

# **Impact of Large Landslides in the Mountain Environment: Identification and Mitigation of Risk**



**Contract n° EVG1-CT-2000-00035**

**3<sup>rd</sup> Scientific Report on Activities**

**March 1<sup>st</sup> – August 31<sup>st</sup> 2002**

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## 1 INTRODUCTION – BRIEF DESCRIPTION OF THE PROJECT

The project IMIRILAND focuses on management of risk in the case of landslides, in its scientific, technical and land planning aspects, considering mainly phenomena of large magnitude, with a low probability of evolution as a catastrophic event, but which might have a large direct and indirect impact on man, infrastructure and environment.

The main objectives of the project are to:

- a) get a review of hazard analysis methodologies;
- b) compare the reliability of hazard assessment in different situations according to various criteria
- c) develop practical risk analysis methods considering direct and indirect potential damage;
- d) apply the developed methods to real situations in different countries to show how they can be included in land planning procedures;
- e) test the applicability of such approaches by a close interaction with administrators.

To achieve such objectives, the following phases (consisting in 9 workpackages) have been foreseen:

Phase 1: Data collection. Some large landslides have been selected, where geological, geomechanical and monitoring data are available and a complex risk situation exists.

Phase 2: Development of risk assessment methodology. In order to compare, in terms of landslides scenarios evolution, the results of different hazard assessment methodologies, the following approaches are considered: a) field analysis, b) mechanical modelling, c) black box methods. For each approach, state of the art, critical analysis of the methods and application to selected sites are foreseen. Vulnerability and risk analyses are also carried out.

Phase 3: Application to management. Application of developed methodologies to the management of endangered landslide zones. The actions are defined in relation to problem urgency, the legal frameworks and the powers of local and regional authorities, the relevant economical conditions. A criterion for the definition of acceptable risk level will also be worked out.

Phase 4: Dissemination of risk management methodologies among end-users.

In table 1 are listed the workpackages and figure 1 illustrates the foreseen time-table.

*Table 1. Workpackage list*

	<b>Workpackage title</b>	<b>Phase</b>
WP1	Collection, analysis and organisation of the existing data for each selected site	1
WP2	Establishment of scenarios on the basis of field analysis: application of geology, geomorphology and tectonics	2
WP3	Establishment of scenarios on the basis of mechanical modelling: application of numerical methods	
WP4	Establishment of scenarios on the basis of mechanical run-out modelling: application of numerical methods	
WP5	Establishment of scenarios on the basis of neural networks and statistical methods	
WP6	Evaluation of vulnerability and risk assessment	
WP7	Application of risk assessment methodologies to the selected sites	3
WP8	Establishment of mitigation strategies in the short and long term and evaluation of residual risk within several legal frameworks	
WP9	Diffusion of risk evaluation methodologies among users (administration or political managers)	4

