LANDLSIDE INVENTORY USING A GISMA SYSTEM EXTENDED WITH STATISTICAL ADAPTIVE METHODS

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ABSTRACT

The development of Internet technologies and applications of global geographic maps such as Google Maps have given a rapid development in the field of Geographic Information Systems (GIS). New models have been already studied like the GISMA (Geographic Information System Multi Administration) where the information's administrated from multiple users from different places of the world. In these systems it is important the information security, and the possibility of extensibility, the ability of self-management and self-development of the system. Thus, each user must have specific rights, can receive results from different mathematical and statistical methods, can update or not the data etc.

In this work we present a GISMA system that has been developed to manage information for Landslides in the region of Achaia. This system follows the basic principles of GISMA. The system has the ability to display information on Google Maps in order to displays the information anywhere in the world via internet. Authorized users in different places of the world, depending of their rights can enter data in the system, can enter new mathematical and statistical processes in order to analyze the data, and addition can add new tables and fields in the database for more complex analyzes. Finally, the implementation and evaluation of the system showed that GISMA systems are a flexible solution where GIS systems handle several users as research systems, system for Business Administration, or Government Organizations.

INTRODUCTION

Internet GIS utilize network communications to disseminate or to access geographic information. Different Internet GIS applications may need different kind of network environments for their specific purposes. The development also of Internet technologies and applications of global geographic maps such as Google Maps have given a rapid development in the field of Geographic Information Systems (GIS).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.

New models have been already studied like the GISMA (8) (Geographic Information System Multi Administration) where the informations administrated from multiple users from different places of the world. In these systems it is important the information security, and the possibility of extensibility , the ability of self-management and self-development of the system. Thus, each user must have specific rights, can receive results from different mathematical and statistical methods, can update or not the data etc.

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 area or a different area. (8)

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., or some of them as their permissions allow.

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.

In this work we present an new 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.

The data presents on several google maps, and the user can select records using geographical queries. This GISMA system was installed in a Web Server with 1TB storage space and a bandwidth 50MBps. 20 users use this system and we test it using different procedures. The volume of information that was applied was 120 MB. The behaviour of the system was quite satisfactory (maximum time of access, insert, update and delete records was 2sec).

METHODS

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(1,2,3).

In this work a Landslide Inventory Form was used for data codification mainly based on landslide report (12), summary (13) and glossary (14) including the former suggestions regarding landslide causes (15) and rate of movements (16).

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 (11) to include all the required information obtained from the above mentioned different data sources.

GISMA (Geographic Information System Multi Administration)

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<table>
<tr><th colspan="6">Landslide Inventory Form</th><th colspan="2">Inventory Number: 214</th></tr>
<tr><td rowspan="2">Landslide location (Region, Municipality, city – village, area)</td><td colspan="5" rowspan="2">Western Greece, Achaia, Patras, Platani village</td><td colspan="2">Coordinates</td></tr>
<tr><td>lat (°)</td><td>long(°)</td></tr>
<tr><td></td><td colspan="5"></td><td>38°17’42’’N</td><td>21°49’45’’E</td></tr>
<tr><td>Land – use:</td><td colspan="2">Agriculture</td><td colspan="2">Crown elevation (m):</td><td colspan="2">280</td></tr>
<tr><td>Date of landslide:</td><td colspan="2">22 February 1999</td><td colspan="2">Date of observation:</td><td colspan="2">23 February 1999</td></tr>
<tr><td colspan="2">Ground slope before landslide (degrees):</td><td>30°</td><td colspan="2">Slope orientation:</td><td colspan="2">N30E</td></tr>
<tr><td rowspan="2">Dimensions of landslide:</td><td>length (m):</td><td>300</td><td>width(m):</td><td>190</td><td>depth(m):</td><td>5 – 10</td></tr>
<tr><td>crown length(m):</td><td>120</td><td>volume(m^3):</td><td>210×10^3</td><td>area (m^2):</td><td>28×10^3</td></tr>
<tr><td>Rate of movement:</td><td colspan="2">10 m/day</td><td colspan="2">Orientation of movement:</td><td colspan="2">N50W</td></tr>
<tr><td>Landslide type:</td><td colspan="7">Composite (translational – rotational)</td></tr>
<tr><td>Geology (lithology – structure – weathering)</td><td colspan="4">Plio-Pleistocene stiff clayey marls (CL) and clayey sands (SC). Weathered zone mixed with recent materials.</td><td>mantle thickness (m):</td><td>3 – 5</td></tr>
<tr><td rowspan="2">Landslide causes:</td><td>Triggering</td><td colspan="6">intense and prolonged rainfall</td></tr>
<tr><td>Preparatory</td><td colspan="6">ground conditions, human causes (excavations, loading)</td></tr>
<tr><td>Impacts to:</td><td colspan="7">Residential (one two-story house destroyed), road (failures in cutting slopes 130 m long and in an embankment 90 m long)</td></tr>
<tr><td colspan="2">Landslide reported by (organization):</td><td colspan="6">Region of Western Greece</td></tr>
</table>

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

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.

