



Preliminary conceptual framework of integration (“Dresden Paper”)

February 2006

Report T18-06-02

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DOCUMENT INFORMATION

Title	Preliminary conceptual framework of integration (“Dresden Paper”)
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Distribution	FLOODsite
Document Reference	Report T18-06-01

DOCUMENT HISTORY

Date	Revision	Prepared by	Organisation	Approved by	Notes
28/02/06	1_1_Pn04	J.Schanze	IOER		

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SUMMARY

The report deals with the question how to develop a basic framework for flood risk management. It starts with a brief introduction of two different concepts of risk management which show the necessity to define the appropriate one for the FLOODsite research project. One concept includes risk analysis as part of flood risk management, the other is restricted to risk reduction only. For the derivation of the relevant understanding for FLOODsite, the meaning of the term management is further elaborated and references are given to European water policy. From both, the literature of business economics as well as the European Water Framework Directive and other instruments, the inclusion of risk determination in flood risk management seems to be obvious.

Against this background “flood risk management” is defined as “*holistic and continuous societal analysis, assessment and reduction of flood risk*”. It is dedicated to the whole causal chain constituting flood risks, ranging from the flood hazards as *sources* over various *pathways* to the *receptors* with the *consequences* of floods. There is the necessity to also consider the interrelations between risk factors within whole river catchments and coastal cells. Therefore, subjects of flood risk management cover the whole system of the SPRC-model of flood risks – the “flood risk system”.

Society, represented by politicians, experts and individuals, manages flood risk due to manifold interrelations between society and floods. The representatives of society perceive flood risks and assess whether a certain flood risk is acceptable respectively tolerable or not. Flood risk management accordingly takes place as a decision making and development process at different levels involving various fields and adjacent areas. Flood risks and decision-making processes of FRM differ depending on types of waters, flood types as well as natural and societal conditions and trends.

Three sub-tasks can be used for structuring: Flood risk analysis, flood risk assessment and flood risk reduction. *Flood risk analysis* determines the current or – based on proposed activities or uncontrollable trends – future risks. It is based on the determination of the flood hazard, the vulnerability and their combination considering exposure. For an appraisal of certain risks a *risk assessment* is needed which covers the risk perception and the decision regarding the toleration of a certain risk. *Risk reduction* encompasses permanent physical measures as well as regulatory, financial, planning and other instruments for pre-flood reduction, event management and post-flood reduction.

Representatives of the society have to consider these sub-tasks of flood risk management as a workable whole. This means that scientific work on the sub-task also has to take this final use of the results of risk analysis, assessment and reduction into account. Specific requirements for such a decision-making and development process are due to the spatial and temporal interdependences of flood risks with regard to a catchment-wide understanding of the flood risk system. Hereby, the integration of contents and contexts of many policy issues can be relevant for flood risk management. To accomplish the complex management task, formal as well as informal cooperation between actors of risk management may play an important role.

A comparison of the framework with the literature does not show any facts that questions the basic concept developed for FLOODsite. Therefore the use of the framework for the entire FLOODsite research project has been recommended including a specification of the contributions of each theme.

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1. Introduction

1.1 Background

The development of an integrated methodology of flood risk management requires a common understanding of relevant terms as well as a theoretical and methodological concept of integration. During the initial phase of the FLOODsite research project the term “flood risk management” turned out to be crucial for all further efforts in this respect. This was especially true due to the existence of a different understanding within the FLOODsite project team. To discuss this issue a group of representatives of sub-themes 1.3 and 2.1 and themes 2 to 4 met in Dresden on September 13th and 14th, 2004. The group agreed on a common understanding of the term “flood risk management” as well as a on a basic framework for its theoretical and methodological specification.

The following report is based on the discussion of that meeting and the further elaboration of its results. It provides the basis for further work in Task 18 which is dealing with the conceptual and technological integration for long-term flood risk management. Moreover, the report is dedicated to the whole project team of FLOODsite to foster a common understanding of flood risk management, to specify the contribution of each theme and task to the integrated methodology and to facilitate communication among team members.