IMIRILAND project: detailed time table

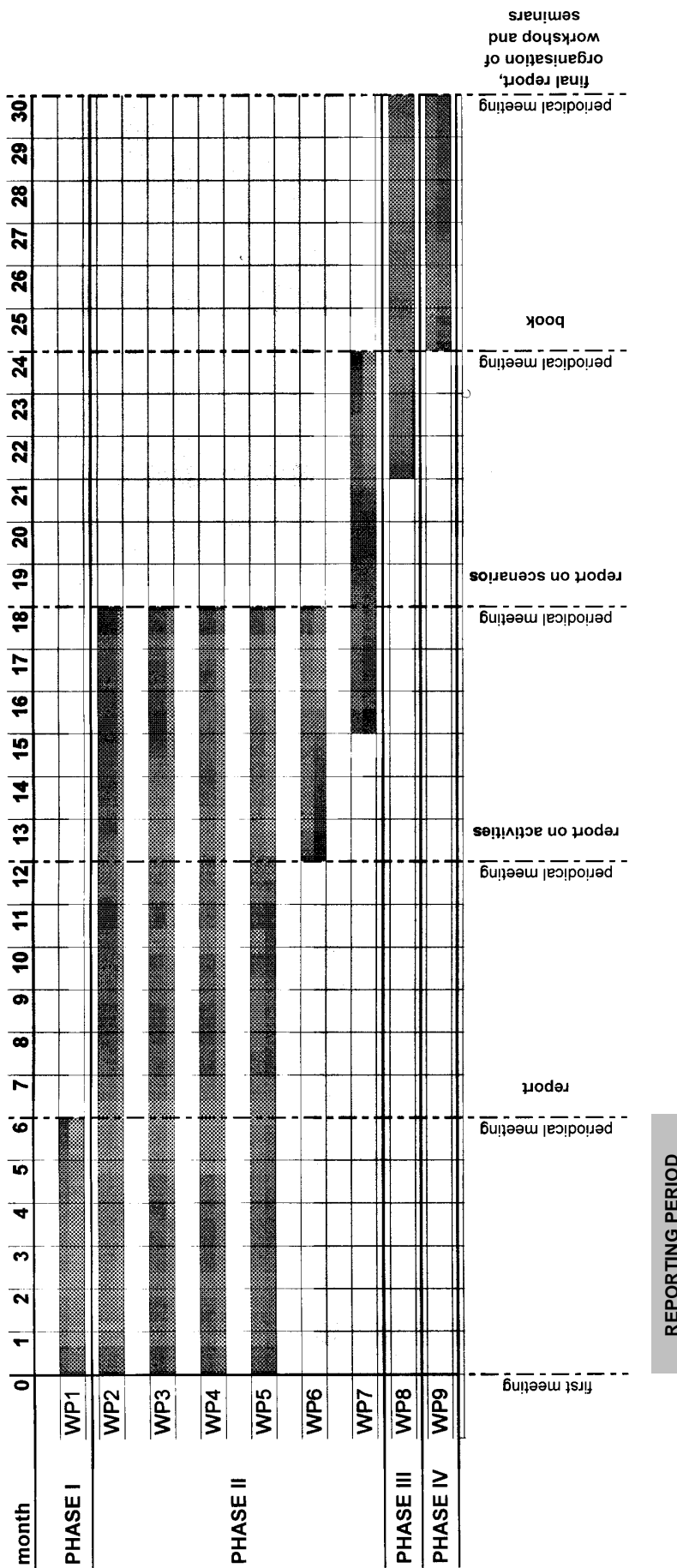


Figure 1. Planned time-table

## 2 ACTIVITIES CARRIED OUT DURING THE REPORTING PERIOD

This report covers the period from March the 1<sup>st</sup> 2002 to August the 31<sup>st</sup> 2002, i.e. from month 12 to month 18 of IMIRILAND duration. As can be seen in figure 1, from the scientific point of view, such period has been dedicated to phase 2, whose duration is 24 months. Additionally, LCPC, leader of WP8, started the activity in advance. This was decided by the consortium taking into account the period of presence at LCPC of the temporary staff working on WP8. Moreover, this allows to provide to all the partners a more comfortable time schedule for the collection of data and the analysis of their politics in the risk management and for the synthesis to be done by the LCPC. Therefore, WP8 is included in this report.

Phase 2 work is based on the results of Phase 1 (data-base containing a collection of organised data for eight selected landslide site, see table 2).

Table 2. Selected sites

Site	Country	Volume [ $\cdot 10^6 \text{ m}^3$ ] or affected area [ $\text{km}^2$ ]	Elements at risk
ROSONE	Italy	$50 \cdot 10^6 \text{ m}^3$	Rosone village and main road SS 460 Hydroelectric power plant Downstream valley
CASSAS	Italy	$20 - 30 \cdot 10^6 \text{ m}^3$	Highway A32 (Frejus) International railway Torino-Modane
CEPPO MORELLI	Italy	$4 - 6 \cdot 10^6 \text{ m}^3$	National Road N. 549, only connection to the Macugnaga tourist resort Prequartera and Campioli hamlets
ENCAMPADANA	Spain	Several tens $\cdot 10^6 \text{ m}^3$	Important ski resort El Tarter small village Main road Andorra - France Downstream communities
OSELITZENBACH	Austria	$150 \cdot 10^6 \text{ m}^3$	Downstream villages of Tröpolach and Watschig Main road "Naßfeld – Bundesstraße", important connection to the valley "Gailtal"
SÉCHILLENNE	France	$25 \cdot 10^6 \text{ m}^3$	National road RN 91 Downstream valley
CONTERS-GOTSCHNAHANG	Switzerland	$25 \text{ km}^2$ over a total length exceeding 10 km	New A28 national road Lanquart town Downstream valley
SEDRUN	Switzerland	Area approx. $1 \text{ km}^2$	Regional railway line National road Sedrun touristic resort

