Flood Risk Management: Research and Practice – Samuels et al. (eds)
© 2009 Taylor & Francis Group, London, ISBN 978-0-415-48507-4

Flood risk management: Experiences from the Schelde Estuary case study

M. Marchand, K.M. de Bruijn & M.J.P. Mens
Deltares, Delft, The Netherlands

J.H. Slinger & M.E. Cuppen
Delft University of Technology, Delft, The Netherlands

J. Krywkow & A. van der Veen
Twente University, Enschede, The Netherlands

ABSTRACT: As part of the FLOODsite research project a case study was executed in the trans-national Schelde Estuary region bordering Belgium and the Netherlands. The objective was to apply and test the FLOODsite approach to flood risk management. We hypothesised that active involvement of citizens can contribute to knowledge development for a flood risk assessment. We used modelling and scenario analysis, semi-structured interviews, workshops and a questionnaire in our study. Individual perceptions and knowledge regarding flood risk were explored of three actor groupings in the region: the scientists, local citizens and regional and local policy makers. We found that local citizens were realistic and knowledgeable with respect to a possible failure of the flood control system. This enabled fruitful discussions with scientists on the modelling results and preferred measures. Many viewpoints expressed during these discussions were also reflected in the questionnaire results. Our experiences offer insights on the benefits of using science and engineering in a participative approach to flood risk management. We also derived valuable discussion points with respect to: the importance of trust, the use of local knowledge and social learning in the communication process.

1 INTRODUCTION

1.1 *A history of floods*

The trans-national Schelde estuary extends from the upper reaches near Gent in Belgium to the lower reaches and the mouth at Vlissingen in The Netherlands (Fig. 1). In its Dutch part, called "Westerschelde", the estuary is a meandering multiple channel system, with intertidal islands and areas on the inner side of channel bends. In its Belgian part, called "Zeeschelde", the estuary is a single meandering channel with intertidal areas along the channel margins. The higher parts of the intertidal areas host fauna and flora-rich salt marshes. The lower intertidal flats are important feeding grounds for birds and resting areas for the increasing population of seals.

The study area is home to around 300,000 people in the Netherlands and less than 1 million people in Belgium (Zeeschelde area). This includes the city of Antwerp with a population of around 450,000 (2003). The estuary is of economic importance as a major shipping artery, hosting the harbour of Antwerp, as well as providing an access route to the harbour of Rotterdam via the Rhine-Schelde canal. In 1999 to 2001, breaking with a 300 year tradition of conflict over the Schelde, the Dutch and Flemish authorities developed a joint long term vision for the Schelde estuary (Zanting et al. 2002). In this broad policy document (LTV 2001) the triple functions of shipping, safety from flooding and the ecosystem are emphasized. Since then many activities have been undertaken under the auspices of a joint Dutch-Flemish project bureau tasked with the implementation of the measures necessary to achieve this long term vision.

In 1953 the Dutch part of the Delta area experienced a disastrous flood, which inundated about 136,500 ha of land and caused a total of 1836 fatalities. Tens of thousands livestock perished and approximately 100,000 people had to be evacuated. The damage to buildings, dikes and other infrastructure was enormous (Gerritsen 2005). The majority of the flood defence structures that failed were not high enough for the water level and waves at the time.

Figure 1. The Schelde Estuary.

The overtopping of the dikes caused damage first to the inner slope. Sliding and erosion of the inner slope subsequently led to a complete dike breach.

The 1953 flood disaster provided the impetus for the development and implementation of a new flood defence system in the Netherlands. This was developed by the *Delta Commission* which was inaugurated only 17 days after the disaster. Key elements of the *Deltaplan* included:

- Provision of a very high level of safety through flood defence (dikes and barriers);
- Diversification of safety standards based on a (relatively simple) cost-benefit analysis;
- Shortening of the dike system length by closing off tidal inlets;
- Revision and improvement of the institutional responsibilities with respect to design standards, maintenance and crisis management.

