State-of-the-Art in Risk Management Technology: Implementation and Trial for Usability in Engineering Practice and Policy

START_it_up

Common Strategic Paper and Final Booklet

Alpine Space
EUROPEAN TERRITORIAL COOPERATION
THIS PROJECT IS CO-FUNDED BY THE EUROPEAN REGIONAL DEVELOPMENT FUND
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The START_it_up Partnership, 2014

COMMON STRATEGIC PAPER AND FINAL BOOKLET

Project:	Final Booklet
	START_it_up
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Date:	December 2014
Print:	Druckerei Theiss GmbH, www.theiss.at

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EXECUTIVE SUMMARY

START_it_up is a project in the 5th call of the Alpine Space Programme 2007-2014 and was designed as a capitalization project. Hence the major objective was to compile the huge pool of available knowledge in natural hazard engineering and risk management, furthermore to refine this knowledge to generally accepted standards and provide these standards to the engineering and policy practice. Generally speaking activities in START_it_up are characterized as knowledge management and quality assurance supporting expert´s decisions, fostering the public trust in risk policy and enhancing the efficiency of protection measures. The transfer of knowledge from the research and development to the "state-of-the-art" in engineering, from innovation to application, requires transdisciplinary work methods. This challenge was taken by a consortium of project partners from science, administration and engineering practice from 5 Alpine Space countries with core competence in the capitalized pool of knowledge.
The thematic focal points of START_it_up – selected from the wide spectrum of knowledge in natural hazard engineering and risk management and referring to floods, debris flow, avalanches and mass-movements – were the following:

- Hazard and risk assessment
- Hazard and risk maps and their implementation in areal planning and regional development
- Hazard protection systems and engineering solutions
- Good risk governance and information technologies

The START_it_up approach to standardization goes far beyond a one-dimensional unification concept. As the design of technical systems applied to natural hazards has to take into account fragmentary knowledge on hazard processes, imperfection in available information and uncertainties in the prognosis of frequency and intensity of natural events, reliability, robustness and functional efficiency are the most important quality criteria. Thus standardization means not only the provision of commonly approved norms and regulations (voluntary or de jure), but rather a standardized way of thinking, common methods of decision-aid (support) and documentation, approved processes for optimization of alternatives (variants), system design adapted to societal desires, environmental conditions and legal/political framework or simply the establishment of good practice procedures. In order to integrate all these divers approaches of standardization, a simple core model for the consolidation of knowledge was established in START_it_up, in which standards – symbolized as wedges – support the achieved level of quality. The following concepts and instruments for consolidation of knowledge were applied:

- Technical standards (norms) and harmonized policy procedures (regulations, police briefs, best practice)
- Decision making considering traceability of expertise processes and quality (reliability) of information content and sources
- Transnational assessment and benchmark of methods and procedures
- Solution-oriented knowledge management, considering all relevant approaches (methods)
- Provision of reliable and approved methodology to practitioners
- Good governance, involving stakeholders and the concerned public

The tangible results of START_it_up are "state-of-the-art" reports, conceptual models, best practice procedures and databases that have in common to provide comprehensive knowledge in an applicable, reliable and easily accessible form to consumers, such as decision makers, engineers and educational institutions. Among the knowledge compilations presented in this Common Strategic Paper and Final Booklet are reports on the state of the art in monitoring, the application of artificial avalanche release systems, the state of the art in protection work effectiveness assessment, the risk/vulnerability assessment for critical infrastructure, the implementation of forest protection function in risk management for shallow landslides and the legal basis for rock fall protection. New approaches for expert networking and think tanks were developed, such as the START_it_up State of the Art Conference in Natural Hazard Engineering and the Risk Policy Dialogue. Various concept of databases were implemented to provide the available knowledge – standardized and compiled according to the requirements of the target group – to the consumers and concerned public (Risk Technology Platform and Database, CLV Platform for Avalanche Warning Services, Database on assessment of impact to objects).
START_it_up was only a first step towards common standards in natural hazard engineering and risk management and will pave the path for further standardization processes in and beyond the Alpine Space Programme 2014–2020.

MISSION STATEMENT

Sustainable protection is of existential significance for social welfare, regional development and economic growth in the Alpine Space, a region exposed to multiple natural hazards and risks. Hence engineering solutions and safety decisions at the highest possible quality are required. START_it_up project is dedicated to the acquisitions, consolidation and standardization of knowledge in the field of natural hazard engineering and risk management by creating a common "state-of-the-art" and making the huge pool of knowledge and technologies accessible to decision makers, end users (engineers, practitioners) and the concerned public. This mission was supported and reached by three major initiatives:

- Compilation and provision of the available knowledge in norms, "state-of-the-art" reports and best practice recommendations
- Expert decision support and confidence by approved methodologies, standard procedures and quality assurance
- Creation of a transnational expert network and a knowledge exchange platform

Figure 1: Application of quality standards for natural hazard engineering under extreme conditions (picture: die.wildbach)

START_it_up has paved the path for a wide range of strategic initiatives in knowledge management and standardization for the benefit of risk management in the Alpine states. With this project trend-setting approaches in planning, engineering and risk governance, such as protection systems engineering, continuous safety quality improvement and regional risk governance were introduced. Based on a well established transnational cooperation in risk management in the Alpine Space, new procedures and instruments for the transfer of knowledge and the expert networking were tested and proposed for implementation, in due consideration of the Alpine Space Programme (ASP) 2014–2020.
High quality standards in risk engineering and expert decision making directly support the prevention of catastrophes and fatalities. Hence the efforts taken by START_it_up partners are essential contributions for the adaptation of natural risk management to the challenges of global change.

Background and Project Idea

In the course of time a multitude of projects of former innovation programs of the European Territorial Cooperation (ETC) as well as national initiatives have carried out a wide range of valuable results, methods and procedures. However, after these project's closures it habitually happened, that most of the results neither have been promoted sufficiently, nor did undergo further testing and evaluation for common applicability, nor were easily accessible for practitioners and decision makers. A simple principle holds true:

"When money is gone, often also initiatives die!"

START_it_up project has strived to overcome this substantial problem by collecting, evaluating and disseminating the good practice examples and pre-standards that already exist in great number on different levels in the Alpine Space countries and to promote them on the transnational level. The focus was on collecting and testing these documents, seeking general agreement and providing them to potential users. This process was closely coordinated with the partners and observer consortium who represent the primary consumer community of these products. The resulting standards were made accessible on a public database that assists users searching the appropriate knowledge for their daily endeavours. The idea of a common share of available knowledge and technologies for public safety was strongly promoted to gain a great forum of participants on voluntary basis.
On that purpose a consortium of 8 institutions from 5 Alpine countries together with a multitude of observers formed the project START_it_up within the framework of the Alpine Space Programme's 5th call and thus co-funded by the European Regional Development Fund (EDRF). In the project life cycle from September 2013 to November 2014 the partner consortium faced the challenge to promote a common "state-of-the-art" in the fields of natural hazard engineering and risk governance on international level. Due to the short duration the project itself was only able to set the scene and provide the basis for consecutive standardization and harmonization processes. The aim of project partners was therefore to create an appropriate framework for the consolidation of knowledge by fostering future standardization (harmonization) initiatives and an expert network in order to hump these activities and disseminate the results.

Project Objectives and Major Results

START_it_up was initiated as a direct respond to the ASP objective *"to prevent and mitigate natural and technological hazards and manage their consequences"*. The project was designed to deliver innovative and strategic approaches for capitalizing existing knowledge in the field of natural hazard management and risk governance. Projects and activities in START_it_up were focussed on the following categories of natural hazards: floods, debris flow, avalanches & mass-movements. Actions within the project concerned engineering as well as risk management purposes and targets.
The abstract objective, to create and establish a transnational common "state-of-the-art", was approached by a three step procedure: (1) acquisitions, (2) consolidation and (3) generalization of available knowledge aiming at the continuous consolidation of knowledge and quality improvement in safety services. In a demonstrative model (Fig-

ure 4) protection quality is improved by a continuous "PDCA" quality process cycle (Plan-Do-Check-Act) (inspired by ISO 31000:2009), wherein standardization consolidates and generalizes approved knowledge. By definition standardization is a process of developing and implementing common standards, which can help to maximize compatibility, interoperability, safety, repeatability, or quality. The idea of standardization is close to the solution for a coordination problem, a situation in which all parties can realize mutual gains, but only by making mutually consistent decisions. The understanding of standardization within START_it_up reaches far beyond transnational unification, technical norms or legal regulations; in point of fact the conception addresses other strategies to consolidate knowledge, particularly by quality assurance in expert decision making, by solution-oriented knowledge development, by decision support through approved methodology and documentation, by best practice selected from transnational assessment and benchmark of methods and procedures and by good governance. In other words a standard can be a technical norm as well as an approved procedure, process or even generally accepted way of thinking. The standardization processes initiated by START_it_up will strongly foster the resource efficiency in regional development, land-use planning, natural hazard engineering and risk governance by providing generalized and commonly approved standards for technology and policy, in agreement with EU legislation, strategies of the European Territorial Cooperation and regulations by the European Committee of Standardization (CEN).

Figure 2: Presentation of START_it_up objectives and results at the final conference at IRSTEA in Grenoble (France) on the 15th of November 2014 (picture by IRSTEA)

Approved quality standards will bring about competitive advantages for enterprises on the global market and security for consumers in selection appropriate protection systems and concepts. Generalized procedures in risk governance will increase the confidence of people in risk management, raise the risk perception for endangerment outlined in hazard and risk maps and improves the efficiency of risk governance administration.
Major results of START_it_up presented in this CSP are:

(a) best practice methods for hazard and risk assessment;
(b) policy proposals and common procedures for integrating hazard and risk maps into areal planning, regional development and safety planning;
(c) initiation of a transnational harmonization and standardization processes for protection technology;
(d) establishment of a risk policy dialogue;
(e) definition of gaps, potentials and new fields of research, development and policy in natural risk management.

Among the tangible product of START_it_up are: Recommendations for rockfall/landslide hazard and risk assessment; Best-practice guidelines for the implementation of forest protection function in the NHRM of shallow landslide; Common policy directive for the implementation of hazard/risk maps (based on EU Flood Directive); Practice guidelines on monitoring and warning technology for debris flows; Web 2.0 knowledge database and CLV platform for avalanche warning services; Establishment of a transnational expert network on standards and knowledge exchange (recurrent State-of-the Art Conference) in natural hazard engineering.

8 | PRINCIPLES AND VISIONS OF START_IT_UP: QUALITY ASSURANCE AND STANDARDIZATION IN NATURAL HAZARD MANAGEMENT AND RISK GOVERNANCE

Common principles of quality improvement and design processes in natural hazard risk management and engineering

Natural hazard risk management and engineering is a complex ensemble of well-tuned design and life-cycle oriented quality control activities alongside the entire risk management cycle. In this context the role of design is essential and an underestimation of its relevance results in inbuilt system vulnerabilities, which might prove to be hardly mitigated. Robust design, as a general principle of quality improvement, involves interplay between "what we want to achieve" and "how we choose to satisfy the need". Suh (2001) systematized the design thought process involved in this interplay by introducing the concept of domains in order to delineate and demarcate four different kinds of design activities, namely:

1. the customer domain, which is characterized by the needs (or attributes) that the customer is looking for in a product or process,
2. the functional domain, where the customer needs are specified in terms of functional requirements (FRs) and constraints (Cs),
3. the physical domain, where design parameters (DPs) are conceived to satisfy the specified FRs and
4. the process domain, where suitable process variables (PVs) are identified to specify the product development or the process implementation.

One necessary adaptation of this framework concerns the adoption of the Sustainability vs. Stakeholders' interests' domain (i.e. the Su – St Domain, compare Figure 3). In fact, natural hazard risk engineering ultimately seeks to find alternatives and prospects that represent different syntheses amongst: i) what society desires, ii) what complies with the natural evolution patterns (i.e. river styles), iii) what is allowed by the existing legal framework, and iv) what is prescribed in terms of protection levels (or acceptable risk levels) to be attained. As second adaptation we conceive design as an iterative process or as an envisioning-problem setting and problem solving cycle comprising the following steps:

a) Problem identification and description.
b) Formulation and visualization of the Ideal Final Result (IFR) to be achieved. Description of a "model" to be approximated.
c) Analysis of all possible physical, spatial and temporal resources for an optimal attainment of the IRF.
d) Definition of admissible system changes: The planning process is meant to address the removal of obstacles to the full attainment of the IFR.
e) Elaboration of solution concepts based on the IFR by considering the following design principles: separation, dynamization, combination and strategic redundancy (compare for details, Mazzorana and Fuchs, 2010).
f) Evaluation of the developed solution strategies. The evaluation should clearly state for each design solution (i) what has been enhanced, (ii) what has been

worsened, (iii) what has been substituted, (iv) what remains to do with reference to the attainment of the IFR and (v) whether the systemic and developmental contradictions could be solved?

g) Participatory selection of the optimal solution taking into proper consideration cost-benefit criteria.

In the light of (i) long planning horizons for protection systems, (ii) complex participatory planning processes, and (iii) the non-prejudicment principle anchored in various legal requirements, the time dimension of quality is a relevant in natural hazard risk engineering. This issue is properly addresses through a life cycle management approach.

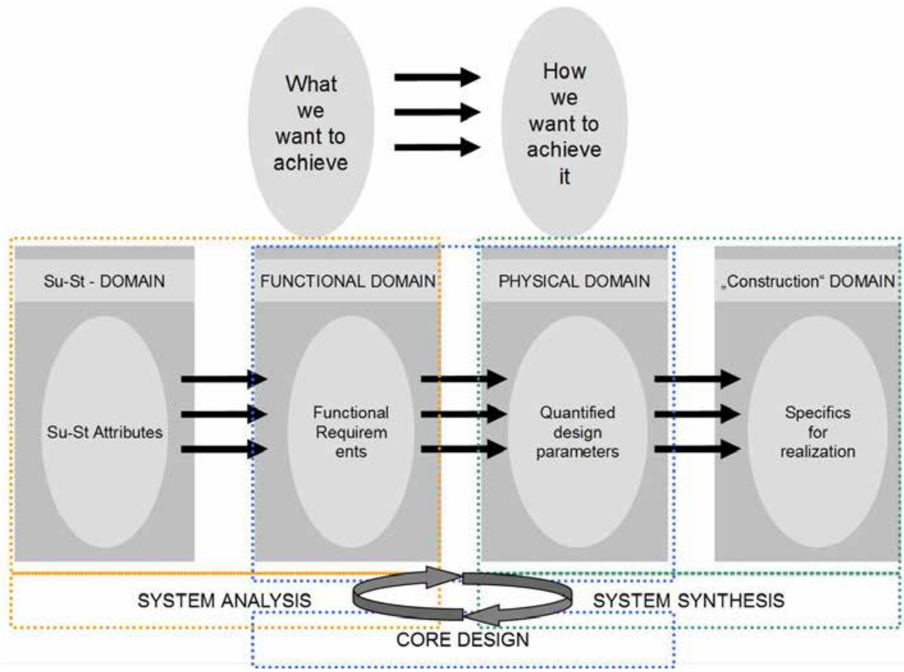

Figure 3: Conceptual planning steps – mappings in the design process (adapted from Suh, 2001)

START_it_up core model: Safety quality improvement by knowledge consolidation through standards and quality control

The demonstrative core model of START_it_up as a quality improvement process based on the well-known APDC-circle (inspired by ISO 31000:2009). PDCA (plan–do–check–act or plan–do–check–adjust) is an iterative four-step management method used in economy and engineering for the control and continuous improvement of processes and products. "Plan" addresses the establishment of objectives and processes necessary to deliver results in accordance with the expected output, applied to risk management the protection goal or expected level of safety. "Do" means the implementation of the plan, the execution of a planned process or the creation of a certain product. "Check" includes the assessment of the actual results and benchmark them against the expected protection goals or levels of safety. Identified deviations from the expected quality induce the verification of the appropriateness and completeness of the plan (procedure), the improvement of shortcomings and extinction of sources of failure and the redesign of the plan, process or measure. “Act” describes the actual corrective actions on significant differences between actual and planned results. When a pass through these four steps does not result in the need to improve, the scope to which PDCA is applied may be refined to plan and improve with more detail in the next iteration of the cycle, or attention needs to be placed in a different stage of the process. The PDCA-cycle symbolizes iteration towards an improved protection system, hence PDCA should be repeatedly implemented in spirals of increasing knowledge of the system that converge on the ultimate goal, each cycle closer than the previous.

Another core idea of START_it_up is the initiation of a knowledge management process in natural risk management and governance. Knowledge management (KM) is by definition the process of capturing, developing, sharing, and effectively using organizational or societal knowledge. Knowledge management efforts typically focus on organizational objectives such as improved performance, competitive advantage, innovation, the sharing of lessons learned, integration and continuous improvement, which are – in an abstract and generalized sense – also applicable to engineering and policy.

In this START_it_up core model available and generalized knowledge is consolidated by standards, which are comparable to wedges preventing quality from “rolling” back on the sloping ramp of improvement. Standards are understood in the broadest sense and can be, either “de facto” standards which means they are followed by informal convention or dominant usage, “de jure” standards which are part of legally binding or generally agreed contracts, laws or regulations, or voluntary standards which are published and available for people to consider for use. Concerning the societal treatment of risks (risk policy), standardization often means the process of establishing standards of various kinds and improving efficiency to handle the risk acceptance of society as well as the related interaction and communication among people. Examples include the formalization of safety decisions by governmental institutions and authorities in catastrophe managements, and establishing uniform criteria for common safety levels (protection goals). Standardization in this sense is often discussed along with large-scale social changes as modernization, homogenization, and centralization of society.

In principle this START_it_up model of quality improvement by knowledge consolidation is applicable to any of the processes in risk management, engineering and governance. The model is meant to visualize the principle of quality improvement and quality assurance. Although the specific projects and results of START_it_up are quite heterogeneous and require adapted approaches to quality improvement, the model provides a good visualization of the meaningfulness of acquisitions, consolidation and generalization of knowledge in all sectors of natural hazard engineering and risk management (governance).

In other words: The model shows – bolt and simple – the common understanding of safety quality improvement of a interdisciplinary group of experts in the START_it_up partnership.

