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Persistence of Alpine natural hazard protection

Meeting multiple demands by applying systems engineering and life cycle management principles in natural hazard protection systems in the perimeter of the Alpine Convention

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Persistence of Alpine natural hazard protection

Meeting multiple demands by applying systems engineering and life cycle management principles in natural hazard protection systems in the perimeter of the Alpine Convention

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Preface – Maria Patek (PLANALP)

We are at a “cross road” - in terms of - is it necessary to set the priority in investing in new future protective infrastructure or “just” to try to keep the present state of functionality (or simply said: the present state) of protective structures throughout the perimeter of the Alpine Convention?

To me – as representative of all torrent and avalanche-related protective policies, strategies and - of course - structures in Austria – the answer is not easy (given to all politically and citizens needs in practice in our provinces or municipalities) but rational and practically: Priority has to be given clearly on maintenance! I clearly understand the upcoming years and decades as a demand / or challenge to further invest into the maintenance of the functionality of all protective infrastructures in place.

As many other Member states within the perimeter of the Alpine Convention, Austria has invested billions of EUR since centuries into protective systems against natural hazards and risk, and yes: they are effective! But these systems require permanent monitoring and improving of their structural functionality and this requires the involvement of all that are concerned and / or are the beneficiaries of these structures. And yes: that can’t be a task of the state’s administration or institutions responsible for disaster mitigation alone: this clearly needs the awareness, perception, and acceptance of the public society too.

This publication will contribute to a better understanding about the needs to invest into the maintenance / preservation of existing structural prevention facilities in place. It should be understood as a support by or being aware or using all of the recommendations / good practices that has been highlighted within the brochure. The close alliance of the countries located within the perimeter of the Alpine Convention – confronted with similar challenges – calls for the exchange of transnational experience in order to reassure the increase of resilience of alpine areas against natural hazards.

The common challenges have to be managed by each Member state individually – but cooperation, harmonisation and coordination will support their individual visions and efforts too.

My sincere thank go to all that have been actively contributed to this notable publication.

Maria Patek

President of the Platform of Natural Hazards of the Alpine Convention (PLANALP)

Preface – Markus Reiterer (Alpine Convention)

Already the early inhabitants of the Alps needed to protect themselves against natural hazards. So it is no surprise that the systems and infrastructures humans put into place for the purpose of protection have evolved considerably throughout history. Today we have a notable number of protection facilities throughout the Alps and we are constantly improving cooperation as a key ingredient to minimize and cope with natural hazards. One of the most striking advantages of the Alpine Convention and its PLANALP platform is this emphasis on cross-border cooperation and exchange of knowledge, data, expertise and support between the Alpine countries. This type of cooperation will enhance our ability to prevent, address and manage natural hazards and it will increase our resilience against them. Even though, each of the countries, though facing similar challenges, adopted their own policies, strategies and actions, they all work towards a common goal.

When we talk about long-term investments in protective infrastructures, we should not only consider its financial implications, but also address the knowledge and innovation that these installations require. Applying the methods of systems engineering to protective systems, requires considering the entire life-cycle starting with the conception, including planning, creation, operation and maintenance. Furthermore, these structures need on-going monitoring and inspection in order to assess their status quo in terms of operability and functionality as well as any possible need of maintenance or replacement. Lastly, also the disposal or reconfiguration has to be planned.

Most importantly, it is necessary that protection systems meet the expectations and needs of the local inhabitants. These systems also have important functions as a backbone of social and economic prosperity of the alpine region, since they provide structural and subjective safety to people, our societies as well as to economic investments.

With this brochure the Natural Hazard Platform intends to support national and regional authorities, policy makers as well as practitioners in their work concerning the monitoring, inspection and maintenance of prevention facilities and to provide insights into the advantages of the integrative methods. It is my sincere hope that the target audience will consider this publication and use it when planning their future activities.

I would like to sincerely thank the authors of this publication for the work done and to all the members of the Platform for their inputs. My special thanks go to the chair of the Natural Hazard Platform, Ms Maria Patek, for all her efforts and finally to all the partners in elaborating, disseminating and applying this publication.

Markus Reiterer

Secretary General of the Alpine Convention

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1. Executive summary

Protective infrastructures provide the basis for a smooth development of the regions and countries within the perimeter of the Alpine Convention in terms of economic and societal welfare. Over centuries billions of Euros have been invested by public and private institutions within the respective Member states into protection systems in order to significantly decrease the level of risk against natural hazards and to provide at least an acceptable level of safety.

Although most of these structures are designed and built for long serviceable lives (e.g. structures made by concrete or steel about 80 years), there is always the risk of non-performance – or failure. Permanent monitoring and maintenance to maintain the performance of these structures is therefore a conditio sine qua non within the structures' lifespan and needs long term planning and strategic decisions.

Based on the current high level of protection and safety standards against alpine natural hazards in the Alpine Conventions' Member states, the preservation of protective facilities in the future is a great challenge which has direct consequences to living and economy in the Alpine Area.

Although the related task of monitoring, inspection, and maintenance of protection facilities are regulated in detail by legal and technical standards and organisational structures and financing instruments are available in general, but several deficits in the execution of these tasks exist in practice. This gap has to be bridged by supporting all that are concerned with prevention facilities (in what manner ever) with evidence based, practically tested, and future-oriented strategies and actions. By applying Systems Engineering (SE) and life cycle management principles in natural hazard protection systems a first step towards bridging this essential gap can be set.

Systems engineering is an interdisciplinary field of engineering that focuses on how to design and manage complex engineering systems over their life cycles. SE deals with work-processes, optimization methods, and risk management tools in such projects/systems. SE ensures that all likely aspects of a project or system are considered, and integrated into a whole. The approach requires the rethink from linear, one-dimensional to cybernetically orientated planning processes.

Introducing SE into natural hazard and risk management is relatively new and needs common co-operation, coordination and exchange of experiences made with the practical implementation of this complex approach throughout the perimeter of the Alpine Convention. By providing both – information in detail on the background and content of SE, its implication for implementation into practice, as well as examples of good practice among the Member states – this brochure will support policy- and decision makers, practitioners as well as the scientific community to common develop strategies for a foresighted maintenance of the functionality of the protection systems within the alpine area.

2. Persistence of Alpine natural hazard protection – Introduction and Challenges

Since centuries, the member states of the Alpine Convention invested billions of Euros into structural protection facilities against natural hazards in order to provide the basis for a smooth development in terms of economic and societal welfare. Long lasting decisions of inhabitants (e.g. residence choice, building private wealth, social and familiar dispositions) as well as the economy (e.g. business location, investments, creation of new jobs) in the alpine region are often based on the (subjective) perception of risk or safety. Public and private investments into protective infrastructure have to be therefore sustainable and which includes the maintenance and reconstruction of these facilities too.

From the point of view of regional and local decision makers as well as the concerned population, investments into protection facilities have to notable contribute to decrease the level of risk against natural hazards and to provide at least an acceptable level of safety. Losing this level of safety (e.g. by deterioration or decreased performance of protective structures) – what unambiguous would lead into an enlargement of hazard zones – won't be politically or societal accepted.

At present approximately **2 Mio. structural protection facilities** related to alpine natural hazards (torrent, avalanche, rockfall, landslide) have been counted in the alpine parts of Austria, Germany, Italy, Liechtenstein, Slovenia and Switzerland, representing a **replacement value** of about **50 billion Euros** (this figures are based on expert opinion, because there is the challenge to count exact figures because of different administrational responsibilities; this figures doesn't include estimations on structures hold / owned by e.g. infrastructure authorities / companies (like railway, roadway etc.), nor include numbers on protective infrastructure in the alpine parts of France). Most of these structures are designed and built for long serviceable lives (e.g. structures made by concrete or steel about 80 years). Decisions made during the design stage of such a structure or system are invariably fraught with significant uncertainties. In light of these uncertainties, there is risk of non-performance – or failure – of the structure over its lifespan (e.g. the loadings may vary significantly including forces from unforeseen or even unexpected natural hazards). With respect to financial issues, there is a serious risk in under-estimating the whole life cost of a given structure or mitigation system. Experience in practice with the holder (operator) or beneficiary of such structures or systems lead to the perception that only a few decision makers are aware about the whole life costs that include costs of development, operation, maintenance and repair, cost of failure, re-cycling, as well as indirect costs of non-performance or failure. A survey on typical maintenance costs among the Member states resulted in a share of about 1,5% per annum of the building costs that has to be dedicated to regular operation and maintenance of prevention structures. That means in practice that over the life span of a given prevention structure a re-financing of the original building costs will be necessary in order to provide the intended performance of the structure.

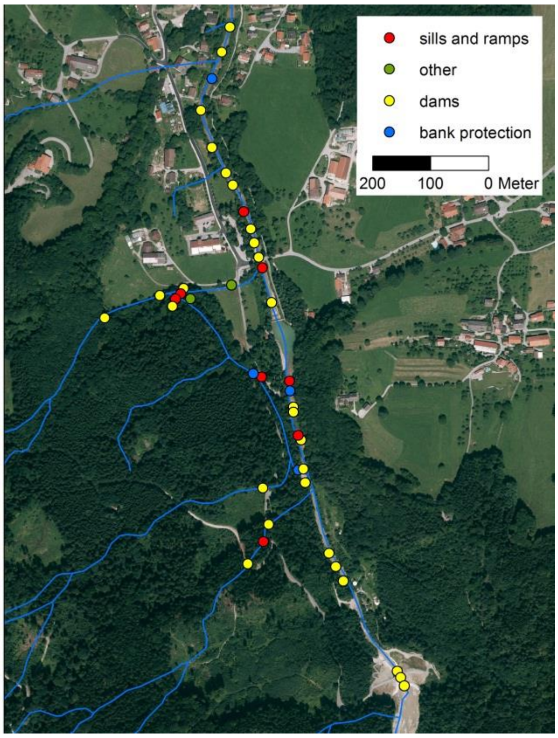

Fig. 1: Example for high number of protection structures; Jenbach, Bavaria (LfU)

Given the impressive number of existing structural prevention facilities throughout the Alpine Area (comp. example in Fig. 1) and the capital stock they represent, there is the serious question on how best to maintain the performance of these structures, especially under the **challenges** of

a) *Advanced age* of a number of prevention facilities in the Alps what calls for immediate actions
b) *Little knowledge on the condition / performance levels of these structures*
c) *Limitations on resources* (mainly financial, but also personal)

d) *Changes in legal frameworks* and implications (implications of EU-Water Framework Directive, Flood Directive)
e) *New demands* on existing systems, e.g. due to development of new and sensitive infrastructures or social attitudes
f) Demographic *changes in alpine regions* and altered regional development potentials (also based on the development of transportation infrastructures) what lead to changes in the desired performance needs / functionality of these structures (comp. Fig. 2)
g) Decreasing *knowledge and awareness* of holders (operators) or beneficiaries of such structures on the maintenance needs or life-cycle based interventions (with exception were the federal state / Länder are the holders, like Bavaria) including the permanent monitoring
h) Question of *responsibility and liability* concerning these structures in countries where investment costs have to be shared among the public (administration) and the holder (operator) – especially in terms of non- (or minor) performance during a disaster event
i) *Quick development* in the fields of risk management and high interactions, e.g. between structures and risk assessment

Based on the current high level of protection and safety standards against alpine natural hazards in the Alpine Conventions' Member states, the preservation of protective facilities in the future is a great challenge which has direct consequences to living and economy in the Alpine Area. Therefore it should be on the top of the political agenda. Thereby different impact levels to regard protection facilities can be distinguished, whereas each level has its own view on the risk management topic:

- Single structure, where questions of stability, maintenance,… are vital
- Protection system / catchment area, where functionality or resilience are important topics
- Effect area in which land use questions but also societal consequences gain importance
- State level where mainly questions of funding and security are interesting
- European level, which gives some common basis for dealing, like flood directive

Although the related task of monitoring, inspection, and maintenance of protection facilities are regulated in detail by legal and technical standards and organisational structures and financing instruments are available in general, several deficits in the execution of these tasks exist in practice. This gap has to be bridged by supporting all that are concerned with prevention facilities (in what manner ever) with evidence based, practically tested, and future-oriented strategies and actions. By applying systems engineering and life cycle management principles in natural hazard protection systems, the members of PLANALP want to contribute by this comprehensive brochure to a better understanding of the potential of system engineering especially in the frame of natural hazard and risk management and the promotion of its advantages.

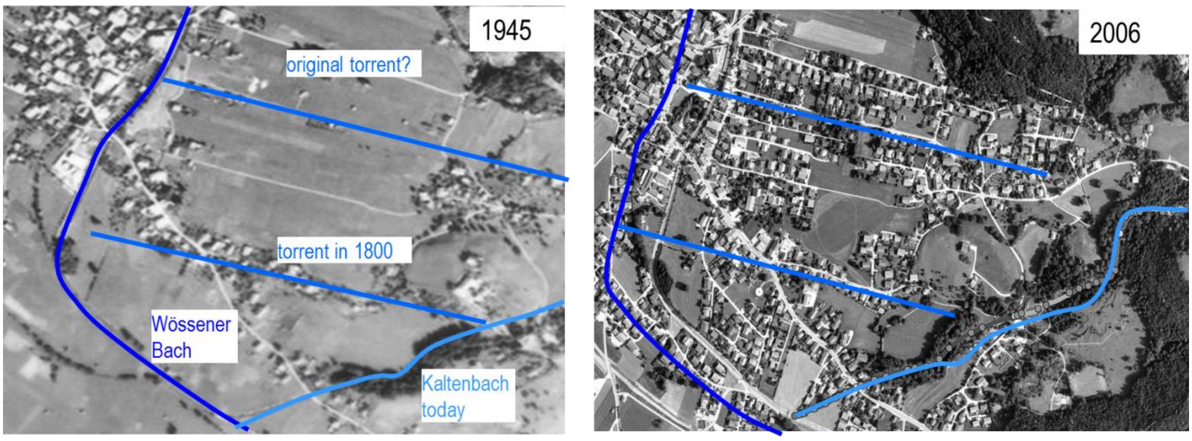

Fig. 2: Example for change in alpine regions – municipality of Unterwössen in Bavaria.(LfU)

3. Systems engineering: consequent holistic answer to multiple demands of integrated risk management

3.1 Overview

For long times the only possibility or strategy dealing with natural hazards was a kind of “hazard defense”, which means to avoid the hazards. This could be simplified as a “one-dimensional” strategy (compare green area in Fig. 5).

Anyway a high number of structures were realized in over time. So we have to deal with many single elements in different condition and different age. While the function of the structures has to be ensured at every time, the conditions of the single elements change and so the time perspective becomes more and more important. Especially questions like how to monitor the structures or what to do with elements reaching the end of life time have to be answered. So to stay in the “dimension picture” a second dimension arises, where life cycle management approaches can help to face the challenges.

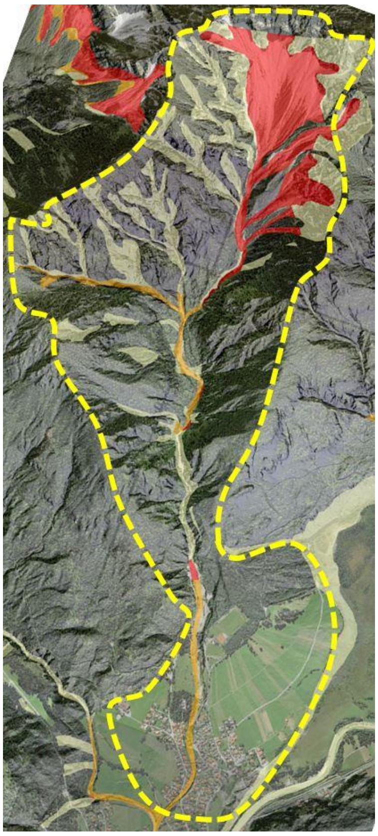

Fig. 3: For example an alpine catchment area is a complex system (LfU)

But we learned, that dealing with natural hazards one is obviously concerned with several complex systems: the catchment area with all the processes and interactions (Fig. 3) and the social system which demands for example protection - just to mention two of them. That is the reason that nowadays we promote integral risk management (Fig. 4) as best option to cope with natural hazards, which means that we try to live with natural hazards. So it is necessary to develop not only “one-dimensional” single purpose structures and regard them over the life time (second dimension). But we have to realize complex and multipurpose protection systems consisting of many single elements, which could be regarded as third dimension. In this field system engineering can provide interesting approaches to improve our protection system engineering.

Fig. 4: Principle of integrated risk management (ClimChAlp (2008))

3.2 Principles and definitions

The main purpose of technical protection systems and protective structures is the reduction of risks and other negative effects by natural hazards for the endangered zones to an acceptable (reasonable) level. In the evidence of the increasing complexity of protection systems the challenges for configuration, planning and design of these systems goes far beyond the classical construction engineering. Modern protection systems embrace not only technical structures, but also measuring devices, regulation and control technology and even biological measures; furthermore they often consist of various separated structures, functional units or structures in sequences/functional chains and closely interact with other planning, legal and organizational measures. Some examples of complex protection systems:

- Cascades of controlled flood retention reservoirs
- Avalanche protection systems embracing defense structures in the starting zone, artificial avalanche release systems and deflecting/retarding structures in the run-out zone
- Flood protection systems consisting of permanent control structures, mobile flood protection systems and flood alert systems

Hence complex protection systems represent assemblies of structural, mechanical, mechatronic and digital elements with unequal ruggedness, service life, maintenance requirements and risk of failure. Another characteristic of complex protection systems is the multidisciplinary competence necessary to plan, design, construct, operate and maintain them as well as the multitude of responsibilities bringing about a high demand for coordination among planning engineers, approving authorities, operating institutions and beneficiaries of protection. The principle of integrated risk management is not only applicable for the protection function of these systems but also to reduce risks concerning the stability, serviceability and durability of the protection system itself, mainly to prevent malfunction or even total failure (breakdown) after extreme events.

The management of complex technical systems in general requires approaches oriented at the sustainability, the life-cycle perspective and quality assurance. This principle also applies for natural hazard protection systems, pointing out the gaps of conventional planning procedures and paving the path for the implementation of “systems engineering”. **Systems engineering** is by definition an interdisciplinary field of engineering that focuses on how to design and manage complex engineering systems over their life cycles. Issues such as reliability, logistics, coordination of different teams (requirements management), evaluation measurements, and other disciplines become more difficult when dealing with large or complex projects. Systems engineering deals with work-processes, optimization methods, and risk management tools in such projects/systems. Systems engineering ensures that all likely aspects of a project or system are considered, and integrated into a whole. The approach requires the rethink from linear, one-dimensional to cybernetically orientated planning processes.

Infobox systems engineering (SE):

SE is an interdisciplinary approach and means to enable the realisation of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem

(Definition by the International Council on Systems Engineering (INCOSE))

SE means: “Build the right system; build the system right”.SE considers the whole problem, the whole system, and the whole system lifecycle from concept to disposal

(by UK Chapter of INCOSE)

Origin: 1940s in telecommunication; fundamental enhancements in space flight

Although at first sight the application of the “systems engineering” approach in natural hazard and risk appears to be highly theoretical and strongly limited by the capacity of engineering practice, hereinafter it will be shown that a wide range of systems engineering elements are already standard in natural hazard engineering. Whereas systems engineering as a comprehensive engineering concept is a new approach and needs further characterization and specification. In a conceptual sense, systems engineering may also be applied – with some simplifications – to the whole risk management cycle as the criteria of quality life-cycle, reliability and service standards also apply to comprehensive protection and safety functions.

3.2 Elements (methods) of systems engineering and system life cycle

When the systems engineering concept is applied to protection systems, the whole life-cycle starting with the conception, including planning, creation, operation and maintenance and ending with the decay, disposal or reconfiguration, is covered. One fundamental principle is the compliance of the functionality of protection system with the “customer expectation”, in concrete terms the congruence of protection effects with the protection needs of the beneficiaries. In general the fulfillment of protection goals is the most important benchmark for the quality of a protection system (structure).

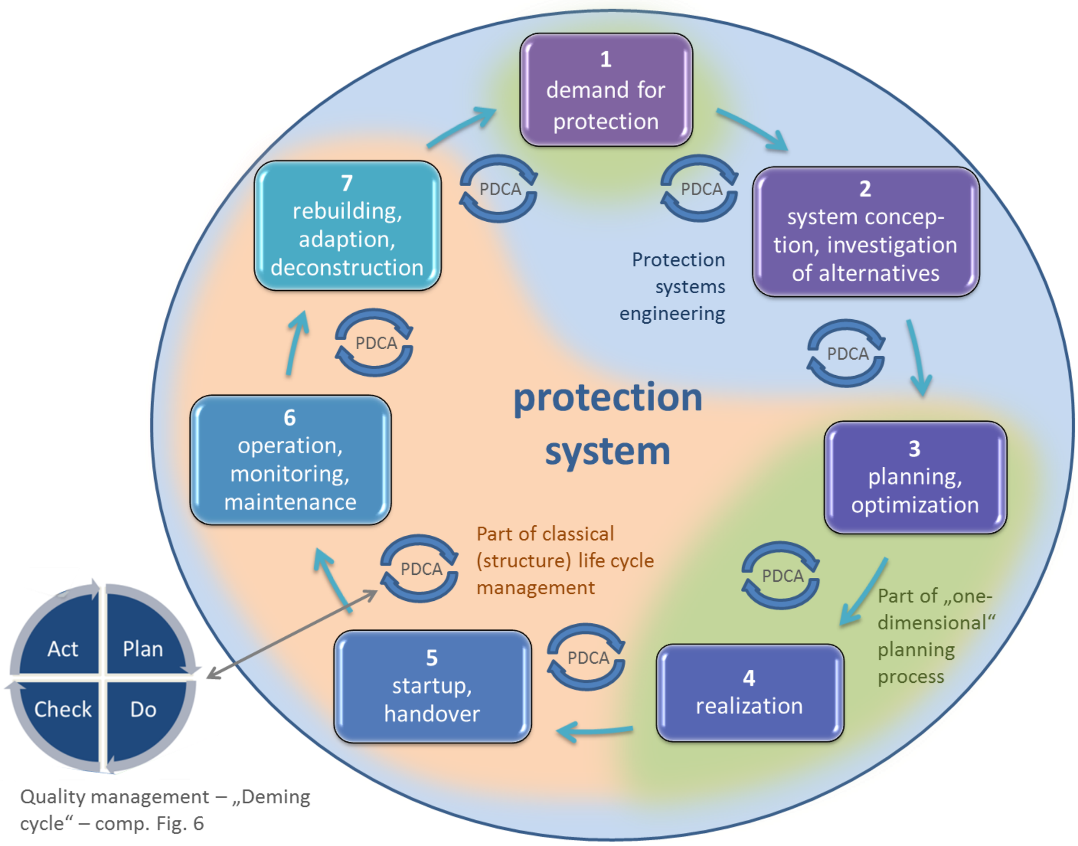

Fig. 5: Systems engineering for protection systems: 7 phases of the system life cycle, sustained by the cyclical reevaluation (feedback) displayed as PDCA-cycle ("Deming cycle") of quality management

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There are **seven main phases of systems engineering** which can be displayed in the "system life cycle" (Fig. 5) of natural hazard engineering:

1. **Demand for protection:** identification of protection needs and definition of protection objectives: hazard and risk assessment, analysis of vulnerability, determination of safety level (limit values), determination of system requirements.
2. **System conception and investigation of alternatives:** variant studies including assessment of management alternatives referring to the criteria efficiency, costs/benefits and risks; final target: conception of protection system regarding elements of the whole risk management cycle.
3. **Planning and optimization:** optimization of protection effects: protection concept, design of measures, functionality assessment, study of the cost-effectiveness.
4. **Realization:** creation (construction) of the protection system.
5. **Startup, handover:** putting into operation: quality check, functionality test, handover to the holder (operator) of the protection system.
6. **Operation, monitoring and maintenance** of the protection system: service, inspection, recurrent condition assessment, repair and restoration.
7. **Rebuilding, adaption or deconstruction:** what to do after reaching the end of life time - renewal, replace, adapt new boundary conditions or needs, removal (disposal) or controlled decay.

The process in the system life cycle is supported by a constant (recurrent) feedback displayed in form of the PDCA-cycle ("Deming cycle") of the quality management. The principles of this feedback are: Plan, Do, Check, Act (Fig. 5 and 6).

Hereinafter several **methods (functions) of systems engineering** are presented that show the practical value of implementation of this approach in natural risk management:

- **Project management** is an essential function to steer complex and multi-layered planning, creation and operation processes of protection systems, including the coordination of a multitude of actors and stakeholders in the project.
- **Requirement analysis** and **systems design** aims at the design of robust,

efficient and less failure prone protection systems and is achieved by definition of concrete protection goals, variant study, minimum standards, functionality testing and application of approved technology. System design is oriented to relevant hazard scenarios and has to be carried out already at the start of the planning process. It focuses on the configuration (architecture) of the protection system, die functionality and the design of structures, taking into account effect-interrelation and the serviceability of the protection system (structure). Additionally the protection needs, the technical, organizational and economic capacity and the legal requirements of the operators (beneficiaries) is considered.

- **Engineering change management** aims at current adaptation and reconfiguration of protection systems to changing framework conditions, primarily of environment (e.g. climate change) and society, technology and societal risk acceptance. A most important function is the documentation and controlling of these changes as well as the current control and recurrent condition assessment. Protection objectives have to be cyclically adapted as well.
- **System integration** deals with the reconfiguration, enhancement or realignment of existing systems in the course of a restoration campaign at the end of the first life cycle or after severe damages caused by extreme events. New elements (e.g. protection structures, rakes and grills, measuring and control devices) are integrated into the existing protection system changing the functionality and/or the risk of failure. Hence system integration requires the revision of protection targets and security levels, further functionality testing and the adaptation of maintenance strategies.
- **Standardization** is a key function of quality assurance in systems engineering and serves the continuous improvement process (CIP). Complex systems with a multitude of planers, performers, operators and responsibilities requires strict and applicable regulations and standards (norms) in order to guarantee smooth and error-free planning processes, work flows and interface work. Standards support all phases in the PCDA-cycle, while standards themselves recurrently have to be checked concerning their accuracy and applicability and have to be adapted if necessary. (Fig. 6) Standardization refers to all kinds of norms, including legal norms, common technical standards as well as specific standards, guidelines and operation regulation for a concrete protection system (structure) and may cover design, dimensioning, steering, organizational as well as safety issues.

Infobox life cycle management (LCM):

(Product-)LCM) is a process of managing the entire lifecycle of a product from inception, through engineering design and manufacture, to service and disposal of manufactured products. LCM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise.

(Definition by WIKIPEDIA))

Origin: 1930s in product development; fundamental enhancements in regarding mainly the life cycle of industrial products

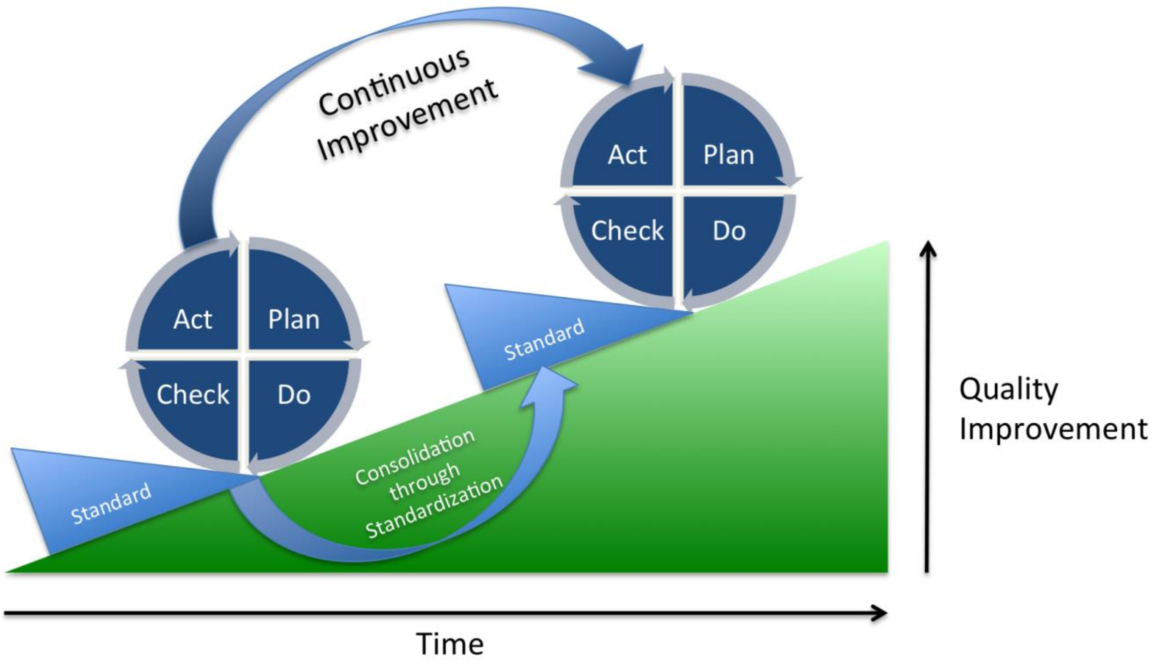

Fig. 6: Continuous improvement of protection systems by recurrent application of PDCA-cycle, supported by standardization.

- **Risk management for protection systems** is a tool to identify early enough potential hazards and risks for the stability, serviceability and durability of the system (structures) and prevent system failures or total breakdown by appropriate measures, safety reserves and redundancies for key elements in the system. Concerning protection systems for natural hazards risk management has also to take into account the impact of extreme (catastrophic) events and the consequences in case of overload. Protection systems that include complex decision support systems based on measuring, controlling or warning devices also need increased attention concerning electronic (digital) system breakdown, interruption of power supply or simply human failures.

3.3 Legal, economic and organizational aspects of systems engineering

The more complex protection systems are, the more likely is the occurrence of malfunction, failures or total breakdown. Hence increasing complexity also raises the risk of liability for planers, operators or approving authorities. The planning, design, operation and maintenance of complex protection systems involves as a rule a multitude of actors and decision makers with different levels of expertize, competence, technical and economic capacities or even risk awareness. This unbalanced situation requires the creation of protection systems that are oriented to the capacity of the holders or beneficiaries (as a rule lay-person) who carry the load of liability as well as in case of failure or breakdown the risk of compensation of damages to third parties.

As a rule legal norms and official approvals of protection systems presuppose the application of a "common state of the art" which hardly exists for protection systems (structures). To a large extent protection structures, control devices or warning systems have the characteristic of prototypes rather than frequently approved technologies. Due to the rareness of real occurrence of design events few experiences exists concerning the functionality (serviceability) of protection structures under extreme impact. The sustainable serviceability of protection systems that need recurrent supervision, adjustment, inspection or maintenance by the operator (holder) presupposes standardized operation procedures, regular instruction and training. As protection works are rarely in function and responsible persons may fluctuate very often, the documentation and transfer of knowledge are additional challenges for the operation of these systems.

Traditionally the cost calculation for protection systems (structures) is limited to the planning and construction phase, while operating expenses or maintenance costs are not taken into account. Recent research clearly has proven that the latter costs may clearly exceed the costs of production over the lifetime (service life) of a protection system (structure) and exponentially increase with crowing complexity. An new approach in systems engineering is “**life cycle costing**” (Fig. 7), a method of cost calculation that takes into account all phases of service life (planning, construction, operation, maintenance, disposal or renewal). An additional problem is that these costs occur at different times and parties; while planning and construction costs as a rule are funded by governmental (public) institutions in the beginning of the service life, the costs of operation and maintenance primarily concern holders or beneficiaries of the protection measures in the operation phase. Life cycle costing guarantees the common truth about costs and supports awareness for all parties: Who has to cover which costs in what phase during service life.

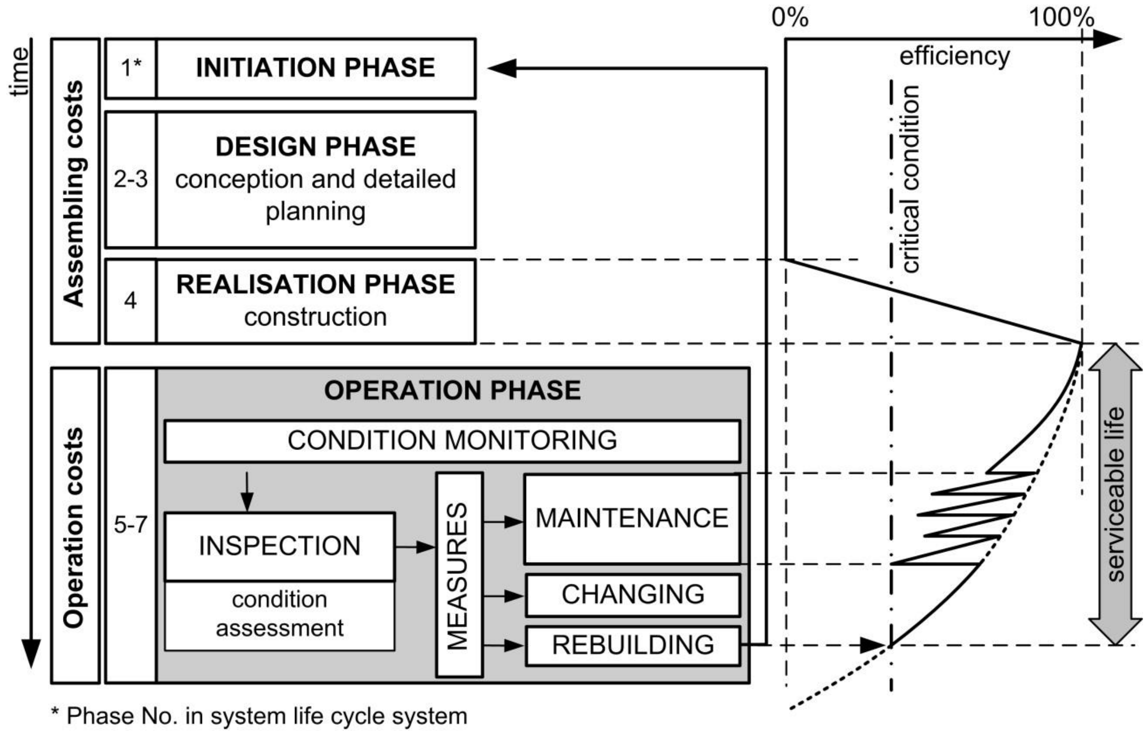

Fig. 7: Principle of life-cycle management of protection systems as basis for life-cycle costing.

Special attention has to be given to the interests of landowners that are involved if protection structures are placed on private properties with beneficiaries others than the landowner himself. This situation requires solutions concerning the utilization of private real estates and the compensation of economic detriments for the whole service life. This problem is subject to expropriation in the public interest or the granting of rights of utilization based on contractual agreements.

Furthermore an important aspect of inspection and maintenance of protection measures are legally determined maintenance obligations of catchments, water courses or water infrastructure. Other legal obligations concern the duty of sustainable management of protection forests, the clearing of torrents from drift wood or the preservation of a good status of water bodies according to the EU water framework directive.

Consequently planning and design of protection systems has by all means take into account the life-cycle costs and the shared responsibility among planners, operators, holders and legally bounded persons concerning inspection, operation, maintenance, risk management and public safety assurance. The handover of protection systems to operators (holders) after completion is therefore also a transfer of risks, liability and economic loads that have to be taken into account and to provide awareness of by both parties (with exception of Bavaria). In simple terms: System engineering also requires directions for use of protection systems (structures). As protection structures as a rule are created in the public interest respectively are public good from its use nobody may be excluded, the instructions concerning functionality, maintenance requirements, operation rules and residual risks involve all beneficiaries (even the citizen of whole municipalities or all participants in traffic). Hence the instruction and documentation of operation rules is also part of the common risk communication on local level. In this sense the life-cycle of public risk awareness and operational knowledge has also be taken into account.

4. Life cycle management (LCM) for protection systems

4.1 Introduction

Following the comprehensive systems engineering approach, integral protection concepts have to be elaborated in a structured manner aiming to fulfill the requirements of effectiveness and efficiency with respect to a broad spectrum of objectives (compare section 3.2).

The feasibility of the integral protection concepts has to be evaluated under changing system loadings, as well as adapted maintenance strategies. Taking into consideration these aspects, the necessity to optimize the functional performance and the operational reliability over the entire life cycle of the envisaged protection system is mandatory. With such a long term planning perspective (i.e. a planning horizon of 100 years) a suitable LCM approach is required.

The major principles of system LCM, as an integral part of the systems engineering approach, are related to

(1) an improvement of methods to determine the *system requirements* in terms of functionality according to specific needs already early in the design phase, i.e., the cost/benefits and reliable performance and implementation of mitigation strategies;

(2) an *assessment of the entire system* studied including all necessary elements needed;

(3) a consideration of the *intra-relationship* between individual system components and interrelationships between higher-order and subordinated levels within the system hierarchy;

(4) a *flexible protection concept and monitoring strategy* allowing for adaptations and adjustments throughout its life span; and all above considered.

In fact, without the consideration of proper design principles and the implementation of suitable maintenance strategies, the effectiveness of protection systems is going to decline faster over time. In parallel, on several debris cones and alluvial fans a clear increasing tendency of wealth moving into flood prone areas could be retraced over the last decades (compare also Fig. 2). This leads to an exacerbation of flood risk and should be taken into account in integrated risk management or better be avoided in future. What's particularly worrisome in this situation is that resulting flood risk patterns might remain largely concealed, since limited attention has been devoted in the past to assess both the damage susceptibility and the functional performance of protection measures over their entire life cycle.

Structures forming the protection systems are of a dual nature because they are designed to mitigate natural hazards but on the other hand they are prone to be damaged throughout their lifecycle by the same processes they should mitigate, thus reducing their performance over time. Furthermore, a normally not allowed, but in praxis not totally avoidable sudden or unexpected collapse of check dams can result in increased hazards downstream due to the formation of dam-break surges and the release of large volumes of sediments.