A flood occurred along the Belgian part of the estuary in 1976. A North-western storm pushed water into the Schelde river leading to dike breaches at several locations along the river. More than 800 ha along the Zeeschelde were inundated. The municipality of Ruisbroek was particularly heavily affected (900 houses under water). This prompted the Flemish government to adopt the *Sigma-plan*. This plan aimed at achieving as high a safety against flooding as was envisaged by the Dutch Deltaplan. Recently (2006), the Flemish Parliament ratified an updated version of the Sigma Plan. It includes a combination of dike strengthening and managed realignment along parts of the Zeeschelde.

High river floods in the Netherlands in 1993 and 1995 triggered renewed political attention for flood risk. Scenarios of accelerated sea level rise and increased peak river discharges induced by climate change led to questions regarding the robustness of the current flood safety system.

This trans-national flood prone and densely populated region provides the context within which the Schelde pilot study on flood risk management was conducted.

1.2 *Study objectives*

The rationale for the Schelde pilot study was to apply and test the approach to flood risk management developed in the FLOOD*site* project. This approach consists of three main elements (Gouldby & Samuels 2005; FLOOD*site* 2008):

- *Flood risk analysis*, to determine risk objectively by analysing and combining probabilities and negative consequences of floods;
- *Flood risk assessment*, to understand perception of risk, to assist societal weighing of costs and benefits of risk and to support decisions; and

– *Design and implementation* of physical measures and policy instruments for flood risk management.

Our pilot study focused on the first two elements, i.e. flood risk analysis and flood risk assessment. Design and implementation of measures was not included in the study as such. However, both in the analysis and assessment parts, a wide range of potential measures and instruments was taken into account.

Linked to flood risk analysis, the first objective was *to study the future vulnerability of the people living along the Schelde Estuary to flooding, taking into account changing hydraulic conditions and demographic and economic developments.* As part of a flood risk assessment the second objective was *to evaluate sustainable flood management strategies in association with stakeholders,* thereby acknowledging the importance of the process dimension as part of strategies for flood risk management (Hutter, 2006).

2 RESEARCH APPROACH: LINKING SCIENCE WITH PUBLIC AND POLICY PERSPECTIVES

The FLOOD*site* project adopted a multidisciplinary approach to studying the vulnerability of the people living along the Schelde Estuary. Our approach combined insights deriving from engineering and the natural and social sciences. Research activities were planned so that they complemented other on-going or recent flood risk studies in the region.

In evaluating flood risk management strategies in association with stakeholders, we chose to engage with scientists, policy makers and the public (citizens). Instead of assuming that only improved scientific assessment (e.g. via hydrodynamic model simulations and flood risk mapping communicated directly to policy makers via reports) can accomplish this, we hypothesised that active involvement of citizens can contribute to knowledge development for a flood risk assessment. We used modelling and scenario analysis, semi-structured interviews, workshops and questionnaires in our study. The idea behind this set up was to gain insight in the perception of local citizens with respect to flood risk through the interviews and questionnaire, as well as in the effect of communication between people of different backgrounds on their opinions through the workshops.

Detailed descriptions of the individual research activities of the Schelde pilot are provided by De Bruijn et al. (2008); Slinger et al. (2008) and Krywkow et al.(2008). This article presents the overall findings of the pilot study and places them within the wider flood risk management context. The results and conclusions pertain to three different questions:

– How will flood risk along the Schelde Estuary evolve in view of future climate change and socio-economic developments?
– How do the local citizens along the Schelde Estuary perceive flood risk and what are their policy preferences?
– What lessons have been learned in regard to public participation in flood risk management?

3 FLOOD RISK ANALYSIS: THE SCIENCE PERSPECTIVE

3.1 *Method*

The assessment of current and future flood risks for the Schelde estuary was prepared using an approach developed as part of the FLOODsite project (De Bruijn et al. 2008). Central to the method is the definition of flood risk in terms of a probability of flooding times its consequences. In order to calculate the flood risk both a hydrodynamic and a damage model were used. With the hydrodynamic model a representative set of storm conditions and river discharges ('events') were combined with assumptions on breach locations and breach growth to generate water depth maps. These maps were subsequently used as input for the Standard Dutch Damage Module (Kok et al. 2006) to assess the corresponding flood damages. The number of affected persons and the number of casualties were also calculated using the same damage module.

