

# The integration between planning instruments and evaluation tools in the management of landslide risk

M. Magoni

*DiAP, Politecnico di Milano, Italy*

## Abstract

The paper shows the main factors to integrate the planning instruments, the evaluation tools, and the certification procedures for the management of landslide risk. The integration is based on the Risk Analysis for the methodological aspects and on the Territorial Risk Certification for the procedural ones. The Risk Analysis structures the evaluations in three main factors: the quantity of goods, people and activities with different levels of sensitivity (exposition), the probability that goods, people and activities could have damage (vulnerability), and the nature, the frequency and intensity of potential catastrophic events (hazard). The Territorial Risk Certification structures the procedure in four main steps: territorial and risk analysis; the production of a structure of objectives and targets; the individuation of strategies and the planning of interventions; the monitoring of territorial risks factors and the adoption of corrective measures.

*Keywords: instruments of landslide risk management, landslide risk evaluation.*

## 1 Introduction

Many of the landslide events, like all the catastrophic events, differ from ordinary phenomena because of their elevated drama due to the speed of their arrival, the difficulty in foreseeing the time and intensity of their occurrence and the large amount of damage which is produced in a short time. For example, the effects of a landslide can ruin buildings or make them collapse, much more quickly than the effects that time has on buildings.

In order to limit damage due to landslide events, man tries to intervene whenever possible on the processes that cause a disaster as well as the related



potential and real effects. Furthermore, experts elaborate, refine and utilize specific methods of analysis and evaluation designed to improve the efficacy and efficiency of actions to prevent and mitigate catastrophes. These methods, which range from the catastrophic event tree to the analysis of risk, permit evaluation of the totality of the causal effects which underlie a landslide, with varying degrees of depth and systematicness. These can then support current policies of prevention and mitigation of territorial risks, which are increasingly finalized at attaining territorial conditions which maintain an acceptable level of risk over time, whose acceptability threshold tends to decrease as the economic well-being and perception and conscience of risks increases in the population.

The intent of this article is to furnish a contribution in order to arrive at an increased integration between planning instruments, evaluation tools and certification procedures in the management of landslide risk. This integration, which should be carried out in both procedural and methodological terms, constitutes an important step in order to improve the capacity of elaboration and implementation of interventions for landslide prevention and mitigation.

## 2 The instruments for the reduction of landslide risk

Interventions for reducing landslide risk can be distinguished with respect to their varying types:

- form, such as the financing of the construction of regimation works or the approval of urbanistic norms;
- object of interest, which can regard factors causing a calamitous event or its targets;
- structural nature, when they act upon the cause, such as the containment of the processes of deforestation like the prohibition of building on areas of landslide;
- mitigating, when they act on the effects, for example, building the retaining and consolidation walls of landslides;
- and emergency, when they monitor the movements of a landslide rather than limit the negative effects following a catastrophe which has just occurred.

The majority of instruments of intervention in this sector fall under the direct or indirect competence of the planning instruments, evaluation tools and certification procedures.

Planning instruments have an effect on the character of various types of settlements, infrastructures and plants, on where they are located and on the methods with which they are carried out. The plans can then act on the causes, for example avoiding the placement of a road infrastructure along an area of landslide; or on the effects, for example prohibiting construction in areas subject to landslide.

The methods with which planning tools can affect landslide risk are a function of the scale of intervention, which can range from the city to the region,



and their general, sectoral or actuative nature. In this way, planning tools can act on one, more, or all factors which could create damages on things or people as a result of a landslide, in order to prevent or mitigate the relative effects.

If the general plans determine and orient the major transformations of a territory, and therefore define the relationship between possible catastrophic events and human activities and settlements, sectoral plans define the strategies and program interventions designed to resolve problems of a specific plan of action. They are thus very different among themselves because they can affect industrial activity or road infrastructure, refuse or energy. Among the sectoral plans are those which specifically relate to the management of risk, such as the plans of the hydrographic basin, emergency plans, and risk prevention plans.

Actuative plans and programs, whose function is to determine the methods and timing of transformation of those portions of the territory most interested by the dynamics of development, are particularly useful tools needed in order to ensure that the activities of the above plans are correctly carried out.

Instruments of environmental evaluation are used to structure a plan's decision making process, in order to improve the quality of the solutions and increase consensus on the available choices, and to verify that the choices made correspond to the needs of the evaluation. These instruments fall in two categories: those which evaluate the project, and those which evaluate the plans and programs. The former evaluate the environmental impact, and are mature tools since they have been systematically applied for around 15 years. The latter is a strategic environmental evaluation, and is in the consolidation phase, having been introduced by a European directive in the year 2001. Both tools are divided in three phases:

- the ex-ante evaluation, which supports the preparation of the project or plan;
- the in itinere evaluation, which is the verification of the progress of the project;
- the ex-post evaluation, which verifies the intervention performed or the plan carried out.

Through the certification of territorial risks, it is possible to consider a large part of the direct and derived interventions that influence landslides, since this requires that a public administration instigate not only direct actions, meaning those for which it is directly responsible, but also indirect ones. These are the responsibility of those who are motivated, when necessary, to adopt practices for reducing landslide risks in order to maintain a relationship with the public administration. It could be possible to certify those companies which operate in hazardous areas.

