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Risk Communication: the connection between assessment and management of changing risks

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Working toward effective risk mitigation strategies amidst ever-present and increasingly changing risks requires first effective communication between assessment and management spheres. This notion permeates the spectrum of what can be considered the physical changing risk inputs that feed into the risk governance processes of assessment, management and communication of risks. Close connections and overlaps between assessment and management requires communication to serve as the crux for the close collaboration necessary for encouraging preventative, long-term strategies for reducing disaster risks.[1]

More specifically, communication of risk information plays this connective role by informing and advising policy and decision making processes conducted by actors such as spatial planners who receive this information. In this way, those who assess the risks provide information to those who must manage these risks. When this one-directional communication pathway is reciprocated, risk managers provide information to risk assessors, enabling two-way communication amongst actors working toward risk reduction. This communication and exchange of information enables development of strategies and actions taken toward creating and improving risk mitigation measures within a given territory and community. Further, management actions taken (especially for mitigative measures) can alter the physical and social elements of the spatial context of their territory.[2] This demands an adjustment of the previous risk assessment information and communication of the change in potential risk.

These conceptual underpinnings are addressed and presented through explanation of an analytical framework encompassing changing risk inputs into risk governance processes. The framework elaborates the risk communication component and is supported by practical examples from stakeholder meetings and site visits in the Polish and Romania case study areas of the Marie Curie ITN, CHANGES.[3] Specific examples are provided especially within the topic of mitigation through spatial planning, as one of the risk management actors using the provided risk information to implement effective measures. Results of example analysis indicate that, in Poland, alteration in risk assessment methods according to the implementation of the EU Floods Directive may be detrimental to local level management strategies. In the case of Romania, evidence suggests that severe deficiencies exist in the communication and use of risk assessment information especially in the formation and implementation of land use plans. Utilizing these and other examples, the research concludes with some key points gleaned from the combination of the both conceptual and practical approach in order to foster dialogue and discussion toward future research.

[1] International Risk Governance Council (IRGC). 2006. Risk Governance: Towards an Integrative Approach. White Paper No.1 Geneva, Switzerland.

[2] German Advisory Council on Global Change (WBGU). 1999. World in Transition: Strategies for Managing Global Environmental Risks. Annual Report 1998. Springer, Berlin.

[3] Marie Curie ITN Changing Hydro-meteorological Risks as Analyzed by a New Generation of European Scientists (CHANGES) is funded by the European Community's 7^{th} Framework Programme FP7/2007-2013 under Grant Agreement No. 263953.

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Analysing the problems involved in assessing hydro-meteorological triggers.

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A key component in risk assessments is quantifying the probability of occurrence and the intensity of the hazards, which will alter with climate change. However, before future changes in these hazards can be determined, the current relationship between the hazard and the meteorological trigger should be understood. It is known that intense short duration precipitation, long-lasting rainfall and snow-melt are all important for mountainous areas in Europe, yet determining the precise triggers and their temporal probability faces many challenges. While long records are necessary to capture natural variations in the climate and a number of hazard occurrences, long records are often incomplete and not homogeneous. There is also often a spatial mismatch between climate observations and the meteorological mechanism which is actually triggering a flood or a landslide. Furthermore, meteorological triggers do not act alone – land cover and use, engineering works and changes in the slope conditions can all influence the probability of occurrence.

The objective of this work is to explore the current challenges faced when trying to determine the temporal probability of hydro-meteorological triggers as well as potential solutions to the challenges identified. Examples are drawn from floods and landslides observed in the Ubaye Valley (France) and in the Fella River Basin (Italy), focusing on how data availability and quality, conceptualization of the problem and different statistically based approaches all alter the temporal probability of hydro-meteorological triggers. With a better understanding of the underlying uncertainties in meteorological triggering conditions for hydro-meteorological hazards, this will hopefully lead to a better understanding and quantification of hydro-meteorological hazards for risk assessment, for now and future projections.

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Application of a web-based Decision Support System in risk management

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Increasingly, risk information is widely available with the help of advanced technologies such as earth observation satellites, global positioning technologies, coupled with hazard modeling and analysis, and geographical information systems (GIS). Even though it exists, no effort will be put into action if it is not properly presented to the decision makers. These information need to be communicated clearly and show its usefulness so that people can make better informed decision. Therefore, communicating available risk information has become an important challenge and decision support systems have been one of the significant approaches which can help not only in presenting risk information to the decision makers but also in making efficient decisions while reducing human resources and time needed.

In this study, the conceptual framework of an internet-based decision support system is presented to highlight its importance role in risk management framework and how it can be applied in case study areas chosen. The main purpose of the proposed system is to facilitate the available risk information in risk reduction by taking into account of the changes in climate, land use and socio-economic along with the risk scenarios. It allows the users to formulate, compare and select risk reduction scenarios (mainly for floods and landslides) through an enhanced participatory platform with diverse stakeholders' involvement in the decision making process. It is based on the three-tier (client-server) architecture which integrates web-GIS plus DSS functionalities together with cost benefit analysis and other supporting tools. Embedding web-GIS provides its end users to make better planning and informed decisions referenced to a geographical location, which is the one of the essential factors in disaster risk reduction programs. Different risk reduction measures of a specific area (local scale) will be evaluated using this web-GIS tool, available risk scenarios obtained from Probabilistic Risk Assessment (PRA) model and the knowledge collected from experts. The visualization of the risk reduction scenarios can also be shared among the users on the web to support the on-line participatory process. In addition, cost-benefit ratios of the different risk reduction scenarios can be prepared in order to serve as inputs for high-level decision makers. The most appropriate risk reduction scenarios will be chosen using Multi-Criteria Evaluation (MCE) method by weighting different parameters according to the preferences and criteria defined by the users.

