ARTICLE IN PRESS

Measurement xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement

Landslide characterization using a multidisciplinary approach

Ernesto Ausilio [a,*], Paolo Zimmaro [b]

[a] Department of Civil Engineering, University of Calabria, Via Pietro Bucci, Cubo 44/B, 87036 Arcavacata di Rende (CS), Italy
[b] Department of Civil and Environmental Engineering, 5731 Boelter Hall, University of California, Los Angeles, CA 90095-1593, USA

ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Permanent scatterer interferometry
Electrical resistivity tomography
Geotechnical investigations
Inclinometer measurements
Landslide characterization

ABSTRACT

A large number of factors should be taken into account to understand landslide phenomena and to facilitate stabilization design especially for complex cases. In this paper the case history of the Gimigliano landslide in the Calabria region (southern Italy) is investigated by using a multidisciplinary combined-technique approach based on conventional geotechnical measurements and modern technologies. The first technique (with reference to inclinometer measurements) is usually affected by errors. Particular care is devoted to the data processing by using *ad-hoc* methodology to take these errors into account, with the purpose of ensuring a high reliability. For the second technique (electromagnetic sensing techniques and electrical resistivity tomography) convenient methodologies for data post-processing are used and herein presented. The combination of information taken from the different techniques allows the measurements obtained to be validated by conventional and modern approaches and the accuracy of each to be enhanced.

1. Introduction

A very large number of factors are involved in complex natural phenomena such as landslides. Geometrical aspects and their time-evolution, parameters of the geomaterials and hydrogeological conditions are critical factors that should be taken into account in order to have a credible understanding of the process. Slope stabilization planning needs an adequate preliminary landslide characterization. Owing to its complexity, in order to improve knowledge about the process, it is necessary to use data and information from different techniques and combine the obtained results.

Landslides are generally studied using "direct recognition" or geotechnical investigations. These investigations usually consist of boreholes, laboratory and *in-situ* tests. The boreholes are then equipped with instruments such as piezometers, to define the groundwater conditions and inclinometers for the evaluation of deep displacements and then for the detection of the sliding surface. These standard geotechnical techniques are essential and indispensable because they provide direct information but have a limited spatial representativeness. Therefore they do not allow a complete spatial characterization of the landslide except by multiplying their number and accordingly the cost. From this comes the need to integrate the information from geotechnical investigations with what can be obtained by using other techniques suitable to extend it on a broad spatial and temporal scale. Several modern techniques can be useful for this purpose. Among others, it has been decided to use technologies that have been developed and used for investigating and monitoring landslides during the last few years.

A multidisciplinary approach that involves the combination of different techniques is presented and applied in this paper, by using standard geotechnical techniques and innovative geophysical and electromagnetic sensing techniques, for investigating the Gimigliano landslide

* Corresponding author. Tel.: +39 0984 496527; fax: +39 0984 496526.
E-mail addresses: ernesto.ausilio@unical.it (E. Ausilio), pzimmaro@ucla.edu (P. Zimmaro).

http://dx.doi.org/10.1016/j.measurement.2016.01.009
0263-2241/

Please cite this article in press as: E. Ausilio, P. Zimmaro, Landslide characterization using a multidisciplinary approach, Measurement (2016), http://dx.doi.org/10.1016/j.measurement.2016.01.009

(Italy). The main aim of this work is to show how the combination of these investigation approaches and techniques leads to a better and more accurate understanding of landslide phenomena.

2. The Gimigliano landslide

The village of Gimigliano (Fig. 1) is located in the Calabria region (southern Italy). The site object of the present study can be divided into two main areas within the town: the medieval village and a new building estate (Fig. 2). The area of Gimigliano is affected by the presence of several instability phenomena which are characterized by different types of landslides with different states, distributions, and styles of activity because of the complex geological settings, as shown on PAI (Piano per l'Assetto Idrogeologico) [1] landslide inventory map (Fig. 3).

In the winter seasons of 2009–2010 the activity of the instability phenomena showed an appreciable intensification which caused damage to buildings and infrastructures resulting in the evacuation of some buildings and a block on the viability of some roads. The basic stratigraphic sequence presents phyllites, metarenites and metaconglomerates intercalated by metalimestones overlaying banks of metabasites alternated with serpentinites and ophicalcites that are part of the Monte Reventino Ophiolitic unit.