Future changes in flood risk have been explored through a scenario approach. Scenarios were formulated for three different developments:

– climate change (i.e. sea level rise);
– developments in regional economy;
– regional demographic changes.

Sea level rise projections were based upon the latest IPCC reports and Dutch climate studies (KNMI 2006). Economic and demographic scenarios for the region were downscaled from projections at national level. Using the *Foresight study* in the UK as reference (Office of Science & Technology 2004; Evans et al. 2004a, b), four different future scenarios were formulated that proved to be sufficiently consistent, contrasting and feasible:

– *World Market*: an internationally-oriented world that focuses on liberalism with a minimal role for policy;
– *National Enterprise*: a nationally-oriented and individualistic world that has a state-centred policy;
– *Global Sustainability*: an internationally oriented world that has strong social and environmental goals with strong governance;

– *Local Stewardship*: a co-operative world that focuses on local solutions with a strong and local governance.

In terms of policy alternatives, a continuation of the current flood risk management strategy was analysed (*Current Policy*) as well as three alternative flood risk strategies: a *Storm Surge Barrier* at the mouth of the estuary and two combinations of differentiation of protection levels and (future) land use planning: *Risk Approach* and *Spatial Planning.*

3.2 *Results*

The increase in economic risk and expected casualties under the current flood risk strategy depend on which scenario becomes reality, although the differences are limited until around 2050. Beyond this time horizon differences tend to become substantial: in the scenario of Local Stewardship the flood risk increases from 0.53 M€/year in 2000 to 1.5 M€/year in 2100, whereas in the World Market scenario an almost 30-fold increase could be expected (14 M€/year in 2100). Because the Current Policy strategy includes a gradual increase in embankment height to account for sea level rise, the large differences between the scenarios are almost entirely due to the assumed pace of economic development. In contrast to the big differences in economic risk between the scenarios, calculations show only a twofold difference between the highest and lowest expected annual number of casualties in 2100.

When comparing the expected annual damage for the year 2050 under the different strategies (Fig. 2), we can observe that i) a Storm Surge Barrier would provide the highest safety, albeit also with the highest investment (very roughly estimated at 3.8 billion €), ii) the Spatial Planning alternative produces quite similar risks compared with the Current Policy and iii) the Risk Approach alternative will result in considerably higher economic risks than the other alternative strategies, especially in the World Market scenario.

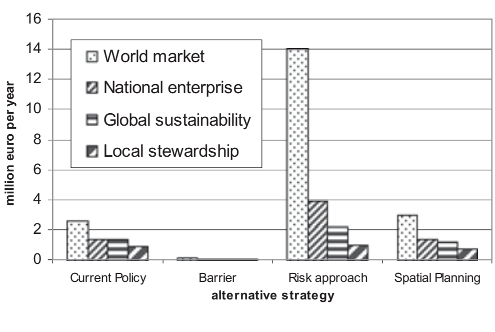

Figure 2. Expected annual damage for each combination of alternative strategy and scenario for the year 2050.

The differences in the results of the Risk Approach and Spatial Planning alternatives can be explained by their different management approaches towards land use planning. Under the Risk Approach land use developments are considered to occur autonomously and flood protection standards *follow* these developments, but only when the costs of raising embankments are equal to, or lower than, the expected risk reduction that could be obtained by this measure. In this way the urban areas have the highest protection level and extreme events are expected to flood mainly rural areas.

Under the Spatial Planning alternative, spatially differentiated flood protection standards determine land use development. The strategy consists of a combination of safety differentiation, embankment strengthening and land use planning. Embankments of currently vulnerable areas are made higher while those of the rural areas remain lower. Thus the current land use determines which sub-areas receive the highest protection. Future land use developments are also directed towards these highly protected areas. In the remaining coastal areas economic investments are only allowed in such a way that flood impacts do not increase. Through this strict spatial policy the overall flood risk remains lower than under the Risk Approach without spatial planning.