The role of public participation has been changing from one-way communication between authorities, experts, stakeholders and citizens towards more intensive two-way interaction. Involving the affected public and interest groups can enhance the level of legitimacy, transparency, and confidence in the decision making process. Due to its important part in decision making, online participatory tool is included in the DSS in order to allow the involved stakeholders interactively in risk reduction and be aware of the existing vulnerability conditions of the community. Moreover, it aims to achieve a more transparent and better informed decision-making process. The system is under in progress and the first tools implemented will be presented showing the wide possibilities of new web technologies which can have a great impact on the decision making process. It will be applied in four pilot areas in Europe: French Alps, North Eastern Italy, Romania and Poland. Nevertheless, the framework will be designed and implemented in a way to be applicable in any other regions.

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Land use/cover changes in European mountain areas: identifying links between global driving forces and local consequences

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Minor land use/cover changes in mountain areas can aggravate the consequences of hydro-meteorological hazards such as landslides, avalanches, rockfall and flash floods. What is more, they change the provisioning of ecosystem services; also as their recovery after anthropogenic induced changes in mountains are slower or not occurring at all due to harsh climate and soil conditions. Examples of these changes are urbanization in high risk areas or deforestation on slopes. To understand the driving forces behind land use/cover changes in European mountain areas, the focus is on the two case study areas: The Val Canale valley in the Italian Alps and the Buzau valley in the Romanian Carpathians.

Land use/cover changes were analyzed in the recent decades applying various remote sensing techniques, such as satellite imagery classification and visual interpretation, as well as integration of various databases (e.g. forestry, spatial planning and cadaster plans). Instead of identifying the statistical significance of particular variables (e.g. population change), the links between different driving forces of global change (e.g. political and policy changes, infrastructural plans) and local socio-economic variables were investigated further through interviewing local and regional stakeholders.

The results show how both areas differ in the consequences of global changes in terms of land use/cover change. The Italian area witnessed a trajectory from a commercially active and competitive area, to an area with a large portion of abandoned commercial, customs, industrial and mining zones. These processes were accompanied by the expansion of settlements comprised mostly of secondary housing on areas with high risk, resulting in catastrophic consequences in recent flash floods and debris flows events. The Romanian site also witnessed a breakdown of local commercial and industrial activities. Together with land ownership reforms, this has resulted in the emergence of subsistence farming and illegal logging. This intensification of activities has mostly affected land on slopes in an area where over 40 % of the area is subject to landslides.

Relatively, the prevailing land use/cover change process in both areas, as usually in most European mountain areas, is reforestation. Small-scale changes however were most important in terms of negative consequences. Therefore we think it is necessary to focus on the local scale when identifying possible future negative consequences of land use/cover change.

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Development of a Spatial Decision Support System for Analyzing Changes in Hydro-meteorological Risk

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In the framework of the EU FP7 Marie Curie ITN Network "CHANGES: Changing Hydro-meteorological Risks, as Analyzed by a New Generation of European Scientists (http://www.changes-itn.eu)", a spatial decision support system is under development with the aim to analyze the effect of risk reduction planning alternatives on reducing the risk now and in the future, and support decision makers in selecting the best alternatives.
The SDSS is one of the main outputs of the CHANGES network, which will develop an advanced understanding of how global changes, related to environmental and climate change as well as socio-economical change, may affect the temporal and spatial patterns of hydro-meteorological hazards and associated risks in Europe; how these changes can be assessed, modeled, and incorporated in sustainable risk management strategies, focusing on spatial planning, emergency preparedness and risk communication. The CHANGES network consists of 11 full partners and 6 associate partners of which 5 private companies, representing 10 European countries. The CHANGES network has hired 12 Early Stage Researchers (ESRs) and is currently hiring 3-6 researchers more for the implementation of the SDSS.
The Spatial Decision Support System will be composed of a number of integrated components. The Risk Assessment component allows to carry out spatial risk analysis, with different degrees of complexity, ranging from simple exposure (overlay of hazard and assets maps) to quantitative analysis (using different hazard types, temporal scenarios and vulnerability curves) resulting into risk curves. The platform does not include a component to calculate hazard maps, and existing hazard maps are used as input data for the risk component. The second component of the SDSS is a risk reduction planning component, which forms the core of the platform. This component includes the definition of risk reduction alternatives (related to disaster response planning, risk reduction measures and spatial planning) and links back to the risk assessment module to calculate the new level of risk if the measure is implemented, and a cost-benefit (or cost-effectiveness/ Spatial Multi Criteria Evaluation) component to compare the alternatives and make decision on the optimal one. The third component of the SDSS is a temporal scenario component, which allows to define future scenarios in terms of climate change, land use change and population change, and the time periods for which these scenarios will be made. The component doesn't generate these scenarios but uses input maps for the effect of the scenarios on the hazard and assets maps. The last component is a communication and visualization component, which can compare scenarios and alternatives, not only in the form of maps, but also in other forms (risk curves, tables, graphs). The envisaged users of the platform are organizations involved in planning of risk reduction measures, and that have staff capable of visualizing and analyzing spatial data at a municipal scale. This paper presents the main components of the SDSS and the overall design and plans for the user interface.

