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2015

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citation for published version (APA)

Becker, G. (2015). *Adaptive flood management: Institutional challenges and opportunities in the German Rhine basin*.

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Summary

In Germany, recent flood events had disastrous consequences despite growing investments in preventive measures and intensified efforts in disaster management. The risk of economic losses and fatalities is even expected to increase, due to climate change, economic growth and human settlement in vulnerable regions. The high degree of damage from the recent floods in Germany does not reflect a lack of technical knowledge or resources, but rather a low level of public risk awareness, deficiencies in institutional performance and an insufficient understanding of how to cope with the inherent (future) uncertainties and complexity of flood management.

The goal of this thesis is to assess the political changes and progress of German flood management during the previous four decades, and to discuss the lessons we can draw from this when anticipating future changes. The focus is on the role of institutions, how they cope with the challenges of the transition and how they foster the introduction of new management concepts as adaptive co-management (ACM) while reducing the vulnerability of the society. ACM emphasises the need for the collaboration of the state with stakeholders and the public. Above all, it includes a focus on the *adaptability* of governance, i.e., on the capacity to adjust in response to external perturbations (such as extreme flood events), with the aim to moderate harm or to exploit beneficial opportunities.

Institutional changes in German flood management: drivers and barriers

During the previous four decades, German flood management has been transformed from a ‘flood protection, engineering perspective’ towards a more holistic, adaptive concept with a precautionary, collaborative and risk-orientated perspective (Chapter 2). These changes comprise an adjusted balance of ‘hard’ and ‘soft’ mitigating measures, including the combination of ‘nature and safety’ through additional water storage (the ecological ‘*more space for water*’ concept), a basin-wide flood prevention program (Flood Action Program [FAP]), an increase in the active involvement of stakeholders and water-related sectors, and a new national flood legislation restricting land use in flood-prone areas. The policy changes starting in the 1970s were often induced by drivers or triggers, such as extreme flood events and new environmental and democratic discourses. This study also illustrates the importance of leadership or individual change agents (*‘policy entrepreneurs’*), to conceive of innovative ideas and

get those realized by their ability to link experimentation in pilot projects with formal policy formulation. However, there are also signs that the transition has not yet been completed. Jurisdictional barriers between, e.g., federal states, still restrict joint planning, knowledge dissemination and funding. The implementation of risk-reducing measures is, therefore, frequently delayed by complicated and time-consuming application procedures, in combination with a reluctant interplay between administrative levels and an inadequate or ad hoc involvement of stakeholders and the public.

Towards a new basin-wide Rhine strategy

The establishment of effective flood risk management in a transboundary river basin such as the Rhine, ideally follows one common, transboundary flood management strategy. This thesis addresses this issue by exploring the cooperation between Germany and the Netherlands in the Rhine basin, and their differences in flood management styles (Chapter 3). In both countries, the principles of adaptive flood management, and the need for coordinated strategies, are widely acknowledged, as shown for example by the Action Plan for Floods under auspices of the International Commission for the Protection of the Rhine (IKSR) or the Dutch-German Working Group on Floods. However, the research also revealed a number of significant differences in institutional structure, policy and approach. Dutch flood management is nationally dominated, with a high political and societal focus and an affirmative priority on safety. This resulted in one national ‘*Delta program*’, with a clear long-term vision, dedicated budgets and regional and local involvement. Flood protection standards are fixed in the legislation. In Germany, flood management is distributed across the different federal states and communities with weak national responsibilities, leading to divergent safety strategies and standards, the fragmentation of resources and a lack of cross-border cooperation and operational responsibilities. The planning horizon is short term as compared to the Dutch approach, and oriented on ‘damage minimisation’, for example by land use restrictions, promoting disaster management and self-responsibility. Complicated approval procedures and insecurities or overlapping regarding operational responsibilities result in the delayed implementation of flood risk-reducing projects, and demonstrates the need for more common goals across actors and synchronisation of mitigation measures in the Rhine basin.

Institutional prescriptions for Adaptive Co-Management (ACM)

To analyse the changes in German flood management, four institutional prescriptions have been used that are central to the Adaptive Co-Management (ACM) concept: ‘*polycentricity*’, the distribution of responsibility across different centers and levels; ‘*a bio-regional approach*’, the definition of the river basin as the administrative

unit; *'public participation'*, the involvement of the public in the decision process; and *'experimentation'*, the development, testing and monitoring of new ideas and political options (Chapter 4). The findings suggest a substantial application of these prescriptions in the transition process during the previous decades. *Experimenting* resulted in new flood management strategies (such as *'more room for the water'*) and concepts, and finally in the national institutionalization of the Flood Control Act (2005) and the Federal Water Act (2010) with stricter rules for spatial development, clearer procedures for disaster management and cross-border cooperation. The *poly-centric structure* enabled specific solutions and increased the innovative capacity. Certain weaknesses became also evident, in cases of weak coordination and cooperation between the federal states, in shortcomings of vertical interplay, in the limited involvement and strategic freedom of the lower and local administrative levels, and in the frequently-restricted dialogue between flood-related sectors. The *bio-regional* prescription recognises the need to “manage water across administrative borders.” A good example is the Flood Action Plan (FAP), which was established by the International Commission for the Protection of the Rhine, and synchronised the individual flood-retention projects of the federal states. Yet, the state sovereignty and the individual interests of the federal states (and countries) remain dominant, hampering dissemination of information and harmonisation of flood protection standards. The research shows earlier *participatory processes* in the planning and decision process, increased use of local capacity and delegation of responsibilities to lower administrative levels (e.g., the development of the retention polders Hördt and Ingelheim). However, research also shows that this style of participation and bottom-up governance is not yet common practice.