4 FLOOD RISK ASSESSMENT FROM DIFFERENT PERSPECTIVES

4.1 *The practice of public participation*

There is an increasing awareness that a valid flood risk assessment requires the involvement of the local public living in the area liable to flooding. Indeed, the new EU Flood Directive (EU 2007) stipulates that all stakeholders must be given the opportunity to participate actively in the development and updating of flood risk management plans. Designing and achieving a satisfactory level of public participation, however, remains a challenge. Examples of good practice in participatory flood risk management are still scarce and theoretical guidance is developing slowly (HarmoniCOP 2005). Problems range from unwillingness to participate because of lack of interest or lack of trust in the process (see for instance Van der Werff 2003) to the authorities' lack of knowledge how to design, implement and monitor a participatory process (Krywkow & Speil 2007) and communication barriers due to differences in knowledge level between citizens and experts (Siebenhuner & Barth 2005). This component of our research focused specifically on the problem of accessing and using different types of knowledge in discussions on flood risks between stakeholders, scientists and policy makers.

The approach used three different methods of interaction: semi-structured interviews, workshops and a questionnaire.

4.1.1 *Semi-structured interviews*

Seventeen citizens from the Netherlands and from Belgium living in the vicinity of the Schelde Estuary, who normally do not participate in research or policy processes dealing with flood risk management were selected for participation in the study. The selection included farmers, fishermen, people working in the recreation business, environmentalists, housewives, sailors, a pastor and a priest.

Semi-structured, in-depth interviews were held either at the homes of the respondents or at their places of work. The interviews lasted approximately 1,5 hours during which the respondents were questioned on their relationship with the area, their affinity with water, whether (and what) they thought about flooding and the risk of flooding, their or their family's experience of flooding (if any), their knowledge of evacuation plans, their ideas regarding evacuation and the recovery process after a flood. They were also asked specifically what they knew of measures to prevent or ameliorate flooding.

4.1.2 *Workshops*

In total three workshops were held during a period of slightly more than 2 years. The first workshop engaged only scientists and policy makers, during which the findings from the interviews with local inhabitants were discussed. A second workshop included seven of the original interviewees as well as four of their partners, relatives or friends. Also four scientists that were involved in the flood modelling tasks within FLOODsite participated in the workshop. During this workshop no policy makers were present. The workshop enabled an exchange of information between scientists and citizens, especially with regard to the results of the flood risk modelling and analysis (section 3). Opinions of the participants regarding flood risk management measures were surveyed both prior to the workshop and at the end of the workshop, thus enabling measurement of the effects of the exchange of information and ideas.

The final workshop was held with scientists and policy makers. Central to this workshop was the question 'to what extent is a new flood risk approach necessary and/or feasible for the Schelde Estuary?'. The results of the flood risk analysis were explained to policy makers as were the results of the interviews and previous workshops.

4.1.3 *Questionnaire*

In addition to the interviews and workshops a questionnaire was sent out to 3000 inhabitants living along the embankments of the Schelde estuary in the Dutch province of Zeeland, with the objective of obtaining insight in the level of risk perception and the representative nature of the workshops and interview results. Also an on-line version of the questionnaire was provided for respondents. After disseminating the letters on the 22nd of February 2008, a press release was sent to a regional daily newspaper in order to generate a positive attitude towards the questionnaire among the public in Zeeland, and to increase the response. The regional TV station reacted to the press release immediately and invited requested an interview, which was broadcast the next day.

The questionnaire encompassed six different groups of questions: (1) individual data including education, age, profession, experience with inundation and related damage, (2) risk perception (worry), (3) damage on assets and willingness to pay, (4) measures for flood protection, (5) evacuation and early warning systems, and (6) The role of the responsible authorities.

The questionnaire included multiple-choice questions, Likert-Scale questions (from strongly agree to strongly disagree) as well as open-ended questions to give the respondents the possibility of expressing their opinions in their own words.

