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LANDSLIDE INVENTORY USING GISMA TECHNIQUES

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Abstract

The use of GIS for various types of data is considered to be of high importance, mainly because it is bringing together information from multiple sources. In addition, the new Internet technologies and applications of global world maps, like Google Maps, give the opportunity to build systems that the geographical information can be recorded and administrated by many users from anywhere. This kind of GIS systems is suitable for Business Administration, or Science, or Government Organizations, which need GIS systems with multiple users from many places and multiple kind of information. This system is defined as GISMA (Geographic Information System Multi Administration). In GISMA many users may input the data and use the information from different distance. Each user has specific permissions of use of data as the administrator sets.

In this work, the basic principles and rules of a building GISMA system are evaluated and an application is presented based on data and GIS techniques for the slope instability studies. Data obtained from historical landslide occurrences were verified with new locations obtained from high resolution orthophotos and Google Earth application. Landslide areas were mapped using Arc Map and finally the Landslide Inventory for the Achaia's Prefecture was created.

Keywords: *GIS, GISMA, WEBGISv.*

Περίληψη

Τα GIS συστήματα είναι πλέον ευρέως διαδεδομένα για την καταχώρηση και χρήση δημογραφικών, τεχνικογεωλογικών, τουριστικών κ.α. στοιχείων. Η τεχνολογία Google Maps και άλλων παρόμοιων παγκόσμιων χαρτών στο διαδίκτυο επέκτεινε την χρήση αυτών και σε άλλες εφαρμογές όπως η χρήση για εύκολη πρόσβαση σε πληροφορίες κάθε τόπου. Η χρήση όμως των GIS μπορεί να επεκταθεί και σε συστήματα διοίκησης και επιστημονικών εφαρμογών με πολλαπλούς χρήστες και πολλαπλές πληροφορίες. Τα συστήματα αυτά ορίζονται από την παρούσα εργασία σαν Γεωγραφικά Συστήματα Πληροφοριών Πολλαπλής Διαχείρισης (GISMA - GIS Multi Administration) τα οποία μπορούν να εφαρμοστούν σε επιχειρήσεις, επιστημονικές ανάγκες, κρατικούς οργανισμούς κ.α. Στην εργασία αυτή εισάγουμε την έννοια των GISMA και ορίζουμε τις βασικές αρχές που πρέπει να πληρούν. Επίσης παρουσιάζεται μια εφαρμογή GISMA, ενός συστήματος καταγραφής κατολισθήσεων για την περιοχή του Νομού Αχαΐας. Το σύστημα μετά από τις ανάλογες δοκιμές παρουσιάζει ικανοποιητική συμπεριφορά.

Λέξεις κλειδιά: *LANDSLIDES, LANDSLIDE INVENTORY, GIS, GISMA, WEBGIS.*

1. Introduction

Geographic information system (GIS) (Clarke, 1986) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. The acronym GIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology.

A GIS can be thought of as a system—it digitally creates and "manipulates" spatial areas that may be jurisdictional, purpose, or application-oriented. Generally, a GIS is custom-designed for an organization. Hence, a GIS developed for an application, jurisdiction, enterprise, or purpose may not be necessarily interoperable or compatible with a GIS that has been developed for some other application, jurisdiction, enterprise, or purpose. What goes beyond a GIS is a spatial data infrastructure, a concept that has no such restrictive boundaries.

The aim of GISMA (Geographic Information System Multi Administration) is to manage geographical information from multiple sources. In GISMA, the data input, controlled and updated by different users. Users can be located either in the same or in different areas.

In GISMA the users have specific permissions of use of data as the administrator sets. So, the users can input information, take statistical or other results, update data e.t.c., according to their permissions defined by the system administrator.

The GISMA systems can be applied to administrative services, scientific applications, general applications of information where the information is managed directly correlated with topological data (coordinates in space) while simultaneously managing the volume of information and knowledge of these have multiple supply points.

