6TH INTERNATIONAL CONFERENCE ON FLOOD MANAGEMENT
September 2014 - São Paulo - Brazil
ICFM6

ADAPTIVE FLOOD RISK MANAGEMENT FOR UNEMBANKED AREAS IN ROTTERDAM, THE NETHERLANDS; CO CREATING A LEGITIMATE ARRANGEMENT FOR CLIMATE ROBUST PLANNING.

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ABSTRACT: Changing climate conditions have major consequences for the unembanked parts of cities in the low-lying Dutch delta. Cities like Dordrecht, Almere and Rotterdam are therefore busy to rethink their local flood risk and spatial planning strategies. In Rotterdam the city government decided in 2010 to rethink flood risk approaches for unembanked areas. The current strategy (to formally oblige elevating ground levels in case of new developments) will not suffice and would be too expensive in the long term. For the area of Feijenoord and Noordereiland earlier research provided insight in possible alternative strategies for flood risk management. One strategy was aimed at realizing collective provisions (a retaining wall) to protect the area. Another strategy was built upon the principle of self-reliance of owners in the unembanked areas. Possible measures were investigated that complied with these strategies.

The city government decided in 2012 to start a co-creation process with experts, policy-makers and stakeholders to find out how these strategies could be refined in such a way that they could be implemented. Part of the research question was which arrangements (financial, legal, organizational) would be necessary to enable the implementation of these strategies. This co-creation process was executed by an interdisciplinary team of researchers and a policy-maker from the city of Rotterdam. The co-creation process was built upon several workshops with stakeholders and experts and in-depth interviews. During this process knowledge questions were formulated and answered. In this paper we describe in detail the process of co-creating knowledge, the main problems and the lessons we can draw from this case study in order to create an adaptive flood risk management strategy. Moreover recommendations are made in how the gained insights can be used elsewhere. More information will be given how the tipping point analysis can be valuable to influence governance arrangement for climate robust planning.

Key Words: Flood Risk Management, Co-creation, Adaptive strategies, Knowledge

1. INTRODUCTION

In the nineties two high water events in the rivers Rhine and Meuse and the near floods in 1993 and 1995 precipitated a breakthrough in Dutch water policy (Van Stokkom *et al.,* 2005). A possible relationship between climate change and flooding lead to an opening for other alternative flood protection strategies. This led to a new policy based on the “room for the river’ concept and it was formally adopted in legislation in 2000 (Van Heezik, 2007). Also in Europe the traditional focus on building flood defences was gradually replaced by focus on managing flood risks (De Bruijn *et al.,* 2007).

In the Netherlands the dikes and dunes ensure that we may feel safe. The primary water defences protects us from flooding by the sea, main rivers and our Lakes. The secondary defences are also

important, but the consequences of a dike failure are not as dramatic. The Flood Defences Act indicates the safety standards for every dike ring area. The standard is higher if more economic activities take place within the ring and if the number of inhabitants is high. The standard is expressed in a probability per year that a critical water level will occur, e.g. 1:1,250 per year. The requirements for a flood defence structure in terms of height and strength are derived from that standard. Rijkswaterstaat and the regional water authorities are responsible for the primary and secondary flood defences in the Netherlands. Some say that the Netherlands is one of the best protected deltas of the world.

However, along the rivers, a substantial unembanked area is located, often hosting urban and industrial areas. Many of these areas are relatively safeguarded against flooding because of their high level of elevation. This is caused by a process of sedimentation and additional manmade structures. Part of the area is protected against storm surges by a system of barriers that can be closed during a storm surge.

Currently, cities in the Netherlands are reshaping their local flood risk and spatial planning strategies. The occurrence and impact of river discharges and higher sea levels will increase the expected impacts of climate change. New challenges arise for these areas if combined with the on-going development of urban waterfronts. In Rotterdam, the city government launched a research project in 2010 to rethink rethink flood risk approaches for unembanked areas. This project is co-funded by a large-scale research program Knowledge for Climate.

In this paper the approach of flood risk management for unembanked areas is further described. We have identified three steps that lead in the end to a governance arrangement. All three steps will be (briefly) described in this paper. Firstly the possible measures including the so-called adaption pathways were developed. This formed a base for the synthesis to two adaptive flood risk management strategies. Co creation already took place in this stage, although not all stakeholders were part of this stage. Last but not least a design for governance arrangements was developed for the implementation of these strategies. In the development of these arrangement co creation formed part of the approach. Main research question was how an adaptive flood risk management strategy can be developed and thus creating a legitimate governance arrangement for climate robust planning in the unembanked areas.

2. CONCEPTUAL FRAMEWORK

Adaptation of the water system to a changing climate is the primary focus of low-lying Deltas like the Netherlands. Even with the most far-reaching restriction on the worldwide production of greenhouse gasses, the climate will change in the course of the coming century and the sea level will continue to rise. We must adapt our water system but the question is how and when. The approach until now was to develop one or more possible climate scenarios and then use these to calculate their effects.

Climate changes deals with many uncertainties. The crucial challenges for implementation is often to involve stakeholders in identifying the problem and opportunities for solution. All stakeholders have their own priorities and interests. Different problem frames imply different solution strategies (Hisschemoller and Hoppe, 1996). Hoppe (1998) and Hisschemoller (1993) both speak of unstructured problems. Problems are characterised by the values at stake and the kinds of knowledge that may contribute to a decision. Here, learning is the key concept, because by the interaction with others, new insights are gained. Stakeholders learn about the position taken by others and about their own interests. Scientists and other experts may play a remarkable role, but do not have rights distinct from those of the lay people. An unstructured problem is time-consuming. Parties cannot be forced to really participate in the process. The role of knowledge and of scientists is the one of stimulator. They deliver an effort that contributes to a pro-active learning and creative attitude of the stakeholders and institutions involved (van Paassen et al., 2011)

Designs were made for the purpose of water management strategies based on, for example, hydraulic conditions. However the scope, speed and even the direction of climate change are surrounded by uncertainties. The additional disadvantage of this traditional approach is that as soon as there are new insights into changing climate, the conditions change and with that the starting points for the strategy

previously designed. For that reason the Adaptation Tipping Points approach (ATP) (Kwadijk et al., 2010) has been developed. Earlier research (Kwadijk *et al*., 2010) focussed on the issue to what extent the climate can change before the current water management and water policy are no longer adequate. This can be considered as a sensitivity analysis of the water system.