The reporting period is dedicated to the development of hazard analysis methodologies through a multidisciplinary approach, the evaluation of vulnerability and the assessment of the risk. Workpackages 2 to 5 are dedicated to different hazard assessment methodologies, with a duration of 18 months: at the present they are therefore concluding their activities. WP6 is dedicated to the development of a risk assessment procedure, to be applied to the selected sites within WP7 (end date: month 24). In particular:

- **WP2: Geology, geomorphology and tectonics.** The leader is CNR, with the participation of all the partners. Annex 1 consists in a detailed report of the activities carried out in this WP, and contains deliverable D4, devoted to the geological, geomorphological and tectonic model for each landslide. More detailed studies appear to be necessary for a better calibration of the

geological model and definition of the scenarios in some cases; due to this, Deliverable D4 will be integrated in the 4th report on activities, where deliverable D5 (guidelines to be followed for the interpretation of landslides) will be also included.

- **WP3: Numerical methods for the study of landslide triggering (mechanical models).** The leader is UPC, with the participation of POLITO and TUW. The sites object of study in this WP are: Rosone, Ceppo Morelli, Encampadana, Oselitzenbach and Sedrun. Annex 2 consists in a detailed report of the activities carried out in this WP, and contains the deliverable D6 (2D and 3D numerical model of the sites, including all relevant topographic, geologic and geomorphologic features) and part of D7 (scenarios of failure based on numerical “triggering” methods). Due to the late start on the activities for WP3, an extension of the numerical work is necessary. Therefore, deliverable D7 should be completed by the end of December and deliverable D8 (guidelines on the use of numerical triggering models for the prediction of failure) will be produced and made available during January 2003. Both the deliverables will be included in the 4<sup>th</sup> report on activities.
- **WP4: Numerical methods for the study of landslide evolution (mechanical models).** The leader is TUW, with the participation of POLITO. The sites object of study in this WP are Ceppo Morelli, and, Oselitzenbach. Annex 3 consists in a detailed report of the activities carried out in this WP, and contains deliverables D9 (Numerical model of the run-out areas of the study sites), D10 (Scenarios based on the numerical model of the run-out areas), and D11 (Report on the improved computation procedures for the run-out areas).
- 1. **WP5: neural networks and statistical methods.** The leader is EPFL, with the participation of RP and POLITO. Annex 4 consists in a detailed report of the activities carried out in this WP, in particular regarding the description of the methodologies chosen to carry out the analyses, the input for neural network study and an example on how the neural network analysis can be carried out. It has been seen that the probabilistic approach can not be applied to selected sites of the project because the needed input data are not completely available. Therefore, Deliverable D14 cannot be produced. Finally, due to the necessity of revising some data and proceeding to renewed computations, the final conclusions about the approach with the artificial neural network (Deliverable D12) are not fully developed, and will be ready within two months. They will be available and downloadable, together with the technical recommendations (Deliverable D15), inside the web site of the Project IMIRILAND. Deliverable D13 is included in a Floppy Disk, which contains, in a compressed Win Zip archive, the whole input and output files corresponding to the various analyses, as described in WP5 report.
- **WP6: Evaluation of vulnerability and risk assessment.** The leader is EPFL, with the participation of RP, LCPC and UPC. Annex 5 consists in a detailed report of the activities carried out in this WP, in particular regarding the proposal of a methodology for vulnerability and risk assessment, to be applied to the selected sites within workpackage WP7.
- **WP7: Application of risk assessment methodologies to the selected sites.** The leader is POLITO, with the participation of all the partners. Annex 6 consists in a detailed report of the activities carried out in this WP, in particular regarding the preparation of a scheme to be used for the assessment of risk level(s) for each site, on the basis of the results obtained in the previous workpackages (WP1-WP6).
- **WP8: establishment of mitigation strategies in the short and long term and evaluation of residual risk within several legal frameworks.** This WP started the activity in advance. The leader is LCPC, with the participation of RP, UPC, TUW and EPFL. Annex 7 consists in a detailed report of the activities carried out, in particular regarding the review of the legal frameworks related to landslide mitigation in the countries involved in the project (Austria, France, Italy, Spain, Switzerland), and the knowledge and management of the landslide risk in each country.

Each WP report collects the contribution of all the partners involved.