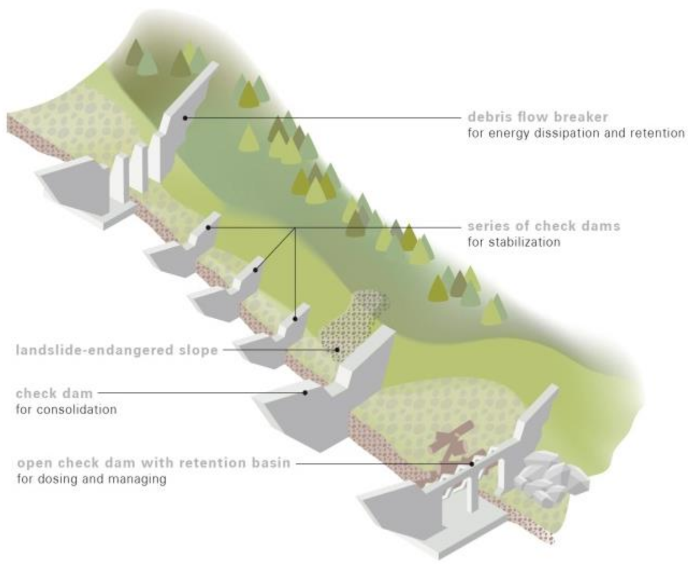

Fig. 8: Several structures form a "function chain", whereas interactions have to be considered (LfU)

Following these premises the design of a protection system has to be pillared on

1. an ex ante and technically sound verification of its functionality
2. structural reliability of the system including the case of overloading, when no sudden uncontrolled collapse of the structure and/or at least the system should occur

ad 1.: That means the ascertainment that the planned system interacts in the desired way with the analytically determined hazard process spectrum. The desired interaction has to be functional to the full and cost-efficient achievement of the risk mitigation goal and the defined ecological and hydro-morphological condition targets.

Technically speaking, the verification of the functionality of a particular system entails an ad hoc definition of the verification concept, which might include for example the computation of hydraulic performance indicator values, the assessment of event based and long-term sediment balances, peculiar performance indices for certain functional components (i.e. dosing efficiency of open check dams).

Ad 2.: It includes, that the structural reliability of the system has to be assured by taking in mind that this concept is tightly linked to the previous one (due to the above mentioned dual nature of protection systems). To this aim two different types of limit states are considered, namely ultimate limit state and serviceability limit state. As stated in EN 1990 it has to be verified, based on the application of load models and structural models, that no limit state is exceeded when the design values for actions, material properties and geometrical data are used. Here (a) the **U**ltimate **L**imit **S**tates – **ULS** – and (b) the **S**erviceability **L**imit **S**tates – **SLS** – are briefly illustrated in their essential aspects.

(a) Ultimate Limit States – ULS: The exceeding of these limit states may result in a structural collapse or other forms of structural failures. They are related to the safety of people and/or the safety of the structure. **In this context EN 1990 prescribes the set of verifications listed in the box below**.

(b) Serviceability Limit States – SLS: The design situations to be considered in this case are **structural function** of the entire structure or of a portion, the **comfort of people** and the **appearance** of the structure. These aspects are generally of limited relevance for typical protection systems in mountain streams. To assess these limit states the following criteria can be adopted: limitation of strain, deformations, crack widths and oscillations.

- **ECU:** Loss of static equilibrium of the entire structure or of specific parts, all considered as rigid bodies. In this case small deviation of the value and the spatial distribution of the considered action type (e.g. dead weight of the structural parts) are relevant, whereas the strength of construction materials or the building ground are of no influence;
- **STR:** Failure or excessive deformation of the structure or its parts including the foundation, piles. Here the bearing capacity and the strength of materials are relevant;
- **GEO:** Failure or excessive deformation of the building ground, whereas the bearing capacity of the soil (or rock) is decisive;
- **FAT:** Failure of the structure as a consequence of fatigue.

The reader may note that the verification approach with respect to structural reliability is of single structures anchored in various directives and norms, whereas the verification of functionality of single structures and even more the system is problem specific and complementary to a rigorous cost-benefit analysis. Hence, from a LCM perspective, the proper design of highly functional systems is of highest priority.

The adoption of a robust verification concept is crucial to assure quality throughout the systems life cycle and helps to clearly define both inspection and maintenance activities, which are very resource demanding both with respect to available finances and personnel.

4.2 Phases of LCM cycle

As shown in figure 7 the system life cycle encompasses different phases.

The whole cycle can be divided into an acquisition phase (Fig. 5 parts 1 to 4) and an operation phase (utilization phase, Fig. 5 parts 5 to 7). This allows to distinguish between

a) actions necessary to develop the system and

b) actions necessary to maintain the system at a high performance level, and to adapt the system if the performance level becomes sub-optimal.

The acquisition phase, from a theoretical point of view, starts with the identification of needs (critical system analysis) and extends through conceptual and preliminary design to detailed design and development (compare Fig. 5 and 7). The utilization phase is characterized by the use of the product, re-configuration and phase-out. System life cycle engineering includes thereby concepts of the product life cycle, which is restricted to the manufacturing process, and concepts of maintenance and support capability as well as re-configuration processes; the latter being of particular importance with respect to existing hazard mitigation strategies that have proven to be sub-optimal and should therefore be enhanced. Possible starting points for such a system life-cycle approach in integrated risk management may include

Fig. 9: Operation can also cause high efforts, for example retention basins have to be emptied from time to time

(1) an analysis conducted on a regional scale showing a need to increase the level of risk management against natural hazards (e.g. by further reduction of vulnerability or by higher protection level) in a highly exposed area;

(2) a survey carried out by the respective administrative agency highlighting a particular need to maintain and/or enhance the technical functionality of an existing protection system; and

(3) a recently produced hazard map delineating frequency and magnitude of a specific hazard processes which once overlain with a map of elements at risk exposed provides a valuable indication of the areas at risk. Furthermore, as a result of

(4) post event documentation which represents an indispensable knowledge base for any intervention aiming at effectively reducing risk.

4.2.1 Structuring the planning process

In this section we outline a conceptual planning approach to tackle planning problems in the field of protection systems engineering. It is flexible enough to master design situations where a completely new protection system has to be conceived as well as maintenance or restoration of existing protection systems. It was ideated as a step-by-step workflow to support practitioners in everyday planning activities:

1. Definition of **the system boundaries** of the considered study site; focusing on the extent of the significant catchment and any relevant tributaries and deposition areas.

2. Definition of the **system characteristics** regarding protection system, natural hazard processes, damage potential and vulnerability.

3. **Problem identification** and description: Definition of (with the new and enhanced knowledge status) the problems to be solved with a particular focus on risk mitigation and ecological functionality and explicit description of the systemic contradictions to be overcome.

4. **Formulation of the Ideal Final Result (IFR)** to be achieved by description of a “model” to be approximated. The IRF has to be intended as a specification supporting the planner throughout the planning process. Since the IFR is formulated in an early planning phase it is essential to explicitly refer to the previously identified system contradictions and to define a continuous target system. Expressed in another way, the targets to be attained are formulated in terms of maximization (minimization) objectives. An ideal protection system should have, among others, the following characteristics:

- long **durability** (high reliability), easy and cheap maintainability;
- high **functionality** (efficiency) with substantial mitigation effects for short return periods and just sufficient mitigation effects for long return period events;
- **low uncertainties** about protection system responses to extreme events, which leads to an easier integration and more effective implementation of early warning systems etc.;
- and **resilient response** to extreme loadings (beyond design events), which especially requires robust and adaptable systems.

In special cases, like torrent control, further demands can occur, like

- high **sediment transport** regulation capacity with progressive reduction of the remaining sediment yield potential;

- **ecological requirements**, not only by Water framework directive, e.g. ecologically careful design of transverse structures prevent erosion and at the same time preserve essential characteristics of the natural water flow and allow best development of aquatic ecosystems.
- **social function** of watercourses as important element of land- and townscape, recreation facility, water power, …

5. Analysis of all **possible physical, spatial, temporal and financial resources** for an optimal application of the IRF. In this phase the planner should go beyond the assessment of available space for hazard mitigation. For example in torrent control besides traditional consolidation and retention concepts also possibilities of dosing transported solid material (woody debris) or smoothing in space and time the peak flow intensity (e.g. diverting excessive loads towards damage minimizing sectors), should be explored. From an integrated risk management perspective it could be essential to identify objects to be "sacrificed" in case of a worst case scenario (i.e. damage minimizing sacrifice).

6. Elaboration of **solution concepts and/or variations** based on the IFR and following the principles shown in table 1.

7. **Evaluation** of the developed solution strategies.

8. **Selection of the optimal solution** concept based on cost/benefit criteria answering for each proposed solution the following questions:

- what has been enhanced;
- what has been worsened;
- what has been substituted; and
- what remains to do with reference to the attainment of the IFR?

9. **Communication of residual risk** to affected people.

Root Principles	**Derived Principles**
(i) Separation Principles	a) Spatial separation: The overall aim is to separate areas characterized by relevant process intensities from areas at risk perspective, i.e. with a relevant accumulation of values at risk. Corollary: Concentrate adverse effect in low vulnerable areas. b) Temporal Separation: The overall aim is to decouple in time the intensity maxima of liquid discharge and sediment transport on the process side, and to displace movable objects at risk from endangered areas during the critical timeframes within the extreme event duration (e.g. by evacuating people at risk). c) Separation by change of status: The aim is to achieve a reconfiguration of critical system configurations during the critical timeframes within the event duration (e.g. by avoiding bridge clogging). d) Separation within the system and its parts: It may be possible to create subsystems with a lower degree of susceptibility while the residual parts of the system remain unaffected (e.g. local structural protection for individual buildings).
(ii) Dynamisation Principles	a) Dynamisation of the sediment transport process: The overall aim is to control the sediment transport process (e.g. by dosing it through open check dams) and the wood transport process (e.g. by preventive entrapment through retention structures). b) Ecosystem dynamisation: The overall aim is to enhance ecosystem functionality. c) Dynamisation of mitigation – Modularization of the protection system: The overall aim is to create a flexible modular mitigation concept taking into account the entire range of possible alternatives. This principle allows for adaptation if the parameterization will change in the future.
(iii) Combination Principles	a) Combination of mitigation: The overall aim is to efficiently reduce effects with respect to hazard and vulnerability, and to increase the system reliability and maintainability. b) Multipurpose combination: The overall aim is to design parts of the mitigation concept with respect to alternative uses (e.g. modeling the landscape in order to achieve flow deflection without compromising the agricultural use of the area).
(iv) Redundancy Principles	Redundancy in intervention planning: In particular for a worst-case scenario, certain elements of the mitigation concept should be redundant in order to avoid system failures.

Table 1: Principles for the planning of effective flood risk mitigation strategies.

4.2.2 Realization

The detailed design is the interface between the planning phase and the realization phase in the course of the LCM-cycle. In this stage the approved draft plans are edited and structural details are elaborated. It is still possible to wield influence on the operation phase of the structure even at this moment. The resulting design plans contain and display all information, which is required for the construction respectively realization.

A detailed statement of work and a bill of quantities based on the design plans are necessary to find a suitable company carrying out the construction services. All required workings and materials are described in these documents. The bill of quantities can be put together out of single building blocks, which in most cases are available as patterns. To achieve an economical realization of the measure, an invitation to tender should be implemented. The offered prices are the foundation of the final settlement.

Within the invitation to tender it can be practicable to allow variant solutions of the bidders. Alternative procedures, ways of construction or building materials can be suggested in this way. The assessment of innovations and newly developed solutions should consider the following lifecycle of the structure. Alternative solutions can influence the upcoming monitoring or maintenance of the structure in a positive or negative way. Even adaptions or changings of the building in the future can be affected.

After the placing the offered prices should be compared with the calculated costs. On the one hand the financial framework has to be maintained. On the other hand the offered prices can be used as calculation basis for prospective construction projects. Existing standard values can be adapted.

The execution of the construction work is symbolized by the ground breaking ceremony. It is an important step in the structures lifecycle. An accurate implementation of the planning into reality is essential, so that the structure can fulfil its function for the whole lifespan. The predefined construction materials and quality standards have to be strictly monitored. Building materials as concrete for example can be sampled and examined for their stability or consistence in a laboratory.

An incorrect or sloppy realization can cause an accelerated abrasion of the structure or deficiencies, which might be detected only after the end of the warranty period. Constructional faults within the realization require attendance and corrective maintenance works earlier in the lifespan. And this leads to additional maintenance costs. A worst case scenario as a result of deficiencies can be the failure of the whole structure in the calculated loading case.

Fig. 10: Realization of a debris flow control structure in the torrent Zillenbach, municipality Hindelang, Oberallgäu (Picture: WWA Kempten)

In the course of the realization it has furthermore to be checked, whether the boundary conditions of the planning – as for instance the condition of the building site – apply. If the parameters set in the planning phase do not correspond to reality, the stability of the structure can be endangered (e.g. base failure, soil erosion).

Therefore, it is important to manage and supervise the construction progress. Periodical site meetings of the builder-owner or his representative and the construction company lead a higher quality of the realization and its result.

In certain circumstances it is required to vary from the design plans in the course of the realization. In these cases the changes have to be documented in the as-completed drawings, which are an important basis for adaptions or changes of the structure in the future. The as-built documents can also be a helpful tool, to assess the condition of the structure in the context of the monitoring. If these plans do not exist, the design plans have to be used instead. But the uncertainty, if these plans were implemented one-to-one, remains.

The actual performed services are the calculation base for the settlement. Service items, not mentioned in the invitation to tender or occurred within the realization, lead to additional costs. In these cases the approved financial framework has to be kept in sight.

The acceptance of the construction marks the end of the realization phase and the structure is put into operation. Deficiencies, discovered prior to the handover, have to be set down. The remedy of defects has to be cleared with the construction company.

4.2.3 Operation and Maintenance

Operation

In some cases the operation of protection facilities causes noteworthy permanent efforts. Operation does not change the condition of the structure or facility, it contains just the effort during normal work or steady cost. Also these efforts can add together to an important amount, which should be recognized already during planning phase. Just to mention a few examples for operation costs: power costs for measuring devices, light or pumps; personnel costs for operation including stand-by duties; steady clearing works and (self-)monitoring.

Monitoring Concept

A fundamental task to guarantee a reasonable safety level of the protection works is their periodic monitoring concerning their condition and effectiveness. This task is mainly the duty of the protection works holder (e. g. state, communities, beneficiaries, water cooperatives, or the holder of the protected traffic way (e. g. Railway Company) – refer also to the good practice example B3). The monitoring concept can be divided in two parts: the inspection and the measurement or intervention part (Figure 12).

Fig. 11: Monitoring is essential to detect the necessity of maintenance and in consequence to keep up functionality

The main target of the inspection part is to assess the condition in a comprehensive manner. This is guaranteed by the comparison of the actual state with a reference state. The aim of the inspection is to classify the structure in different condition levels, e.g. in a range from “new” or as “good as new” to “completely destroyed”. For classification the condition at the actual state, the possible development of the condition in the future and the necessary moment for measures must take into account.

Inspection concepts should consider the importance of different structures. Barriers that represent a key structure in the protection system are subject to more frequent inspection and have to be maintained primarily. A key structure is characterized by massive damages in the protected area in the case of its failure.

The organization of the inspection is regulated quite different in the countries of the alpine region. But in any case it is essential, that the inspection is carried out by a qualified person and that the result of the inspection is well documented. In Italy, Austria and Germany for example the results are stored in databases for a further use (refer to Annex A – databases of structures).

It is important, not only to monitor (and later on to maintain) structures, but also the watercourse, the banks and the waterside land. Also those elements fulfil functions in the whole system and therefore it can be for example necessary to remove deposited debris, excessive vegetation on the bank or woody debris. The interaction between watercourse, banks, slopes and the structures have to be taken into account.

Of course every monitoring concept has to be flexible to changes and especially after events a separate monitoring is essential to prove the functionality of the system and to initiate necessary maintenance. To allow monitoring and maintenance a permanent access to the facility is necessary during the whole lifetime.

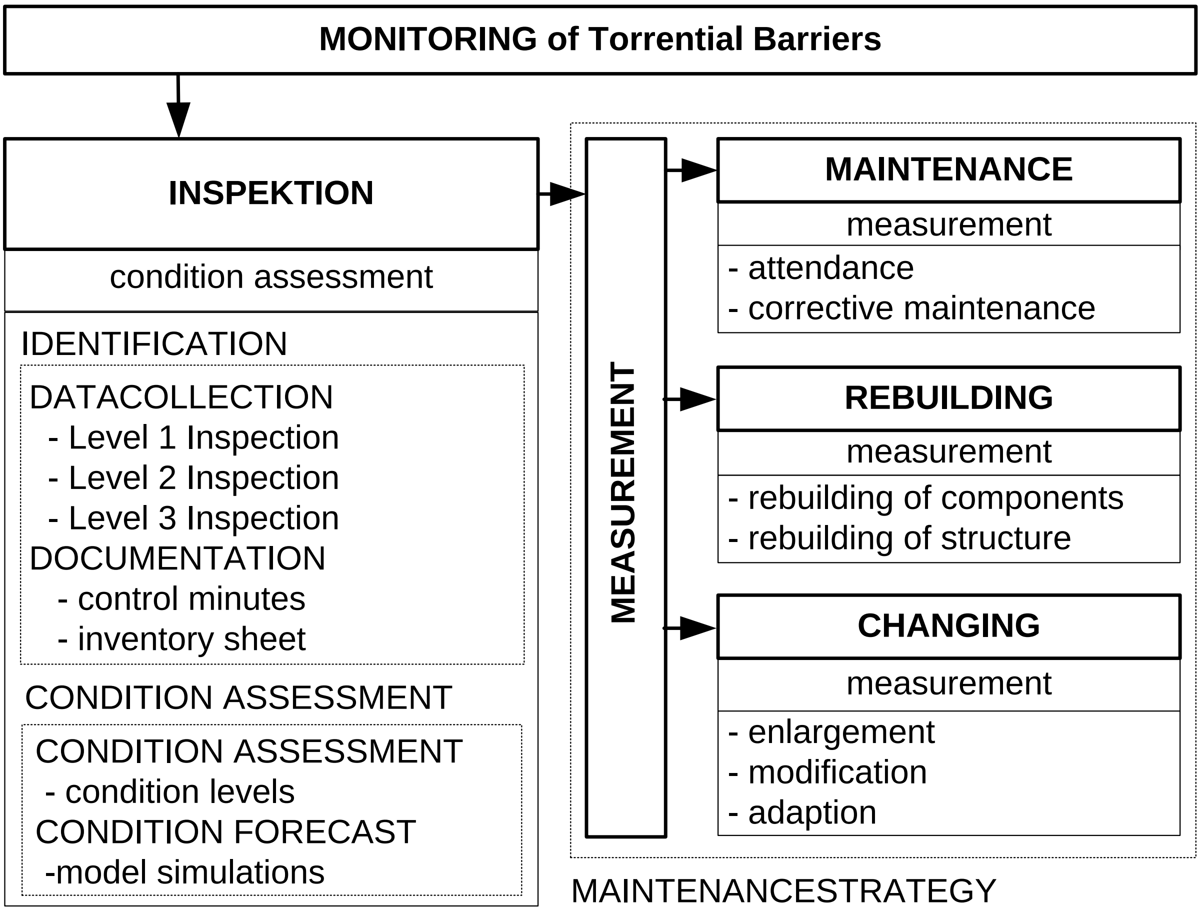

Fig. 12: Configuration of the maintenance concept for protection works

Instruments for inspection, documentation and assessment

To identify the actual condition and to ensure a consistent assessment, standardized instruments are useful (refer especially to good practice example B1). These instruments can be spitted in the operational instruments, the instruments of documentation and the instruments of assessment.

Example for Operational Instrument for inspection (Austria)

Three different inspection levels consider economic limits. In level 1 all structures will be periodically inspected e.g. by lumbermen during the annual inspection of the torrents (e.g. task of the community due to the Forest Act). If a damage on a structure is identified a competent expert will do a level 2 inspection. If there is no chance of assessing the structures actual condition a level 3 inspection will be held.

Level 1 and 2 are done with visual inspection methods. For a level 3 inspection complex engineering methods are used, e.g. analyses of material samples, measuring systems, static and hydraulic simulations. Ideally this inspection level is carried out by an interdisciplinary expert team. These operational instruments are suitable to the RVS 13.03 – standards.

A consistent and comparable description of the structures' damages is assured by well-developed control minutes. In Austria for example a damage catalogue for torrent protection works was developed. This catalogue is based on the experience of practitioners and the theoretical background of researchers. The catalogue contents a classification of damages and detailed descriptions for several types of damages. The classification scheme divides the damage-types in those with relations to the ultimate limit state, to the serviceability limit state and to the durability limit state (terms in according to EN 1990). In addition the classification considers the type of structure and the design material. A consistent and comparable description of the structures' damages can also be assured by well-developed instruments enable effective decisions regarding type and timing of measures and enable control form-sheets, which guide the inspector.

The collected data will be used for maintenance planning as well as the further inspection planning to get a precise and efficient maintenance management. It enables effective decisions regarding type and timing of measures. A completed database could also be used as base for simulations of further developments depending on different maintenance scenarios, to optimize life-cycle costs.

Maintenance

Regular maintenance of protection systems and structures is an important part of integrated natural hazard management. It provides the protection function, improves operation security and keeps structures in a good condition. Thereby no change in protection function or of the whole system is attended, which generally also means, that no legal permission is needed. Main elements of maintenance are: reconditioning, repairs, (small) reconstructions.

The lifespan of a structure is affected by the maintenance strategy, especially the minimum triggering level respectively the frequency of maintenance actions. Regular attendance and corrective maintenance extend its lifespan. The more the structure approaches the critical condition (Fig. 3), the more urgent measures have to be taken.

Maintenance should take into account several boundary conditions, like ecological questions. For example during several times, like spawning season of fish, major measures within the watercourse should be avoided.

Rebuilding or changing system?

Anyway every structure will reach the end of its lifespan sometime. In this case several possibilities are available:

- Rebuilding the structure(s) or its components
- Adaption, modification or enlargement of the structure(s) because of changing boundary conditions
- Controlled decay, because no more structure is necessary
- Complete removal of the structure, because it meanwhile has a negative impact on the system
- Change of the whole system (e.g. one new large structure replacing several old ones)

For the assessment of the further course of action the whole system (catchment area) has to be observed by an integrated approach (refer e.g. to good practice example B2). This is the only way to identify the best strategy for a protection system, that consists of many single structures, erected in different times and under different boundary conditions. An example for such an approach is given in the good practice example of Habichtgraben (B4, Germany), Gadria (B8, Italy) or the management of old avalanche protection structures (B12, Switzerland).

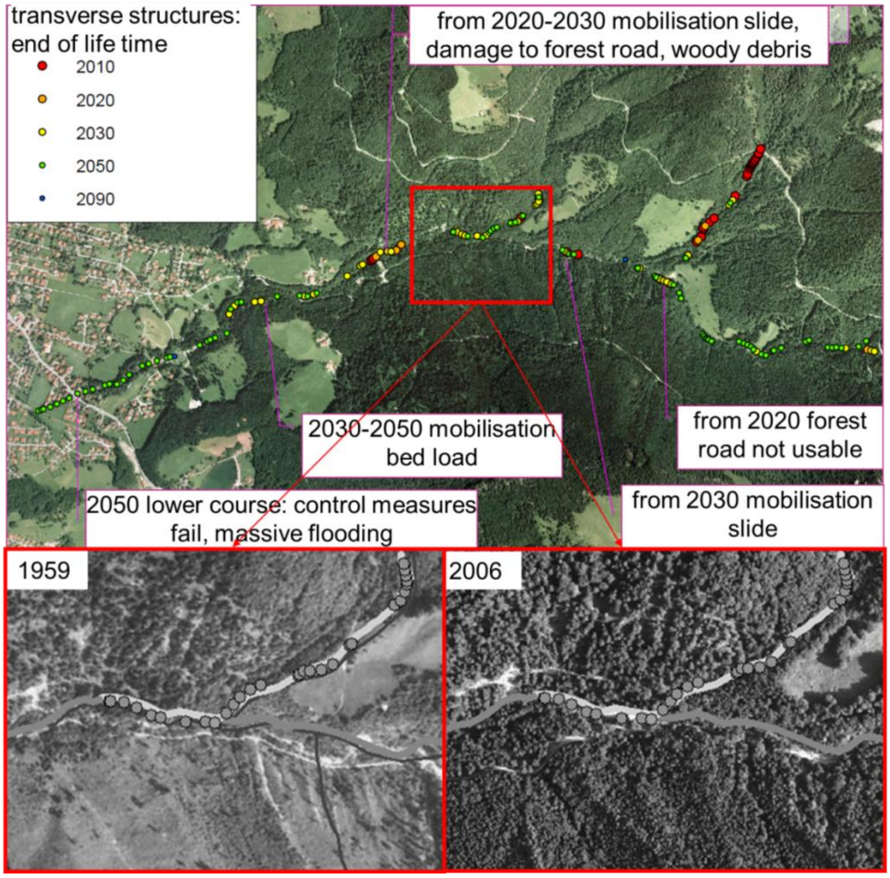

Fig. 13: Assessment of consequences after reaching end of life time (Rimböck, A.; Asenkerschbaumer, M. (2012))

5. Implications and recommendations

CONCERNING THE DIFFERENT IMPACT - LEVELS OF PROTECTION SYSTEMS, FIGURED OUT IN CHAPTER 2, WE WANT TO DISTINCT ALSO OUR IMPLICATIONS AND RECOMMENDATIONS REGARDING THESE LEVELS.

5.1 Overall / general recommendations

Introduction of system engineering in management of natural hazards: System engineering contents many valuable elements, which can promote an improved, sustainable and integrated approach in natural hazard management.

Innovative protection systems based on the cradle to cradle (former: cradle to grave) concept (life cycle management): with this perspective it is possible to make use of the intelligence of natural systems and to provide green care and green jobs for the future. Thereby it is sensible and necessary to widen the perspective from cradle to grave into a cradle to cradle perspective regarding the whole cycle and to optimize the consumption of resources.

Homogenization of figures concerning capital stock / replacement value: as we realized, the data base in the several countries regarding the number and value of the protection structures is heterogeneous. To gain better comparable numbers for this important "security infrastructure" a standardization for the value assessment and therefore a homogenization of the data base should occur.

Take into account ecosystem services: With better understanding, enhancing and incorporating ecosystem services in protection systems investments become more sustainable. Thereby lifetime can be extended and cost of maintenance reduced. In some cases, even a full transfer of protection function from structures to ecosystem services can take place.

5.2 Structural level

Observation and documentation system for protection facilities: all single protection elements of a system should be covered by an area-wide and well-adjusted system for careful inspection and documentation of all actions. This can assure a proper overview and therefore the system can be adequately handled, which allows an optimization of operation and maintenance of the whole system.

Application of a life cycle costing approach: already during preparation and pre-planning aspects of functionality, stability, serviceability and durability have to be assessed in a well-adapted way. Such an early consideration of life cycle costing approaches facilitates the search of optimized solutions.

5.3 Catchment level

Analysis of development in the catchment area: only a careful consideration of all aspects in the whole catchment areas can found a reliable basis for all planning phases. On this background concrete scenarios can be derived which have to be considered in the planning process. By this approach and a periodic update it should be possible to react to future developments/changes and to gain adjustable and resilient protection systems.

Integrated approach to ensure sustainable and adjustable protection systems: only an integrated risk management under consideration of all protection elements - like protection forest, structural measures, planning measures - and under participation of all persons concerned can lead to sustainable results and allow adjustable solutions.

5.4 Impact area level

Taking into account protection systems in spatial planning: only if the risk assessment and the protection systems with their consequences and constraints are systematically considered in spatial planning this leads to functional and reliable overall solutions.

Balance of risks, chances and charges: the realization of protection systems is a great effort. Not only the costs but also the resulting chances and the residual risks have to be shared beyond the concerned persons to allow best identification, acceptance and function.

5.5 National level

Reliable and continuous finance planning: only if finances are continuously available and the amount is based on an analysis of condition of the existing structures and an assessment of the future need (e.g. by help of a data base, by capital stock calculation or other) an adequate maintenance level can be ensured. This is vital for an unrestricted function of the protection systems and for the reliability of the safety level.

Legal and technical minimum standards: to ensure a comparable high quality and reliable protection effects some standards should be worked out and introduced into praxis. This is even more important, as many different interested parties work together in the elaboration of suitable protection systems. Furthermore standards are a suitable instrument to share experience and to facilitate quality management.

5.6 Alpine Space (resp. European level)

Consider protective infrastructure issues separately in funding programmes: many planning guidelines, protection systems and other elements of risk management are encouraged by national or European based funds. If the functionality, reliability and long term maintenance of the protective infrastructure get improved, the proper use of these financial instruments is optimized.

Cross border approach in the Alpine Space: natural hazards do not know borders. Therefore it is more than sensible to face this fact by a cross border approach. Furthermore there is always the problem between upstream and downstream riparian's, which requires strengthening solidarity principles. A lively exchange of experience and information shall provide comparable status of protection systems regarding systems engineering in the different countries.

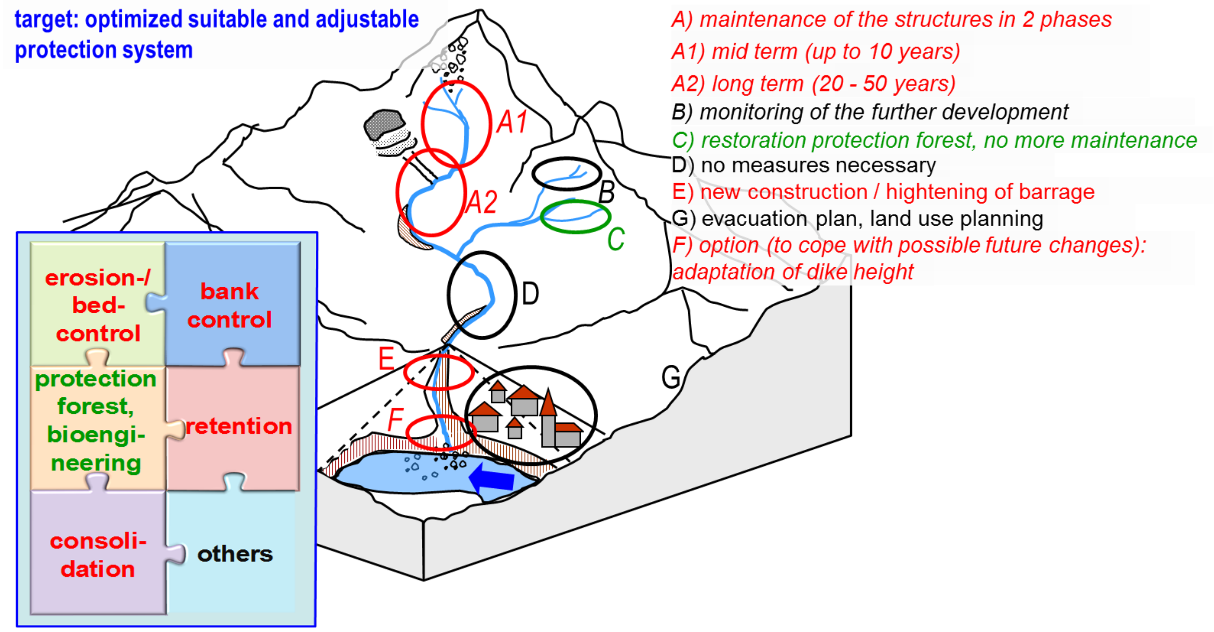

Fig. 14: Vision of maintenance and change management in a torrential catchment area (Rimböck et al (2012))

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ANNEX

ANNEX A - Country-related facts and figures regarding systems engineering in natural hazard management

ANNEX B - Good practice examples from Member states

ANNEX C – Good practice examples from Member states on construction details that support or prolong the lifetime / functionality of a protective infrastructure in place

ANNEX A – Country-related facts and figures regarding systems engineering in natural hazard management

Torrents

Duty of maintenance

a) Monitoring and inspection
b) Attendance and corrective maintenance
c) Rebuilding and changing

Country (alphabetical order)	**Who is responsible**	**Who is financing**	**Who is operating**	**Legal Basis**	**Costs (€/year)** incl. definition of the costs
Austria	a) In general: Water authority, torrent and avalanche control service; for specific protection work: holder (operator) (e.g. Municipality, road administration, water cooperative)	a) Holder (operator) or beneficiaries of protection system: e.g. Municipality, road administration, water cooperative	a) Holder (operator) of protection system: e.g. Municipality, road administration, water cooperative or commissioned civil engineer	Water Act Forest Act Water Engineering Funding Act	Up to 15 % of annual investment costs: approx. € 20 Mio.
	b) Holder (operator) (e.g. Municipality, road administration, water cooperative)	b) Beneficiary for recurrent measures; extraordinary maintenance: Public funding, shared among federal state, province and beneficiary) (e.g. Municipality, road administration, water cooperative)	b) Holder (operator) of protection system: e.g. Municipality, road administration, water cooperative; Extraordinary maintenance work by Austrian Torrent and Avalanche Control Service		
	c) Holder (operator) (e.g. Municipality, road administration, water cooperative)	c) Public funding, shared among federal state, province and beneficiary) (e.g. Municipality, road administration, water cooperative)	c) by Austrian Torrent and Avalanche Control Service or Provincial Flood Control Service		
Germany (Bavaria)	a) state (State Offices for Water Management)	a) state	a) state (State Offices for Water Management)	Bavarian Water Law	about 12 Mio
	b) state (State Offices for Water Management)	b) state	b) state (State Offices for Water Management)		
	c) state (State Offices for Water Management)	c) state	c) state (State Offices for Water Management)		

Italy	a, b, c) local authorities (provinces, regions, municipalities) for public safety and public infrastructures, institution in charge of the object to be protected (highways and railways companies, privates)	a, b, c) local authorities (provinces, regions, municipalities) for public safety and public infrastructures, institution in charge of the object to be protected (highways and railways companies, privates,)	a) owner or competent authorities b, c) private firms, public firms	National soil defense law (183/89) Regional soil defense laws	
Liechtenstein	a) Municipalities / Office for Civil Protection	a) state	a) Municipalities / Office for Civil Protection	Water management laws (Rüfeschutzbauten gesetze, Rheingesetz)	3.4 Mio (incl. new investments)
	b) Office for Civil Protection	b) state	b) Office for Civil Protection		
	c) Office for Civil Protection	c) state	c) Office for Civil Protection		
Slovenia	a) state (relevant Ministry for Water Management)	a) state	a) Slovenian Environmental Agency & Concessionary service in Water Management	Slovenian Water Act and it's sub-legislations	about 7 Mio
	b) state (relevant Ministry for Water Management)	b) state or in some cases state with co-financing of local community	b) Slovenian Environmental Agency & Concessionary service in Water Management		
	c) state (relevant Ministry for Water Management)	c) state or in some cases state with co-financing of local community	c) Relevant Ministry (Water Management or Infrastructure) with support of Slovene Environmental Agency & the Concessionary service or Construction Contractor		
Switzerland	a) Cantons and local authorities	a) Federal state, cantons, local authorities	a) cantons or local authorities	Federal Forest Act Federal Water Engineering Act Corresponding cantonal acts	
	b) Cantons and local authorities	b) idem	b) cantons or local authorities		
	c) Cantons and local authorities	c) idem	c) cantons or local authorities		

*Maintenance of water and waterside land in Slovenia is carried out under the mandatory public utility services in the field of water management performed by selected concessionaires under a concessions contract and directed and managed by Slovenian Environmental Agency (body of Ministry relevant for water management))

Duty of maintenance

Avalanches

a) Monitoring and inspection
b) Attendance and corrective maintenance
c) Rebuilding and changing

Country (alphabetical order)	**Who is responsible**	**Who is financing**	**Who is operating**	**Legal Basis**	**Costs (€/year)** incl. definition of the costs
Austria	a) In general: Water authority, torrent and avalanche control service; for specific protection work: holder (operator) (e.g. Municipality, road adminis-tration, water cooperative)	a) Holder (operator) or beneficiaries of protection system: e.g. Municipality, road administration, water cooperative	a) Holder (operator) of protection system: e.g. Municipality, road administration, water cooperative or commissioned civil engineer	Water Act Forest Act Water Engineering Funding Act	Up to 5 % of annual investment costs: approx. € 2 Mio.
	b) Holder (operator) (e.g. Municipality, road administration, water cooperative); for protection forest: land owner	b) Beneficiary for recurrent measures; extraordinary maintenance: Public funding, shared among federal state, province and beneficiary) (e.g. municipality, road administration, water cooperative); for protection forest: land owner or public subsidies (Provincial Forest Service)	b) Holder (operator) of protection system: e.g. municipality, road administration, water cooperative; Extraordinary maintenance work by Austrian Torrent and Avalanche Control Service;); for protection forest: land owner or public subsidies (Provincial Forest Service)		
	c) Holder (operator) (e.g. Municipality, road administration, water cooperative)	c) Public funding, shared among federal state, province and beneficiary) (e.g. Municipality, road administration, water cooperative)	c) by Austrian Torrent and Avalanche Control Service or Provincial Flood Control Service		
Germany (Bavaria)	a, b, c) <u>object protection structures:</u> institution in charge of the object to be protected (street building authorities, privat) <u>remediation of protection forest:</u> state (Forest+Water Officies)	a, b, c) <u>object protection structures:</u> state, privat <u>remediation of protection forest:</u> state	a, b, c) <u>object protection structures:</u> institution in charge of the object to be protected (street building authorities, privat) <u>remediation of protection forest:</u> state (Forest+Water Officies)	<u>object protection structures:</u> duty to implement safety precautions	<u>remediation of protection forest:</u> 0,5 – 1,0 Mio (only part water)

Italy	a, b, c) avalanche control structures: local authorities (provinces, regions) for public safety and public infrastructures. institution in charge of the object to be protected (highways and railways companies, privates, ski resorts companies). forest management: local authorities (regions, provinces, municipalities)	a, b, c) avalanche control structures: local authorities (provinces, regions) for public safety and public infrastructures institution in charge of the object to be protected (highways and railways companies, privates, ski resorts companies), forest management: local authorities (regions, provinces, municipalities)	a, b, c) avalanche control structures: private firms, public firms forest management: Private & public forestal firms	National soil defense law (183/89) Regional soil defense laws Regional forest laws	
Liechtenstein	a) Office for Civil Protection	a) state	a) Office for Civil Protection	Forest law	0.2 Mio (incl. new investments)
	b) Office for Civil Protection	b) state	b) Office for Civil Protection		
	c) Office for Civil Protection	c) state	c) Office for Civil Protection		
Slovenia	a, b, c) institution in charge of the object to be protected (e.g. road & railway management authorities, local communities)	a, b, c) state roads & railway management authorities, local communities, companies, privat	a, b, c) institution in charge of the object to be protected (e.g. road & railway management authorities, local communities)	The Construction Act, duty to implement safety precautions	
Switzerland	a) Cantons and local authorities	a) Federal state, cantons, local authorities	a) cantons or local authorities	Federal Forest Act Corresponding cantonal act	
	b) Cantons and local authorities	b) idem	b) cantons or local authorities		
	c) Cantons and local authorities	c) idem	c) cantons or local authorities		

Rockfall

Duty of maintenance

a) Monitoring and inspection
b) Attendance and corrective maintenance
c) Rebuilding and changing

Country (alphabetical order)	**Who is responsible**	**Who is financing**	**Who is operating**	**Legal Basis**	**Costs (€/year)** incl. definition of the costs
Austria	a) In general: Water authority, torrent and avalanche control service; for specific protection work: holder (operator) (e.g. Municipality, road administration, water cooperative)	a) Holder (operator) or beneficiaries of protection system: e.g. Municipality, road administration, water cooperative	a) Holder (operator) of protection system: e.g. Municipality, road administration, water cooperative or commissioned civil engineer	Water Act Forest Act Water Engineering Funding Act	Up to 5 % of annual investment costs: approx. € 1,0 Mio.
	b) Holder (operator) (e.g. Municipality, road administration, water cooperative); for protection forest: land owner	b) Beneficiary for recurrent measures; extraordinary maintenance: Public funding, shared among federal state, province and beneficiary) (e.g. Municipality, road administration, water cooperative); for protection forest: land owner or public subsidies (Provincial Forest Service)	b) Holder (operator) of protection system: e.g. Municipality, road administration, water cooperative; Extraordinary maintenance work by Austrian Torrent and Avalanche Control Service;); for protection forest: land owner or public subsidies (Provincial Forest Service)		
	c) Holder (operator) (e.g. Municipality, road administration, water cooperative)	c) Public funding, shared among federal state, province and beneficiary) (e.g. Municipality, road administration, water cooperative)	c) by Austrian Torrent and Avalanche Control Service or Provincial Flood Control Service		
Germany (Bavaria)	a, b, c) institution in charge of the object to be protected (e.g. street building authorities, municipalities)	a, b, c) state, municipalities	a, b, c) institution in charge of the object to be protected (e.g. street building authorities, municipalities)	duty to implement safety precautions (Verkehrssicherungspflicht)	

Italy	a, b, c) local authorities (provinces, regions, municipalities) for public safety and public infrastructures institution in charge of the object to be protected (highways and railways companies, privates),	a, b, c) local authorities (provinces, regions, municipalities) for public safety and public infrastructures institution in charge of the object to be protected (highways and railways companies, privates)	a) owner or competent authorities b, c) private firms, public firms	National soil defense law (183/89) Regional soil defense laws	
Liechtenstein	a, b) Roads: Office for Building and Infrastructure; Rest Office for Civil Protection	a) state b) state	a, b) Roads: Office for Building and Infrastructure; Rest Office for Civil Protection	forest law (Waldgesetz)	0.2 Mio (incl. new investments)
	c) Office for Civil Protection	c) state	c) Office for Civil Protection		
Slovenia	a, b, c) institution in charge of the object to be protected (e.g. roads & railway management authorities, local communities)	a, b, c) state roads & railway management authorities, local communities, companies, privates	a, b, c) institution in charge of the object to be protected (e.g. road & railway management authorities, local communities)	The Construction Act, duty to implement safety precautions	no data
Switzerland	a) Cantons and local authorities	a) Federal state, cantons, local authorities	a) cantons or local authorities	Federal Forest Act Corresponding cantonal acts	
	b) Cantons and local authorities	b) idem	b) cantons or local authorities		
	c) Cantons and local authorities	c)idem	c) cantons or local authorities		

Databases of structures

Country (alphabetical order)	**Is there a structural protection measure-related database/register**	**Number of protection structures**	**Contents of the database**						**Interface to other databases**
	(if yes: name of database if no: ---)	(in database)	Structure dimensions	Assessment of condition	Use for planning of monitoring	Documentation of monitoring and inspection	Documentation of attendance and corrective maintenance	Documentation of rebuilding and changing	
Austria	Austrian Torrent & Avalanche Cadastre: Protection measure data ; Structure data base of road and railway operations	WLV: 150.000 (actual state of recording and assessment); ÖBB: ?	**x**	**x**	**x**	**x**	**x**	**x**	Export of data in *.xls or *.shp-file (GIS) possible; Outline in interactive PDF-maps
Germany (Bavaria)	Torrents: InfoWiba	about 50.000	**X**	**X**	**X**	**X**	**(x)**	**(x)**	Export of data in *.xls or *.shp-file (GIS) possible
	Avalanches: --- (no nationwide consistent database)								
	Rockfall: --- (no nationwide consistent database)								

Italy	ReNDIS (Repertorio Nazionale degli Interventi per la Difesa del Suolo)								WebGIS and shapefile
	South tyrol: BAUKAT (torrent control structures)	about 35.000	**x**	**x**	**x**	**x**			Shapefile
	South tyrol: LAWBAUKAT (avalanche control structures – under construction)		**x**	**x**					Shapefile
	South tyrol: VISO (rockfall protection structures – under construction)		**x**	**x**					ORACLE
	Autonomous Province of Trento: database of protection structures	About 18.000	**x**	**x**	**x**				
	Region Friuli Venezia Giulia – cadastre of protection structures								Shapefile
Liechten-stein	Schutzbautenkataster (SBK) Avalanches, Rockfall	1’000	**x**	**(x)**				**x**	Export of data in *.xls or *.shp-file (GIS) possible
	Torrents: --- (in development)								
Slovenia	Water infrastructure: "Vodni objekti"	about 14.000	**X**	**(x)**	**(x)**	**(x)**	**(x)**	**(x)**	Export of data in *.xls or *.shp-file (GIS) possible
	Avalanches: --- (no nationwide consistent database)								
	Rockfall: --- (no nationwide consistent database)								
Switzerland	ProtectMe								

ANNEX B – Good practice examples from Member states

Note: The good practices collected with the support of the Member states are a non-exhaustive representation of the different complex situations existing in the alpine area

Phase of LCM: operation

INSTALLING A SYSTEM FOR A REGULAR, PERIODICAL INSPECTION OF THE CONSTRUCTIONS THROUGH PROFESSIONAL SKILLED EXPERTS AS A STEP TOWARDS BETTER MAINTENANCE AWARENESS.