Bottom-up approaches focus on vulnerability and risk management by examining the adaptive capacity and adaptation measures required to improve the resilience and robustness of a system exposed to climate change (Carter *et al*., 2007)].On the other hand there is critique on the applicability of the approach. The approach is set to be time-consuming. Yet there is also the perception that the system is far too complex for a proper comparison of all the drivers.

It has been concluded that "vulnerability assessment often promises more certainty, and more useful results, than it can deliver" (Patt *et al*., 2011: 411). Another disadvantage of this approach is the greater reliance on expert judgment and qualitative results (Füssel, 2007). The risk is that the gained knowledge will be contested, leading to a more complex decision making process.

Adaptation involves dealing a.o. with predictability of climate change (some aspects of climate change can be predicted with reasonable confidence like temperature rise, while others are surrounded by more uncertainties); non climatic conditions (it occurs against the background of current and future use of the area); timing (proactive or reactive) and time horizon (short or long term actions) (Gladwell, 2000; Smit *et al.*, 1999). Planned adaptation focuses on the use of information about current and future climate to review the suitability of current and planned management (Füssel, 2007).

ATPs in water management are thus the specific boundary conditions where technical, economic, spatial or societal acceptable limits are exceeded. The time at which an ATP will occur (which is dependent on the climate scenario considered) defines the moment that alternative adaptation measures will be needed. ATP or adaption pathways describe a sequence of water management policies (for measures) enabling policy makers to explore options for adapting to changing environmental and societal conditions (Haasnoot *et al.,* 2012a). Elements of the method such as the 'visualisation of moment to switch' and 'the possibility to explore options' aid in making choices which involve taking uncertainties into account.

An important building block to the development of the adaptation pathways is the information on the effectiveness over time of possible measures. A tipping point analysis defines the moment (or period) in time when climate change effects (e.g. increasing water levels or flood frequencies) reach such an extent that certain policy objectives cannot be met anymore and thus give an indication of the urgency for adaptation. A tipping point analysis can be applied to assess current policy as well as give insight into the effectiveness of proposed flood risk reducing measures in view of climate change.

Stakeholder participation in climate change adaptation

The threats of climate change and its impact on a lowland country like the Netherlands have put flood (risk) management upfront on the political agenda. By involving citizens, NGOs and stakeholders, public decision-makers hope to enhance support for their decisions (which can heavily impact upon the daily life of citizens, and thus to accelerate decision-making processes. Moreover, participation can strengthen both the quality and democratic legitimacy of policy processes and decisions (Michels, 2011; Edelenbos *et al*. forthcoming).

At the same time, it is not easy to organize stakeholder involvement in Dutch water management (Edelenbos, 2010). Flood management is a strongly expert-dominated policy domain. Within the world of civil engineers, citizen participation is often seen as a threat to decisive and uncompromised action, which is deemed necessary to prepare for serious crises (Warner, 2006). Citizen participation is sometimes even seen "to contribute to the problem rather than to add in the solution" (Pearce 2003, pp. 218). Oftentimes, citizen participation is not deliberately organized by policy-makers in order to get support for policy decisions, but is the unintended consequence of policy proposals which do not fit into the agendas and ambitions of local people (Nye *et al*, 2011).

Participatory decision-making and stakeholder involvement are frequently discussed in literature on water (resource) management (House, 1999; Leach and Pelkey, 2001; Leach, 2006; Rinaudo and Garin, 2005; Petts and Brooks, 2006; Huitema et al., 2009; Scholz & Stiffel, 2006; Sabatier *et al*., 2005). However, there is little insight in the interaction between local stakeholders and governmental actors in actually elaborating on adaptation strategies before and during implementation. Although there is literature focusing on pressure or interest group strategies (e.g. Kollman, 1998; Binderkrantz, 2005), the literature on flood management and climate adaptation doesn't pay much attention to issues like co-creation and stakeholder involvement in climate change adaptation (cf. Edelenbos *et al.* forthcoming).

This is particularly true when adaptation is aimed at anticipating on uncertain circumstances in the long term. Both lack of urgency and uncertainty about what actually will happen makes it very difficult to motivate citizens to take part of participatory planning processes. From mainstream participation literature we know that participation is mainly successful when actors are really affected by policies, when there is a real danger that their current rights are at risk. Otherwise, actors are difficult to mobilize.

3. RESEARCH METHODOLOGY: ACTION RESEARCH

For the development for the adaptive strategies, till finally the possible arrangements for the implementation of these strategies several research approaches were followed. Earlier we identified three stages in research. Stage 1 and 2 follow more or less the same approach. Here mainly the public stakeholders and experts were involved.

In all stages action science was seen. Friedman (2001: 160) describes action science as "attempts to bridge the gap between social research and social practice by building theories which explain social phenomena, inform practice, and adhere to the fundamental criteria of science". Action research is specifically suitable for initiating and guiding change processes. Action research is driven by reflection on interventions aimed at changing certain situations (cf. Argyris *et al*., 1985). First step is to examine what the challenge is, and by changing the undesired situation (e.g. a problem or missed opportunity) in small steps, under continuous (reflexive) monitoring, a bridge is built between "is" and "ought", according to those involved (cf. Biggs, 1999). In that respect, action research is a productive method to give shape to more reflective practice, in and between organizations, through direct collaboration between practitioners and researchers (cf. Duijn *et al.,* 2010).

