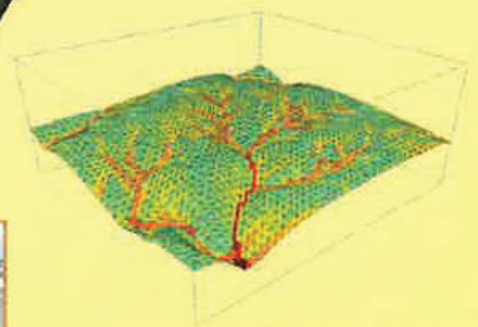
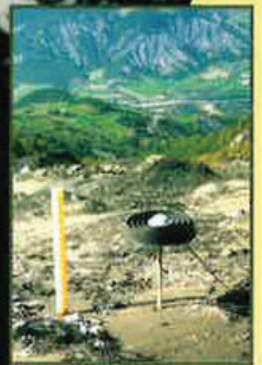


# **Geomorphology: from Expert Opinion to Modelling**

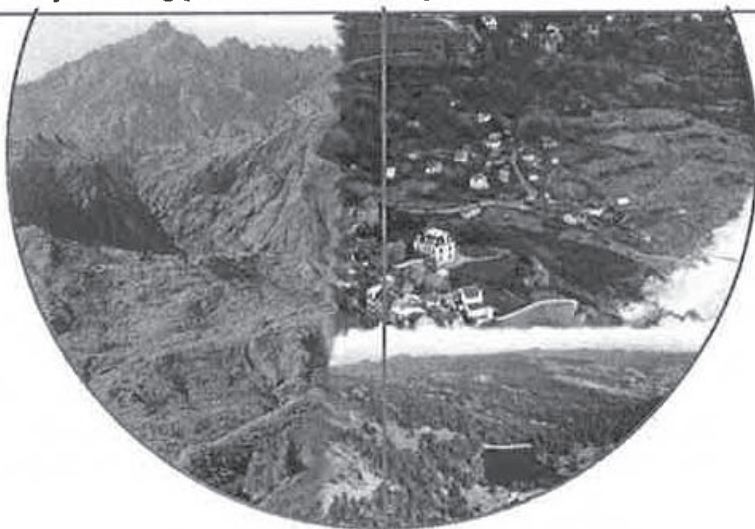
**A tribute to Professor  
Jean-Claude Flageollet**



**Edited by D. Delahaye  
F. Levoy and O. Maquaire**

**Strasbourg, France  
April 26-27, 2002**

Symposium  
'Geomorphology : from expert opinion to modelling'



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***Proceedings of the Symposium held in  
Strasbourg, France, on April 26-27, 2002.***

*Edited by D. Delahaye, F. Levoy and O. Maquaire*

*Published by the European Centre on Geomorphological Hazards, Strasbourg, France.*

*First published April 2002.*

***First cover:***

*Photo-montage by Jean-Philippe Malet (IPGS)*

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***ISBN : 2-9518317-0-6***

*Price: 20 €*

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*Printed and bound in France, by SODIMPAL-Imprimeur, Rouen*



# A GIS-based model for Geomorphological Impact Assessment of a railway track in Castelfranco Emilia territory (Italy)

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**Résumé :** This article illustrates a model for the assessment of geomorphological impacts and risks related to the construction of an high speed railway track. This model fits into general multi-criteria analysis methods based upon the use of GIS techniques, and has been tested in the study area of Castelfranco Emilia Municipality (Province of Modena, northern Italy). The core of the analysis is based on a series of crossing operations between thematic maps that enable the network of mutual interrelationships between geomorphological components and the alternatives for the project to be outlined in impact and risk matrixes of maps.

**Mots clés :** Geomorphological Impact Assessment, Multi-Criteria Analysis, GIS, railway track, Castelfranco Emilia.

## 1. Introduction

A model for the assessment of geomorphological impact and risk related to the construction of an high speed railway track in a flood plain area has been developed as part of the activities of GETS project (Geomorphology and Environmental Impacts Assessment to Transportation Systems) financed by the EC Programme TMR (Training and Mobility of Researchers). This model has been applied to an area located in the Municipality of Castelfranco Emilia (Province of Modena, Northern Italy), where such a type of transportation system will soon be constructed. In particular, the model has been conceived for the analysis and the quantitative assessment of possible geomorphological impacts and risks related to each of the three alternative paths of the railway that were proposed to decision makers by the constructing company. The model provides such an assessment in the form of overall impact and risk maps that can be used for immediate visualisation as well as precise estimation of the consequences of any alternative track of the project.