2. The Term “Flood Risk Management”

2.1 Two Concepts of Flood Risk Management

Within the initial phase of FLOODsite, two different concepts of the term flood risk management (FRM) were being used project. The two concepts differ with regard to the question whether flood risk management includes or excludes risk analysis. These can be described as follows:

1. Management refers to decisions and actions undertaken to reduce flood risk by controlling the hazard and reducing the vulnerability. Flood risks before have been assessed by scientific investigation:

⇒ Dealing with flood risks and floods = FR Analysis + FR Management

2. Management refers to decisions and actions undertaken to analyse, assess and reduce flood risks and floods:

⇒ FR Management = FR Analysis + FM Reduction
(including the decision-making process)

Both concepts are real alternatives and therefore cannot be considered as complementary or basis for combination.

2.2 The term “Management“ in selected References

Originally the term “management” comes from business economics. It is defined as all activities to control the decisions and actions of an actor, an organisation, or a set of organisations (network) effectively and efficiently. Such activities include planning (data gathering, analysing, goal setting, assessment of options, and so forth), organising, directing, staffing, monitoring, controlling, and learning (Wehrich & Koontz 1992).

In this sense “management” is also used in European Water Policy. As one example the requirements (selection) of River Basin Management Plans (Art. 13) specified in Annex VII of the WFD (2000/60/EC) can be seen. They encompass:

- General *description* of the characteristics
- Summary of the *analysis* of pressures and impacts
- Results of the *assessment* of the water status
- Summary of *economic analysis*
- Programme of *measures*
- Public information
- *Updates*

Similar requirements can be found in the “Guidelines for an integrated Management of Coastal Zones” (2002/413/EC)¹ and the Communication of the EC on FRM (EC 2004)².

¹ (e.g. chapt. 2)

² Chapt. 4.1: The essential features of this action programme would include: ... b) developing and implementing flood risk maps as a tool for planning and communication

2.3 The term “Flood Risk Management”

Against this background “flood risk management” has been defined as *holistic and continuous societal analysis, assessment and reduction of flood risk* (Schanze 2005a, 2006; cf. Sayers et al 2002, Hall et al 2003).³ It is dedicated to the whole causal chain constituting flood risks, ranging from the flood hazards as *sources* over various *pathways* to the *receptors* with the *consequences* of floods (SPRC-Model; Kundzewicz, Samuels 1997). There is the necessity to also consider the interrelations between risk factors within whole river catchments and coastal cells. Therefore, subjects of flood risk management cover the whole system of the SPRC-Model of flood risks – the “flood risk system” (Schanze 2006).

Society, represented by politicians, experts and individuals, is the managing system due to manifold interrelations between society and floods (Parker 2000). The representatives are perceiving flood risks and are evaluating whether a certain flood risk is acceptable respectively tolerable or not (Adams 1995). Flood risk management accordingly takes place as a decision making and development process on different levels (e.g. local, regional, national) involving various fields (e.g. water authority, spatial planning authority) and adjacent areas (e.g. communities).

Flood risks and decision making processes of FRM differ depending on types of waters (e.g. mountainous river, lowland river), flood types (e.g. flash floods, plain floods), land uses (e.g. rural, urban), planning and administrative systems (e.g. structuring according catchments or communities) as well as natural (e.g. geomorphology, regional climate) and societal (e.g. social, economic) conditions and trends. (Schanze 2005a, 2006)