4.2 *Results*

4.2.1 *Citizens: aware of risk and confidence in current safety policy*

The presentation of the results from the flood risk analysis during the second workshop brought about slight changes in participants' preferences regarding future flood risk measures. Worry about future flood risk and an urge to do things differently was not provoked. Most opinions expressed during the workshop as well as in the preceding interviews revealed that citizens had confidence in the current flood risk policy based on strong and high primary embankments. Among the various flood risk management measures, the strengthening of primary embankments (sea dikes) received the highest positive score. This confidence was also reflected in the questionnaire results, since a high percentage (77.2%) of the 413 respondents think that technical measures, such as dikes, should be given high or the highest priority.

Nevertheless, the discussions and information exchange caused participants to shift their attention more evenly over the different flood risk management phases. They indicated that policy makers should do more to mitigate the impacts during and after a flooding event, yet still pay attention to primary defence. Again, this tendency was corroborated by the questionnaire results.

The creation of safe havens and inspection of the dikes were the most favoured measures during the workshop. This reflects a growing understanding on the part of the participants that evacuation out of the area would not be possible for all citizens, and that a safe haven located relatively near by was likely to offer more safety in the short term and make rescue at a later date possible. Dike inspection was viewed as necessary because those individuals who are most threatened could then be evacuated first and others warned to go to the safe havens. Participants expressed a need to know which buildings or dikes were highest in their area. Farmers indicated that they know, but the other participants were more unsure.

Alternative strategies were initially not considered to be highly relevant or viewed to be not without serious shortcomings. Following the presentations and discussions, a more nuanced picture emerged. For instance the Storm Surge Barrier initially received mixed, relatively neutral reactions. However, following the discussions it received slightly more positive reactions. Doubts were expressed about prohibiting or limiting the development of low-lying land as proposed in the Spatial Planning strategy. Moreover, this measure received even more negative than positive votes after the discussions. Also the use of secondary dikes to create compartments (one of the measures in both the Spatial Planning and Risk Approach alternatives) was less favoured after the discussions, in which the risk of deeper inundations at particular locations was mentioned.

The questionnaire results tend to confirm the relatively low preference for spatial measures, and show a discrepancy between the respondents' preferences and the preferences that respondents believe the authorities have in this regard. However, this could also be attributable to the interpretation of the 'spatial measures' concept as being identical to managed realignment of the coastline. This 'de-poldering' (i.e. giving previously reclaimed land back to the sea) has given rise to a furious debate in the province of Zeeland, that was also clearly noticeable during the workshop discussions.

The stakeholder consultation also brought out elements that were hitherto not acknowledged in the flood risk analysis. For instance, the importance of safety from flooding in ensuring (foreign) investment and the risk that after a flood these companies would not return is something that has received little or no attention. Also it was interesting to note that instead of having their say in selecting and weighing criteria for a risk assessment, participants stressed their worry about the whole procedure of decision making. For example, when it comes to the expropriation of farming land for nature development or to protect the city of Antwerp from flooding, some participants view this as necessary, but would like to see that the procedure goes more rapidly. Such concerns are presently not considered explicitly in a policy process because the public are not involved in the design of the process itself.

4.2.2 *Policy makers: confusion about how to organize the discussion*

The workshop with policymakers focused on the advantages and disadvantages of a new flood risk policy enabling a differentiation of safety standards based on costs and benefits. This approach of which the Risk Approach and Spatial Planning strategies are examples was considered to have economic advantages and to enable practical combinations with spatial planning policy. It would also make people more aware of the flood risk than under the current policy. However, the participants also identified a number of problems, such as:

- A shortage of knowledge;
- Implementation hurdles;
- Communication difficulties;
- Resistance of citizens;
- Institutional complexity.

One of the main problems of this risk approach is that it allows flooding to occur more often than it is currently the case, e.g. in an area with low economic value and low population density. This signifies a leap in thinking about flood risk management in the Netherlands, where protection against flooding was—and still is—the cornerstone of Dutch safety policy. A spatial differentiation in safety levels is difficult to implement because it requires a decision process in which many government levels need to be involved as well as the public and stakeholders. This necessitates a transparent and objective communication of flood risk, which implies that somehow the differences in risk perception between stakeholders, policy makers and scientists need to be bridged.

