International comparative analysis of flood risk management measures and adaptation policies

Work package leader : Prof. dr Jeroen Aerts

Content

1 Description work package

1.1 Problem definition, aim and central research questions

Economic losses caused by natural disasters have increased significantly in recent decades (Munich Re, 2008). The impact of natural hazards on European societies and economies is likely to increase in the future due to two complementary trends. Firstly, climate change is expected to increase the frequency and severity of climate-related events. Secondly, the economic impact is increasing due to the growing number of people living in flood-prone areas, as well as increased economic activity in these areas (e.g. Bouwer et al., 2007; Höppe and Pielke, 2006).

Flood risk management, whereby flood risk is defined as flood probability multiplied by potential flood damage, addresses both these trends (e.g. Büchele et al., 2006; Merz et al., 2004). Adaptation measures may (1) lower the probability of flooding, (2) reduce the potential damage; or (3) transfer risks. Examples in the first group include embankments to prevent flooding. Examples in the second group include risk zoning and building codes. Risk transfer covers the residual risks, i.e. those risks that remain after risk reduction measures have been implemented; for those insurance and other financial instruments (e.g. catastrophe-bonds or weather-derivatives) play an important role.

All these types of measures have been studied and implemented, but to date there is no comprehensive assessment of the effectiveness of combinations of these measures. For example, in the Netherlands flood risk management follows a flood protection strategy with embankments and storm surge barriers with only minor attention for damage reduction. Flood insurance is not available. In the UK, a fully private flood insurance system is in place that influences spatial development and building practice, but following recent floods questions are being raised whether government investments in flood defense are lagging behind. In Germany, a body of research exists on the effectiveness of local flood damage reduction measures.

The main objective of this WP is to perform an assessment of flood risk management practices abroad and of their applicability to the Netherlands' situation. To this end, we defined the following four projects:

- 5.1 Adaptation to flood risk, the role of insurance: how can flood insurance arrangements be used to spread risks in such a way that it assists communities and nations in adapting to climate change and increasing flood-hazards?
- 5.2 Flood risk management under conditions of uncertainty, an international comparison: international review of how flood risk management policy is being adapted to the highly uncertain sea level rise projections, with a focus on the possibilities of a risk- based approach under conditions of deep uncertainty
- 5.3 Local flood damage reduction: international review to gain more knowledge about the potential of flood damage mitigation measures, more specifically flood risk zoning, spatial planning and regulations for building precautionary measures.

- 5.4 Synthesis and translation to Dutch situation: This activity integrates the different international studies and translates the results into recommendations for flood risk management in the Dutch situation.

1.2 Interdisciplinarity and coherence between the projects

We will work with specialists from different disciplinary backgrounds (earth sciences, geography, engineering) but with due experience in inter- and transdisciplinary research, ensuring a complementary research team covering state-of-the-art research in flood risk management.

The first two projects focus on different measures to reduce flood impacts , viz.through risk transfer and local damage reduction by technical measures. The third shows the governance requirements needed to move towards a risk-based management policy. The fourth translates the foreign experiences to the Netherlands cultural and physical context and draws together the conclusions on these kind of non-structural measures.

All studies are internationally oriented and follow a comparative structure. Recommendations will be made on how international experience can be applied toin the Netherlands flood risk management policy. The outcomes will be directly used in WP4.

1.3 Stakeholders

The Hotspots Large Rivers and Rijnmond Region have indicated their interest in research into flood damage reducing measures, building codes, and new flood risk management measures and instruments. We shall involve stakeholders in the Rijnmond Region (Waterboards, Cities of Rotterdam and Dordrecht, Port of Rotterdam, and private companies currently working on KfC-projects) during the research process through interviews and workshops to develop an “Open Rijnmond Estuary Strategy” (WP4 in co-operation with WP1).

The research team has vast networks, for example to: EU-FLOODsite, Thames 2100, Delta Alliance, Connecting Delta Cities (CDC), Munich RE, ABI, the Wharton Business School. As a part of the CDC network, we envisage a further strengthening of the co-operation between the Cities of Rotterdam, London, Hamburg, Jakarta, and New York.

Project 5.1 Adaptation to flood risk: the role of insurance

Project leader: Prof. Edmund Penning-Rowsell

1.4 Problem definition, aim and central research questions

The central question in this research is how far can flood insurance arrangements be used as risk-spreading mechanisms to assist communities and nations to adapt to climate change and the resulting increased flood risk. The aim of the research, based on a UK study, is to determine how far the arrangements there might be adopted (and suitably amended) by other countries, including the Netherlands.