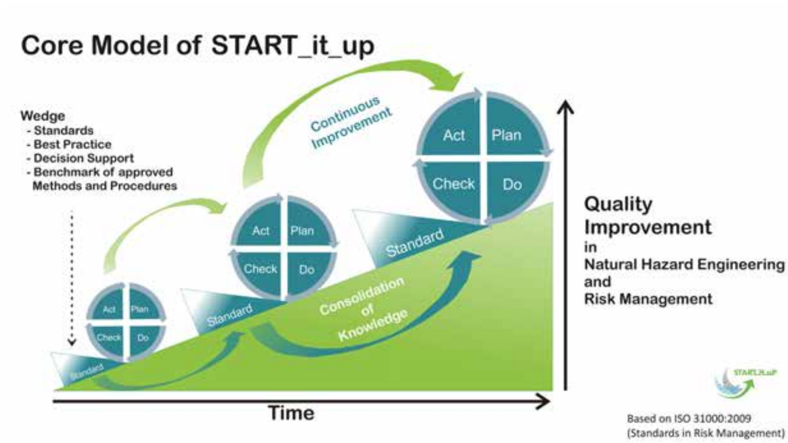

Figure 4: Quality improvement model based on APDC-cycle (inspired by ISO 31000:2009)

This model is a clear and easy understandable representation of the START_it_up objectives. However, one must recall that it should be considered as a conceptual proposal and a "way of thinking" rather than a definitive solution. Some issues related to process quality assessment in the context of natural hazards still remain:

a) First, in many cases, standards should be considered as a shared information or practice rather than a fully normalized document (such as ISO, Afnor, …) standards. To a certain extent, standards should be supplemented by indicators: indeed, quality exists if and only it is possible to check or measure its achievement. One input of the START_it_up project has been to share this point of view and prepare the evaluation process rather than providing a definitive unified approach.
b) Secondly, in the natural hazards contexts, information is often fragmentary and it is not always easy to apply directly methods coming from industrial context. As an example, safety and reliability analysis is currently used for technological devices. However, the application of this technique to natural hazard context is not direct. Technical systems, such as protection works are closely linked to a natural environment and it remains quite hard to determine systems failure probability in comparison with an industrial, fully monitored device.

Decision making in risk management: indicators and benchmarks for quality improvement

Risk management decision processes appear as quite complex. Therefore, it appears that the decision contexts have to be clearly described in order to be able to contribute to decision support systems. A deep dialogue with decision-makers is needed. Key issues consist in correct modelling of the decision problem, information imperfection assessment and decision support systems validation. To model the decision problem, corresponding to strategic regional or local decisions, a simple 5WH approach is proposed to describe decision context (Figure 5): **W**hat, **W**hy, **W**ho, **W**hen, **W**here, **H**ow is it decided? (see the generic framework proposed in the ASP-Paramount project). Several cross-cutting methods are available and must be used (e.g. multi-criteria decision-making, dependability, reliability and safety analysis, numerical modelling, uncertainty propagation, expert-based models, economic approaches, geographical information systems) (Figure 6). Economic approaches such as cost-benefit approaches (CBA) are perfect but they rely on strong assumptions about probabilities and monetary estimation of losses which are known to be questionable when dealing with cost of human life, indirect and remote effects of phenomena.

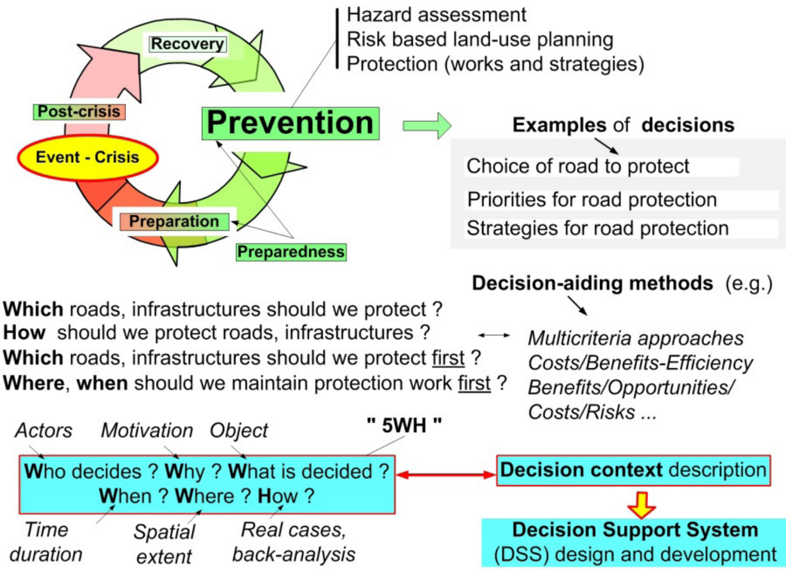

Figure 5: Decision processes have to be clearly described (Tacnet et al. 2012 – Paramount project)

At the end, quality indicators in risk management process can be summarized as follows: Number, nature and diversity of used methodologies.

The use of the state-of-the art concepts is required with at least bibliographic and critical comparison with other existing approaches. No single approach (e.g. numerical modeling, economic approaches, expert assessment) should be used exclusively. Integration of approaches should be the rule (Figure 6).

1. Use/number of ad-hoc frameworks to consider information imperfection: practical needs and usability should not lead to ignoring lack of used methods and knowledge.
2. Data, information and reasoning processes traceability level: clear description of hypothesis, tools, sources of information, methods, knowledge capitalization level etc.
3. Information imperfection quality and sources reliability assessment levels: any decision process should be documented. Any numerical modeling should be associated to uncertainty, sensitivity, robustness analysis.
4. Adaptation level of decision-facilitating methods: references to state-of-the-art existing methods, design and validation process have to be discussed and should integrate a critical analysis. A clear elicitation of decisions contexts is always needed.
5. The ability to assess effectiveness, quality of measures, strategies decisions: risk management decision processes and related decision support systems must include a way to assess their validity and relevance.

6. Interoperability, sharing of information and tools has to bee proven and tested (particularly in a trans-national European perspective).

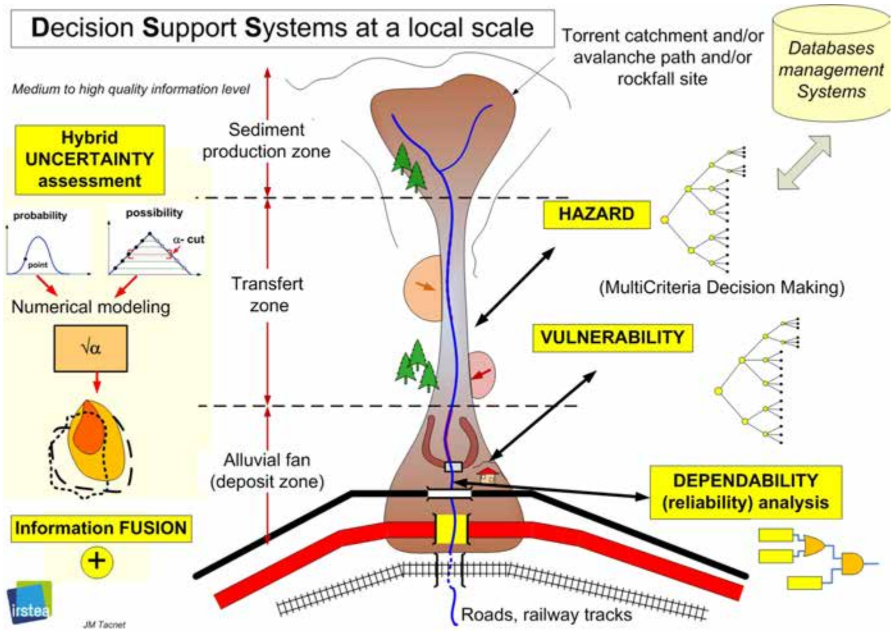

Figure 6: Methods have to be integrated in the risk management process (Tacnet et al., 2014)

(New) developments have recently been proposed and can be (are already) implemented in practice and used as standards (see CSP) but to move from the classic approaches, some needs remain:

1. To assess and propagate information quality (uncertainty) in risk management process;
2. To use decision-aiding methods (e.g. multi purpose, multi-scales decision-contexts identification, comparison, benchmark);
3. To assess risk reduction measures, protection works and strategies effectiveness: safety and reliability-based techniques implementation, introduction/ assessment of resilience concepts;
4. To integrate approaches (technical, economic): move from the classic approaches (physics) to real, multi-scale, integrated decision support systems;
5. To improve and develop information systems developments (e.g. traceability, interoperability (sharing), crowd sourcing).

PROCEDURES (TOOLS) FOR CONSOLIDATION OF KNOWLEDGE AND QUALITY

Consolidation through standardization and harmonization

The most direct and tangible strategy of consolidation of knowledge is by standardization and harmonization. Standardization, on the one hand, describes a framework of agreements to which all relevant parties must adhere to ensure that all processes associated with the creation of a object, technical system, process or service are performed within set guidelines. This is done to ensure the end product has consistent quality, and that any conclusions made are comparable with all other equivalent product in the same class. Harmonization, on the other hand, aims at the creation of consistent regulations, standards and good practices, so that the same rules will apply to as many actors and institutions in one or more countries. The principles of standardization and harmonization apply as well for engineering and technology as for policy and governance.
A *technical standard* is an established norm or requirement in regard to technical systems. It is usually a formal document that establishes uniform engineering or technical criteria, methods, processes and practices. A technical standard may be developed privately or unilaterally, for example by a corporation or regulatory body. Standards can also be developed by groups such as expert networks, associations of institutions or working parties. Standards organizations usually develop voluntary standards: these might become mandatory if adopted by a government. *Harmonization*, on the contrary, is usually not comprehensive but is relatively partial and unsystematic. It takes place either on a overarching level of governance or by individual actors and is focussed on specific topics of common interest. The instruments of harmonization aim at change,

Figure 7: Standards in natural hazard engineering and risk management (examples)

in particular improving and establishing consistent conditions for the operation of engineering and policy principles.
There are several manifestations of standards existing. Most existing standards emerge as “de facto” standards as a consequence of an informal convention or dominant usage fostered by the market or traditional techniques or procedures in engineering. In a next step standardization organizations (e.g. ISO, CEN, EOTA) issue voluntary standards, which are published and available for people to consider for use. Governmental organizations transfer voluntary standards with high relevance for public safety and health to “de jure” standards which are part of legally binding contracts, laws or regulations. Standards become mandatory either by being incorporated into a legal act (law, ordinance) or by an act referring to normative document (former voluntary standard). Legally binding standards as a rule are publicly accessible without restriction and free of charge, while some voluntary standards are customary. There are at least four levels of standardization: *compatibility, interchangeability, commonality* and *reference.* The existence of a published standard does not necessarily imply that it is useful or correct. The people who use standards or related services (engineers, trade unions, etc.) or specify it for application (e.g. building codes, governmental ordinances, industry) have the responsibility to consider the available standards, specify the correct one, enforce compliance, and use the item correctly. Furthermore voluntary standards need not be applied if tantamount or better techniques or procedures are applied.

Figure 8:
Flexible rockfall barriers are subject to technical standardization and approval (picture by Rudolf-Miklau)

A basic principle of START_it_up was to make standards publicly accessible free of charge as far as possible or at least transfer standardized knowledge into an applicable form. Thereby it was not the target to establish an additional standardization organization or working party on transnational level; it was rather the goal to fill the abundant gaps which exist in general standardization processes, to satisfy the specific needs and cope with the peculiarities of natural hazard engineering and risk management. START_it_up fosters tailored standardization (harmonization) by a clear 4-“I”-procedure:

1. Identification of knowledge appropriate for standardization and harmonization;
2. Integration in a comprehensive “best practice” in natural hazard management and risk governance and compilation in a knowledge pool;

3. Implementation and trial for usability;
4. Initiation of a formal standardization process.

Explicitly ETC/national project results were gathered, completed, selected and benchmarked, compiled in the web 2.0-database, discussed on expert level in conferences, workshops and a policy dialogue forum, tested for usability in practice and finally disseminated as approved standard or best practice. The dissemination was carried out within an institutionalized expert networks in close cooperation with the observers. If useful the quality label "state-of-the-art" was authorised together with participating authorities or standardization bodies and approved by evaluation and review of an expert panel.

Consolidation through quality assurance in expert decision making processes

The risk management process is a complex decision framework related to different geographical areas (release area, displacement track and deposition zones). It involves multiple actors (e.g. public bodies, technical experts, decision makers, concerned public) during the different temporal steps (crisis management, recovery, prevention and preparation) in the risk cycle (Figure 9). Information is collected and processed during to help and make decisions. Classical corresponding to hazard, vulnerability and risk assessments are often based on technical, physically-based methods. However, needs for integration, information quality or uncertainty assessment and propagation are

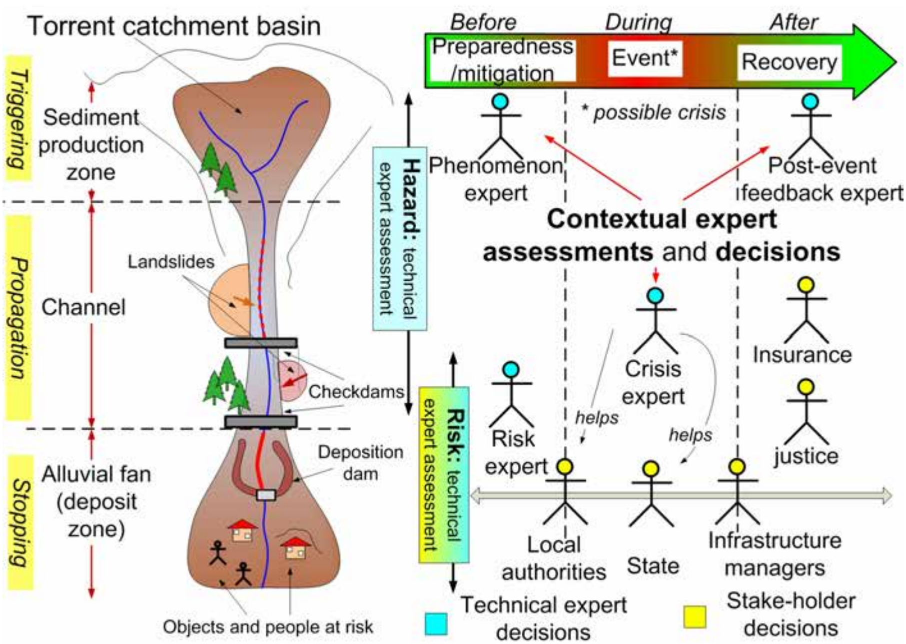

Figure 9: Complexity and context of decisions related to mountain risk management (Tacnet et al., 2014)

recognized. A global information quality management framework in the risk management process is expected and proposed in the START_it_up project (see also InterReg Alpine Space PARAmount project).
Risk managers, local authorities and infrastructure managers face different decision needs corresponding, as an example, to the choices of best combination of these structural and non-structural measures, to the choices of the best maintenance strategy or to chose the most cost-effective protection concept. Decisions often result from a combination of several sources (e.g. expert assessments, eye-witness accounts, numerical modelling, historical databases). However, making those best decisions in the event of a natural hazard in mountain region encounters problems in the assessment and management process because of the lack of information and knowledge on natural phenomena and the heterogeneity and reliability of the information sources available (e.g. historical data, field measurements, and expert assessments). Decisions are therefore often based on imperfect information (uncertain, imprecise, incomplete, conflicting) provided by multiple and heterogeneous sources (e.g. numerical models, expert assessments, Geographic Information Systems (GIS) or historical databases).
The START_it_up project is a capitalization project aiming to identify the "state of the art", which also refers to standard process and expert decision quality (reliability). One major goal was to assist decision-making and to trace the expertise process while considering the availability, quality and reliability of information content and sources. In the START_it_up project, users and decision–makers are the center of the development target. One input of the project is therefore to extend the classical approaches, somewhere hazard-focused, to more decision- and information-based approaches.
Classical approaches are mainly based on physical and deterministic approaches to assess hazard, vulnerability and then risk using expert assessment and numerical model-

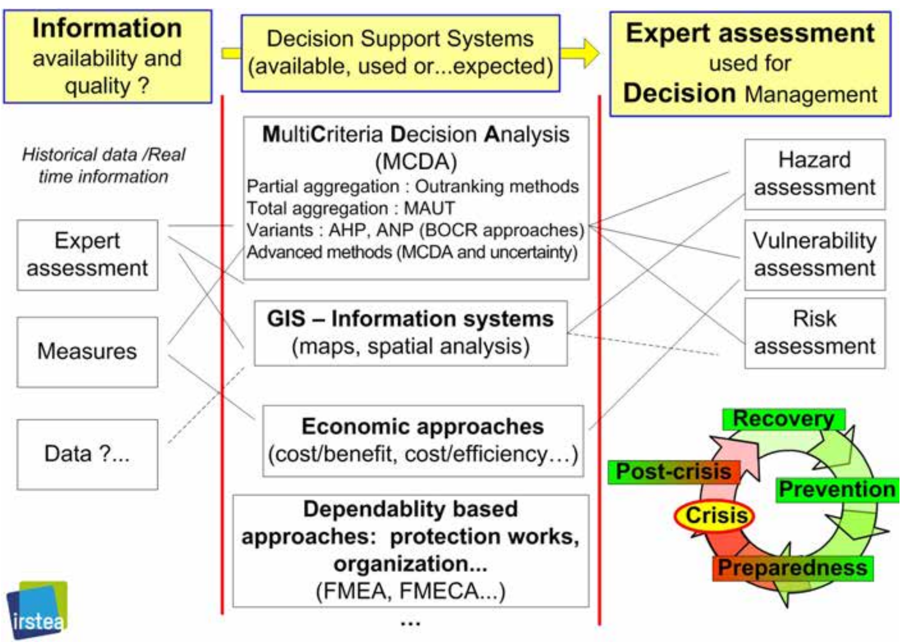

Figure 10: Different tools and methods involved in the information-decision-expertise process (Tacnet, 2014)

 ing. However, decision-making is often the expected result of all technical assessment steps. Recent developments and approaches have been proposed to introduce a more decision-based approach and also to consider the information imperfection assessment and propagation in this global process. This requires a realistic analysis of the decision processes and also a review of existing methods to help decision and also to assess information imperfection. The input of START_it_up report are based on recent developments included those related to decision-making processes that should be considered in new developments and guidelines to be developed or adapted. Some of them are already usable in practice with some remaining needs to transfer: that is the reason why this contribution is important and useful in the START_it_up project as much as a state-of-the-art contribution than possible recommendations. It provides an overview of available and needed techniques to improve the risk management process (Figure 10).

Concerning the decision-aiding methods, conclusions of the project START_it_up can be summarized as follows:

- Decision-making methods appear as a valuable complement to classical approaches since they allow to formalize and to trace the reasoning process.
- Decision processes description is essential but not so easy: even if the domains, the physics of phenomena are the same from one country to another, legal, technical, administrative frameworks remain different with consequences on expected standards.
- Integration of knowledge management, information capitalization is crucial (specific information systems are needed). Specific methods can be used to gather bibliographic, technical and scientific information.
- Information traceability (data, models, hypothesis) from raw to processed data (in expert assessment, legal documents such as risk prevention maps) is needed.