As a first step in developing possible flood risk management strategies for the Rotterdam area, a vulnerability analysis identified the areas where flood risks are high and through a design research exercise, (packages of) possible measures to reduce the flood risk within the case study areas were identified. A tipping point analysis evaluated the sustainability of the current policy as well as the proposed flood risk reducing measures. This information was used as input for the development of the adaptation pathways. The analysis resulted in a series of adaptation pathways which provide insights for policy makers into options, lock-in possibilities and path dependencies, thus providing a valuable starting point for decision makers on short term policy actions, while keeping options open and avoiding lock-ins (Haasnoot *et al*., 2012b). Next, possible measures, which are able to solve or delay the tipping point were identified. In several expert sessions these measures were assessed on legal, spatial, economical and technical feasibility (Van Veelen, 2013). Moreover, an in-depth analysis of the acceptability of these measures among (specifically public) stakeholders was conducted. This resulted in a selection of most preferred measures Finally this resulted in building blocks to build up an adaptive strategy. The two most promising set of measures could be turned into two adaptive strategies, applicable for several cases in the Rotterdam surroundings. Thus stage 1 and 2 were finalized.

To explore possible arrangements for implementing these adaptive FRM strategies (stage 3), an action-oriented research approach was developed (Van Buuren *et al*., 2014). Here the objective was to activily involve (local) stakeholders, in order to fully explore new insights about arrangements for alternative strategies for flood risk management. In Stage 3 the whole approach was around the action-oriented. So the approach could be altered during the process, what naturally happened.

At the start of stage 3, our approach is based on the following general theory of action:

> A structured interaction process between representatives of stakeholder organizations and experts, and guided by a core group (including researchers and facilitator) will support the formulation of governance arrangements for local adaptation strategies, that can create a foundation for tangible agreements between stakeholders who are active in the development of unembanked areas in general, and more specific in Kop van Feijenoord and Noordereiland.

Implementing a research project in a live situation, involving actual stakeholders and using tangible problems, is likely to undergo adjustments and changes. We had planned to organize five workshops to facilitate the stakeholder – expert interaction, all in the presence of the core group, and aimed at facilitating two meetings with local residents[1], prior to and after the stakeholder – expert workshops. For the stakeholder – expert interaction, we intended to organize two separate workshops with stakeholders and two with experts, followed by a joint final workshop to conclude the iterative process. First, stakeholders will separately discuss the research objective and case study area. Second, the same is done by the experts. Third, stakeholders were asked to formulate the principles for the intended arrangements for local adaptation strategies. In turn, in a fourth workshop experts would review these principles and provide suggestions for improvement or adjustment. Fifth and last, stakeholders and experts would collaboratively discuss and finalize remaining issues around the desired arrangements.

4. FLOOD RISK MANAGEMENT FOR UNEMBANKED AREAS: CURRENT INSTITUTIONAL ARRANGEMENTS

At this moment, there is no integrated flood risk policy for flood protection in the unembanked areas. The prevailing long-term flood risk policy i.e. of the City of Rotterdam is based upon a formal regulation to raise the ground level of new building lots to the 1/10.000 storm surge flood level. The current storm surge flood level height is set to a level that fluctuates between 3,90 to 4,10 m above sea level, depending on certain local conditions, such as wind direction and wave upset. This policy implies that new buildings and assets have to be raised to approx. 1 m above average street level. For existing urban areas there is no additional policy or regulation in effect to minimize the effects of a potential flood (Veelen *et al.*, 2010). Homeowners are held responsible for possible damages caused by a flood and to take precautionary measures, although at this moment they are poorly informed about local flood risks. Community disaster management is currently limited to closing-off quay sections and public areas. In addition flood risk is not included in home insurance.

The national government has redirected responsibility for flood risk of the unembanked area to local governments. Local authorities are responsible for deciding whether and under what conditions spatial development in flood plain zones is allowed. Integrating flood risk management in spatial planning, however, has proved to be problematic. In the Dutch prevention-based flood risk management system there is little or no experience with flooding, causing lack of knowledge on flood proofing measures and methods (Van Vliet, 2012; Van Vliet & Aerts, 2012; De Moel *et al*., 2013). As there is little experience with flood proofing measures, national laws and regulations are often not clear on the use and impact of them. Currently, flood risk management is not included in zoning plans, and only on voluntary basis risks are mentioned in zoning documents to inform stakeholders. Flood-proof building regulations are neither included in the National Building Act, nor in local building codes. In addition, flood zoning as instrument in existing areas does not suffice as land use zoning plans are no appropriate legal instruments to change current functions. Only recently the provincial government is thinking about assisting local governments in weighing flood risks in spatial planning of unembanked areas (Van der Lee, 2013).

[1] Involving residents had to be limited because of the limited time frame in which the research project had to be carried out.

The regional water authorities do not have a formal task in the protection of the unembanked areas. They only have a responsibility for maintaining the water system and ensuring that evacuation routes are available, i.e. on the dikes. The Safety region, responsible for crisis management, has a task to ensure an evacuation plan is available and to inventarise the risks on (natural) hazards and advise the legal authority on these risks.

5. FLOOD RISK MANAGEMENT FOR UNEMBANKED AREAS OF ROTTERDAM

The region of Rotterdam is vulnerable for both tidal and pluvial floods. The majority of this urbanized region is protected by a network of primary flood defences. Another characteristic is that a large part lies outside the protection of the primary flood defence system. These so-called unembanked areas are the focus of this research. In the Rotterdam-Dordrecht floodplain about 65.000 people (distributed over 46 municipalities) live in these unprotected areas (Veerbeek *et al.,* 2010). Moreover the Rotterdam port industrial complex, which is vitally important for the Dutch economy and that of the neighbouring countries, is located outside of the primary defence system.