The country study is that of the UK, where internationally unique insurance arrangements have been in place for the last 50 years. Indeed, flood insurance underpins much flood risk management policy in the UK (Defra, 2005), in contrast to practice elsewhere (Green and Penning-Rowsell, 2004). To ensure that flood insurance cover remains widely available, the government has agreed a “Statement of Principles” with the Association of British Insurers (ABI) that sets out the commitments from the insurers to maintain flood cover for the majority of domestic and small business properties at risk in exchange for complementary commitments made by the Government on levels of investment in flood risk management.

Flood insurance is widespread in the UK, but not universal. Based on the government’s Household Expenditure Survey and evidence from its own members, the Association of British Insurers (ABI) estimates that the take-up of insurance in the UK is such that 93% of all homeowners have buildings insurance cover, although this falls to 85% of the poorest 10% of households purchasing their own home (where this insurance is a standard condition of a UK mortgage). Some 75% of all households have home contents insurance, although half of the poorest 10% of households do not have this cover.

Therefore the research questions are:

1. How does flood insurance feature within the portfolio of structural and non-structural flood risk management measures in play in the UK today?
2. What has been the historical evolution of flood insurance in the UK: what have been the driving forces and the important contextual features?
3. What have been the relations between flood insurance and government flood risk management policy in the past, and what are those relations today?
4. What is the character of domestic and commercial flood insurance today in the UK, and what are the perceived strengths and weaknesses in these arrangements (and their sustainability), as seen by the key stakeholders involved?
5. What international comparisons are useful to add further insight into the UK scene (e.g. USA; France)?
6. How does the insurance community assess flood risk, and how does climate change feature in risk assessments for the future?
7. What are the distributional effects of flood insurance in the UK and how far do these limit the efficiency and effectiveness of insurance as an adaptation measure?

1.5 Approach and methodology

The approach is one of detailed policy analysis using:

- ∇ Historical analysis (documentary evidence of policy character and change).
- ∇ In-depth interviews of a range of stakeholders/actors within and outside the insurance industry, including government and government agencies (up to 30 such interviews).
- ∇ Selected interviews with insurance policy holders to determine:
    - the nature of the incentives (and disincentives) they face to purchase flood insurance cover today and with increased risk in the future;
    - the degree of penetration of cover now, and its current trends;
    - claims experience in the past (1998; 2000; 2005; 2007 and 2009 floods in the UK).
- ∇ Synthesis of results and the development of recommendations.

1.6 Scientific deliverables and results

The deliverables will be:

1. An inception report refining the research domain and the research questions (month 3)
2. An intermediate report based on research questions 1-3 above (month 12)
3. A final report on the project (month 24)
4. At least two papers in internationally peer reviewed outlets (e.g. journals; book chapters).

1.7 Integration of general research questions with hotspot-specific questions

The Hotspot Rotterdam as well as the city of Dordrecht have indicated that they would like to learn how flood insurance could be developed for the " Buitendijkse gebieden" (areas outside the protection of dikes). For these areas, flood insurance would be an interesting option. We will show the experience in the UK with flood insurance and how an insurance arrangement is an incentive for flood damage reduction and the development of building codes.

1.8 Societal deliverables and results

1. Advice to the cities of Rotterdam and Dordrecht and flood risk management agencies about the potential use of flood insurance as a flood risk adaptation measure.
2. Advice to the insurance industry about its future role in relation to climate change induced rises in flood risk.
3. An overview of the UK experience of how flood insurance can stimulate measures to reduce flood damage.