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Extratropical Transitions in Atlantic Canada: Impacts and Adaptive Responses

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Cyclones originating over the tropical Atlantic may undergo the process of extratropical transition as they move northeastward along the coast of North America. Interaction with eastward-moving mid-latitude cyclones or frontal systems can result in the formation of spatially larger, more powerful storms, marked by frontal characteristics, changes (either increases or decreases) in wind speed and track velocity, and less predictable tracks coupled with increased precipitation and potential for storm surge. Of the 330 tropical cyclones formed over the North Atlantic from 1991 to 2011, 134 (40.6%) underwent partial or total extratropical transition.

The dynamics and threats of extratropical transitions have not been extensively studied. Consequently, forecasters refer to approaching storms as "hurricanes," although they are frequently extratropical in character by the time they reach New York and New England, and almost always have undergone partial or complete transition before making landfall in Atlantic Canada. In rare instances, extratropical transitions may continue to progress eastwards across the North Atlantic. In a typical summer-autumn, Atlantic Canada is impacted by 5 to 7 storms of tropical origin. Due to variations in track and interaction to form extratropical transitions, the number of summer and early autumn storm events in Atlantic Canada is not linked to the total number of hurricanes in any specific year. Overall tropical cyclone frequency in the North Atlantic cannot be directly correlated with temperature variations, or with the frequency or magnitude of summer and early autumn storms in Atlantic Canada.

Extratropical transition "Igor" directly impacted more than 40,000 km2 of eastern Newfoundland on 20-22 September 2010. Current estimates of damage to human property exceed $165 million, and one human life was lost. River flooding resulted from rainfall in excess of 150 mm/24 h in several locations, with peak stream flow locally exceeding 600 m3/s. Storm surge damage occurred along the north shore of the Bonavista Peninsula. Similar effects, differing only in the size of the affected areas, have resulted from several extratropical transitions which have impacted Atlantic Canada since July 1989.

Extratropical transition "Leslie" impacted Newfoundland on 10-11 September 2012. Although the area affected was comparable to "Igor", wind velocities and rainfall totals were less, fortunately limiting damage. Preparation, advance warning to the population, proaction, and response efforts all showed significant improvement, however, indicating that the experience gained from coping with "Igor" had been successfully applied in adaptation to "Leslie".

Extratropical transitions pose a significantly different set of challenges for adaptation in comparison to purely tropical hurricanes, and responses and adaptation strategies should be tailored to address these specific events. Calculating the frequency, magnitude and intensity of potential shifts is important for accurate forecasting and public awareness, safety management, preparedness, and adaptation. Available data indicate an increase in extratropical frequency and severity in Atlantic Canada since 1991, but there are difficulties in establishing the extent and nature of transition for previous storm events. A cautionary policy would assume no significant changes in extratropical transition frequency for Atlantic Canada, but would also acknowledge that large events remain probable.

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Changing pattern of natural hazards due to extreme hydro-meteorological conditions (Apulia, southern Italy)

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Recent international researches have underlined the evidences of climate changes throughout the world. Among the consequences of climate change, there is the increase in the frequency and magnitude of natural disasters, such as droughts, windstorms, heat waves, landslides, floods and secondary floods (i.e. rapid accumulation or pounding of surface water with very low flow velocity). The Damaging Hydrogeological Events (DHEs) can be defined as the occurrence of one or more simultaneous aforementioned phenomena causing damages.
They represent a serious problem, especially in DHE-prone areas with growing urbanisation. In these areas the increasing frequency of extreme hydrological events could be related to climate variations and/or urban development. The historical analysis of DHEs can support decision making and land-use planning, ultimately reducing natural risks.
The paper proposes a methodology, based on both historical and time series approaches, used for describing the influence of climatic variability on the number of phenomena observed.
The historical approach is finalised to collect phenomenon historical data. The historical flood and landslide data are important for the comprehension of the evolution of a study area and for the estimation of risk scenarios as a basis for civil protection purposes. Phenomenon historical data is useful for expanding the historical period of investigation in order to assess the occurrence trend of DHEs.
The time series approach includes the collection and the statistical analysis of climatic and rainfall data (monthly rainfall, wet days, rainfall intensity, and temperature data together with the annual maximum of short-duration rainfall data, from 1 hour to 5 days), which are also used as a proxy for floods and landslides. The climatic and rainfall data are useful to characterise the climate variations and trends and to roughly assess the effects of these trends on river discharge and on the triggering of landslides. The time series approach is completed by tools to analyse simultaneously all data types.
The methodology was tested considering a selected Italian region (Apulia, southern Italy).
The data were collected in two databases: a damaging hydrogeological event database (1186 landslides and floods since 1918) and a climate database (from 1877; short-duration rainfall from 1921).
A statistically significant decreasing trend of rainfall intensity and an increasing trend of temperature, landslides, and DHEs were observed. A generalised decreasing trend of short-duration rainfall was observed. If there is not an evident relationship between climate variability and the variability of DHE occurrences, the role of anthropogenic modifications (increasing use or misuse of flood- and landslide-prone areas) could be hypothesized to justify the increasing occurrences of floods and landslides..
This study identifies the advantages of a simplifying approach to reduce the intrinsic complexities of the spatial-temporal analysis of climate variability, permitting the simultaneous analysis of the modification of flood and landslide occurrences.

