevonden., can be concluded that a shared design process regardless whether the goal is a Superlevee or something else, might become difficult. The role of technical constraints and the importance of (technical) knowledge are very different. An urban designer is used to a negotiation process revolving around objectives and constraints, whereas for flood protection these are regulated by legislation. This could lead to communication and cooperation problems. Secondly, flood protection is a common good while housing is a market oriented sector. The combination of these two into one artefact requires a clear division of responsibilities. The design processes that both sides are used to differ most significantly in the fact that flood protection is used to start the design from a problem perspective, whereas an urban designer tries to fully utilize the possibilities of a certain opportunity.

Design techniques are evidently different. Also the design methodologies show great differences as can already be concluded on the difference in literature on flood protection design and urban design. Moreover, when
taking table 1 as reference, we can conclude that flood protection shows the most similarities with the Rational Problem Solver design paradigm and the urban development with the Reflective Practitioner.

3.1 Effect of design approaches on the design of a Superlevee
For both functions the design environment has been studied and the challenges that are mentioned previously. For both functions this leads to a vision on a Superlevee - containing the definition, the need and the added value of a Superlevee. Evidently the definition and the added value of a Superlevee differ between the two; With regard to flood protection a Superlevee should be very strong and should be able to deal with the changing water level. For urban development the possibility for multifunctional use of a levee is the focus.

However, the main obstacle for a shared design process of a Superlevee is the fact that from the viewpoint of a Municipality or urban developer the Superlevee is seen as an opportunity with great potential. Development of the waterfront can be very interesting in multiple situations. On the other hand the Waterboard mostly does not have a problem regarding its water barriers. With the running High Water Protection Program all primary water barriers that did not comply with the safety norm have been or are being enforced (In Flevoland the enforcement projects have been completed in 2005). As long as these barriers will comply to the legally safety norm, no need exists to develop a Superlevee for the Waterboard.

Although the first conclusions above on a shared design process of a Superlevee are not very optimistic, two other aspects are important to state as well:
Firstly, most Waterboards are very willing to look beyond the task of flood protection and the care for water barriers. Also the Delta Commission and the National Water Plan support the idea of a Delta dike and Climate dike. Waterboards underline this.2
Secondly, Waterboards are experiencing a pressure for urban development. In the example of Flevoland and more specific the needed expansion of Almere, the national government supports the idea of waterfront development (Nota Ruimte, 2006). It has not been articulated that this development should be a Superlevee, but for the Waterboard of Zuiderzeeland it has been the reason to investigate the possibilities of such a levee.

3.2 Potential Consequences
The research continues with the investigation of design challenges and issues and questions that need to be dealt with in order to make the Superlevee indeed an applicable concept. The identified design issues and question show similarities with the ones identified in the case Flevoland and in the platform Climate dike. The most interesting outcome is the amount and the type of uncertainties for both sides: a Waterboard still struggles with many content related issues (technical, institutional) and also process issue. For municipalities most uncertainties are directly related to the design choices of the Waterboard because to a large extent this determines the feasibility of the urban development. In case a Waterboard is unable/ unwilling to

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2 Informal conversations during the ARCADIS Project “Kustnota en Nota Waterkeringen” for the Waterboard of Rijnland.
Present were: representatives from Waterboard Schieland en de Krimpenerwaard, Delfland, Hollandse Delta
cooperate for a Superlevee a municipality will have the incentive to realize their design objectives in other ways.

With these issues and questions in mind and the urban pressure that is being practised, the Waterboard will have to take a certain position with regard to the matter. Two variables are especially important in this.

**Re-active attitude versus Proactive attitude:**
The wish for urban development comes from a different actor then the Waterboard. The Waterboard could wait for more information to become available or for the municipality to come with a design variant. The function of the Waterboard in that situation will be to provide or neglect permits for development. A Waterboard could also take a pro-active attitude and start the discussion with municipality and others and become part of the process.

**Problem-focused versus Opportunity-oriented approach:**
The idea of a Superlevee can be approached as an issue and the implementation of this issue will bring about many problems. Or the Superlevee could be a possible solution to deal with the challenges of climate change and to construct a dike that is stronger than the safety level while providing opportunities for development as well.

The lack of need for a Superlevee would implicate that the most rational attitude of the Waterboard with regard to the Superlevee would be a re-active and problem-focused one. The uncertainties and the questions that are left open will aggravate this already reserved attitude. However, a scenario sketch shows that exactly this attitude might contain the greatest risk.

### 3.3 Increased applicability of the Superlevee

The conducted analysis of the design processes and a translation into the vision on a Superlevee has lead to understanding of the attitude towards a Superlevee, of the difficulties in a shared design and of the risk of a non-shared design. True synergy in the design process is only realized when the design process is a co-production and should thus contain a win-win for all involved actors. Although the Waterboard is currently not experiencing the need to step into a co-production, it should to prevent an outcome of a single urban design to be a deterioration compared to the existing one. This requires a pro-active attitude from the Municipality but especially from the Waterboard. To support the Waterboard in adopting a pro-active and opportunity oriented attitude towards the Superlevee concept, an action plan has been drawn up. The starting point of this action plan is the fact that the Waterboard should focus on the main goal of its water barriers - providing safety against flooding – and should not focus on the (institutional) instruments and obstacles for managing the water barrier. Regarding the safety level, the Win of a Superlevee could be that the barrier is made burst-and climate proof. The effects of surface and underground constructions on the safety level of the barrier should be assessed on a conceptual level. In depth discussions about design criteria such as costs of a Superlevee, manageability and others are advised to postpone. The outcome of this action plan will serve as input for the co-production design process of the Superlevee.
4 Conclusions

This article has introduced the concept of a Superlevee which is presented to be the solution for Dutch challenges in flood protection and urban development. The general conclusion that can be deducted from this research is the fact the combining two or more functions into an artefact that previously had only been designed for one function can contain more difficulties than expected at first sight and should not be underestimated. In the enthusiasm for a new multifunctional concept (in this case the Superlevee) designers from both sides will start by focusing on the final artefact and relate that back to their existing design approach. Approaching an innovative multifunctional concept this way will lead to situation in which one element is forgotten; the discussion about how both sides see the path from existing situation to the new one with the multifunctional artefact. This is directly related to the design paradigm of the functions that are integrated, the design methodology and the techniques. Not taking this into account could lead to a long and dreadful process with misunderstandings and frustrations form both sides.

The research shows that understanding of the separate design approaches of functions - that are to be combined into one design process - provides a great amount of understanding about the design challenges and their effect on the potential of a co-production. The attitude of involved actors can be better understood; consequently it becomes easier to steer the process (as was done in this case by drawing up an action plan for the Waterboard).

Especially for the ongoing study to the application of a Superlevee but in general for multifunctional designs recommended is to take the differences between functions into account. It will provide better understanding of the position of the actors involved and thus more insight into the way that the positions can be adjusted.

5 Discussion

With the growing scarcity of space in the Netherlands the pressure of combining functions in smaller areas will ever increase. This leaves a very interesting field of study for research on multifunctional design and multiple land use. With this article is tried to make a first step in connecting general design theory to literature on multiple land use. It hopes to have shown the reader that a knowledge gap exists and to have clarified the importance of filling this knowledge gap.

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