1.9 Most important references

1. Green, C.H., Penning-Rowsell, E.C., 2004. Flood insurance and Government: “Parasitic” and “Symbiotic” Relations. The Geneva Papers on Risk and Insurance – Issues and Practice, 29(3), 518-539.
2. Priest, S. et al., 2006. Confronting flood risk: implications for insurance and risk transfer. Journal of Environmental Management, 81(4), 351-359.
3. Evans, E., Ashley, R., Hall, J., Penning-Rowsell, E., Sayers, P, Thorne, C., Watkinson, A. 2004. Foresight. Future Flooding, Volume I and Volume II: Office of Science and Technology, Department of Industry, London, UK.
4. Evans, E.P., Hall, J.W., Penning-Rowsell, E.C., Saul, A., Sayers, P.B., Thorne, C.R., Watkinson, A.R., 2006. Drivers, responses and choices for future flood risk management. Proceedings, Institution of Civil Engineers, Water Management, 159, 53-61.
5. Thorne, C., Evans E.P., Penning-Rowsell, E.C., 2007. Future Flooding and Coastal Erosion Risks. Thomas Telford, London, UK.
6. McFadden, L., Nicholls, R., Penning-Rowsell, E.C., 2006. Managing coastal vulnerability. Elsevier Science, Oxford, UK.
7. DEFRA, 2005. Making Space for Water: Taking forward a new Government strategy for flood and coastal erosion management. DEFRA, London, UK.
8. Johnson, C., Penning-Rowsell, E.C., Parker, D.J., 2007. Natural and imposed injustices: the challenges in implementing ‘fair’ flood risk management policy in England. Geographical Journal, 173(4), 374-390.
9. Johnson, C., Penning-Rowsell, E., Tapsell, S., 2007. Aspiration and reality: flood policy, economic damages and the appraisal process, Area, 39(2), 214–223.
10. Penning-Rowsell, E.C., Johnson, C., Tunstall, S.M., 2006. ‘Signals’ from pre-crisis discourse: Lessons from UK flooding for global environmental policy change? Global Environmental Change, 16, 323–339.
11. Penning-Rowsell, E.C., Wilson, T., 2006. Gauging the impact of natural hazards: the pattern and cost of emergency response during flood events. Transactions, Institute of British Geographers, 31(2), 9-15.
12. Parker, D.J., Penning-Rowsell, E.C., 2005. Dealing with Disasters. In: Hunt, J. (ed.) London's Environment: Prospects for a Sustainable World City. Imperial College Press, London, UK, 175-201.
13. Johnson, C.L., Tunstall, S.M., Penning-Rowsell, E.C., 2005. Floods as catalysts for policy change: historical lessons from England and Wales. International Journal of Water Resources Development, 21, 561-575.

2 Project 5.2 Flood risk management under conditions of uncertainty, an international comparison

Project leader: Natasha Marinova

2.1 Problem definition, aim and central research questions

A number of countries (e.g., the Netherlands, UK, US, Australia, Germany, Italy) have started to reconsider their policies for flood protection, taking into account the projected climate change (Delta Committee, 2008; Murphy et al, 2009; Munaretto et al, 2009; House of Representatives, 2009). In this project it will be analyzed and compared how the current policies and management practice of these countries and especially their urbanized deltas address the challenge of adapting to anticipated sea level rise, which options and approaches they consider, how they deal with the uncertainty in (extreme) climate, whether or not there are policy tools that handle uncertainty in the sea level projections and how these tools enable the policy makers to deal with incomplete knowledge, how these countries balance among current and future goals for coastal protection and what is their perception of urgency.

Adaptation to climate change could be considered as a transition to more robust, “climate proof” technology. As policy-makers and other social actor are starting to seek effective ways to control and encourage this transitional process, it could be very helpful to use the insights, generated within the transition framework on: how other countries attempt to avoid early lock-ins, taking into account the large uncertainties in the long term sea level projections; what is their attitude toward the path dependency – can they change their trajectories and do they need and like to change it; do they go for incremental or for radical changes, for stable or for robust options?

Geels (2004) defines the transition as a shift from one socio-technical system to another and emphasizes that “existing systems are locked in at multiple dimensions, they are stable and not easy to change”. Complex adaptive systems exhibit strong path-dependence and while they still undergo changes, more often these changes are incremental and reinforce existing technical trajectories. As long as the climate changes incrementally and taking into account the lock-ins and path dependency, adaptation will be most probably an incremental process.
Advantages of incremental changes include low risk and measurable short term benefits. On the other hand radical changes may have the opportunity to generate more co-benefits than incremental changes and are likely to be more effective and less costly in the long run. Rretrofitting technological solutions could be also very costly and in some cases even prohibitively expensive. Radical changes require, however, more foresight and a strong preparedness for proactive investment. They will require a lot of concerted efforts, because they can not be brought about only by the replacement of one technology or sea defense option with another, but, as every radical change, are coevolution of technological and social changes (e.g., Rotmans et al., 2001; Geels, 2004; Elzen et al., 2004). Therefore, in this study both technological and social changes will be taken into account.

The technological and social co-evolution requires changes on multiple levels: micro (niche), meso or regime (it refers to the existing institutions, regulations, networks etc.) and macro or landscape (a broad exogenous environment that can not be changed by the actors, like climate change, globalisation, etc.) According to the transition theory, system transition is initiated when a'window of opportunity' emerges: this happens when a pressure from the landscape coincides with a regime instability. Novelties emerge at micro-level and move to macro-level, become established and help to strengthen new practices, skills, norms and networks. Such new emergent new practices, skills, norms and networks and the existent multilevel governance will be a focus of the proposed research.