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First level inspection by trained-volunteers of torrent control structures in mountainous catchments: Towards a quality-evaluation of data collected

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Modern approaches for emergency management promote exchange of information between local authorities and community aiming at more appropriate and effective ways to manage hydro-meteorological risks[1]. In this framework, risk communication should not only start during the build-up of the hazard, but also in pre-warning and 'peace' time and it contribute to better emergency preparedness. Lately, a rapid growth of interest emerges to enable citizens to inspect hazard-related processes on their territory[2]. From the risk managers perspective, substantial advantages of taking this citizen-based approach include (1) the opportunity to identify on a quick and 'relatively' low cost basis one or more risk components at different geographical locations and (2) the ability to provide a practical application for citizens interested in creating and communicating useful information toward establishing a better understanding of their territory. From the citizens perspectives, it provides the opportunity to generate benefit through increasing and encouraging interest for self-awareness as well as self-preparedness. However, the use of citizen-based information also bring forth the need to train and establish standardized forms, guidelines and tools, particularly if the data collected seek to be useful information for decision-making activities and emergency management[3].

In this research work, we address the question on the quality of data collected by volunteers for decision-making activities. This in the framework of the civil protection organization of the Friuli-Venezia-Giulia (CP-FVG) and the Italian study area of the CHANGES project, Municipality of Pontebba[4]. An experiment is carried out by analyzing the results of a questionnaire form dealing with the inspection of the functional status of check dams and bridges across streams. This form is filled by volunteers (in this case, citizens and university students), that register to a web-portal with access by browser after a standardized training given by practitioners and scientists. During the latter, the guidelines to fill the questionnaire, i.e. various conditions of hydraulic structures and the proposed criteria for quality evaluation[5], will be disseminated to the volunteers. The quality of the data are analyzed on the basis of these guidelines in order to determine if the citizens-based data collection approach can be used to prioritize the structures to be inspected by the risk managers.

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[2] Yetman., K. 2002. *Using Maryland's stream corridor assessment survey to prioritize watershed restoration efforts*. Journal of the American Water Resources Association. Vol 38. No4

[3] Goodchild, M.F. & Li, L. 2012. *Assuring the quality of volunteered geographic information.* Spatial Statistics 1 (2012) pp. 110–120.

[4] Marie Curie ITN Changing Hydro-meteorological Risks as Analyzed by a New Generation of European Scientists (CHANGES) is funded by the European Community's 7^{th} Framework Programme FP7/2007-2013 under Grant Agreement No. 263953.

[5] EPA, 1997. Volunteer Stream Monitoring: A Methods Manual. EPA 841-B-97-003. Water Division Region 10, Seattle Washington.

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Coordination of short-term and long-term mitigation measures of hydro-meteorological risks: the importance of establishing a link between emergency management and spatial planning

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The management of natural hazards involves, as generally known, the four stages of the risk management cycle: Prevention, preparedness, response and recovery. Accordingly, the mitigation of disasters can be performed in terms of short-term and long-term purposes. Whereas emergency management or civil protection helps to strengthen a community's capacity to be better prepared for natural hazards and to better respond in case a disaster strikes, thus addressing the short-term perspective, spatial planning serves long-term planning goals and can therefore implement long-term prevention measures.

A purposefully applied risk mitigation strategy requires coordination of short-term and long-term mitigation measures and thus an effective coordination of emergency management and spatial planning. Several actors are involved in risk management and should consequently be linked throughout the whole risk management cycle. However, these actors, partly because of a historically fragmented administrative system, are hardly connected to each other, with spatial planning only having a negligible role compared to other actors[1], a problem to which Young (2002) referred to as the "problem of interplay". In contrast, information transfer and decision-taking happen at the same time and are not coordinated among different actors. This applies to the prevention and preparedness phase as well as to the recovery phase, which basically constitutes the prevention phase for the next disaster[2]. Since investments in both risk prevention and emergency preparedness and response are considered necessary, a better coordination of the two approaches is required. In this regard, Decision Support Systems (DSS) can be useful in order to provide support in the decision-making aspect of risk management.

The research work currently undertaken examines the problem of interplay in the four case study areas of the Marie Curie ITN, CHANGES[3]. The link between different risk management actors will be explored by means of exploratory questionnaires and interviews with government agencies, local administrations, community and research organizations on each study site. First results provided will address the general role of spatial planning in risk management. Additionally, preliminary observations are made in regard to the coordination of emergency preparedness and long-term spatial planning activities. The observations consider that integration facilitates proactive strategies that aim at preventing disaster occurrence and promote interaction between involved parties. Finally, consideration is given to the potential use of a DSS tool to cover both aspects of spatial planning and emergency management in the risk management cycle.