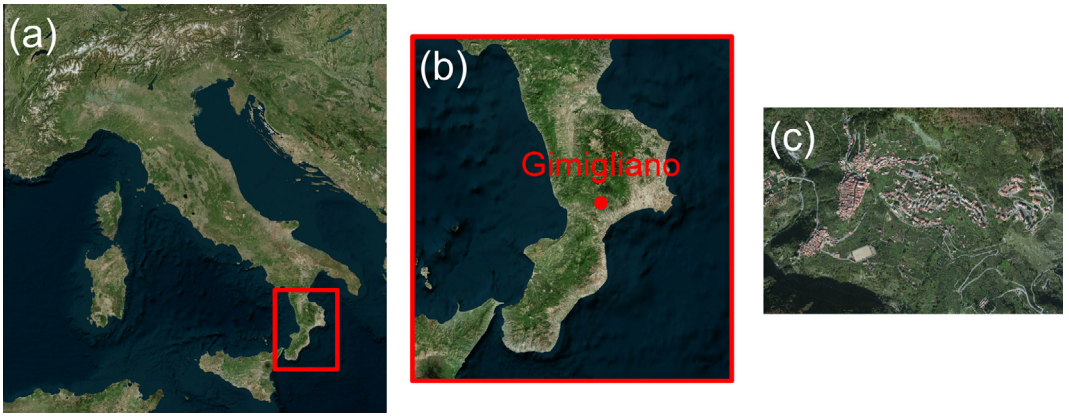

Fig. 1. Location of the village of Gimigliano (c) in the Calabria region (b), Southern Italy (a).

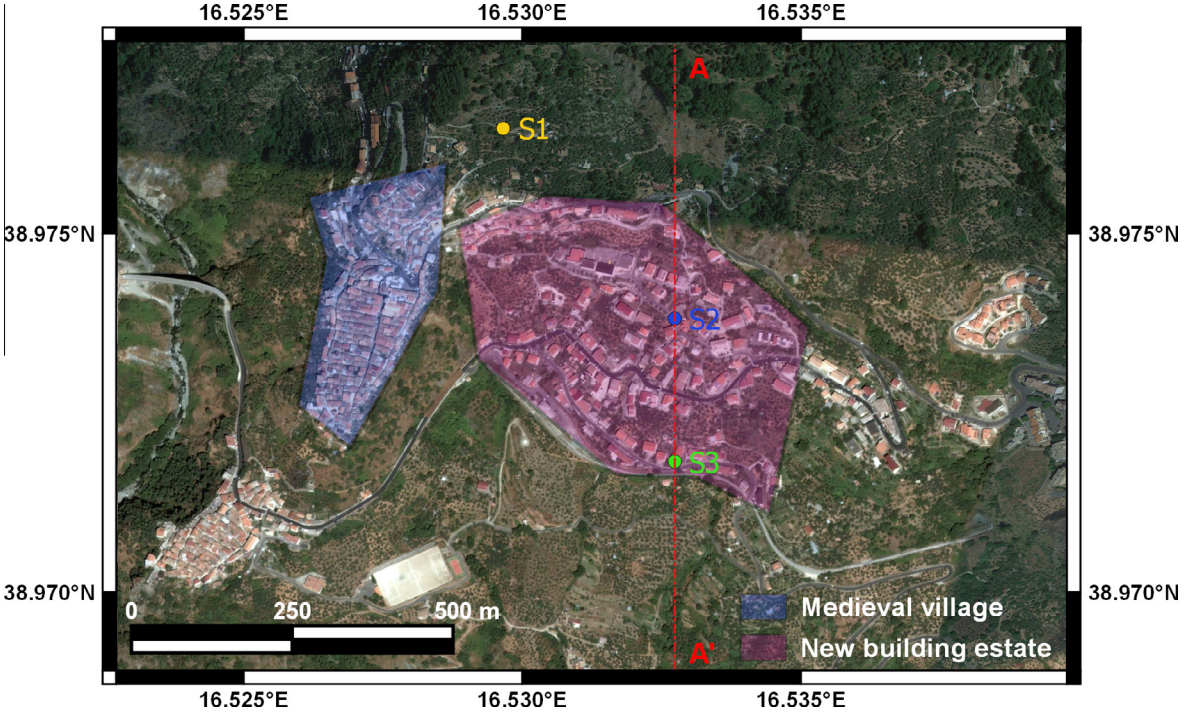

Fig. 2. Overview of the village of Gimigliano and position of the boreholes.

Please cite this article in press as: E. Ausilio, P. Zimmaro, Landslide characterization using a multidisciplinary approach, Measurement (2016), http://dx.doi.org/10.1016/j.measurement.2016.01.009