2015 October 27th	

IPL Project Proposal Form 2015

(MAXIMUM: 3 PAGES IN LENGTH)

1. Project Title: *INTEGRATED SYSTEMS FOR LANDSLIDES MONITORING, EARLY WARNING AND RISK MITIGATION ALONG MOTORWAYS*
2. Main Project Fields

   Select the suitable topics. If no suitable one, you may add new field.

   (1) Technology Development

   A. Monitoring and Early Warning, B. Hazard Mapping, Vulnerability and Risk Assessment

   (3) Capacity Building

   B. Collating and Disseminating Information/ Knowledge

   (4) Mitigation, Preparedness and Recovery

   A. Preparedness, B. Mitigation,

3. Name of Project leader

   Prof. Eng. Pasquale VERSACE

   Affiliation: (Director of Laboratory of Environmental Cartography and Hydraulic and Geological Modeling – CAMILab, DIMES, University of Calabria; Consorzio Interuniversitario per l'Idrologia CINID (Interuniversity Consortium for Hydrology) - POTENZA).

   Contact: (Via Pietro Bucci 41/b, 87036 Arcavacata di Rende (CS), ITALY.

   +39 0984.496619, +39 0984 406593, linoversace@libero.it; camilab@unical.it)

   Core members of the Project

   Names/Affiliations: (4 individuals maximum)

   - Ing. Giovanna Capparelli / CAMIlab, DIMES, University of Calabria
   - Prof. Giuseppe Di Massa / Department of Computer Engineering, Modeling, Electronics and Systems Science (DIMES), University of Calabria
   - Ing. Fabrizio Paoletti /Autostrade Tech S.p.A - Via Bergamini, n. 50 00159 ROMA
   - Prof. Antonino Cancelliere Department of Civil and Environmental Engineering (DICA), University of Catania, Viale Andrea Doria 6 - 95125 - Catania

4. Objectives: the project aims to develop an integrated early warning system (EWS) in order to mitigate the landslide risks along motorways and other transport infrastructures. The final goal is to timely identify the potentially dangerous landslides for define information delivery and activate the necessary safeguard measures.
5. Background Justification: Landslides represent a widespread natural hazard that often cannot be solved with structural works because their costs would be unsustainable. The planning of non-structural measures is very often the only solution. Advanced early warning systems, linked to the proper contingency plans, can save lives and prevent the risk. In particular, along the major transport infrastructures the landslides problem is extremely complex and requires the development of specific

solutions.

6. Study Area: three highway stretches, located in the south of Italy.
7. Project Duration: (8 years): 3 years for research development and 5 years for experimental application of devices and models designed.
8. Resources necessary for the Project and their mobilization

   The project involves about 70 people and around 13000 man-days. This research is funded by the Italian Ministry of Education, University and Research (MIUR), PON Project No. 01_01503 in the framework of the National Operational Programme for "Research and Competitiveness" 2007-2013. The total budget is almost 10 million euros.
9. Project Description: (30 lines maximum)

   The project develops original components of the EWS (risk scenarios, monitoring sensors, networks, models, data acquisition and processing centers, traffic control centers) and provides its integration.

   (1) Through the inventory and characterization of landslide types in the test sites, a proper procedure for risk scenarios identification is defined, which includes the types and guidelines for on-site testing and the presentation of results, such as the risk maps.

   (2) Landslides can be observed through appropriate monitoring systems: the “punctual system”, made up by a network of sensors that measure the local displacements, and the “areal system” to remotely measure the displacements in large areas. In particular, as punctual systems, in addition to the classical schemes of in situ geotechnical control, a network of acceleration sensors by MEMS technology and an original system designed for the measurement of position and inclination have been developed. Among the areal sensors: a system based on interferometric techniques of image analysis which use a synthetic aperture radar on a rail, operating at 17 GHz; two new radar sensors in X-band and in L-band, and the relative on-board electronics. A wireless network system, with smart sensors, acquires and transmits data.