The main research questions for this study is therefore: What policy responses to the (uncertain) long term sea level projections can be distinguished in the selected countries and what determines these responses? Are there transferable innovative practices, which could be deployed in the Dutch coastal protection as well?

2.2 Approach and methodology

For this analysis process of climate proofing the coastal defense will be approached as a transitional issue. The reason to choose for this approach is threefold:

1. The transition framework offers analytical tools for structuring and explaining the behaviour of socio-technological systems.
2. Transition management offers a novel perspective on multilevel governance that tries to improve the interaction between different levels of government.
3. This management paradigm starts from complexity and uncertainty as triggering mechanism of societal innovation, not as obstacles that have to be fully controlled" (Rotmans et al., 2001).

This study will be conducted in three steps: 1) desk study research will be performed for each of the selected countries; 2) unstructured interviews will be conducted with policy makers from the case study countries; the findings of the desk study and interviews will be analysed and compared.

These steps should not be considered as temporal consecutive phases. In this study rather the principles of grounded theory will be deployed – using a constant comparative analysis, whereby data collection and data analysis occur on an ongoing basis. All new data will be analysed immediately and the outcome of this analysis will dictate the direction of new data search. Therefore it will not start with hypothesis formulation, but will formulate and try to test hypotheses it in the course of the research.

2.3 Scientific deliverables and results

At least

1. One publication in peer reviewed journals.
2. One conference presentation.

2.4 Integration of general research questions with hotspot-specific questions

The project will produce up-to-date overview of how other countries address the challenge of adapting FRM policy to climate change. It will give insight into the current best practices and many economic, social, cultural, regulative and infrastructural constraints, encountered by other countries in their efforts to improve their ability and capacity to implement and control adaptation processes. These insights will be helpful for the hot-spots in addressing their own “climate-proof” transitions.

2.5 Societal deliverables and results

At least

1. One publication in non-scientific journal
2. One workshop

This project will contribute also to the research basis of the new established Delta Alliance Network.

2.6 Most important references

1. Berkhout, F., Smith, A.and Stirling, A. ,2004. Socio-technological regimes and transition contexts. SPRU Electronic Working Papers, 106
2. Dessai, S., Hulme, M., Lempert, R., and Pielke Jr., R. 2009. Do we need better predictions to adapt to a changing climate? EOS Transactions, American Geophyiscal Union, 90(13), 111–112
3. Cayan, D., M. Tyree, M. Dettinger, H. Hidalgo, T. Das, and E. Maurer., 2008. Climate Change Scenarios and Sea Level Rise Estimates for California 2008 Climate Change Scenarios Assessment
4. Gerrits L., Marks P., 2008. Complex bounded rationality in dyke construction. Path-dependency, lock-in in the emergence of the geometry of the Zeeland delta Land Use Policy, 25 (3), pp. 330-337
5. Klauer, B., and J. D. Brown, 2004. Conceptualising imperfect knowledge in public decision making: ignorance, uncertainty, error and “risk situations”, Environmental Research, Engineering and Management 27(1):124–128
6. Lempert, R. J., Groves, D.G., Popper, S.W., and Bankes, S. C. ,2006. A general, analytic method for generating robust strategies and narrative scenarios, Management Science, 52(4), 514–528
7. Lempert, R.J., and M.T. Collins, 2007. Managing the risk of uncertain thresholds responses: comparison of robust, optimum, and precautionary approaches, Risk Analysis, 27, 1009-1026
8. Munaretto, S., Marinova, M., Vellinga, P., 2009. Adaptation to climate change in coastal zones: An analysis of the interventions to safeguard Venice and its lagoon, presentation at Climate change congress, 10-12 March, Copenhagen, session 35: Adapting Coastal Zone and Marine Resources to Climate Change
9. Murphy, J. M., Sexton, D. M. H., Jenkins, G. J., Booth, B. B. B., Brown, C. C., Clark, R. T., Collins, M., Harris, G. R., Kendon, E. J., Betts, R. A., Brown, S. J., Humphrey, K. A., McCarthy, M. P., McDonald, R. E., Stephens, A., Wallace, C., Warren, R., Wilby, R., Wood, R. A., 2009. UK

Climate Projections Science Report: Climate change projections, Met Office Hadley Centre, Exeter