Consolidation through transnational assessment and benchmark of methods and procedures

A quality improvement process in Mountain Natural Risk Management (MNRM) has to be consolidated by a bottom up participative assessment reaching all stakeholder's type. It should involve not only high level experts, researchers and politicians but also practitioners and local decision makers to ensure that real needs are effectively identified, that relevant problems are tackled and that adequate propositions are prepared for governments.
The institutional framework for quality improvement in MNRM has already interested organizations at transnational level with the existence of groups of experts in NRM like the PLANALP platform under the Alpine convention, INTERPRAEVENT, FAO, WPMMW, etc. START_it_up activities reinforced tools of INTERPRAEVENT (START_it_up platform and database) in order to facilitate knowledge sharing and networking between international experts.
Those existing transnational structures if they have the aim to play a role in transnational assessment of methods and procedures in MNRM should be first of all reinforced with the participation of officials of all states belongings to the Alpine space which is not the case for the moment (there is a need for an institutionalization process to make transnational assessment possible). As they are already playing a role of reviewers for scientific workshops and publishing of reports, existing experts groups will be there-

Institutional framework for a bottom up transnational assessment of methods and procedures

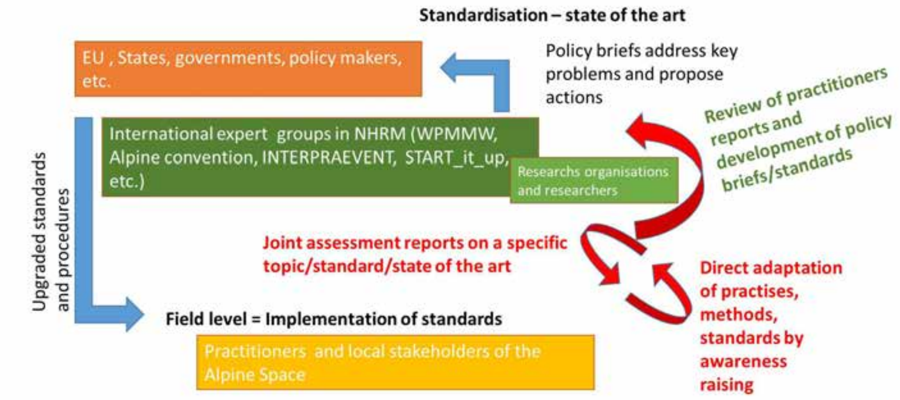

Figure 11: Institutional framework for a bottom up transnational assessment of methods and procedures (by Delvienne)

fore appropriate to review transnational technical assessments. Policy briefs, issued from the review of transnational assessment reports, should be one of the product of international experts groups that contribute to quality improvement and to the establishment of common standards.

Consolidation through solution-oriented knowledge

Throughout the distinct problem solving phases in natural hazard engineering (i.e. diagnosis or system analysis, prognosis or expected system development and synthesis or

Figure 12:
Laboratory models support the solution of complex engineering problems that cannot be solved by traditional methods or even numerical modelling (by die.wildbach)

system design) a solution-oriented knowledge management is required. This entails an integrated and balanced use of knowledge

1. from event documentation or subjective sources (empirical approaches),
2. from the application of numerical models and
3. from the insights gained from scaled laboratory models.

Whereas the state of the art in event documentation is well established for all process types, professionally applied numerical modelling and as well laboratory experiments are, so far, fully reliable only for floods and bed-load transport process characteristics. However, extensive research with a great progress and a potential added value for practical applications has been accomplished in the last decades, both, in numerical and experimental modelling of debris floods and debris flows (e.g. Rosatti and Begnudelli, 2013). For the performance assessment and the design of specific torrential hazard mitigation measures, still more effort is required in order to provide reliable numerical models or modelling approaches which are applicable to situations in practice and thereby fully accepted by the stakeholders.

The illustrated limitations should, however, not discourage the application of numerical models and laboratory experiments, since, conversely, through backward oriented knowledge generation approaches, the interpretable problem spectrum is limited to what past events highlighted and serious difficulties may arise both in quantifying process intensities and frequencies. Moreover the pure backward oriented strategy is practically useless for inferring possible process behaviors outside the occurred range of historical hazard events. This strategy alone is suitable for a complete and verified system design if and only if perfect analogy and comparability with previously solved problems exist.

Reflecting the available approaches within the solution-oriented knowledge generation process, a considerable mutual dependence between the different knowledge sources becomes apparent. Basically, numerical-mathematical simulations as well as laboratory experiments require the availability of data from field surveys and historical event documentations for an adequate parameter setting and for the models calibration and validation. Furthermore, regarding the zone of influence and the impact area of specific torrential hazard mitigation measures, numerical models are often applied to a larger extent. They provide process input data for the laboratory experiment (Figure 12), which is specifically focusing on the mitigation structure within a rather small area. They also allow for an assessment of the mitigation measure on a considerably larger scale. Accordingly, with the intention of a comprehensive solution-oriented knowledge management, the consideration of all approaches and their interrelationships appears mandatory.

Consolidation through decision support by approved methodology and tools

The natural hazards risk management improvement involves the consolidation of decisions based on approved methodologies and tools. Even more, in this time of economic hardship, the solution of the problems related to the management of natural hazards through the implementation of defense structures (e.g. artificial avalanche release systems, Figure 13: GazEx) appear anachronistic and inappropriate. Often, in fact, the creation of these structures, costly in economic terms, solve specific problems linked to very specific cases. Moreover, these works require, in the following years,

Figure 13: The effectiveness of new technology in risk management (here: GAZ-EX © avalanche release system) requires reliable and approved methodology for support of decisions by responsible experts

major interventions for maintenance and to ensure their effectiveness and efficiency. Vice versa, the implementation of consolidated methodologies and tools allows to extend the solution of the problem to wider geographical areas that are not related to a specific problem or territory, but which may extend to all natural hazards risk even beyond national borders. All of this involves a lower economic resources expenditure with the advantage of extending the benefit to a greater number of end users.

Of course, the tools and methodologies, to be effective and to meet the real needs of land management, have to pass through an attentive validation phase, which can require years of testing and controls. This validation phase consists of surveys and tests on experimental sites, but also on the real sites where to apply the methods, to identify their strengths and weaknesses and try to extend the methodology to wider regional contexts. Even in this case, as in the design of engineering structures, still more effort is required in order to provide common natural risk management methodologies, through the development of reliable numerical models or modeling approaches which are applicable to situations in practice. In addition, the management implications arising from the methodologies application should be fully accepted by the stakeholders. These land management methodologies and tools in relation to natural hazards, more often, are closely linked to innovative technologies that, over the years, with the improvement of technology, can make evolve them, hand in hand, without changing their functionality and, especially, with a limited cost. These innovative technologies, very often, concern the communication of information to the citizen. This means, therefore, that the land management methodology is more accessible to the citizen, making it more conscious and involving them in decision-making processes that often seem imposed from above.

Example of the methodology applied to land management within the project Start_it_up is the development of web platform to support decision-making for the CLV. A tool that required a small cost, but that allows you to optimize the management of avalanche risk on an entire region.

Consolidation through good governance

Good governance in sense of risk governance incorporates criteria as accountability, participation and transparency within all procedures by which risk-related decisions have to be made. Participation means that the specific public should get involved already on an early stage of risk management. The interest in participation depends on the degree of affection and hence mainly proper information coming from authorities is needed. On the other hand participation of stakeholders is an advantage for decision makers and risk managers because valuable information can be gained. Nevertheless participation can be offered in several ways but should be adapted to the needs and the number of possible stakeholders.

Transparency in risk management also means to make information on natural hazards publicly accessible. Possible affected persons should at least have the chance to reach information – nowadays digitally. As information on hazards is often too specific additional attributes and "how to be used" information has to be added. For example, hazard profiles, which have been elaborated in the previous AdaptAlp project (incorporating all typical alpine natural hazards), were revised concerning layout and usability within START_it_up. With that potential users have the possibility to see their own affection by natural hazards at a glance.

Stakeholder involvement is preferably achieved by public workshops, discussion forums and negotiation processes taking into account a non-homogeneous level of information (risk perception), conflicting expectations and various willingness to compromise. Furthermore these processes bring face to face expert and laypeople views, public

Figure 14a: Involvement of stakeholders during the "flood-day" in Klagenfurt (Austria)

Figure 14b: Involvement of stakeholders during the elaboration of the flood operation map in Hermagor (Austria)

and private interests as well as economic, ecologic and social perspectives. A good example is the integrated flood risk management.
As within the elaboration of the EU-flood directive several public bodies are affected it seemed to be useful to involve stakeholders already on an early stage by informing them on:

- how and how much they are affected,
- which steps are needed concerning their involvement,
- which possible gaps in their own risk management could be found
- and how possible measures to fill gaps could look like.

Although the risk cycle shows all necessary measures of integrated risk management at a glance in practice several steps are processed by different units. Hence there is a need to fill these gaps by further intensive communication. Generally on municipal level hazard maps are mainly used as the basis for structural protection measures and spatial planning (passive protection). As hazard maps show potential threats of natural hazards they already include indications for possible disaster control measures. But to define possible intervention measures for stakeholders from disaster control stakeholders already need to be involved in the process of definition.
Even if the involvement of stakeholders seems to be a logical step, in practice participation takes additional resources, work and time. But there is a huge advantage concerning results after stakeholder participation: under professional guidance problems, chances and solutions can be highlighted from different point of views.

SELECTED PRODUCTS AND OUTPUTS OF START_IT_UP

Preface

START_it_up was designed as a capitalization project aiming at the refinement and dissemination of knowledge and innovation from preceding ETC-, transnational and national R&D projects. Products and outputs of the project partners aim to meet the requirements of

1. contributing to a common state of the art,
2. support and improve expert decision quality,
3. representing solution- and application-oriented knowledge and technology,
4. being approved by testing, validating, formal certification and recurrent application, and
5. being commonly accepted as good governance or good practice.

The following examples demonstrate the added value of the capitalization process performed in START_it_up for safe and efficient solutions in natural hazard engineering as well as sustainable strategies and procedures in risk management and governance. The paramount importance of standardization as a principle and mean to consolidate and disseminate knowledge gets comprehensible. (The examples shown in the CSP were selected as representative actions, further projects of START_it_up are presented in the Final Booklet, published digitally.)

Example 1: State of the Art for monitoring and warning technology for debris flows

Monitoring can be defined as »the systematic repetition of observations of a particular object or area«. For debris flows (DF), different monitoring parameters can be selected, generally grouped into triggering parameters, such as precipitation rates and/or intensities, and process parameters (transport/dynamics parameters), such as direct ones (head height, flow depth, head/flow velocities, impact and shear forces) respectively indirect ones (ground motion/seismic waves, air motion/air waves/acoustic emission). Different measuring devices are applied for each parameter: for precipitation different types of rain gauges (standard, tipping bucket, weighing, optical, acoustical) and distrometers; for transport/dynamic parameters different types of laser (optical) sensors, high speed video cameras, acoustic (ultrasound) Doppler radars, vibration sensors (geophones), (differential) pressure transducers etc., or simple wire sensors and light sensors across a DF channel at selected elevations. All continuous/discrete monitoring data must be recorded by such sensors and then transmitted and stored/archived in a database (digital archive); a secure energy supply of the monitoring system is also important. For a successful DF monitoring system, a well-tuned/integrated/validated system of individual components (sensors, data loggers, control units, communication units, energy, and storage devices) is essential.
Early warning system (EWS) was defined within the EU 7th FP SAFELAND as »The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss«. The UN-ISDR defines 5 key elements of the human-centered EWS: a) knowledge of the DF risk; b) monitoring, analysis, and forecasting of DF hazards;

c) operational centers; d) communication or dissemination of alerts and warnings; e) local capabilities to respond to the warnings received. The EWS are usually based on DF hazard maps (hazard zones within the maximum run-out zone), meteorological forecasts (rainfall forecasts, rain radars), and monitoring data from hazard areas, issuing DF pre-trigger warnings (using different empirical thresholds) or post-trigger warnings (event triggered warnings). The EWS is normally associated by evacuation plans/guidelines and/or safe sheltering, including instructions for closure of transportation routes, and must therefore run in real time, allowing large enough lead time for preventive actions.

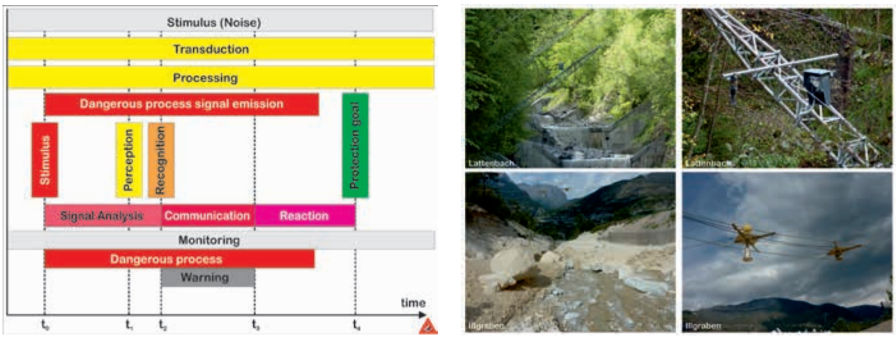

Figure 15: System of debris flow monitoring and warning technology, examples (Hübl & Mikoš, 2014)

Example 2: State of the Art in protection work effectiveness assessment in European Alpine Regions

According to this global context, this study was focused on decision-making related to protection works effectiveness assessment methods. It describes particularly multi-criteria decision making methods and methodology, safety/reliability and dependability analysis based methods and also economic approaches. The developments described below consist in

1. the analysis of existing methods to assess economic effectiveness, and
2. an application example of multi-criteria decision-making method: the chosen decision context relates to consideration of protection works into land-use planning regulation rules.

All over European mountainous regions, protection systems against natural risks have been set up to reduce natural risks for more than 120 years. For instance, in France, more than 19,000 works have been built in French public forests since the end of the 19th century. Different types and scales of protection systems exist ranging from isolated (protection) work, such as dams, snow-nets or barriers, to group of works (so-called device). Analyzing and comparing their effectiveness to reduce risk with their cost (investment and maintenance) is a key question in the risk management process.
For isolated and device scales, the effectiveness assessment is mainly technical: how far do civil engineering structure resist to the defined constraints? How far do they fulfill their planned functions? Assessment is generally based on expert knowledge and indicators can be different from one country to another. Comparing indicators and using dependability analysis improves these technical assessment. At the watershed scale, protection systems aim to reduce the risk. Their effectiveness is directly related to their

effect on risk reduction introducing economic questions. At this scale, the main questions are: what is the baseline risk, without protection? What is the effect of protection on risk? Defining a common risk definition and analysis method between European countries is possible but need to be compared with implementation. To analyze the effect of protection works, the combination of expert knowledge and numerical or analytical modeling is usually used. Methods (including their limits) and applications in different countries are compared. Taking decisions needs knowing risk reduction impact and costs of each strategy to compare them at each system scale. The Cost-Benefit Analysis (CBA) is the most used method. It is based on a monetary valuation of costs and risk considered as an expected value of damage. Other decision-aid methods exist: the MCDA-methods can integrate non monetary cost and damage. Considering physical effectiveness and related effect of protection systems is still needed. Integrating structural and functional analysis of protection systems is essential to estimate their effect. For each phenomenon and system, common indicators have still to be defined (including their imperfection representation).

Following a continuous improvement process, land-use planning rules updates are under consideration. In the framework of the project, the contribution consists in a methodological contribution to decision-maker's needs (e.g. MEDDE). The question under consideration are: how to consider (or not to) protection works in risk prevention plans (PPR)? The principle is not to provide a new regulation rule but to show how technical inputs related to decision-making methods, safety and reliability analysis can contribute to such a decision process, introducing and using new approaches and methods which are candidate to become future standards. The inputs of the methodology is to identify needs and practices, terminology and glossary, to formalize expert knowledge and to propose a practical implementation of multi-criteria decision making method. Different multi-criteria decision-making methods exist but this application shows that those techniques have a valuable added-value to help decisions. Using the proposed framework is a way to trace and improve the decisions processes.

The outputs of this action in the START_it_up project are described below

1. a state-of-the-art in France to value costs and benefits of flood management strategies in France with a critical view on their drawbacks and applicability in the context of mountain torrent floods,
2. the proposition of a global framework to analyze the different features of protection works effectiveness including structural, functional and economic approaches (Figure 16),
3. the introduction of the use of decision-making methods to assess the indicators related to protection works effectiveness, and
4. the application and use of decision-making method and safety/reliability/dependability analysis concepts to land-use regulation guidelines update (consideration of protection works in risk zoning application).

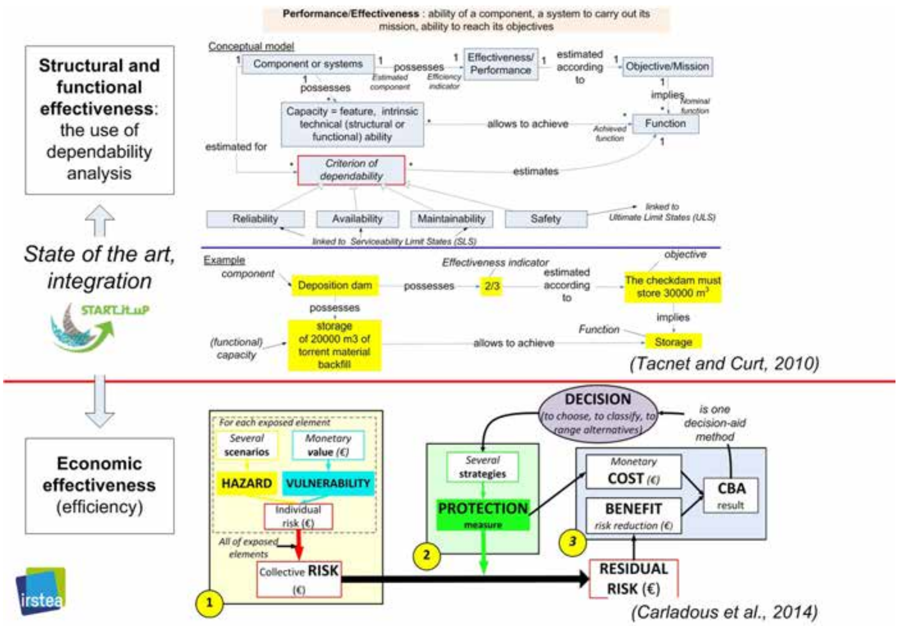

Figure 16: Structural, functional and economic features of protection works effectiveness

Example 3: Vulnerability of strategic infrastructure

With respect to the vulnerability of strategic infrastructure recent research prevailingly explored graph-theoretic methods as means of both representation and assessment. In the field of natural hazard risk management, however, limited research efforts has been devoted to a thorough understanding of the vulnerability of strategic infrastruc-

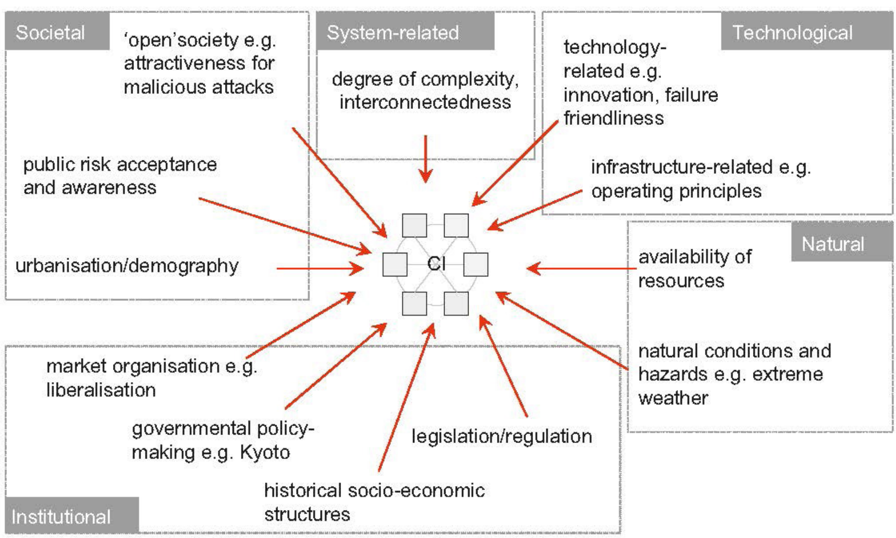

Figure 17: Factors shaping the risks faced by critical infrastructures (Kröger 2008)

 ture. Gaps exists in relation to data availability (in relation to quality, quantity, coverage and level of aggregation) for a complete and spatially reliable representation of the networks under consideration. As a consequence the representation of such networks is approximate and incomplete and external key variables are often neglected. In spite of these limitations network-based methods in combination with spatial and temporal assessment approaches seem to be appropriated to represent vulnerability of strategic infrastructure and capture its complexity.