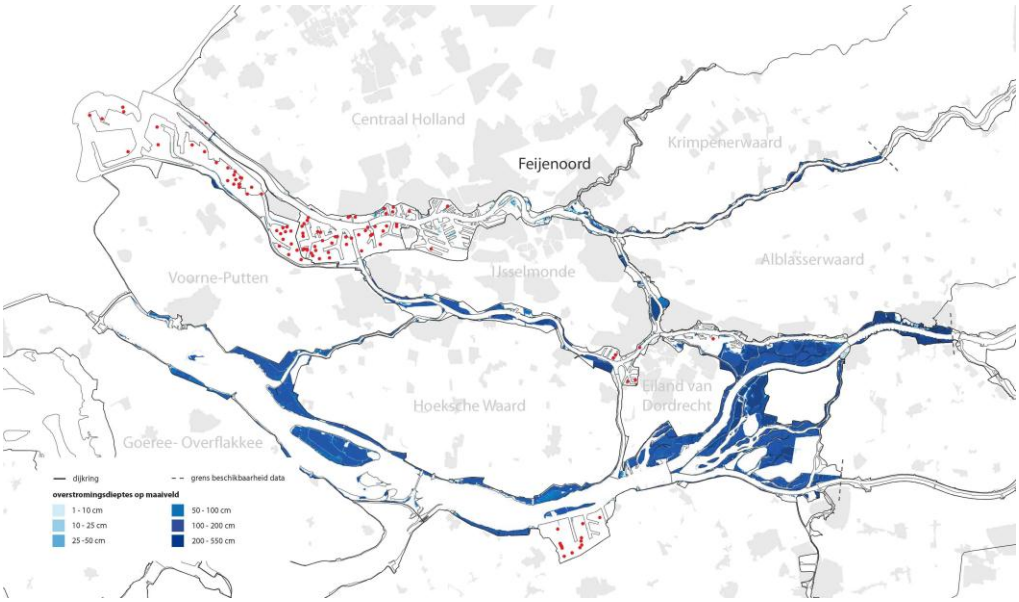

Figure 1. The unembanked areas in region Rijnmond-Drechtsteden. The blue colors indicates the flood depth at a 1/100 flood event (source: Deltaprogramma Rijnmond-Drechtsteden, courtesy picture: DeFacto Architectuur en Stedenbouw)

Although these unembanked areas benefit protection by the Maeslant Barrier, there is still a considerable risk of flooding (Veerbeek et al., 2012, Van Veelen et al., 2010). Large parts of the areas has already been reaised to 3 to 3,5 meters above average sea level. Few areas, like Heijplaat and Noordereiland have a higher potential risk (e.g. between a yearly to a one every 100 years event) of flood damage (Veerbeek *et al.,* 2012). In the following decades the city of Rotterdam encounters two major developments. (1) The land use of the unembanked areas will be intensified and (2) Climate change will increase risk of flooding. This aggravates both the risk of future disasters, while at the same time the increased economic value and activities could cause the possible consequences of flooding to become more severe.

6. FLOOD RISK MANAGEMENT FOR THE CASE FEIJENOORD, ROTTERDAM

Previous Knowledge for Climate (KfC)-research projects, (Veerbeek *et al*., 2012; Nabaliek *et a*l., 2013) on potential physical-spatial measures to reduce the negative impacts of climate changes, indicated that an

integrated local(ized) strategy could be cost effective. Current strategy is a mandatory elevation of ground levels in case of new developments. This strategy will not suffice for the long term. Real estate investors and housing corporations already search for alternatives as this strategy implies a large percentage of their investments. In the current economic times it is difficult to start feasible projects.

6.1 Flood Characteristics Of Noordereiland And Kop Van Feijenoord

Although the Noordereiland and Kop van Feijenoord are both low-lying flood prone areas, they differ when it comes to flood characteristics such as flood frequency, water depth and flood duration (Veerbeek *et al.,* 2012). The Noordereiland is a low-lying mound shaped island that has to deal with high flood frequencies. The quays of the island are flooded at a yearly or 10 year flood event. At a 50-year flood event (3,04m+NAP) water can enter the basements and ground floors of buildings that are situated at the southern and northern end of the island. By the mound shape of the island the duration of a flood event is expected to be short. The higher part of the island also forms a relatively safe ´backbone´ that can serve as an evacuation route when the low-lying areas along the quays are flooded.

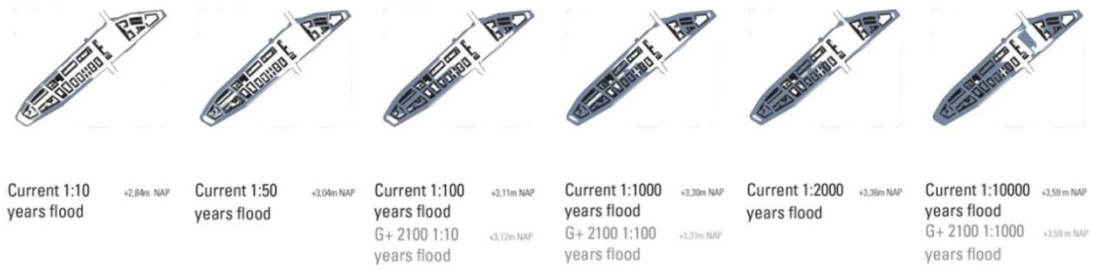

Figure 2. Flood characteristics at different return periods and climate change scenarios for Noordereiland (Nabielek *et al*., 2013)

The Kop van Feijenoord is a deep basin with a high risk of flooding (Nabielek *et al*., 2013). In contrast to Noordereiland, the area can be compared to a ´bath tub´ that retains floodwater after a flood event. Already, at a 50-year flood event (3,04m+NAP), half of the case study area would be flooded to a water depth of 50-75 cm (see figure 3). Water enters the ground floors of more than half of the buildings in this area. During extreme flood events, the exposed area hardly changes but the water depths rise considerably to 80 – 100 cm and serious damage to the façade and the interior of buildings can be expected (Veerbeek *et al.,* 2013). Due to the bath tub-like shape of the area, the floodwater cannot run-off or drain to the river. It is expected that recovery in this area will last for a couple of days.