The new risk approach has been studied and discussed for a long period of time. However, there seems to be little progress in terms of decision-making. Guidance and vision seems to be lacking, which lead to more studies and postponement of decision making. Some workshop participants voiced the concern that the subject is too difficult for public debate and others regarded the discussion to be too much of a hype in the wake of recent media coverage of disasters (such as hurricane Katrina in 2005) and climate change related issues.

However, the workshops and interviews with citizens proved that it is possible to discuss these issues in a sensible and constructive way with those directly involved without the debate becoming emotional or irrational.

5 DISCUSSION POINTS

Despite the exploratory nature of the research, some valuable discussion points can be distilled and addressed under the three main questions of our study (see section 2).

5.1 *Future flood risk along the schelde*

There is little doubt that flood risk along the Schelde tend to increase in the future. If sea level rise does accelerate, this will result in more frequent extreme high water levels, whereas autonomous economic development and population growth result in an increase in potential damage and casualties. The current flood protection policy consisting of strong embankments that can withstand storm surges with a 1/4000 y^{-1} probability is capable to offset the impact of sea level rise for at least the next 25 years (Heijer & Calle 2000). Depending on the scenario of economic development the future flood risk could nevertheless increase significantly, especially in the longer term.

The strategy analysis clearly shows that a significant reduction of flood risk can be reached by investing in a storm surge barrier. After the 1953 flood disaster the Delta Commission explicitly decided not to opt for this measure for the Westerschelde: maintaining free navigation for Antwerp was (and still is) essential. Despite an increase in flood risk over the past 50 years (because of economic development), it is questionable if present or near future conditions would result in a different trade-off. Although technical improvements could nowadays provide a solution that combines safety and navigation demands, the financial and environmental consequences are still excessive.

The two other strategies tend to entail similar or higher risks compared with the current policy. Thus a choice for either of these strategies cannot be motivated primarily from the desire for a reduced flood risk. Other arguments that play a role in the discussion include: costs and benefits, the desire for a more resilient strategy, environmental motives, etc. Since the societal implications of such a change in current flood risk thinking are profound, discussions cannot be limited to the scientific domain.

5.2 *Public perceptions and preferences: a realistic view on flood risk*

Local citizens were realistic and knowledgeable with respect to a possible failure of the flood control system. Even in the Dutch case where relatively high safety standards are present, people have diverse and explicit opinions and knowledge about what to do when things go wrong. Probably, this can be attributed to the fact that the 1953 flood is still present in the awareness of the residents alongside the Schelde estuary. Nevertheless, the shift exhibited by participants at the workshop to spread attention more evenly over the flood risk management phases represents learning by the citizens about the value of redundancy in combating a natural hazard (De Bruijn et al. 2008). Participants also expressed this after the workshop, by indicating a desire for information on potential safe buildings in their area. This indicates a potential change in behaviour from trying to evacuate along a busy, low-lying road to seeking a refuge in the area should a flood occur.

Interestingly, there was a marked difference between local citizens from both countries with respect to the role of the government after the occurrence of a major flood. The Flemish residents were convinced that the state would do as much as it could to help the recovery and were relatively secure in this trust. The Dutch respondents were less convinced. They thought that the Dutch government would do its best, but this would be insufficient and the recovery would have to come from the people themselves.

5.3 *Lessons for public participation in flood risk management*

The Schelde pilot opened three windows of knowledge: the scientific domain where probabilities, models and uncertainties dominate; the local citizens perception and experience of flood risk, that largely remains unused in decision making; and the policy and management institutions, where innovative approaches compete with vested interests, procedures and legislation. Lessons can be learned with respect to: the importance of trust, the use of local knowledge and mutual learning in the communication process.

5.3.1 *The importance of trust*

Appropriate communication implies an open exchange of information based on recognition of equality and mutual trust. A lack of trust between stakeholders was illustrated in the discussions on managed realignment along the Westerschelde. Over the past 15 years this item of 'de-poldering' appeared on the political agenda several times, but with different arguments. Safety reasons and nature compensation were alternately put forward and thus made people sceptical about the real reasons. Scientific evidence plays a minor role here, not in the least because there is not yet enough knowledge about long-term hydro-morphodynamic consequences of 'de-poldering' as a measure (Jeuken et al. 2007).