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Multilevel integrated flood management aproach

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The optimal solution for complex flood management is integrated approach. Word »integration« used very often when we try to put something together, but should distinguish full multiple integrated approach of integration by parts when we put together and analyse only two variables. In doing so, we lost complexity of the phenomenon. Otherwise if we try to put together all variables we should take so much effort and time and we never finish the job properly. Solution is in multiple integration captures the essential factors, which are different on a case-by-case (Brilly, 2000).
Physical planning is one of most important activity in which flood management should be integrated. The physical planning is crucial for vulnerability and its future development and on other hand our structural measures must be incorporate in space and will very often dominated in. The best solution is if space development derived on same time with development of structural measures. There are good examples with such approach (Vienna, Belgrade, Zagreb, and Ljubljana). Problems stared when we try incorporating flood management in already urbanised area or we would like to decrease risk to some lower level. Looking to practice we learn that middle Ages practices were much better than to day. There is also »disaster by design« when hazard increased as consequence of upstream development or in stream construction or remediation. In such situation we have risk on areas well protected in the past.
Good preparation is essential for integration otherwise we just lost time what is essential for decision making and development. We should develop clear picture about physical characteristics of phenomena and possible solutions. We should develop not only the flood maps; we should know how fast phenomena could develop, in hour, day or more. Do we need to analyse ground water – surface water relations, we would like to protected area that was later flooded by ground water. Do we need to take care about sediment transport, phenomenon close related to floods – could the river bad bottom increase or decrease for some meters or river completely rearrange morphology – how then inundated area will look like. Hazard of floods should be presented properly, with maps, uncertainty and trends related to natural and anthropogenic impacts. We should look time back, how our river look in past centuries and what are water management plans for future. Which activities are on the river? There are good practice in flood protection, hydropower development and physical planning (Vienna, Sava River).

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Land Use Adaptation Strategies Analysis in Landslide Risk Region

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In order to respond to the impact of climate and environmental change on Taiwanese mountain region, this study used GTZ (2004) Risk analysis guidelines to assess the landslide risk for 178 Taiwanese mountain towns. This study used 7 indicators to assess landslide risk, which are rainfall distribution, natural environment vulnerability (e.g., rainfall threshold criterion for debris flow, historical disaster frequency, landslide ratio, and road density), physicality vulnerability (e.g., population density) and socio-economic vulnerability (e.g., population with higher education, death rate and income). The landslide risk map can be obtained by multiplying 7 indicators together and ranking the product. The map had 5 risk ranges, and towns within the range of 4 to 5, which are high landslide risk regions, and have high priority in reducing risk.

This study collected the regions with high landslide risk regions and analyzed the difference after Typhoon Morakot (2009). The spatial distribution showed that after significant environmental damage high landslide risk regions moved from central to south Taiwan. The changeable pattern of risk regions pointed out the necessity of updating the risk map periodically.

Based on the landslide risk map and the land use investigation data which was provided by the National Land Surveying and Mapping Center in 2007, this study calculated the size of the land use area with landslide disaster risk. According to the above results and discussion, this study can be used to suggest appropriate land use adaptation strategies provided for reducing landslide risk under the impact of climate and environmental change.

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Landslide Potential Assessment by Using Geographical Index

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In the August of 2009, Typhoon Morakot brought heavy rainfall and caused several landslides, floods and debris flows in southern Taiwan. The horrible disasters seriously threaten the safety of the residents live and property. Typhoon Morakot struck Taiwan from 6th to 10th August, 2009 and caused serious damage in the middle and southern part of Taiwan. Under the effect of rainfall type with high intensity and long duration, it had been causing server damage especially in GaoPing drainage area.

While the potential landslide occurrence evaluated by physiographical factors has been extensively investigated, the independence of physiographical factors and the quantification relationship between physiographical factors and landslide occurrence are relatively unexplored. Using 98 debris-flow-prone streams within Gaoping river watershed in southern Taiwan as an example, the independence of physiographical factors were analyzed by statistical method. The quantification functions of the physiographical factors were established by using the fuzzy statistics method. Aside from these, each weighed value related to landslide occurrence for the physiographical factors was estimated by using the Analytic Hierarchy Process (A.H.P.). The product of the weighting values and the quantification values for the physiographical factors is defined as a landslide potential index (PI), mentioned in this paper, is using the Weibull distribution which divided into (low, medium & high) three different landslide potential index, and mapping the landslide potential index in the small watersheds.

To excerpt from the events of Typhoon Morakot and Typhoon Fanapi, this paper is developed by applying (landslide potential index in watershed), through (correlation analysis) to check the ratio between PI value and the landslide ratio. Hence, this particular research can easily and effectively demonstrate the level of landslide potential in watershed area. Moreover, the PI value has moderately positively correlation with landslide ratio. Thus, this research paper can be a handful tool for slope disaster prevention.

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Integration of landslide hazard maps into probabilistic risk assessment in context of global changes: an alpine test site

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The aim of this work is to develop a methodology to integrate global changes scenarios into quantitative risk assessment. This paper describes a methodology to take into account effects of changing climate on landslides activity and impacts of social changes on exposure to provide a complete evaluation of risk for given scenarios. This approach is applied for demonstration purpose on a southern alpine test site.