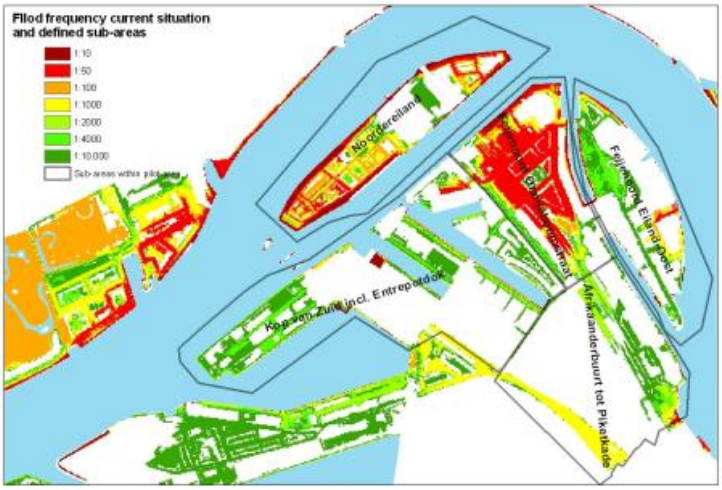

Figure 3 Defined sub-areas according to the flood characteristics (Veerbeek et al. 2012)

The mandatory elevation strategy has worked well in recent past, when abandoned port areas were redeveloped within large-scale redevelopment projects, based on public land-development models and supported by public investments. Investments in elevating building plots and public space were developed within an integral land development plan and funded from the surplus value of the area after development. This policy is a clear example of traditional hierarchical government steering (Kokx, 2012). Due to the financial crisis and structural decline in demand for housing, business premises and office space, the coming period will be characterized by limited need for developing new urban areas. It is expected that large-scale urban area developments will increasingly give way to small-scale transformations of the existing city, with other stakeholders and limited public funding involved and plan periods that are prolonged or kept open (Krabben, 2012). Evidently these changes affect urban flood risk policies.

6.2 Adaptation Pathways For Noordereiland And Kop Van Feijenoord

In order to be able to identify possible FRM strategies the ATP has been used for the locations of Noordereiland and Kop van Feijenoord (Stone, 2012). When using the ATP the current urban layout was taken as the reference situation and compared to a situation with implementation of measures. The effectiveness over time of the measures was tested against a set of maximum acceptable limits on flood risk. The method results in an insight into the urgency to adapt to climate change, insight into the effective-ness over time of the possible measures and visualizes the link between long term policy approaches and the possible measures.

A tipping point analysis assesses for an area the moment in time at which the maximum acceptable limits are reached due to climate change. This point in time is called the tipping point. A tipping point analysis was performed for the unembanked areas of the Feijenoord neighbourhood and the Noordereiland.

The next step was to assess the list of possible (packages of) measures (Nabielek *et al.*, 2012). Implementation of measures will result in a reduction of flood impacts and risk and therefore stretch the moment in time at which the tipping point is reached. Some measures will be more effective in moving the tipping point than others. For the ATP the objectives and threshold values have been defined in line with the policy of the Province South Holland. At the time of the research, they were developing an alternative policy for new urban developments based on a maximum tolerated flood risk to people and social disruption. These objectives have been extended with those for damage to buildings and infrastructure.

The results from the tipping point analysis, an overview of the effectiveness of the possible measure, act as building blocks for the development of adaptation pathways. The adaptation pathways visualise the possible flood risk management measures through time and indicate if and when a switch should be made to another measure when due to climate change the effectiveness of a measure reduces.

During a workshop with stakeholders (mainly public agencies) and specialists, several adaptation pathways were developed with different policy approaches as a starting point. A simplified version of the workshop process as described in Roosjen (2012) was followed. By following this method the participants were stimulated to an ‘adaptive way of thinking’ through elements such as the diversity of future perspectives and the possibility to switch to other measures or adaptation pathways (Roosjen, 2012). For the development of the adaptation pathways, the following steps were applied. Steps 1 and 2 were executed preceding to the workshop. Steps 3 to 5 were implemented at the workshop.

1. *Urgency to adapt,* Determine the tipping point, the moment in time where climate change effects reach such an extent that the objectives cannot be met anymore;

2. *The effectiveness of implementation of measures*. Assess to what extent the implementation of measures will stretch the time of reaching the tipping;

3. *Definition of policy approaches* (PA's). Define the policy approaches (PA's) as a starting point, e.g. keep water out or full responsibility citizen;

4. *Development of the PA based adaptation pathways*. For each case study area select from the overview which shows the effectiveness of the possible measures, a measure (or group of measures) in line with the policy approach. Determine at which point the measure does not meet the objectives (end of the line) and consider which alternative measures, in line with the policy approach, could be switched to. Repeat this exercise until no alternatives are required or available. This step results in the adaptation pathway which correspond to the specific policy analysis;

5. *Overall picture of the adaptation,* see figure 4;

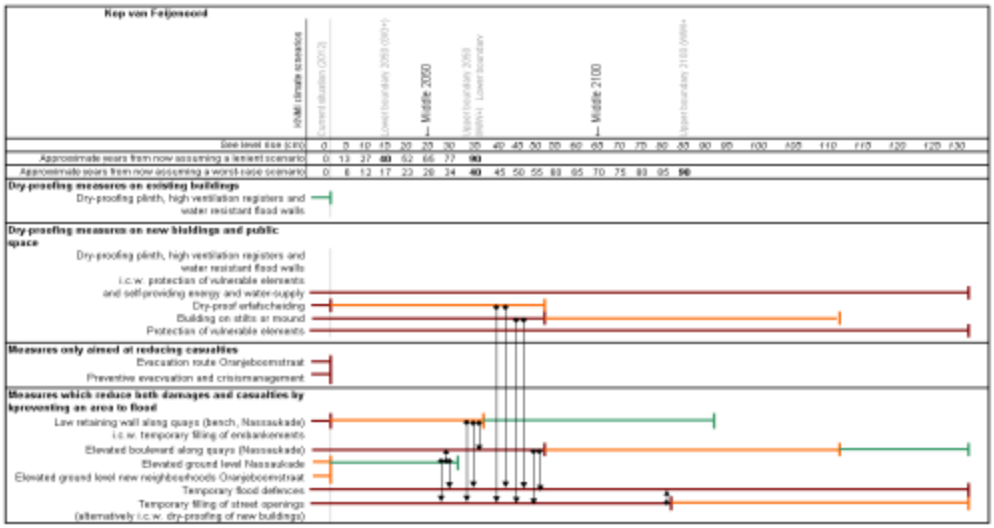

Figure 4 Effectiveness of flood risk reducing measures for the case study area 'Kop van Feijenoord' on reducing damage to existing buildings and public space (green lines), reducing damage to all buildings (orange lines) and reducing risk of social disruptions as well as damage to all buildings (red line). Note that measures aimed at reducing damages to new developments will not have an effect on reducing damages to existing buildings. The arrows indicate the possibilities to switch to other measures (Stone, 2012).