   (3) Simulation models which include the analysis of triggering condition and propagation phase. In particular, the models are represented by: (A) a physically based model, developed in a GIS environment, which provides the soil water circulation, the water and energy balance at the catchment spatial scale and the probabilistic slope stability conditions; (B) a punctual complete model that analyzes the hydrological processes at slope-scale and the soil deformations induced by soil water pressure, both in saturated and unsaturated conditions; (C) for phenomena such mud-flows, based on to Macroscopic Cellular Automata, a model provides the landslide propagation and the affected area.

   (4) The setting up of the center of data acquisition and processing and of the center of traffic control is the core of the integrated system. The former, newly designed, acquires and processes data ranging in intensity, dimensions, characteristics and information content. The latter integrates the informations regarding monitoring and early warning of hydrological risk with the ITS (Intelligent Transport System) and other aspects of management of infrastructure.
10. Work Plan/Expected Results: (20 lines maximum; work phases and milestones)

    The project includes a research step, in which all the components of the system are developed and a test step, in areas where the integrated system is experimentally validated. The project is organized in

"development goals" (DG), which comprise: a) definition of procedures aimed at identification of event and risk scenarios (DG1); b) development of sensors able to monitor the stability condition of single points of a slope or large areas (DG2 and DG3); c) development of mathematical models suitable for simulation of triggering and propagation of landslides induced by rainfall (DG4); d) realization of a data transmission system, able to collect and transmit the recorded data from sensors (DG5); e) development of a center of data acquisition and processing , aimed at acquisition, validation and storage of data, and able to provide information in real time (DG6); f) realization of a control center, from which alerts are sent to Authorities (DG7); g) definition of guidelines for organization and management of contingency phases (DG8). The integrated system is applied in three motorway areas (DG9).

11. Deliverables/Time Frame: (10 lines maximum; what and when will you produce?)

The project is started in October 2011 and it will be ended in October 2019. As of today, all the development activities of the research have been completed and the implementation phases of testing have been started to allow the validation of all realized devices and models. Updating of research products will be ongoing until the end of the whole project, on the basis on results of the site tests. The test step is started in October 2012, with preliminary activities concerning the scenario analysis along the selected motorway areas and choice of landslides to be monitored. The laboratory applications of research products are started in October 2013. The end of the project is scheduled for October 2019.

12. Project Beneficiaries: (5 lines maximum; who directly benefits from the work?)

The research will promote innovation in the field of environmental monitoring and of mathematical modeling of landslides, improvement of services to support mobility, the enhancement of skills of involved research groups, who will improve their level of excellence in the scientific community. The main beneficiaries will be the managers of motorways and national roads; the managers of the railways; the national civil protection; the manufacturers of the various components of the integrated system.

13. References (Optional): (6 lines maximum; i.e. relevant publications)

- Formetta G., Capparelli G.& Versace P., "Modelling rainfall induced shallow landslides in the Landslide Early Warning Integrated System project". Proceedings Books of the XVI European Conference on Soil Mechanics and Geotechnical Engineering (ECSMGE 2015).
- Costanzo S. et al. "Multiband software defined radar for soil discontinuities detection", Journal of Electrical and Computer Engineering, 2013.
- Avolio M. V. et al. "SCIDDICA-SS3: a new version of cellular automata model for simulating fast moving landslides", The Journal of Supercomputing, 2013, Vol.65, Issue 2, pp 682-696.
- Laganà R. et al. "Modeling and Processing L-Band Ground Based Radar Data for Landslides Early Warning", Journal of Electrical and Computer Eng. 2013
- Muto F. et al. "Multidisciplinary approach to evaluate landslide susceptibility along highway in northern Calabria, Italy", Geophysical Research Abstracts, EGU2014
- Capparelli G. et al. "Landslides risk mitigation along lifelines", Geophysical Research Abstracts,