## 2. Model overview

The model has its scientific roots on studies carried out in a previous EC-project called "Geomorphology and Environmental Impact Assessment", funded in the framework of the "Human Capital and Mobility" Programme [1]. The basic principle put forward in that project is that a mutual influence between engineering projects and geomorphology exists, resulting, on the one hand, on an impact of the project on the geomorphological components of the construction site and of surrounding areas and, on the one other hand, on a risk for the project itself related to natural processes [2], [3], [4]. Ultimately, this network of mutual interrelationships between geomorphological components and the alternatives for a certain

project can be framed into general Multi-Criteria Analysis approaches [5], with impact and risk matrixes being structured using maps as basic elements.

The adopted model is divided into two main parts, an impacts branch and a risks branch and, altogether, comprises three basic work-steps.

The first work-step regards the creation of a cartographic database within a GIS. This database has to include thematic maps representing all of the three different proposed railway tracks, as well as other thematic maps, and related attribute tables, representing the various geomorphological components to account for [6]. From this database the following thematic maps have been extracted: geomorphological assets, superficial lithology, quarry activities, flood process and land use.

The second work-step is about the generation of a set of maps displaying impacts and risks for each given alternative track. In the impacts branch, the following operations need to be performed:

- transformation of the qualitative thematic maps (representing classes of geomorphological components), into values maps, ranging from 0 to 10;
- transformation of the railway alternatives track maps into potentially impacted areas maps. These maps represent areas of value ranging from 0 to 10, in relation to the level of potential impact due to the railway;
- one-by-one cross multiplication of geomorphological components parametric maps and potentially impacted areas map. This results in impact intensities maps that quantify, in a range from 0 to 100, the actual impacts related to each geomorphic component and alternative.

In the risks branch, which is dedicated to the assessment of flood risk suffered by each of the three alternatives, the following operations need to be performed:

- transformation of qualitative maps of classes representing flood hazard [7] into values maps representing zones with hazard levels ranging from 0 to 10 (min - max hazard).
- transformation of the railway alternative tracks into maps of vulnerability to floods, by setting vulnerability values according to the different constructional characteristics of the railway (embankment = 10, viaduct = 5);
- one-by-one cross multiplication of flood hazard values maps and project vulnerability values maps to create a flood risk map which quantifies, in a range from 0 to 100, actual levels of flood risk for the structure associated to each alternative.

Third work-step is focused on the identification of a railway track, within the set of given alternatives, that is preferable from the geomorphological standpoint. This is achieved by means of a Multi-Criteria Procedure of comparative assessment centred on the definition of priorities within the environmental components suffering impacts and the risk suffered by the structure [8]. In practice, the following operations need to be performed:

- identification of priorities for the different environmental components which suffer impacts and for the risk suffered by the structure;
- comparison of the overall weighted sum of impacts and of the risk associated to each alternative with various combinations of priorities (a Sensitivity Analysis on priorities);
- identification of the best alternative, from the geomorphological standpoint, for each combination of priorities. This can be carried out by computing the overall levels of impacts and risk in terms of combined impacted areas and impact levels.

### **3. Conclusions**

With the Sensitivity Analysis it is possible to create a series of final impact maps by modifying the relative importance (priority) of the single impacts. This permits the



influence of each parameters on the total impact to be evaluated. In other words, this analysis enables the decision makers to choose the best alternative according by the relative importance he decides to attribute to the single geomorphological components suffering impact.

It can be concluded that the model presented in this paper has permitted the analysis of impacts caused by the high speed railway on geomorphological features to be defined numerically. Also, the model can permit the flood risk suffered by the structure to be assessed. Also this specific procedure for Environmental Impact Assessment is quite simple and enables the generation of map sets that can be of strong support to decision makers.

## **Acknowledgements**

The Authors are grateful to Prof. M. Panizza, co-ordinator of the GETS research group from University of Modena (I), for continuous support during the three year of project, and to Prof. A. Fabbri from ITC-Enschede (NL), co-ordinator of GETS Project.

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