The aim of this work is to give through an application of GISMA system a well documented landslide inventory of the studied area including the mapping of past and recent slope movements, together with the identification and mapping of the predisposing factors of slope instability. The data of the system include (a) past landslide occurrences and existing information on mass movements (historical catalogue) based on historical archives (review of scientific studies, technical reports, geological map descriptions, file reports, university theses, newspaper clippings etc) and (b) recent landslide occurrences based on a systematic interpretation of satellite images and aerial photographs.

2. Landslide Inventory Form

The primary requirement in predicting future landslides is a well documented landslide inventory of the studied area including the mapping of past and recent slope movements, together with the identification and mapping of the predisposing factors of slope instability. This constitutes the basic concept of landslide susceptibility which includes the spatial distribution of factors related to the instability processes in order to estimate zones of landslide – prone areas without any temporal implication (Radbruch, 1970) (Dobrovolny, 1971) (Fernandez et al., 2003) (Ayalew et al, 2004) (Chau. and Chan, 2005) (Chacón et al., 2006).

In this work a Landslide Inventory Form was used for data codification mainly based on landslide report (WP/WLI, 1990), summary (WP/WLI, 1991) and glossary (WP/WLI, 1993.) including the former suggestions regarding landslide causes (WP/WLI, 1994) and rate of movements (WP/WLI, 1995).

It also noted that Landslide inventory derived from historic archives is usually unrepresentative as regards its spatial distribution. This is because the landslide data recorded and obtained by the Authorities (Public Organizations) constitute only cases that have affected residential areas and road network causing financial damages with serious socio – economic consequences. Landslides that occurred in uninhabited areas without causing damages, usually no recorded. In order to include all that occurrences, a systematic interpretation of satellite images and aerial photographs is needed. That means an inventory form suitably designed to include the obtained remote sensing information.

The inventory form shown in Fig. 1 was appropriately designed (Sabatakakis et al 2013) to include all the required information obtained from the above mentioned different data sources.

Landslide Inventory Form					**Inventory Number: 214**	
Landslide location (Region, Municipality, city – village, area)	Western Greece, Achaia, Patras, Platani village				**Coordinates**	
					lat (°)	long(°)
					38°17′42″N	21°49′45″E
Land – use:	Agriculture		**Crown elevation (m):**		280	
Date of landslide:	22 February 1999		**Date of observation:**		23 February 1999	
Ground slope before landslide (degrees):		30°	**Slope orientation:**		N30E	
Dimensions of landslide:	length (m):	300	width(m):	190	depth(m):	5 – 10
	crown length(m):	120	volume(m^3):	210×10^3	area (m^2):	28 ×10^3
Rate of movement:	10 m/day		**Orientation of movement:**		N50W	
Landslide type:	Composite (translational – rotational)					
Geology (lithology – structure – weathering)	Plio-Pleistocene stiff clayey marls (CL) and clayey sands (SC). Weathered zone mixed with recent materials.				**mantle thickness (m):**	3 – 5
Landslide causes:	Triggering	intense and prolonged rainfall				
	Preparatory	ground conditions, human causes (excavations, loading)				
Impacts to:	Residential (one two-story house destroyed), road (failures in cutting slopes 130 m long and in an embankment 90 m long)					
Landslide reported by (organization):	Region of Western Greece					

Figure 1 - Landslide inventory form completed with a recorded occurrence (Sabatakakis et al., 2013).

In this work, the form of the GISMA shown in Fig. 2, designed as the inventory form was introduced in a recent paper (Sabatakakis et al., 2013).