In figure 5 the results of the adaption pathways for Kop van Feijenoord are shown. The adaptation pathways, which assume a flood defence policy, provide a long term solution that addresses both the casualty risk and the prevention of flood damages. The research focused mainly on the areas where the flood risks were highest. For the area where large flood depths are expected, the emphasis is on solutions aimed at flood prevention such as flood walls and temporary barriers. Solutions where water can flow controlled within the urban area are less effective in these areas, but these measures could be interesting in areas which flood with smaller water depths. The urban scale of the study resulted in very specific and concrete measures. The choice of a policy cannot be made without considering the larger scale level.

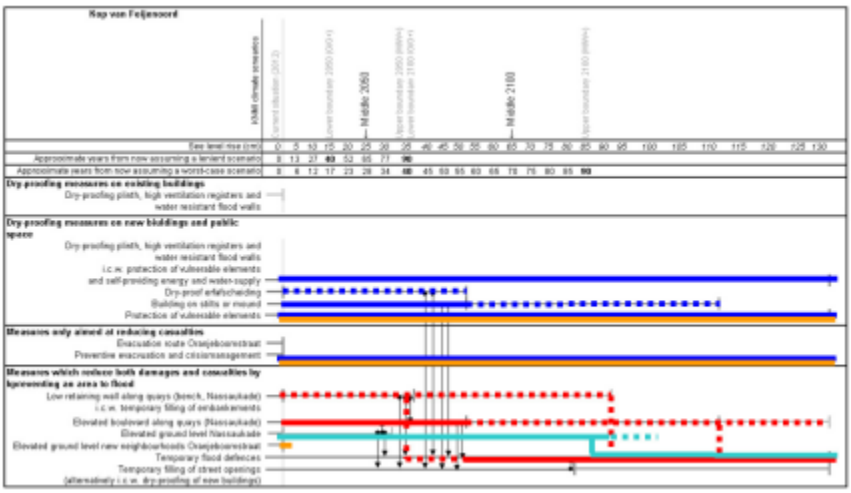

Figure 5 Overview of adaptation pathways Kop van Feijenoord (Stone, 2012)

The method proved to be an added value to the design research process as it adds an extra dimension through the insight into the effectiveness of solutions on the longer term. By connecting the technical solutions, different policy approaches and information on the physical boundary conditions such as the flood risk and climate change, a bridge towards developing long term policy was created. In addition it links the urban planning and flood risk management.

6.3 Integrated Adaptive FRM Strategies

Based on a.o. the ATP & adaptation pathways two possible strategies were identified (Van Veelen, 2013): a preventive community-level based strategy and a resilient -individual level based strategy. These strategies were, as stated earlier, developed during in-depth stakeholder – expert sessions. During these sessions new insights were gained by all participants. Learning is the key concept. Here you can see the role of experts and scientists as the one of stimulator. Proactive learning and mutual understanding about the most optimum strategies is gained. A co creation process took place, where the participants agreed on the two strategies. Interestingly to see is that the ATP and Adaptation Pathway, which were, perhaps difficult to grasp, have been moved to the background.

The first strategy is a collective-preventive one based on keeping water out of the area by gradually raising the low-lying quay areas to design level. Due to the specific morphological situation of the subarea Kop van Feijenoord, where a large part of the quay area already has been elevated, preventing floodwater to enter the area can be achieved by raising a limited section of quays. This strategy seems less appropriate for Noordereiland because it would require the elevation of all quays around the mount-shaped island. This would be very expensive and destroy the unique cityscape.

The second strategy is an individual-adaptive one, based on creating a waterproof urban area that is able to recover within a considerable amount of time from a flood event. This strategy is based on both dry-proofing and wet-proofing new buildings and existing buildings, utilities and civic infrastructure. As the Kop van Feijenoord area housing stock mainly consists of poorly renovated nineteen-century apartment blocks, flood proofing the area implies retrofitting measures, which are in many cases technically and financially unfeasible. Flood-proofing new buildings however proved to be much easier. The long-term feasibility of this strategy will depend on the future development strategy (renovation or rebuilding) of the social housing corporation. For Noordereiland this strategy would be more feasible because floods are likely to have a short duration due to the mount shape of the island. It could make sense for private homeowners to take dry-proofing and/or wet-proofing measures to protect their houses in short periods of flooding.

The proposed solutions for Noordereiland and Kop van Feijenoord differ from the current flood -safety policy in the unembanked areas, in more than just the technical domain. They also call for new types of partnerships between public institutions and private parties such as homeowners, housing associations and real estate investors. Private and public parties are jointly responsible for the construction, financing and management of the proposed adaptive flood measures. This shared responsibility for local flood management delivers a host of new issues, such as the question of how the short-term costs for flood protection can be made up for by the long-term benefit.

7. PERCEPTIONS FROM LOCAL STAKEHOLDERS DURING ACTION RESEARCH

During the action research several stakeholders were involved, either during the workshops or in-depth interviews. Some stakeholders took the liberty to actively be involved in both. Others, for several reasons, chose between the two options. At the time of stage 1 and 2, most perceptions were related on the chosen objectives for the vulnerability analysis and ATP approach. The objectives used at the ATP approach were dominated by the Province of South Holland, whereas during stage 3, their involvement was limited. The conclusion from stage 1 & 2 was that it is difficult to work with different policy objectives for social disruption, damages and individual risk. It seemed to be subjective to reach consensus on thresholds for vulnerable functions. With the stakeholder-expert sessions in stage 1, there was a strong emphasis on creating support from stakeholders. This resulted in stage 3 in an action-oriented approach.