10. Rotmans, J., Kemp R. and van Asselt, M., 2001. More Evolution than Revolution; Transition Management in Public Policy', Foresight, 3(1), pp. 15-31
11. Sterr, H., 2008. Assessment of vulnerability and adaptation to sea-level rise for the coastal zone of Germany. Journal of Coastal Research, 24(2), 380–393
12. Tol, R.S.J.; Klein, R.J.T., and Nicholas, R.J., 2008. Towards successful adaptation to sea-level rise along Europe's coasts. Journal of Coastal Research, 24(2), 432–442
13. Vellinga, P., Katsman C.A., A. Sterl and J.J. Beersma, (eds), 2008.Exploring high end climate change scenarios for flood protection of the Netherlands: - an international scientific assessment in: Working together with water, A living land builds for its future, Findings of the Deltacommissie 2008
14. Willows, R. I. & Connell, R. K. (Eds.),2003. Climate adaptation: Risk, uncertainty and decision-making. UKCIP Technical Report. UKCIP, Oxford

3 Project 5.3 International review of measures to reduce flood damage

Project leader: Prof. dr. Bruno Merz

3.1 Problem definition, aim and central research questions

Damage due to disasters has dramatically increased during the last few decades, and further increases are also expected due to climate change (Munich Re, 2003). Combined structural and non-structural flood mitigation measures seem like promising adaptation measures (Hayes, 2004), since they take into account that flood defence systems may fail, and prepare for such unexpected crisis situations.

Significant economic benefits are expected from non-structural options like flood risk zoning and spatial planning policies, as well as building precautionary measures like elevated configuration, shielding with water shutters or sand bags, waterproof sealing, and fortification or safeguarding of hazardous substances. It is believed that these measures are especially effective in areas with frequent flood events and low flood water levels (ICPR, 2002), but some also showed a significant mitigation effect during the extreme flood event at the Elbe river in August 2002 in Germany (Kreibich et al., 2005).

Precautionary measures are often voluntary, and undertaking measures demands self dependent action by the potentially affected population (Heiland, 2002). Therefore, it seems to be helpful to install or extend historical flood marks immediately after an event, to implement flood commemoration days, to carry out regular information gatherings at which the public is informed about private precautionary measures, etc. (Petrow et al., 2006). The application of building precautionary measures may be enforced by building codes. The implementation of flood management in guidelines and legislation supports the consideration of flood risk in decision making.

Information about the potential (e.g. quantitative mitigation effects, operational use), of such flood mitigation measures is scarce. Some empirical studies have been undertaken (e.g. Botzen et al. 2009;

Kreibich et al. 2005). However, an international comparison and structured collection and analysis of information and data about the potential of flood mitigation measures is expected to reveal valuable knowledge for an improved cost effective risk management.

For cost effective flood risk management, more knowledge about the potential of mitigation measures is required. However, (quantitative) information about the damage reducing effects of mitigation measures in different flood situations, as well as the conditions under which such measures are operationally used, are lacking.

The objective of this project is the assessment of the potential of flood mitigation measures, i.e. spatial measures (flood risk zoning and spatial planning) as well as building precautionary measures. Most effective mitigation measures will be identified for different flood situations. Additionally, successful strategies for the promotion of such measures will be described.

In order to address this objective, the following research questions have been formulated:

1. What are the damage reducing effects of various non-structural mitigation measures in different flood situations (e.g. coastal, riverine floods)?
2. To what extent are the measures operationally used in different countries with their different political, legal, and societal conditions?
3. What strategies are used to increase the operational use of such measures in different countries?

3.2 Approach and methodology

The assessment of the potential of flood mitigation measures focuses on spatial measures (flood risk zoning and spatial planning) as well as on building precautionary measures supported by building codes. The assessment will cover the following topics:

- Damage reducing effects of the measures in different flood situations.
- Extent of operational use of the measures under different conditions (e.g. link to building codes, combinations with other measures).
- Governmental and societal perception of the measures (e.g. are they seen in relation to climate change?).
- Strategies (e.g. programmes, financial incentives) to increase the operational use of the measures.

The international information collection and comparison will cover the Netherlands, Germany, the UK and the USA. A literature review including project reports will be undertaken, as well as personal expert interviews. Relevant experts in the different countries will be identified on the basis of the literature review, as well as on advice from the project partners from the Netherlands and the UK. Additionally, as far as possible, empirical data on mitigation measures and their damage reducing effects from the different countries will be collected and analysed. Information from the different countries will be

systemised, and similarities as well as differences identified, so that as much as possible can be learned from international experiences.