Presentation of the problem: During the operation of the retention basins it became evident, that the operator of the construction – municipalities and water boards – neglected the maintenance of the construction and the inspection of important system parts. Often there has been a lack of expertise.

Framework (responsibilities, law, organization): The maintenance of retention basins is regulated in the Water Law Act 1959 (WRG 1959). Generally the operator (mostly a community) is responsible for the maintenance work.

Solution / description: In 1993 all retention basins have been inspected in regard to design or constructional shortcomings as well as in terms of weak points during the operation of the constructions. The results of this analysis and the shown shortcomings disposed the responsible persons in the regional government authority to install a system for a regular, periodical inspection of the constructions through professional skilled experts. Together with representatives of the Chamber of Engineers of Styria and Carinthia the scopes of work of the “retention basin supervisor” has been worked out 1994 (refer to Fig. 6).

During the annual site inspection and control of the construction in regard to existing shortcomings in construction, design and static also the functional capability of all plant components have to be checked. Additional to the annual control the retention basins have to be inspected after every event respectively after every ponding of the basin. The inspection report is forwarded to the client, to the operator of the basin as well as to the Water Right Authority. Further a caretaker, e.g. a municipal employee, is responsible for the maintenance of the construction which is documented in an operation diary. This system is financed by the federal ministry, the Government of Styria and by the operator.

Tasks of the supervisor:

- Preparation of a retention basin book (technical and legal documents)
- Preparation of a handbook and work rules
- Annual inspection of the construction visual and functional
- Report to the water right authority, Styrian Government Department 14, operator, district construction manage-ment and torrent und avalanche control
- Training and education of the caretaker
- Inspection of possible reconstruction works
- Monitoring and checking of any refurbishment

Tasks of the caretaker:

- Keep an operation diary
- Maintenance of the construction
- Status control of all plant components (4 times a year)
- Removal of log jams
- Inform the operator in case of emergency

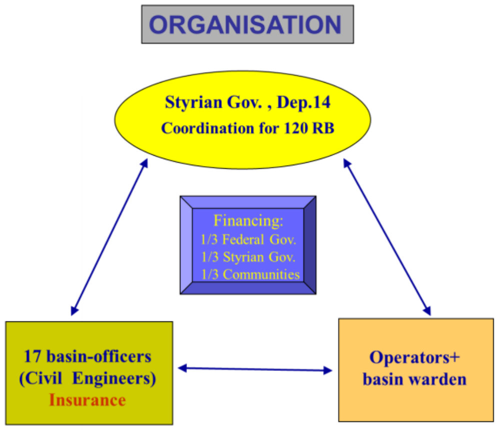


Fig. 15: Organisation of the inspection system in Styria

FURTHER INFORMATION/LINKS:

The inspection of the retention basins in Styria via civil engineers has proved itself optimally. All constructions are in a proper condition. The sense of responsibility is increased due to the activities of the civil engineers and because of the common annual field inspection.

www.wasserwirtschaft.steiermark.at

B2 - Galina Torrent – Redevelopment of historic protection systems Austria

Phase of LCM: planning

WITH RESPECT TO CHANGING ENVIRONMENTAL AND SOCIETAL CONDITIONS THE 100 YEARS OLD PROTECTION SYSTEM IN THE GALINA TORRENT (NENZING, VORARLBERG) – CREATED AS PART OF THE HISTORIC RHINE RECTIFICATION - REQUIRED A COMPLETE REDEFINITION OF PROTECTION TARGETS, REDEVELOPMENT OF PROTECTION CONCEPT AND ESTABLISHMENT OF A NEW CONSORTIUM OF BENEFICIARIES.

Presentation of the problem: After a service life of more than 100 years torrent control works and successfully reforested erosion scars in the Galina catchment have reached a critical stage concerning stability and serviceability and require cost-intensive restoration. The Galina torrent control works originally were built to retain enormous masses of loos rock and gravel from erosion in order to unburden the Rhine rectification from sedimentation and colmation. Although the catchment and huge debris cone are well afforested and carry no major settlements, several important infrastructures (such as railroad, provincial load, power plant) were established in the former hazard zone of the Galina torrent which are now exposed to increasing risks.

Framework (responsibilities, law, organization): The torrent control works in the Galina catchment were created and financed in the framework of the bilateral treaty Austria-Switzerland for the rectification of the Rhine river with 100% funding by the state. Due to the historic origin of the protection works there are maladjusted responsibilities for maintenance and monitoring of the protection system, excluding the actual beneficial occupants of the protection effects and services. The critical condition of the protection structures is obvious, while a prognosis for the ongoing process of decay (protection works and forest stands) is debatable and dependent of the development of disasters. As the actual hazard map shows a moderate risk (assuming full protection function) the beneficial occupants still needed to be convinced about their responsibility and financial involvement for maintenance and restoration.

Solution / description: The restoration of the protection system and reforestation in the Galina catchment requires a concept adapted to the new risk scenarios and changed protection needs of the actual beneficial occupants. As no legal basis exists anymore to justify a 100% financing by the federal state, a new model for financing urgent maintenance and restoration works, and an appropriate legal basis in order to involve all beneficiaries to the extent of their benefits and averted losses was crucial. After hard and intensive negations concerning the relevant risk scenarios (potential amplification of hazard zones), the scope and priority of restoration measures and the cooperation of the beneficiaries in a new protection concept a new project with total cost of € 2,8 million was elaborated and financially approved in 2014 including fare-sighted restoration measures until 2035.

FURTHER INFORMATION/LINKS:

http://www.naturgefahren.at/projekte/galina.html

Fig. 16: Historic protection works and reforsted erosion scars in the Galina catchment (Vorarlberg)

B3 - The role of Water Cooperatives in collaborative risk governance Austria

Phase of LCM: planning and operation

LOCAL WATER COOPERATIVES - A LEGAL BODY COMPOSED OF INDIVIDUALS, MUNICIPALITIES, COMPANIES ETC. – IN THE FRAME OF NATURAL HAZARD MANAGEMENT AS A STRONG VEHICLE TO SHARE THE FINANCIAL BURDEN/RISK OF NATURAL HAZARD PREVENTION ALONG A BROADER AUDIENCE.

Presentation of the problem: In order to strengthen the current efforts to boost resilience in Austria, there is also the question about a more privatisation of risks. This requires stronger engagement of non-governmental actors, such as private households and businesses, to increase investments in self-protection and also to increase risk awareness and perception. Exploring the potential of collaborative financing mechanisms is one – but vital – step towards collaborative risk governance and therefor also to systems engineering.

Framework (responsibilities, law, organization): As understood in Austria, in accordance with the Water Act of 1959, a water board or water cooperative is a legal body composed of individuals, municipalities, companies etc. with a variety of tasks, including the sharing of the (financial) risk associated with water-related hazards at a specific site – mainly valleys and regions, as well as the maintenance of the structures. Each member contributes financially to a common fund, which is intended for use in the development of mitigation or prevention measures. The idea behind this is to share the financial burden, e.g. to develop protection measures in a torrent/river with all of the people/organisations that anticipate a given safety level in a valley/region – regardless of whether they are directly affected by natural hazards or not.

Solution / description: A number of water boards or water cooperatives currently exist in Austria (some of which are over 100 years old, e.g. the Schmittenbach, Zell am See, Salzburg water board), however it is not yet a common cooperative structure throughout the Austrian country. With regard to torrent and avalanche-related hazards, the highest number of water boards can be found in the province of Salzburg (approx. 260) and include approximately 230,000 households. The level of the contributions made to the common fund by each member is formalized using a points-based system which reflects the degree of exposure of a given property and/or building. Due to this “direct” involvement of the members of a water board in natural hazard management, a high level of identification with the “products” of protection strategies can be observed and this, in turn, supports maintenance and further mitigation measures in the areas in question.

FURTHER INFORMATION/LINKS:

www.wg-schmittenbach.at (for example)

B4 - Habichtgraben - Change of system in a torrent Germany

Phase of LCM: operation

IN THE TORRENT "HABICHTGRABEN" ONE NEW LARGE BARRAGE WAS BUILT TO REPLACE SEVERAL OLD AND ALMOST DESTROYED SMALL BARRAGES IN THE UPSTREAM CATCHMENT AREA.

Presentation of the problem: The Habichtgraben is a torrent in the municipality Eurasburg, which flows into the river Loisach 7 km south of Wolfratshausen. About 60 check dams (construction material: concrete, stone or wood) in the catchment area meanwhile are in a bad condition or already destroyed. The maintenance of these old barrages would be very costly.

During the last the decades, benefitted from the check dams, a dense forest has grown up and stabilized the slopes in the upper area. But the settlement area in the lower catchment was still in danger. The positive ecological development allowed a change of the protection system.

Framework (responsibilities, law, organization): For the old barrages the state as builder of the structures was in charge of maintaining the torrent and its protection works also in the upper catchment, before the system change was realized. The local state office for water management (Wasserwirtschaftsamt) Weilheim representing the state was also responsible for the upkeep of the protection level for the settlement area. Legal basis is the Bavarian water law.

Solution / description: An integrated approach was the basis for the planning phase. The whole catchment area was observed in this process. Finally the planners came to the decision, that a single new sediment control dam in short distance upstream of the settlement area could fulfil the purpose of the existing old check dams and therefore could replace them. Lower building and maintenance costs were only one advantage of this solution. Because the Habichtgraben passes through a nature protected area according to the Flora-Fauna-Habitats-Directive (FFH), the preferred solution caused a smaller intervention to this valuable territory. The structures in the upper catchment area are no longer maintained after the finalization of the new protection works. A removal is however not intended. As a legal consequence the obligation for maintenance of the upper torrent (upstream the new protection works) itself switched from the state to the municipality Eurasburg. This shift of responsibility was finalized by an onsite inspection where the details were arranged and written down in a protocol.The measure was legally approved by the local administrative district office and is already realized. Because the protection level remained the same, the municipality was not participated in the building costs of the new barrage.

FURTHER INFORMATION/LINKS:

State office for water management Weilheim
www.wwa-wm.bayern.de

Fig. 17: Building of the new sediment control dam (Picture: WWA Weilheim)

B5 - Mountain Forest Initiative Germany

Phase of LCM: operation

THE MOUNTAIN FOREST INITIATIVE AS A CONTRIBUTION TO ADJUSTABLE LONG-TERM STABLE CONCEPTS REGARDING CHANGING INTERESTS.

Presentation of the problem: Measures in the catchment basins of torrents are able to support technical protection structures or even replace them. A mountain forest in good condition for example can reduce the peak discharge in the channel and stabilizes the slopes. An integrated approach in torrent catchments enables to achieve adaptable protective systems and thus to react on changing boundary conditions in the future (e.g. climate change). The ability of mountain forests to protect residential areas and infrastructure against abiotic natural hazards has to be maintained or restored by pointedly protection forest management.

Framework (responsibilities, law, organization): In 2007, Bavaria launched the "Climatic Program Bavaria 2020" which includes different measures for the reduction of greenhouse gas emissions, adaptation to climate change and the intensification of research and development.

Solution / description: A special set of measures known as the "Mountain Forest Initiative" (Bergwaldoffensive, BWO), focuses on the adaptation of the alpine forests in Bavaria to climate change.The central aim of the BWO is to stabilize and sustainably adapt the alpine mountain forests to climate change. For this purpose, 30 projects were identified in areas with special climatic risks. Integrated master plans were developed for these projects, which include different silvicultural measures like thinning, planting and natural regeneration, the construction of forest roads, and hunting and pasture management for the reduction of browsing damage.A large number of owners are usually affected by the projects. Thus, the pilot measures are planned and initiated in agreement with the land owners and local stakeholders. This strong focus on participation renders the process transparent – a crucial factor for the success of the projects.

Other important elements of the BWO include improving the supply of suitable tree seeds for the alpine region in Bavaria, strengthening applied research and generating new basic information for the management of alpine forests. For example, a digital map of forest soils in the northern Alps was generated as basis for restoration and forecasts by the WINALP project (Waldinformationssystem Nordalpen) in cooperation with partners from Austria (Tyrol, Salzburg).

FURTHER INFORMATION/LINKS:

www.forst.bayern.de
www.hswt.de
http://arcgisserver.hswt.de/Winalp

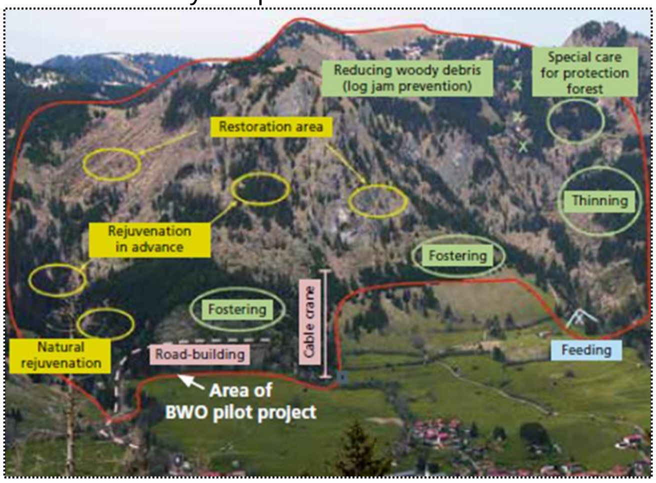


Fig. 18: Example of measure combination within a Mountain Forest Initiative Area. (Bavarian State Institute of Forestry)

Phase of LCM: planning

IDEA FOR (FINANCIAL) EVALUATION OF ALTERNATIVES REGARDING DIFFERENT CONSEQUENCES IN CASE OF OVERLOAD RESP. DIFFERENT RESIDUAL RISK.

Presentation of the problem: Alternatives might safeguard the same protection level (e.g. 100 years flood), but have different residual risk, due to “silent reserves”, different failure process (suddenly, stepwise etc.) or other effects. At the moment there is no common approach to regard such effects on residual risk resp. behavior in the case of overload.

Framework (responsibilities, law, organization): the responsibility for regarding the case of overload resp. the residual risk is with the responsibility for planning the protection measures - for measures at medium and large rivers as well as for torrent control in Bavaria it is the state, for measures at small streams and rivers it is the municipality.

Solution / description: At the moment the comparison between different alternatives for protection measures focusses on the building costs. This is based upon the assumption, that all alternatives safeguard the same protection level. In terms of risk assessment this means, that both the protected and the residual damage potential is the same for the alternatives and thus can be neglected.

In reality there are differences regarding the residual risk for several alternatives. So we started thoughts to regard these differences in the selection process for the favored alternative. This could be done by elaborating more detailed damage functions, also considering some more rare events compared to the design event. Calculating the average damage on this basis should show differences in the residual risk (see fig. below). Therefore it is vital which supporting point s for the calculations are chosen. But we are still in the beginning of the thoughts and need more investigations on this before introduction it as standard.

FURTHER INFORMATION/LINKS:

Spackova, O.; Rimböck, A.; Straub, D.; (2014): Risk management in Bavarian Alpine torrents: a framework for flood risk quantification accounting for subscenarios; IAEG XII Congress - Torino, September 15-19, 2014

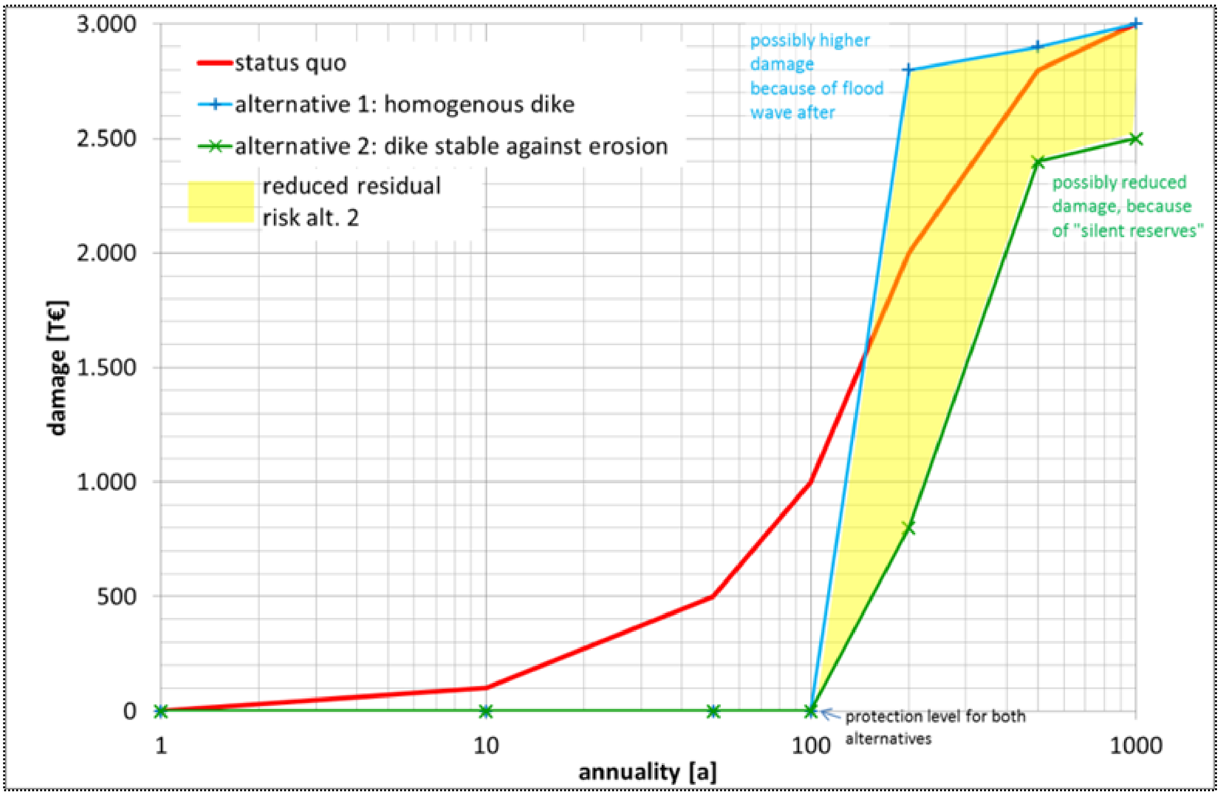


Fig. 19: Suggestion for calculation different residual risk concerning protection alternatives

EFFECTIVENESS IN RIVER CORRIDOR MANAGEMENT REQUIRES CLEAR AND MEASURABLE TARGETS

Presentation of the problem: River managers are increasingly aware that land development within river corridors may bring about persistent, wicked or unstructured problems. Thus, river corridor management processes are particularly challenging due to their inherent complexities, uncertainties and the variety of actors with different perspectives involved at various levels. The potential lack of transparency and consistency of the decision making processes in a participatory environment continuously risk reducing benefits for the concerned societies.

Framework (responsibilities, law, organization): River corridor management ultimately seeks to find alternatives and prospects that represent different syntheses amongst: i) what society desires, ii) what complies with the natural evolution patterns, and iii) what is allowed by the existing legal framework. Put another way the objective is to identify the decision space in terms of intersections among the following dimensions: (i) desiderata or space of desirability (i.e. the value system and the preference structure of the concerned society; (ii) the developmental possibilities (i.e. river corridor evolution trajectories, assessed ecosystem resilience and natural hazard risks, forecasted developmental trends and economic scenarios) and (iii) the constraints (i.e. legal and institutional settings, budget limitations, conjunctive and disjunctive restrictions, modus operandi etc.) Making the desiderata of the concerned society and stakeholders (or of a smaller representative steering panel) explicit is the first milestone in the holistic river corridor management approach we propose. The elucidation of the developmental possibility space is achieved through a multidisciplinary approach, aiming at integrating river corridor related environmental science and socio-economic science. Every river corridor development attempt is embedded in peculiar legal and institutional settings imposing constraints on the management process.

The operational target system: The conceptual scheme of an operational target system is shown in the figure 10. With respect to the objectives to be considered in river corridor management we elaborated for the Drava River the following categorization (from Nardini and Pavan, 2012): Risk (R) (in different forms: flooding, fluvial dynamics, debris flow/landsliding; residual); Costs (C) (investment and management); Disturbance (D) to existing activities, particularly because of: landuse change, change of property, delocalization, modification of hydropower generation; "Nature value" (N), namely the ecological status of the river ecosystem; Externalities (E), particularly the impacts that the considered sub-basin may export to the rest of the river. In the green boxes we list indicators that are commonly assessed in objective terms, whereas in the orange boxes we report decision relevant knowledge to be elicited from experts, stakeholders and decision makers.

FURTHER INFORMATION/LINKS:

For details: email: wasserschutzbauten@provinz.bz.it

References:

Nardini A., Pavan S., River restoration: not only for the sake of nature but also for saving money while addressing flood risk: a decision-making framework applied to the Chiese River (Po basin, Italy). Journal of Flood Risk Management 2012; 5:111–133.

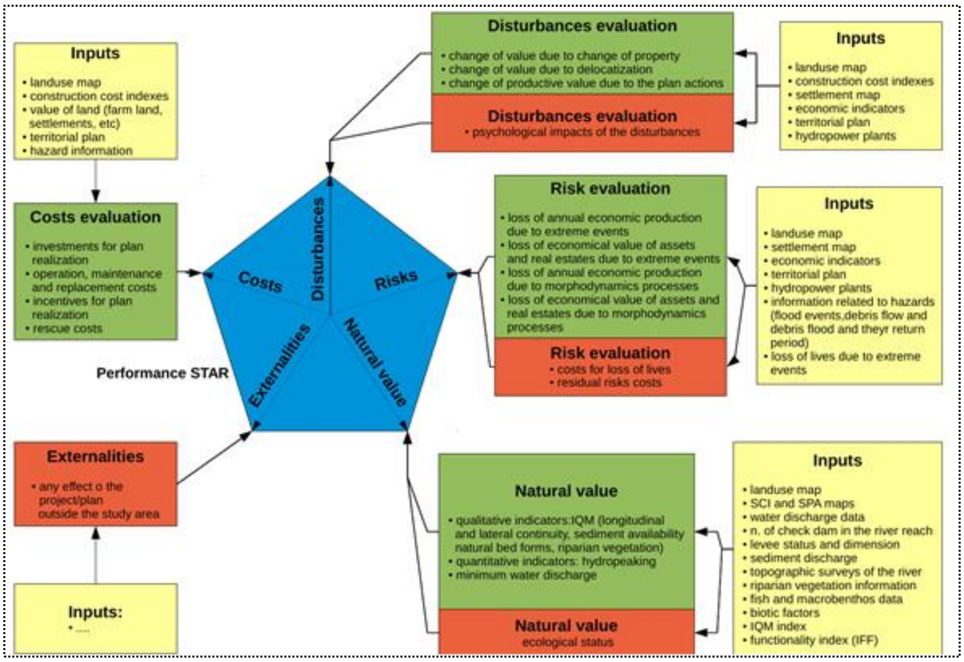


Fig. 20: Operational Target system

B8 - Towards a protection system reconfiguration on the Gadria stream Italy

Phase of LCM: planning

A BALANCED PLANNING APPROACH

Presentation of the problem: The Gadria catchment (South Tyrol, Italy) with a drainage area of 6 km² presents one of the largest fans in the Alps (10.9 km²) with frequent debris flow rates (1-2 per year). The average precipitation in the main valley is quite low (about 500 mm) compared to similar debris flow basins in the Alps. Thunderstorms are responsible for most of debris flow occurrences. Since the middle eve 39 events have been documented. The main tributary, the Strimmbach, recently showed debris flow activities and erosion processes in the lower part of the stream. In the current unfavourable configuration the Gadria- and the Strimmbach frequently deliver considerable sediment volumes to a single retention basin. This, in the long run, entails unsustainable clearing costs for the public administration. Moreover, despite the presence of the deposition basin, the alluvial fan is prone to hazard impacts. Simulations showed that for events with a return period > 30-yr, outburst of the channel boundaries is possible. For events with larger return periods, clogging of the bridge in the village of Allitz is to be expected, which would induce hazard propagation on larger portions of the cone area.

Planning objectives

The risks for the endangered objects on the debris cone should be significantly reduced. This entails a reduction of the specific risks for residential buildings and infrastructure (mainly roads) and commensurately for the agricultural areas. Simultaneously the functionality of the protection system should be enhanced. This essentially means to design a sediment dosing system capable of buffering the peaks of the involved hazard processes without generating additional maintenance costs (clear up costs for deposited debris flow volumes). The ideal solution would be a self functioning dosing system.

Planning approach

Since the performance of the envisaged system will crucially depend on its dosing functionality a balanced planning approach elaborated by Simoni et al. (2014) involving backward oriented indication, numerical simulation and physical scale modelling (Hübl et al., 2012) was adopted (compare Figure 1).

Possible solutions

The adopted investigation strategy clearly indicates that modifying the existing check dam by widening its opening could significantly contribute to increase the functionality of the system thereby reducing the life cycle costs to a significant extent. Possible flood risk exacerbations for the endangered settlement areas could be avoided by established techniques (e.g. local object protection, local deflection walls and a modification of a wood bridge). On a conceptual level also more radical interventions have been hypothesized (compare Stecher et al. 2012) entailing a complete removal of the retention check dam to re-establish the sediment continuum. Provided that integrative local protection measures will be realized, this solution would contribute significantly to a complete solution of the acute counterproductive debris flow material deposition problem.

FURTHER INFORMATION/LINKS:

For details: email: wasserschutzbauten@provinz.bz.it

Hübl, J., Fleisch, M., Chiari, M., Kaitna, R. (2012): Physikalische Modellversuche zur Optimierung der Geschieberückhaltesperre am Gadriabach (Vinschgau,Südtirol); IAN Report 144, Institut für Alpine Naturgefahren, Universität für Bodenkultur - Wien (unpublished)

Simoni, S., Vigoli, G., Zambon, F. (2014): Assessment of mutual interactions between control structures, torrential and river sediments, and large wood. SEDALP Project (unpublished)

Stecher, M., Mazzrana, B., Hübl, J. (2012): Proposal of risk mitigation strategies based on a conceptual planning approach. 12th Congress INTERPRAEVENT 2012 – Grenoble / France - Conference Proceedings.

Fig. 21: Gadria creek: Details of the clogging mechanisms (i.e. through driftwood and solid material) of the check dam openings and the consequent full aggradation of the disposition basin.

Phase of LCM: planning

RECONCILING FLOOD PROTECTION AND ECOLOGY

Presentation of the problem: Until recently the planning approach of river engineering works was mainly targeted at mitigating hazards, designing hydraulically suitable and stable river cross sections. As a consequence of such river regulation interventions, areas located in the valley bottom could be made available for various developmental interests. Conversely and inevitably aquatic habitats have shrunk over time. An increasing societal concern about the loss of ecosystem integrity and functionality induced a necessary rethinking of the traditionally planning paradigms: multi-functional solutions mitigating risks and commensurately enhancing the ecological value and meeting the recreational demand are now largely preferred.

Framework (responsibilities, law, organization): Within the EU-funded Interreg IIIB Project River Basin Agenda the Department of Hydraulic Engineering of the Autonomous Province of Bolzano elaborated a restoration project for the Mareta river.

Solution / description:
The Mareta River flows through the Ridanna valley in South Tyrol and joins the Isarco river nearby the city of Vipiteno. Its watershed has an area of 209 km² and its elevation ranges from 935 to 3470 m asl. The reference flood discharges are 90 m³/s for a recurrence interval of 10 years and 230 m³/s for a recurrence interval of 100 years.
In the second half of the last century the Mareta River was subjected to intense gravel extraction activities and afterwards, during the 80ies, the river engineering works in form of a series of grade control structures to consolidate the stream bed were implemented converting its river typology from braided to mono-cursal with a substantial interruption of the sediment continuum.

To re-establish the conditions for river dynamics a substantial ecological enhancement in a first development stage 16 check dams were removed to re-establish the river continuum. The stream consolidation was achieved by posing huge boulders with a minimum weight of 2 tons.

A monitoring program was initiated to verify in the long run the quality of this river restoration project. Morphological changes are detected by topographically assessing cross sectional variations. The ecological status is monitored by ad hoc vegetation and habitat survey.

A major aim is to foster a better human-river relationship Flood protection works realized in the last century exacerbated the perception of fear with respect to water-related hazards. Now in the new setting the river is accessible and attractive for recreational purposes. The “new” Mareta River is a good practice example for both recreating a human-river symbiosis and providing the necessary protection function for the exposed elements at risk.

FURTHER INFORMATION/LINKS:
For details: email:
wasserschutzbauten@provinz.bz.it

Fig. 22: Mareta river before and after human-river symbiosis improvement

Phase of LCM: operation – conversion of structures

Presentation of the problem: The last decades have shown that mainly in terms of discharge peaks it is not possible to completely control flooding processes with just checkdams. Therefore, the focus of structural measures has moved to the enlargement of sediment traps and flood retention basins.

Framework (responsibilities, law, organization): Knowledge of natural hazards prone areas due to the hazard maps, consideration of overload cases and application of cost-benefit analyzes for protection concepts.

Solution / description: The natural hazard maps showed that hazards associated with rare and very rare events as well as the overload cases can rarely be solved in the catchment area itself. The more the financial resources are limited and by using cost-benefit analyzes it is obvious that the solution can mostly not be found just in building barriers along the channel. Therefore new concepts have to be found or existing ones have to be changed.

Runoff modeling showed that in long-lasting heavy precipitation compared to the years 1999 and 2000 it is not possible to bring the collected runoff through the outfall into the Rhine. Since in thunderstorm events, the debris flow and sediment deposits are an additional problem the idea arose that therefore used sediment traps could also provide additional retention. The enlargement of the sediment traps itself provided the opportunity to question the existing structural measures by check dams and to minimize them wherever possible.

Of course, such system adjustments are only possible if the space for retention measures is available and the geological conditions allow those kinds of solutions. But it shows that additional knowledge or changing circumstances require a review of the used structural measures. The changing of existing structure systems is always hard to communicate but the consideration of overload cases and the cost benefit analysis help to do so.

An example of an adapted system is the enlargement of the retention basin in Balzers. Before increasing the maximum retention of all basins up to 100'000m3 already a HQ20 caused problems. Now a one hundred year event can be managed without causing any damage to the village. In addition the enlargement of the sediment traps leads to a later and less frequent use of the retention basin. As for the retention the use of agricultural land is needed, compensation payments could be reduced by this measure. Due to the enlargement of the sediment trap the cross-border road connecting Liechtenstein and Switzerland is now protected from debris flows without having built any barriers along the channel.

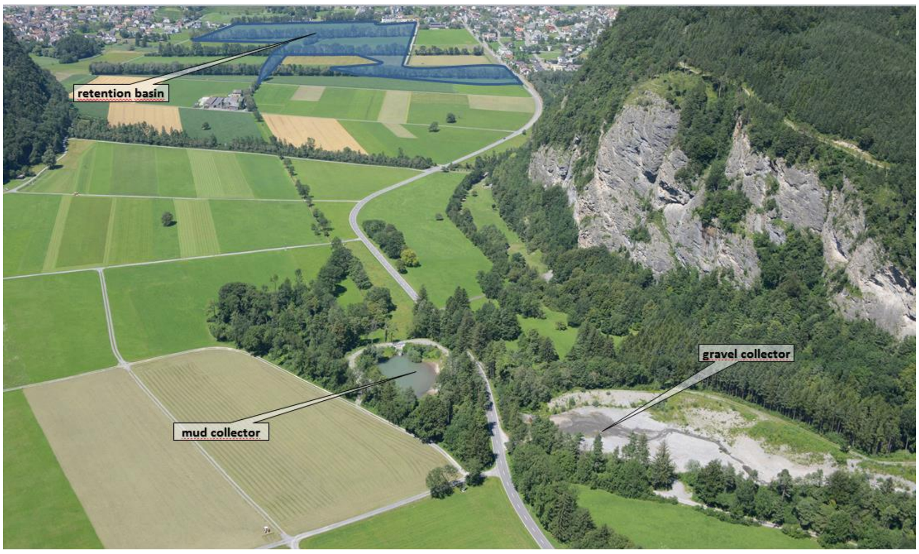


Fig. 23: Overview of Sediment traps at Andrüfe and retention basin at Balzers

Phase of LCM: monitoring, analyzing and planning

Presentation of the problem: Scarce public awareness of the dangers which could be posed by dams, and the lack of the information necessary for the emergency preparedness to perform evacuation in case of failure of a dam, spurred the Administration for Civil Protection and Disaster Relief at the Ministry of Defence of the Republic of Slovenia (ACPDR) to conduct a complex review of documentation and state of Slovenian dams and reservoirs for water management purpose (in 2012).

Framework (responsibilities, law, organization): Four partner organizations: the Faculty of Civil and Geodetic Engineering, University of Ljubljana, Hidrotehnik, d.d., IBE,d.d., and the Slovenian National Building and Civil Engineering Institute participated in the elaboration of review. As the result of the review, the consortium prepared recommendations for improving the safety of the dams and for raising public awareness.