Mechanical approaches represent a solution to quantify landslide susceptibility and to model hazard on unprecedented conditions, as it is likely to occur. However, as the quantity and the quality of data are generally very heterogeneous at a regional scale, it is necessary to take into account their uncertainty in the analysis. In this perspective, a new hazard modeling method has been developed and integrated in a GIS-based software called ALICE®. To go further, climate change scenarios have been computed for the alpine test site (Barcelonnette area, France) using the REMO-COSMO-LM. From the precipitation time series, a daily index of the soil water content has been computed thanks to a reservoir-based model (GARDENIA®). Hence, the program classifies hazard zones depending on the several spatial data (lithological, DEM, etc. . .) and different hydrological contexts varying in time. The probabilistically initiated landslides are then propagated thank to a semi-empirical model (BORA) to provide real hazard maps.

Different scenarios of land-use have been developed using an automate cellular model to cover the probable range of development of potential elements at risks in the future. These exposure maps are then combined with the aforementioned hazard maps to obtain risk maps for the different periods and the different land-use development scenarios. Potential evolutions of landslide risks are then evaluated, with a general increase in the 7 communes. This methodology also allows the analysis of the contributions of both considered global changes (climate and land-use) to the evolution of risk.

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Changing level of vulnerability and risk due to floods - case study of the Becva River, the Czech Republic

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Nowadays flood risk management is different in each risk zone. But are these zones define correctly? In the Czech Republic there exist three flood risk areas – high, low, and no; but only along major rivers. In the last few years we witnessed an upward trend flooding on the small streams. And therefore we should determine which variables influence the level of flood risk. The main goal of this paper is to compare pattern of flood risk areas due to diverse defined variables by GIS. Among the basic variables there can be included flood areas, social perception of flood risk, and vulnerability presented by damages, quality / quantity of flood protection measures, and inhabitants' demographic structure. All these factors result from the risk equation. The integrated approach in our study is a significant added value. This requirement is contained in many disaster research strategies of international organizations, e.g. IRDR, ICSU as well as the EU itself.
The case study was carried out in the Becva River basin in the eastern part of the Czech Republic. The study area represents landscape along middle section of the river, in the foothills of the Beskids Mountain. We made there the interdisciplinary questionnaire and field mapping research, where we asked over 300 households and mapped about 184 square kilometres. We confirmed decreasing of deaths and increasing of economic losses. This new concept of flood risk areas assessment has a high potential to improve risk management strategies. Especially for prediction, prevention, and preparedness phase. And we try to apply these results to improve river management in the national level.

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Uncertainty associated within regional landslide risk analysis – a case study in Buzau County, Romania

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When analyzing the risk for a region where landslides constitute a threat for the society and the environment, a fully quantitative approach often becomes impracticable. The magnitude, frequency and location of landslides and a reasonably complete inventory of historical events is commonly not available. Likewise, a thorough investigation of the damaged assets and quantification of losses is rarely possible. Nevertheless, an alternative approach can be engaged in areas where information regarding the environmental conditions leading to the occurrence of landslides including their relative location, and the characteristics and distribution of elements at risk are known.
This contribution proposes a methodology for a landslide risk analysis applicable at regional scale taking into account the spatial probability and consequences of past damaging events. Since the temporal information used to calculate the detailed hazard probability is missing, a susceptibility analysis is performed by using a data-driven Bayesian method (Weights of Evidence modeling technique) which analyzes the relation between a training set (past landslide events) and multiple predisposing factors (lithology, landuse, slope, aspect, internal relief, altitude), in order to predict areas that are less-to-more susceptible to landslide initiation. The consequence analysis is based on a generalized assessment of vulnerability, exposure and value of the elements at risk (i.e. buildings and roads) using cadastral and statistical data. For both components of the risk analysis (susceptibility analysis and consequence analysis) an estimation of uncertainty is performed by defining a central value (which represents the statistical mean) and a measure of value range (minimum and maximum) of the input parameters. As the procedure operates at a spatial level, the distribution of risk and the annual probability of expected losses are expressed numerically as well as spatially with the use of GIS.
The developed landslide risk assessment methodology is tested in Buzău County, a region located in the Curvature area of the Romanian Carpathians and Subcarpathians. In this region, recurrent hydro-meteorological events and earthquakes are the cause of considerable damages to critical infrastructure incl. lifelines, build-up environment and cultivated areas.
The main advantages and limitations of the proposed methodology are outlined and recommendations for future improvements are given. The results may serve as basis for decision making and risk management in areas where no or limited information about the risk to landslides is available.