As an examples of the usefulness and importance of a geo-spatially integrated approach one may consider the occurrence of a natural disaster, where a controlling authority (e.g. state government, private utility) may want to divert a node's power to serve only the areas with the greatest amount of people and the most critical infrastructure, such as hospitals, fire departments, and shelters. In this case, the controlling authority may choose to shut down substations that serve fewer people and divert that power to a node with larger concentrations of critical infrastructure and population.

Kröger (2008) identified several factors that can shape the vulnerability to critical infrastructure. These factors are categorized by: societal, system-related, technological, natural, and institutional. Societal factors include attractiveness for attack (exposure for natural hazard contexts), public risk awareness, and demographics. System-related factors include the complexity and inter-connectedness of the network. Technological factors include failure friendliness (propensity) and infrastructure related operating principles. Natural factors include availability of resources and natural hazards. Finally, institutional factors include historic structures, legislation, and market organization (Figure 17).

Example 4: CLV Platform for Avalanche Warning Service

The management of local avalanche hazard has always been one of the vital aspects in mountain areas. Besides being a job of great social commitment, it entails a deep knowledge of local territory and avalanche dynamics, snowpack formation and micro-Alpine meteorology. For this reason, with the innovative regional law n. 29/2010, the Aosta Valley (IT) has regulated the Avalanche Local Commissions (CLV), set up to support the local authorities in managing avalanche hazard.

- CLV are engaged in forecasting and monitoring of snow and weather conditions;
- evaluation of the snow cover stability;
- early warning, emergency management and intervention in case of avalanche hazard.

The 3.260 km^2 of Aosta Valley Alpine region (with total area exposed to avalanche hazard) has been subdivided into 17 zones (by grouping all 74 municipalities) in the urbanized territory, each under the supervision of one CLV.

To facilitate the management of local avalanche situations with uniform criteria and methodologies, thanks to the Alpine Space project Start_it_up, in collaboration with CELVA-Consortium of Local Authorities of Aosta Valley, the Region of Aosta Valley is starting the implementation of a platform for the visualization and data storage about snow, weather and avalanches as well as the verbalization of actions performed and suggested by CLV in avalanche emergency.

Based on the experience of Austrian colleagues, the platform is developing through open source tools and frameworks to reduce the cost of software managing and the hardware architecture will support plug-ins to facilitate future new deployments (Segor et al., 2014).

Figure 18: The new platform supports and documents the decisions of local avalanche commissions (CLV)

Example 5: Best-practice guidelines for the implementation of forest protection function in the NHRM of shallow landslides

Shallow landslides represent a relevant process in the alpine regions and are related to different types of risks. The demand for common standards in this field is strongly requested in order to support the better quality and reliability of expert decisions and public administrations. The project START_it_up has offered the possibility to contribute to the international knowledge exchange on the analysis and quantification of shallow landslides in the context of "resource efficiency and ecosystem management".
Within the context of the standardization of natural hazard engineering and risk management, the study provides an overview on the "state-of-the-art" for best practice methods and to promote a knowledge exchange on the characterization and quantification of shallow landslide processes in the alpine region. A review was carried out in four thematic sections that summarizes the information of seven alpine countries:

1. Event analysis,
2. Mapping and modeling,
3. Slope instabilities in torrent processes, and
4. Implementation of protection forests in shallow landslide hazard analysis.

In the presented review we describe the state-of-the-art of these four major topics related to the assessment of shallow landslide hazards in the alpine countries. We pointed out the efforts that have been made in the past decades to set up databases on event analyses in different levels of detail, and how this information has yet to be implemented in the hazard assessment. We identified major improvement potential in the detailed description of events (e.g., more information about vegetation cover) and in the application of remote sensing analyses. We showed that there is wide heterogeneity regarding the state-of-the-art of shallow landslide hazard analyses and mapping across the alpine regions. In some countries, shallow landslides hazard analyses are supported by detailed thematic information (geology maps, soil maps, digital elevation models, etc.) and results of numerical models (e.g., some hazards maps in CH), whereas in other countries shallow landslides are not even considered in hazard mapping. In a wider context, there is the general agreement that shallow landslides are also important processes for hazard analyses at catchment scale, in relation to debris flows or flood hazards. Therefore, a better quantification of the interaction between shallow landslides and torrential processes should be strived for in future. In particular, the lack of quantitative tools for the assessment of such processes at practical level needs to be improved, possibly by the further adaptation/development of existing research results (Mazzorana, 2014). Finally, we discussed that although the protection effect of forests against shallow landslides is recognized in all alpine countries (from a cultural and legislative point of view), the lack of quantitative methods is causing difficulties in the consideration of the effect in hazard/risk analyses. For this issue, further research is needed in order to provide more solid knowledge for practical application.

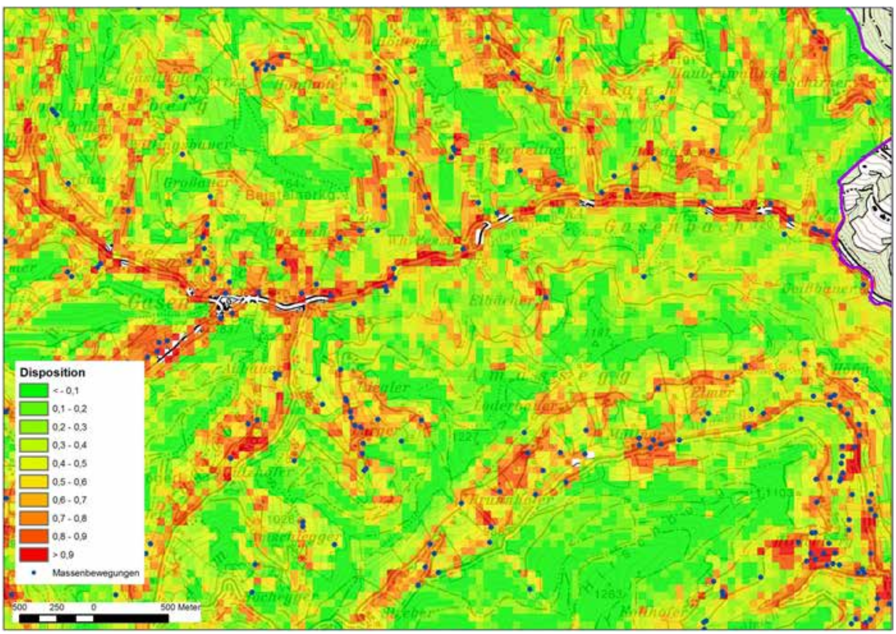

Figure 19: Modelling the disposition for shallow landslides in the area of Gasen and Haslau (Styria), based on documented events of the catastrophes in 2005 (© Geological Survey of Austria)

Figure 20: Risk Policy Dialog in Hinterstoder (Austria): A new format for expert think-tank in risk governance

Example 6: Risk Policy Dialogue

Risk communication is an emerging topic which involves stakeholders from various disciplines and levels. There are various exchange forums in the context of natural hazard and risk management and in synergy to these the aim of the Risk Policy Dialogue was to create a new format for the interdisciplinary discussion and development of policy briefs in natural hazard risk management in the Alpine Space. This think-tank enabled a divers group of experts to discuss the topic of natural hazard risk management controversially, aside from daily business in a confidential atmosphere, which was ensured by introducing the so-called "Chatham House Rules" at the beginning of the event. The specific topic of the Risk Policy Dialogue 2014 was: "Risk communication on local level: Avoidance of conflict escalations within the evaluation of risks".
After a brief introduction the two-day event started with an excursion to a concrete example of conflict potential. In the next step this example was abstracted by a penal discussion and a very polarizing keynote presentation. Therefore the aim of the first day was to listen and discuss on conflict potentials and problems, however not giving any solutions. In contrary to the second day, which was a very active day for all participants. The program involved different discussion rounds and presentations of the subsequent results on potential solutions to the areas of conflicts that were collected on the first day. The different sequences were structured in a way that the broad picture was condensed and cumulated in a concise draft of policy briefs. After the event this common position was structured and a document was drafted before reconsulting the participants for their agreement.
Overall the event itself but also the format was appreciated by the participants which is also mirrored in the active participation and the profound results of the first Risk Policy Dialogue.

Example 7: Risk Technology Database and Network

One of the core products for capitalization within START_it_up was the launching of a knowledge platform and database for the provision of standards and documents regarding specific fields of natural hazard engineering and risk management. The concept of the database is either to provide and promote the results of START_it_up but also to collect available and approved good practice methods (provided by partners on a voluntary basis), standards and norms and make this information accessible. To have a quick overview for users about the status and applicability of these documents, all of them have to go though a system of classification and evaluation carried out by an expert panel. This expert panel reviews the uploaded documents according to certain criteria like the scope of application, bindingness and target groups. The documents themselves or the referring links will be published clustered in thematic fields on the publicly accessible part of the database.

It is important to notice that Start_it_up can only motivate partners to participate in this knowledge transfer, as intellectual property (copy rights) and liability for correct and safe application of methods have to be respected. On the other hand most of the innovations were financed by public funds and should therefore be public interest.

With the Natural Risk Technology Database START_it_up on the one hand gives institutions, researchers and experts the platform to present their good practice methods, norms and standards (on their own interest) and have them evaluated, and provides on the other hand a tool for practitioners and decision makers to easily find available documents and methods in the certain disciplines together with information about status and applicability.

To ensure the maintenance and it's currentness the database will be established within the framework of the INTERPRAEVENT website and is online with a constantly growing user community since April 2014.

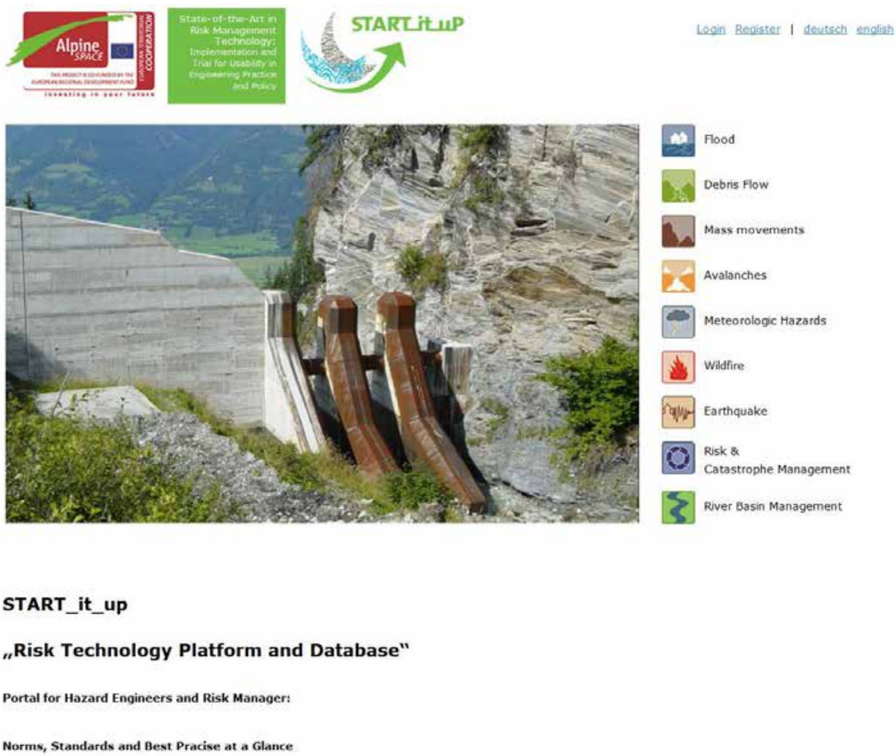

Figure 21: Risk Technology Platform and Database: www.interpraevent.at/start_it_up

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STRATEGIC RECOMMENDATIONS AND POLICY BRIEFS

START_it_up was designed as a capitalization project and therefore emphasizes existing in natural hazard engineering, policy briefs for risk governance and general recommendations for risk management at the European scale. The following recommendations and policy briefs shall be integrated in the strategies for societal and regional adaptation in the Alpine Space as well as in the goals and funding principles of the Alpine Space Programme 2014–2020.

Standardization and Transfer of Knowledge

Available knowledge and technology in natural hazard engineering shall be compiled and provided in standards and norms (de jure or voluntary), that are commonly approved and publicly accessible.
Relevant knowledge shall be provided in comprehensive, coherent and applicable form to political or administrative decision makers, preferably as standardized policy briefs.
Standardized knowledge shall be accessible for educational purposes (academic, professional education, in-job training) in form of courses, handbooks, best practice recommendations and through the internet. Knowledge transfer shall be based on commonly agreed definitions and terminology (also multilingual).

Expert Decision Support and Quality Assurance

Decision support methodology shall be established as standard (mandatory) procedure in all fields of risk management and governance.
Expert and policy decisions in risk management shall be based on the traceability of expertise (decision) processes and the reliability of decision-making basis.
Decision processes in risk management shall be defined and standardized concerning the decision steps, the tools and methodology and the quality assurance of data and information used.

Information Technology

Information on natural hazards and risks shall be publicly provided through the internet to the largest possible extent and comprehensible for all target groups. Information provision in a standardized form shall be a public task, while the use and application of this information shall be an obligation and responsibility of the user.
The classical data acquisition methods related to natural hazard process shall be enhanced to a standardized transformation of data into applicable information, adapted to the requirements of the target group and concerned public.
Information databases (e.g. CLV avalanche warning commission, Risk Technology Platform) shall be further developed and enhanced by implementing new functions and tools (e.g. statistical analysis, scenario assessment, sophisticated search functions), furthermore a transnational use shall be reached by multilingual (GE, FR, IT, EN, SLO) content.

Risk Assessment and Documentation

Standardized procedures (tools) for documentation and acquisition of information on hazard events (especially mass-movements) shall be established; furthermore uniform nationwide storage of event date in central databases shall be brought into use.
A commonly approved benchmark framework on process simulation and application of process models shall be established in the Alpine countries aiming at comparable data quality, scenarios and assessment of model results.
A standardized method for assessment of damages (caused by catastrophes) including the economic valuation shall be harmonized and implemented by Alpine countries.

Hazard Mapping and Consideration in Development Planning

Common minimum (formal) standards for the public presentation of hazards and risk, furthermore for the application and consideration of hazard and risk maps in areal planning and regional development shall be harmonized among Alpine countries.

Hazard and risk scenarios and the related assessment process shall be further developed taking into account climate change. A common understanding of scenarios in a coherent form shall be established in an interdisciplinary form across sectors and target groups.
The legal and formal basis for the consideration of hazard maps (for all kind of natural hazard) in areal planning and regional development shall be harmonized among Alpine countries, following the example of the integrated approach of the European Flood Directive.

Protection Systems and Engineering Solutions

Comprehensive protection systems shall integrate structural and non-structural measures in the most efficient combination.
The priority of protection measures shall be assessed on risk-based economic criteria.
Protection forests shall be treated as green protective infrastructure in European (Alpine Space) environmental policy and funding principles. The prerequisite are harmonized standards for protection for protection forest mapping and condition assessment.

Early Warning and Organizational Measures

Standardized procedures in early waning and alert, including recurrent testing and training, shall increase the public trust in warning systems and reduce the risk of false alarm.
Efforts shall be taken to develop a real-time early warning system for landslides, facilitating a regional prognosis of risk due to meteorological, hydrological and geotechnical criteria.
Comprehensible threshold values for warning system shall be defined and communicated. Changes of these threshold shall be traceable and justified.

Good Governance and Stakeholder Involvement

A new think tank format for the discourse and exchange of experts, opinion leaders and decision makers shall be established as a recurrent event, such as the START_it_up Risk Policy Forum, allowing unbiased discussion and confidentiality in order to issue objective policy briefs.
New procedures and types of events shall be created and implemented in order to actively involve stakeholders and attract decision makers.
Good risk governance shall foster the resilience of society in the Alpine Space and aid to the reduction of vulnerability along the entire risk cycle.

Further Development and Research

A transnational network for the exchange of knowledge and technology, especially in the field of natural hazard engineering shall be established and further expanded integrating existing institutions like INTERPRAEVENT, PLANALP, IUFRO and FAO.
Connectional methods of decision making shall be subject to further research focused at the application for the solution of complex engineering problems.

START_IT_UP LINKS

Start_it_up Website
http://www.startit-up.eu/

Start_it_up Risk Technology Platform and Database
http://www.interpraevent.at/start_it_up/

Start_it_up Database for Rock Fall Embankments
http://www.interpraevent.at/rockfall/

CLV Web-Platform for Avalanche Warning Service
http://piattaformaclv.regione.vda.it/

State of the Art in mass movement susceptibility assessment

Project Partner: GeoZS
Author: Tina Peternel / Mateja Jemec Auflič

Areas of the Alpine regions are exposed to different types of slope mass movements. Slope mass movements that represent a common type of natural disasters can be generally divided into three groups: landslides, debris-flows, and rockfalls. In this investigation the main focus is on landslides but the presented approaches can be also used to assess debris flows and rockfall hazards susceptibility. In the following text the term "landslide" will be used as a term that might not always be strictly connected only to landslides but also to other slope mass movements. In a way it has a broader meaning.

Majority of slope mass movements events cannot be prevented, but they can be mitigated or avoided by applying different approaches of mass movements risk assessment. With using the appropriate approaches we can prevent losses or reduce potential future consequences. In general, susceptibility assessment represents prior phase of elaboration of risk maps and assessments. In this case risk is defined as a probability that on specific susceptibility area, elements at risk could be affected. The creation of a landslide susceptibility map is a challenging task comprised of many steps, from landslide data collection, through data analyses to susceptibility model calculation.

Fell et al. (2008) defined landslide susceptibility as a quantitative or qualitative assessment of the classification, volume (or area), and spatial distribution of landslides which exist or potentially may occur in an area. Susceptibility may also include a description of the velocity and intensity of the existing or potential landsliding. Landslide susceptibility zoning usually involves developing an inventory of landslides which have occurred in the past together with an assessment of the areas with a potential to experience landsliding in the future, but with no assessment of the frequency (annual probability) of the occurrence of landslides. Generally, landslide susceptibility zoning for determining slope instability due to landslides is based on simple landslide inventories or heuristic, statistical (including machine learning) or deterministic approaches. Statistical landslide susceptibility models are particularly useful for modelling large areas on a medium scale (1 : 25.000 – 1 : 500.000) to get an overview of which slopes or slope sections might be prone to landslides in the future (Fell et al., 2008), meanwhile the deterministic approach can be applied to a local susceptibility model at scale 1 : 5.000.