Different stakeholders; different dominant perceptions

An employee of the municipality of Rotterdam stresses out the importance of keeping the current mandatory elevation strategy. He ensures that that is the most sustainable solution in the long end. The real estate investors can save money to build a lower ground floor level as they can save investments costs. However in a few years' time, the residents of the houses will encounter problems during flooding. They will suffer the consequences. They are not the benefiters, only the real estate investors are. When wet or dry proof buildings are built, you accept that water will enter the houses. How do you ensure that future home owners know that when they buy their homes? Formally the municipality does not have any responsibility for these unembanked areas, but when an area is flooded and the media is all over it… you cannot say, as municipality, it is the problem of the home owners. Corporate image of the municipality is a great asset. When an adaptive strategy is followed, more responsibility must be taken by the real estate investors and home owners. It should be obligatory to tell if a building is lying in the unembanked area. So, future homeowners can decide for themselves whether they are willing to take some risks. The municipality should be a more controlling institution, meaning that they check whether the required first floor level is reached during the construction phase.

During the interviews, home owners from the Noordereiland ensured that owners from this island are reluctant to invest in adaptive measures. They are often not aware that their homes lay in the unembanked areas. Moreover they are unaware that no (local) government has any responsibility in safeguarding their homes. Also the lack in sense of urgency is not helping. High water situations occur infrequently. In recent years they only had to relocate their cars, if they were parked on the quays. According to the respondents, first step is to raise awareness about the (future) problem. Sense of urgency must be created. Recent research (Kokx, 2012:51) showed that citizens and home owners often point to government instead of taking their own responsibility. The respondents said that the Vereniging van Eigenaren (VVE) could play a central role in the future when taking adaptive measures.

The interviews also gave more insight in the feasible strategy. This is really dependent on the amount of local stakeholders and the interests. Here some results from the in-depth interviews are highlighted (Van der Lee, 2013)

On the Kop van Feijenoord, the housing corporation Woonstad is owner of many building blocks. During the interview they stated that their wish is to create another adaptive strategy for multiple reasons. Firstly a lower ground level is safe enough. It also has a negative impact on the attractiveness of public space because of height differences of the first floor level and street level. It also generated negative effects on

the overall policy ambitions for the area, such as improving the spatial quality and the (social) quality on street level. This policy leads to different ground floor levels of buildings, creating 'blind' corners and spaces that cannot be monitored and maintained easily. A discrepancy will develop with respect to flood safety in a neighbourhood. From a social justice perspective, this approach can be questioned with respect to social equity: residents in social housing with fewer resources may be excluded from flood safety policies, whereas more affluent households in the new dwellings are included. Ultimately, the lack of an integrated flood risk policy, based upon incremental urban development processes and a strong separation of responsibilities between levels of government, contributes to an increased vulnerability of the area.

The housing corporation is willing to invest adaptive measures for the new building blocks. For the current stock they are not the primary stakeholder to ensure the safeguarding of citizens. According to the housing corporation, this is a public responsibility, so the government should take that task on their shoulders.

For this area the respondents stresses the higher feasibility of a collective preventive strategy. There is a tension between the desire to anticipate on the future and the large amount of buildings that will not be restructured in the next 20 years. Large parts of the area will remain vulnerable and only against large investments will be made adaptive. Also the real estate investor AM Wonen stresses that it is more logical from a financial/ economic point of view to take a collective measure. They believe that a collective measure will be more cost effective than an individual measure on building scale.

On the Kop van Feijenoord several large companies are situated a.o. Unilever, Stedin and Hunter Douglas. Hunter Douglas has stated that they will take measures, if possible. Naturally they will look at the efficiency of the required investments. For Hunter Douglas taking measures on building level is no option for them. When the sense of urgency is high enough they will participate in collective-preventive measures.

Difficulties with organizing co-creation

From the experience (Stone, 2012) it was learned that the concept of adaptation pathways is not easily understood. A development of adaptation pathways session therefore requires taking time to introduce the method. It was also seen that the effectiveness of measures and strategies depends strongly on the choice of the objectives. In this research the objective on social disruption was set quite strict and for the current urban design already none of the assessed areas complies with the set objective. Less strict objective will result in lower flood risk and more robust measures. It is of great importance to choose a set of objectives which is sufficiently supported by the stakeholders. The exercise also showed that some of the objectives could not be assessed thoroughly due to a lack of information. It is therefore recommended to define objectives which can be assessed in accordance to the data availability and with *all* local (public & private) stakeholders.

The development of the pathways took place with limited input from the stakeholders. Several discussions took place on the set objectives and threshold values. It also was seen that understanding these pathways is difficult; the conclusion can be drawn that the support of and usability these pathways could be relatively low. Adaption pathways have a relative long planning horizon. There is a tension as many stakeholders have a short term perspective. In setting up the process of co-creation this must be taken into account. Thinking on adaptation pathways in co-creation processes should be focussed on short term achievements (no regret measures). The adaption pathways can be used to shed more light on possible measures that have to be taken in the near future. Also the effect of certain choices can be identified for the long term.

It is interesting to note that co-creation soon became strategic behavior. This came from fear. Right after the start of the research, the team encountered a major setback. The Planteam Feijenoord, which was a joint venture of public authorities and private project developers was dismantled only a few weeks after starting the project. Originally this team would be in the position to make the desired agreements with other stakeholders on new local adaptation strategies and implement alternative measures. The

dismantlement of the Planteam followed the conclusion that no large scale developments in the Feijenoord district would be initiated on the short term due to the financial crisis. This Planteam would have played a crucial role in creating support for the developed adaptive FRM strategies. Some of the participants were also involved in the previous stage of the research, when the adaptation pathways were developed.

We organized a kick-off meeting with relevant civil servants of the municipality and the district of Feijenoord. Involving the district authority was not easy, as climate change adaptation does not belong to its primary task. The upcoming reorganization of the districts governments in Rotterdam was another obstacle for active participation of the district representatives of Feijenoord with regard to tasks that do not belong to their core business, such as flood prevention.