Solution / description: The care for safe use and exploitation of dams and reservoirs in the world has made considerable progress in recent decades. Due to intensive use of space and the increasing need of building dams closer to populated areas, more and more attention is given to the integration of such facilities into space and to the fulfilment of higher demands imposed by standards to ensure safe operation and exploitation of dams. A more detailed analysis in the research and development project "State of dams for water management purpose in Slovenia" (VODPREG) covered water dams and reservoirs in public use (the owner being the State or local communities) while a concession was awarded to qualified operators, holders of public water management services (final selection, 45 dams and weirs). With regard to the national regulations, structural behavior of large dams (with a structural height over 15 m) has to be regularly monitored. In the scope of the project the established monitoring systems for 42 earth dams were reviewed (8 of them higher than 15 m).

The work was divided into three sections. In the first one, a survey of all relevant archive documentation on the structures was made while in the second one, field investigations were performed in the following scope: (1) visual examination of structures, (2) inspection of mechanical and electrical equipment, (3) underwater diving inspection. Within the third section, a synthesis report was prepared with relevant findings of the inspections carried out; based on the identified state, an assessment of an individual structure hazard level for the environment was made.

After the above mentioned tasks were accomplished, it relatively soon turned out that the measures were necessary in practically all dams. The final analysis result combines a review of estimated costs needed for rehabilitation of individual dams and an assessment of total duration of remedial interventions. The overall financial scope of proposed rehabilitation measures amounts to approximately 13.6 million €. The investment structure is as follows: out of total amount 12% are needed for arrangement of expert and technical bases, 1% for arrangement of documentation, 9% for creation or rehabilitation of monitoring systems, 54% for interventions in dam bodies, 10% for interventions in concrete and masonry structures and 14% for interventions in storage reservoirs and in the downstream areas.

Further information/Links:
ACPDR: www.sos112.si (Project Report) and SLOvenian COmission on Large Dams (SLOCOLD): www.slocold.si

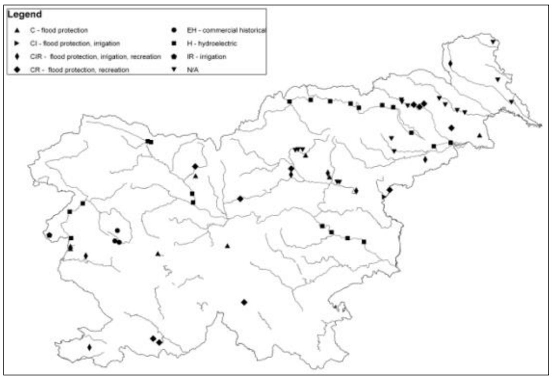


Fig. 24: Project VODPREG - 68 dams classified into the category were identified for the task (Kryžanowski et al., 2013)

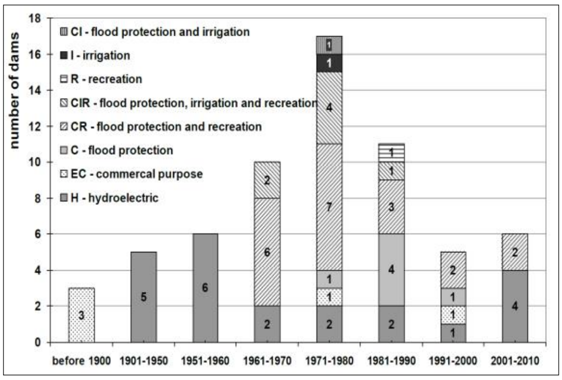


Fig. 25: Dynamics of dams' construction according to their intention of use

B12 - Management of old avalanche protection structures Switzerland

Phase of LCM: operation

Presentation of the problem: Old avalanche control structures in Switzerland often consist of stonewalls and masonry terraces. Due to their long duration of use, the walls and terraces in many locations are in poor condition. Because their effect in preventing avalanche release no longer meets the current technical requirements, the question arises as to whether such structures should be repaired or whether it would be better to dismantle them and replace them with modern control structures. The Federal Office for the environment edited a manual to help in the evaluation of conservation strategies to be adopted in individual cases and in identifying the measures to be carried out on avalanche control structures consisting of stonewalls and masonry terraces. The manual is addressed to cantonal authorities and the owners of such structures.

Framework (responsibilities, law, organization): the maintenance of protective works is under the responsibility (commune, canton, railway company) of the entity that has constructed them and owns them. The Federal state can subsidize their reconstruction under the Forest Act.
The owner is liable for any damage that a deficient protective work can cause to a third party.

Solution / description: There are about 1'000 kilometers of stonewalls and masonry terraces for protection against avalanches. These structures were built from 1890 until 1940, when these techniques were replaced by metallic snow bridge or snow net.
Stonewalls and masonry terraces stayed in service over many decades. They were exposed to the harsh conditions of high mountain climate and were sometimes reconstructed when some parts were destroyed (see Figure 26). A more general approach to their maintenance was necessary, as they have reached the end of their lifetime.
A six steps approach was defined for the systematic evaluation of the structures and the definition of the measures to be taken:

1. Data acquisition: localization of the structures, type
2. Summary assessment: shape of the structure, identification of values to be protected
3. Effect assessment: protective effects of the structures, hazards due to the shape of the structure
4. Definition of possible measures: deconstruction, reparation, replacement, no action
5. Global assessment of the measures: efficiency, cost effectiveness, sustainability
6. Implementation of the chosen measure

For step 1, an inventory of protective works can help to get an overview and to fix priorities at a regional level.
In step 5, not only technical arguments from hazard prevention are taken into account, but also more general criteria like protection of the cultural heritage and of the landscape. An economic model completes the evaluation of the measures.
The approach has been applied in different cantons and has led to a significant progress in the systematic management of old protective works against avalanches.

FURTHER INFORMATION/LINKS:

Margreth S., Blum M. 2011: Gestion des ouvrages paravalanches en murs de pierres et terrasses en maçonnerie. Guide pratique. Office fédéral de l'environnement, Berne. Connaissance de l'environnement n° 1109: 80 p.

http://www.bafu.admin.ch/publikationen/publikation/01610/index.html?lang=fr

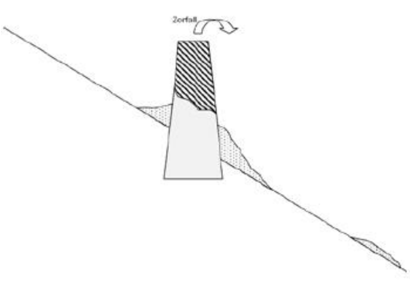


Fig. 26: Dismantled stonewall against avalanche

Phase of LCM: planning (rehabilitation and alternatives)

AFTER AN OLD ARRAY OF CHECKDAMS HAS BEEN DESTROYED DURING TWO DEBRIS FLOW EVENTS IN THE GUPPENRUNSE TORRENT, A CHANGE IN PROTECTION SYSTEM IN A NARROWER SENSE OF INTEGRATED RISK MANAGEMENT IS PLANNED FOR REHABILITATION.

Presentation of the problem: In 2010/2011, two debris flow events destroyed and damaged the over 100 years old and 1 km long array of checkdams in the catchment area of Guppenrunse torrent and parts of the underlying canal. This heightened strongly the risks caused by debris flows for the settlements lying on the two debris fans of the torrent. Authorities had to decide, whether the old array of checkdams should be reconstructed or another strategy of protection could be more adequate.

Framework (responsibilities, law, organization): The communal corporation is in charge of the rehabilitation of protection measures. The project will be realized on credit of the federal state, the canton and the municipality.

Solution / description: A detailed analysis with a debris flow model in consideration of different scenarios (full reconstruction, partly reconstruction, no reconstruction of the checkdams) was carried out with the following result: The retention effect of the checkdams in the catchment area on the sediment charge in the settlements on the debris fans amounts practically null, because the topographic situation would provoke anyway a huge sediment deposition at the fan apex.

On the basis of this analysis, a new variant with another protection strategy was worked out. It includes the construction of three fixing checkdams, two new retention basins at the fan apex and the reconstruction of the canal. The system can completely hold back the expected sediment volume.

The new variant „retention at the fan apex" shows several advantages in comparison with the variant „reconstruction of the array of checkdams":

- better security in case of „over load events"
- higher robustness in connection with natural variety in run of process and uncertainties in hazard assessment (general and with climate change)
- combined protection against debris flows and avalanches
- better cost-effectiveness (in spite of higher costs for maintenance, construction costs and total costs are very much lower. Moreover it leads to a higher risk reduction for the settlement)

As a disadvantage of the new variant, an alternative drinking water supply for the settlement Schwändi on the debris fan must be built up, since the new retention basins are located in the protection zone of the only source of drinking water.

Overall, in comparison with the old system the new variant represents an appropriate change from active cost intensive measures in the catchment area to a new protection system in a narrower sense of modern integrated risk management.

Further information/Links:
Tiefbauamt of Canton Glarus, Switzerland
http://www.marty-ing.ch/referenzen.html?1085

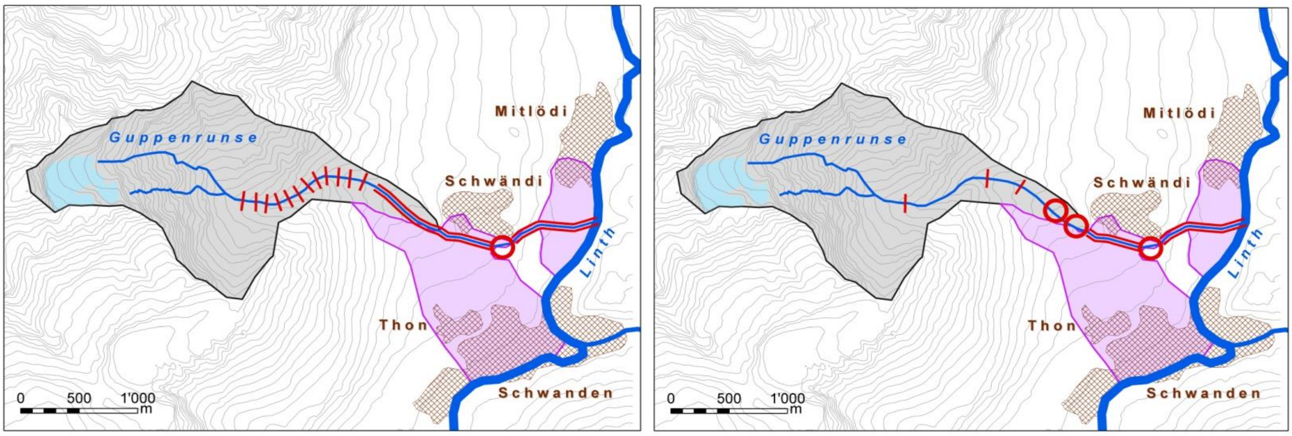


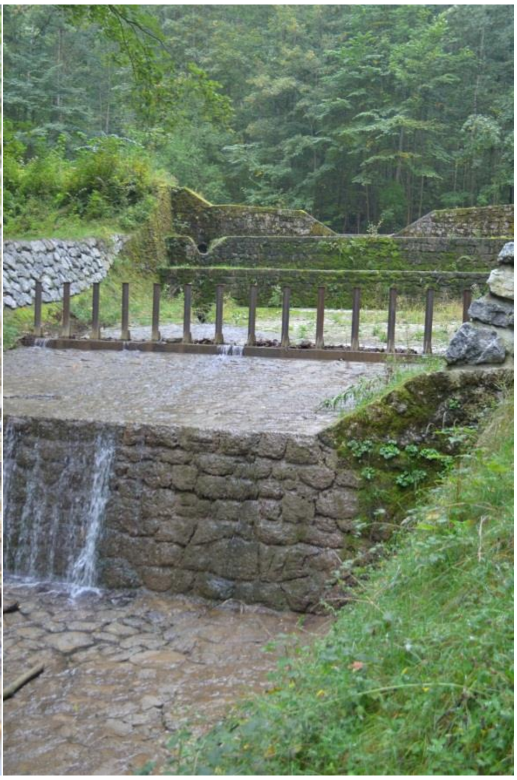
Fig. 27: Left: schematic map of the old protection system with destroyed array of checkdams
Right: schematic map of the new protection system with retention at the fan apex

ANNEX C – Good practice examples from Member states on construction details that support or prolong the lifetime / functionality of a protective infrastructure in place

C1 - Reuse of old construction parts

The old rock dam was not stable enough. Instead if total replacement it was reinforced by back-anchored concrete columns. Example Maigraben, Landkreis Rosenheim, Bavaria

C2 - Adjustable rake columns



The steel columns of this woody debris entrapment rake can easily be fixed in different distances to each other. So this construction can be adapted to further experience, without having to rebuild it. Example Maigraben, Lkr. Rosenheim, Bavaria

C3 - Steel cover of the spillway section of gabion dams

Gabions would quickly get destroyed due to abrasion especially in the spillway section. Therefore “easy to replace” steel plates cover the endangered part of the dam construction. Example Talgraben, Lkr. Bad Tölz-Wolfratshausen, Bavaria

C4 - Adjustable beams in dam construction

The vertical distance of the steel beams in this retention dam can easily be changed. So this construction can be adapted to further experience, without having to rebuild it. Example Maigraben, Lkr. Rosenheim, Bavaria

C5 - Mobile unit for quality control of building materials

Mobile unit for quality control of building materials during the early contraction phases - a contribution to a prolonged durability and an increased reliability of protection structures (Autonomous Province of Bolzano)

C6 - Reconstruction of old concrete dam

One of the solutions to maintain the design functionality of decrepit old dams is the reinforcement with building of massive supporting stone construction in front of old structure, god anchored and connected with the existing one, that actually working like one object (two examples from torrents Mačkov graben and Prošca, photo: Hidrotehnik, Slovenia

C7 - Upgrading and adapting of old stone dams

New boundary conditions demand upgrading of functionality of existing protection structure – a common measure is the raising of protection dams. On the photo is such an example from the torrent Lučno, with additional adapting of structure with manageable passage (closed with removable wooden trunks) for local owners who have to occasionally gathering the woods from the forested headwaters (photo: Hidrotehnik, Slovenia)

C8 - Rehabilitation of an existing array of checkdams in Steinibach Hergiswil, NW

The array of checkdams was built as block dams lying on a rock-filled log crib in the year 1956. After the log cribs were exposed by scouring and erosion, the stability of the array of checkdams couldn't be ensured anymore. Rehabilitation measures were taken in the years 2012 and 2013 consisting of pre-concreting of the checkdams, construction of subsidiary dams, scouring-protection and rehabilitation of training structures.

Situation before rehabilitation
Source: Kanton NW

Situation after rehabilitation
Source: BAFU

Pre-concreting

Source: Kanton NW

Finished pre-concreting and coverage with log

Source: Kanton NW

Construction of a subsidiary dam

Source: Schubiger AG

Pre-concreting and training structures

Source: Schubiger AG

C9 - Modification of the bedload retention basin Grosstanne, Steinibach, Hergiswil, NW due to change in scenarios (landslides)

Since the retention volume of the three bedload retention basins Grosstanne (construction year 1979) was too small and the system was constructed without consideration of woody debris, it was modified in the years 2013 and 2014. The three arch dams were elevated to create more retention volume. The structure was improved by stiffening the dam toes with slices of concrete and enlarging the dam body. The lowest retention basin was functionally converted into a retention basin for woody debris. Before the rehabilitation measures were carried out, they had been simulated in physical model tests.

Arch dams 1 and 2 before modification Source: Kanton NW

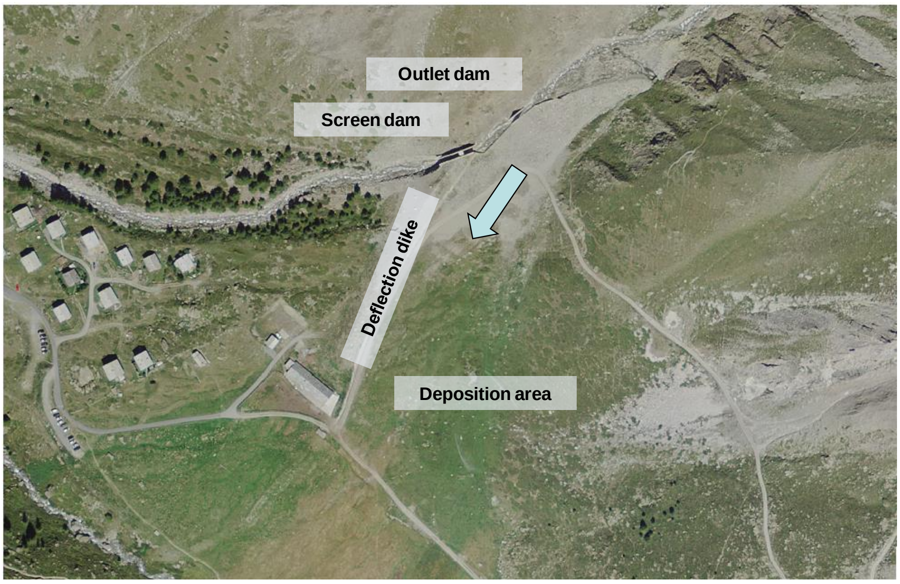
Arch dams 1 and 2 after modification Source: Kanton NW

Modification of arch dam 3 for retention of woody debris Source: Kanton NW

View over the finished construction Source: Schubiger AG

C10 - Bedload retention with outlet structure and deflection dike Ottawan, Täsch, VS due to new sce-narios (climate change)

Because of melting permafrost, landslide processes and a potential outbreak of a glacier lake, the sediment potential in the catchment area of Rotbach and the following Täschbach is practical infinite. The protection of the settlement Täsch couldn't be ensured by the existing retention basin at the fan apex, because the retention volume was several times too small. A flexible and robust protection system was needed to deal with these high and uncertain design values. In 2006 a protection system was built up in the 700 m higher lying valley Täschalp, consisting of the following elements: An outlet structure and a deflection dike lead bedload in a large unsettled area for deposition in case of medium and extreme events. Runoff and small events flow through a screen dam.



Overview Source: BAFU

Outlet dam (right), screen dam (left of outlet dam) and deflection dike with deposition area (left)

Source: BAFU

C11 - Modification of the bedload retention basin Humligentobel, Wolfenschiessen, NW due to man-agement of over load case

The settlement of Wolfenschiessen lying on the left side underneath the retention basin was endangered by potential debris flow over load events from an activated rockfall area in Humligentobel. To ensure a controlled overflow out of the basin to the right side, the outlet dam of the existing retention basin was modified in the year 2004. In August 2005 the construction was successfully „tested" during an extreme debris flow event. It flowed over the outlet dam on the right side in a forest and in agricultural used grassland without leading to higher damages.

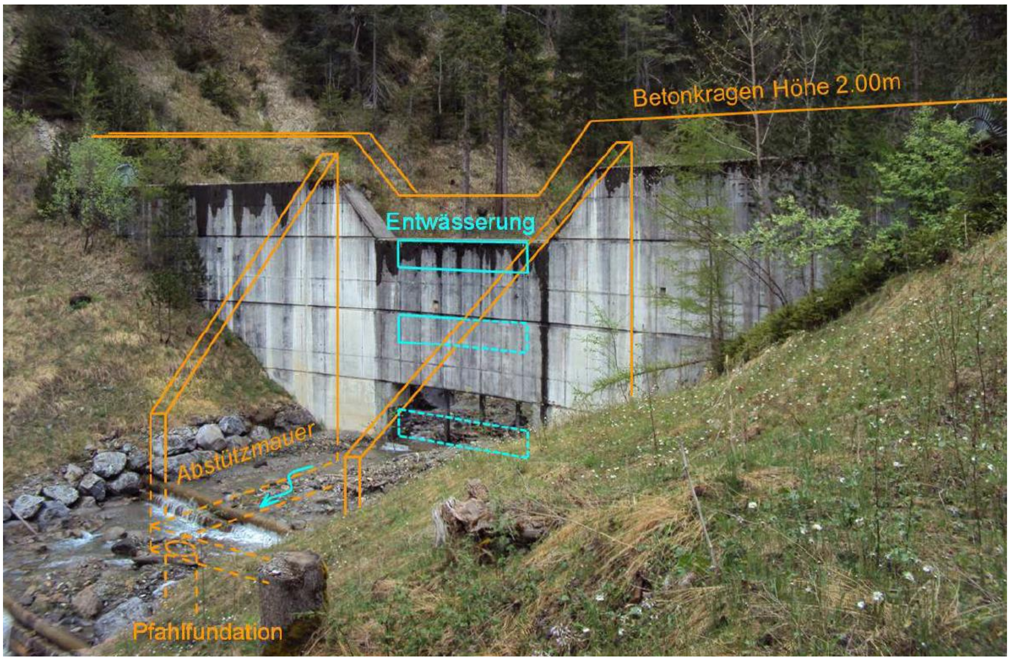
Retention basin before modification Source: BAFU

Retention basin after modification Source: BAFU

C12 - Modification of bedload retention basin at Betelriedgraben, Blankenburg, BE due to new order/law

Due to the new Federal act on dams and reservoirs, which is valid from 1.1.2013, certain retention basins for flood protection must fulfill advanced structural standards. The arch dam of the retention basin of Betelriedgraben doesn't comply with these requirements. A modification is planned for the years 2016 and 2017 within a flood protection project. The planned structural enhancement consists of an elevation of the dam crest, a brace support of the instable outlet dam and measures to avoid scouring underneath the outlet dam.

Existing arch dam, retention basin of Betelriedgraben Source: BAFU



Modification measures planned in the flood protection project   Source: Theiler Ingenieure AG

C13 - Protective infrastructure in torrents influenced by lateral mountain pressure

Control works at torrents within the influence of sagging of mountain slopes is a notable challenge. Most of all the lateral mountain pressures lead to negative impacts and sometimes to a rapid destruction of conventional check dams. Good experience has been made in Austria with a construction type, where the wing of the check dam can move (to a certain degree) against a stable overflow section.

Check dam with a slidable wing to balance lateral mountain pressure, Source: die.wildbach (Salzburg)

Persistence of Alpine natural hazard protection

Meeting multiple demands by applying systems engineering and life cycle management principles in natural hazard protection systems in the perimeter of the Alpine Convention

PLANALP Brochure 2014

PLANALP
Platform Natural Hazards of the Alpine Convention

Evaluation of the current mandate

The Platform on Natural Hazards of the Alpine Convention was set up to develop common strategies designed to prevent natural hazards in the Alps as well as to reflect on adaptation strategies. The platform consists of 16 to 20 members with no more than two representatives (national and/or regional) per Contracting Party and has been chaired by Austria since February 2013.
The general aims of PLANALP cover:

- generating synergies, strengthening and enhancing cooperation and collaboration with other thematically relevant platforms of the Alpine Convention
- continuing actions as a network of high-level experts and
- evaluating concepts for integrated risk management for protection against natural hazards.

The mandate of PLANALP covers both the formulation of strategic concepts on integrated risk management against natural hazards and the coordinated implementation of subsequent measures. In detail, the current mandate 2013-2014 covers:

- Assessment of concepts aiming at integrated risk and natural hazard management
- Strengthening the identification and transfer of good practice between the Member States
- Developing and implementing recommendations for the following fields:
  - Risk governance for a changing climate (including gender issues)
  - Life-cycle management of structural protection measures
  - Flood Risk Management Plans (regarding FD 2007/60/EC)

The assessment of concepts aiming at risk management as well as strengthening the identification and transfer of good practices between the Member States is a continuous process. This exchange of knowledge is a part of each meeting of PLANALP and ensures exchange of knowledge and new strategies in the field of natural hazard and risk management. This knowledge exchange is also recorded in the protocols of the biannual PLANALP meetings. Further key objectives of PLANALP's activities in this period were the elaboration and implementation of recommendations in the field of **life cycle management of protection measures** and the **implementation of Flood Risk Management Plans** in Alpine areas.
Risk governance is a topic, which was also discussed repeatedly. No explicit product, however, was established on this part of the mandate. Referring to the topic of life-cycle management of structural protection measures, knowledge and strategies were exchanged based on a questionnaire. Subsequently, a special task force to work on this topic was established. After discussing jointly the outline of the planned brochure, this group started to work on a brochure referring to the issues of life-cycle management and, in exchange with the members of PLANALP, the brochure will be finished by the end of October 2014.
Referring to the last point, PLANALP focused on the topic of Flood Risk Management Plans (regarding the FD 2007/60/EC). Therefore, a conference with more than 100 participants from 11 different countries was organised to discuss the topic of the problems of the Member States to implement the FD in the Alpine areas. Apart from a keynote lecture and a general introduction to this complex issue the conference "**Breaking fresh ground in protecting Alpine Environments – Flood Risk Management Plans**" included presentations from all Member States on the challenges and strategies applied, and in July 2014 the conference proceedings were published by PLANALP.

The conclusion of the evaluation of the mandate indicates that all topics were treated and discussed. The depth of treatment and the products, however, vary. The focus related to products valuable for a wider range of experts and stakeholders was definitely set on the implementation of Flood Risk Management Plans and life-cycle management of protection structures.

Activities

In this section the meetings and activities organised by PLANALP are summarised and complemented by various events, where members representing PLANALP were actively involved. Additional activities are covered in the list below:

- Contributing to the "Guidelines for climate adaptation at the local level in the Alps" that were launched by the Italian Presidency of the Alpine Convention in the 2013-2014 period
- Observer roles in the Alpine Space projects SedAlp and START_it_up

Meetings

Members of PLANALP met four times trying to implement PLANALP's mandate 2013-2014 and dealt with:

- discussing concepts for an integrated reduction of natural hazards in the Member States,
- intensifying the cross-border exchange of experiences and
- identifying "good practices" and how to implement these best in subsequent actions of the Member States.

- February 2013 Innsbruck, Austria
- October 2013 Brescia, Italy
- March 2014 Graz, Austria
- October 2014 Liechtenstein, Austria

- Meeting of the Alpine Convention Platforms, June 2013, Cortina d'Ampezzo
- Meeting of the presidents and the Permanent Committee, June 2014, Brescia

Conferences/Events

- Participation in the WS "Experiences and paths in the implementation of the Flood Directive in Alpine Areas", 19 March 2013,_Aosta
- Presentation of PLANALP to WG F in Dublin, 2013
- Conference "Breaking fresh ground in protecting Alpine Environments – Flood Risk Management Plans" 25-26 March 2014 in Graz, Austria
- Participation and presentation of PLANALP at the 5th Alpine Water Conference, 25 – 26 September 2014, Trento
- Presentation of PLANALP to WG F in Rome, 2014
- Presentation of PLANALP at EGS Workshop "Living with Geological Risks", 22 October 2014, Bern

Documents

- Proceedings of the conference "Breaking fresh ground in protecting Alpine Environments – Flood Risk Management Plans" can be found in the attachment
- Brochure on life-cycle management of protection structures will be finalised by the end of October 2014

Graz, 25 March 2014

Conference proceedings

Breaking fresh grounds in protecting Alpine Environments – Flood Risk Management Plans

Platform on Natural Hazards of the Alpine Convention PLANALP

Graz, 25 March 2014

Conference proceedings

Breaking fresh grounds in protecting Alpine Environments – Flood Risk Management Plans

Imprint

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Preface – Maria Patek (PLANALP)

The large rivers Rhine, Danube, Drau, Po and Rhône originate in the Alpine range; therefore the Alps play an important role within the European water regime. However, the areas mostly affected by floods, also with respect to serious economic implications, are located outside of the Alpine region. Therefore the focus of the European Flood Directive is clearly on these flat and densely populated areas. The specific characteristics of Alpine catchments are merely ancillary.

Inherent characteristics for the Alpine region are a wide range of hydrological and gravitational natural hazards (e.g. debris flows or flash floods), appearing suddenly and without warning plus transferring huge volumes of sediment. Consequently the threat and risk for human lives is often higher in comparison to areas alongside low lying river courses. Especially in the last years extreme floods and debris flows occurred frequently in the Alpine region and thereby revealed the specific problems in this special environment. The close alliance of the countries located within the Alpine Arc, confronted with similar challenges, is necessary to reassure the increase of resilience of Alpine areas against flooding disasters. The common hazard scenarios and resulting risks cannot be managed in established river partnerships or bilateral boundary water commissions only, but need a forum on the basis of Alpine regions.

This forum is provided by the Alpine Convention and therein the platform on natural hazards – PLANALP - , which dedicates its work to the exchange of knowledge and development of strategies. The conference "Breaking fresh ground in protecting Alpine Environments – Flood Risk Management Plans" in Graz in March 2014 offered a unique opportunity to discuss Alpine flood risk management among politicians, academics, practitioners, and stakeholders.
It became apparent, that close cooperation among experts and stakeholders from the Alpine Space is needed to represent the needs of Alpine flood protection on a European level more efficiently. In respect to the newest report of the IPPC this issue is especially relevant because the Alps are most affected by climate change. The safety of the Alpine region therefore is a pan-continental issue for a water abundant Europe. With the conference in Graz this topic could reach a wider audience. As president of the PLANALP I hope that with breaking fresh ground regarding flood protection in Alpine environments we enabled further steps towards a sustainable implementation of the flood risk management plans in the Alps.

It was a pleasure to welcome more than 100 experts from 11 different countries in Graz, which in fact showed the great importance of knowledge exchange in the field of flood risk management. Hopefully the conference in Graz has moved us a few steps closer to promote further joint and transnational approaches for tackling the implementation of flood risk management plans and therefore contribute to a sustainable development of the Alpine region.

Vienna, June 2014

Maria Patek

Maria Patek
President of the Platform of Natural Hazards of the Alpine Convention (PLANALP)

Preface – Markus Reiterer (Alpine Convention)

Experience from the past years has taught us that flood management in the Alpine region is an issue of utmost importance that has significant effects on downstream areas. At the same time, we should also be aware that the number of natural hazard events is likely to increase in the following years due to climate change. We need to adapt to this new situation and we need to do it fast. The Natural Hazard Platform of the Alpine Convention (PLANALP) has made a major contribution to that effect by preparing guidelines for an Alpine strategy for adaptation to climate change in the field of natural hazards in 2012.

At the recent "Breaking fresh ground in protecting Alpine Environments – Flood Risk Management Plans" conference held in Graz it was highlighted that smart and effective management of flood risks in the Alpine area can significantly reduce the damages in the lower areas. This conference was enriching for all participants and will have a lasting impact on the future in managing risks in our area. This is all the more important as water management issues, though listed as a priority area in the Alpine Convention, are not subject to further elaboration through a protocol or declaration. PLANALP is an important forum to focus on Alpine specificities and to showcase the fact that measures taken in our region have real life effects outside.

Exchange of experience is one of the priority fields of activities in the Alpine Convention since it represents a platform not just for the presentation of good practices, but also for a collective brain-storming on the possible solutions of common challenges. The current efforts towards a macro-regional strategy for the Alpine area will also have to focus on this type of exchange and cooperation. It is with great pride that the Alpine Convention can present the good experiences in this process, and PLANALP is a flagship example of the value of international cooperation. This was proven yet again through this conference. It also outlined the cross sectorial exchange of experience between different working groups and platforms, since the risk of flood management was addressed from the natural hazards and water management perspectives.

I would like to congratulate the organizers of this conference, in particular the president of the PLANALP working group, Ms Maria Patek, as well as the Austrian Ministry for Agriculture, Forestry, Environment and Water Management, the Land Steiermark and the City of Graz for their excellent efforts and hospitality.

Innsbruck, June 2014

Markus Reiterer
Secretary General of the Alpine Convention

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Structure of the conference

I. STRUCTURE OF THE CONFERENCE

Welcome notes

The president of the Platform on Natural Hazards, Maria Patek, welcomed the participants to Graz, expressing hopes for an "action-oriented discussion" across the various communities (academic, policy and science) represented in the auditorium. The topic today reflects one component of the present mandate of PLANALP and the conference should be understood as an opportunity to broadly discuss different aspects of Flood Risk Management Plans.

As representantive of the Styrian Government, Johann Seitinger welcomed also all participants to the conference and especially to the Austrian province of Styria. He referd to some notable impacts of climate change especially in the area of natural hazard management and stresses the importance of strengthen individual responsibility and self-provision.

The Secretary General of the Alpine Convention, Markus Reiterer welcomed all participants on behalf of the Alpine Convention and stressed the importance of sustainable flood risk management for a high-quality livingspace within the Alpine Arc. He reminded all participants that also some other natural hazards may endanger the space we live in and that collaboration and cooperation builds a fruitful ground to address the challenge of improving quality of life by integral natural hazard and risk management.

The City of Graz was represented by Stefan Haberler and he emphasized how important an effective flood risk management for a big city like Graz is. With the special flood protective programme "The Streams of Graz" several aspects of what the EU Floods Directive now is stipulating are already implemented in Graz.

Setting the Scene

The scene was set by a key note speech given by Mark Adamson, Head of the Flood Relief and Risk Management Division, Office of Public Works, Ireland.

Mark Adamson provided a broad overview about the framework of the EU Floods Directive, the principles, requirements, and administrative arrangements. He also stressed the challenges in the implementation of this directive for EU Member States, because of the very different flood risk contexts, governance arrangements and state of development of flood risk management in the different countries and regions. Mr Adamson advocated the flexibility of the current Directive that offers Member States a significant degree of subsidiarity in almost all areas to determine the approach to implementation that is most suitable for their own particular circumstances, including those concerning governance arrangements and available information and resources.

The focus of the discussion round afterwards was briefly on the special role of mountains in the Floods Directive implementation, the content of the Water Framework Directive and what incentives the state can offer to support people in manging their own risk or to strengthen resilience. Mark Adamson explained that the EU Commisson plans actually not to focus on mountains especially. The

Water Framework Directive is flexible; it is only a frame and allows room for each region to decide on how to implement it. If sediment transport, for example, is an issue, the Framework Directive allows treating it appropriately. Considering sediment management issues is not definitely excluded from all approaches at the moment and it is up to Member States to include that as well. Concerning incentives that a state can offer he remembered that sometimes the costs of a respective protection system are too high compared to the benefit. If a flood warning is given, residents can take measures themselves. There is a part funding for residents (up to 75%) for the purchase of protective measures. Self protection can be seen as a responsibility of every one of us – and that means also additional risk precaution (like insurance) measures.

Consecutive sessions

The rest of the programme was divided into three consecutive sessions, each chaired and moderated by Ms Karin Staller:

In **Session I**, Mr Rudolf Hornich, Styrian Federal State Government, Mr Clemens Neuhold from the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW), and Mr Heinz Stiefelmeyer from the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) gave insights into specific problems and challenges regarding flood risk management in Alpine catchments as well as pointed out the links between the Flood Directive and Water Framework Directive.

Rudolf Hornich remarks on specific problems regarding flood risk management in Alpine catchment areas. He described the significance that protection against natural hazards always had in the Alpine area. The presentation and mapping of hazard zones in the form of hazard zone maps – as a basis for planning and decision making in land use planning – has been applied in Austria for more than 30 years. His conclusion with the implementation of the EU Floods Directive was positive, because it will serve as a crucial basis for the security and future development of Alpine living spaces.

Clemens Neuhold stressed the links between the Floods Directive and the Water Framework Directive. There are several reasons for coordinating both Directives in terms of optimizing synergies and minimizing conflicts on the same medium: Water. Altough links are generally discussed on an administrative level there is a strong link due to wording, approach, and implementation cycle in both directives already determinable, what may also lead to a common reporting precedure in the future.

Heinz Stiefelmeyer explained the status quo of the implementation of the EU Floods Directive in Austria and especially the methodology and challenges to develop the required flood risk management plans.

The discussion with the panel afterwards focused on issues like conflicts between the safety goal of the Floods Directive and the ecological status of the Water Framework Directive, the priorisation of the basin scale instead of rivers, what incentives for land users are there or the role of sediment management. The panel remarked that the goal of both the Water Framework Directive and the Floods Directive is to gain good ecological status and human safety. However, there is a conflict between the safety goal and the ecological status – in terms of what the overriding public interest is. As the Floods Directive is very flexibel, the commission only gives general standards. Each country has the possibilities, to adapt the directive to their national needs (e.g. to consider bedload-

transport). Regarding the right scale, e.g. Austria is focussing on the catchment area because of considering all activities that are contributing to the management of floods (e.g. forestry measures, land use planning). Regarding incentives for land users there was consensus that it is important to shift the focus on non-technical measures (incl. legal instruments) when it comes to flood prevention. The community should also deal with it because dams are not an endless option for flood risk protection, nor a guarantee for success on the long run. Concerning sediment management, the panel referred that not in all reaches a plus of sediment is available, there are also some reaches that have less sediments. The question is how to balance sediment budget/transfer on the basis of a whole basin approach effectively, further input from research/science as well as practitioners is still needed.

Session II ("methodology and challenges") was intented to exchange status quo and experiences regarding the implementation of flood risk management plans across countries of the Alpine Convention. Mr Luka Stravs from the Slovenian Ministry for Agriculture and the Environment, Mr Riccardo Rigon, president of the Alpine Conventions' Water Platform, Jean-Michel Helmer & Marie-Pierre Meganck from the French Ministry for Ecology, Energy, Sustainable Development and Sea and Mr Andreas Rimböck from the Bavarian Environment Agency informed about methods, implementation and challenges in their country.

Luka Stravs informed that Slovenia is at the moment intensively working on the preparation of the Slovenian Flood Risk Management Plan. The Slovenian FRMP will consist of 17 smaller river basin FRMPs, which cover all of the identified 61 APSFRs.

Riccardo Rigon gave insight into the complex structure of water and flood risk management in Italy and stressed the importance to develop from a project view to a process view.

Jean-Michel Helmer & Marie-Pierre Meganck introduced into the status quo of the Flood Directive implementation in France. Focus was given also to the French national strategy for flood risk management, which set out three key objectives that should have to be achieved in the next 20-30 years: solidarity, subsidiarity and synergy.

Andreas Rimböck informed about the situation of torrential flood risk management in Bavaria and focused on the current state concerning the Floods Directive and the planned procedures for the future. Due to the strong consequences of the torrential hazard zones there is a high demand on exact data, modern and proved calculation procedures and comparability of the results. For the extensive mapping within the Bavarian torrents a standardized procedure is planned.

Topics of the discussion round were especially the role of science in the frame of implementing the Floods Directive, the role of building zone in Bavaria, the status of implementation in the Member States as well as what solidarity on a catchment level means. It reached consensus in the auditorium that more R&D is needed especially in torrent catchments, but also regarding social sciences. Integration of different levels of administration and regions as well as issues like communication/perception, urban/regional planning, cost-benefit analysis aspects are worth for improvement in this frame. Regarding the exceptions from the building ban and the arrangements in context to geo- and avalanche risks in Bavaria, Rimböck explained that the strictest exception is that if there are other non flood prone areas available for building there is no permit to build in a particular area. Also, building is allowed if there are no negative effects on discharge and the current. On the other hand there are no red zones for avalanche and rock areas – only a warning about the

possible dangers. This means that building is not strictly forbidden because more investigation is needed. Solidarity on a catchment level means that all people contribute to common risk transfer mechanisms. The mechanism is working on the national level already for all risks – not only floods. Money is given to the territories to manage the development for floods. The solidarity is given because money is provided for all catchment areas even if they are not directly flooded.