According to Van Westen (1993), the susceptibility assessment methods have been divided into four groups of analysis. The selection of one method over another depends on several factors: availability and the data costs, the scale, the output requirements, the geological and geomorphological conditions, the tectonogenetic and morphogenetic behaviour of the landslides, and computing capabilities of software and hardware tools. Firstly, inventory analysis, which are based on the analysis of the spatial and temporal distribution of landslide events and such inventories are the basis of most susceptibility mapping techniques. On detailed landslide inventory maps, the basic information for evaluating and reducing landslide hazard on a regional or local level may be provided. Secondly, often used heuristic analysis (Castellanos and van Westen, 2003) based on expert criteria with different assessment methods. Landslide inventory map is accompanied with preparatory factors to be main input for determining landslide hazard zonation and then experts define the weighting value for each factor. Many researchers utilize statistical analysis (van Westen, 1993; Komac & Ribičič, 2008; Komac et al., 2010), where several parameter maps are surveyed to apply bivariate and multivariate analysis. The key of this method is landslide inventory map when the past landslide occurrences are needed to forecast the future landslide areas. Deterministic analysis is based on hydrological and slope instability models where many researchers attributed a great importance to precipitation and relationship between rainfall and landslides to evaluate the safety factor and rainfall threshold (Dai and Lee, 2001; Guzzetti et al., 2007). One of the relatively new methods applied to landslide susceptibility assessment are artificial neural network (ANN) tools. ANN is a useful approach for problems such as regression and classification, since it has the capability of analysing complex data at varied scales such as continuous, categorical and binary data.

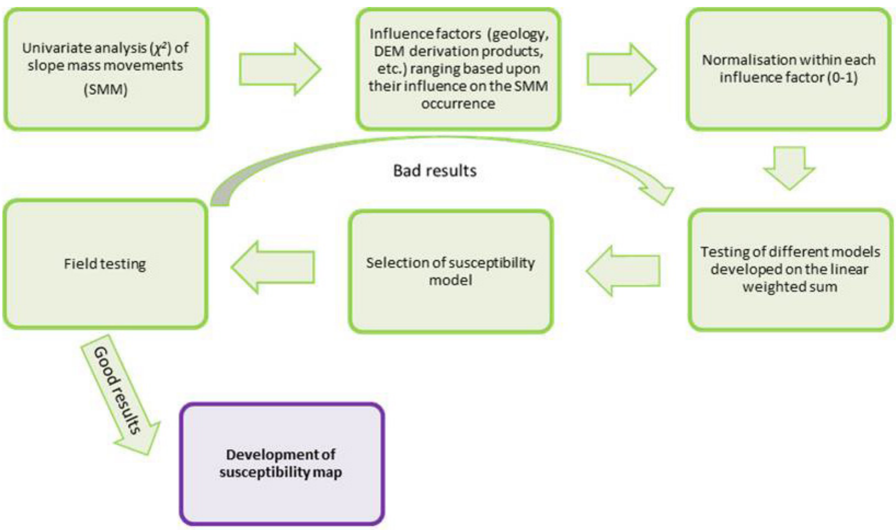

Figure 22: Conceptual model of development of general or detailed slope mass susceptibility maps (adopted after Komac & Jemec Auflič, 2011).

Within the project START_it_up approaches for the evaluation of slope mass processes used in the Alpine space were reviewed. Based on that, we can see that different approaches to elaborate slope mass movements susceptibility assessment are used. Selection of the approach mainly depend on data availability. Consequently, susceptibility maps have different accuracy and reliability due to using a variety of qualitative or quantitative input data. Many countries focused on remediation measures instead of producing susceptibility maps due to lack of the financial support, meanwhile in countries with high standard the approach to the topic is focused into prevention.
In Slovenia, deterministic, statistical, and probabilistic methods have been used to elaborate slope mass movements susceptibility maps. At the national level landslides (Komac & Ribičič, 2008), debris-flows (Komac et al., 2010), and rockfall (Čarman et al., 2011) susceptibility maps were elaborated. Landslide susceptibility model for Slovenia

 at scale 1:250.000 is based on the extensive landslide database that was compiled and standardized at the national level, and analyses of landslide spatial occurrence. Development of debris-flow susceptibility model for Slovenia at scale 1:250,000 was calculated using geology elements, intensive rainfall, derives of digital elevation model, hydraulic network, and locations of sixteen known debris flows. Rockfall susceptibility map (1:250.000) was elaborated based on lithology, slope inclination, distance to tectonics elements and expert knowledge (Čarman et al., 2011). Expert estimation approach was based on the experience and historical events. Recently, landslide susceptibility map for selected municipalities were also elaborated at the scale 1:25.000.

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Project Partner: BMLFUW/Carinthia
Author: Florian Rudolf-Miklau/ Catrin Promper

The EU flood directive streamlined the procedure of risk assessment and mapping in the European Union and it can be anticipated that this influences also the procedures related to the cartographical representation of other natural hazards. Therein it is important to elaborate a consensual approach among the different territorial entities for gravitational mass movements. For this reason a study and workshop together with the "ÖREK-Partnerschaft" (temporal partnership within the Austrian Spatial Development Conference) on gravitational mass movements, were carried out to exchange ideas and experiences on approaches on risk assessment and mapping.
The main topics addressed were state-of-the-art, minimal standards, applicability for stakeholders, possibilities to reach decision makers and the preparation of the maps for non-experts. The workshop revealed several areas of action wherein a coordinated and cooperational approach would be beneficiary:

- The public needs a simple set of rules, guidance and a presentation of the "positive" side referring to hazard delineation,
- Quality characteristics of maps for risk communication
- Interactive maps to meet changing needs of various stakeholders,
- Set of precise definitions for common use
- Appropriate layouts for different aims, scales and stakeholders
- For harmonization of methods an overview on currently applied methods is needed
- Public awareness for residual risk and the individual responsibility need to be strengthened
- Distribution of powers, responsibilities and financial aspects need to be regulated clearly to enhance efficiency.

The above points indicate clearly that the issues to be dealt with for common risk assessment and mapping related to gravitational mass movements are interdisciplinary. Therefore these need to be addressed jointly by stakeholders from administrative units of different levels, experts (e.g. Service for Torrent and Avalanche Control, Geological Survey), science but also communication experts, sociologists etc. Further recommendations to decision makers on key issues are an essential part of the harmonization

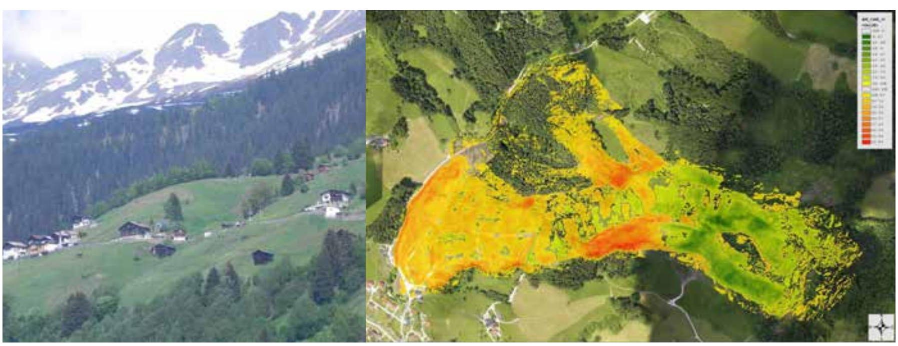

Figure 23: risk assessment and mapping of graviational hazards

process. This process is currently in an initial phase and it will last several years to implement common procedures for risk assessment and mapping for gravitational natural hazards. Concluding the major output of the workshop is the commitment to a common strategy that serves as basis to address the specific tasks step by step.

State of the Art for monitoring and warning technology for debris flows

Project Partner: GeoZS
Author: Matjaž Mikoš

Monitoring can be defined as »the systematic repetition of observations of a particular object or area«. For debris flows (DF), different monitoring parameters can be selected, generally grouped into triggering parameters, such as precipitation rates and/or intensities, and process parameters (transport/dynamics parameters), such as direct ones (head height, flow depth, head/flow velocities, impact and shear forces) respectively indirect ones (ground motion/seismic waves, air motion/air waves/acoustic emission). This variety of different measuring techniques/methods is making standardization of DF monitoring a hard task to be performed. In many cases, "old" traditional techniques are mixed with new methods applying advanced techniques. Anyhow, for a successful DF monitoring system, a well-tuned/integrated/validated system of individual components (sensors, data loggers, control units, communication units, energy and storage devices) is essential.

From the standardization point of view, it is important to see debris flows as part of mass movement processes resp. land slide process, i.e. according to the Cruden and Varnes (1996) landslide classification system; it uses long descriptions of the landslides with given activity, distribution and style, together with descriptions of first and second movement types. The DF under consideration should be classified according to Cruden and Varnes system. Furthermore, the task of the DF monitoring should be stated and the DF monitoring techniques used should be given. Therefore, we need to have a classification of the landslide monitoring techniques. Many classifications could be found in the literature. Based on Mikkelsen (1996) the landslide monitoring techniques are divided in monitoring of surface movements, monitoring of pore water pressure inside the landslide, monitoring of ground displacements and others. The equipment could be further divided based on how the measurements are performed. The measurements could be manual, as in case of probe inclinometers or automatic by sampling in regular time intervals with electronic data loggers. The measurements collected by data logger could be collected manually or could be transferred automatically via internet, radio or mobile phones. It is essential that a debris-flow monitoring system is as simple as it goes on one hand, and as robust and precise as it can be on the other hand. In important constraint are also financial sources for its design, implementation and maintenance (!).

Also the purpose of the monitoring system should be known in advance: a) research monitoring (process recognition and field studies); b) design of technical (structural) counter-measures for a specific field case; c) support for an early warning system (EWS). In the recent years the project SafeLand (2012a) produced several reports dealing with landslide detection, fast characterisation, rapid mapping, monitoring and early warning systems, with a slightly different division of landslide monitoring techniques, based more on who performs the tests and not the physical quantity. Report D4.4 of the SafeLand project (SafeLand 2012b) gives a comprehensive review of remote sensing techniques and also guidelines for their selection for long-term landslide monitoring, based on landslide rate, movement type, and for different phases of the risk management cycle. Report D4.5 (SafeLand 2012c) describes some new methods for landslide monitoring.

Similar to the SafeLand project the ClimChAlp project (2008) divides monitoring methods into 4 main categories: geodetic, geotechnical, geophysical and remote sensing.
Starting from landslide monitoring methods we may propose a classification for DF monitoring methods (Figure 24), where methods are divided into methods being continuous or discrete in time, being in contact with debris flows or applying non-contact (remote) techniques, performing measurements in space in points, profiles or areas and finally they are divided according to what they measure: rainfall, debris flow occurrence, and kinematic, dynamic or other debris-flow parameters.
Using such a XYWZ classification we may use abbreviations for different methods as proposed for some typical DF monitoring methods in Table 1.

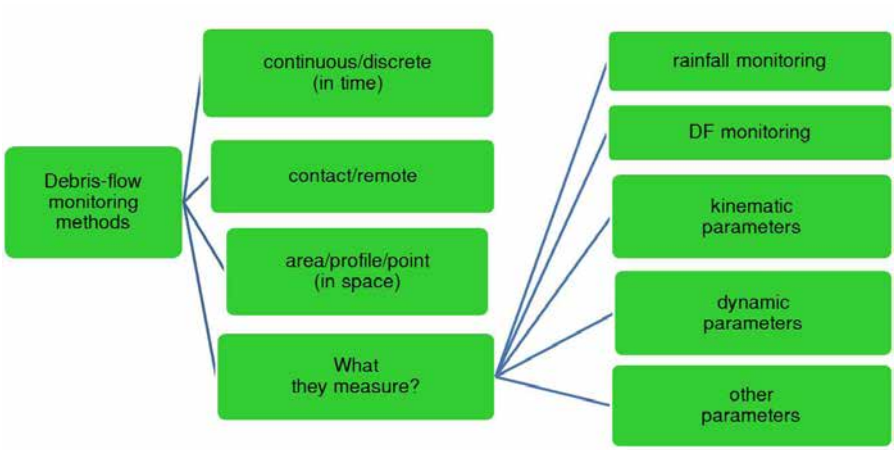

Figure 24: A proposed classification of debris-flow monitoring methods (adopted from Maček et al., 2014).

Method	*Description of the measurement method – XYWZ*
Rain gauge	*continuous contact point rainfall monitoring – CCPoRM*
Disdrometer	*continuous remote point rainfall monitoring – CRPoRM*
High speed video camera	*continuous remote area surface movements – CRASM*
Acoustic (Doppler) radar	*continuous remote point kinematic parameters – CRPoKP*
Geophones	*continuous remote area kinematic parameters – CRAKP*
Pressure transducers	*continuous contact point dynamic paremeters – CCPoDP*
Wire/light sensors	*discrete contact profile DF monitoring – DCPDFM*

Table 1: The classification of some typical debris-flow monitoring methods (Cruden and Varnes 1996).

Early warning system (EWS) is "the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss«. There are 5 key elements of the human-centred EWS: a) knowledge of the DF risk; b) monitoring, analysis, and forecasting of DF hazards; c) operational centres; d) communication or dissemination of alerts and warnings; e) local capabilities to respond to the warnings received.
The EWS are usually based on DF hazard maps (hazard zones within the maximum run-out zone), meteorological forecasts (rainfall forecasts, rain radars), and monitoring data from hazard areas, issuing DF pre-trigger warnings (using different empirical thresholds) or post-trigger warnings (event triggered warnings).

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Project Partner: BMLFUW
Author: Rudolf Schmidt/ Markus Buchauer

Mobile Warning systems for natural hazards are meant to warn employees of impending events and reduce the risks of damages to construction sites, exposed to such dangers (machines, equipment, site infrastructure etc.).
Such warnings systems are meant to be universal, handy and mobile monitoring units which can be installed and be removed in short time.
In contrast to pure monitoring systems, mobile warning systems have an acoustically, optically or mechanically induced electronic alarm triggered in case of an acute natural hazard.
The study wants to give an overview of current used mobile warning systems within the technical service for torrent and avalanche control in Austria (users) together with an analysis of current available systems on the market (producers). This state of the art was surveyed by sending out questionnaires (by e-mail) to the above mentioned stakeholders completed by telephone interviews.
The questionnaire has been sent to 21 regional offices, 7 provincial headquarters and 3 staff units within the technical service. Currently 6 regional offices are using mobile warning systems, mainly for floods and rockfall. In 5 cases the system MOSES (Mobile Security and Emergency System, Sommer Company) is used. Monitoring of avalanches only was reported by the regional office of the district Pinzgau in the Province of Salzburg. The regional office Carinthia Northwest reported a warning system for debris flow. The cost for one MOSES varies from € 5.000 to € 15.000 depending on the equipment.
The questionnaires also contained questions concerning technical details like type of sensors, power supply, data transfer, data storage and data management. Practically the technical possibilities of MOSES are used in a wide range, depending on the special needs of the users and the monitored natural hazard. Overall the feedback about reliability is a very good one though data management is to be considered the biggest weakness of all currently running systems.
In total 13 producers from Austria, Switzerland and Germany received questionnaires and were contacted via telephone. 8 questionnaires including different reference projects were returned. For each natural hazard relevant to the technical service at least 5 different producers offer suitable products in their portfolio. In general the producers noted that mobile warning systems always have to be specially set up according to the needed application and therefore the questionnaire can only be a rough overview of what is technical possible.
The named sensors range from standard geophones to meteorological sensors and three dimensional image creating systems like radar, ultrasonic and cameras. Most of the systems use radio to connect sensors and different system units. Some companies offer a direct link/data transfer to data portals (web hosting) operated by the company. According to the producers, costs for such systems depend very much of the given specification regarding type of hazard, topography etc. and therefore only rough numbers have been reported. The investment costs for warning systems usually start from € 6.000 an can easily reach an amount beyond € 100.000. Monthly maintenance costs are estimated around € 100 minimum. In order to operate a mobile warning system on a construction site properly means more than just to install and run it. The system has

to be self-sustaining, independent of power supply on the construction site and it is essential that every interference or malfunction is identified immediately.
In order to obtain a (intern) documentation of incidents a consistent documentation and management of the data for a longer period is crucial. This is especially important to enable a subsequent analysis of the natural hazard and to investigate the chronological trends.
For the technical service it is especially important to work out general specifications for mobile warning systems and to set up a team responsibly for the efficient and fast installation and maintenance of those systems (including data management).

Figure 25: Monitoring of a construcition site using MOSES (Mobile Security and Emergency System, Sommer Company)

Project Partner: GeoZS
Author: Jože Papež

Target and content of project

Slovenian partners in PARAmount project, PUH and UL FGG, have been cooperated with Slovenian Railways (also observer in START_it_up project) with intention to prepare expert and practical oriented recommendations to contribute to greater safety and economy in the Slovenian rail transport, especially in the area of development, modernization and infrastructure management regarding protection against natural hazards. Bohinjska Railway was chosen for an analysis on regional level. More detailed surveys were executed on the most problematic 20 km section between Podbrdo and Baška in the very narrow valley with very steep slopes above and below the railway. Even it is not the main track, (it is categorised as regional track) it has ca. 350 000 passengers per year (mostly daily commuter (job, school)) and ca. 400.000 t transport of cargo per year. Therefor decisions about a safety level are very important.
The main challenges were hazard/risk assessment and evaluation of the efficiency of existing protection structures and early warning systems and proposing improved concepts of risk management.
Existing Slovene legislation does not satisfactorily tackle the problems that rockfall hazard pose to the traffic (road, railway) infrastructure. Because of this, Slovene partners used in PARAmount project some procedures defined in the Slovene flood risk management regulation, prepared as result of the adaptation of legislation for implementation of EU Floods directive (Directive 2007760/EC) as the basis for the rockfall hazard/risk evaluation. The provisions of the directive were transposed into national law by adoption of amendments to the Water Act and new implementing regulations: the most important - Rules on methodology to define flood-risk areas and erosion areas connected to floods and connections of classification of plots into risk classes (Official Gazette RS, No. 60/2007).
Hazard assessment highlights: Based on DEM and data of past events; the latter exist for the whole Slovene rail network; high precision (10 meters stretches); enhanced with 1D and 2D numerical modelling; danger zones set by the Slovenian railways ltd. considered. Hazard map gives a good overview of hazard zones for the test bed to be used by the railroad management and commuters.
Risk assessment highlights: high precision (10 meters stretches), a simple procedure, when hazard and vulnerability are known; applicable to the whole rail-network. Risk map gives a good overview of risk for the test bed to be used by the railroad management and commuters; sets priorities for risk management and reduction; can easily be applied to the whole rail network.
Regarding general protection concept against rockfall and snow avalanches, investigated in the project, a significant difference exists between road and railway infrastructure. For protection of roads against rockfall hazard in last 15–20 years dominated mainly modern flexible and certificated rockfall protection barriers. Compared to this the Slovene railway is at the beginning. The dominated systems for railway protection are early warning and alerting called EAN or NOJP and rigid catching wooden-fences and simple light rigid mesh-fences. Many of these measures are losing partially or completely their efficiency and functionality after an occurred impact or because of lacking maintenance work.