3.3 Synthesis of results and the development of recommendations.Scientific deliverables and results

- An inception report refining the research domain and the research questions (month 3)
- An intermediate report based on research questions 1-3 above (month 12)
- A final report on the project (month 24)
- At least two papers in internationally peer reviewed outlets (e.g. journals; book chapters).

3.4 Integration of general research questions with hotspot-specific questions

The Hotspot Rotterdam and the city of Dordrecht have indicated that they would like to learn how flood damage mitigation measures could be used for their flood management strategies. For example, the international experience on flood measures in Hamburg and London could be used as building blocks for an "Open Rijnmond" strategy as described under WP 4.1. We will, therefore, focus on flood damage mitigation measures in urban areas (waterfronts, elevation, etc). For the Hamburg case, we shall focus on adaptive waterfront development and on how building codes have been implemented in architecture to reduce potential flood damage.

3.5 Societal deliverables and results

1. Advice to the cities of Rotterdam and Dordrecht and flood risk management agencies about the options for flood damage reduction.
2. An overview of the international experience, especially in coastal cities, on how flood damage mitigation measures can reduce flood damage.
3. Link to WP 4.1, in order to see how international experience can be used to develop an “Open Rijnmond” strategy (link to the Deltaprogramme).

3.6 Most important references

1. Botzen, W.J.W., Aerts, J.C.J.H., van den Bergh, J.C.J.M.,2009. Willingness of homeowners to mitigate climate risk through insurance. Ecological Economics, 68(8-9), 2265-2277.
2. Hayes, B.D, 2004. Interdisciplinary planning of non-structural flood hazard mitigation. Journal of Water Resources Management and Planning, 130, 15–25
3. Heiland, P., 2002. Vorsorgender Hochwasserschutz durch Raumplanung, interregionale Kooperation und ¨okonomischen Lastenausgleich (Precautionary flood protection by spatial planning, interregional co-operation and economic distribution of burdens) Schriftenreihe WAR 143. Technische Universität Darmstadt, Darmstadt, Germany.
4. ICPR, 2002. Non Structural Flood Plain Management – Measures and their Effectiveness. ICPR, Koblenz, Germany.

5. Kreibich, H., Thieken, A.H., Petrow, T., Müller, M., Merz, B., 2005. Flood loss reduction of private households due to building precautionary measures—lessons learned from the Elbe flood in August 2002. Natural Hazards and Earth Systems Sciences, 5, 117-126.
6. Munich Re, 2003. Topics Annual Review: Natural Catastrophes 2002. Munich, Germany.
7. Petrow, T., Thieken, A.H., Kreibich, H., Bahlburg, C.H., Merz, B., 2006. Land use planning as a measure of flood risk management. Lessons Learned from the Elbe flood in August 2002 in Germany. Environmental Management, 38(5),717–732.
8. Kreibich, H., Thieken, A.H., Grunenberg, H., Ullrich, K., Sommer, T., 2009. Extent, perception and mitigation of damage due to high groundwater levels in the city of Dresden, Germany. Natural Hazards and Earth Systems Sciences, 9, 1247-1258.
9. Kreibich, H.; Thieken, A.H., 2009. Coping with floods in the city of Dresden, Germany. Natural Hazards, 51(3), 423-436.
10. Kreibich, H., Müller, M., Thieken, A.H., Merz, B., 2007. Flood precaution of companies and their ability to cope with the flood in August 2002 in Saxony, Germany. Water Resources Research, 43, W03408, doi:10.1029/2005WR004691.
11. Thieken, A., Kreibich, H., Müller, M., Merz, B., 2007. Coping with floods: preparedness, response and recovery of flood-affected residents in Germany in 2002. Hydrological Sciences Journal, 52(5), 1016-1037.
12. Petrow, T., Thieken, A.H., Kreibich, H., Merz, B., Bahlburg, C.H., 2006. Improvements on flood alleviation in Germany: Lessons learned from the Elbe flood in August 2002. Environmental Management, 38(5), 717-732, doi:10.1007/s00267-005-6291-4.
13. Kreibich, H., Thieken, A.H., Petrow, T., Müller, M., Merz, B., 2005. Flood loss reduction of private households due to building precautionary measures—lessons learned from the Elbe flood in August 2002. Natural Hazards and Earth System Sciences, 5,117–126.

