ON MONITORING LANDSLIDES AROUND TRASPORTATION INFRASTRUCTURES

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ABSTRACT

Designing, building or maintaining transportation infrastructures require a suitable knowledge of the landslides around them. To this aim, nowadays, they are identified, studied, and monitored spending large amounts of energy, time, and labour necessary to carry out on-site inspections and place different kinds of sensors that must be properly installed, configured, and protected against theft. New technologies, mainly based on new generations of space satellites, if properly integrated with dedicated software tools, could significantly change the state of the art by reducing quantities and costs of on-site activities. In this framework the main aim of the paper is to evaluate which are the best technologies, what is the proper way to use them, and how they can be integrated with the set of sensors usually installed on-site. The possibilities to perform “virtual on-site inspections” and to control the evolutionary process of landslides directly by satellite represent the first step for a more coordinated, homogeneous, and distributed monitoring system which could work independently, or be seamlessly integrated with other types of sensors. In particular the paper deals with the application, based on a real case study, of a suitably defined methodology consisting of:

Data acquisition: acquiring of ancillary data, optical images and radar images;
Data processing: identification and mapping of landslides;
Data interpretation: landslide phenomena characterisation.

To this aim, the chosen location for the case study gathers all the possible kinds of transportation infrastructures since in this area there are a railway line, a stretch of highway and other kind of roads with the scope of pointing out how the proposed analysis methodology could be applied to all the different kinds of transportation assets, without neglecting that also all the other man-made structures could be monitored in the same way.
Starting from an area considered at risk, the paper shows all the procedures to be followed in order to identify the landslides, study their nature and conformation and identify the level of risk associated to each of them.
In details, in the first part of the paper is therefore presented how to geographically identify the landslides and, beyond that, how to analyse the radar satellite images of recent years in order to understand how the identified landslides evolved over time. The evolution process of each landslide combined with the information about the relevant nature and conformation could be used to identify the level of risk associated and evaluate the best way for monitoring the area.
Moreover, the present landslides study is integrated with a deep analysis of potentialities of satellites. All the satellites involved in radar images collection have well-defined orbits (ascending if directed from south to north and descending if moving from north to south) and due to this aspect some areas of the earth couldn’t be covered only with a single image acquisition of one of the two orbits. The different orientation and the

various slope exposures of each area on the earth makes essential to perform a preventive analysis of the sites to be monitored.

Hence, in the second part of the paper, the characteristics of the site under analysis are discussed in order to guide the satellite images acquisition, aiming at reducing the costs and upgrading the quality of the images collected by the different kind of satellites presently in use.

Another important aspect discussed in the present paper is the land use definition and analysis, again carrying this out based on satellite images, that could be useful if combined with the level of risk associated to each landslide. The land use, in fact, could be used to understand on one hand which are the conditions of the area under analysis, and on the other hand could give a rough estimation of people, structures and infrastructures that could be affected by possible landslides: in a word an estimation of damages related to risky events.

All these analysis could also be integrated with information related to watercourses, the flora of the area and the different statistics of the site collected by the all institutions existing in the territory.

In conclusion, the last aim of the presented paper is to evaluate the potentialities of the monitoring system hypothesised during previous studies using a real case application. With the proposed example it will be demonstrated how the identified monitoring system could represent a not only a more flexible and less expensive procedure, but also how it can be potentially applied to all different distributed transportation systems, and, if necessary, also to isolated locations subject to landslide risks.

To conclude, it is worth underlining that that the presented procedure can be used not only for the monitoring but also for the design, the realization and the development control of all the possible different man-made infrastructures in any part of the planet.