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
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

In this study we implement a GISMA in order to record Landslide inventory of various areas. The system gives the opportunity to use many different researchers to enter information, obtain Geographical projections through different geographical queries, and use all be done from anywhere in the world anytime using internet technologies.

RESULTS

The introduction screen of the user is the Fig 2. The user gives username and password and according to his right which gives the administrator can enter new records, update, delete data. The user also cancreate or import new forms of recording, new fields in existingforms.

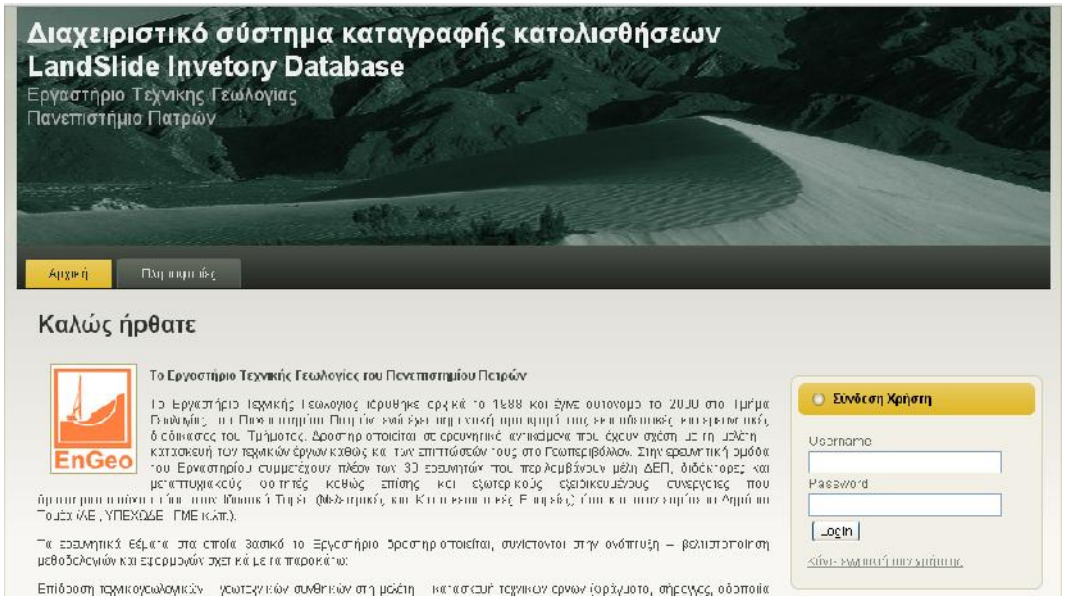

Figure 2. Introduction Screen. User gives username and password in order to have access in GISMA.

All the user can give geographical queries and take the geographical views that they want. Administrators can manage users, give those rights and control the overall system.

This GISMA system was installed in a Web Server with 1TB storage space and a bandwidth 50MBps. For this implementation we use PHP, MYSQL and many parts of Javascript and JQUERY (7).

The GISMA system follows all the basic principles of GISMA as described previously.

The system testing with the follow amount of users

- 20 Ordinary users
- 5 Registrars
- 5 Information managers
- 1 Guarantor
- 1 System Administrator

The volume of information that was applied was 200 MB.

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

In Fig 3 the user can use the form of the GISMA which designed as the inventory form of Sabatakakis et al 2013. Administrator can design with a very easy way every form that is necessary for the system and add, delete or change fields in already designed forms.

Figure 4 show the screen that the administrator can create, update or delete fields in a form.

Figure 5 show the screen of a geographical google map that present a geographical query that a user gives. In this figure the user ask to take all the records of landslides inventory of Achaia.