3. GISMA system

3.1. General Requirements and Principles

It is obvious that in GISMA there are two requirements:

1. The primary knowledge is in different places - users.
2. Data may be administered from various locations

The previous two requirements lead us to the following necessities:

1. Access to the GISMA application from different access points

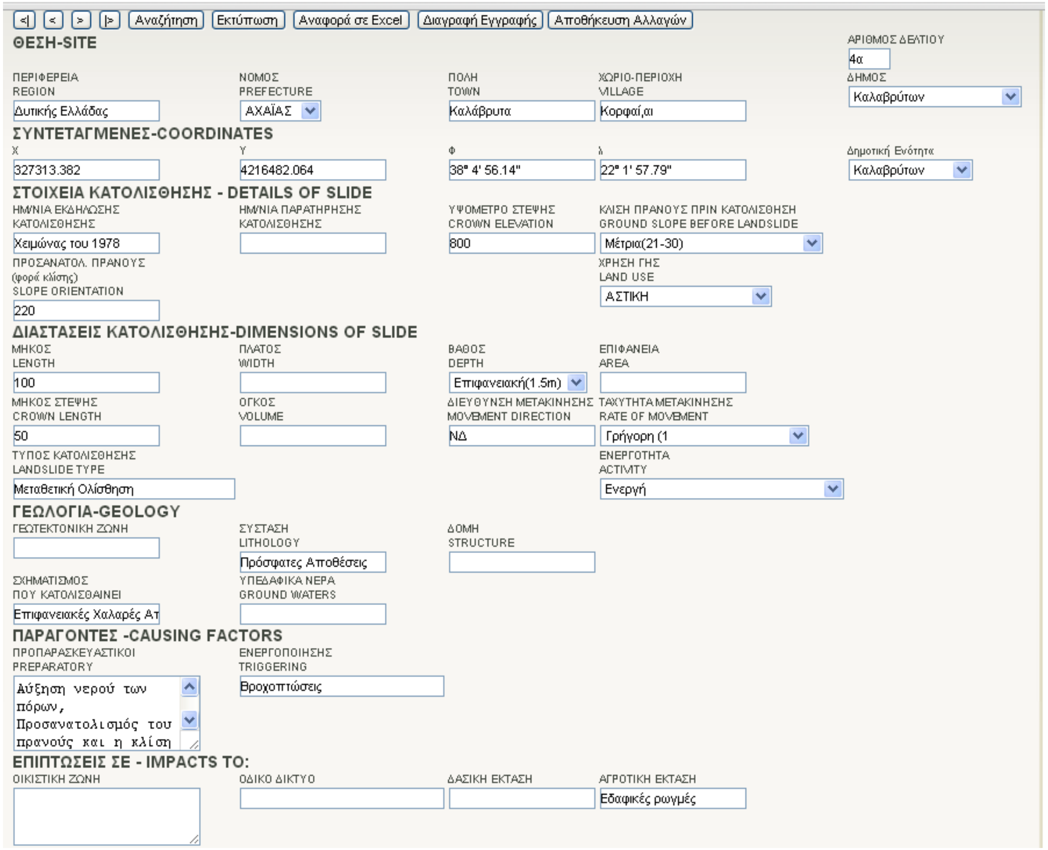

Figure 2 - Landslide inventory form in GISMA completed with a recorded occurrence.

2. Access and management of the application by different authorized users
3. Distinction between primary users in recording and updating information and administration-management users
4. Control whether the information is valid
5. Ability to collect information and process it according to the requirements of the central administration bodies.
6. The systems must be compatible to possible changes in system requirements

The above necessities give the following principles:

(a) Principle of Multiple Access (b) Principle of identity of the information (c) Principle of Role Graduation (d) Principle of Remote-Controlled Access (e) Principle of valid Information (f) Principle of Security (g) Principle of Adaptability/Compatibility

3.2. Implementation

The used technologies are PHP-MySQL (Kerner, 2008) and Google Maps API (Finley, 2011). PHP is an open source server-side scripting language designed for Web development to produce dynamic Web pages. It is one of the first developed server-side scripting languages to be embedded into an HTML source document rather than calling an external file to process data. The code is interpreted by a Web server with a PHP processor module which generates the resulting Web page. It has also evolved to include a command-line interface capability and can be used in standalone graphical applications. PHP can be deployed on most Web servers and also as a standalone shell on almost every operating system and platform, free of charge. PHP was originally created by Rasmus Lerdorf in 1995 (Kemer, 2008). The main implementation of PHP is now produced by The PHP Group and serves as the formal reference to the PHP language. PHP is free software released under the PHP License, which is incompatible with the GNU General Public License (GPL) due to restrictions on the usage of the term PHP.