5.3.2 *Relevant local knowledge*

Prior to the study we were concerned as to whether we would even be able to identify relevant local knowledge regarding flooding and the danger of flooding amongst the citizens selected for the study. But we found a depth of understanding of their living environment amongst the people of the Schelde that astonished us. Especially those persons with professions providing them with primary contact with the water, showed an understanding of flooding comparable with that of the scientists. However, local knowledge of the consequences of flooding and the post-flood recovery went deeper than scientific understanding. Also their comments regarding the (lack of) utility of some of the planned policy measures to promote safety from flooding were confirmed as valid by policy makers. In fact, the policy advisors were also surprised by the high quality of the information derived from the study and felt challenged by the request for precautionary post-flood planning measures.

5.3.3 *Social learning process*

The Schelde pilot has demonstrated the value and feasibility of involving citizens, scientists and policy makers in framing a future flood risk management strategy. Clearly, this process of strategy formulation does not and should not follow a strict sequential number of steps such as *risk analysis* → *risk assessment* → *measures*. Our experiences support the statement of Hutter (2006) that 'strategy processes do not always follow a simple step-by-step logic to solve complex and dynamic problems' (Hutter, 2006, p.235). Instead, this process requires iteration in which frequent and open discussions among the different groups exchange ideas and facts. Indeed, it is in a social learning process where participants acquire new knowledge from others and create new knowledge (cf. Siebenhuner & Barth 2005).

6 CONCLUDING REMARKS

Our experiences from this study offer insights on the benefits of using science and engineering in a participative approach to flood risk management. Yet it is difficult to derive general conclusions from these experiences. There are two reasons for this. In the first place it must be acknowledged that the discussions between the different groups of people were held in a research context instead of a real policy making process. Had real decisions to be made, it would have been likely that elements of strategic or tactic nature would interfere with the content of the discussions. This could especially affect the necessary trust and the success of social learning. To our opinion, however, this only underlines the importance of providing criteria for the participatory planning process. In this respect, it is illustrative that the respondents in our study provided criteria for the planning process itself rather than for the detailed measures therein. This indicates that it is public involvement in its design that could potentially lead to improvements in the quality of the planning process and its results.

Secondly, we have to be careful to use the results of this case study for other flood prone areas and situations. The observed differences in risk perceptions and preferences between the Dutch and Belgium part of the Schelde estuary show how important physical and cultural characteristics are in this respect. Indeed, in Europe a great diversity can be found with regard to hazard, risk, awareness and preparedness. But it is our conviction that only through a participatory approach that this diversity is discovered and accounted for in flood risk management.

ACKNOWLEDGEMENTS

We are grateful to the respondents for their willingness to share with us their concerns and their experience of living and working on, or near, the Schelde Estuary. The work described in this presentation was supported by the European Community's Sixth Framework Programme through the grant to the budget of the Integrated Project FLOODsite, Contract GOCE-CT-2004-505420.

REFERENCES

Bruijn, K.M. de, Klijn, F., McGahey, C., Mens, M.J.P & Wolfert, H. 2008. Long-term strategies for flood risk management: scenario definition and strategy design. Final report on Task 14 of FLOODsite. Report no. 14–05–01. Delft Hydraulics, Delft, The Netherlands.

Bruijn, K.M. de, Mens, M.J.P. & Klijn, F. 2008. A method for developing long-term strategies for flood risk management. Paper Int. Conference FLOODrisk 2008, 30 September—2 October, Oxford.

Evans, E.M, Ashley, R., Hall, J., Penning-Rowsell, E., Saul, A., Sayers, P., Thorne, C. & Watkinson, A. 2004a. *Foresight. Future flooding. Scientific Summary: Volume I—Future risks and their drivers.* Office of Science and Technology, London, UK.

Evans, E.M, Ashley, R., Hall, J., Penning-Rowsell, E., Saul, A., Sayers, P., Thorne, C. & Watkinson, A. 2004b. *Foresight. Future flooding. Scientific Summary: Volume II—managing future risks.* Office of Science and Technology, London, UK.