Major results

Slovenian PARAmount's partners have, among others developed following tools:

- Rockfall hazard map for Baška grapa test bed
- Damage potential cadastre with a vulnerability map for Baška grapa test bed
- Rockfall risk map for Baška grapa test bed

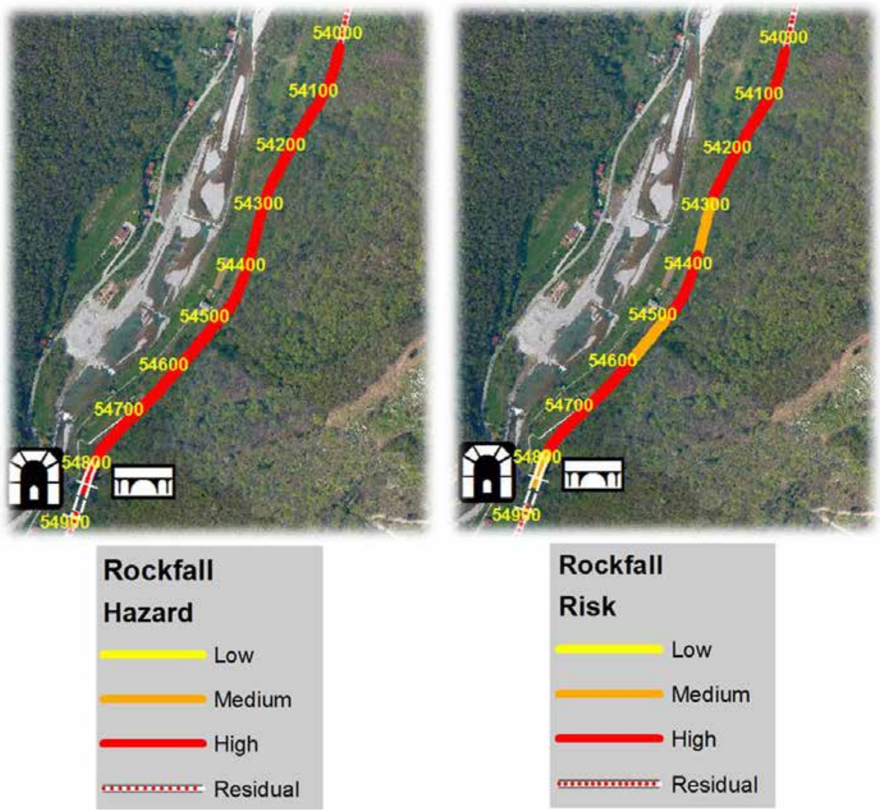

Figure 26 and Figure 27: Rockfall hazard & Risk map of the rockfall hotspot in the Baška grapa test bed

The using of modern calculation / simulation, combined with detailed studies carried out in those points that the modelling at regional scale has mapped as the most critical, can lead to an improvement of current techniques of hazard and risk assessment. Good praxis examples of technology and protection solutions from other countries significantly contribute to acceptance of accelerating development and increasing investment in the field of natural hazard protection.

Railway's management team has to take both short termed (urgency interventions) decisions and middle termed interventions (priority list of intervention/protection works). They need expert support (defining the hazard level) and suggestions (up-do date advisable set of mitigation measures) from competent institutions/companies, which could provide the technical part of the set of decisions.

Experts have to support decisions related to: Primary or secondary protection measures? Active or passive measures? Primary protection is carried out in the areas where rockfall phenomena occur. Secondary protection is used when rocks have already been released. Where possible it is more adequate to stabilize slopes on the source area (primary), but based on preliminary assessment of the slope conditions definitely secondary measures will be prevailed. Today's up to date rockfall barriers can retain falling rocks and boulders from 75 kJ up to over 8000 kJ of dynamic pressure. The rockfall barriers can be combined with avalanche protection measures. By the application of sound engineering principles to a predictable range of parameters and by the implementation of correctly designed protection measures in identified risk areas the exposure of injury and loss of property can be reduced substantially. These structures (rockfall barriers) can serve their purpose only when they are regularly inspected/checked, cleaned and maintained. Only this procedure could assure the desired protection level. Provisions must be taken to mitigate the residual risk. By decision of repairing and installing new so called "light semi-rigid net's fences" without knowing baring capacity and certification, a transparent explanation about the purpose of such measures is needed. It is obviously, that with this approach the railway maintenance team could cover larger endangered sections of railway with minimum protection / limited functionality in a period with very limited available funds. This action has to be accompanied by a hazard assessment, which will show remaining/residual risk and adequate plans how to deal with the most critical sections of the tracks in the future. We must not allow ourselves, to be satisfied with minimum protection – we have to plan optimum protection and in the middle time to raise awareness about residual risk and implement all measures to minimize potential damage effects.

Slovenian Railways have to continue to pursue and strengthen the development of integral system of protection against natural hazards. This has to be visible in planning and funds for this field of activities.

Project Partner: BMLFUW
Author: Michael Mölk

The Austrian Standard Rule ONR 24810: Technical Rockfall Protection includes a design concept for rock-fall embankments. The design approach was developed based on the results of more than 200 model tests in a scale of 1:50. In order to evaluate the design concept, published real scale impact events were analized. Due to the fact that there are only few such well documented events where rock-fall impacted in an existing real embankment, additional event documentation is considered essential to further evaluate and develop the design approach.

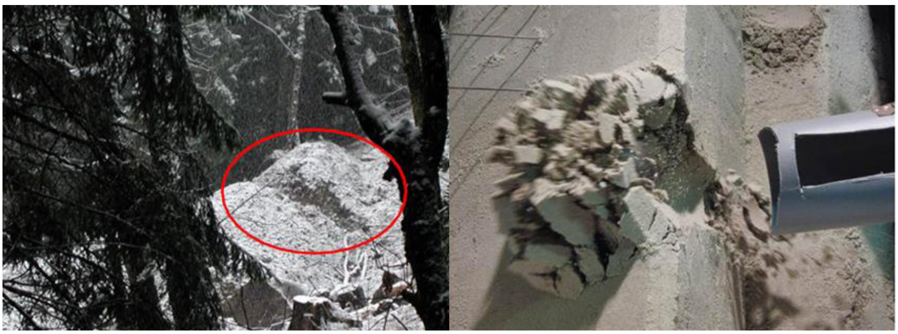

Figure 28 left: documented impact in embankment with failure. right: model test with similar behaviour

To encourage the international community to contribute to the elaboration of a database of well documented impact events on rock-fall embankments, a web based database was developed in the framework of Start_it_up and Interpraevent. The database is online and currently running in a beta version, some adaptions still to be implemented. The access to the database is available via the homepage of the international research society Interpraevent. The existence and availability of this platform is frequently presented on national and international conferences and publications.
Anybody being registered for free on the database platform can contribute by entering event data and every registered user can also take advantage of the whole database to use the information for research and development of better protection systems or the improvement of design concepts.
The database for event documentation is openly available via the following web-link:
http://interpraevent.at/rockfall/

Global information quality management framework in the risk management process

Project Partner: Irstea
Author: Jean-Marc Tacnet

Target and content of project

The risk management process is a global complex decision framework related to different geographical areas (triggering, propagation and stopping zones). It involves several actors (public bodies, technical experts…) during the different temporal steps (crisis management, recovery, prevention and preparation) (Figure 29). Information is collected and processed to help and make decisions. Classical approaches corresponding to hazard, vulnerability and risk assessments are often based on technical, physically-based methods. However, needs for integration, information quality or uncertainty assessment and propagation are recognized. This report presents a global information quality management framework in the risk management process.
Natural phenomena in mountainous areas put people and assets at risk. Risk is classically assessed as a combination of hazard and vulnerability in the natural hazard context. Hazard relates to the intensity and frequency of phenomena, whereas vulnerability concerns damages and values assessment (of elements at risk)and can be seen as a combination of exposure and potential losses. Risk reduction measures and strategies are based on non-structural measures such as land-use control through risk zoning maps, preventive information and structural measures such as civil engineering protection works (checkdams, snow nets etc.).
Therefore, risk managers, local authorities and infrastructure managers face different decision needs corresponding, as an example, to the choices of best combination of these structural and non-structural measures, to the choices of the best maintenance strategy (Figure 29). Decisions often result from a combination of several sources (expert assessments, eye-witness accounts, numerical modelling, historical databases, …). However, making those best decisions in the event of rapid mass movements in mountain areas encounters problems in the assessment and management process because of the lack of information and knowledge on natural phenomena and the heterogeneity and reliability of the information sources available (historical data, field measurements, and expert assessments). Decisions are therefore often based on imperfect information (uncertain, imprecise, incomplete, conflicting) provided by multiple and heterogeneous sources (numerical models, expert assessments, Geographic Information Systems (G.I.S.) or historical databases etc.).
The goal of the approach is to assist decision-making and to trace the expertise process while considering the availability, quality and reliability of information content and sources.

Major results

The imperfection of information is inseparable from the numerous and successive decision processes involved in the risk management process. One must accept this inescapable reality as a basis for the development of decision-aid methods. Finally, the main recommandation to the decision-makers should be that, at every stage of the risk management process, they should never accept and use a single decision-aid method or method that does not consider information imperfection. Indeed when trying to pro-

pose a state-of-the art related to risk management, technical approaches should be mainly expected. This article (and the related report) extends the analysis to alternative methods and domains corresponding to decision-aid, information quality assessment, uncertainty propagation, knowledge management and capitalization.
It focuses on the principles of an integrated risk management methodology considering and propagating all types of information imperfection in the reasoning process. It explains the overall needs for traceability and describes the nature and reality of information imperfection. It also sketches the integrated methodology implemented to identify the decision contexts, to aid decision, to consider information imperfection in multi-criteria decision-making methods and to propagate uncertainty in the expert assessment process including numerical modelling. The main input consists in the multidisciplinary convergence of methods coming either from industrial or natural hazards contexts, decision sciences, information processing.

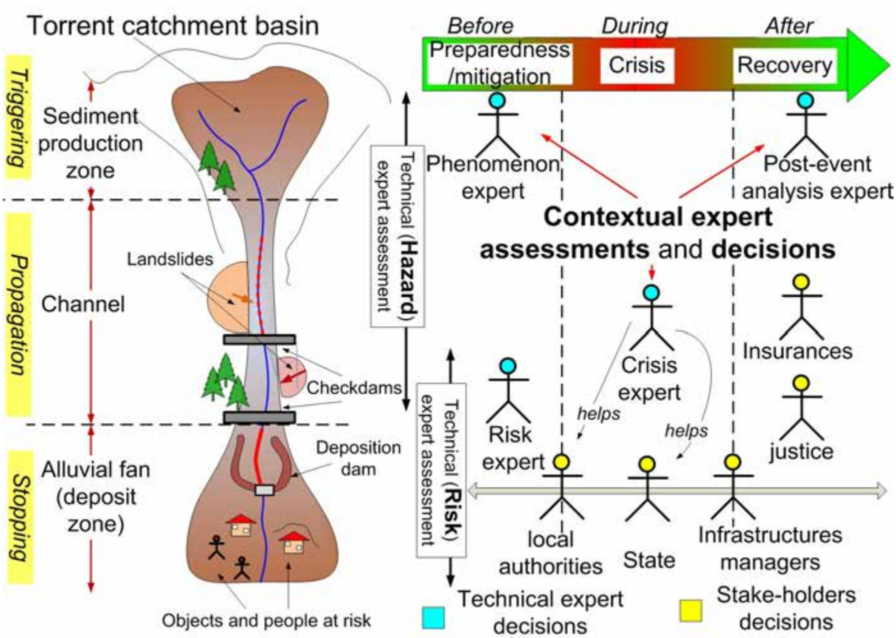

Figure 29: Mountain risk management is based on several temporal and geographical decision contexts (Tacnet et al., 2014– Envt. Systems and Decisions)

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Knowledge management for risk management: application to an European survey of protection works effectiveness assessment

Project Partner: **Irstea**
Author: **Félix Philippe/ Simon Carladous/ Jean-Marc Tacnet**

Target and content of project

The START_it_up project, within the Alpine Space Program, was lunched in order to impulse transnational acknowledgement in the fields of natural hazard engineering and risk management. Following the previous works leaded thanks to several national and transnational projects, as well as recent several national initiatives for standardization, START_it_up is expected to capitalize knowledge and promote standardization initiatives through an enhanced collaboration between Alpine states. One of the key outcomes of the Start_it_up project relates to the general need for common practices in the ways of assessing protection works (including forest) effectiveness, which is a key question in the risk management process. The main aim of this contribution is to put in place a methodological practical framework to establish a consistent and exhaustive state-of-the-art in the ways of assessing protection work effectiveness over European alpine regions. According to four main effectiveness concepts developed in several previous works: structural effectiveness, functional effectiveness, capacity and efficiency (Carladous & al., 2014, Tacnet & Curt, 2013, Tacnet & al., 2012), this state-of-the-art focuses on methodologies, methods, tools and decision support methods (including economic and risk-based approaches analysis such as cost-benefit analysis or multi-criteria decision aid) commonly used over alpine states. The results allow giving an overview of what is done in these domains, highlight the possible gaps, divergences or convergences in practices between countries. The state-of-the-art methodology presented is innovative in terms of data gathering, sorting and processing. It gives a consistent overview of the state of advancement of research and technical works, as well as the degree of collaboration on these fields between countries and institutions involved in risk management issues. First results highlight a significant scope for improvement in terms of knowledge and experiences exchange at the European scale. The current bibliographical database must now be supplemented thanks to partner's countries intakes, in order to improve outputs consistency and exhaustiveness. This methodological tool to establish a state-of-the-art represents a great support to strengthen further initiatives of establishment of common standards and methods for expert decision making within the natural hazard engineering field.

Major results

- Development of a reproducible methodology for data gathering, sorting and processing based on four effectiveness concepts: structural effectiveness, functional effectiveness, capacity and efficiency
- Establishment of a workable bibliographical database on protection works effectiveness assessment works
- Possibility of improvements of the database by partners countries intakes
- Compilation of the entire process in a final synthetic report explaining the general approach, methodology and major results.

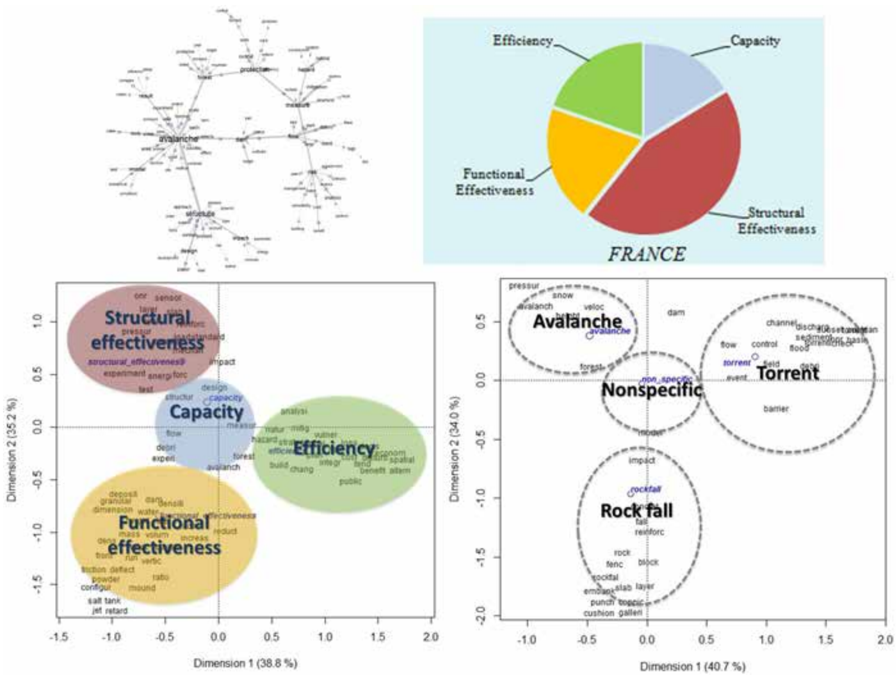

Figure 30: Synthetic results of the bibliometric knowledge analysis dealing with protection works effectiveness: 4 core concepts are confirmed, repartition for each phenomenon is emphasized.

References

Carladous S., Tacnet J-M., Eckert N., Curt C. and Batton-Hubert M., 2014, Vers une analyse intégrée de l'efficacité des ouvrages de protection contre les risques naturels en montagne, 8ème Journée Fiabilité des Matériaux et des Structures, 12 p.

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Tacnet J-M., Curt C., Rey B. and Richard D., 2012, Efficiency assessment for torrent protection works – An approach based on safety and reliability analysis, 12th Congress Interpraevent 2012, Grenoble (France), 11 p

State of the Art in protection work effectiveness assessment in European Alpine Regions

Project Partner: Irstea
Author: Jean-Marc Tacnet/ Simon Carladous

Target and content of project

The context and specific methods about a global decision framework have been proposed in the report related to global information quality management framework in the risk management process. According to this global context, this study is a focused contribution to the state-of-the-art in the domain of decision-making related to protection works effectiveness assessment methods. It describes particularly multi-criteria decision making methods and methodology, safety/reliability and dependability analyis based methods and also economic approaches. The developments described below firstly consist of the analysis of existing methods to assess economic effectiveness and, secondly, of an application example of multi-criteria decision-making method: the chosen decision context relates to consideration of protection works into land-use planning regulation rules.

INTEGRATION OF MULTI-CRITERIA-DECISION MAKING METHODS AND ECONOMIC ANALYSIS IN RISK MANAGEMENT FRAMEWORKS

All over European mountainous regions, protection systems against natural risks have been set up to reduce natural risks for more than 120 years. For instance, in France, more than 19,000 works have been built in French public forests since the end of the 19th century. Different types and scales of protection systems exist ranging from isolated (protection) work, such as dams, snow-nets…to group of works (so-called device). Analyzing and comparing their effectiveness to reduce risk with their cost (investment and maintenance) is a key question in the risk management process.

For isolated and device scales, the effectiveness assessment is mainly technical: how far do civil engineering structure resist to the defined constraints? How far do they fulfill their planned functions? Assessment is generally based on expert knowledge and indicators can be different from one country to another. Comparing indicators and using dependability analysis improves these technical assessment. At the watershed scale, protection systems aim to reduce the risk. Their effectiveness is directly related to their effect on risk reduction introducing economic questions. At this scale, the main questions are: what is the baseline risk, without protection? what is the effect of protection on risk? Defining a common risk definition and analysis method between European countries is possible but need to be compared with implementation. To analyse the effect of protection works, the combination of expert knowledge and numerical or analytical modelling is usually used. Methods (including their limits) and applications in different countries are compared. Taking decisions needs knowing risk reduction impact and costs of each strategy to compare them at each system scale. The Cost-Benefit Analysis (CBA) is the most used. It is based on a monetary valuation of costs and risk considered as an expected value of damage. CBA is widely but differently used as more or less known drawbacks. Other decision-aid methods exist: the MCDA methods can integrate non monetary cost and damage. Considering physical effectiveness and related effect of protection systems is still needed. Integrating structural and functional analysis of protection systems is essential to estimate their effect. For each phenomenon and system, common indicators have still to be defined (including their imperfection representation).