MySQL is the world's most used open source relational database management system (RDBMS) as of 2008 that runs as a server providing multi-user access to a number of databases. MySQL is a popular choice of database for use in web applications, and is a central component of the widely used LAMP open source web application software stack (and other 'AMP' stacks). LAMP is an acronym for “Linux, Apache, MySQL, Perl/PHP/Python.”

The following screenshots (Figure 3, Figure 4 and Figure 5) constitute the web page.

This GISMA system was installed in a Web Server with 1TB storage space and a bandwidth 50MBps.

Our GISMA system follows the basic principles of GISMA as described previously.

The system testing with the follow amount of users

24 Ordinary users

10 Registrars

5 Information managers

1 Guarantor

1 System Administrator

The volume of information that was applied was 120 MB.

The behavior of the system was quite satisfactory (maximum time of access record was 2sec).

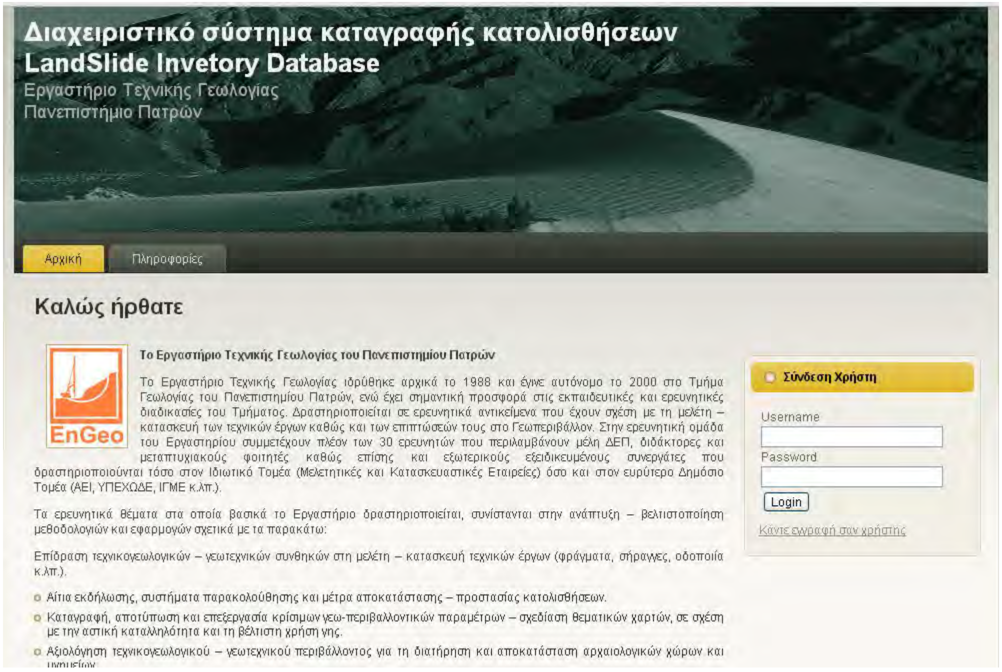

Figure 3 - The users give their username and passwords in order to have access in the system.