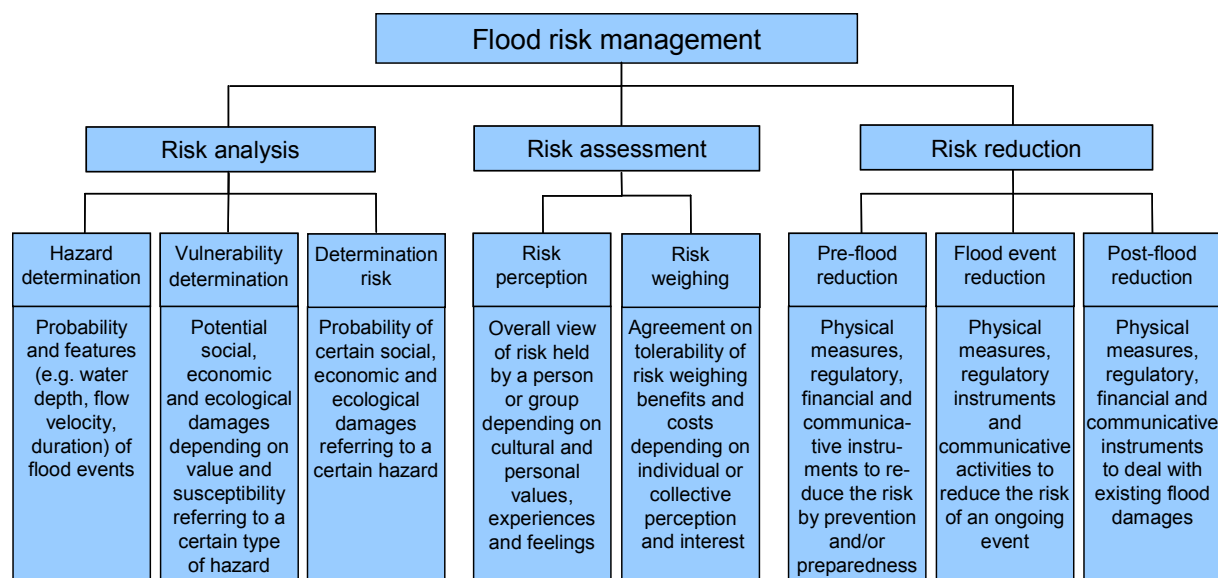


Figure 1 Components of flood risk management (Schanze 2005b, 2006)

The components of flood risk management are shown in figure 1. Three sub-tasks can be used for structuring: flood risk analysis, flood risk assessment and flood risk reduction. *Flood risk analysis* determines the current or – based on proposed activities (risk reduction) or uncontrollable trends (global change) – future risks. (For a general discussion of the term risk see Knight 1921, Adams 1995, WBGU 1999). It is based on the determination of the flood

³ In contrast to the paradigm of „flood protection“, which beside others is based on design floods.

hazard and the vulnerability and their combination considering exposure. Hereby, the flood hazard can be defined by probability, magnitude and duration of a hazardous event (Plate 1999). Vulnerability can be understood as the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards (ISDR 2004).⁴ Flood risk analysis with other words describes the flood risk system.

For an appraisal of certain risks a *risk assessment* is needed (Adams 1995, Plate 1999). It covers the risk perception and the decision regarding the toleration of a certain risk. Risk perception means an overall view of risk held by individuals or groups depending on values, experiences and feelings. The latter are influenced by culture, religion, policy, family and others. The decision to tolerate a certain risk needs a weighing of „costs“ and „benefits“ in monetary and non-monetary terms. It is based on the assumption that an element on risk has both, costs by potential damages and (current or potential) mitigation measures on the one hand and the potential economic yield and other benefits for using a flood-prone area on the other hand. The weighing is dedicated to current risks with a certain degree of mitigation as well as to alternative mitigated risks. It takes place on different levels from individuals to the actors of FRM of international river basins. In principle costs and benefits are covering all three dimensions of sustainability.

Risk reduction encompasses physical measures as well as regulatory, financial, planning and other instruments for pre-flood reduction, event management and post-flood reduction (cf. Kundzewicz, Samuels 1997). The term risk reduction is used as general definition for all structural and non-structural interventions with a potential to reduce risks within the flood risk system before, during and after flood events.⁵ Pre-flood reduction can be distinguished in structural prevention and organisational preparedness (DKKV 2003). The relevance of certain measures and instruments depends on the type of flood risk and the natural and societal conditions. For plain floods for instance *prevention* in regard to maintenance or reestablishment of inundation areas play an important role, whereas in flash flood catchments strategies to increase *preparedness* and flood warning systems are of special importance.

Measures and instruments can be combined to strategic alternatives of flood risk mitigation (not strategies; see FLOODsite Consortium 2005). Such alternatives represent potential overall choices for planning decisions.

⁴ Has to be finally adjusted with the LoR.

⁵ The implicit orientation of this definition of mitigation to reduce flood risks is in line with the European and national Water Policies.

3. Framework of Flood Risk Management

3.1 Description of the overall Framework

As the society with its individuals is the managing system, all components of the flood risk management have to be oriented to the societal decision making process (Schanze 2005b). This process covers multiple areas, fields and levels of activities. Its main task is the weighing of costs and benefits based on risk analysis and risk mitigation to derive acceptable respectively tolerable flood risks. In addition it needs to formulate and implement joint strategies⁶. Plate (2002) states that this orientation of flood risk management with regard to the actors involved is still missing in the extensively scientific discussion.