4 Project 5.4 International assessment of flood risk sensitivity to socio-economic developments

Project leader: Dr. Philip Ward

4.1 Problem definition, aim and central research questions

Although Dutch water management focuses traditionally on flood protection, there is a growing interest in a more integrated flood risk management approach whereby flood risk is defined as the probability of flooding multiplied by the potential flood damage. Furthermore, Dutch water managers are preparing for the elaboration of the new European Directive on Flood Risk Assessment and Management (EFD) (Directive 2007/60/EC) which entered into force in 2007, and requires Member States to assess which areas are at risk from flooding, to map flood hazards and risks, and to take adequate and coordinated measures to reduce flood risk. As a result of these continued efforts, several activities in The Netherlands have been developed to assess what international experience can be used for flood risk management.

For example, new flood zoning policies could be used to create space on the long term in vulnerable locations. Or, new building regulations that are commonly implemented in Germany and the UK could be applied in the un-protected areas in The Netherlands to reduce potential flood damage.

A development of a new Dutch flood risk management approach also requires new and or updated modelling techniques. In terms of quantifying flood risks for The Netherlands, the HIS-SSM model is mostly used to estimate potential flood damage for various scenario's. This model is based on the so called 'Standard Method' that uses stage damage functions for describing the relation between water depth and flood damage (Kok et al., 2005). It would be interesting to assess whether international information on building codes could be used in the existing damage functions of the HISS SSM. And also, whether additional damage reducing measures from other countries are effective in The Netherlands. In Europe, methods have been developed to assess flood damages at various scales. In the UK the 'multi-coloured manual' (Penning-Rowsell et al., 2003) often forms the basis for flood risk assessments (as in Hall et al., 2005). In Germany, the HOWAS database contains a few thousand records of flood damage to different buildings from historical floods, and forms the basis of many assessments including the method employed by the IKSR for the Rhine-Atlas (IKSR, 2001). In Flanders (Belgium), Vanneuville et al. (2006) created a method to assess damage based mainly on land use types.

Finally, transitions in flood risk management need institutional change. Hence, socioeconomic and governance aspects need to be assessed on how they stimulate or hinder a risk based approach. An understanding of the transitions to a risk based approach in flood management in other countries may provide recommendations for a flood risk management approach in The Netherlands. And important example is how both spatial planners and water managers can incorporate flood risk maps and impacts of socioeconomic developments when developing short- and long-term plans. And, what kind of institutional cooperation would be needed to achieve the inclusion of flood risk information in spatial planning. Note also that flood insurance in The Netherlands is not available and that new public private partnerships are needed to setup such insurance arrangement.

In this work package we will integrate the previous international assessments (5.1, 5.2, 5.3) and translate these into recommendations for the Dutch situation. In particular, we will connect the Rijnmond case study area (WP4.1) and the development of the HIS-SSM model (WP4.2) to these international activities.

Research questions:

1. What kind of international damage reducing measures are applicable for the Dutch situation, and in particular for the region Rijnmond?
2. What are the main institutional requirements for implementing flood zoning, damage reduction and building regulations in The Netherlands?

Can we use international knowledge on flood risk modelling to update the stage damage functions of the Dutch HIS-SSM model?

4.2 Approach and methodology

The methodology of this project will generally consist of the following activities:

1. This activity organizes international meetings of WP5 researchers to exchange and synthesize information
2. We will link results from the international assessments to stakeholders, and in particular to stakeholders in the Region Rijnmond, for example through workshops and interviews.
3. We will closely cooperate with projects WP 4.1 and WP 4.2 to see how we can incorporate international experience in Dutch flood risk modelling
4. A synthesis report will be written that summarizes the international experience and provides recommendations for the Dutch water management and spatial planners

We, hence, envisage that the findings will be implemented in WP4, and also in the KfC-hotpots (e.g. KfC-Hotspot Large Rivers, Hotspot Rotterdam).

4.3 Synthesis of results and the development of recommendations.Scientific deliverables and results

- ∇ Kick off workshop (month 2)
- ∇ Report on updating existing HIS SSM model (month 12)
- ∇ Stakeholder workshop to communicate international experience (month 18)
- ∇ Synthesis report and peer reviewed overview paper.

4.4 Integration of general research questions with hotspot-specific questions

Much has been stated in the WP overview, but we intent to closely follow the requirements of the Hotspots “Grote Rivieren” and “Rotterdam-Rijnmond”. They have clearly indicated there is a need for research into spatial developments in Coastal Urban areas and how this affects vulnerability to flood risks.

