GEO4SLOPE

Risk analysis for slope stability and reinforcement design along infrastructures

Long infrastructures can cross areas with high probability of landslides and landslips of both artificial and natural slopes, causing serious problems to the serviceability and compromising safety. ETS has developed an advanced approach to assess the hazard, manage the risk and design the reinforcement along railway lines in a clear, repeatable and objective orientated-way. The procedure has been applied to more than 10 km so far by ETS in each step. The heuristic methodology complies with the following steps:

-High productivity surveying techniques with the ETS multi-dimensional mobile mapping ARCHITA, in order to minimize time, cost and field work to access to the railway line;
-Small-Medium Scale thematic datasets integrating the survey, official sources, client's data and documented case studies, intersected with the infrastructure in a GIS environment for first hazard assessment;
-Identification of Typological Slopes (TS) that cover the possible geotechnical and geomechanical context and the mechanisms of failure. The TS are investigated with proper site and lab surveys by engineers in order to assess the stability with advanced numerical approach (Plaxis, Flac, RocScience);
-Extrapolation of the Typological Slopes (large-scale) to all the infrastructure (small-scale) for detailed hazard and risk assessment along the ling. Large Scale thematic datasets are refined and created ad hoc based on both mobile mapping and proper site surveys;
-Design of the monitoring system, early warning system, reinforcements and interventions to adapt along the lines (if necessary) in order to guarantee efficient design through all the scales and the desired safety level.

A Multi-Criteria Analysis (MCA) is used to assess the hazard and the risk along the lines, resulting in thematic datasets. Spatial Decision support system (SDSS) web-GIS based can integrate thematic layers and enable data analysis to support and show the results of the MCA. The WEB-GIS service makes all the data easily upgradable and accessible using a common browser, both from pc and mobile. The tool can also send georeferenced warnings with annexed documents, notes or pictures.
The described methodology allows the analysis of both short and long infrastructure. For long infrastructure, the procedure consistently guarantees reduced cost and time in terms of survey, design and management, compared to standard approaches based on visual inspections, static database and large-scale design. The slope stability and the design can now be incorporated trough different scale and part of the process based on a solid and objective assessment on the line.

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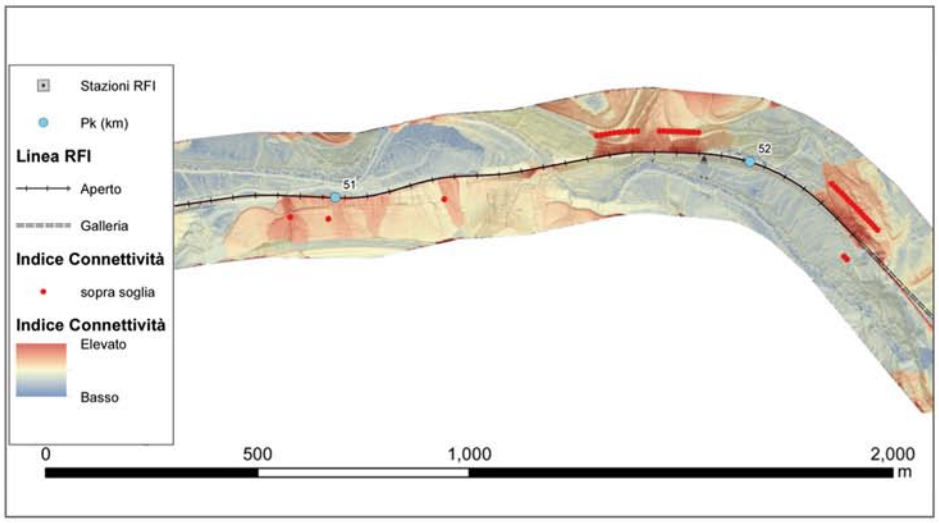
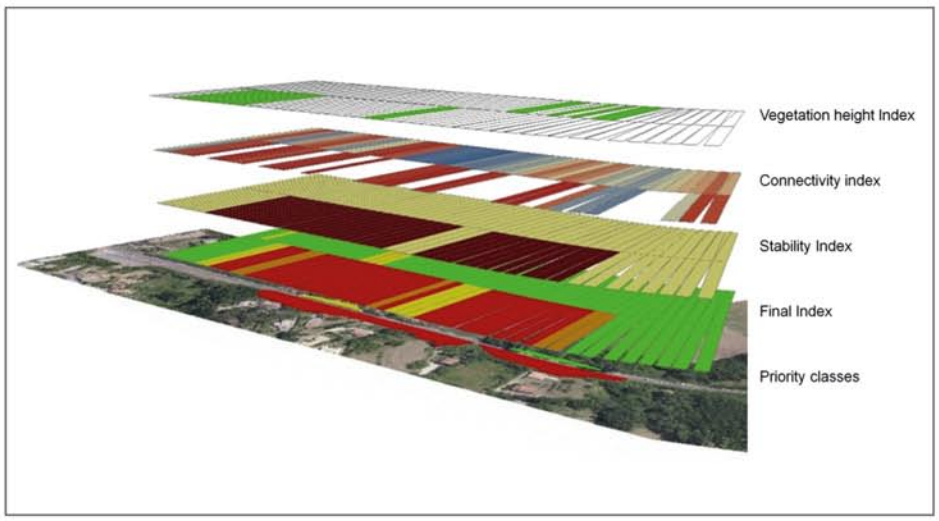
Geomatics, Geology, Geotechnics and Geomechanics for Rock Engineering