A theoretical framework for an actor-oriented functionality of flood risk management is shown in figure 2. On the top, the society with its individuals is presented as the cause of and context for FRM. On the bottom, the real-world physical system appears, which covers all flood risks generating processes. The activities of FRM are stretched between both. As red box in the centre the decision making and development process of the society's representatives (e.g., politicians, authorities, experts or even individuals) is displayed. They are the actors, who commission and interpret risk analysis, commission and carry out risk assessment and decide on risk reduction measures and instruments.

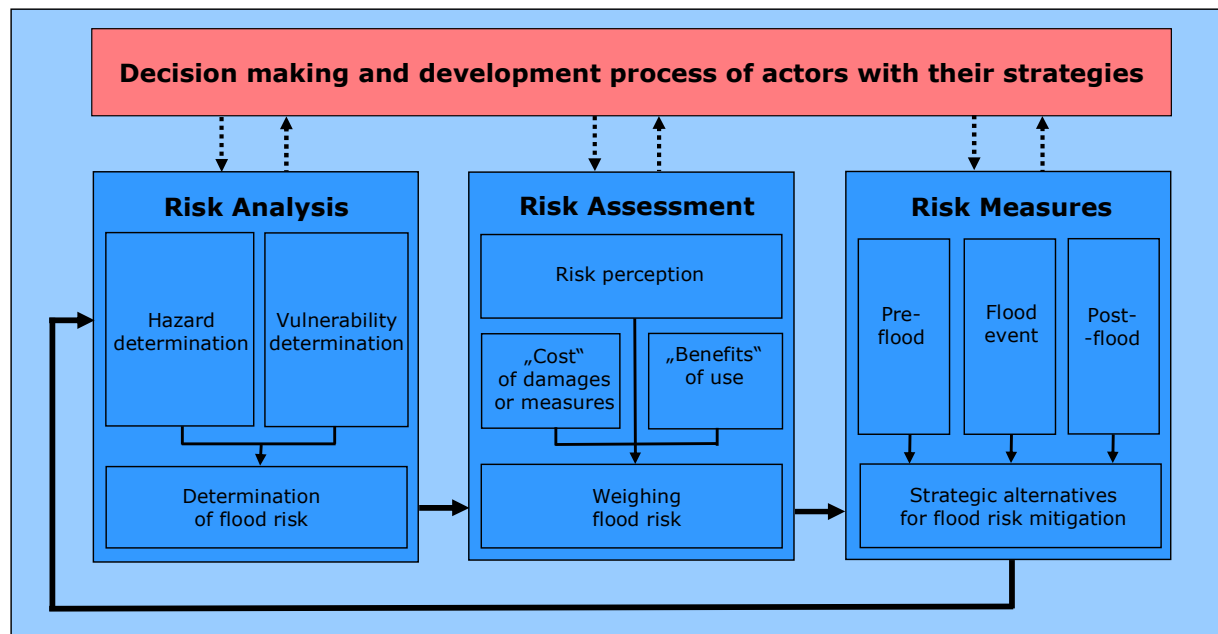


Figure 2 Framework of flood risk management (Schanze 2005b)

⁶ Strategies are defined as a combination of long-term goals, aims, specific targets, technical measures, policy instruments, and process patterns (e.g. participation, intense horizontal communication) which are continuously aligned with the societal context. The societal context comprises economic, social, and political conditions, formal and informal institutions, resources and capabilities (see Pettigrew & Whipp 1991, Volberda 1998, Brown & Eisenhardt 1998, Pettigrew et al. 2003).

The three sub-tasks of FRM are structured to provide a cycle of decision making. This cycle in science is mostly understood as linear till now, starting from risk analysis, following by risk assessment and ending with risk reduction (options). In reality it occurs as an interdependent cycle which in a time horizon can be considered as a continuous helix. Otherwise, changes in the flood risk system by external factors or the effectiveness of mitigation measures and instruments could not be reflected.⁷

From a methodological point of view *risk analysis* requires the development of scientific model systems, which allow the simulation of the meteorological, hydrological, hydraulic and hydrogeological processes on the one hand, and vulnerability, damage generation and societal consequences on the other hand. Moreover, they have to display features of mitigation activities.⁸ For hazard determination the regional meteorological events and their intensity, rainfall-runoff-relations, stage-discharge relations respectively flood waves, matter fluxes and others have to be investigated by using mathematical models. It can be carried out as full probabilistic approaches or by deterministic methods with an additional statistical distribution.