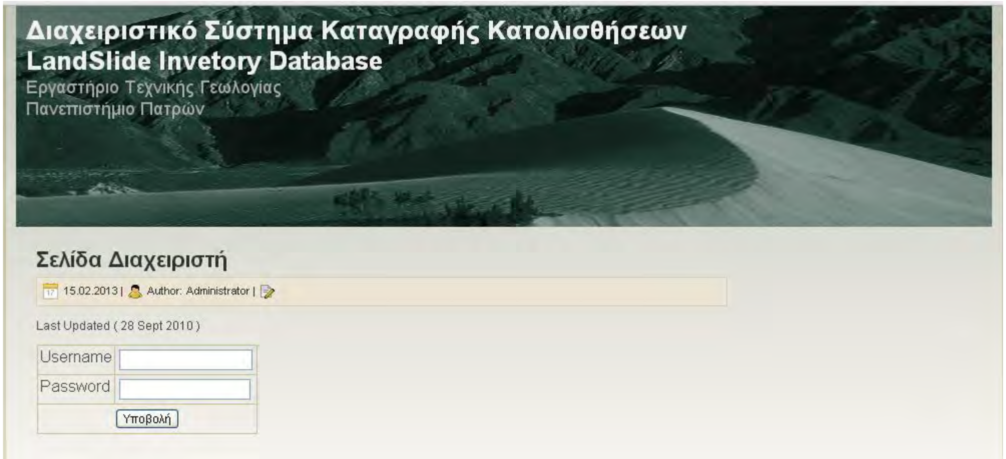

Figure 4 - The administrators give their username and password in order to have access in the system.

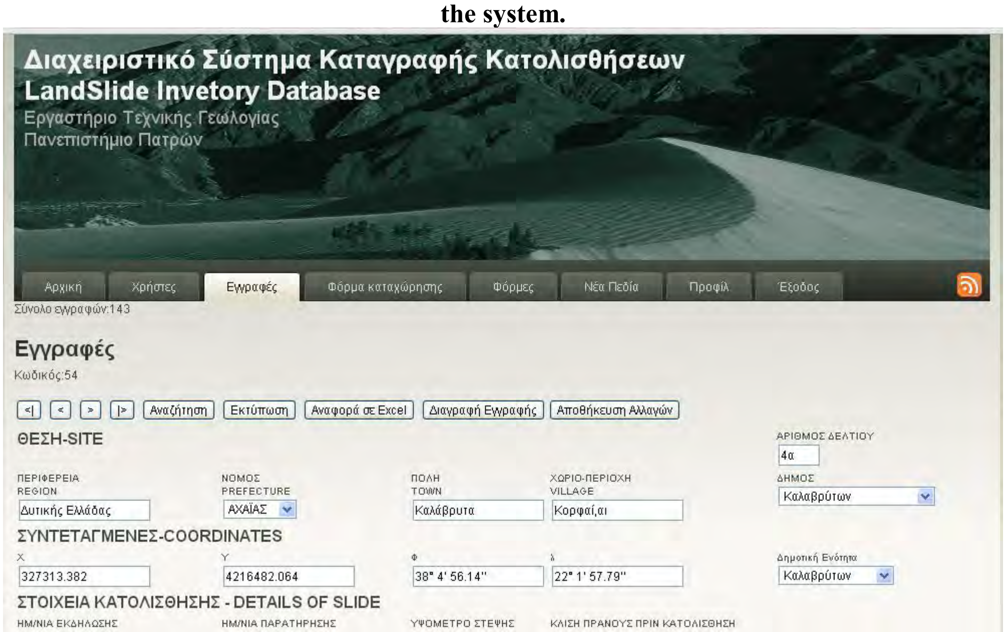

Figure 5 - A data page that the users or administrators can input or update data, take statistical results, take reports about the system.

4. Conclusion

Landslide occurrences are generally governed by numerous spatial predisposing factors that can be, for the purpose of susceptibility assessment, recorded and storage using a regional inventory. A reliable and accurate susceptibility assessment strongly depends on the proper identification and selection of these factors, while the inclusion or omission of some may change significantly the capability of that assessment.

A landslide inventory is usually derived from historical archives, meaning that is unrepresentative of the real spatial distribution, but also from systematic interpretation of satellite images and aerial photographs. The proposed inventory form in this work can be attempted through both sources of existing information on mass movements including historical and remote sensing data.

The created GISMA system already include over than 200 landslide cases occurred in Achaia Prefecture which have been selected as "pilot study". The system was properly designed to record and manage information from multiple users such as undergraduate, postgraduate students and other researchers of Patras University It also constitutes the basic tool for inventory-based, probabilistic approaches for landslide susceptibility zonation mapping.

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