APPLICATION OF A MULTI-CRITERIA DECISION APPROACH TO CONSIDERATION OF PROTECTION WORKS INTO LAND-USE PLANNING REGULATION RULES

Following a continuous improvement process, land-use planning rules updates are under consideration. In the framework of the project, the contribution consists in a methodological contribution to decision-maker's needs (e.g. MEDDE). The question under consideration: how to consider (or not to) protection works in risk prevention plans (PPR)? The principle is not to provide a new regulation rule but to show how technical inputs related to decision-making methods, safety and reliability analysis can contribute to such a decision process, introducing and using new approaches and methods which are candidate to become future standards. The inputs of the methodology is to identify needs and practices, terminology and glossary, to formalize expert knowledge and to propose a practical implementation of multi-criteia decision making method. Different multi-criteria decision making methods exist but this application shows that those techniques have a valuable added value to help decisions.Using the proposed framework is a way to trace and improve the decisions processes.

Deliverables

The outputs this action in the START_it_up project are described below 1) a state-of-the-art in France to value costs and benefits of flood management strategies in France with a critical view on their drawbacks and applicability in the context of montain torrent floods 2) the proposition of a global framework to analyze the different features of protection works effectiveness including structural, functional and economic approaches (Figure 31) 3) introduction of the use of decision-making methods to assess the indicators related to protection works effectiveness 4) application and use of decision-making method and safety/reliability/dependability analysis concepts to land-use regulation guidelines update (consideration of protection works in risk zoning application).

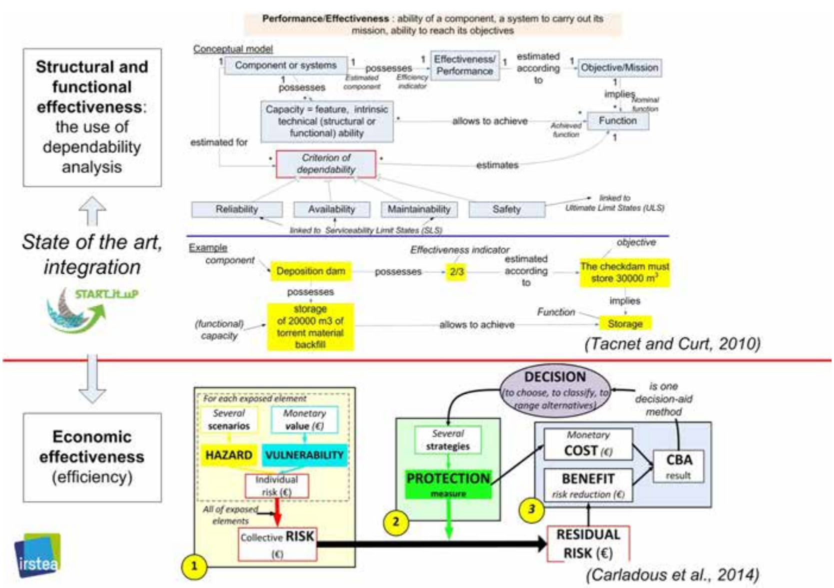

Figure 31: Structural, functional and economic features of protection works effectiveness

Carladous S., Tacnet J.-M., Curt C., Batton-Hubert M., Marco O. (2013), Méthodologie d'analyse de l'efficacité des ouvrages de protection – Application aux risques naturels en montagne, in Assises Nationales des Risques Naturels, France (Poster).

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A survey on protection works databases used at the Alpine Space level: analysis of contents and state of the art related to protection works effectiveness assessment

Project Partner: **Irstea/ ONFI - ONF RTM**
Author: **Simon Carladous/ Marie-Pierre Michaud/ Jean-Marc Tacnet/ Quentin Delvienne**

Target and objectives of the survey

Natural phenomena in mountainous areas put people and assets at risk. Risk is classically assessed as a combination of hazard and vulnerability. Hazard relates to the intensity and frequency of phenomena, whereas vulnerability concerns damage and values assessment. Risk reduction measures and strategies are based on non-structural measures such as land-use control through risk zoning maps, preventive information and structural measures such as civil engineering protection works (checkdams, snow nets etc.).

To ensure prevention and limiting risks, protection works have an essential role to reduce both causes and effects of phenomena. Decision support tools are needed for long term monitoring and management of protection works. Assessing their effectiveness considering both their structural state and functional abilities is challenging.

As described in *Global information quality management framework in the risk management process,* the decision-making process is based on available information. In the framework of the START_it_up project, the first objective of this contribution is to put in place a methodology to analyze how information about protection works is collected in existing databases all over European project partners. The second is to analyze main differences. On this basis, recommendations are proposed for a better design, management and interoperability of database management systems (DBMS) related to protection works. The survey objectives are summarized as following:

- to give a picture in 2014 of the existing processes for protection works monitoring;
- to analyze options taken in existing databases to monitor effectiveness indicators;
- to compare the use of collected data during the monitoring of protection works;
- to identify best practices used in the monitoring of protection systems that should be included in future upgrading of databases and to make recommendations.

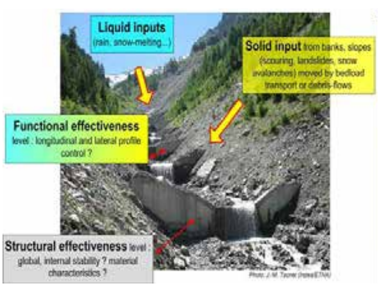
General methodology of the survey

- Development of a questionnaire related to protection work databases: objectives, database management and uses, contents (work inventory, description, analysis, propositions of evolutions), assessment of effectiveness and efficiency concepts (Figure 32).
  The survey question form is structured in two levels: 1) Level 1: Characteristics of databases – general information (internal, external use, management, organization, updates…) 2) Level 2: protection works monitoring data description, description of main analyzed features in relation with the safety and reliability indicators, use and post-processing of collected data.

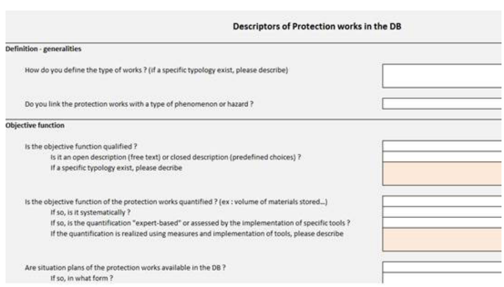
- **Analysis of four existing databases:** ONF-RTM (France), TAC (Austria), Autonomous Region of Valle d'Aosta and Autonomous Province of Bolzano (Italy) and formulation of recommendations.

Major results of the survey

- **Comparison of databases.**
  - Having an overview of existing protection systems and assessing their condition are common initial objectives. Protection forests are not included in these databases.
  - Decision support objective to plan interventions is not clearly expressed.
  - Databases are not externally well known and, consequently, underutilized.
  - Databases are based on a GIS registration.
  - Indicator definitions to describe works are different.
  - Protection works assessment are based on expert field analysis.
  - Structural condition is always assessed unlike functional ability. Assessment methods are different.
  - Comparing protection works with exposed elements they protect, natural hazards they reduce is not registered in databases. Intervention costs are not always registered.
- **Recommenderrions** for a better design, interoperability and management of databases on protection works and for monitoring protection works effectiveness.
  - Survey should be widened to all Europe and other structures than federal/provincial ones.
  - A common expert English glossary and terminology is a key point to homogenize databases.
  - Database management could be improved defining database objectives, choosing the adapted management organization, communicating about their existence.
  - Databases should be upgraded from a registration tool to a decision-aid tool for protection works management. Assessment methods need to be homogenized.



Effectiveness concepts (Tacnet et al, 2014)



Descriptors of Protection works in the DB

Definition - generalities

How do you define the type of works ? (if a specific typology exist, please describe)

Do you link the protection works with a type of phenomenon or hazard ?

Objective function

Is the objective function qualified ?
Is it an open description (free text) or closed description (predefined choices) ?
If a specific typology exist, please decribe

Is the objective function of the protection works quantified ? (ex : volume of materials stored...)
If so, is it systematically ?
If so, is the quantification "expert-based" or assessed by the implementation of specific tools ?
If the quantification is realized using measures and implementation of tools, please describe

Are situation plans of the protection works available in the DB ?
If so, in what form ?

Database survey extract for level 2

Figure 32: Protection work databases are analyzed according to their thematic and spatial contents with a specific focus on information related to effectiveness assessment

Carladous S., Tacnet J-M., Eckert N., Curt C. and Batton-Hubert M., 2014, Vers une analyse intégrée de l'efficacité des ouvrages de protection contre les risques naturels en montagne, 8ème Journée Fiabilité des Matériaux et des Structures, pp 61–74

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Recommendations for a better integration of protection forest in rockfall, snow avalanche and shallow landslide NHRM in the Alpine Space

Project Partner: Irstea/HAFL
Author: Fred Berger/Massimiliano Schwarz

Target and content of project

In order to improve the role played by mountain forests in risk mitigations in the Alpine Space (AS) ,a state of the art issued from the analysis of previous AS projects dealing with mountain forests and risk prevention has been conducted. From this state of the art, which summarize the general context, some recommendations have been formalized for policy and decision makers.

To sustain and protect livelihoods in the AS today, forests are indispensable. They cover the steep slopes of the main valleys and protect these developed and densely populated areas against rapid mass movements that pose risks to infrastructure and inhabitants. The primary function of protection forests is to protect people or assets against the impacts of natural hazards. For assuming this function, the first product of these forests is standing trees which act as obstacles to the acquisition of the initial conditions necessary to the release of mass movement hazards and/or to the propagation down slope of these hazards. This protective function has been clearly identified in the first paragraph of the Mountain Forest Protocol of the Alpine Convention of 1996: "mountain forests …provide the most effective, the least expensive and the most aesthetic protection against natural hazards."

The protective effect of mountain forests against geo-hazards, such as rockfalls for example, cannot be anymore neglected in risk management. That's one of the reasons why in the last few decades, forest management has shifted its focus from timber management to multiple uses and so to forest ecosystem services management. Furthermore, forest cover is not unchanging, and a specific silviculture is needed to maintain or increase its protective role. The protection forest management has evolved with time from doing nothing (banned forests), to strictly silvicultural based management, and finally to ecological engineering.

The development of an adapted protection forest management required firstly to map the place where forest stands can have a protection role, secondly to evaluate the efficiency of this protection, thirdly to define the best ecological engineering strategy for maintain and/or optimize this role, and finally to develop a risk prevention policy which integrates (recognition & funding) the protection function offered by forest stands. However, forests cannot always provide sufficient protection. In the case of rockfall for example this is because slopes are too steep or too short, or/and the forest is degraded or/and its structure is not dense enough to stop falling rocks. In those cases protection could be provided by technical measures such as rockfall dams, nets, etc.

Currently in the AS, 2 countries have produced a protection forest silviculture national handbook: Switzerland (first version in 1999, updated in 2005) and France (2006 Northern Alps, 2012 Southern Alps). In Italy only the Aosta valley has edited a similar document (2006). These handbooks are mainly based on the empirical knowledge of the foresters and are friendly using oriented. The feedbacks on their uses are that 1) due to the will of simplification some thresholds are too restrictive and 2) they require an exhaustive mapping of protection forests in order to know where to apply them.

But, even if eco-engineering and silviculture concepts, as well as these practical guidelines are based on forest ecosystems natural cycles, adopting this type of management is impossible on all mountain forests due to financial restrictions. In this context, the knowledge of the spatial distribution of these protection forests and of its effects to prevent natural hazards becomes essential. Recognizing that forests offer protection against natural hazards is one matter, quantifying this effect is another one.

Throughout the European Alps, geohazard simulation models are used, in so-called propagation or trajectory studies, in the process chain for estimating the risk generated by natural hazards (hazard and risk zoning) and to design the appropriate technical protective measures. But very few of these models are able to integrate the actions played by forest stands. Currently, only some rockfall and shallow landslide models are able to explicitly integrate the mechanical actions of individual trees or forest stands.

Although the protection forest mapping methodology and associated models for rockfall and snow avalanches exist, only Switzerland has produced, using systematically propagation models, the map of its protection forest for its entire country.

Major results

The major results of this action are recommendations for policy and decision makers in the field of scientific research and/or risks prevention.

- An exhaustive mapping of protection forest has to be done at national and Alpine Space level for mountainous territories
- The methodology, the models and the forest data to be used for the protection forest mapping have to be harmonised at the Alpine Space scale
- In order to optimize the mapping process and its uses, the building up of an alpine protection forest experts network is necessary. This network should include practitioners, researchers, decision makers, representatives of civil society.
- The protection forest mapping has to be done in close connection with national forest inventories offices.
- In the European regulation and policy, protection forests have to be considered as natural protective works. This can only be done if the mapping of protection forest is done for each of the concerned countries.
- The regional, national and European funding of the silvicultural actions for maintaining and optimizing the efficiency of protection forests can only be done if protection forest mapping using an harmonised methodology and harmonised guidelines exist.
- To empower the beneficiaries of this function, they have to be involved in its funding. This can only be done if a clear and an efficient communication strategy is established.
- The current protection forest management guidelines need to be updated using the last scientific knowledge and the geohazard propagation models which are able to integrate the actions of trees and forest stands.
- The building up of an Alpine virtual experimentation platform, for testing different scenarios of protection forest management, for validating the thresholds to be given to the practitioners, has to be iniated. This platform associated to the protection forest expert network should work in close connection with Long Term Ecosystem Research networks and permanent plots.
- According to the current state of the knowledge on the interactions between forest and natural hazards, to the calibrated models available, and to the data

currently available at a national scale the order of priority for the protection forest mapping and the updating of the guidelines should be 1) rockfall, 2) snow avalanches, 3) shallow landslides, 4) erosion and debris flows.

- A specific attention has to be paid for integrating the efficiency of forest stands in the protection forest mapping, on the development in 2 dimensions of modelling tools (RockforNET, SlideforNET) currently developed for a 1 dimension diagnose (using a profile in the direct slope). The equivalent of these tools for the other natural hazards has to be done.

Project Partner: WBV (Department of Hydraulic Engineering, Autonomous Province of Bolzano, Bolzano, Italy)
Author: Bruno Mazzorana

Based on a thorough analysis of river corridor management processes conducted in the last decade in South Tyrol, Italy, the following deficiencies could be identified:

i. partial inability to create, from the early planning stages onward, an efficient problem setting and solving environment;
ii. inaccurate spatial and temporal framing of the problem of creating a river corridor;
iii. rather poor investigation of the quality of the river corridor's hydro-morphological and ecological dynamics and incomplete understanding and representation of the main interactions taking place at the intersection between the river corridor related hydro-, litho- and antroposphere;
iv. partial incongruence between projects and agreed river corridor development scenarios;
v. opacity and inconsistency of the decision making process in a participatory environment and inability to create, from the early planning stages onward, an efficient problem setting and solving environment;
vi. inadequate quantification and representation of the flows of benefits and costs to the concerned society, which may result from the implementation of envisaged management alternatives, and, hence, excessive exposure to sabotage actions by restricted segments of the concerned society;
vii. long term strategic inability to stimulate the legislator to adapt the legal framework and remove obstacles for the integrated river corridor management process.

To enhance the river corridor management process as a whole and as a contribution to meet the requirements of the European water, flood, birds and habitat directives as well as the indications contained in the blueprint to safeguard European waters it is worth to consider the following strings of argumentation as a explanation of conceptual approach represented in Figure 33.
According to Lim et al. (2008) working with models and prototypes in design processes (i) enhances anticipated evaluation and testing, (ii) fosters a better understanding of user experience, needs and values, (iii) supports the generation of ideas and (iv) fuels communication among planners and stakeholders.
Following Adenauer and Petruschat (2013), a first major ancillary function in transferring this model and prototype based design approach to the domain of river corridor management is a better argumentation and representation capability. Models and prototypes show (i) that certain management options might be successful, (ii) that defined actions might be feasible and (iii) that expected results could be achievable. In development processes, these tools not only support the generation of ideas, but also help to anchor the design prospects. Finally, if developed in a participatory environment of multi-competent teams of geo-morphologists, ecologists, engineers, facilitators, stakeholders and decision makers, models and prototypes may, referring to Schrage (2000), act as "social media and mechanism" promoting team and capacity building processes.

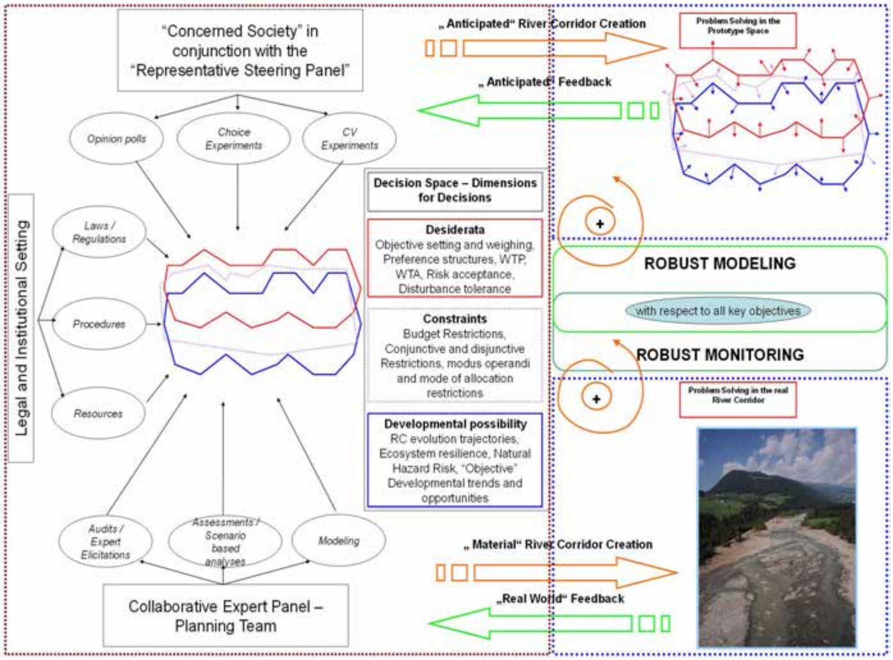

Figure 33: Model of anticipatory and participatory management based on river corridor virtual prototyping

Ultimately river corridor management seeks to find alternatives and prospects that represent different syntheses amongst: i) what society desires, ii) what complies with the natural evolution patterns (i.e. river styles), and iii) what is allowed by the existing legal framework. But 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, its WTP (or WTA) for risks mitigation or new opportunities and or its compensation requests for disturbances; (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 proposed holistic river corridor management approach. It is widely recognized, that stakeholders are an intrinsic part of every management and design process taking place at the intersection between the river corridor related hydro-, litho- and antroposphere. Hence, stakeholder engagement is a *conditio sine qua non* in solving complex problems. Transdisciplinary science supports strategy in contexts where stakeholders contribute to improve the understanding across formal and informal knowledge bases and to glue together the data and the theories originating from different disciplines (Stauffacher et al. 2008). Opinion polls, choice experiments, contingent valuation exercises may help, among other techniques, to assess the total economic value of envisaged management options. 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. A collaborative expert panel is needed to perform all analytic steps and to structure the river corridor specific knowledge base for a well informed decision making process. In this context, the discipline of integrated environmental modeling (IEM) can support the problem solving processes in increasingly complex real world problems involving the environment and its relationship to human systems and socio-economic activities (compare for example Blind et al., 2005). River corridor management problems feature exactly these characteristics. Different modeling approaches are commonly applied in conjunction with scenario based analysis techniques (Scholz and Tietje, 2002) and expert elicitation methods.
Every river corridor creation attempt is embedded in peculiar legal and institutional settings, which contribute to determine the constraints space for the management process. We suggest an *iterative* and *consistent* procedure throughout the key steps of the participatory decision making process (compare Figure 34).