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Changing flood magnitude and frequency in snow-melt dominated catchments: the case of the Bucegi Mountains, in the Romanian Carpathian region

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Flooding in mountain environments is an issue of particular concern given the impacts of possible climatic changes and especially where those environments are occupied and/or used for activities like tourism. Central to understanding the flood risk in such environments is the analysis of historical data coupled with predictive modelling to understand possible changes in the hazard dimension of flood risk. Here we focus upon a little studied but important part of Eastern Europe, the Valea Cerbului, a mountainous basin, located on the eastern slope of Bucegi Mountains in the Romanian Carpathians. This study has two components. In the first, analysis of monthly and annual maximum discharges from 1961 to 2010, (daily and hourly discharges during the analyzed floods) from Buşteni hydrometric station on the Valea Cerbului river showed that rather than extreme flood events being distributed randomly in time, they tend to be clustered and not simply related to extreme rainfall events, but extreme rainfall events superimposed upon snow cover, which substantially increases the surface runoff potential. This clustering occurs inevitably at the seasonal scale (the annual maximum discharges have a maximum frequency from June to August: 19,2% of cases in June, 19,2% of cases in July, 23,1% in August, for the period 1961-2010) but also in terms of series of years when there is an elevated frequency of significant snow accumulation remaining in the basin at the time at which the probability of extreme, convective rainfall events starts to increase. In the second part of the study, we have considered how these processes might change given possible climate warming. Using a distributed, physically-based hydrological model (WaSIM-ETH) we show that under climate futures, a decrease in solid precipitation in the Winter plus the earlier onset of spring snowmelt has two important flood effects. First, it reduces the probability of a deep snow cover in the summer months, and hence the size of the maximum annual flood. Second, the floods start to occur earlier in the year, more commonly in late spring rather than summer. This kind of shift is important as it implies a need to change the way in which floods are managed to be more sensitive to extreme events in periods of the year where floods, hitherto, have been relatively rare.

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Estimation of the fascine efficiency in terms of runoff infiltration and sediments deposition

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Runoff inundations and mudflows are more and more frequent phenomena.
In 2011, Belgium had a lot of its municipalities affected by this problematic. Since then, mitigation measures are more and more set up in agricultural watersheds.
The fascines are one of these measures which allow to protect the public and private infrastructures and in the same way, which don't reduce the famers productivity. They consist in branches faggots piled up between two rows of stakes. These linear constructions are mainly put in place across concentrated runoff axis in order to slow down the water and to filter the mud.
Only few quantifications of their effectiveness (in terms of flow and concentration water reduction) exist and are however needed to better recommend these types of mitigation measures.
Our experiment aims at measuring discharge and mud concentration reduction due to the fascines in a completely defined context.
The tests were realised through fascines planted in field border. A watertight surface of 2,45m to 0,80m carries the water to the fascines.
Three types of fascines were tested (willow wood fascine, straw fascine, straw compacted fascine), three different water flows were applied (0,5L/s, 3L/s and 6L/s) and three water concentration in dry soil (13g/L, 26g/L, 38g/L) were used. The different factor combinations were tested.
The results show that we can expect a reduction of 60% of the flow for the biggest water flows (proportional efficiency with the water flow). The factor interaction study doesn't allow to see a difference between the type.
About the sediment water concentration, the filtration can reach 50%, the fascine with wood faggots showing a better efficiency.
Finally, the difference between the fascine type show that straw fascine can support a biggest watershed (25 hectares) than the wood faggot fascine can (5-10 hectares) but during a smaller return period (one year against five years).

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Estimation of climate change impact on the runoff from a small alpine watershed in Austria

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The hydrologic regime in alpine watersheds is affected by changing climate conditions. Studies on impacts of climate change on the runoff of small mountain streams are rare, mainly due to difficulties of local climate projection and/or the lack of discharge data. The aim of this study is to estimate the impact of climate change on future flood hydrographs on the exemplary model region, the Wartschenbach catchment in Eastern Tyrol/Austria. An ensemble of five climate change projections, based on the meteorological station in Lienz, was used to simulate the climate of the mid-21st-century scenario period (2021-2050). A one-hour design rainfall event with a return period of 100 years was calculated using a standard engineering approach for past rainfall data and for the different scenarios. A conceptual rainfall-runoff model was setup based on daily and hourly discharge and rainfall data. To quantify possible changes the calibrated hydrologic model was driven by five future design rainfall events and the design event under current conditions. Additionally three scenarios (best, worst, and average) according to different antecedent moisture conditions were investigated. All five model ensembles indicated an increase in 100-year hourly rainfall intensities, whereas three out of five changes are significant. Accordingly, all future flood hydrographs indicated an increase in hourly peak discharges, with a multi-model ensemble average between 18% and 28% under different soil moisture conditions. The results highlight the importance of investigating the impact of climate change for a sustainable secure dimensioning of protection measures and hazard zones. The uncertainty range that originates with each additional model application is high. Nonetheless, the projected signals represent a possible and probable evolution of the future climate towards higher peak floods, whereas the exact magnitude of the expected increase is highly uncertain.

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A Multi-Hydro simulation for evaluation of the impacts of flood management at Heywood, RU.