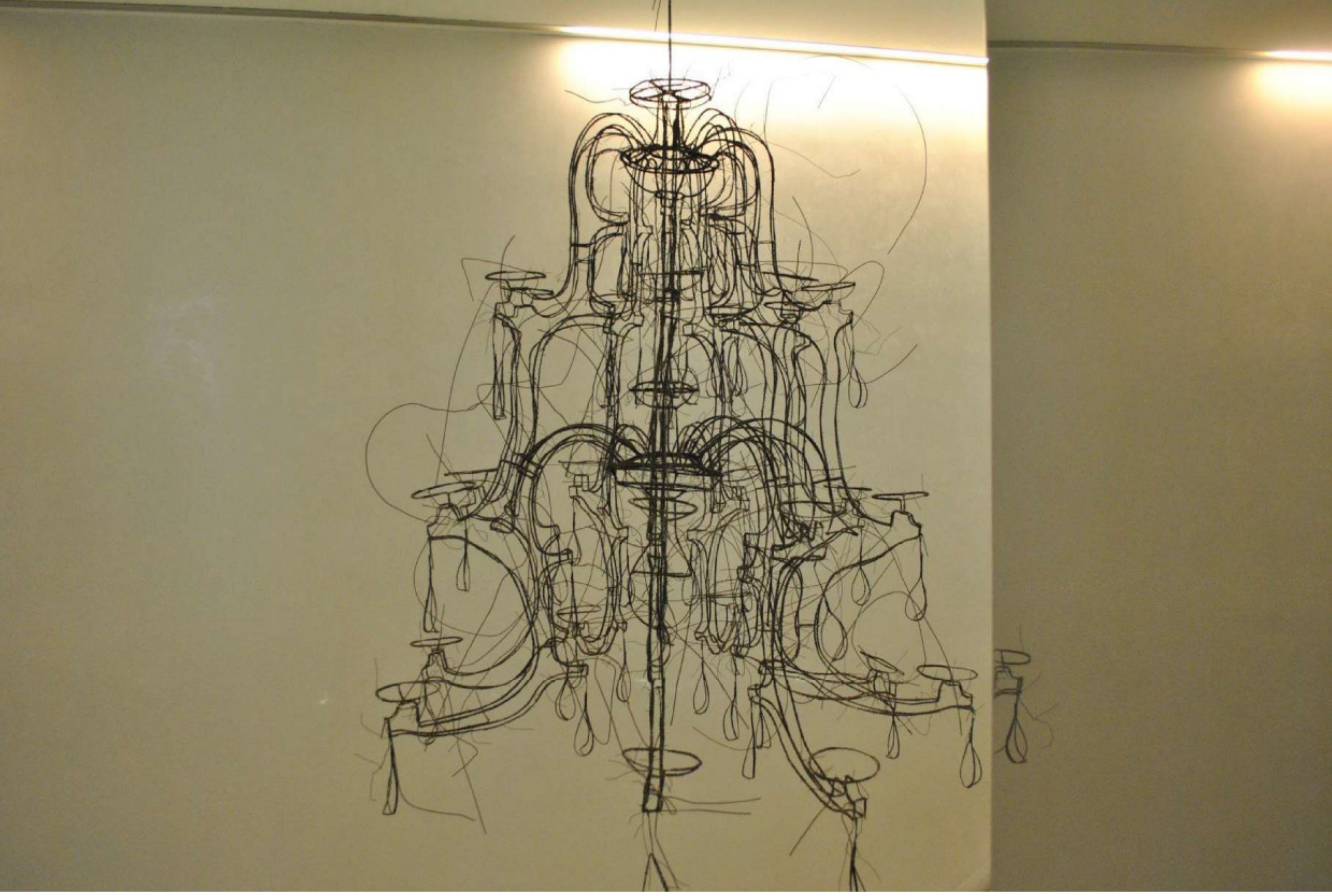
In **Session III** ("methodology and challenges – cont."), Mr Olivier Overney from the Swiss Federal Office for the Environment, Ms Therese Stickler from the Austrian Environment Agency, and Ms Eva Mayer from the Bavarian Ministry of the Interior, Building and Transport introduced further aspects of flood risk management.

Olivier Overney informed about flood risk management in Switzerland and stated that an efficient flood risk management can only be achieved if all possible measures are effectively taken thanks to a clear division of tasks between public authorities. Responsibilities must be clarified between the different state levels and the private sector (insurance companies and property owner). In addition good cooperation is crucial to the fulfilment of the stated objectives. The successful implementation of integrative risk management coordinates the action priorities: protective structures alone cannot guarantee safety. An optimal combination of response, recovery and preparedness measures must be sought under financial, social and ecological constraints.

Therese Stickler introduced into participatory approaches for risk management and risk communication which are crucial to involve the public in the development of flood risk management plans. She stressed the importance to involve concerned lay persons not only in the design of the hazard and risk maps or the risk assessments itself but in the cooperative elaboration of the risk assessment approach.

Eva Mayer explained the links between flood risk management plans and contigency planning in the case of Bavaria and underlined challenges and chances from a disaster prevention perspective. The creation and update of local alarm and action plans on municipal level as well as the creation and update of special flood disaster control plans on a county level are two main elements that concern the field of disaster management and the municipalities as local security authorities.

The discussion round concerning session III focused on the role of disaster management in the frame of Floods Directive implementation, what kind of channels are useful to convey information, the role of trust in public participation, as well as some specific question to the Swiss situation in flood risk management. It reached consensus in the auditorium that disaster management is an important aspect of a holistic risk management approach. The Floods Directive meets all fields of policies. Every field should take their own measures and should coordinate those. Disaster plans should not have specific priority, they are all equally important. Regarding public participation, it is important to adjust a map to a particular group and meet their use. Administration is often seen as neutral and trustful - wherefrom conflicts and mistrust can arise. A good idea is to get partners – maybe an environmental NGO, or influential people – into the process in order to strengthen credibility and common understanding.



Overall conclusions

II. OVERALL CONCLUSIONS

- **Flood risk management is a complex process among different policy areas, stakeholders, information sources and operating systems.**
- **To achieve future flood-resilient communities, it is essential to take an integrated approach – by considering a range of regulatory, social and economic responses.**
- **Flood risk maps are key in identifying which areas are most at risk and will help professionals to plan for and to tackle flood risks head on.**
- **There is a need to improve linkages across Europe on risk based, broad scale modelling and better exchange on common standards and harmonized definitions.**
- **Awareness of the risks from water is high among the community of experts but further work remains to propagate this awareness among the public.**
- **Capacity building is a main pillar for implementing an adaptive management structure in any river basin. The demand will be to improve education and communication in order to integrate stakeholders on all levels.**
- **Public stakeholders need to be involved in this learning process to enhance their capacity both to be willing to engage, and to engage effectively, with the communities they serve.**
- **Investments in training and exercises should be combined with a greater focus on identifying and sharing lessons learned on an international level.**

Speaker presentation notes

THE EU „FLOODS“ DIRECTIVE – PROGRESS AND CHALLENGES

Mark Adamason

Head of the Flood Relief and Risk Management Division,
Office of Public Works, Ireland
Co-Chair, EU Working Group on Floods (WG F)

THE EU 'FLOODS' DIRECTIVE

Between 2002 and 2013, floods in Europe have caused around 1000 fatalities, the evacuation of more than 1.7 million people, and have caused a total extrapolated cost of €150bn in damages[1]. Floods and storms are recognised as the major natural threat to people and communities in Europe, and have been identified as a major in risk in almost all of the National Risk Assessments submitted by Member States (MS) to date under the framework for EU cooperation on disaster prevention[2].

While floods are referred to in the EU Water Framework Directive (WFD) [2000/60/EC], the focus of this Directive is on the environment and water quality, rather than the reduction of flood risks.

To provide a common framework for flood risk management in Europe, and address the gap in EU water policy, the Directive on the assessment and management of flood risks [2007/60/EC], often referred to as the 'Floods' Directive, was brought into force on 26th November in 2007, only 20 months after publication of the first proposal on 18th January 2006.

Beyond transposition into national law (required to have been completed by November 2009 - Article 17), the key requirements of the 'Floods' Directive are that MS:

- Undertake a Preliminary Flood Risk Assessment (PFRA), based on available and readily-derivable information (Art. 4.), to identify areas of potentially significant flood risk (APSFR), to be completed by the 22nd December, 2011 (Art. 5)
- Prepare flood hazard and risk maps for the APSFR by 22nd December 2013 (Art. 6)
- Prepare by 22nd December 2015 Flood Risk Management Plans (FRMPs) at the level of the river basin setting out objectives for the management of flood risks in the APSFR, and a prioritised set of measures aimed at achieving those objectives (Art. 7, 8 and Annex).

The above requirements are then to be reviewed on a six-yearly cycle, with the exception of the first review of the PFRA that is due in 2018 (Art. 14).

MS are able to apply transitional measures (Art. 13) where certain requirements have already been met, or where MS decide to prepare flood maps and FRMPs for a river basin (or for certain types of floods within a river basin) without undertaking a PFRA.

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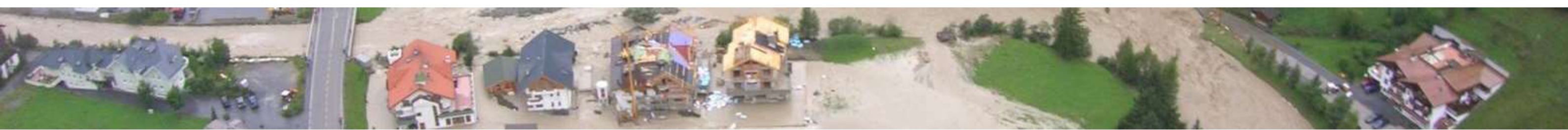
[1] HKV Consultants and RPA Risk & Policy Analysts (2014). Study on Economic and Social Benefits of Environmental Protection and Resource Efficiency Related to the European Semester. (ENV.D.2/ETU/2013/0048r). Final Report prepared for DG Environment February 2014

[2] Council of the European Union, Council conclusions on a Community framework on disaster prevention within the EU, 30.11.2009



In addition to the three key stages set out above, there are three cross-cutting requirements that apply to each:

- Rivers do not respect borders, and so MS are required to exchange information and coordinate, and may prepare joint FRMPs, in trans-boundary river basins, supporting the principle of solidarity (Art. 4(3), 5(2), 6(2) & 8)
- While the WFD considers water as an asset and a resource that needs to be protected from human activities, and the 'Floods' Directive considers water as a threat that humans and human activities need to be protected against, both Directives deal with aspects of water and river basin management. Given the opposing paradigms, it is clearly necessary to ensure coordination in implementation to avoid or manage potential conflicts in objectives, and to achieve synergies and 'win-win' outcomes where possible (Art. 9), and MS may indeed integrate the processes and the FRMPs with the WFD River Basin Management Plans (RBMPs)
- As with all environmental Directives, and in accordance with the Aarhus Convention, there are also requirements for MS to publish outcomes of all of the key stages and to encourage the active engagement of the public in the preparation of the FRMPs (Art. 10)

Finally, there are certain definitions and administrative arrangements set out in the Directive as well as requirements on reporting to the Commission (Art. 15).

EU WORKING GROUP ON FLOODS - WG F

In 2005, an 'Expert Group' was convened by the European Commission (COM) to discuss the potential structure and contents of a Directive on the assessment and management of flood risks. This Group met twice early in 2005, and then became the 'Stakeholder Group' for meetings in late 2005 and 2006. In December 2006, the Water Directors adopted the establishment of WG F (the 'F' being fortuitous but coincidental, with Working Groups 'A' to 'E' already in existence) within the CIS, which met formally as WG F for the first time in spring 2007.

The purpose of WG F, that includes representatives of COM, the MS and other relevant organisations and stakeholders, is to facilitate the effective implementation of the 'Floods' Directive by providing a forum for the exchange on information between MS and between MS and COM, including providing feedback on implementation. The Group also provides a focal point with respect to flood risk management in the EU for links with other WFD, and wider COM, activities.

WG F has met since it's formal establishment on a regular six-monthly basis, with sub-groups being formed to address specific issues; particularly the preparation of the reporting sheets and schema (defining what the MS need to report to COM and how), but also on other matters such as the preparation of a resource document outlining the links and synergies between the WFD and the 'Floods' Directive.

The Group has also organised and held a number of workshops; with each covering in detail one of a wide range of specific topics, including (in order of occurrence):

- Land Use Planning (two workshops)
- The PFRA
- Flood Mapping
- Climate Change (two workshops)
- Natural Flood Risk Management
- The Preparation of FRMPs

- Flash Floods & Pluvial Events
- Economics and Flood Risk Management
- Stakeholder Involvement
- Decision-Making under Uncertainty
- Objectives, Measures and Prioritisation
- Trans-boundary Issues

The 'thematic workshops' are, in the view of the author, probably the most productive and fruitful activities of WG F, at least beyond the critical tasks of preparing reporting requirements and discussing the formal issues of implementation. They allow for in-depth discussions on specific issues, common problems or uncertainties and methods and approaches for implementation. This is through open and informal debate and where possible, the description and sharing of past practice and experience and lessons learned. A report is prepared for each workshop outlining the discussions held and the key findings.

The documents of WG F, including the workshop reports, are publicly available from the DG Environment website pages on the 'Floods' Directive[3] *and links from this page to the on-line* repository; CIRCA.

CHALLENGES OF IMPLEMENTATION OF THE 'FLOODS' DIRECTIVE

Overall Approach

The overall approach being adopted by MS differs widely across the EU. This was to be expected given the very different flood risk contexts, governance arrangements and state of development of flood risk management in the different countries and regions. The variability was intentionally provided for in the Directive in so far as it was established only as a framework with a significant degree of subsidiarity provided in how each MS would work within the framework to meet the stated requirements.

Notwithstanding the above, there are examples where approaches between different MS have similarities; often due to the information exchange made possible and promoted through WG F. An example of this would be the approaches used to undertake the PFRA in Finland and Sweden and in Ireland and the UK, between which some meetings and discussions were held bi-laterally early in the PFRA process to compare ideas and methods.

The Preliminary Flood Risk Assessment

For many or most MS, the PFRA would have been the first such spatially extensive, indicative assessment of flood risk undertaken, and hence required the development of new methods, taking into account what information and technical data was available to, or could be readily-derived by, each MS. This naturally gave rise to some significant challenges, of which some are outlined below.

Spatial Scale: Many MS would have significant experience of assessing flood risks in detail at a local level. Working at a river basin or national level however requires different methods and approaches, as detailed datasets will often not be available, and on-the-ground validation of data and conclusions may not be possible within reasonable costs. MS would typically have had to deal in undertaking the PFRA with very large, national datasets that may lack the detail usually required for local risk assessments, or may not have had datasets with full spatial coverage that they would have liked to

[3] http://ec.europa.eu/environment/water/flood_risk/3_compo.htm

have used. This would have necessitated various assumptions and approximations being made, and the adaptation of familiar and tested methods to work with the limited information available.

Sources of Flooding: Across Europe, MS have historically undertaken flood risk assessments for fluvial and coastal / tidal flooding. However, the definition of flood risk under the 'Floods' Directive is open and all-inclusive (with the optional exemption of floods from sewers). This required MS to consider sources of flooding that some may not have had previous experience of assessing, such as pluvial or groundwater flooding. However, the Directive only requires for the PFRA the consideration of past floods (with the predictive assessment of flooding, e.g., based on modelling, optional), and for assessments to be based on available and readily-derivable information. As such, some MS may have, at this stage, undertaken assessments as to whether significant floods from atypical sources have occurred in the past, with consideration being given to undertaking more detailed, and potentially predictive, assessments for the second cycle of implementation.

Assessment of Risk for Certain Sectors: Many MS would have established methods for determining economic losses and the risk to people. The 'Floods' Directive however requires the assessment of risk to people, the environment, cultural heritage and the economy. Methods are not well established for determining the risk from flooding to our cultural heritage and the environment, particularly if it is intended that the risk be monetarised, and the spatial scale of the assessment would generally have prohibited detailed assessments on a site-by-site basis. Some MS would have tackled this using a count of flooded sites (e.g., cultural assets or potential sources of pollution), or making use of reported impacts from past events, while others undertook some work to assess the potential vulnerabilities and degree of loss if such sites were flooded.

17 As an example, Ireland, building on and adapting some previous work undertaken in the UK, developed a method of determining the value of cultural assets, and their vulnerability to damage in the event of flooding, and then using this combined with the probability of flooding in a broader (multi-sectoral) risk analysis to derive a numerical, but non-monetarised, Flood Risk Index.

Definition of Significant Risk: As noted above, for the PFRA MS were required to undertake a cross-sectoral assessment of risk, and hence needed to consider this range of sectors in determining what constitutes significant risk. MS have taken different approaches to this challenge. Some have applied thresholds to each sector (e.g., whether the number of properties flooded, or whether the level of economic losses, exceeded a given threshold), while others made use of an integrated threshold (such as in Ireland based on the non-monetarised Flood Risk Index as described that described risk in each sector).

Provision for Climate Change: The consideration of climate change was not obligatory for the first cycle of the PFRA. However, for the second cycle, this is required and will introduce another dimension of uncertainty to be taken into account along with those related to scale, sources of flooding and cross-sectoral assessments of risk.

Further Information: The PFRA undertaken by the MS, and the outcomes of these (the defined APSFR) will soon be published by COM through the Floods Directive Viewer on the Water Information System for Europe, WISE[4], which will allow readers to examine, on a country-by-country basis, how each MS met the above challenges.

[4] http://www.eea.europa.eu/themes/water/interactive/floods-directive-viewer

Flood Mapping

Most MS have extensive experience of preparing flood maps, and so from a technical perspective, this stage of implementation might have appeared to have been less challenging than others, although clearly the scale of work involved has been a very significant challenge; particularly during such times of economic difficulty. However, some non-technical aspects have, and will continue in future cycles, require considerable work and thought.

Transboundary Coordination: The Directive requires the exchange of information between MS in Transboundary RBDs / UoMs, which might include the exchange of, and preferably agreement on, cross-border flows and levels, as well as other data such as survey information. The exchange may extend beyond this to agreements on the use of common hydraulic models, such as has been achieved between Ireland and Northern Ireland (UK), and between Finland and Sweden.

This requires good communication and strong relationships between the relevant parties to be effective and efficient. It appears that the degree of transboundary coordination has been variable around Europe, although seems to be stronger in areas within International River Commissions or where pre-existing cross-border relationships exist.

A WG F workshop has been held in March 2014 on transboundary issues for implementation of the 'Floods' Directive, and the report on this workshop will be available from the DG Environment website in due course.

Communication of Risk: Flood maps are a critical tool in the communication of flood risk to the public and other users, such as land-use and emergency planners, and it is important that the maps are formatted and presented in a way that will facilitate the intended users clearly understanding the information presented. This is however difficult to achieve, in particular noting that different users have different needs and may have differing levels of familiarity with the use of maps. The issues and difficulties in communicating flood risk through flood maps were considered during the WG F flood mapping workshop and EXCIMAP work (see below), and also in the workshop on stakeholder involvement hosted by Romania.

Climate Change: As with the PFRA, the preparation of flood maps indicating the potential impacts of climate change was not obligatory in the first cycle of the implementation of the 'Floods' Directive. However, the issue has been discussed by WG F, and it is clear that there are diverse views, with some MS taking the view that it is important to provide information on potential future risks and/or uncertainties to help users better understand the information provided, while others have the view that the information provided should be clear and simple, and that providing such information might confuse users and / or undermine confidence in their use.

Further Information: The reporting date for the flood mapping was 22nd March 2014, and so this information is not yet available on WISE but will be so in due course, linking down to national websites or map-viewers, to indicate how MS have implemented the flood mapping requirements.

A WG F workshop was held on flood mapping in Dublin in September 2008, and the report of this workshop is available through the DG Environment website. This workshop built on the work of EXCIMAP, an information exchange circle that was formed around the same time as WG F, and that

produced the Handbook on Good Practices for Flood Mapping in Europe' (2007), available from the DG Environment website[5].

Flood Risk Management Plans

The Flood Risk Management Plans (FRMPs) are the final requirements of the Floods Directive (other than future monitoring and reviews), and will set out prioritised sets of measures aimed at achieving the defined flood risk management objectives. While some MS have experience of preparing such Plans, many do not, and those that have may not have developed them in the way required under the Directive. As such, and although the FRMP delivery deadline is still some time away, it is already clear that there are a range of common challenges MS are considering.

Setting Objectives: At the WG F / StarFlood workshop on Objectives, Measures and Prioritisation held in Brussels on the 16th October 2013 (and available from the DG Environment Website), it became clear that MS were adopting quite different approaches to the definition of objectives, such as in the following ways:

- At a high level in terms of a general intention to reduce risk, and / or to implement the broad areas of flood risk management (prevention, protection and preparedness, response and recovery)
- As the implementation of types of measures
- As achieving defined standards of protection
- As reduction in risk to certain sectors
- As a combination of two or more of the above

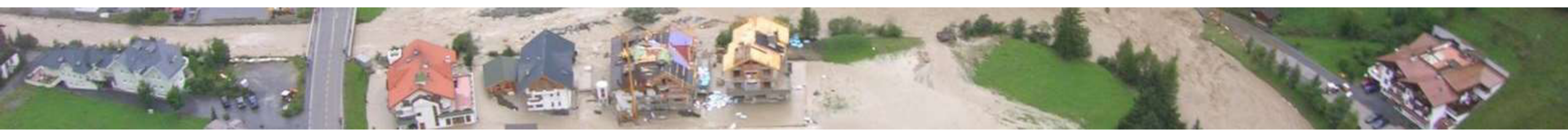
The level at which the objectives are set (i.e., nationally, regionally, locally) also varies between MS, with some defining a nationally-consistent set of objectives centrally, while others define guidelines on setting the objectives centrally with specific objectives then set regionally or locally, to allow for greater local responsibility and flexibility.

There is no specific, or 'correct', way to define objectives, as this is a matter within the competence of the MS, and the range of approaches has evolved from the different contexts in each MS in terms of governance arrangements and legacy of how flood risk management is viewed and approached in the MS, and each MS needs to determine which approach is most suitable in their specific context.

Coordination with the Water Framework Directive: As noted above, there may be conflict in the implementation of the 'Floods' Directive and the WFD, but also synergies, and so there is a clear need (as well as a requirement) for coordination in the implementation of the two Directives. It is considered that the area of most potential for both conflict and synergy is at the Plan preparation stage, where objectives are set and measures considered, appraised and defined. However, as this is the first cycle of implementation of the 'Floods' Directive, there is limited experience in coordination to build upon to ensure that the coordination process at this stage is effective and efficient, and so this aspect of implementation is a challenge for most MS.

WG F has developed a resource document exploring the links between the 'Floods' Directive and WFD that has been approved by the Water Directors (available from the DG Environment Website), although the limited experience has been recognised and it is proposed to review and update this document after the first cycle of implementation.

[5] http://ec.europa.eu/environment/water/flood_risk/flood_atlas/index.htm



Climate Change: Again, taking account of climate change in the preparation of the FRMPs is not obligatory in the first cycle of the 'Floods' Directive. However, investment in measures without consideration of the potential impacts of climate change on flood hazard and hence risk could lead to the implementation of measures that are not adaptable to future change and that could require significant additional costs to adapt or that otherwise might reduce in standard of protection or effectiveness over time.

While there is strong evidence that mean sea level is rising, there is uncertainty over the future rate and degree of rise, and there is significant uncertainty over the impacts of climate change on rainfall patterns over many parts of Europe. This uncertainty makes decision-making with consideration of the potential impacts of climate change difficult to implement, where there may be hesitancy to invest slightly more or to reserve land now for flood risk management measures for a future scenario that may or may not occur, or where there may be merit in making lower-cost interim investments now to permit an appropriate long-term investment at a future point when changes might be occurring or be understood with greater certainty. While, approaches exist to put a framework on this decision-making process, such as using representative futures to test decision-trees, MS and regional and local flood risk management authorities will face challenges in working through sustainable approaches and developing public and political acceptance of decisions where such uncertainty exists.

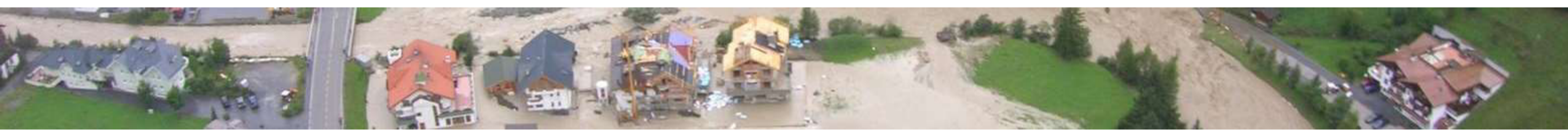
Land-Use Planning: Sustainable decision-making in land use, through planning and development management that is cognisant of flood risk, is a corner stone of 'prevention' within the flood risk management cycle and is essential for long-term effective flood risk management.

Thematic workshops were hosted by Norway and then jointly by Austria / Slovenia on the topic of land-use planning, with reports available from both workshops through the DG Environment website. The workshops found that the approaches to land-use planning across Europe were variable, from very limited regulation through to strict legal controls based on defined flood zones, but that there was a general trend towards stronger regulation.

The consideration of climate change in land use planning is a matter also considered at the WG F workshops. Addressing the related uncertainty is challenging, where land-use decisions can have significant financial, social or economic consequences, and great care is needed when making such decisions under significant uncertainty.

The 'Floods' Directive requires that MS address prevention within the FRMPs. Consideration needs to be given as to how this should be set out, bearing in mind that the FRMPs will often be a parallel set of plans to the land use management plans. It may be that the measures related to prevention in the FRMPs might reflect the legal requirements for planning taking into account the flood maps produced under the Directive or refer horizontally to the land use plans with land use zoning coordinated (perhaps over time) with the objectives in the FRMPs. As with so many aspects of the implementation of the requirements of the Directive within the framework established, the appropriate approach will depend on the context of the individual MS.

Prioritisation: MS will have published flood maps identifying people, properties and assets at risk from flooding. The public and stakeholders may well then have an expectation that the state (at whatever level) will implement measures to reduce that risk. In Ireland, and quite possible in many other MS, there is a strong preference that the reduction in risk is by way of protection measures. However, at all times, and in the current economic conditions in particular, the state will have limited



budgets and will not be able to implement measures to reduce the risk to all areas immediately. There is hence a need to prioritise, and to select which measures to implement and when.

The effects of prioritisation, while aiming to ensure maximum return on investments (by way of benefits achieved and / or losses avoided per euro spent) or to reduce risk in certain critical areas, are that some areas will not be scheduled to receive protection or risk reduction measures; either for a considerable period of time or indeed, at all. This outcome will naturally be unwelcome news for those not prioritised for the implementation of measures in the near future.

The system for prioritisation therefore must be fair and transparent to facilitate understanding and acceptance by those detrimentally affected as above, and this may often involve democratic procedures and agreements. Metrics, such as benefit-cost ratios, or the outcomes of multi-criteria analyses, can often be helpful to demonstrate the processes involved in arriving at the prioritisation outcomes. The introduction of resilience measures (see below) can also facilitate acceptance of prioritisation outcomes.

As noted above, the WG F Workshop held on 16th October 2014 included discussion on the issue of prioritisation, and the workshop report will be available on the DG Environment website.

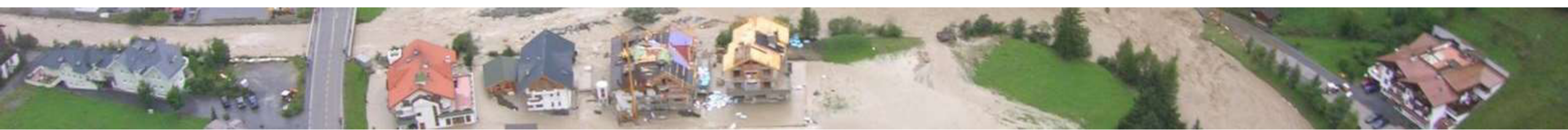
Resilience: The state, be it at national, regional or local level, can not, due to budgetary constraints as discussed above, or should not, due to general or specific rules on public expenditure, provide protection or reduce the risk to locally desirable levels in all areas. As a result some areas may benefit from no significant state expenditure on flood protection, or may have to wait a considerable period of time before such expenditure can be committed.

However, people, businesses and communities are able to reduce the risk to themselves through their own actions. As an example, the City of Cork in Ireland recently suffered floods where a large number of streets and businesses in the city centre were flooded. However, the flood risk in the area was known and many businesses were prepared such that within hours of the flood waters receding, many businesses were open and operating again as normal.

Relatively low-cost measures that build resilience can be introduced in areas assigned a lower priority for major investments in risk reduction; either in the short-medium term pending the implementation of protection measures, or as a long-term approach to managing flood risk or residual flood risk in the area.

It should not be assumed however that community resilience will develop by itself. Some investment by the state can greatly enhance the rate and degree of development of resilience through measures such as awareness raising and capacity building programmes (for example, by establishing, promoting and empowering local flood groups), providing information on how to prepare and how people and businesses can protect themselves and then recover quickly from a flood event, the implementation of incentive or grant schemes for the purchase and installation of individual property protection measures, etc. These programmes would generally require some state financing and investment of resources, often at a local level, but can achieve reductions in risk at a low cost relative to major structural community protection works.

Further Information: The FRMPs are not due for completion under the 'Floods' directive until December 2015, and so no information will be available on WISE until at least 2016. However, many



topics relevant to the preparation of FMRPs have been discussed in WG F Workshops for which reports are available through the DG Environment website.

SUMMARY

The EU 'Floods' Directive has set out a common framework for managing the adverse impacts of flooding on people, the environment, cultural heritage and the economy. The Directive sets out requirements for MS to undertake a Preliminary Flood Risk Assessment (PFRA), prepare flood maps and develop Flood Risk Management Plans (FRMPs). Each of these requirements pose significant challenges that MS across Europe have been working, and will continue to work, to overcome. Common challenges are generally related to governance and communication, rather than technical issues, although the scale of work involved is, in its own right, a significant challenge to be met.

While the Directive does set out some specific requirements that MS must meet, the Directive is very flexible and offers MS a significant degree of subsidiarity in almost all areas to determine the approach to implementation that is most suitable for their own particular circumstances, including those concerning governance arrangements and available information and resources. As such, MS are able to implement the Directive according to their own context, and there is rarely any one 'correct' approach to overcome the challenges and meet the requirements of the Directive, and equally rarely a 'one-size-fit-all' best practice.

It might also be remembered that we are only in the first cycle of implementation of the 'Floods' Directive. There are requirements to be met, but there is always scope to improve and expand the approaches taken in future cycles of implementation.

Disclaimer and Author's Note

The views expressed in this paper are the personal views of the author only. They do not constitute a formal interpretation of the EU 'Floods' Directive or any other legislation, and do not represent the official position of the Irish Government, the Office of Public Works, Working Group F, or any other organisation, group or committee.

Reference is made herein to examples of implementation and practice in Ireland. This is not intended to imply that the examples presented represent best practice. These examples are used solely due to the familiarity of the author with practice in Ireland.

SPECIFIC PROBLEMS REGARDING FLOOD RISK MANAGEMENT IN ALPINE CATCHMENT AREAS

Rudolf Hornich

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The Alps encompass an East to West length of about 1200 km, a width between 150 km and 250 km and a surface of about 190.600 square kilometres (Figure 1). Due to the topographic circumstances and a particular climatic situation there are specific natural hazards with which the population of the alpine areas has learned to live over centuries. Because of the high amounts of precipitation – which are distributed throughout the year in both solid and liquid states – floods are a constantly present hazard in alpine living environments. In order to manage flood risks the Council of the European Union and the European Parliament implemented the European Floods Directive 2007/60/EC in November 2007. However, not only the applications of this new strategic instrument, but also the specific problems in alpine catchment areas pose a challenge to alpine countries.

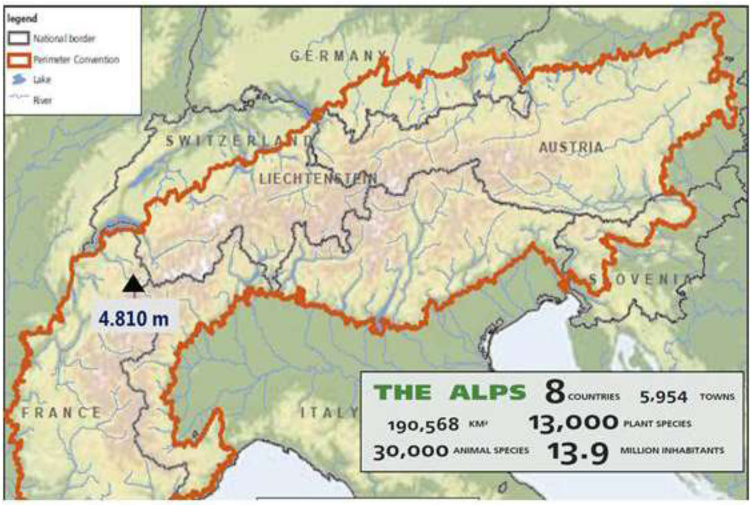


Figure 1: Alpine region

BED LOAD, BED LOAD TRANSPORT, SEDIMENT MANAGEMENT AND DRIFT WOOD

The alpine area is often affected by the European general weather situation – for example the Vb-weather situation. As a consequence of rainfalls for days the effects are extreme natural disasters – such as the floods in 2002, 2005 and 2013. Extreme precipitation with high intensity and short duration can also cause floods with high damage. Flood catastrophes have been the most frequent natural disasters in recent years in the alpine area

In article two of the Floods Directive the following definition can be found: “flood” means the temporary covering by water of land not normally covered by water. This shall include floods from rivers, mountain torrents, etc.

However, in alpine catchment areas this definition is not sufficient. Due to the geological and topographic situation there is a difference between flood events in the alpine area and the lowland. With alpine rivers it is important to not only consider the pure water mass – in case of torrential rain and floods huge masses of rubble are mobilised by landslides and erosion processes. The discharge processes are affected by sediments and drift materials, which not only cause great damage, but also

cause problems with cleanup efforts due to the huge amounts of rubble and debris mass. Huge amounts of driftwood that is carried along aggravate this situation. Log jams lead to uncontrolled discharge and, consequently, to great damage in residential areas. In the course of creating the catalogue of measures for the flood risk management plan structural measures (bed load retention dam, drift wood rack) as well as grove tending strategies and maintenance procedures and suitable measures for drift and sediment management are to be provided. Currently there are some international projects, surveys and academic works dealing with this topic (for example: www.sedalp.eu).

Morphodynamics

Rivers in alpine areas are characterised by their pronounced morphodynamics. In his project Floodrisk II Professor Habersack has proved that the river Trisana in Galltür, Tyrol, showed an enlargement of the river width by a factor of 3,47 and a change of its run length by 1% - this happened during the extreme flood event of 2005 after the discharge of the flood wave. This means that the rivers have to be provided with an appropriate space for the flood discharge. In addition to this safety aspect, in case of floods there is also an improvement of the morphological situation of the stream (synergy effect with the Directive 2000/60/EC). The protection of the drainage space and the consideration of the flood discharge areas in the course of the creation of flood risk management plans is one of the most important tasks for land use planning.

Land use planning, restricted settlement area, retention spaces

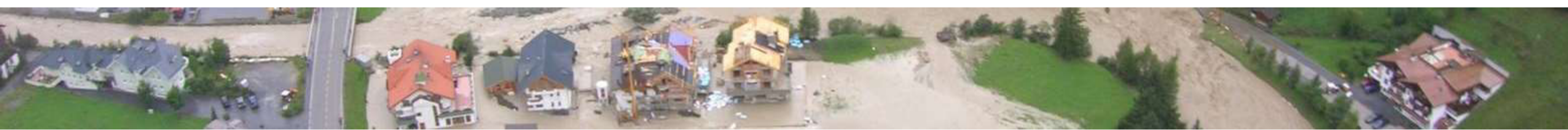
When creating flood risk management plans in alpine areas, great significance is given to the measures of land use planning. In the whole alpine region the areas for permanent settlement are very restricted. In Tyrol, for example, only 12% of the land surface is available for permanent settlement. Additionally, there is pressure from various sectors, such as economy and industry, nature conservation, tourism, agriculture and infrastructure. Thereby, they mostly claim the surfaces in the valley floors which are also of importance for the retention areas in case of floods. The task of land use planning is to consider the possible effects and scenarios of natural hazards and a detailed weighting of interests with regard to land use. It is important to turn attention to surface areas that are relevant for flood discharge and retention use. In doing so, suitable measures and legal frameworks should be provided in order to secure these spaces in the long run or to improve already existing flood retention spaces or to create new ones. The University of Natural Resources and Life Sciences, Vienna – with guidance from Professor Habersack – has created a method for the evaluation of flood retention spaces. With the help of the Floodplain Evaluation Matrix (FEM) method it is possible to assess the effects of flood retention spaces (in case of floods) on the downstream and upstream residents in terms of reduction of the water level or retardation of the peak flow. Thus, an important basis for the creation of management plans is available.

Further specific problemsTourism effects on PFRA

The touristic use of the alpine area represents a specific problem for flood risk management. Depending on the season the number of people living and staying in a locality differs strongly. A provincial town with some dozen inhabitants during off season sometimes has to accommodate thousands of tourists during peak season. In the course of flood risk management it is important to consider this both during the preliminary evaluation of the flood risk as well as in the preparation of the hazard zone maps and in planning the measures for the flood risk management plan.

Forecast model

Another big challenge for the alpine area is the fact that there are no suitable forecast and advance warning models of good quality at the moment. Forecasts from weather data are difficult to derive



for the mostly small catchment areas. Due to a short flow path and a high flow velocity, the reaction time from the start of the precipitation event to the effect of the floods on protected property is very short. An improvement of the forecast data would be of great advantage particularly for the action force. Measures for the improvement of the forecasts are to be included in flood risk management plans.

