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Modelling rainfall-induced shallow landslides at different scales using SLIP - Part II

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Abstract

This paper (Part II) is companion of another one published in this Conference (Part I). Both the papers describe the approach followed in the application of the SLIP model at different scales to foresee the triggering mechanism of rainfall-induced shallow landslides. In particular, this paper (Part II) focuses on the modeling at medium and large scale (regional and national level). The possibility of using the same means to model the phenomenon from the scale of the representative elementary volume (i.e. flume laboratory tests) to the medium and large scale (hundreds or thousands square kilometers wide areas) allowed from the one hand to strengthen the model assumptions and on the other hand to develop a "flexible" tool, to be used easily for early-warning purposes.

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1. Introduction

As already explained in the companion paper (Part I), the simplified model named SLIP (Shallow Landslides Instability Prediction) falls in the category of the physically-based models suited to be applied at different scales. In particular, the SLIP model has been tested through a series of back analyses, on the basis of really occurred landslides, on single slope scale [1,2], on regional scale, i.e. on areas of the order of hundreds square kilometers wide

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[3,4,5], and on the entire Italian territory. The application of the SLIP model to reproduce the phenomenon at large scale will be presented in the following sections. The presented methodology allowed to develop a tool to be used easily for civil protection purposes, from the site-specific level towards preliminary early-warning at national scale.

2. Application of the SLIP model at single slope scale

Starting from the observation of a huge number of rainfall-induced shallow landslides occurred in the Modenese Apennine (Emilia Romagna Region, northern Italy) on May 2004, April 2005 and December 2005, the SLIP model was applied at single slope scale on different sample sites [1,2]. The landslides were triggered in foothill areas, with altitudes between 300 m and 700 m a.s.l. and with average slopes between 20° and 38°, where Quaternary continental deposits are widely present. In particular, some sample sites were identified to carry out a detailed analysis, including field surveys and geotechnical characterization of soils from laboratory tests (Table 1). The shallow altered soil that could be considered potentially unstable was classified as sandy silt. The slope was derived from the available 20mx20m Digital Elevation Model (DEM) and the depth of the potentially unstable soil layer was evaluated during field surveys. Daily pluviometric data were acquired from a historical database, taking into account the time span of about 12 months around the date of each event. In particular, the Polinago pluviometric station was used for the events of May 2004 and April 2005 (5_04P1; 4_05P4), the Serramazzoni station was used for one event of May 2004 (5_04S1), and the Montese station was used for the events of December 2005 (12_05M2). The results obtained by applying the SLIP model gave the F_S evolution over time, highlighting the condition of instability (F_S=1) only in correspondence to critical meteorological events, which triggered the real phenomenon. Fig. 1 shows the results of the model application at four considered sites.

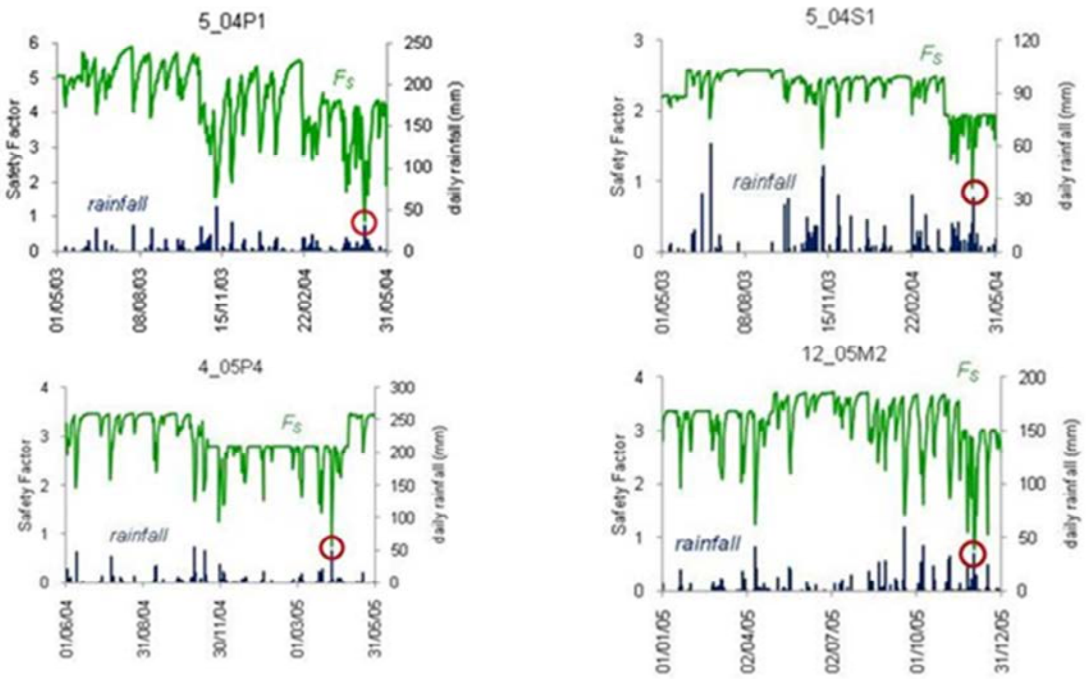

Fig. 1. Model application on a local scale: measured daily rainfall and trend of the safety factor versus time for the studied sample sites.