It was difficult to get all stakeholders involved as the sense of urgency was lacking. The same occurred when we tried to make connections with two key actors in the area development in Feijenoord, housing corporation Woonstad and real-estate investor AM Wonen. It appeared to be hard to involve these parties in research on climate adaptive area development. The knowledgeable professionals at these parties had only limited time and willingness to participate. The initial stage of the research project was not meant to negotiate about the distribution of costs and benefits but attempts were made immediately to use it as such. The disintegration of the Planteam and slowing down of area development in Feijenoord turned the research process into a more political issue as it became a stage on which the developing parties could display their interests.

During the first workshop the project team outlined the different adaptive FRM strategies, with possible measures to be taken. We have encountered difficulties to take the stakeholders on board with choices made in earlier research. It is interesting to see however that during the interviews and workshops the respondents came with a whole new adaptation path. They suggest that first investments should be made in bringing back social security and thus creating a more livable and attractive neighborhood. In this way a return potential could arise to invest in flood safety. Social equity is an important aspect of a possible FRM strategy.

Thirdly, we experienced difficulties in involving citizens and homeowners in the research project. The lacking sense of urgency and the limited level of coherence stood in the way of involving them on a short notice. A meeting with some members of the core group revealed that administrators were reluctant to agree to involve citizens and homeowners in this stage of the policy-making process with regard to the city's adaptation strategy. Therefore the intended interaction with citizens and home owners was to be framed as 'doing collaborative research' instead of allowing for a formal point of contact for questions about policies or measures with regard to local adaptation strategies. From the interviews with citizens and home owners, it was observed that there is no (or very limited) awareness that their homes are situated in unembanked areas. Also the fact that they are responsible for safeguarding their homes in times of flooding was not recognized. They assume that the municipality will play a role in the protection. It was understood that in the process of creating awareness and sense of urgency a delicate process should be outlined. Step- by- step their involvements and level of knowledge should be increased. Once understood they can better understand the problem and possible (adaptive) FRM strategies and taking their responsibility in the whole process.

8. REFLECTION

The KfC research projects starting point was from an academic point of view searching for the most optimum solution. Must attention is paid on reducing the possible uncertainties due to climate change. Also the list of measures in combination with the adaption pathways led to more understanding of the system. However support from (local) stakeholders is of utmost importance for the implementation of an adaptive FRM strategy including measures in spatial planning. Naturally, this increases the legitimacy of the decision-making process and creates opportunities for mutually approved integrated measures.

In the first stages, relatively little focus was on co-creation with all stakeholders. Most attention was paid to understand the system and possible (technical) measures. Setting the objectives turned out to be difficult. For most participants the long planning horizon was a bridge too far. Their time horizon is only a decade ahead. There was no to little co creation in stage 1 and 2.

Due to the project characteristics of stage 3, co creation appeared to me difficult. There were several reasons, ie. due to lacking sense of urgency, complexity between long en short term decision. When reflecting on the followed approach the first conclusion must be that the available time was too limited to realize the pre-set ambitions of implementing action research in this context. Our case study shows that it is very difficult to organize action research for an issue that is deemed not very urgent. Participation of citizens and homeowners was very limited, and should be aimed at creating awareness for self-reliance and taking on responsibility first. Subsequently, joint investigation must be aimed at what they need – e.g. practical knowledge or resources – to take measures within their span of control. Such an approach requires a more extensive process than was possible here within the constraints (time, budget) of this research project. Also, it calls for (more) formal administrative commitment and mandate of both municipality and district authority to "work with local residents". After all, flood safety is a politically sensitive issue that should be governed by formally responsible administrators. After all, the democratic anchorage of our action research project had to be stronger in order to get more impact (Edelenbos, 2005).

Secondly, co-creation suggests a process of social learning, where all stakeholders develop mutual understanding on the problem statement and possible strategies. Creating a sense of urgency requires thoughtful communication (Moser & Dilling, 2006) and cannot without processes of social learning and frame reflection (Dewulf, 2013). For solving unstructured problems, the key is learning. Sometimes institutional choices from the past hinder the implementation of effective adaptation strategies and thus redesigning existing regimes can be necessary (Tompkins & Adger, 2004).It was shown that when the various responsibilities are combined, an adaptive flood risk strategy can be implemented (Van Buuren *et al*., 2013). Our case study underlines the importance of creating awareness when developing adaptation strategies (Hulme, 2009) during the three stages. Local people stick to the traditional distribution of roles and responsibilities and don't feel the urgency to invest in uncertain consequences of climate change, as they were no part in the process.

Thirdly, the development of arrangements fitting with the results from the ATP approach is no sinecure. If created in co-creation it presumes that they are an adaptive arrangement developing over time. Basic assumption is that all stakeholders have trust in the process and approach. Moreover they are willing to commit for a long(er) period to the suggested approach. Especially when there is a perceived lack in knowledge about financial (fiscal), legislative and organizational instruments for sustainable and robust integration of flood risk measures with spatial development complicates decision-making (Van Buuren, 2014). While developing the ATP, it proved to be difficult to work with different (policy) objectives for social disruption, damages and individual risk (Van Veelen, 2013). Even though this classification reflects the complexity and multiple aspects of flood risk, it turned out to be time-consuming and rather subjective to reach consensus on thresholds for vulnerable functions.

The ATP approach is an useful instrument for a systematic assessment on the adaptive measures. Biggest disadvantages is that it is a time-consuming technique, which relies on a detailed analysis of vulnerabilities and effectiveness of measures and a consensus among policy-makers and stakeholders on objectives and hresholds. Moreover, until now the ATP approach encounters difficulties to define spatial tipping point for so-called 'soft' adaptation measures (i.e. evacuation plans or early warning systems). For these kinds of measures thresholds are not clearly defined.

In all the three stages the project was not aimed at organizing a process of social learning with stakeholders, in order to develop a joint feeling of collective responsibility. Afterwards we can conclude that such a learning process is necessary before it is possible to develop legitimate governance solutions and subsequent implementation arrangements (Collins & Evan 2009).

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