CLIMATE CHANGE

The effects of climate change are an important topic for the alpine region as well. The rise of temperature causes additional hazards – especially in high alpine regions where the combination of higher temperatures and permafrost leads to new dangerous situations which have to be considered. The deglaciation and possible flood waves caused by broken dams of glacial lakes pose new threats which have to be addressed in flood risk management in certain regions.
As regards discharge, there seem to be no clear trends which can be attributed to climate change. Already existing test series from discharge sites in the alpine area often only encompass a maximum period of 50 years. Statistic deductions for extreme events are difficult to make due to this rather short observation period. However, changes in intensity and discharge characteristics have been noticed in various alpine streams. Therefore, it is important to consider the effects of climate change in the creation of management plans and to think about new strategies for assimilation.
Living with floods
Living with floods and natural hazards has been part of peoples' lives in the alpine areas for generations. Due to many historic events and constant threats these people have developed a greater awareness for floods than, for example, city residents. Therefore, the local population should be involved and participate in the process of creating flood risk management plans. Local experience should especially be used when choosing the measures to reduce flood risks.
Cultural heritages
The alpine flood events of the recent years have hardly affected historical cultural assets. Since their construction these buildings have not only survived the floods of our century but also numerous natural disasters. This means that their locations and building materials were chosen carefully with regard to natural hazards. The consideration of cultural objects in the alpine area is, therefore, not only rooted in the area of flood risk management but also in local aspects.

SUMMARY

Protection against natural hazards has always had a great significance in the alpine area. Apart from technical safety measures there were also early non-technical measures used for protection. The presentation and mapping of hazard zones in the form of hazard zone maps – as a basis for planning and decision making in land use planning as well as the construction and protection industry – has been applied in Austria for more than 30 years. The EU Floods Directive shifts the focus on flood risk management. Hence, flood risk management plans with regard to the specific circumstances in alpine regions are a crucial basis for the security and future development of alpine living spaces.

LINKS BETWEEN THE FLOODS DIRECTIVE AND WATER FRAMEWORK DIRECTIVE

Summary of the presentation given by Mr Clemens Neuhold by Catrin Promper

BMLFUW, Austria

In this chapter the Flood Directive and the Water Framework Directive are elaborated shortly in order to identify the links in between these directives. This serves further as a basis for emphasizing the main challenges and the chances within these links and synergies respectively.

Floods Directive

The EU Directive on the assessment and management on flood risk [2007/60/EC] was adopted on 23 October 2007. The aim is to reduce the adverse consequences that floods pose to:

- Human health
- Environment
- Cultural heritage
- Economic activity

The origin of the Flood Directive was the huge flood that struck Central Europe in 2002. The principal objective is to reduce the risk of flood and to take future changes in the risk of flooding as a result of climate change into account. The implementation of the FD is segmented into three stages:

- Preliminary Flood Risk Assessment (PFRAs) by the Member states for river basins and for coastal zones by December 2011 to identify areas of existing or foreseeable future potentially significant flood risk APSFRs – Areas of Potentially Significant Flood Risk, flood risk being based on the probability of the process and its (adverse) consequences.

- Flood hazard and risk maps for the APSFRs should be identified by the member states by 22 December 2013. Therefore identify areas prone to flood with a high, medium and low probability of occurrence. These maps have to include extent and water depth as well as, economic activities potentially affected, number of inhabitants at risk and the potential environmental damage.

- Flood Risk Management Plans (FRMPs) have to be produced by the Member States by December 2015. Therein these have to be harmonized with the WFD River Basin Management Plans (RBMO) cycle. The focus will be on prevention, protection and preparedness, setting objectives for managing the flood risk within the APSFRs and setting out a prioritised set of measures for their achievement.

Therein increase of flood risk for neighbouring countries (e.g. due to measures) should be avoided. Additionally longterm developments should be taken into account. Overall public information and consultation is a key issue in the whole process.

WATER FRAMEWORK DIRECTIVE

The Water Framework Directive (WFD) was adopted in October 2000 [2000/60/EC]. The main aims are the improvement and integration of the way that water bodies are managed throughout Europe (Catchment based – integrated water resources management). Thereby the status of the aquatic ecosystems should be enhanced and further deterioration prevented. A long-term protection of water resources by sustainable use, reduction of pollution of water and ensure progressive reduction of groundwater and contribute to mitigating the effects of floods and droughts. Therein it should contribute to mitigating the effects of floods and droughts.

REASONS FOR COORDINATION

The coordination of the water framework directive and the flood directive enables to optimise synergies and thereby minimises potential conflicts. This coordination is further required due to overlaps of legal and planning instruments in various Member States, both directives use the catchment areas as geographical unit and it creates the potential of aiding the (resource) efficiency by the opportunity to maximise synergies by identifying measures serving both purposes. Additionally it is expected from many stakeholders that an integrated approach will be taken.
Moreover a holistic approach to water management is supported; through references to the WFD in the FD to support coordination and possible integration. Summarizing the benefits of the coordination of the FD and the WFD are:

- Improving the efficiency by presenting information to the public in one place, ensure mutual benefits by cross referencing the objectives and the coordination of the consultation of the FRMPs and the RBMPs increases opportunities for synergies to be recognised.

- Information exchange by collecting data once and using it also for other purposes, the integration of the data allowing easier identification of pressures on water environment and sharing data assists understanding the problems and solutions to identify reductions in flood risk, thus improving the environment.

- Approving common synergies and benefits with regard to environmental objectives (in article 4 of the WFD) includes improved integrated river basin management and the identifications of areas where measures can meet objectives if the FD and the WFD e.g. use of Sustainable Drainage Systems (SuDS).

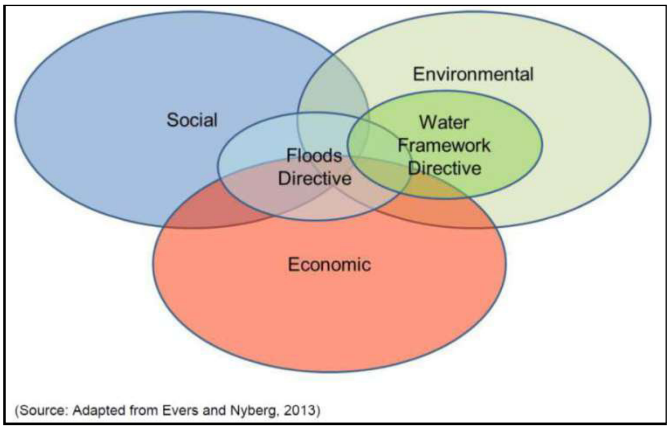
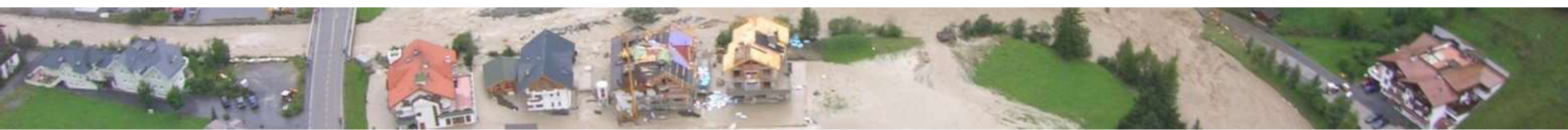


Figure 2: Sustainability aspects addressed by the FD and WFD



There are different dimensions of sustainable development: economic, social and environmental, see Figure 2. The WFD covers wide parts of the environmental aspects whereas for the FD all aspects are relevant. Therefore there are areas where FD and WFD overlap, which does not only imply challenges but also synergies in different dimensions.

This text is based on:

Neuhold C., 2014, Links between the Floods Directive and the Water Framework Directive, oral presentation at PLANALP Cofererence Breaking freh ground in protecting Alpine Environments – Flood Risk Management Plans, 25 – 26 March 2014, Graz Austria

Evers M. and Nyberg L., 2013, Coherence and inconsistency of European instruments for integrated river basin management. International Journal of River Basin Management 11:2, 139-152

EC, 2014, Links between the Floods Directive (FD 2007/60/EC) and Water Framework Directive (WFD 2000/60/EC) Resource Document, Office for Official Publications of the European Communities, Luxembourg

ON THE WAY TO THE AUSTRIAN FLOOD RISK MANAGEMENT PLAN: METHODOLOGY AND CHALLENGES

Summary of the presentation given by Mr Heinz Stiefelmeyer by Catrin Promper

BMLFUW, Austria

There are various challenges associated with the implementation of the flood risk management plans in Austria. Firstly the legal and administrative framework and secondly the topographic characteristics and the high vulnerability pose challenges to the responsible actors. It was necessary to elaborate an approach meeting these challenges and find a suitable way for all administrative levels, stakeholders and actors.

CHALLENGES

In Austria the legal and administrative framework is based on the Federal State where the water act is anchored. However the land-use management and spatial planning, the building code and the emergency management are based in the nine Provinces. Further the 2,354 communes are responsible for building permissions. This high diversity of accountabilities increases the complexity among the implementation process. The second big challenge is the topography of Austria limiting the space for permanent settlements to 37.5% for Austria (see Figure 3) in combination with a very dense river network.

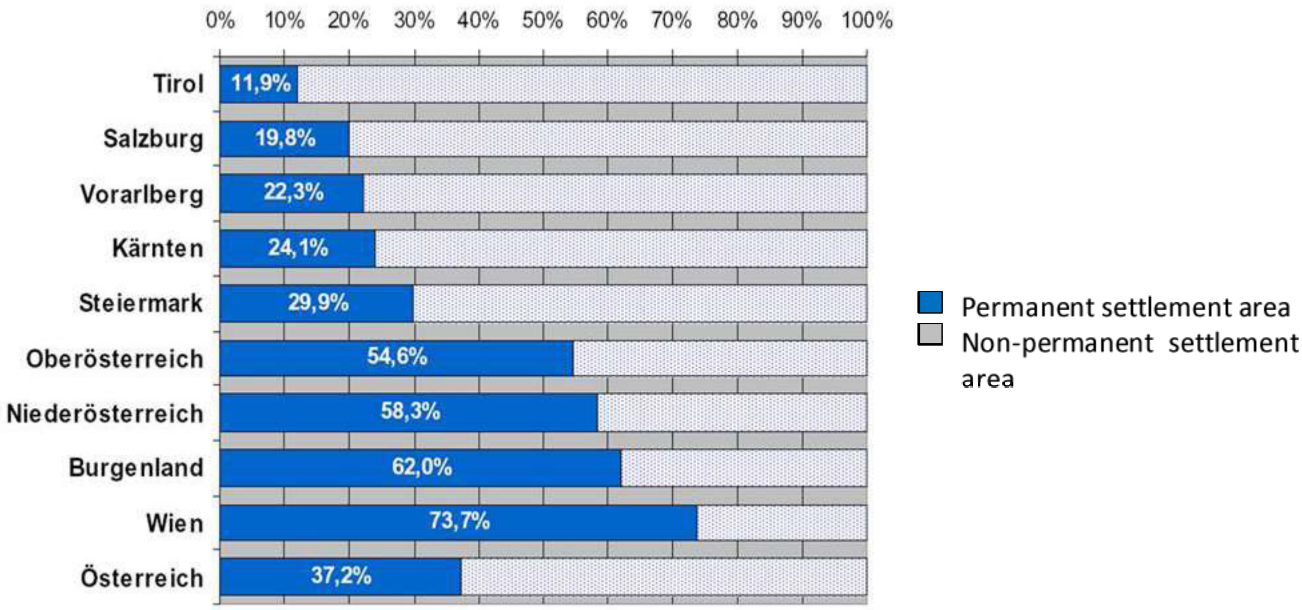


Figure 3: Permanent settlement area for Austria

Additionally there is a high vulnerability related to floods with high frequency incorporating a high number of houses and subsequently high values affected. All these factors underline the need for a working committee on the EU Floods Directive complemented by associated working groups which were established to meet the challenges and foster the implementation of the flood risk management plans.

OBJECTIVES

In the first cycle of the implementation of the risk management plans the following four objectives were identified:

- Prevention of new flood induced risks
- Reduction of existing risks before a flood
- Reduction of existing risks during / after a flood
- Strengthening risk and hazard awareness

To achieve these objectives the risk management plan incorporates measures (§ 55l Abs. 3 WRG 1959). These and the prioritization targeting the realization of the aims related to the flood risk management plans are to be outlined. This obliges the description of the prioritization and the methods according to which the progress of the implementation of the plans can be monitored and documented.

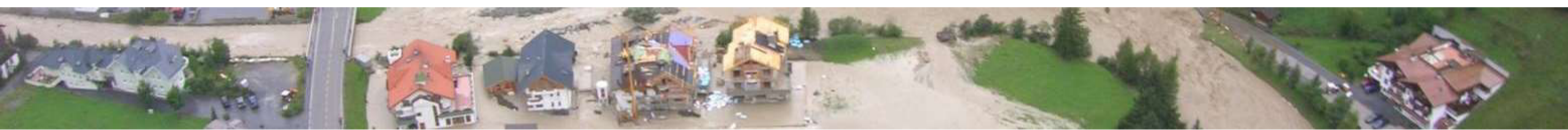
The catalogue of measures contains 22 (types of) measures related to the different fields of action related to the risk cycle: Prevention (5), Protection (8), Awareness (3), Preparedness (3) and Recovery (3). Each measure is described generally and illustrated with examples. Additionally there is a characterisation of the measures including the contribution of the measure to achieve the objectives, the assessment of the impact of the measure on risk reduction, the assignment of the impact to a field of action (risk cycle) and additional decision support for prioritisation. Examples of these measures incorporate:

- Consideration of hazard zone plans (M2)
- Restoration of retention areas (M7)
- Structural measures (planning and building) (M08)
- Edit information about Flood hazards for the public (M14)
- Create/control early-warning and forecast systems (M17)

Each measure contributes to reach on or more of the four objectives however, is related to only one field of action. All measures are characterised by the following parts:

1. Title
2. Description
3. Examples
4. Legal frame
5. Relevant divisions, work steps

Regarding the prioritisation of measures three possible ways (reporting sheets by the EC) are outlined: 1) either a timetable for implementation, 2) as a category of priority or 3) a summary text. The status of the prioritisation can be from (x) not possible to (5) periodical implementation and on



another meta level ordered by the point in time of implementation: “current cycle”, “next cycle” or “later than next cycle”.

PARTICIPATIVE PROCESS

The need for a harmonisation process for the different sectors was overcome by public participation and therefore the process indicated in Figure 4 was established. The federal blueprint is edited on the provincial level before optional workshops on either APSFR or provincial level take place. In a next step the consultation of the public starts and is followed by workshops on the level of the APSFRs including stakeholders as well as representatives of the municipalities.

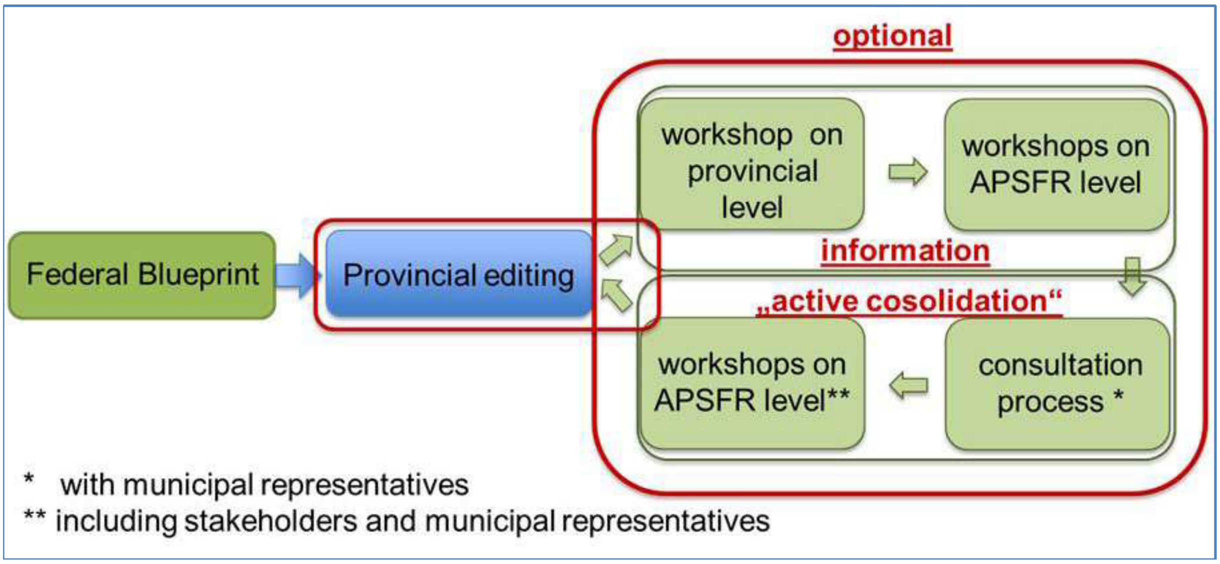


Figure 4: Public participation prior to legal obligation

STATUS QUO AND OUTLOOK

At the moment the provincial editing is conducted and in May/June 2014 two mid-term workshops are planned. The information of the public and the consultation therein will start at the end of 2014 together with the water framework directive. The kick-off is planned for January 2015 and for the first half of 2015 three to four provincial events are planned.

This text is based on:

Stiefelmeyer H., 2014, On the way to the Austrian Flood Risk Management Plan: methodology and challenges, oral presentation at PLANALP Cofererence Breaking freh ground in protecting Alpine Environments – Flood Risk Management Plans, 25 – 26 March 2014, Graz Austria

FLOOD RISK MANAGEMENT AND FLOODS DIRECTIVE (2007/60/EC) IMPLEMENTATION IN SLOVENIA

Luka Stravs

Ministry for Agriculture and the Environment

INSTEAD OF INTRODUCTION

Republic of Slovenia has suffered some substantial direct damages after larger flood events in the last 25 years:

1990: cca 580 mio EUR,
1998: cca 180 mio EUR,
2007: cca 200 mio EUR,
2009: cca 25 mio EUR,
2010: cca 190 mio EUR and
2012: cca 310 mio EUR.

Based on the fact that these values represent only direct damages we can make a quick and simple estimation that average yearly flood damages in Slovenia ammount to approx. 100 to 150 mio EUR.

FLOODS DIRECTIVE IMPLEMENTATION IN SLOVENIA

Premilinary Flood Risk Assessment (by applying Article 4 of the Floods Directive) was published on 22.12.2011 and reported to European Comission on 22.03.2012. It is publicly available Link 1 (only in Slovene language).

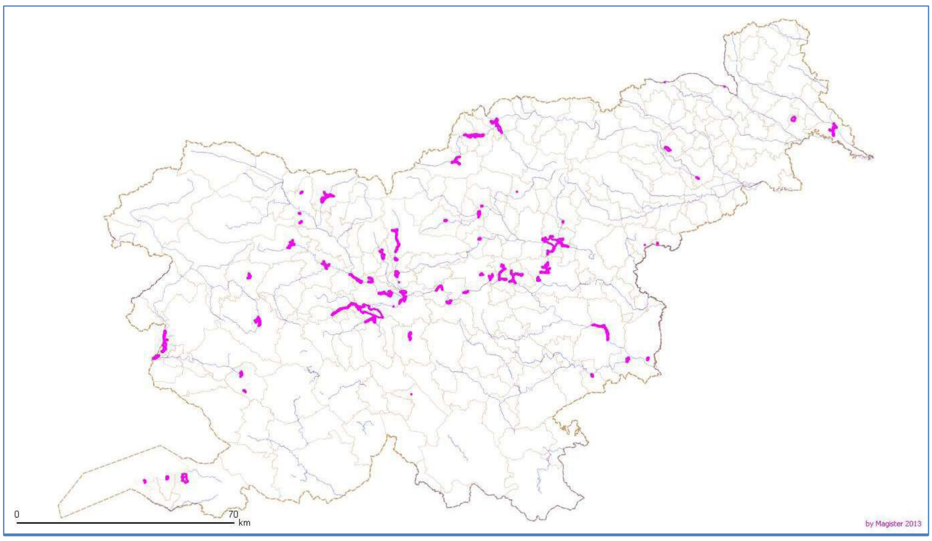
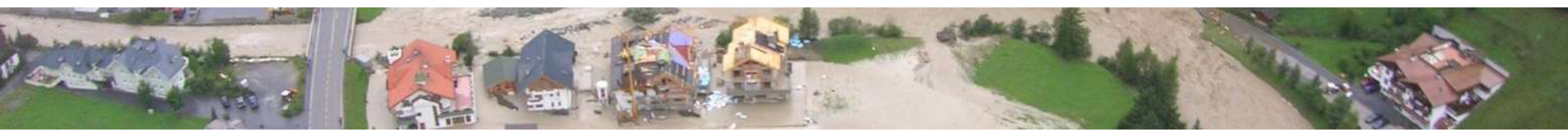


Figure 5: Map of the Slovenian APSFRs



Areas with Potential Significant Flood Risk (Article 5 of the Floods Directive) were identified on 14.02.2013 and reported to European Commission on 21.03.2013. Map of all 61 Slovenian APSFRs is published and available at Link 2.

It is estimated that approximately 600 mio EUR would have to be invested into reduction of the flood risks at these 61 areas of potential significant flood risk. 600 mio EUR of needed investments include both structural and non-structural flood protection measures.

Flood Hazard and Flood Risk Maps for most of the Slovenian APSFRs are done and can be viewed and accessed by browsing through the following table/framework (links to the 10-year, 100-year and 500-year flood scenario hazard maps and links to the flood risk maps are available on the right side of the table) (see Link 3).

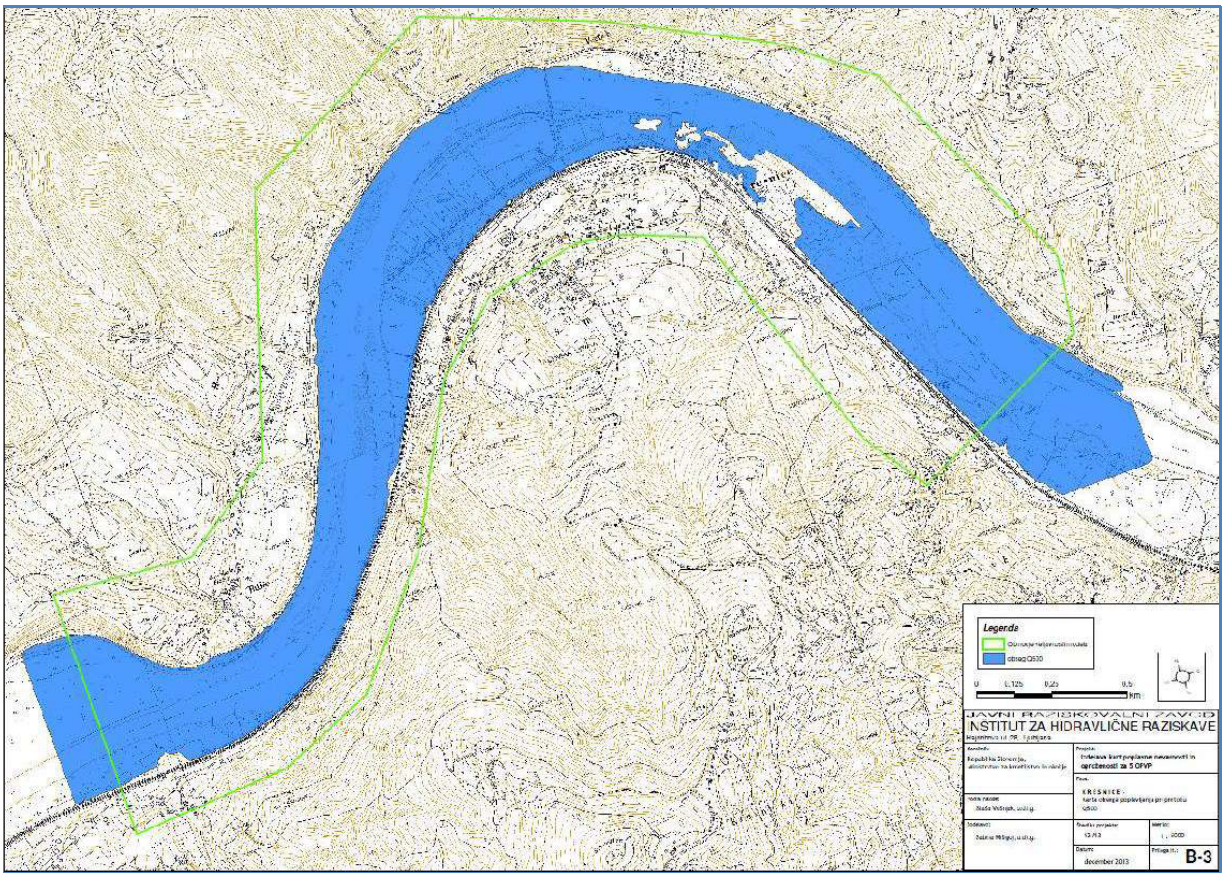


Figure 6: An example of flood hazard map (500-year flood scenario for the Kresnice APSFR)

At the moment Slovenia is intensively working on preparation of the Slovenian Flood Risk Management Plan. Slovenian FRMP will consist of 17 smaller river basin FRMPs, which cover all of the identified 61 APSFRs.

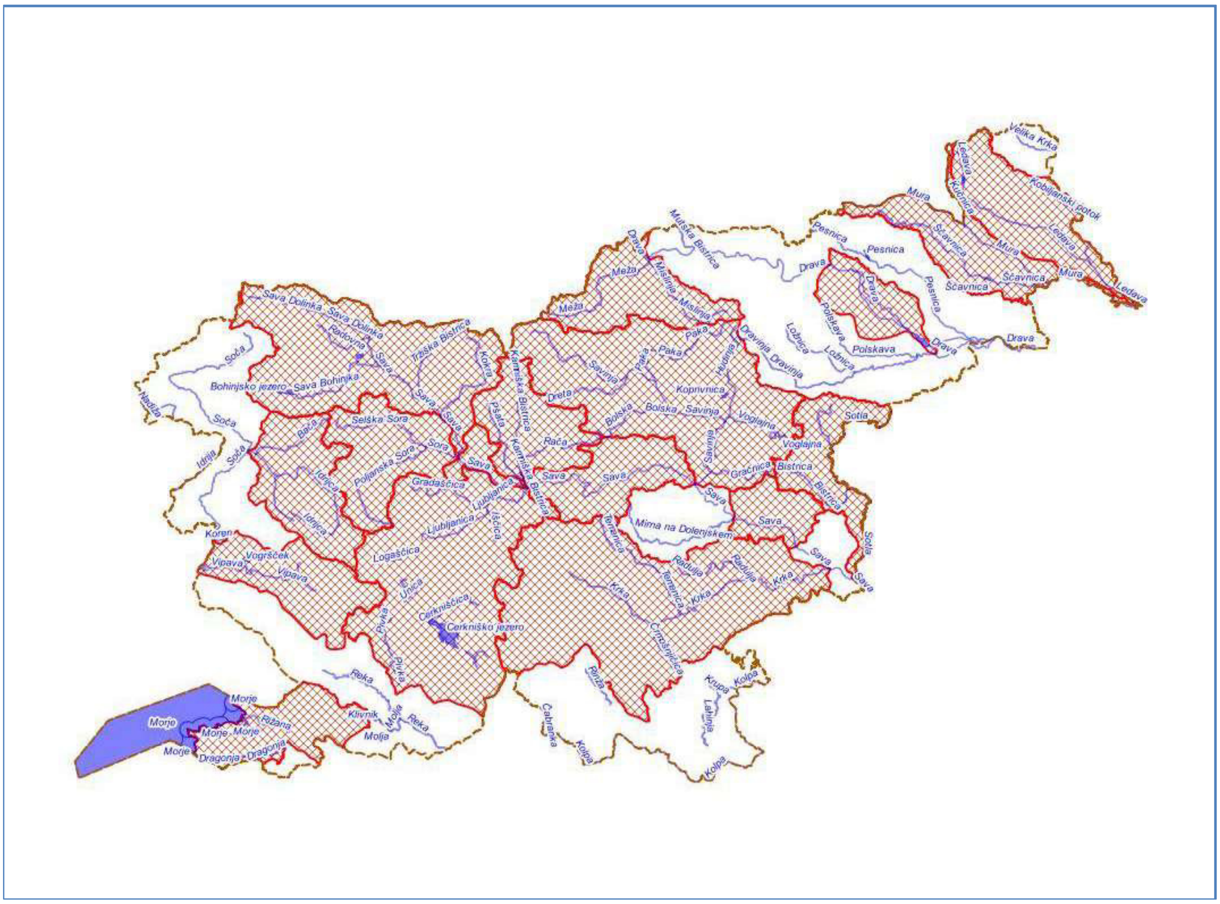


Figure 7: A map of 17 Slovenian river basins with APSFRs.

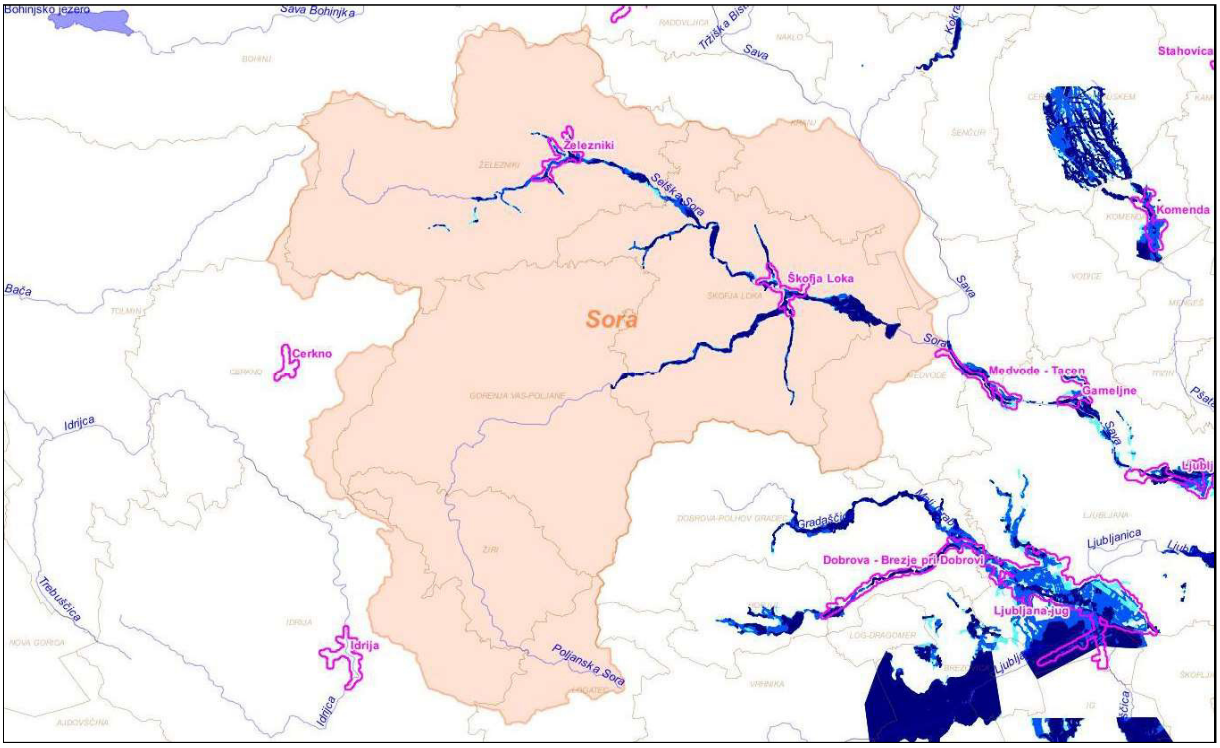


Figure 8: A map of the Sora River Basin with two identified APSFRs (Zelezniki and Skofja Loka).

Always updated additional information regarding the Floods Directive implementation in Slovenia can be found here:

http://www.mko.gov.si/si/delovna_podrocja/voda/poplavna_direktiva/

All relevant flood-related interactive maps (APSFRs, flood hazard maps, past flood events, etc.) can always be viewed at the homepage of Environmental Agency of Republic of Slovenia:

http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso

LINKS

Link 1:
http://www.mko.gov.si/fileadmin/mko.gov.si/pageuploads/podrocja/voda/predhodna_ocena_poplavne_ogrozenosti.pdf

Link 2:
http://www.mko.gov.si/fileadmin/mko.gov.si/pageuploads/podrocja/voda/karta_obmocij_OPVP.pdf

Link 3: http://www.mko.gov.si/fileadmin/mko.gov.si/pageuploads/podrocja/voda/opvp/OPOPO.xls

METHOD, IMPLEMENTATION AND CHALLENGES - ITALY

Riccardo Rigon[1], Matteo Dall'Amico[2], Antonio Ziantoni[3]

1) Dept. Of Civil, Environmental andMechanical Engineering, University of Trento (Italy)
2) Mountain-eering GmbH, Siemenstr. 19 Bozen (Italy)
3) Autorità di bacino dell'Adige, Autorità di Bacino del fiume Adige, Piazza Vittoria 5, Trento (Italy)

INTRODUCTION

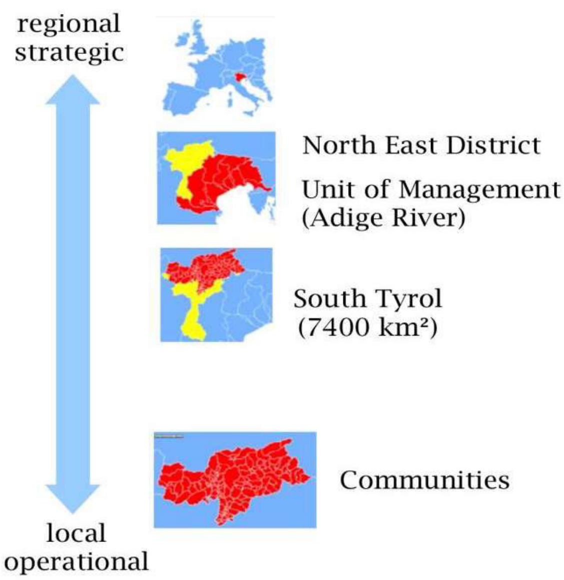


Figure 9: From regional to local level.

The 2007/60/EC Directive (art. 7) prescribes the production of the flood risk management plan (FRMP) coordinated at the level of the river basin district. The production of the FRMP and the successive updated is encouraged to be realized through the involvement of the public (art. 9 and 10).

In Italy the jurisdiction on the planning phase of water management has been assigned to 8 River Districts (Decree 49/2010 and 152/2006), interregional administrations competent on one or more river basins. In the italian Alps, two river districts are present: the Po river district, corresponding to the whole territory of Piedmont, Aosta Valley, Lombardy, Emilia Romagna and part of Trentino and Veneto; the Easter Alps district that comprehends multiple river basins like Adige/Etsch, Piave, Tagliamento etc. and includes the territory of Alto Adige-Süd Tirol, part of Trentino, Veneto and Friuli Venezia Giulia. The jurisdiction on water management during the emergency has been left to the single Regions. This fragmentation in multiple decision levels requires a high coordination between the various levels of planning (national and regional to set the strategic targets) and local level (communities) to set the operational procedures (Figure 9).

HAZARD AND RISK MAPS

Before the emission of the 2007/60/EC Directive, in Italy the hydro-geological risk management was handled through the "Hydro-geological Arrangement Plans" (*Piani per l'Assetto Idrogeologico*: PAI), introduced by the Law 267/1998. These plans, produced by 41 Rive Basin Authorities, were aimed at localize and delimitate the areas prone to flood, landslides and snow avalanches according to multiple probability scenarios, and to determine the necessary mitigating actions (both planning and structural measures).

The risk was calculated according a pre-defined classification, considering the exposition and the vulnerability. However, the risk classification was not shared among the different Districts, creating heterogeneity in the number of classes and in the interpretation of the risk. As far as the vulnerability is concerned, the most used methodology was to assume a value equal to 1 for all the "exposed"

elements, however, in some basins, different approaches lead to calculate the vulnerability as a function of the exposure and the number of inhabitants.
The transposition of the 2007/60/EC Directive has created the necessity to homogenize of the various methodology in order to produce a national standard for the representation of the hazard and risk maps, in particular the agreement on standards to calculate the vulnerability and then to assess the risk. In particular, the Decree of transposition in the Italian law (Decree n. 49 dated 23 February 2010) states that the hazard maps must be calculated according to three probability scenarios (low, medium and high probability) and for each scenario the phenomenon intensity must specify the extension, water height ad velocity. Furthermore, it states that the risk maps must indicate the potential negative consequences of a flood event, according to 4 classes: 1) number of inhabitants; 2) presence of strategic infrastructures e.g. highways, hospitals, schools, etc.; 3) presence of cultural heritage; 4) presence of industrial plants that could cause pollution in case of flooding; 5) areas subject to debris flow or solid transport or to pollution risk.
The hazard and risk maps have been completed and the information is available on the internet sites of the River Districts.

PLANNING PHASE

Numerous initiatives are present for mountain basin management plans.
For example in South Tyrol four mountain basin management plans and five river area management plans have been undertaken (see Figure 10), with a plan structure that includes information, public involvement and engagement. So far, the key lessons learned in this process are:
1) the organization structure of the working practice needs to be "institutionalized" and include a watershed manager with "leadership";
2) the river management plan require a careful planning of the implementation phase, where the catalogue of measures should be not too general and not too detailed, leaving space to a consensus-based decision making process, and then a regular monitoring of implementation;

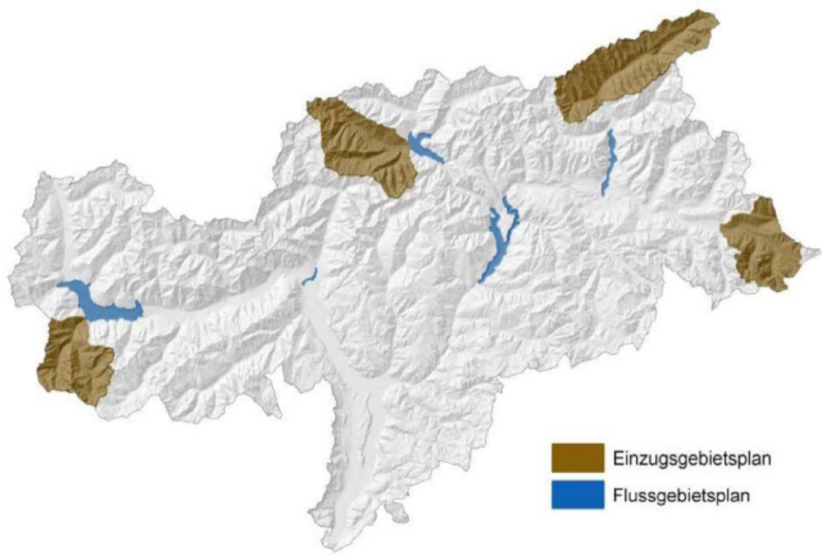


Figure 10 River and basin management plan in South Tyrol

3) the public participation process requires continuity, information exchange and transparency, the adaptation of technical language to the demands of the involved stakeholders and a careful planning of public participation according to the 5 W (where, who, when, what, how).
Among other experiences, it is worth to mention, the Eastern Alps district, inside the framework of the FP7 financed project KULTURisk, has participated in an experimental laboratory on communication of the hydraulic risk in the international basin of the Vipacco river (Italy, Slovenia).
The risk communication has been faced according to the following phases:
1. hazard and risk mapping: with the objective of deriving the most appropriate accuracy and representation modality of the information, together with the best communication channels.