For vulnerability determination exposure and susceptibility of elements of risk need to be analysed,⁹ including among others an examination of land use pattern and change, inquiry of immobile and mobile elements at risk and determination of their value, estimation of potential direct and indirect flood effects, social structure of population and identification of vulnerable groups with major impediments to recover from flood events. Up to now, the scope of most investigations on vulnerability is quite narrow and mostly restricted to direct economic losses (Messner and Meyer 2006). Considering all these aspects of flood vulnerability will lead to a rather complex picture of flood risk.

For single models and for the whole model system (cf. Apel et al. 2004) uncertainty has to be specified as a basis for the interpretation of the validity of the results. It is important to estimate both, the current risks as well as the targeted risk reductions. As far as the prediction of future flood risks is concerned in addition the dynamic (trends) of natural and societal factors of flood risks and accordingly the changing of flood risk itself plays are relevant (Foresight 2004). Flood risk managers therefore should be provided with scenarios of possible developments and again with the uncertainty of their predictability (Weichselgartner, Obersteiner 2002).

Risk assessment is the most subjective sub-task within flood risk management. It strongly depends on the societal context and fundamental sociocultural, economic and ecological aims of the society. Regarding the latter different levels, binding characters and societal interest groups are meaningful. As far as the costs and benefits are concerned weighing should provide acceptable respectively tolerable risks and criteria like efficiency of measures and instruments (see below). As one problem for a catchment-wide flood risk management the fact has to be considered that the person who reaches the benefits are not always the one who have to take the costs or burden.

To support risk assessment a large spectrum of methods is available ranging from traditional cost-benefit-analysis to GIS-based multi-criteria analysis (MODM; cf. Yoon & Hwang 1995).

⁷ Details in this respect will be explained in the enhanced framework, which will be provided by Task 18.

⁸ (e.g. interrupt the exposure, like dikes, or to reduce damages, maybe by preparedness)

⁹ Analysing the vulnerability will always contain a subjective moment. In the overall context of FRM its understood as measurement instead of evaluation.

Because of partly sophisticated algorithms with additional weights the results have to be most transparent for the flood risk managers. Otherwise they maybe will mistrust them and stick on existing opinions and previous experience. Beside such cost-benefits-considerations in terms of material goods human rights will not allow any relative evaluation in respect to human beings and their risk of loss of life or getting injured.

Risk reduction provides virtual studies (e.g., research like FLOODsite) and afterwards implementation (e.g. real-world management) of concrete impacts in the flood risk system. Actors of the decision making process propose, select and combine measures and instruments. Scientists and experts are operationalising them to ensure compatibility with models and methods of the risk analysis. Effectiveness¹⁰, robustness and flexibility¹¹ are determined by simulating strategic alternatives with or without scenarios of natural and global change. Calculating efficiency¹² means using the risk assessment to derive reduced risks per effort, which again is a cost-benefit issue.

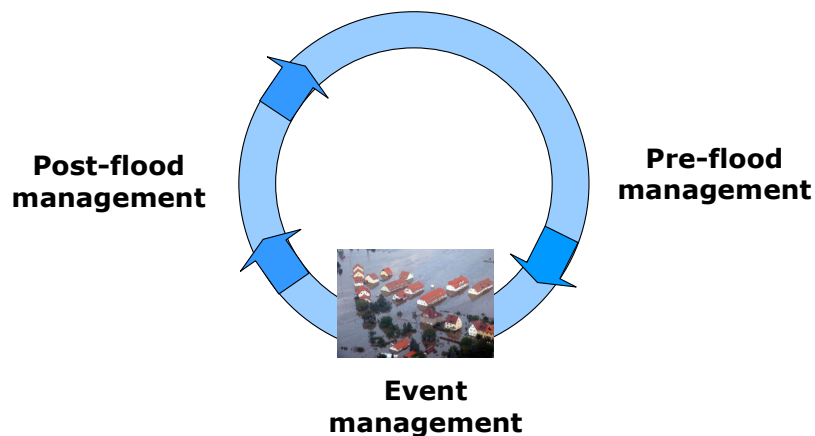


Figure 3 Scheme of modes of flood risk management (Schanze 2005b)