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The flooding problems in urban and peri-urban areas have more and more important impacts on city life. Indeed, with the expansion of the latter, the floodplains are more intensively used and floods will generate significant damage very expensive. In the aim to reduce these costs and facilitate a return to normal faster after the flood, the FP7 SMARTeST project aims to provide users of these areas a guide to help them choose the most appropriate protection measures.
It is in this context that the Multi-Hydro model has been developed and improved in the Ecole des Ponts ParisTech. This model consists into a coupling between four modules (relying on existing open source and widely validated physically based model): one for the rainfall scenario generation, one for the surface processes, one for the subsurface processes and one for the load of the sewer system. This structure of coupling allows to represent all the parts of the water's path from the surface to the sewer system's pipes and to the soil of the considered catchment and it allows to disconnect one element of the coupling system if it's necessary. Moreover, this model uses some GIS data as the elevation, the land use, the soil description and the sewer system description which can be managed by a dedicated open source SIG allowing to use directly the data in the model.
The Multi-Hydro model has been used on a street of Heywood, Rochdale, Greater Manchester urban area. This residential street has known some important events during this last 10 years. Thus, Multi-Hydro has been used to evaluate the effects of the implementation of protection measures supposed to reduce the damages of the flood: a storage basin, located between Wilton Grove and the Egerton street and two barriers across the streets.
For a given event, NIMROD radar data have been used to reproduce the flood. Then, the protective measures were put in place virtually. Analysis of water height maps obtained with Multi-Hydro allowed better understand and better assess the hydrological behavior of étidié neighborhood. Thus, the early assumptions about the location of the barriers have proved misguided. The results and the multiplication of the protection scenarios could thus permit to improve protection strategy in the studied streets.

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Methodological framework for the probabilistic risk assessment of multi-hazards at a municipal scale: a case study in the Fella river valley, Eastern Italian Alps

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Local and regional authorities in mountainous areas that deal with hydro-meteorological hazards like landslides and floods try to set aside budgets for emergencies and risk mitigation. However, future losses are often not calculated in a probabilistic manner when allocating budgets or determining how much risk is acceptable. The absence of probabilistic risk estimates can create a lack of preparedness for reconstruction and risk reduction costs and a deficiency in promoting risk mitigation and prevention in an effective way. The probabilistic risk of natural hazards at local scale is usually ignored all together due to the difficulty in acknowledging, processing and incorporating uncertainties in the estimation of losses (e.g. physical damage, fatalities and monetary loss). This study attempts to set up a working framework for a probabilistic risk assessment (PRA) of landslides and floods at a municipal scale using the Fella river valley (Eastern Italian Alps) as a multi-hazard case study area. The emphasis is on the evaluation and determination of the uncertainty in the estimation of losses from multi-hazards. To carry out this framework some steps are needed: (1) by using physically based stochastic landslide and flood models we aim to calculate the probability of the physical impact on individual elements at risk, (2) this is then combined with a statistical analysis of the vulnerability and monetary value of the elements at risk in order to include their uncertainty in the risk assessment, (3) finally the uncertainty from each risk component is propagated into the loss estimation. The combined effect of landslides and floods on the direct risk to communities in narrow alpine valleys is also one of important aspects that needs to be studied.

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Climate change impact assessment on food security in Indonesia

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As Indonesia is the world's fourth most populous country, food security is a persistent challenge. The potential impact of future climate change on the agricultural sector needs to be addressed in order to allow early implementation of mitigation strategies.
The complex island topography and local sea-land-air interactions cannot adequately be represented in large scale General Climate Models (GCMs) nor visualized by TRMM. Downscaling is needed. Using meteorological observations and a simple statistical downscaling tool, local future projections are derived from state-of-the-art, large-scale GCM scenarios, provided by the CMIP5 project.
To support the agriculture sector, providing information on especially rainfall and temperature variability is essential. Agricultural production forecast is influenced by several rain and temperature factors, such as rainy and dry season onset, offset and length, but also by daily and monthly minimum and maximum temperatures and its rainfall amount. A simple and advanced crop model will be used to address the sensitivity of different crops to temperature and rainfall variability, present-day and future.
As case study area, Java Island is chosen as it is fourth largest island in Indonesia but contains more than half of the nation's population and dominates it politically and economically. The objective is to identify regions at agricultural risk due to changing patterns in precipitation and temperature.

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Changes in rainfall thresholds for debris flow initiation and run-out on a local and regional scale in the Wenchuan earthquake area, SW China.

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For the development of early warning systems for the initiation and run-out distances of debris flows, to avoid or mitigate intolerable risks, it is necessary to assess rainfall thresholds. However one must be aware that these thresholds can change. These changes can be ascribed to environmental and climate change as well as socio-economical changes. In the Wenchuan area in the Sichuan Province, SW China, changes in thresholds are related to a depletion of source materials for these debris flows.
The intensive Earthquake of 2008 in the Wenchuan area generated many co-seismic landslides, which delivered a lot of loose source material. It caused a dramatic increase in debris flow occurrences in the subsequent years. A preliminary model was designed, with entrainment processes driven by run-off water as the main triggering mechanism, to describe the relationship between rain input and debris flow run-out with the intention to assess rainfall thresholds for the start of debris flows and critical run out distances. The model was calibrated on the depositional volumes of debris flow events which occurred in individual catchments in August 2011. The calibrated model was used to construct rainfall intensity –duration threshold curves. These curves describe the thresholds for a critical run-out distance, determined by the outlet of the catchment, which was considered as the limit beyond which elements at risk situated in the main river plain are threatened. The research is focused on the change in these thresholds curves after a range of consecutive debris flow triggering rain events. It appeared that for individual catchments the rate of change of these thresholds can vary dramatically which is related to the location of available loose erodible material in the catchment.
The model is also applied on a regional scale in the Jingxiu area. A method was proposed to made a general estimate of the time duration to arrive at a debris flow frequency level before the earthquake, which depends on the diminution rate of the loose co-seismic source materials for these debris flows.