Risk perception of municipal officials and local intention to cope with future floods

Risk perception appears to be an important factor in the interpretation of flood hazards, and influences the decision making and the behaviour of flood managers to minimise risk. To capture the effect of risk perception on flood management at the communal level, a telephone survey was conducted in 70 municipalities and eight dike or river associations along the German part of the Rhine and in the Neckar valley. The results (Chapter 5) show that floods are ranked by the panellists as the top hazard as compared to e.g. wind storms or industrial hazards. Seventy five percent of the officials interviewed stated that their municipality has been hit by a major flood within the previous two decades, and with a damage level that was higher than expected. The data indicate that larger municipalities are better prepared, have larger funds and at the same time higher risk perceptions and levels of awareness. The survey also hints to the complex nature of risk appraisal and of different interpreta-

tions of risk and preventive behaviour. The high level of perceived risk, of worry, or of the demand for additional mitigating action, as expressed by the majority of the panel members (70 – 80 %), seems to conflict with their optimistic perception of preparedness (85 %). This calls for a more profound understanding of the actual risk level and the status of preparedness, in order to provide guidance for preventive management at the municipal level.

Recommendations for policy and research

Effective interplay and collaboration to counter fragmentation

The empirical findings demonstrate that the German flood management regime in the Rhine is fragmented across multiple jurisdictions, sectors and political and administrative hierarchies. Different interests and responsibilities create barriers, uneven distribution of resources and diverse perspectives of flood risk. Collaborative governance and institutional adjustments offer promising opportunities to overcome the barriers. This requires a more effective institutional interplay, vertically between the different levels of the political and administrative hierarchies, and horizontally between the different water-related sectors (particularly spatial development), organizations and municipalities. A review of the traditional responsibilities and procedures could encourage a debate on mutual interests, claims and common goals, and on better involvement of the relevant actors of different levels at the different stages of the planning and decision process. For example, information can be jointly collected across sectors and flood standards harmonised. Common strategic goals can be agreed upon in joint river basin plans, covering both flood management and zoning measures. It is also suggested to reflect on the institutional arrangements at the river basin level, in particular on the institutional barriers of state sovereignty and on the discourse of solidarity, as formalised in the EU Flood Directive, and which is differently interpreted by authorities along the river.

Re-framing the flood risk

Helpful for mediating a transformative learning process would be a ‘re-framing of flood risk,’ so that it can be better understood and accepted by the actors involved as a national task, but also by the affected public and stakeholders. The notion of ‘flood risk’ itself could be re-conceptualised with the aim not only to concentrate on the reduction of the flood hazard (for example on HQ 100, a flood level statistically occurring once in 100 years), but to better address the consequences of flooding in zoning and spatial planning. Thus, the adherence to the current probabilistic safety standard of HQ100 should be reviewed and extended, because it can communicate

an (over)optimistic rating of security and push the risk into some future date without sufficiently taking into account the more extreme flood events or of the local context. Further research is advised on the local safety status, for example by risk audits to stimulate a discussion; first, about the role of the municipalities in the flood safety chain (e.g., raising awareness, zoning measures and evacuation) and second, about opportunities for the active engagement of local stakeholders and the public to increase the municipal capacity to cope with future floods.

Rhine 2100 program

In terms of policy change, it is recommended to review the rather short-term schedule of German flood governance and to establish a ‘Rhine 2100 program.’ Such a long-term basin vision across federal borders, with strategic goals, a legal framework and a roadmap for flood management until 2100, would provide the time necessary for experimenting and adapting institutional arrangements and strategies where required. It would gain time for innovation and new working procedures, for planning, investment and implementation of the necessary measures. Adaptation tipping points could be defined, which would signal when current strategies run the risk of failing the safety targets in the future. Modelling and gaming exercises could be used to support the broad involvement of stakeholders and the public.

Issues for further research

Questions remain about enabling ACM as a promising governance concept and the role of the prescriptions associated with ACM in the transition processes. Further research is proposed to better understand the implications of possible supportive institutional arrangements, and of the specific impacts of the ACM prescriptions.

Research should pay more attention to the different framing and interpretation of flood risk with the aim to ‘mainstream’ flood risk into the related policy domains and the general society. Empirical research is advised to investigate the emotional and the cognitive components of risk evaluation and their direct relation to the intention of responsive action.

The study provides evidence that the ecological issues in flood protection have been considered and integrated without the trigger of a wider public and stakeholder participation. Further research is advised regarding the purpose, scope and execution of public participation. In particular, officials and decision makers need to explore how they can improve the quality of their governance process with the aim to establish a fair balance between effectiveness and democracy.