The orientation of flood risk analysis, assessment and reduction to the societal decision making and development process can be considered as a prerequisite for a continuously flood risk management. It is - generally speaking - dedicated to the evaluation and optimisation of the described cost-benefit-ratios and to the avoidance of losses of life or injuries. Conditions, values and mitigation abilities are changing in time. This is especially the case with regard to the pre-event, event and post-event phases like they are shown in figure 3. During these phases also the velocity of carrying out analysis, assessment and reduction can vary, being relatively fast during flood events and relatively slow in periods between two floods. Furthermore, flood risk management is altering according the changes of the flood risk system and the contents, context and modes of the decision making and development processes (see below).

¹⁰ Effectiveness describes the quantified effect of a physical measure and/or policy instrument referring to initially defined goals (degree of goal compliance) (from Task 12).

¹¹ There seems to be a trade-off between efficiency and flexibility.

¹² Efficiency describes the quantified effect of a physical measure and/or policy instrument relative to the effort needed to achieve this effect. Efforts can be any kind of input invested to achieve the targeted effect (e.g. money, time, etc.) (from Task 12).

An appropriate reduction, interpretation and presentation of the real-world complexity of catchments respectively coastal areas is needed to allow such kind of management. This challenging task is normally targeted by designing DSS-tools. These tools theoretically should include interfaces for all methods and data required for the management and therefore be flexible.^{13,14} Hereby, they have to meet both, scientific requirements of simulating the flood risk system and societal requirements of actor-oriented performance and flexible applicability. This issue will be further elaborated within Task 18.

The causal evidence of the framework with its „management cycle“ and the potential DSS-tools may not belie that the societal decision making and development process with its contexts does not compulsory follow this causality. For that reason the implementation of flood risk management requires a scientific perspective which includes social science knowledge on the real-world context and processes of multi-actor decision making with strategy formulation and implementation as well as the potentials of regional governance. Thus, in the following some more details are provided in this respect.

3.2 Decision-Making and Development Process

As already stated flood risk management is basically a societal endeavour.¹⁵ Practitioners and politicians, not scientists, are strongly influencing risk analysis, risk assessment, and reduction. They have to accomplish the task of integrating these components of flood risk management into a workable whole.

Specific requirements for such a decision-making and development process result out of the spatial and temporal interdependences of flood risks with regard to a catchment-wide understanding of the flooding system and related policy issues. As regards the integration of contents many policy issues (e.g. water management, spatial planning, emergency planning and so forth) can be relevant for flood risk management. Spatially, all municipalities, water management authorities, and regional actors (e.g. the regional planning offices) within one catchment are of importance. Temporally, a continuous process with short-term, medium-term, and long term planning horizons has to be established independently of existing political institutions and related processes (e.g. elections). The implementation and effects of technical measures and instruments have to be monitored.

To accomplish the complex management task of a temporally and spatially integrated flood risk management within catchments, formal as well as informal cooperation should be taken into consideration. Formal cooperation is defined as a cooperative arrangement of two or more actors on the basis of regulations (directives, planning guidelines, strategic plans, and so forth). Informal cooperation develops mainly on voluntary membership, without the guidance of pre-formulated directives or strategic plans. It aims at exchanging information, different cultural perspectives within an open dialog, and attempts to flexibly supplement existing formal structures of flood risk management. Trust and effective organisation of the informal cooperative process are key success factors. Informal cooperation can lead to agreements of

¹³ The DSS of Task 18 is proposed to include certain tools (e.g., hydrological model), but does not include certain model software.

¹⁴ For instance, the UK Environment Agency and DEFRA are developing a suite of tools that support specific decisions that build upon common databases and adopt a common analysis framework. But, the degree of detail varies and so does the emphasis within each separat tool.

¹⁵ FRM is also a task for individuals at risk. In this case the sub-tasks and the aspects of decision making and development processes in principle are the same.

all participating actors to realise aims and targets for flood risk management on the catchment scale. The implementation is primarily based on the contributions of the single actors. Considering informal cooperation enhances the possibilities of flood risk management to integrate bottom-up initiatives and activities into an overall framework for managing flood risk within river catchments and coastal areas.