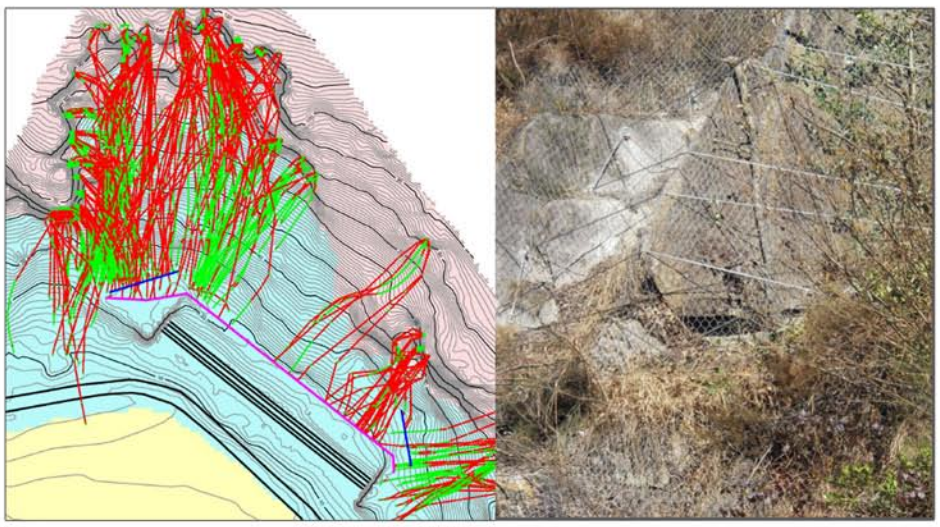
Geomorphometric Analysis

Example of one thematic map produced for the hazard and risk evaluation. For instance, the Connectivity Index is a geomorphometric index (Borselli, 2008) to assess spatial sediment connectivity towards a target, the infrastructure alignment. This dimensionless index represents the exposure of a selected target point to water/sediment transport.



Multi-Criteria Analysis (MCA)

Geocoded thematic layers are analysed in a GIS environment to create a composed and spatially distributed index of landslides hazard. The evaluation of the safety conditions on the Typological Slopes is carried out with the support of advanced FEM and limit-equilibrium numerical analyses with deterministic or probabilistic approaches. The MCA explicit the contribution of each criteria, and so its weight, in the final classification.



Reinforcement works Design

Based on the Multi-Criteria Analysis and the mapping of the hazard/risk along the lines, the operations of monitoring, early warning or reinforcements can be accurately planned and design. ETS can put on the line its consolidated geotechnical and geomechanical knowledge for the slope stability thanks to the experience on active and passive reinforcements design in different and complex geological and geomorphological contexts.

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