EU 2007. Directive 2007/60/EC of the European parliament and of the council of 23 October 2007 on the assessment and management of flood risks. *Official journal of the European Union.* 6.11.2007. L 288/27.

FLOODsite 2008. Webpage accessed 3 June 2008: http://www.floodsite.net/html/flood_risk.htm

Gerritsen, H. 2005. What happened in 1953? The Big Flood in the Netherlands in retrospect. *Philosophical Transactions of the Royal Society A*, **363**.

Gouldby, G. & Samuels, P. 2005. *Language of Risk.* FLOODsite Consortium. T32-04-01.

HarmoniCop 2005. *Learning together to manage together. Improving participation in water management*. Ridder, D., Mostert, E. & Wolters, H.A. (eds.). Osnabruck, Germany: Drukhaus Bergmann

Heijer, F. den & Calle, E.O.F. 2000. *Lange termijn visie Schelde estuarium, grenzen aan dijkverbetering.* H3633. Delft: Delft Hydraulics.

Hutter, G. 2006. Strategies for flood risk management—a process perspective. In: Schanze, J., Zeman, E. & Marsalek, J. (eds.) Flood Risk Management—Hazards, Vulnerability and Mitigation Measures. pp. 229–246. Berlin: Springer.

Jeuken, M.C.J.L., Wang, Z.B., & Keiller, D. 2007. Impact of setbacks on the estuarine morphology. In Dohmen-Janssen, C.M. & Hulscher, S.J.M.H.: 5th IAHR Symposium on River, Coastal and Estuarine Morphodynamics. *River, Coastal and Estuarine Morphodynamics* 2, pp. 1125–1132. 2007. Taylor & Francis.

KNMI 2006. *KNMI Climate Change Scenarios 2006 for the Netherlands.* De Bildt: KNMI Scientific Report WR 2006–01.

Kok, M., Lammers, I.B.M., Vrouwenvelder, A.C.W.M. & Braak, W.E.W. & van den 2006. *Standaardmethode2006-beta. Schade en Slachtoffers als gevolg van overstromingen.* PR1190.10. Delft: Rijkswaterstaat DWW/HKV Lijn in water/TNO Bouw.

Krywkow, J., Veen, A. van der & Filatova, T. 2008. Flood risk perceptions in the Dutch province of Zeeland. Paper Int. Conference FLOODrisk 2008, 30 September—2 October, Oxford.

Krywkow, J. & Speil, K. 2007. Introducing theoretical insights of participatory methods into the practical work of water managers. Basel: CAIWA, November 2007.

LTV 2001. *Langetermijnvisie Schelde-estuarium* (in Dutch). Dutch Ministry of Transport, Public Works and Water Management. Middelburg: Directorate Zeeland. 88pp.

Office of Science and Technology 2004. *Foresight Future Flooding – Executive Summary,* Office of Science and Technology, London, UK. Available at web site www.foresight.gov.uk

Siebenhuner, B. & Barth,V. 2005. The role of computer modelling in participatory integrated assessments. *Environmental Impact Assessment Review*, **25,** 367–389.

Slinger, J.H. & Cuppen, M.E. & Marchand, M. 2008. The policy preferences of citizens, scientists and policy makers. Paper Int. Conference FLOODrisk 2008, 30 September—2 October, Oxford

Van der Werff, P.E. 2003. Multiple stakeholder responses to flood management plans for Rhine river system. In: Marchand, M., Heynert, K., Most, H. van der, & Penning, W.E. *Dealing with flood risk. Proceedings of an interdisciplinary seminar on the regional implications of modern flood management*: 70–85. Delft: Delft University Press. Delft Hydraulics Select Series.

Zanting, H.A., Ten Thij, F., Coosen, J. & Claessens, J. 2002. Developing a bilateral long term vision for the Scheldt Estuary. Paper presented at IAIA'02, 22nd annual conference of the International Association of Impact Assessment "*Assessing the Impact of Impact Assessment*", May 2002, The Hague, Netherlands.