Furthermore, Hutter (2006) shows that the decision making and development process is based on further dimensions and cannot be understood simply as static, uniform and only build upon cause analytical findings. Beside the *content*, two additional dimensions of flood risk management need to be considered: the process itself as well as the context of decision making. Regarding the *process* certain phases (formulation, implementation) and modes of strategic planning (e.g. programming, scenario-based planning) can be differentiated. The *context* takes into account that there are always internal constraints and conditions such as limited resources, personal capabilities, cultural background and political beliefs. In addition, the context is externally determined by political and legal bindings from higher (e.g. European, national) or adjacent (e.g. trans-boundary) levels of decision-making. Therefore, approaches from strategy research have to be included (e.g. Pettigrew & Whipp 1991, Volberda 1998).

The scientific analysis of decision and development processes is still in its infancy. Therefore, FLOODsite analyses weaknesses of flood risk management with regard to the current, often fragmented situation within catchments and identifies key success factors for integrating specific strategic decisions (e.g. for reducing vulnerability in flood-prone areas through spatial planning) into an overall strategy on catchment scale as well for implementing effective and efficient technical measures and instruments (task 13).

4. Comparison of the Framework with existing Approaches

To reflect the state of the art selected references are used to compare the findings of the report. Moreover, it is asked: What is the comparative advantage of the overall flood risk management approach proposed in this paper? To deal with both, recent contributions for defining flood risk management are taken into account (Hall et al. 2003, Hooijer et al. 2004, Plate 1999, Oumeraci 2004).

No basic differences can be observed with regard to the requirements of defining the flood risk system broadly, considering its full range of performance possibilities, and understanding flood risk, simply speaking, as the product of flood probability and consequences (determined by vulnerability and exposure).

As far as the overall management term is concerned it seems that Oumeraci (2004) proposes a risk management which is restricted to the residual risk. This would support the alternative concept of flood risk management, which has not been followed in this paper for reasons explained above. The current DOW also follows this understanding but explains it with very general words.

In contrast especially Hall et al. (2003) and also Plate (1999) are quite close to the ideas developed here. Only, the coherence of the key terms and their relations seem not to be comparatively elaborated. Some differences are quite subtle. Most papers agree that the analysis and risk assessment are heavily influenced by the societal context (e.g. economic,

environmental, social, safety values, see Hall et al. 2003, p. 128, “Integrating flood risk management objectives with other policy objectives”, Hooijer et al. 2004, p. 351). The papers differ with regard to the emphasis put on this complex relationship between analysing and evaluating flood risk and risk reduction comprehensively and continuously with societal decision making and development processes. A clear emphasis on continuously considering actors and their societal context in analysing, evaluating, and mitigating flood risk is formulated in the Dresden paper (cf. Meadowcroft et al. 2001) and will need to be further specified in FLOODsite.

Difficulties in implementing potentially effective flood risk management measures and instruments are widely acknowledged in the literature. Especially Hall et al. (2003) and Hooijer et al. (2004) underline how important it is to understand flood risk management as a real-world endeavour (e.g. Hall et al. 2003, p. 129, Hooijer et al. 2004, p. 354). But, even in these contributions to the literature implementation is not a key topic. Hall et al. (2003) describe a specific aspect of flood risk management aimed at aiding more national prioritisation of expenditure across England and Wales. These approaches are now being taken forward at regional and local scales with considerable effort being devoted towards implementation (including the developing of national databases of physical and societal issues).

Different types of actors are mentioned (Hall et al. 2003, Table 1, p. 129), but, approaches to integrate the decisions and actions of these actors within the whole flood risk management cycle are not discussed in detail. Synergies resulting out of the combination of formal and informal cooperation remain poorly resolved. Hence, although the notion of a hierarchical approach is implicit within the Hall et al paper¹⁶ an approach of flood risk management that stresses the importance of local and regional actors and possibilities of integrating their decisions on regional level are remaining the subject of significant ongoing research. The other papers are more concerned about defining and analysing how an effective, efficient, and social acceptable flood risk management approach *should* be developed rather than analysing how and why practitioners *will* actually implement an effective flood risk management approach under real-world conditions. Defining flood risk management in line with a comprehensive understanding of the term “management” (see section 3) communicates more clearly that formulation and implementation of strategies for flood risk management are right from the beginning in the centre of FLOODsite.