2. Structural mitigation interventions: the objective was to understand the criteria used by the auditory to evaluate the intervention. It emerges that the stakeholder are most interested in "how" and "where" the structure is posed rather that on the type ("what") of the structure.

3. Non-structural mitigation interventions: it is crucial that the information is provided by the technical representatives coming from the local territory with a high reputation. Furthermore, the information should stress the "security conditions" rather that the "hazard conditions"

The methodology developed by the project can be found with details in the project's website (http://www.kulturisk.eu/), and constitutes the basis of the application of the FD in the North-East district as a whole.

All other institutions are equipped with similar procedures, and tables are ongoing to arrived to homogeneous and common solutions along the whole Italian Alpine Arc.

EMERGENCY PHASE

During the emergency phase, it is necessary to be endowed with a decision support system that allows to monitor the phenomenon and to predict future evolution system, in order to take decision for the civil protection. In this context the new research available in hydrology, meteorology and hydraulics science play a crucial role. Among the Institutions above mentioned, models are available that, given the meteorological predictions, the current discharge measures in rivers and dam water levels, allow to estimate the future evolution of the flood in the main rivers, given the appropriate meteorological inputs.

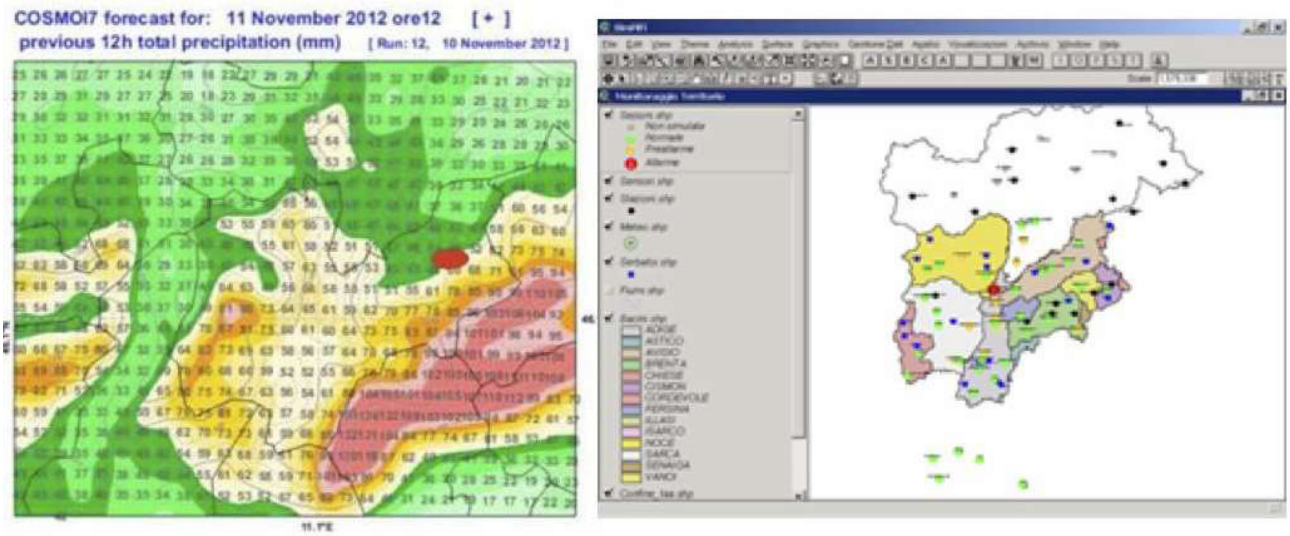


Figure 11: Example of precipitation forecast for the flood emergency plan in Trentino

To give an example, the administration of PAT in this context is now operative with a H24 special personnel availability for the flood service. In real time are available the data on the precipitation and on the water level in the dams (see Figure 11) and, in case the prediction given by the hydraulic-hydrologic-meteorological modeling suggest the necessity of dam regulation and/or civil protection measures, the procedure foresees to activate the regulations and a warning message is given to the various Civil Protection Units of the surrounding regions and river authorities. These models served for instance to successfully act during the recent emergencies of 2010 and 2012.

Ongoing activities in the framework of the Alpine Convention

At the moment the Autonomous Province of Trento is organizing a workshop oriented at outlining the problems in complying with the Directives 2007/60/EC and 2000/60/EC, inviting all the partners of the various Regions in the Italian Alps. The objectives are: 1) to outline common experience in combining both human life defense (2007/60/EC) and the maintenance of a good ecological status (2000/60/EC) in mountain rivers (objectives that, sometimes, appear conflictual); 2) to find indicators for the evaluations of the morphological modification of alpine streams better tuned to mountain context, that for example, accounts not only for the number of cross-profile constructions (dikes and weirs) but also for the type and the dimension of the installations (e.g. slit dam allows the fishes to pass whereas a high weir does not).

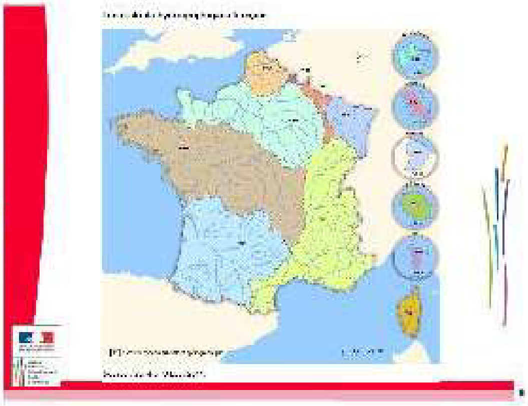
Acknowledgments
We would like to thank dott. Pierpaolo Macconi, ing. Roberto Bertoldi, the Adige River Authority and the Autonomous Provinces of Trento and Bolzano for the supporting material.

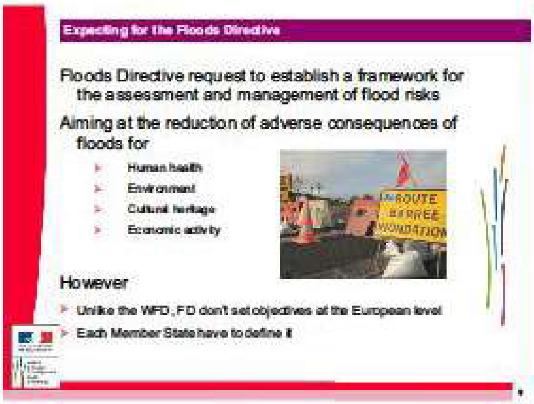
METHOD, IMPLEMENTATION AND CHALLENGES – FRANCE

Jean-Michel Helmer & Marie-Pierre Meganck

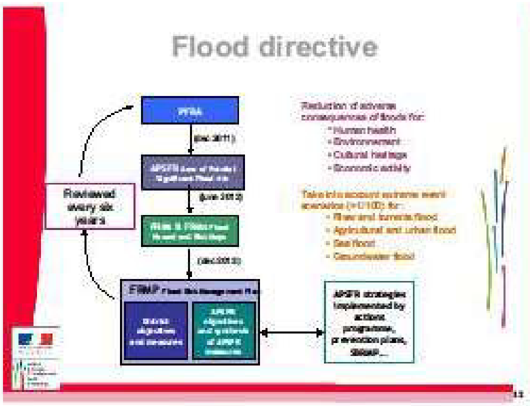
French Ministry of Ecology, Sustainable Development and Energy

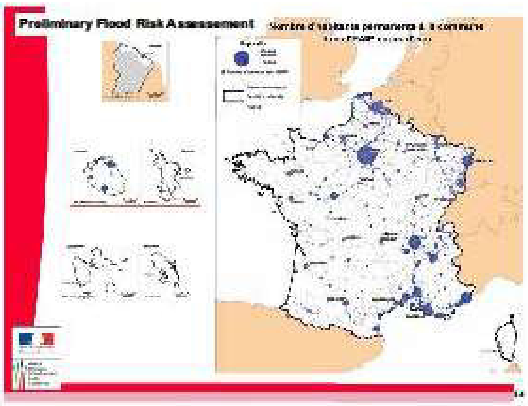

Groundwater floods

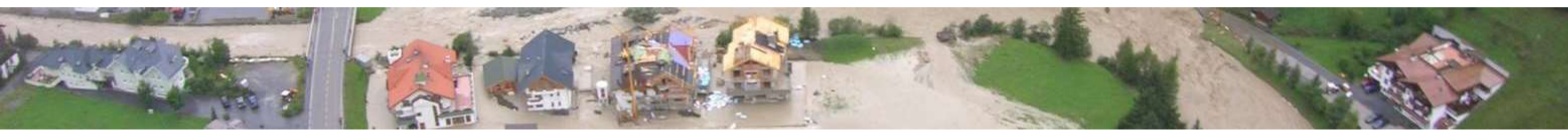


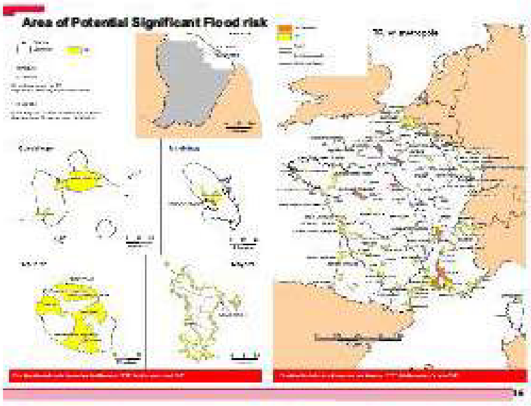

Expecting for the Floods Directive
Floods Directive request to establish a framework for the assessment and management of flood risks
Aiming at the reduction of adverse consequences of floods for
Human health
Environment
Cultural heritage
Economic activity
ROUTE BARREE INONDATION
However
Unlike the WFD, FD don't set objectives at the European level
Each Member State have to define it

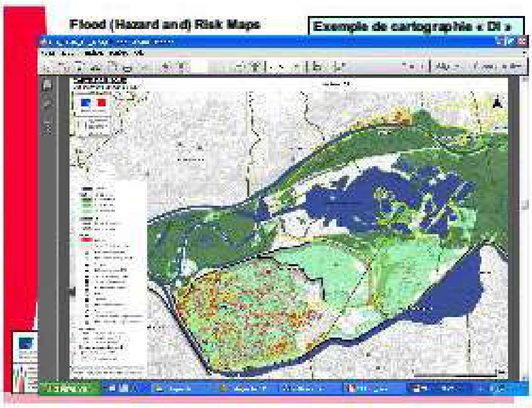

French background
Since 1807 (draining of swamps) and 1856
First mapping with the law of 1935 with the plans of submersible surfaces
Cat Nat and Risk law in 1982
Water laws in 1964 and 1992
Risks law in 1995


Flood directive
PFRA
Reviewed every six years
FRMP
APSFR strategies implemented by actions programme, prevention plans, SMAP...
Reduction of adverse consequences of floods for:
Human health
Environment
Cultural heritage
Economic activity
Take into account extreme event scenarios (>1/1000) for:
River and torrents flood
Agricultural and urban flood
Sea flood
Groundwater flood


Preliminary Flood Risk Assessment




Area of Potential Significant Flood risk

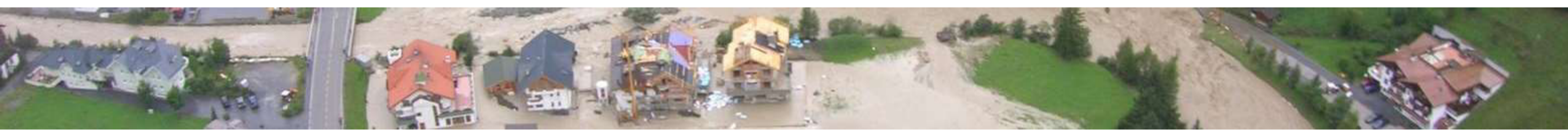

Flood (Hazard and) Risk Maps
Exemple de cartographie « DI »


National strategy
National frame for all flood management
Mobilisation of everybody on identified priorities
Planification of public budget on prior and more efficient actions
2 main principles :
Principle of subsidiarity
Collaboration between all public policies


National strategy
The French national strategy for flood risk management set out 3 key objectives (20-30 years)
Increase the safety of people exposed to flood
Stabilize at short term, reducing at the middle term, the cost of damages
Improve resilience territories

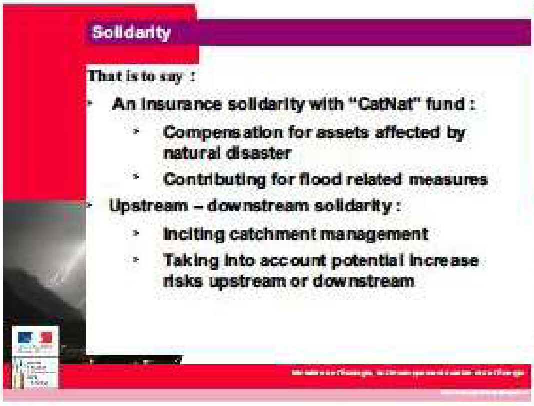

Increase the safety of people exposed to flood
That is to say implementing measures of :
Preparedness :
Developing flood forecasting and warning
Ensuring the safety of people
Public awareness and preparedness
Prevention :
Preserving natural floodplains, wetlands and dune ridges
Prohibiting construction for unsafe flood-prone areas
Limiting setup of sensitive facilities for crisis management issues
Reducing vulnerability on flood-prone areas
Prohibiting construction behind dykes
Protection :
Imposing sustainable management and maintenance for protective works against floods (dykes and dams)
Facilitating procedures for emergency works (with safety issues for people)


Control the cost of damages
That is to say implementing measures of :
Protection reducing the cost of damages for floods with a high probability
Streamlining efficiency investments for building works (cost-benefit analysis)
Encouraging catchment management, water flow regulation, coastal and floodplain works
Prevention stabilizing cost of damages for floods with a medium probability
Reducing vulnerability on flood-prone areas
Regulating land use on flood-prone areas

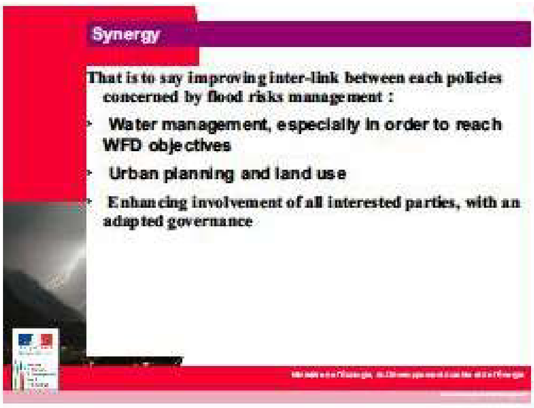


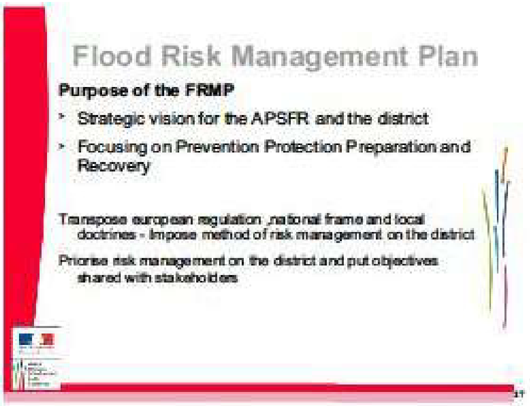

Improve resilience territories
That is to say, when floods are unavoidable, implementing measures of :
Preparedness :
Performing operational tool of crisis management for each decision level
Improving interlink with each decision levels
Enhancing knowledge of territorial vulnerability
Sharing knowledge with stakeholders
Recovery and Review :
Clean up, restoration activities and quick reboot after damages,..
Lessons learns from events

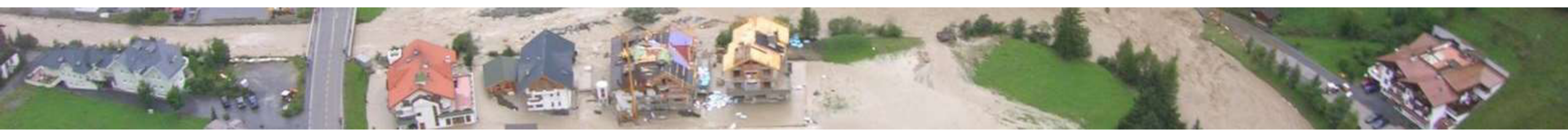

Main pillars for French policy in flood risks management
Solidarity
Subsidiarity
Synergy

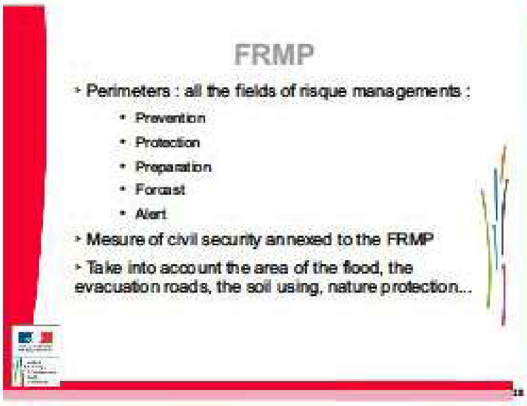

Solidarity
That is to say :
An insurance solidarity with "CatNat" fund :
Compensation for assets affected by natural disaster
Contributing for flood related measures
Upstream – downstream solidarity :
Inciting catchment management
Taking into account potential increase risks upstream or downstream


Subsidiarity
French State :
Police power
Crisis management
Public awareness
Regulation of land use concerning flood-prone areas
Forecasting flood events on main rivers and shoreline
Mobilization of "CatNat" Fund
Mayors at communal level :
Police power at communal level
Crisis management
Public awareness
Inter-municipal authorities :
Water and flood risks management
It could be transferred at relevant catchment level

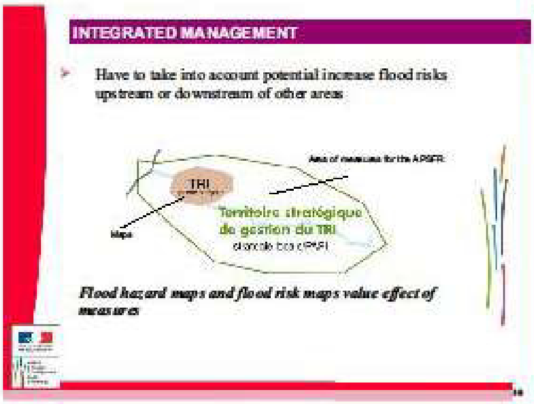

Synergy
That is to say improving inter-link between each policies concerned by flood risks management :
Water management, especially in order to reach WFD objectives
Urban planning and land use
Enhancing involvement of all interested parties, with an adapted governance


Flood Risk Management Plan
Purpose of the FRMP
Strategic vision for the APSFR and the district
Focusing on Prevention Protection Preparation and Recovery
Transpose european regulation ,national frame and local doctrines - Impose method of risk management on the district
Priorise risk management on the district and put objectives shared with stakeholders

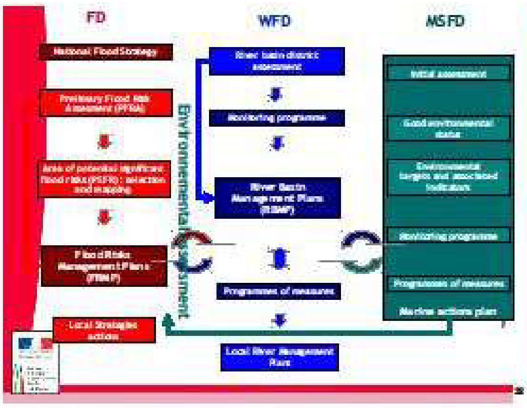



FRMP
Perimeters : all the fields of risque managements :
Prevention
Protection
Preparation
Forcast
Alert
Mesure of civil security annexed to the FRMP
Take into account the area of the flood, the evacuation roads, the soil using, nature protection…


FRMP and APSFR strategies
Purpose of the FRMP=to implement the priorities of the national strategy, to prioritize measures, to allocate public budget on efficient and urgent actions
FRMP=strategic vision for the APSFR and the district:
Impose method of risk management on the district
Prioritize flood management on the APSFR and put objectives shared with stakeholders (20-30 years)
Clarify and decline national frame and local doctrines


INTEGRATED MANAGEMENT
Have to take into account potential increase flood risks upstream or downstream of other areas
Area of measures for the APSFR
TRI
Territoire stratégique de gestion du TRI
Maps
Flood hazard maps and flood risk maps value effect of measures


Compatibility
FRMP have to be compatible with :
Objectives of quality and quantity of the RBMP
Environmental objectives of the Marine strategies
FRMP and APSFR strategies included opposable to administration and its decisions :
Urban planning programmes and tools
Programmes and administratives decisions on the water field and prevention flood plan


FD
WFD
MSFD
National Flood Strategy
Preliminary Flood Risk Assessment (PFRA)
Area of potential significant flood risks (PSFR) : selection and mapping
Flood Risks Management Plans (FRMP)
Local Strategies action
Environmental assessment
River basin district assessment
Monitoring programme
River Basin Management Plans (RBMP)
Programmes of measures
Local River Management Plans
Initial assessment
Good environmental status
Environmental targets and associated indicators
Monitoring programme
Programmes of measures
Marine actions plan


Thank's for your attention !

TORRENTIAL FLOOD RISK MANAGEMENT IN BAVARIA

Andreas Rimböck

Bavarian Environment Agency

INTRODUCTION

This paper gives some insight to the situation of torrential flood risk management in Bavaria. It focuses on the current state concerning the EU flood directive and the planned procedures for the future. It is to say, that risk management as an integrated approach to reduce the damage by natural hazards has a long tradition especially in torrential catchments. Due to the interactions between vegetation, land use, sediment balance, water balance and far more, torrent control ever since tried to reach integrated solutions, regarding protection forests, biological measures, technical measures and so on. Of course these strategies can be improved and especially the coordination between all involved parties is a steady challenge.

LEGAL AND ORGANIZATIONAL FRAMEWORK FOR TORRENT CONTROL

All measures in torrent control are based on the concerned legal and organizational boundary conditions. Therefore this framework has to be introduced in the beginning.
The responsibility for water resources management in Germany mainly lies by the federal states. The Republic of Germany only gives some boundary rules. Torrent control is regulated by the Bavarian Water Law, where also the duties for construction and maintenance are addressed. These are:

- large rivers (1st and 2nd order rivers): free state of Bavaria
- small watercourses (3rd order): the municipalities
- torrents (special 3rd order water bodies with torrential characteristics): Free state of Bavaria for construction and maintenance of the developed sections; municipalities for the maintenance of the natural sections.

The torrents are defined in a special regulation, which names 13.300 km of torrents within 7.700 km² catchment areas. About 1.500 km of these watercourses are modified with the target of flood control. Due to the topographic situation the torrents are concentrated in the southern, eastern and northern edge of Bavaria within the Alps and the uplands (comp. Figure 12).

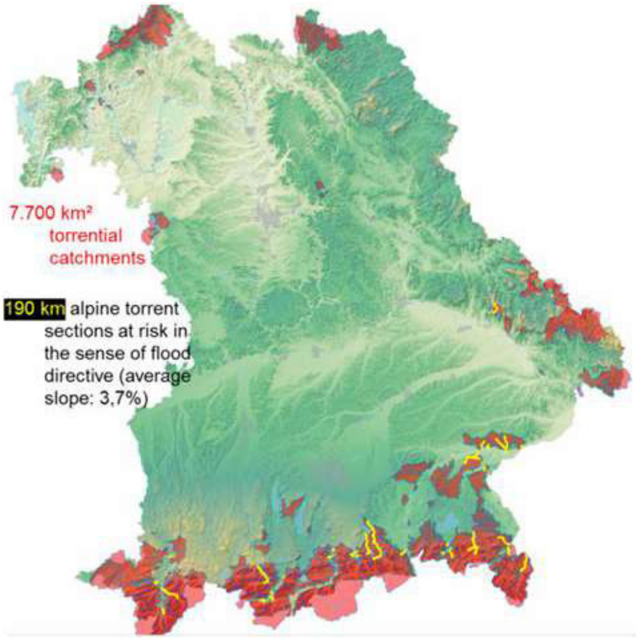


Figure 12: torrential catchments in Bavaria

The Water law demands the identification of torrential hazard zones, but without a deadline. They then have to be legally determined with the consequence that building is forbidden in these zones. Exceptions of this restriction have to fulfil severe criteria. In Bavarian law it is not foreseen to differentiate into zones with total building prohibition and zones where there have to be considered special constraints, like in Austria or Switzerland.

Torrents within the EU flood directive

Preliminary risk assessment

The preliminary risk assessment was made in the same way for all Bavarian watercourses (comp. Figure 13). First of all the potentially flood prone areas were identified. Therefore, the soil mapping and the mapping of the alluvial fans were used. Within the soil mapping all those soils, which come up in fluvial influenced areas were chosen. Then in these areas along the watercourses the subjects of protection (human health, environment, cultural heritage and economic activity) were identified. In the next step the belonging sections of the water course were cut by projection of the protection zones to the watercourse and defined as “possible risk”.

After that the length of the watercourse at risk was summed up, beginning at the mouth going upwards to the last section “possible risk”. If this length was more than 66% of the total length, the whole section of the watercourse was named as potentially at risk in the sense of flood directive.

The results of this procedure are only 190 km of torrential sections “potentially at risk”, close to the mouth of these torrents into the receiving water courses. In average they only have a slope of 3,7% and therefore are not the typical steep torrents.

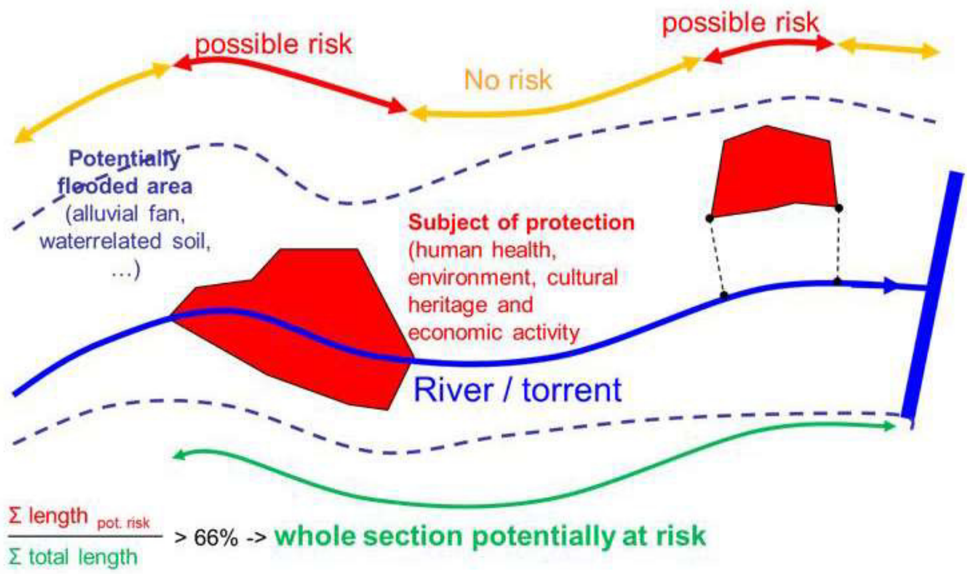


Figure 13: preliminary risk assessment for torrents in Bavaria

Procedure for hazard mapping

In Bavaria, the following scenarios are regarded within the calculations for the flood directive:

- Frequent flood: (5), 10, (20) years return period (whereas those in brackets are just a working basis, but not reported to the EU)

- Medium flood: 100 years return period
- Extreme flood: 1,5 * medium flood

For hazard mapping the Bavarian climate factor (15% surcharge to 100 years flood for new protection structures) is not considered, as the hazard maps have to be actualized, when new knowledge is available.
Due to time restrictions and necessary simplifications the few torrents were mainly handled in the same way as the large watercourses. Only in single cases, special torrential rainfall-runoff models were used to assess the discharge. The hydraulic calculation (2-dimensional) did not concern blockage scenarios. Debris flows do not occur in the treated torrent sections and bedload was regarded in form of an "all-inclusive" addition to the clearwater discharge.

PROCEDURE FOR RISK MANAGEMENT PLANS

It is foreseen, that the risk management plans will be worked out in a combination of a top down and bottom up approach (comp. Figure 14). For whole Bavaria there will be three flood risk management plans, one for the Main, one for the Danube river basin and one for the Lake Constance. Torrent specific topics can be regarded at a local level, due to necessary summary and aggregation they won´t be mentioned in the general management plans.

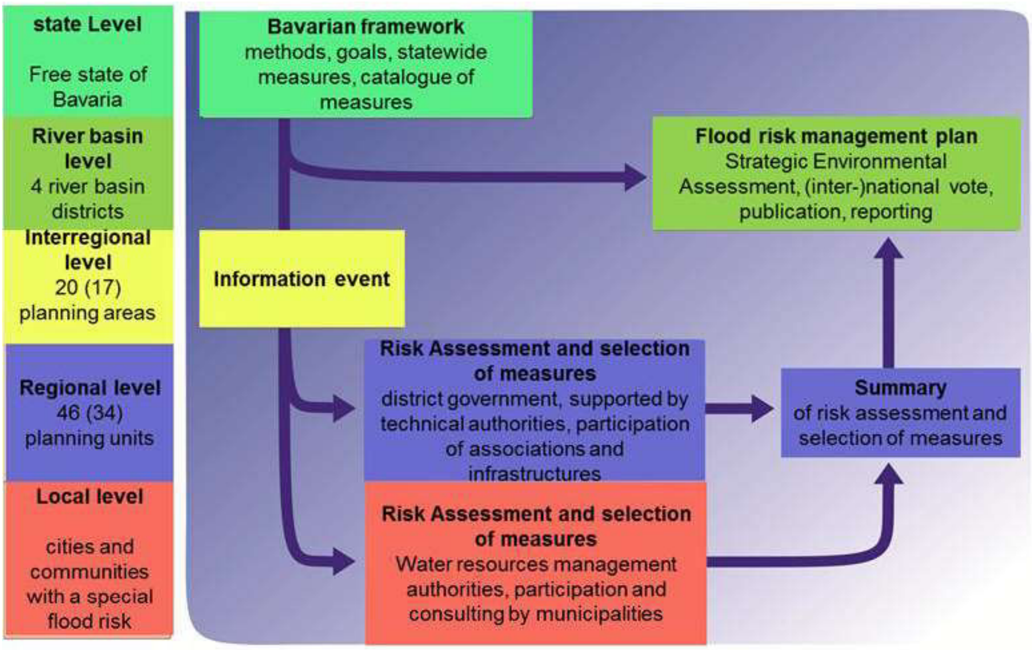
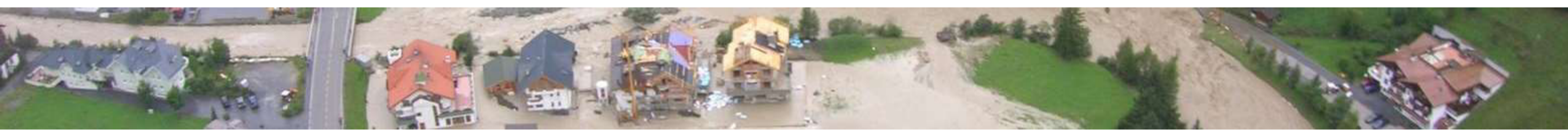


Figure 14: procedure for elaboration of risk management plans in Bavaria

THE FUTURE OF TORRENTIAL HAZARD MAPPING

Since that time the need for torrential hazard mapping was introduced by law the priority was to fulfil the EU flood directive. But for the future also the other torrents have to be assessed step by step.
Due to the strong consequences of the torrential hazard zones there is a high demand on exact data, modern and proved calculation procedure and comparability of the results. For the extensive mapping within the Bavarian torrents a standardized procedure is planned. It should fulfil the demands, balance the effort with the quality of results and also build on the experience of the flood directive and of our alpine neighbors. Therefore a technical concept will be worked out, which is



based for example on the results of the working group OptiMeth of the research organization Interpraevent (comp. Rimböck et al 2013).
Target is, to just give torrent specific amendments to the already existing procedure in the large watercourses, to have as much accordance as possible and as much differentiation as necessary.

FURTHER ASPECTS OF TORRENTIAL FLOOD RISK MANAGEMENT IN BAVARIA

Keeping up the existing protection level, based on more than 50.000 existing structures, will be a great challenge for the future. It has to be considered, that many of the existing structures are up to 100 years old and theses challenges come together with major changes of the boundary conditions for torrent control. So our existing protection systems aroused over long time, in which the general framework changed significantly. Therefore in many cases the parts of our systems do not fit together in the best manner.
To handle these protection systems and to optimize them step by step, we want to work out integrated torrential development concepts (comp. Rimböck et al 2012). They should fulfil the following targets:

- gain flexible and adaptable concepts to face past and future changes in boundary conditions
- optimize the existing protection systems in terms of maintenance effort, financial and personal efforts, residual risk, sustainability and so on
- long term consideration

Our vision is to reach the optimum situation step by step and being able to adjust the concept to new developments. The hazard analysis will be essential basis for this work and all the procedure, both for hazard mapping and for elaboration of the development concepts. All the technical basis and description will be written down in a “loose-leave-collection torrents”, where single chapters easily can be adopted and updated.

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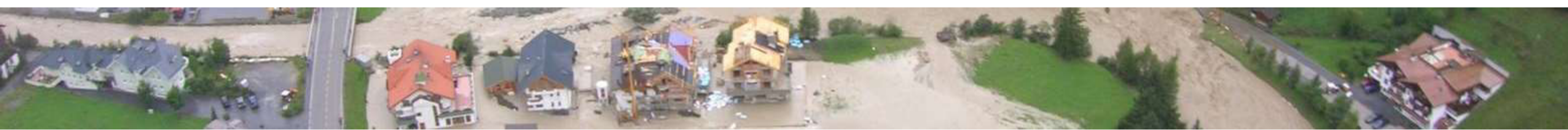


FLOOD RISK MANAGEMENT IN SWITZERLAND

Olivier Overney

Swiss Federal Office for the Environment

Reference: N144-1678

Switzerland has a long history and experience in dealing with natural hazards. However, only in 1987 in the aftermath of major floods, it became clear that structural measures alone are not sufficient to guarantee protection. Since then spatial planning (master planning and land-use planning) has obtained far greater priority in the context of sustainable and hazard-conscious land use. The idea that sufficient space must be given to watercourses also became accepted.

Recent events also showed that damage could be significantly reduced with the help of modern protection concepts: robustly designed protection structures that are conceived to cope with excess loads are the key factors for successful prevention. Moreover, the damage caused by floods can be reduced by around one fifth if the authorities issue timely warnings and alerts and people takes suitable measures to protect their lives and property as part of their own individual responsibility.

Switzerland's approach on integrated flood management is based on three basic steps and two continuous processes:

- Evaluation of the hazards
- Steering the risks through management measures
- Recording events in order to learn from the past
- Continuous monitoring of the risks on both hazard and vulnerability aspect

An integrated and holistic risk management assumes that all types of measures for natural disaster reduction are considered. Generally, measures of preparedness, response and recovery (reconstruction) are equally applied. Planning flood protection works needs to integrate both ecological and security aspects. All measures must complain with sustainability and must provide a good cost-benefit relation.

Integrated flood risk management deals, on one side, with the natural hazard processes and, on the other side, with damages and risks. Sound scientific knowledge in hydrology and hydraulic are fundamental to evaluate correctly flood hazards. Access to information of land use planning and to insurance data is also necessary for the evaluation of vulnerability and resilience. Only with sufficient appropriate data, flood risk management will achieve an optimal use of all chances to influence hazards and risks

As Switzerland is a federal state, the institutional implementation of flood risk management is based on the delegation of competence at different levels. Subsidiarity play an important role as a principle of delegation: the federal state defines the strategy and the legislative framework, the cantons and the municipalities implement the strategy through land use planning, as well as maintenance and construction of flood protection works. The federal state support hazard mapping and flood protection measures through financial subsidies.

Property owners and insurances play an important role, as they have to bear residual risks through flood proofing or compensation.

In 2011 the Federal Office for the Environment has defined 6 priorities for action in a strategy paper on "living with natural hazards":

1. Comprehensive knowledge of hazards and risks
2. Increased awareness of natural hazards
3. Holistic planning of measures
4. Protective structures designed to accommodate excess loads
5. Emergency preparedness
6. Timely identification of hazard events
7.

Three of these 6 priorities for action will be illustrated with the example of the most important actual flood protection project in Switzerland, the third correction of the Rhone River. On its 180 km length from the Rhone glacier to the lake of Geneva, the flood protection works of the Rhone cannot give a protection against the 100-year flood. Like many other flood protection works in Switzerland, peak flow values of the Rhone River have been revised in the last 20 years to take into account higher potential damages, recent extreme flood events and statistic uncertainties. Hydraulic capacities that were designed at the beginning of the 20th century are not sufficient to ensure contemporary safety standards.

1st Priority for action: Comprehensive knowledge of hazards and risks

Central to the integrated flood risk management cycle are hazard and risk assessments. A society can only deal sensibly with natural hazards if it has an in-depth knowledge of the hazards, assesses them objectively, takes preventive measures and reacts quickly and correctly in the case of an emergency. Therefore, hazard fundamentals (incl. event analysis to support economic viability for resilience building) are of primary importance for effective and efficient flood risk management.

Hazard assessment is relevant to determine the magnitude and frequency of environmental processes in affected areas, taking into account already existing protective structures. The result of the hazard assessment is represented in a hazard map. The results of assessments and simulations are compared with the records of previous natural hazard triggered disasters.

Whether due to dam break or hydraulic capacity topping, 12'000 hectares of the cantons of Valais and Vaud are endangered by inundation from the Rhone River. These surfaces are mainly agricultural areas (60%), as agriculture is the dominant land in the plain valley. Inhabited areas, where the potential damages are much higher, represent nevertheless 30% of the potentially inundated area. Total potential damages are estimated up to 10 billion Swiss francs (8 billion €). Hazard maps, based on detailed 2D hydraulic modelling, show that dam break scenarios lead to very high intensity in terms of flow velocity or inundation depth on more than 40% of the surfaces at risk.

The hazard map of the Rhone River in the section of Visp (Figure 15) shows high intensity of both dynamic and static flooding (red zone with more than 2m water depth). The endangered area includes an industrial site with chemical plants. The necessity for action is widely accepted. A priority measure for flood protection has been decided at the regional level and is under construction.