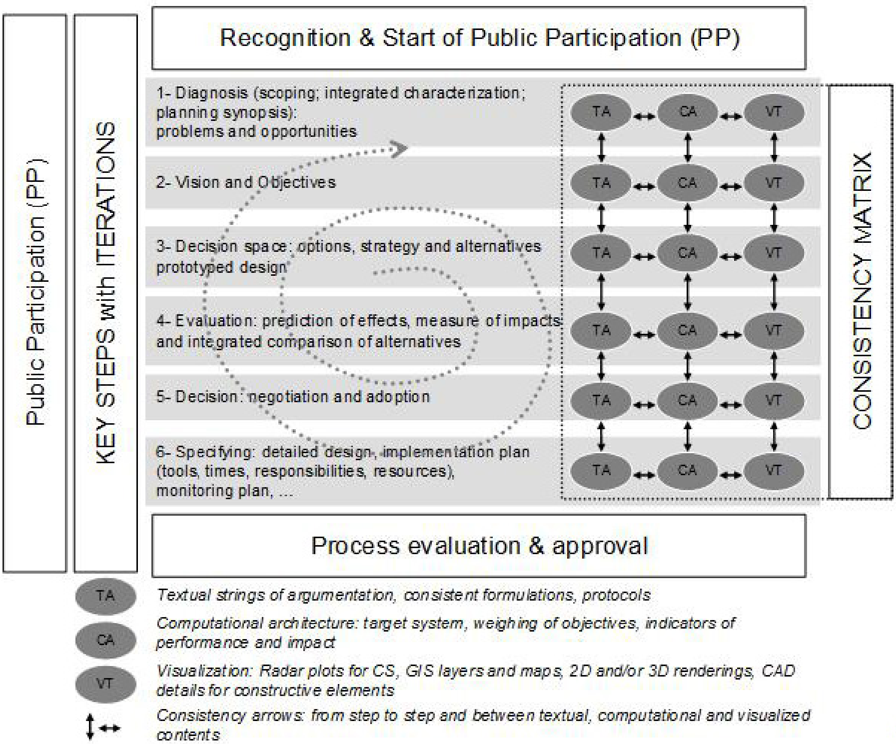

Figure 34: Proposed scheme of participatory decision making process

The essential innovative feature of the proposed procedure is the conception of a consistency matrix which keeps track of the coherency of the content and process related knowledge (data, facts, judgments and computations on the one hand and decisions on the other hand) throughout all six steps of the process.
The applied system analysis techniques and the employed knowledge processing methods have to provide for each key step a consistent pool of textual strings of argu-

mentation (TA) and of quantified knowledge elements, which are processed through a suitable computational architecture (CA) and visualized through an appropriated set of tools (VT, such as GIS, rendering instruments, sketches etc.). Formative scenario analysis methods support the corroboration of knowledge in the TA domain (compare Scholz and Tietje, 2002)

In Figure 35 we show a conceptual scheme of a computational architecture (CA) based on the adopted system of key objectives to be used in river corridor management (Nardini and Pavan, 2012).

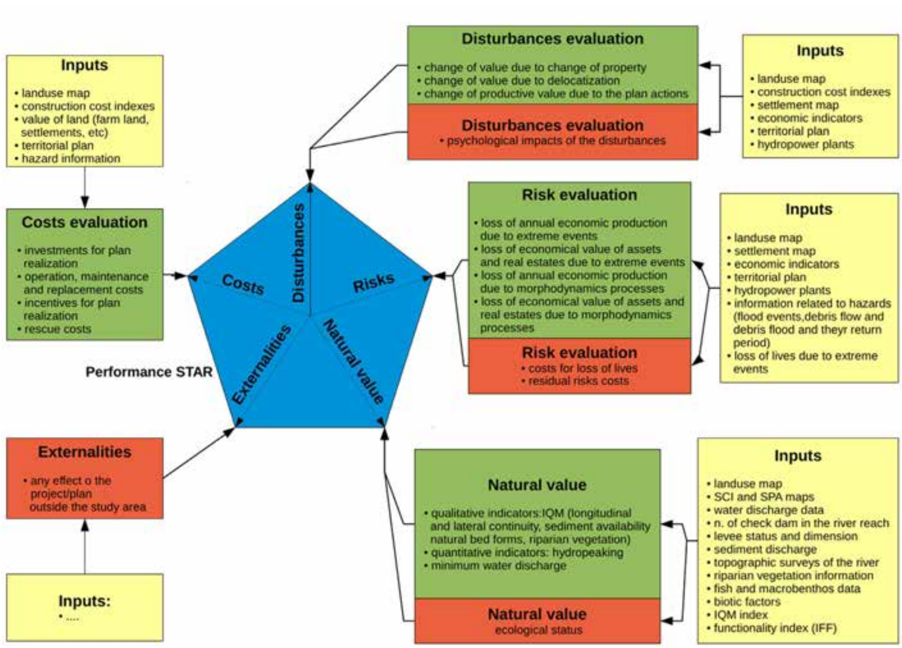

Figure 35: Conceptual scheme of a computational architecture. In the green boxes we list indicators that are commonly assessed in objective terms, whereas in the orange boxes we report decision relevant knowledge to be elicited from experts, stakeholders and decision makers.

Useful visualization principles and techniques have been proposed in the field of landscape design that can be applied with success also within the design processes concerning the river corridor (SEE River Project 2013).

We refer to the term *horizontal consistency* to indicate that the partially complementary and partially overlapping knowledge expressed in textual, numerical and written form needs to be free of contradictions. With the term *vertical consistency* we stress the necessity of a congruent linkage between emerged problems, identified objectives, elaborated options, strategies and alternatives and their technically sound evaluation as well as the resulting design refinements.

We emphasize once more the importance of both a careful elaboration of a developmental vision (Leitbild) and the associated system of objectives and an accurate identification of the river corridor. The dimension of desirability and the existing restrictions are suitably modeled by defining and measuring the objectives of river corridor development. Measuring objectives enables us to:

i) assess the performance of the river corridor,
ii) monitor its evolution and evaluate the impact of projects;
iii) choose amongst alternatives of river corridor developemnt that typically emerge as a response to diverging needs and conflicting objectives of stakeholders.

The developmental possibilities are explored through a preliminary river corridor delimitation based on hydro-geo-morphological principles and the characterization of the river condition with identification of its reference river style with the associated patterns of evolution (Brierley and Fryirs, 2009). Various modeling tools (i.e. flood simulation models, GIS techniques, mapping procedures, renderings of orthophoto images, but also geo-referenced drawings) are valid supports for the creative planning process. Conflicts have to be correctly defined and made explicit in their spatial and temporal dimension from the early planning stages onward. It's by tackling the system inherent contradictions that gateways might be opened toward high level solutions, which have to be visualized and made tangible in the virtual river corridor model as soon as they emerge. We would like to stress again the importance of the strong explorative character of this way of proceeding. Feasible pathways of river corridor creation are modeled (or prototyped) as soon as they start to emerge. This greatly increases the explanatory power of the planning process. As long as the river corridor model evolves, the consistency with the value system of the concerned society has to be monitored and ensured through suitable elicitation approaches. A positive knowledge generation feedback loop is generated well before factual implementation. Material or factual river corridor creation can be implemented (compare steps iv, v, and vi of the conventional river corridor management procedure), if the forecasted river corridor performance is really convincing with respect to the operational target system and a satisfactory degree of consensus is reached or, in our terminology, the conditions to solve the critical system contradictions are given. Monitoring the real world implementations guarantees a second knowledge generation feedback loop, which may lead both to ongoing adaptations in the real world and in the prototype.

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PLATFORM CONCEPT DESIGN

Avalanche Warning Service (AWS) of Aosta Valley decided to structure the CLV website in several interactive sections described below.

The first section

The only static one, picks up the two home pages to present and access the platform:
Public home page. It is the institutional page and the only public one of the website. It presents a map of the Aosta Valley area divided into zones under the responsibility of each CLV with basic information (e.g.; municipalities underlying and the municipality leader of single CLV and the CLV President) together with the relevant legislation. From this page, each CLV component can login to his private access of his CLV.
CLV home page. Accessible only after the login at Public home page, the CLV home page is common and visible to all the CLVs and it is similar to the previous one. It includes the lists of the 17 CLVs (e.g., contacts, role, status (active or not) of each component, etc ...) and useful phone numbers (e.g., Mayors, fax numbers, regional AWS Office, etc ...). Very similar to an address book, the page is not directly editable in this section.

The second section

brings together the dynamic and interactive pages of the portal, obviously reserved for the members of each CLV:
Data – info box. It contains a list of dynamic and customizable links (e.g., favourites and it permits the free insertion and deletion of one link) to monitor the current snow and weather conditions (e.g., data from automatic weather stations and / or radar data, database of in-situ survey performed by mountain guides, etc ...) and prediction (e.g., sites of regional and surrounding areas weather forecasting, etc ...), the snowcover stability (e.g., regional and surrounding areas - Piedmont, France, Switzerland – avalanche bulletins).
CLV Activities Register. It contains the history of the daily monitoring carried out during the winter (e.g., the danger degree of avalanche bulletins, the Hs from automatic weather stations and snow-poles indicated in the PAV (Plan of Activities in the case of Avalanche danger: identification, in the territory of competence, of the critical areas exposed to avalanches who interfere with strongly vulnerable elements), any in-situ surveys, overflights, any avalanche observations in no PAV areas, updating activities, etc ...). Here, in addition to the simple transcription of the activities, there is also the opportunity to up-load photographic and video documentation, etc. ...
Minutes. This is the page to support the CLV to prepare, thanks to predefined masks, reports of activities and technical support to the Mayor, especially in the case of critical situations. The minute will be digitally signed (if on-line) by the Secretary (who write it) and by the CLV components present at the meeting. Besides, the minute will be turned into a non-editable pdf (with any chosen attachments – e.g., photos, etc...) and

directly sent via e-mail from the website to the municipality and to the relevant departments (e.g., regional AWS). This section also includes an archive of minutes drawn up in order to create an historic and accessible database, available to all CLV members of the CLV, on activities and technical choices made.

Budget. Starting from the annual funding available for each CLV, in this page the CLV members can update the budget reporting them expenses incurred by each CLV. In this way, in addition to monitoring the economic situation of the CLV, the annual economic reporting will be easier and uniform.

The third section

presents the quasi-static pages of the site that, however, may be modified only by the members of each CLV:

Avalanche Activities Planning. It contains the PAV directly connected to regional Web Avalanche Cadastre on regional platform "Partout".

Registry. It is the CLV register containing the information of its components (e.g., name, role, phone number, status (active from - to), taken courses, etc ...) together with a backup of the activities carried out in past winters – CLV Activities Register - archived in .rar format and that may be downloaded.

At the end, the News section in which the information for the CLV will be published (e.g., communications by regional AWS or CELVA, meetings, training courses, news on equipment, etc ...), but also thought of as a real time communication system between different components of CLV.

Hardware and software design

After the assessment of the needs, an approach "responsive" to the design of the platform is chosen in order to have a website receptive, responsive and relevant to the dynamic behavior of the user and used device. On this basis, the pages of the application have been constructed to ensure optimal viewing for different environments where they can be displayed (on desktop pc with different resolutions, tablet, smartphone) giving to the user a better use of the content and minimizing the need for resizing and scrolling.

For the design, construction and the production of the application, the choice fell on tools and frameworks exclusively Open Source, in order to optimize the initial costs of development that reduce future operating costs of the hardware and software supports.

Major results

Born from the need to simplify and standardize the CLV activities to support the Mayor in relation to monitoring, forecasting and management of the local avalanche danger and risk, a web platform has been designed and constructed to access snow and weather data, reporting and archiving, as well as transparency and traceability of all activities.

Now under testing by some CLV components, the website will be operational for all 17 CLV operating in Aosta Valley from winter 2014/15.

Based on the Tyrolean experience, the web platform has the ambition to be the basis of an indispensable tool for the CLV, shared and implemented by all the Italian and European AWS.

Project Partner: BMLFUW
Author: Thomas Glade/ Maria Papathoma-Köhle

INTRODUCTION AND BACKGROUND

Risk management for natural hazards is a multidisciplinary field bringing together experts from a wider background such as spatial planning, engineering, geology and other natural sciences, law and the media, as well as, a number of stakeholders that are directly or indirectly affected by decisions and practices related to risk management. These may include local authorities and politicians, individuals, private local businesses etc. Risk reduction strategies require in particular collaboration between the public and the private sector, however, coordination and sufficient communication between these two sectors is often a challenge. There is indeed a need for the development of a forum in the field of risk management which would concentrate on different topics related to risk management setting aside the individual interests and focusing on the development of political recommendations.

One of the aims of START_it_up project was the development of a "Risk Governance Policy Dialogue" which will guide and support the development of interdisciplinary strategies and policy recommendations for natural hazards risk management in the Alpine space.

Although "START_it_up" focuses on the hazards and risks related to floods, avalanches and landslides (including debris flows and rockfalls), the outputs of the project may be transferred and used in other areas of the world for different hazard types and natural processes.

Natural hazard risk communication contributes to the hazard awareness of the community. However, although the main goal of risk communication is the provision of information to the public regarding risk related to natural hazards, it often goes far beyond that by stimulating interest, increasing awareness and involving citizens in decision making. Often, competing land use interests complicate the communication process and lead to inevitable conflicts.

Principles that underpin effective risk communication include important democratic principles such as openness and inclusiveness, as well as, transparency. A participative decision process involves stakeholders and the wider public at an earlier stage. Good risk communication within a municipality may prevent crisis, lead to better decisions and acceptance of these decisions, ensure smoother implementation of risk policies and build trust in authorities. Moreover, by improving the risk perception of the affected parties, a climate of greater empowerment and reassurance is fostered. Thus, the policy makers are in need of methods and recommendations in order to improve risk communication, find ways for better participation and enhance existing approaches in order to achieve good risk communication, in particular at municipal level.

AIM OF THE "RISK POLICY DIALOGUE"

The aim of the policy dialogue was to bring together individuals form different disciplines (e.g. science, administration, private sector, media and the public) in order to discuss a number of topics related to risk communication at municipal level. The result of this forum should be a policy brief outlining the results of this discussion as a number of recommendations that may be considered by the local authorities in order to improve risk communication.

The “Risk Policy Dialogue” should differentiate itself from existing fora in Austria and other Alpine space countries such as PLANALP, FAO and INTERPRAEVENT which bring together institutionalised established factors. The aim of the “Risk Policy Dialog” is to offer an open interdisciplinary and sustainable discussion platform for dialogue.

Interdisciplinary of the participants:

- Authorities, Policy makers (municipal authorities, mayor, ministers, regional authorities)
- Science and research (Universities and research institutes)
- Experts (e.g. geological and meteorological services, construction and water companies, torrent and avalanche control, transport and infrastructure)
- Representatives of local interests (e.g. Insurance companies, tourism, local industries)
- The Public (NGOs, unions and organizations at municipal level)
- Media

Sustainability and transferability:
The event may be recurrent. Preferable it may take place every year. In the first year the event may have a national character followed by an event with a local focus. The central topic of the event may be related to risk management and governance issues, however, this dialogue format may be transferable to other expert fields and other places in the world.

RESULTS AND EVALUATION

In order to ensure the comprehensibility of the results and the outcome of a concrete recommendation deriving from the dialogue process the discussions and results presented were structured according to the following four key headings:

- The status quo: What is the current situation?
- The considerations: What should be considered in the future in order to improve the current situation as described in the previous step? What is the ideal situation?
- The challenges and restrictions: What are the drawbacks in implementing the actions that were proposed in the previous steps?
- The solutions: What are the possible solutions to the addressed problem?

The course of the “Risk policy Dialog” set the ground for an open dialogue which resulted in clear key policy recommendations. The policy recommendations were integrated in a policy brief which aims at policy makers or other individuals who are responsible of formulating policy in the field of risk management.
The multidisciplinary background of the participants in combination with an atmosphere of confidentiality and transparency enabled an open discussion and a realistic depiction of the status quo in the field of risk communication. The positive reaction of the participants reflected on the adequate results that form the basis of the policy briefs. The remoteness of the location and the “closed” character of the meeting gave opportunities for formal and informal talks among the participants.

STATUS QUO	CONSIDERATIONS
▪ … ▪ … ▪ … ▪ …	▪ … ▪ … ▪ … ▪ …
CHALLENGES/RESTRICTIONS	**SOLUTIONS**
▪ … ▪ … ▪ … ▪ …	▪ … ▪ … ▪ … ▪ …

Figure 36: The four key headings for the final presentation of results

CONCLUSIONS AND OUTLOOK

The *"Risk Policy Dialogue"* is a multidisciplinary model for discussion within the community which offers a common ground to a number of participants to express their opinions, discuss in an open and transparent way and result in policy recommendations which will improve policy making and conflict management in municipal level. Following the specific event it is clear that the same format of dialogue may be used again in the future to tackle various conflicting situations. Similar workshops may be carried out in different areas focusing on different topics, but also on the same topic with different participants. The second variation would be interesting in order to compare the outcomes of the two dialogue events and the resulting policy briefs.

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Figure 37: Members of START_it_up partnership (Kick-off Conference in Ljubjana/Slovenia)

OBSERVER INSTITUTIONS:

AUSTRIA (AT):

- Austrian Standards Institute (ASI)
- Geological Survey of Austria (GBA)
- Austrian Federal Railways (ÖBB)

FRANCE (FR):

- French Ministry of Ministry of Ecology, Sustainable Development and Energy

SLOVENIA (SLO):

- Association of Municipalities and Towns of Slovenia (SOS)
- Administration of Republic of Slovenia for Civil Protection and Disaster Relief (URSZR)
- Slovenian Railways (SZI)
- Slovenian Road Agency (SZR)

GERMANY (GER):

- Bavarian Environment Agency (LfU)
- Working Group on Natural Hazards/Natural Risks – German Association for Geography (DGfG)

ITALY (IT):

- Servizio Bacini montani – Provincia Autonoma di Trento (SBM)

SWITZERLAND (CH):

- Swiss Federal Institute for Forest, Snow and Landscape Research (WSL)

International:

- INTERPRAEVENT (IP)
- PLANALP_Alpine Convention

START_it_up, transnational initiative for common quality standards in natural risk management, was started in September 2013 as a so-called capitalization project within the Alpine Space Programme and therefore co-funded by the European Regional Development Fund. 8 partner institutions of 5 Alpine countries are facing the challenge to promote a common "state-of-the-art" in the fields of natural hazard engineering and risk governance on international level. This booklet contains principles, procedures and recommendations for knowledge consolidation, quality assurance and standardization in natural hazard management and risk governance. Furthermore the reader will find information about activities of the START_it_up partner consortium.

www.startit-up.eu