Furthermore, since certification procedures verify the real achievement of objectives, their adoption will tend to favor the planning of interventions in line with available financial resources and capacity of intervention.

If the systematic verification of the work carried out by the public administration, as well as the results of the totality of the tools which this uses to reduce territorial risk, including the landslides, creates a common aspect with the evaluation instrument, that aspect specifically characterizing the certification is

furnished by the search for a continual improvement of the conditions of territorial, and landslide, risk.

Since evaluation tools should be integrated with planning tools (otherwise they are useless), both tools should be regarded as the only and the widest ones to use for planning, which we can define as integrated planning tools. The integration between these two tools means that the latter uses a strategic approach, which entails the adoption of objectives which are verifiable over time and therefore measurable. The adoption of strategic planning approaches is destined to become increasingly more widespread, following the receipt of Directive 42/2004/CE about the VAS by the Member States.

Integrated planning instruments are part of the set of tools that an administration can utilize to reduce territorial risks, once it decides to certify itself, and therefore they make up fundamental reference points for certification. On the other hand, certification favors the achievement of the objectives to reduce territorial risks assumed in the plan since they try to ensure a coherent behaviour of the entire public administration regarding those objectives and verifies the correct determination and execution of the actions indicated by the general, sectoral and executional plans falling under the authority of the public administration.

The phases of certification comply with those phases that characterize the planning processes when the latter adopt strategic approaches; since certification adopts more structured procedures than do planning tools, in order to integrate the two instruments, it is preferable to maintain the certification procedures as a reference.

### **3 The references for the integration of planning, evaluation and certification tools**

The procedure for the management and certification of territorial risks outlined in the European research project Quater (Quarter [5]) was structured in a set of passages which, in order to improve their handling and integrate them with the procedures of integrated planning, are grouped into the following phases: analysis of the territory and the relative risk factors; the determination of the strategies and the programming of the intervention actions; and monitoring the factors of territorial risk and the adoption of corrective measures. It is understood that the process of execution of the total of the interventions of territorial risk, including landslide risk, indicated by the various instruments requires a continual interaction among the instruments, and within them, among the different phases with which they are carried out.

#### **3.1 The analysis of landslide risk factors**

The analysis of landslide risk factors has the dual objective of quantifying the risk levels of a territory and determining the possibilities of intervention for their reduction. This should also consider the interaction between one or more risks, for example between those of earthquakes and landslides.



This phase is supported by methods, such as the risk analysis; the version presented in the Quater research is well suited to integrate the elaboration of the planning, evaluation and certification tools.

The risk analysis allows support not only of the analyses, the evaluations and the verifications relative to catastrophic phenomena due to landslides, but also the determination of preventive and mitigating interventions and the evaluation of their efficacy and cost-effectiveness (if economic evaluations are performed).

The risk analysis can easily be integrated with multi-dimensional integration methods, both aspatial types (multi-criteria analysis, hierarchic analysis, multi-decisional analysis and for certain aspects cost-benefit analysis, so that effects of alternative solutions may be compared) as well as territorial types (such as cluster analysis and land suitability analysis) in order to contribute to the classification of a territory with respect to levels of localization or intervention criticality.

The risk analysis structures the analyses in 3 factors which make up the references of the evaluation methods of the single risks:

- exposition (the presence and quantity of goods, the number of people and activities with different levels of sensitivity);
- vulnerability (the probability that goods, people and activities can be damaged);
- and hazard (the frequency and intensity of potential catastrophic events, including the landslides).

However, it is not applied in the same way for all types of risks, since the latter has different characteristics and requires specific approaches. For example, the hazard from landslides can be evaluated, in terms of the probability that a certain event occurs in a given location in a given time interval, similarly to the hazard of earthquakes. However, since water flows are able to be controlled, the catastrophic events deriving from floods, as opposed to those from earthquakes, can be partially controlled by diverting waters to less vulnerable areas. Furthermore, the hazard of industrial accidents, as opposed to the hazards from landslides and earthquakes, is linked to the decision of whether or not to make certain industrial activities, to their localization and to the plants and substances treated, which makes it possible to prevent these types of events.

### 3.2 The definition of objectives

The definition of the objectives must proceed in a structured way and must be translated in targets, which are objectives measurable over time. This passage is fundamental in order to carry out the systematic verification of the execution of the interventions.

For all types of risks, the articulation of the objectives and related targets can follow certain criteria. For example, the table 1 outlines the goals determined in the Territorial Plan of the Province of Cremona related to the objective of containment of the criticality due to territorial risks.



### 3.3 The determination of the strategies and the programming of interventions

The political-programming phases of certification are analogous to those of the planning processes, even though in the former case one needs to consider all instruments available to the certifying authority, among which the planning instruments.

Table 1: Indicators for the objective of the containment of territorial risks from the Territorial Plan of the Province of Cremona.