4.5 Societal deliverables and results

- ∇ Advice to stakeholders on the use of flood risk methods for the assessment of the impacts of socioeconomic drivers and land use scenario’s on flood risk
- ∇ Reports and Fact sheets on methods and results of relevance to spatial planning and/or water management
- ∇ The insurance industry is very interested in damage mitigation measures and how this would have an effect on risk premiums. Although we do not have flood insurance in The Netherlands, this activity can learn from flood insurance schemes in other countries and how the private sector can be involved in flood risk management
- ∇ The project contributes to the activities related to the implementation of the EU flood directive which aims at identifying both flood probabilities and flood consequences as well as to develop international agreements on flood risk mapping.

4.6 Most important references

4. Aerts, J., Sprong, T., Bannink, B.A., 2008. Aandacht voor Veiligheid. Leven met Water, Klimaat voor Ruimte, Report number 009/2008. DG Water, www.adaptation.nl.
5. Bouwer, L.M., Crompton, R.P., Faust, E., Höppe, P., Pielke Jr., R.A., 2007. Confronting disaster losses. Science, 318, 753.
6. De Bruijn, K.M., Klijn, F., McGahey, C., Mens, M., Wolfert, H., 2008. Long-term strategies for flood risk management: scenario definition and strategic alternative design. FLOODsite report T14-08-01, www.floodsite.net.
7. Evans, E., Ashley, R., Hall, J., Penning-Rowsell, E., Saul, A., Sayers, P., Thorne, C., Watkinson, A., 2004. Foresight. Future Flooding. Scientific Summary: Volume I. Future risks and their drivers. Office of Science and Technology, London, UK, http://www.foresight.gov.uk/OurWork/CompletedProjects/Flood/index.asp.
8. Hall, J.W., Sayers, P.B., Dawson, R.J., 2005. National-scale assessment of current and future flood risk in England and Wales. Natural Hazards, 36, 147-164.
9. IKSR, 2001. Atlas van het overstromingsgevaar en mogelijke schade bij extreem hoogwater van de Rijn. Internationale Commissie ter Bescherming van de Rijn (IKSR), Koblenz, Germany.
10. Kundzewicz, Z.W., Ulbrich, U., Brücher, T., Graczyk, Krüger, A., Pinkswar, I., Radziejewski, M., Szwed, M., 2005. Summer floods in Central Europe- Climate change track? Natural Hazards, 36, 165-189.
11. Merz, B., Thieken, A.H., Gocht, M., Flood risk mapping at the local scale: concepts and challanges, in Begum, S., Stive, M.J.F., Hall, J. W. (eds.), Flood Risk Management in Europe - innovation in policy and practice. Springer, Dordrecht, The Netherlands.
12. Messner, F., Meyer, V., 2005. Flood damage, vulnerability and risk perception – challenges for flood damage research. In: Schanze, J., Zema, E., Marsalek, J. (eds.), Flood risk management. Hazards, vulnerability and mitigation measures. NATO Science Series, Springer, Dordrecht, The Netherlands, pp.149-168.
13. Messner, F., Penning-Rowsell, E., Green, C., Meyer, V., Tunstall, S., van der Veen, A., Tapsell, S., Wilson, T., Krywkow, J., Logtmeijer, C., Fernández-Bilbao, A., Geurts, P., Haase, D., Parker, D., 2007. Evaluating flood damages: guidance and recommendations on principles and methods. . FLOODsite Project Report No:T09-06-01, www.floodsite.net.
14. Meyer, M., Messner, F., 2005. National Flood Damage Evaluation Methods – A Review of Applied Methods in England, the Netherlands, the Czech Republic and Germany. FLOODsite Project Report Contract No:GOCE-CT-2004-505420, www.floodsite.net.
15. Nicholls, R.J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Château, J., Muir-Wood, R., 2008. Ranking port cities with high exposure and vulnerability to climate extremes: exposure estimates. OECD Environment Working Papers No. 1, ENV/WKP(2007). OECD, Paris, France.
16. Samuels, P., Huntingdon, S., Allsop, W., Harrop, J. 2009. Flood Risk Management: Research and Practice. Taylor & Francis Group, London, UK.

17. Tapsell, S. et al., 2008. Socio-economic and ecological evaluation and modelling methodologies. FLOODsite Project Report No:T10-07-13, www.floodsite.net.
18. Ward, P.J., Marfai, M.A., Yulianto, F., Hizbaron, D.R., Aerts, J.C.J.H., forthcoming. Rapid assessment tool for coastal inundation exposure and damage estimation: a case study for Jakarta, in prep. Based on Marfai, M.A., Yulianto, F., Hizbaron, D.R., Ward, P.J., Aerts, J.C.J.H., 2009. Preliminary assessment and modeling the effects of climate change on potential coastal flood damage in Jakarta. IVM, VU University Amsterdam, The Netherlands.