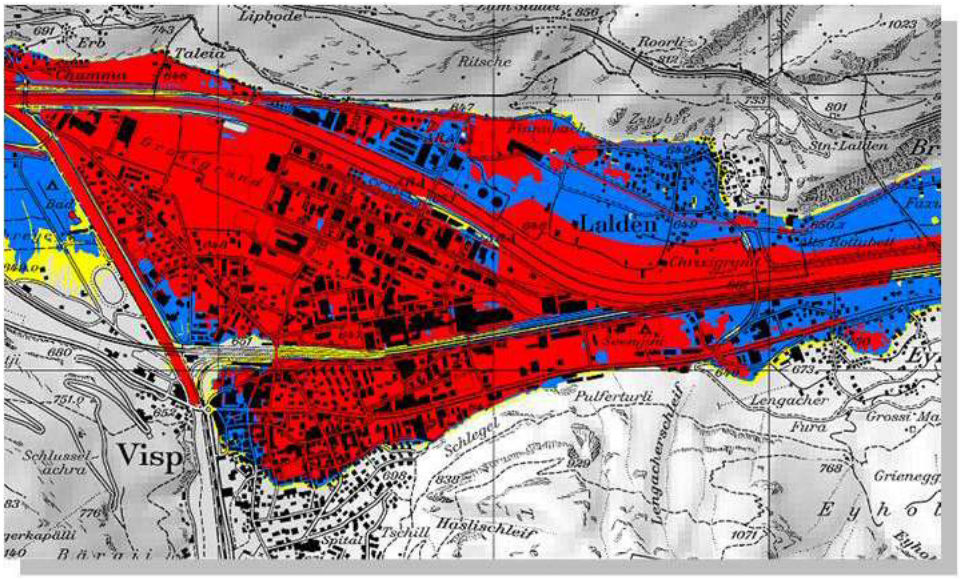


Figure 15: Flood map of the Rhone River in Visp

3[RD] PRIORITY FOR ACTION: HOLISTIC PLANNING OF MEASURES

Switzerland has developed an integrated and holistic flood risk management approach in order to achieve a level of safety that is ecologically acceptable, economically viable and socially acceptable. The principle of flood risk management is the optimal combination of structural, biological, land-use planning and preparedness measures along with insurance protection. Whereas comprehensive hazard fundamentals are central to the approach and preparedness, response and recovery are the main complementary parts.

In the phase before an incident, measures of prevention and mitigation and measures to cope with an incident (preparedness) are taken. Prevention pays out. Investment in flood risk reduction protects lives and livelihoods, public assets and private property. It pays off on a major scale through minimizing the vulnerability of people and material assets to natural hazards. On the one hand damage is primarily avoided by an appropriate land-use planning based on hazard and risk mapping. Where it is not possible to avoid hazards structurally, technical measures (dikes, dams, etc.) or biological measures (silvicultural and eco-engineering measures) have to be taken, which are supposed to minimize the intensity of the hazard. On the other hand damage is avoided by managing and coping with the disaster. Preparedness measures are provisions for emergency situations that can occur and must be managed. Examples of such organizational measures are the implementation of warning systems, emergency intervention and rescue planning, training and public simulation exercises or insurance purchasing for house owners etc.

Because of insufficient hydraulic capacity and high risk of dyke failure, the profile of the Rhone River must be entirely new designed. The main constraint is not to enhance the dyke height and therefore the water level during flood event.

The riverbanks should be large, not steep, so that protective works against side erosion are simple, robust and adaptive. A riparian vegetation can grow on these banks and contribute to the bank stability and to the biodiversity. All in all the Rhone River bed should be widen for 60%, which implies an augmentation of the river corridor of 870 hectares for an actual surface of 1380 ha.

The redesign of the river through systematic dam elevation was dismissed. A hydraulic analysis has shown that dam elevation was not a robust solution because the water level would rise higher during extreme event and so increase residual risk due to dam break. The flood plain would face the same hazard than today but on a much higher level and lower probability. Moreover raising the dams has

negative consequences for the groundwater level and makes the drainage of the floodplain almost impossible. Finally this solution is not sustainable as it offers very limited possibilities for later adaptations.

4TH PRIORITY FOR ACTION: PROTECTIVE STRUCTURES DESIGNED TO ACCOMMODATE EXCESS LOADS

A lesson learnt from previous flood events in the Alps is the possibility of events of much higher magnitude than the design value used for protection work. As we cannot afford to design our works for all possible magnitude or process, we try to take into account an overload case in the design of our protection systems. The first goal is to avoid uncontrolled collapse of the protective works and the second is to handle the overload with non-structural measure.
The Rhone River project is designed to deal with extreme events well above the design value of the dyke. Through a combination of flood routing and flood diversion measures extreme floods are conducted in flood corridors. Although damages are expected to occur during extreme floods, they can be reduced if only one side of the valley is flooded.

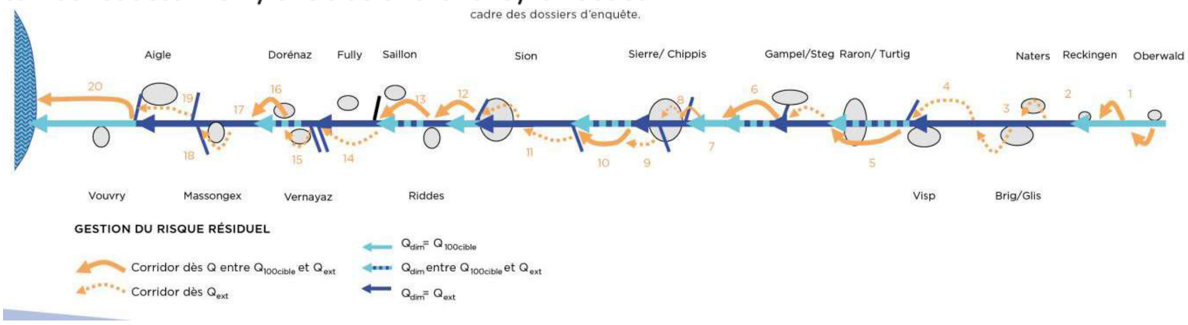


Figure 16: Combination of routing and diversion measures along the 180km of the Rhone River

This principle has been implemented on the section of the Rhone River in Visp, where potential damages of the right side of the valley have the value of a quarter of those of the left side.

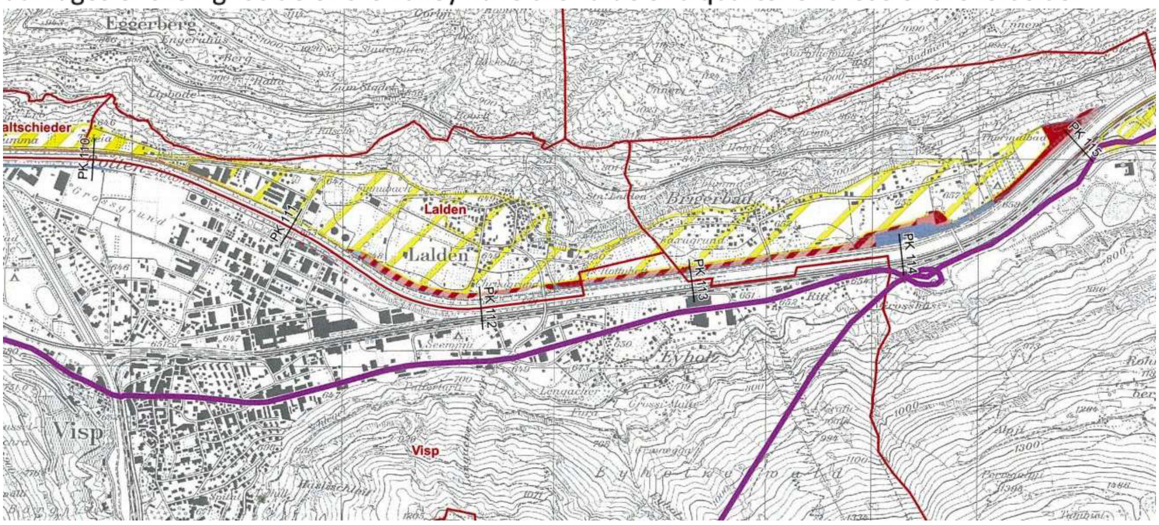


Figure 17: Hazards maps with diversion of the extreme floods on the right bank.

6TH PRIORITY FOR ACTION: TIMELY IDENTIFICATION OF HAZARD EVENTS

Damages can only be limited if timely action can be taken at local level. This necessitates the perfect functioning of forecasting and warning chains and the interpretation of the available information at the end of this chain through on-site observations in the local context.

The retention volume in the Rhone basin is not sufficient to laminate rare events. A detailed hydrologic study has demonstrated that artificial lakes in the lateral valleys and natural retention areas in the floodplain could not laminate the volume of a panel of synthetic hydrograms based on stochastic meteorological scenarios. However the study has shown that the retention volume in artificial lakes and in the floodplain could laminate the peak flow during an extreme event and so contribute to reduce residual risks.

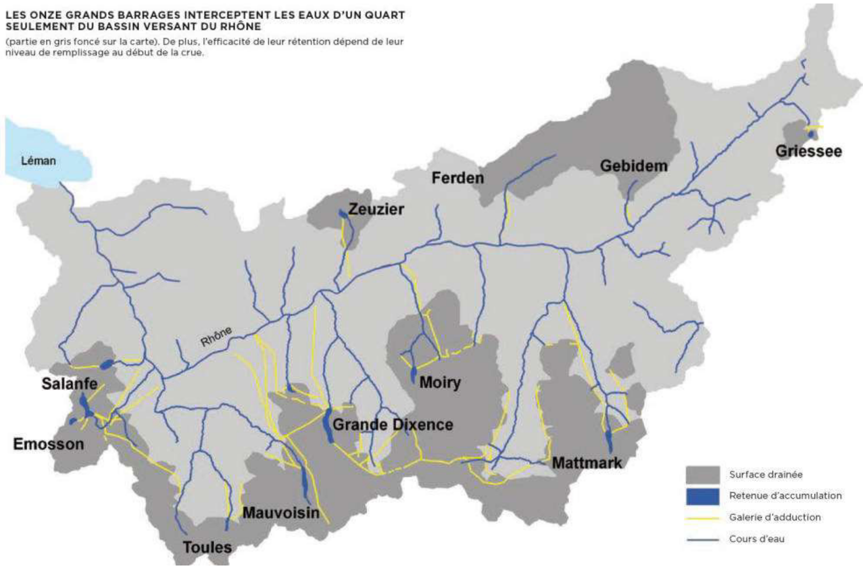
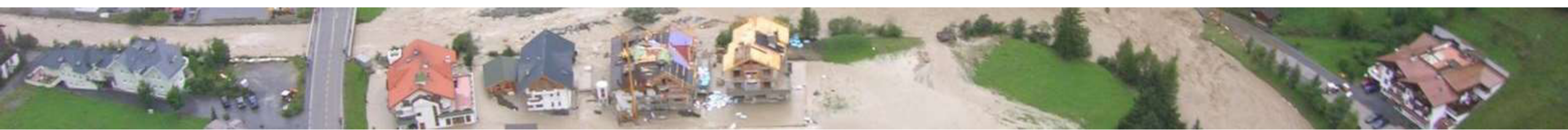


Figure 18: Retention in artificial reservoirs in the Rhone valley

CONCLUSION

An efficient flood risk management can only be achieved if all possible measures are effectively taken thanks to a clear division of tasks between public authorities. Responsibilities must be clarified between the different state level themselves and the private sector (insurance companies and property owner). In addition good cooperation is crucial to the fulfilment of the stated objectives.
The successful implementation of integrative risk management coordinates the action priorities: protective structures alone cannot guarantee safety. An optimal combination of response, recovery and preparedness measures must be sought under financial, social and ecological constraints.



PUBLIC PARTICIPATION IN FLOOD RISK MANAGEMENT- EXAMPLES FROM PROJECTS IN AUSTRIA AND CROATIA

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INTRODUCTION

In the following chapters a few selected participatory approaches for risk management and risk communication will be presented.
All these examples were done within three different projects, embedded in scientific concepts and accompanied by additional information and participation measures. For this paper the more innovative elements that were implemented and tested in these three projects are presented. The projects and the corresponding examples are:

Project	Example	Country
ERA-Net CRUE-IMRA	Workshop comprehensibility of information material	Austria
ERA-Net CRUE-IMRA	Approach of social milieus	Austria
DANUBE FLOODRISK	Participatory flood risk mapping	Austria
Risk Map Twinning CROATIA	Participatory flood risk mapping (Sketch &Match)	Croatia

Table 1: Examples for participation within flood risk management.

EXAMPLES FOR PUBLIC PARTICIPATION

The first two examples are activities from the ERA-Net CRUE project IMRA (Integrative flood risk governance approach for improvement of risk awareness). Goal of the project was to influence and change risk perception and to support decision-making regarding flood risk. The project aimed at an optimization of the flood risk management process by increasing procedural efficiency with an explicit involvement strategy.
To reach this goal the project partners were testing – additionally to rather common methods (e. g. stakeholder analysis tool, stakeholder workshops, questionnaires on risk perception) –two new approaches for dealing with risk perception and risk communication. One of them was the approach of social milieus for risk communication.

EXAMPLE 1: SOCIAL MILIEUS AS A TOOL FOR PLANNING RISK COMMUNICATION

The IMRA risk governance concept was based on an extensive theoretical background on participation, risk communication and stakeholder analysis, using the concept of social milieus for the definition of the target groups, as well as on monitoring indicators and measuring values. Risk perception is affected by attitudes and values – values filter information and color perceptions. To plan a risk communication strategy it is necessary

- to find out what the status of knowledge and risk perception of the local population is,
- to find out which values and attitudes of the target groups can affect their risk perception.

Attitudes, values and other socio-cultural features can be assigned to social groups, to "milieus". Research about social milieus is traditionally performed by market research and psychology. It was not foreseen or possible within the CRUE-IMRA project to perform a detailed socio-cultural analysis of the target groups in the regions of the subprojects. But an overview of the target groups on the national level does exist, including their attitude and values and the kind of information material which might reach them. This can give valuable input to a risk communication strategy.

To have a basis for this discussion the project team decided to use the Sinus Milieus®, developed by the market research companies INTEGRAL (Austria) and SINUS Sociovision (Germany). These Sinus Milieus® give an overview of social groups on the national level. The Sinus Milieus® combine demographic characteristics such as education, profession and income with the real living environments of the people, which means with fundamental value orientations and attitudes towards working and leisure time, family and relationship, consumption and politics. (INTEGRAL, 2009)

The social milieus are not just a theoretic exercise but were used to design tailor-made communication strategies in the case study areas of the project. Social milieus can act as a means to discuss how to reach local target groups. In the Austrian case study in the valley of the River Möll in Carinthia, the project team used statistical data about formal education, age, income, employment rate, sectors of employment as well as the results of the last elections of the municipality of Großkirchheim. Großkirchheim has a population of 1,621. Most of the people are between 14 and 54 years old. Nearly 80 % of the people have a compulsory education (Grundschulabschluss) or a graduation from apprenticeship training; only 7 % have a high formal education. 720 persons do have a job, 600 of them working full time, about 50 are unemployed. Tourism (45,000 overnight stays per year) as well as agriculture and forestry are main economic factors for employment. Most voters (over 70 %) voted for the BZÖ (a right wing party) at the last elections for the municipal council. According to this demographic information it was assumed that most parts of the population belong to the social milieus of rural-traditionalists, the working class and the middle class.

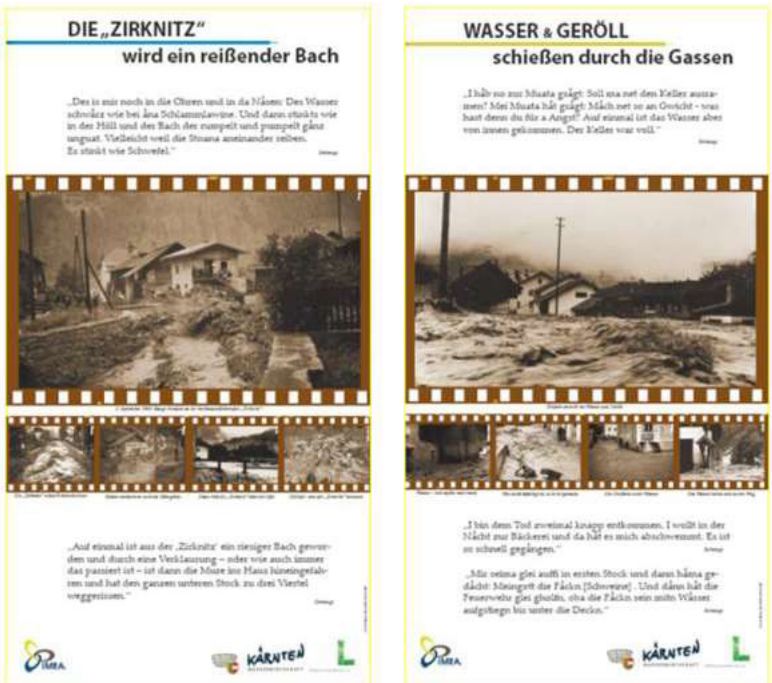

Figure 19: Two examples of the exhibition panels

Basic principles therefore were that all communication activities need to have a strong local focus, have to be written in an easy comprehensible text; people from the region are to be included in activities, such as witnesses of local flood events.
As an example: an exhibition concerning flood risk had only one panel with scientific-technical information, other exhibition panels were designed with emotionalising pictures and text from flood witnesses in the regional dialect. (Stickler et al, 2011).

EXAMPLE 2: WORKSHOP "COMPREHENSIBILITY OF INFORMATION MATERIAL"

This workshop was also an activity within the ERA-Net CRUE project IMRA (Integrative flood risk governance approach for improvement of risk awareness).
Information is the basis for all participatory activities – but do the people we want to reach with information activities understand the content? To test and improve the comprehensibility of already existing information material on flood risk, a workshop with local stakeholders and lay people from the municipality Großkirchheim was performed.

In the workshop existing flood hazard maps, a folder explaining how to use these maps as well as information material about flood risk projects in the region (orthofotos as well as graphical maps showing the water depths, inundation areas, probability of floods etc.) were tested.

Figure 20: Impressions from the workshop on comprehensibility of information material.

During the discussions input for improvement was collected and used for an update of the requirements for map design as issued by the Departement for Water Management of the Provincial Government of Carinthia. Also a tailor-made folder on flood risk of Großkirchheim was elaborated (Stickler et al 2011, Firus et al, 2011).

EXAMPLE 3: WORKSHOP SERIES "PARTICIPATORY FLOOD RISK MAPPING"

In the ETC SEE project "DANUBE FLOODRISK – Stakeholder Oriented Assessment of the Danube Floodplains" (2009-2012), hazard and risk maps harmonized across borders for the Danube main stream were produced. The Austrian pilot area was the city of Krems, upstream of Vienna and located in the province of Lower Austria. Krems has long-standing experience with floods and covers all four receptors mentioned in the EU Floods Directive: human health, economic activity, environment, and cultural heritage. Additionally, it is located in an Area of Potentially Significant Flood Risk (APSFR).

Two scenarios were investigated:

- A medium probability flood event on the Danube (Q100) with the harbour gate failing to close before peak discharge, resulting in possible risks to human health, environment, and economy;
- A medium probability flood event on the Danube (Q100) with a failing mobile defence wall before and at peak discharge, with and without upright second defence wall, resulting in possible risks to human health, environment, economy, and cultural heritage in the area of Krems-Stein.

The most innovative step regarding participation was not the methods used for participation but the involvement of concerned lay persons not only in the design of the hazard and risk maps or the risk assessments itself but in the cooperative elaboration of the risk assessment approach especially for the harbour area. This happened not as an education process of uninformed lay persons by experts but as an iterative learning process on eye-level. With the companies being very different in character, the assets at risk were very different as well, and assessment with respect to only one criterion alone (e.g. land use, hazardous substances) would not give a level picture. Assessment of insurance values or of monetary values was too time-consuming and issues like data protection would limit such approaches. It needed five workshops to agree on a common understanding of risk and risk assessment used for the final risk map of this area that was seen as useful by all participants (Fuchs et al, 2013; Stickler et al, 2012).

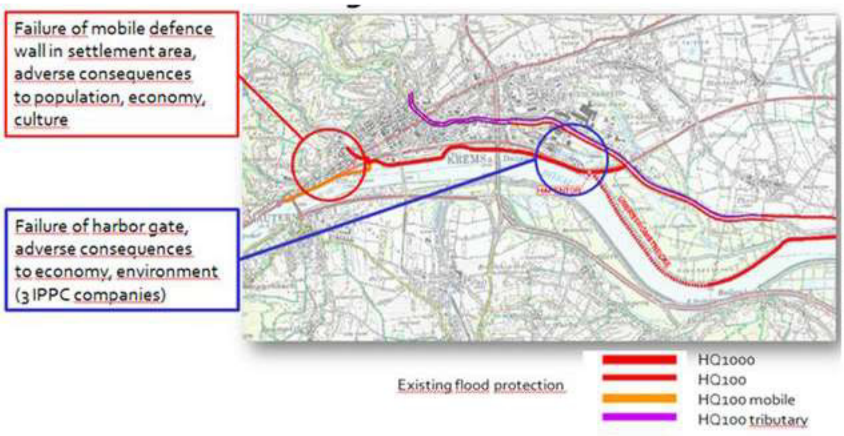

Figure 21: Flood protection structures in Krems and failure scenarios investigated

EXAMPLE 4:"PARTICIPATORY FLOOD RISK MAPPING WITH SKETCH & MATCH"

In Article 10 of the Flood Directive it is said that member states shall encourage the active involvement of interested parties in the production, review and updating the flood risk management plans. The flood risk management plans in Croatia, like in other states, are still in progress, but the flood hazard maps and flood risk maps, which are are important instruments for making the management plans are being developed.
To gain experience with active stakeholder participation during the Twinning Project "Development of Flood Hazard Maps and Flood Risk Maps", a workshop with several stakeholders was organised in one of the pilot areas, the city of Karlovac.

Objectives of the workshop were:
- to inform the stakeholders
- to build up a better understanding between Croatian Waters and stakeholders
- to get feedback and input for flood risk maps

Figure 22: Sketch & Match exercise with flood risk map

Sketch & Match is an instrument, developed by DLG Netherlands, for interactive planning with stakeholders. Instead of long meetings with a lot of papers, a Sketch & Match session is based on the idea that images say more than a thousand words. Under the lead of a landscape architect and moderator, the participants gathered around the map and this was the beginning of an interactive process. Because this was an exercise, this time it only took 45 minutes. In real situations, a Sketch & Match will take at least a half day, depending on the complexity of the problems.
The method is different to the stakeholder discussions on risk mapping presented in example 3, were input was collected on flipcharts or various designs of risk maps printed out and the comments on this designs collected on paper. In Sketch & Match the moderator draws directly on a map covered with transparent tracing paper and includes continuously the comments and discussions of participants by drawing on the map. (Stickler et al, 2013)

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FLOOD RISK MANAGEMENT PLANS AND CONTIGENCY PLANNING: CHALLENGES AND CHANCES FROM A DISASTER PREVENTION PERSPECTIVE

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The German federal system is mainly based on the principles of devolution and subsidiarity. Because of that the German federal states (Länder) have a wide range of legislative (and executive) competences. Also the legislative power for disaster management is assigned to them. The legal foundation of the disaster management in Bavaria is the Bavarian Act on Disaster Control of 24 July 1996.

The administrative organization of Bavaria has below the state government a three-tier structure. At the bottom we have 2,056 municipalities, 96 county authorities and above seven administrative regions (also called districts). Apart from the municipalities, the general administrative structure is largely consistent with the one of the disaster control authorities. The supreme disaster control authority is the Bavarian Ministry of the Interior, for Building and Transport, at medium level we have the administrative regions and the county authorities as the disaster control authorities low-level.

The Bavarian disaster management system is efficient and resilient because of its structure and the (human) resources for disaster response. There are approximately 470,000 (disaster) relief forces, thereof are about 450,000 volunteers. The main pillars of the Bavarian disaster management system are the disaster control authorities themselves and the forces, their education and training for the case of emergency and especially an efficient contingency planning. As effective disaster management requires planning the "unpredictable".

The base of every disaster control planning is the analysis of hazards and risks. In Bavaria, we follow the bottom-up principle. So the county authorities (as disaster control authorities low-level) are first and last self-responsible for risk assessment, the disaster control planning and the overcoming of severe damages and disasters in their administrative area. An efficient disaster control planning enables the timely, consistent and coordinated response to possible disasters.

We differentiate between the general disaster control plans and the special disaster control plans. The general disaster control plans include the recording of all material and human resources for coping with possible disasters. In contrast, the special disaster control plans refer to certain areas or institutions which are subject to specific risks or from which specific hazards emanate (e. g. traffic, thunderstorms or nuclear power plants)and include the special and proper instructions to follow in the case of emergency (alarm and deployment commands).

In the context of the general disaster control plans and in preparation for certain disasters, for example flooding, the Bavarian Ministry of the Interior, for Building and Transport has established special kinds of fire brigade task forces for the transregional, nationwide and cross-border disaster relief. These special task forces have a certain scope of application, e. g. flood- sandbags or flood-pumps and comprehend usually about 110 persons together with the technical equipment. In terms of numbers, for floods we have 31 special task forces flood-pumping and 32 special task forces flood-sandbag throughout Bavaria.

Because of the experiences of former severe floods the Bavarian Ministry of the Interior, for Building and Transport financed together with the Bavarian Ministry of the Environment and Consumer Protection a strategic reserve of sandbags. This reserve contains eleven centres of distribution

throughout Bavaria with about 2,100,000 sandbags. These centres are built up and provided by the water resources authorities. But in the case of emergency the requests of sandbags and their distribution are operated centrally by the Ministry of the Interior, for Building and Transport as supreme disaster control authority.
Especially the flood of June 2013 showed the success of the special contingents and the strategic reserve of sandbags.
In the framework of the implementation of the Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (EU-Floods-Directive) and in order to be consistent throughout Bavaria a guideline for the creation of flood risk management plans was designed. This guideline includes general information of the subject and also a uniform catalogue of measures, of which single measures can be chosen to get implemented.

Two measures of this catalogue concern the field of disaster management and the municipalities as local security authorities:

a) Creation and update of **local alarm and action plans** (municipalities)

This measure should complement and enhance the preparedness of floods in Bavaria. If the municipalities (as local security authorities) want to implement this measure, they should proceed as listed below:

- Analysis of the flood hazard and risks and identification of the geographical areas and the objects or infrastructures which are likely to be affected by floods inside the area of the municipality

In this stage the flood hazard maps and the flood risk maps, which had to be built up till 2013 in the context of the EU-Floods-Directive and persons with local knowledge are very helpful for the risk assessments.

- Risk assessment and scenarios, planning assumptions
- Identification and definition of measures to ensure rapid response and resources mobilization
- Specification of the defined measures and translation of them into alarm and deployment commands

The summary of these alarm and deployment commands forms the local alarm and action plan.

b) Creation and update of **special disaster control plans flood** (lower disaster control authorities = county level)

The special disaster control plan flood contains all local alarm and action plans in the administrative area of the respective county authority as disaster control authority. The aim of this plan is to manage and coordinate the local alarm and action plans in order to ensure a rapid, consistent and coordinated response to the threat of floods. In this manner we integrate the municipalities into the disaster management system, ensure its consistency and enhance the disaster response capability.

Poster session abstracts

List of posters

Anticipatory flood risk management - Development of adaptation strategies under changing flood risk

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C3-Alps: creating a knowledge hub for climate change adaptation in the Alps

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**EURAC (European Academy Bolzano/Bozen) – Institute for Applied Remote Sensing;*

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**** PLUS/Z-GIS (Z_GIS Zentrum für Geoinformatik, Paris-Lodron-Universität Salzburg)*

Improving flood prevention through the development of a standardized approach for small dams risk assessment and management

Mavrova-Guirguinova Maria

University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria

Program Graz Streams - Flood Management in urban areas I and II

Styrian Federal Government, Department 14 Watermanagement, Resources and Sustainability & City of Graz Department A10/5

Rainfall Surface Runoff Maps – Pilot Project Kapfenberg

Josef Terneak Stefan Haider***

**hydrosim*

***BÜRO PIELER ZT GmbH*

Risk Adapt - Flood Risk assessment for Austria under dynamic conditions

Apperl Benjamin, Herrnegger Matthew*, Löschner Lukas***, Neuhold Clemens**, Senoner Tobias*, Nachtnebel Hans-Peter*, Seher Walter****

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Streams of Graz - working progress 03/2014

Bernhard Egger-Schienerl

Received poster summaries

IMPROVING FLOOD PREVENTION THROUGH THE DEVELOPMENT OF A STANDARDIZED APPROACH FOR SMALL DAMS RISK ASSESSMENT AND MANAGEMENT

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University of Architecture, Civil Engineering and Geodesy,Bulgaria

Over 2000 small dams for irrigation were constructed in Bulgaria until 1963, most of which of earth-fill design, primarily of clay with low filtration coefficients. Many of those dams were constructed with little preliminary surveying, using equipment available to the then-existent cooperative farms, influencing the quality of construction. Presently, with the return of agricultural land to its private owners, all small dams and reservoirs are treated as public property of the municipality. Since the municipalities lack the resources to maintain and operate the dams many of these facilities are in inoperable or critical condition. When a cooperation for irrigation is formed, the municipality gives the dam and its related facilities as a part of irrigation system over to the cooperation and discontinues the concession agreement.

The project DAMSAFE was implemented in 2011-2013 with the contribution of the Civil Protection Financial Instrument of the European Union. The project was focused on the improvement of flood prevention as both a study of the influence of small dams in flood risk assessment for flood prone populated areas and as an assessment of the possibility of using or reconstructing a small dam into a flood retention basin. All lessons learned and conclusions drawn from the implemented project studies were used to elaborate a manual for small dams' flood risk assessment and management. www.damsafe.eu

DAMSAFE project partners were: Directorate General Fire Safety and Civil Protection, Bulgaria as a Coordinating Beneficiary; Institute of Hydraulic Engineering and Water Resources Management, TU Vienna, Austria; Department of Flood Water Management, Federal Government of Styria, Austria; WALD+CORBE Consulting Engineers, Germany; Irrigation Systems (Ministry of Agriculture and Foods), Bulgaria; University of Architecture, Civil Engineering and Geodesy in Sofia, Bulgaria; National Institute for Meteorology and Hydrology (Bulgarian Academy of Sciences), Bulgaria; Sofia University "St. Kliment Ohridski", Bulgaria.

C3-ALPS: CREATING A KNOWLEDGE HUB FOR CLIMATE CHANGE ADAPTATION IN THE ALPS.

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C3-Alps is an INTERREG project funded by the Alpine Space programme with the main objective of collecting, analyzing and transferring the knowledge produced in the last years about climate change adaptation in the Alps.

This process is deemed fundamental for supporting municipalities and regions to tackle challenges and opportunities of climate change. The project considers sector specific knowledge such as natural hazards, agriculture and biodiversity. As of great relevance for the Alpine region, great attention is paid to the topic spatial planning and flood risk. It addresses also cross-sectorial issues like awareness raising or CCA communication. The projects main output and tool is the C3 Knowledge Inventory Portal (C3-KIP).

In the C3-Alps project (financed by the European Commission's Alpine Space Programme), „capitalizing" is meant to let significant information and knowledge last in time and be easily retrievable on the web. One of the most important function of the tool that the project is developing is to avoid that people get lost in the „flood" of documentation and data retrievable from countless project websites, when in need and searching for information on the web.

Many projects have generated an own website and a correspondent repository for all the material produced. In the years this process has created a great number of websites, often scarcely visible for the general public, hindering the dissemination of potentially very useful knowledge products. Moreover, often this information is lost when the project website is shut down. Aim of C3-Alps is therefore to save the knowledge asset, make it available, make it useful, in one word: enable it.

C3-Alps is in the process of creating a dedicated portal for the existing „pieces of knowledge", coming primarily from transnational cooperation projects in the Alps and all the contexts that have produced information relevant for the Alps. For instance, regarding flood risk management, the projects AdaptAlp, Dis-Alp, CatchRisk and Paramount may be mentioned. After a criteria-driven selection, a pool of experienced researchers and practitioners in the various sectors of adaptation, have collected the knowledge, inserted it into a dedicated repository and described each item through a series of customized attributes.

After having collected the material in the portal, the so-called C3-KIP, the experts involved in the project analyzed the documents and data with the aim to guide the users and support them in the use of the existing information. From the „pieces of knowledge", organized into sectors of interest (e.g. Natural Hazards, Spatial Planning, Water Management etc..) and typologies (e.g. Adaptation policies, Tools, Practice examples), we created Thematic Collections (TCs). These TC's contain a

presentation of the state of the art of the knowledge, synthesis and considerations on CCA in the Alps regarding the sectors in form of a short document (4 pager) and a list of existing reports, studies and tools. In order to offer additional knowledge, we also looked at „Hot Topics“ involving special aspects of CCA such as costs and benefits, communication, awareness raising and created additional TC's.
Our C3-KIP offers sustainability, evolution and user involvement. Through the system of „search and select“ in the portal, it is always and for every user possible create more Hot Topic collections for its needs: „Flood risk management“ is meant to be one of them.
The portal is still under construction and the first public version will be available in October 2014.

RAINFALL SURFACE RUNOFF MAPS – PILOT PROJECT KAPFENBERG

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For the flood risk management plans, all aspects of flood risk should be considered, with the focus on prevention, protection and preparedness (Article 5 of the EU Floods Directive, RL2007/60/EG).

New developments in the field of hydrodynamics and constantly improved data base, make possible that flood risk maps can be created also for rainfall surface runoff.
A pilot project, commissioned by the city of Kapfenberg, was accomplished by the consulting offices Pieler ZT GmbH and hydrosim in collaboration with the city of Kapfenberg and the department urban water management of the styrian government.

The objective was to obtain rainfall surface runoff maps as a basis for urban areas development and to assess a building site suitability. The investigation included the extended urban area of the Kapfenberg from about 40km².

Three different methods were applied and compared each other, to identify an optimum method in terms of effort and result quality.

- GIS Analysis
- 2d Rainfall Surface Runoff (simplified) - FloodArea©
- 2d Rainfall Surface Runoff - Hydro_As-2D©

The main data are the elevation model, land use and soil map and the statistical heavy rainfall amounts.

The resulted maps are:

- flow paths and catchment areas from GIS analysis
- classified water depths from 2D hydraulics

The rainfall surface runoff maps can be used for:

- identification of flood risk areas
- planning of flood mitigation
- urban development (concepts, control systems, risk mitigation)
- constructive design of the buildings
- alarm and emergency plans

The rainfall surface runoff maps are hazard maps for rainfall events with potential damages in extended settlement areas. Small structures such as walls, fence bases, sidewalks and the sewage network affect the results. Therefore the results have to be understood as indications of possible flood risks and have to be more exactly proved.
The maps supplement river flood investigations to a broader representation of flood hazards in the extended settlement areas. The maps deliver a better understanding of the processes and support the planning of protective measures, the development of the urban areas and operational planning for emergencies.

STREAMS OF GRAZ, EFFECTIVE FLOOD PROTECTION FOR THE URBAN AREA (THE FLOOD PROBLEM)

Summary by Rudolf Hornich

Land Steiermark

The City of Graz has an extension of about 13,000 hectares, of which somewhat more than half are building land and roads. Besides a multitude of smaller watercourses, the Graz urban area counts more than 50 streams plus 10 torrents. The streams of Graz have a total length of about 270 km, of which some 125 km are located within the urban area of Graz. This means that only half of their entire catchment area of 140 km^2 lies in the city itself.
Innumerable historic flood disasters have been recorded in the urban area of Graz. The memory of the 1975 flood prompted the first steps towards a flood prevention strategy.
In 1997, after several years work, an assessment of discharge values with indication of catchment areas for the 1-in-30 and 1-in-100-year event (HQ_{30} and HQ_{100}) for all main Graz streams was finally ready. Calculations revealed that there are about 1000 flood-endangered objects in Graz
As built up areas and higher-order land use are moving more and more towards watercourses, the following results can be observed in urban areas in general and along most streams in Graz: along the lower course, flood catchment areas are disappearing while discharge cross sections are falling rather than rising. The room required to safely take up the arriving floodwaters, therefore, is no longer there. Tubing and covers as well as canalisation out of the depth contour compound the situation by utterly separating run off from the stream bed and leaving water masses to flow off uncontrolled through the urban area. The main flood problems concerning floods in Graz are:

- Pressure of settlement
- Infrastructural and locational problems
- Approach of buildings to streaming waters
- Construction/Covering of discharge cross sections
- Drastic decline of water discharge areas
- Hillside- and surfacewater problems

To solve the flood problems in the city of Graz a study carried out in close cooperation between the Graz City Council, the Government of the Province of Styria, the Forest Technical Service for Torrent and Avalanche Control and the Federal Ministry for Agriculture and Forestry, Environment and Water Management yielded a strategic paper called "Graz Streams Program".

STREAMS OF GRAZ, EFFECTIVE FLOOD PROTECTION FOR THE URBAN AREA (SACHPROGRAMM - INTERDISCIPLINARY COLLABORATION)

Summary by Rudolf Hornich

Land Steiermark

Taking into consideration the requirements posed by the departments for spatial planning, urban development, open space planning, water ecology, water management in urban areas and civil protection, the primary objective was formulated as follows: "To achieve sustainable flood protection of endangered objects in the City of Graz". In the course of the study, the slope water problem, affecting many quarters in Graz, and problems connected to flooding due to surface water were examined and pointed out.

Seven civil engineering firms were hired to develop a flood control plan. Two further firms were tasked with specific assessments in the fields of water ecology and spatial planning. In August 2006 work was completed. The proposed catalogue of measures is very extensive and includes the following objectives:

- Improving flood Protection
- Enhancing the safety for the population
- Improving the ecological condition
- Improving the quality of life in the city by creating and upgrading nearby recreational areas

Implementation will take place within a 10-year programme period (2006-2015) and according to a priority list taking into account the individual flood risk and possible damage at each site. The total cost of this ten-year programme has been estimated at € 65.0 million on the price basis of August 2006. Funding will be provided by the Federal Government, the Government of the Province of Styria and the City of Graz.

The Programme of measures covers the following activities:

- Conservation and activation of inundation areas

- Construction of 29 flood retention basins (retention capacity approx. 1.0 million m^3),
- Streambed widening/elimination of tubing cases
- Mobile flood protection
- Flood RISK Managementplans/risk analysis
- Alarm and disaster contingency plans
- Individual responsibility/self-protection/private emergency plan
- Flood damage insurance
- Public-Relations and awareness reaising

PLANALP conference

“Breaking fresh grounds in protecting Alpine Environments – Flood Risk Management Plans”

Conference proceedings
Graz, 25 March 2014