¹⁶ (Representing the highest level of the tiered approached to flood risk management outline in Sayers et al 2002.)

5. Conclusions

The authors recommend that the term “flood risk management” in general should cover flood risk *analysis and reduction in a holistic and continuous perspective*. This would contribute to the integration of FLOODsite and improve the usability of the deliverables for FRM policy in Europe.

According to these recommendations the management approach of FLOODsite ranges from theme 1 to theme 3 and is developed and tested in theme 4. Each theme will develop and define certain aspects within the context of the framework developed in this paper Theme 1 is dedicated to the details of the methods to determine flood hazards, vulnerability and to analyse the flood risks (i.e notions of reliability – fragility). Theme 2 is dealing with the details of the approaches to exploring risk reduction alternatives and strategies. Mitigation covers pre-flood and event management activities. Theme 3 provides the theoretical development of the management approach of FLOODsite, drafting the framework and improving it using the results from the other themes.¹⁷

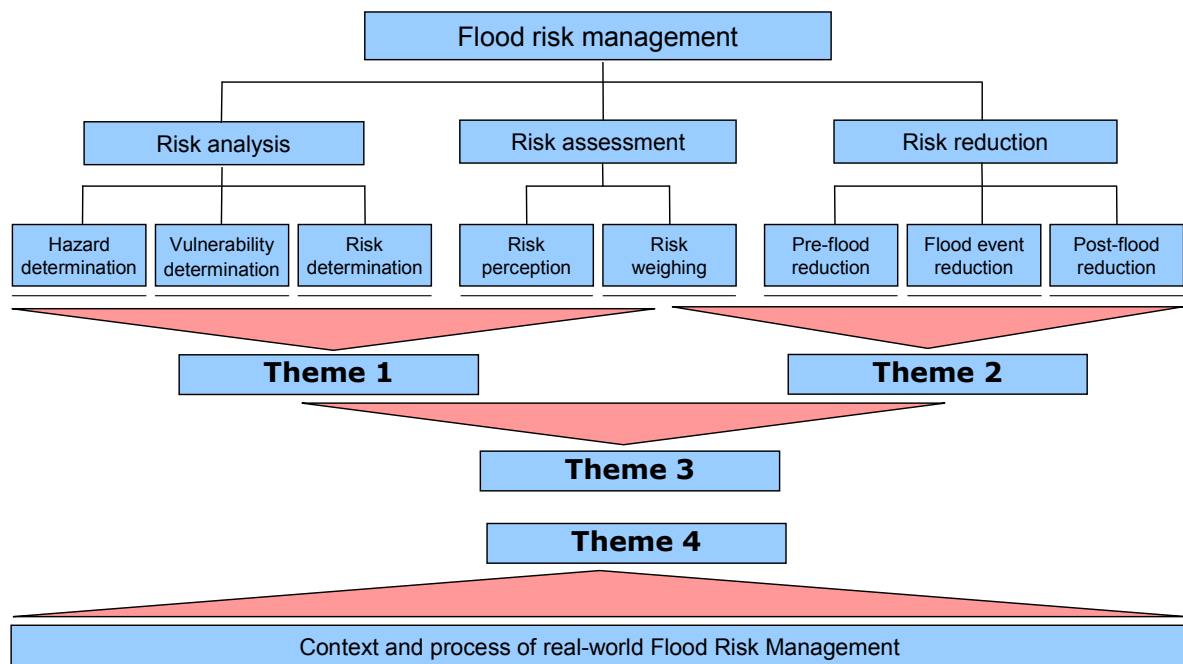


Figure 4 Contribution of the FLOODsite themes to the components of flood risk management (Schanze 2005c)

Theme 4 provides the real-world sites to build up and to test main components of the methodology under specific natural and societal conditions. At least for one or two pilots a comprehensive performance of the methodology according the whole framework is aimed at. The testing in all pilots will include a comparison between the theoretical framework, the

¹⁷ Task 18 provides a theoretical conceptual framework for integrating all aspects of flood risk management within the context of long term “strategic” decisions. Task 19 is doing the same for event management. Based on, both are dedicated to a practical methodology for developing a DSS within the context of the pilots.

methodological deliverables of FLOODsite and the constraints of practical flood risk management.

The proposed contributions of themes 1 to 4 of FLOODsite to deal with the terms introduced above are shown in figure 4.

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