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# IPL New Project Proposal Form 2015

(MAXIMUM: 3 PAGES IN LENGTH)

1. **Project Title**: Multi-scale rainfall triggering models for Early Warning of Landslides (MUSE)
2. **Main Project Fields**

(1) Technology Development

A. Monitoring and Early Warning, B. Prediction of triggering in real-time

(3) Capacity Building

A. Setting up of Operational Early Warning Systems

3. **Name of Project leader**: Filippo Catani

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**Core members of the Project**

Names/Affiliations:

Nicola Casagli, Professor, DST-UNIFI

Veronica Tofani, Assistant Professor, DST-UNIFI

Riccardo Fanti, Assistant Professor, DST-UNIFI

Samuele Segoni, Research Assistant, DST-UNIFI

4. **Objectives**:

The main objective of this candidate IPL project will be the enhancement of knowledge and methodologies related to the integration of landslide prediction models at different scales to build an effective operational multi-scale system for real-time early warning of rainfall triggered mass movements.

5. **Background Justification**:

The modern literature on forecasting and prediction of landslides triggered by rainfall, yearly reviewed in several scholarly contexts such as session NH3.8 at EGU (“Forecasting and prediction of landslides”), conveys a broad range of new ideas and applications for slope-scale or catchment scale early warning but, so far, does not usually give much space to the study of multiple-scale model integration. This is an important step which is still almost missing in the route to the construction of actually usable operational early warning systems at regional or national level. The main gap lies in the lack of a standard way in which regional-scale statistical threshold models can be linked to detail-scale deterministic models in a consistent and constructive way, in order to provide an added-value integrated system and not just a juxtaposition of predictions at different scales. The DST-UNIFI group led by Nicola Casagli has already acquired a notable expertise in this field and will build on such background for successfully completing this IPL project.

6. **Study Area**:

For the first phase of the project, the study area will be Northern Tuscany (about 3000 $km^2$), characterized by recent intense landslide occurrences. Then, a larger area will be selected for the national-scale application.

7. **Project Duration**:

Foreseen project duration is 3 years

8. **Resources necessary for the Project and their mobilization**

Personnel, Facilities, and Budgets

The DST-UNIFI has most of the required resources already, including a 45-person staff, laboratories and facilities for in-situ and laboratory testing, remote sensing instrumentation and numerical codes for rainfall threshold (SIGMA, MACUMBA) and deterministic modeling (HIRESSS) which have been internally developed. The required budget will be covered by DST-UNIFI for all the research and development part. A contribution from ICL-IPL project budget might be required for dissemination purposes concerning the project results.

9. **Project Description**:

The IPL project will be based on a strong background of established research findings and modeling tools developed at DST-UNIFI in the past 5 years. The research and development work of this IPL candidate project (MUSE) will build on this basis to integrate the different types of rainfall triggering models in a single operational system for a multi-scale prediction of landslides in real time and over large areas with a detail much higher than simple rainfall threshold models. The main rationale of the project is that to functionally link statistical, rainfall threshold models to detail-scale deterministic models we need to better constrain the lumped variables in the statistical model to the explicit variables related to the terrain characteristics, such as geomechanical and hydrological properties. Moreover, it is necessary to better integrate direct and indirect rainfall measurements (including satellite, rain gauge and ground weather radar) with weather forecasts, to be able to build a system actually effective and usable for early warning.

The project will act along two parallel lines at the beginning (first 1.5 year). One line will be devoted to a better understanding of the role of spatial variability of soil properties in the behavior of landslides in the framework of the predictive models considered. To this end, a large field and laboratory campaign will be carried out trying to establish some baseline for geomechanical and hydrological data spatial distribution in the study area. The findings of this campaign will be used to study the geostatistical properties of such important variables of slope stability and to formalize new approaches to link statistical rainfall threshold methods to deterministic detail-scale numerical models.

On a parallel research, we will work on the important issue of ameliorating the incorporation of rainfall data in predictive models. The problems of data assimilation in such case are much relevant and related to: i) the different measurement systems which are not directly compatible as units of measurement and accuracy; ii) the difficulty in translating weather predictions into accurate rainfall quantities on the ground. Finally, the two parts of the research will converge towards a unique task in the second half of the project, when the analysis of soil variability and rainfall assimilation will be used to study better model integration methods at multiple scale to be used in operational early warning systems.

10. **Work Plan/Expected Results**: (20 lines maximum; work phases and milestones)

To this end, the MUSE project will be based on 3 Work Packages.

WP1. Soil properties variability study. In this part of the project, a field and laboratory testing will be carried out devoted to analyze the variability of mechanical and hydrological properties of the regolith cover, with special reference to the slope deposits which may be subject to landsliding. This phase, which has already been initiated, will rely on borehole shear testing, saturated hydraulic conductivity measurements and soil analysis to define the spatial variability of properties for each type of geological terrain.

WP2. Analysis and integration of rainfall data and rainfall forecasts. In this work package a series of analysis will be carried out by using several different models for triggering based on rainfall, at scales ranging from slope to catchment in order to understand how to continuously link rainfall measurements made using different tools (meteo satellites, rain gauges, weather radars) in a rainfall path which might be used by prediction systems without introducing large errors. Successively, we will deal with the problem of coordinating and harmonizing the rainfall path resulting from such measurements with those provided by weather forecast models at different scales.

WP3. Wrap-up into integrated multi-scale models. In the final WP the findings of the previous WPs will be used to build an integrated and effective early warning system which will be able to work at 2 levels: a regional level to highlight alert zones with a suitable lead time and a local level, activated on purpose, where a detail scale deterministic model such as HIRESSS will run to provide maps of distributed probability for the factor of safety of slopes in near real-time.

11. **Deliverables/Time frame**

Foreseen deliverables are:

WP1. Database of soil properties and correlated spatial variability in the study area; sensitivity study of impact of variations in model results (T0+18)

WP2. Collection of tools and numerical/statistical schemes for the assimilation of rainfall data into prediction models (T0+18)

WP3. A two-level system for multi-scale early warning of landslides as a research framework to further ameliorate the capability of forecasting rainfall induced events in operational environments (T0+36)

12. **Project Beneficiaries**:

The beneficiaries of this project will be several: Civil Protection offices and institution, Research institutes, Universities, Public administrations, International organizations.

13. **References (Optional)**:

Note: Please fill and submit this form by 1 March 2015 to ICL network <ICL-network@iclhq.org>