<b>Targets:</b>	Maintain current levels of flood risk
<b>Indicators:</b>	Areas of settlements per level of flood hazard; Areas of settlement for level of flood risk
<b>Targets:</b>	Maintain current levels of industrial risk
<b>Indicators:</b>	Area of settlement per level of industrial hazard; Area of industrial settlement at risk for large accidents per level of territorial vulnerability; Area of settlements per level of industrial risk
<b>Targets:</b>	Maintain current levels of landslide risk
<b>Indicators:</b>	Number of buildings subject to the landslide risk

In this phase the intervention strategies must first be determined and then determine and plan the actions needed to carry out these strategies.

The determination of the strategies must take into consideration the objectives of security of the territory assumed by the public administration, and by the need to constantly improve the risk levels, and must propose solutions which integrate the territorial, social and economic dimensions of the problems. In this phase, it is often necessary to compare different alternative strategies of risk reduction, which implicates the use of multi-dimensional analysis methods and the construction of scenarios, with a medium to long period as a reference point with respect to the desired transformations.

The objective of programming the actions of intervention is to achieve the objectives of territorial security and requires the determination of the set of human, organizational and financial resources necessary to arrive at the goals.

Reference to the programs of management of territorial risks, including landslide risk, are a valid support in general, sectoral and executorial planning, while the management of the emergency phases, which differs from classical planning instruments, finds that the territorial and urbanistic plans are the tools

needed to realize those conditions which permit them to operate effectively in such situations.

### **3.4 The monitoring of landslide risk factors and the adoption of corrective measures**

Certification requires the management of the execution of the total interventions indicated for the reduction of landslide and territorial risks. To this end, an audit phase aimed at controlling the efficacy of the strategies elaborate is made. The audit evaluates the retroactions that go from the Territorial Risk Management System to the program of interventions, and determines the corrective actions necessary to make to the management systems and eventually the modifications to make to the strategies and objectives

The monitoring and the consequent adoption of corrective measures is an activity which doesn't fall under traditional planning procedures but which is more widely used with the strategic environmental evaluation, of which the itinere evaluation is a fundamental part of its execution.

The monitoring of landslide and territorial risks assumes a specific character with respect to other types of monitoring since it is necessary to carry out the correct execution of the interventions, both in periods in which there are no calamitous events (in which case the correspondence between the prevention and execution of the interventions) as well as in the periods following catastrophic events. In this case, previsions made on the vulnerability and on the exposition and the efficacy of the interventions of prevention and mitigation can be verified.

## **4 Conclusions**

The integration of planning, evaluation and certification tools enables improvement of the efficacy of the interventions of landslide risk containment. This integration should take into consideration the fact that the content of these tools can be characterized by their aspects of emergency, which are closely linked to the management of calamities when they arise, or structural, which serve to carry out the conditions needed to reduce the risk, in order to render the integration stronger. In particular, it is important to structure the pathway that goes from the management of the emergency, made through the Emergency Plan, to the mitigation of the impacts and the realization of structural interventions, operations that are carried out using the Risk Prevention Plan and the implementation in the general plans and the sectors of action and projects to improve safety. In this way, structural indications are connected with the strategic-structural visions of the plans, through which it is possible to outline scenarios of reference.

The graduality of the method developed under the territorial risk analysis, including landslides, which calls for three phases of successive analysis with an increasingly higher degree of investigation, is suitable for use in integrated certification and planning, since both instruments can postpone the decisional refinements to successive phases. Furthermore, the gradual increase in the



analysis enables the realization of important cognitive synergies among the various instruments.

The hoped-for widespread diffusion of instruments for the management of landslide risk goes from a simplification of the related methods and procedures in order to limit the time and costs of studies resulting in a greater efficacy in the actions. To this end, the integration of these instruments provides a significant contribution following the simplification of the procedures, the standardization of the various approaches and the reduction of time dedicated to the collection and elaboration of data.

If it is easy to achieve the integration of the procedures between planning and certification, the methodologic integration is not completely resolved, since a common scale of evaluation still has not been determined on which to make the elaboration for different risks convene. This passage creates an element of important interest under the operational viewpoint since it would facilitate the attribution of the priorities for the realization of the set of the interventions of the various territorial risks enabling the achievement of aggregate or however comparable evaluations.

## References

- [1] Australian Geomechanics Society, 2000, *Landslide risk management concepts and guidelines*, Australian Geomechanics, March 35, 49-92.
- [2] Casini L, Bonnard C H, Corominas J, Jibson R, 2005, Landslide hazard and risk zoning for urban planning and development, in: Hungr O, Fell R, Couture R, and Eberthardt (Eds), *Landslide risk management*, Taylor and Francis, London, 199-235.
- [3] Crozier M J, 1993, *Management issues arising from landslides and related activity*, New Zealand Geographer 49, 35-37
- [4] Glade T, Anderson M, and Crozier M J, 2005, *Landslide Hazard and Risk*, Wiley, Chichester.
- [5] QUATER, 2004, Territorial Risk Management Systems of Municipality”, Project INTERREG IIIB MEDOC, Research group of Politecnico di Milano coordinated by Maria Cristina Treu.