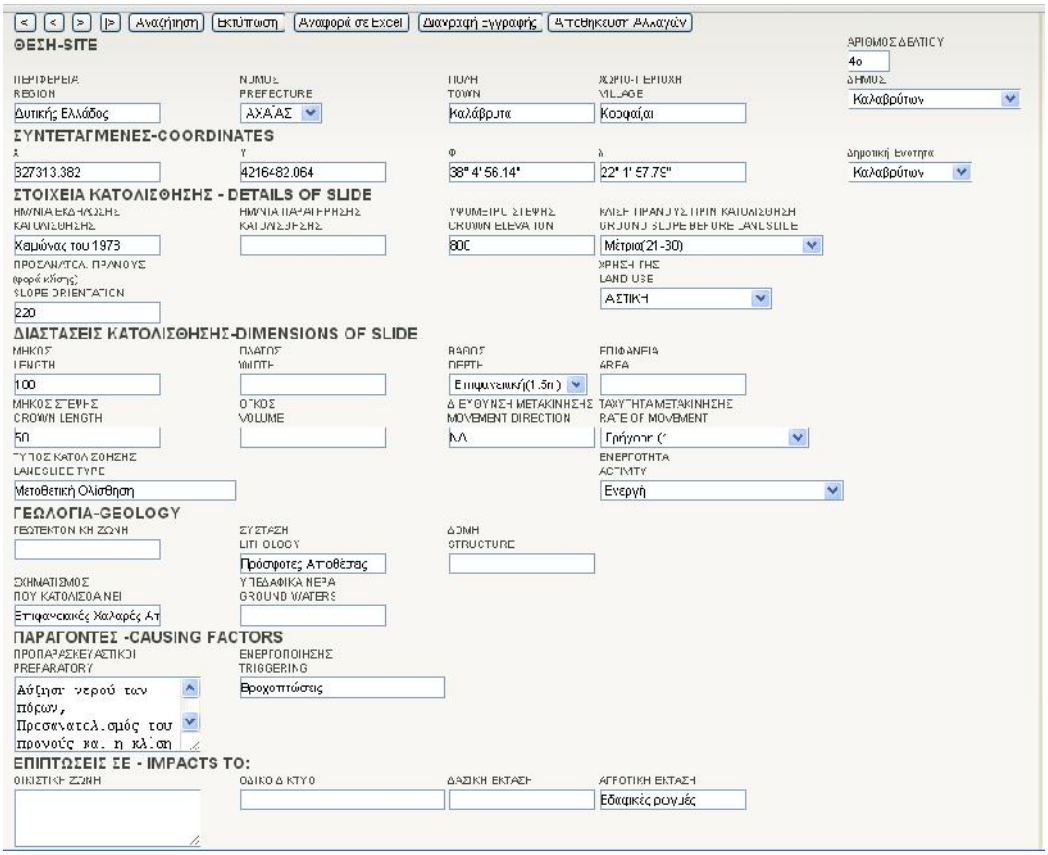

Figure 3. Landslide inventory form in GISMA completed with a recorded occurrence

CONCLUSIONS

In this study we created GISMA system already include over than 200 landslide cases occurred in Achaia, Ilia 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. The system present the data on a google map and the users can select records using geographical queries. The system

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.

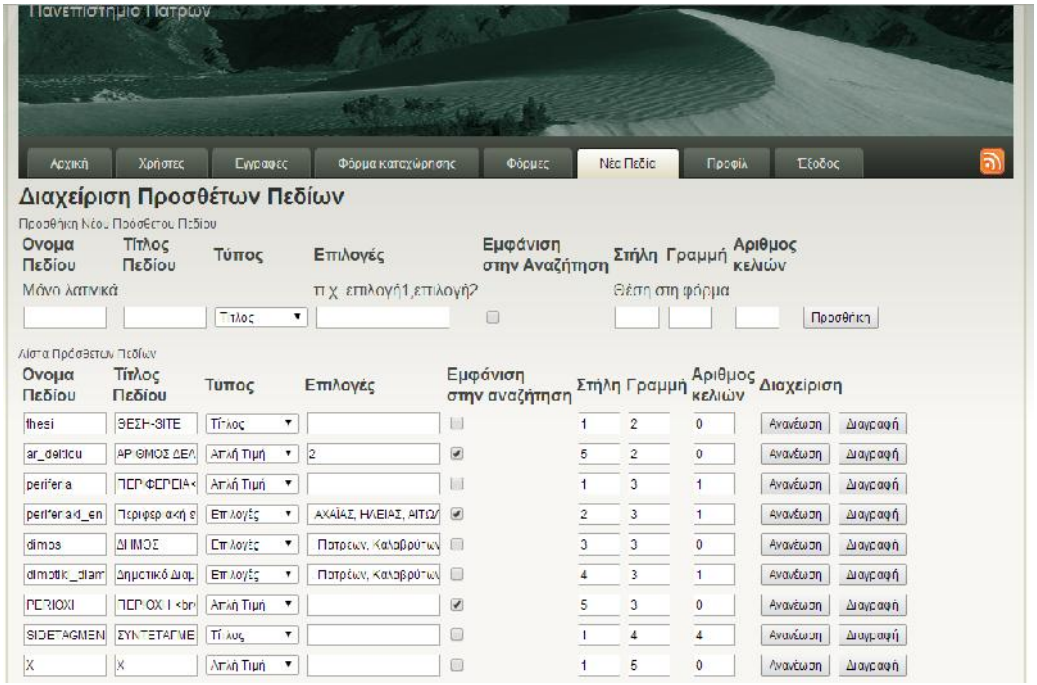

Figure 4 Landslide inventory form in GISMA completed with a recorded occurrence

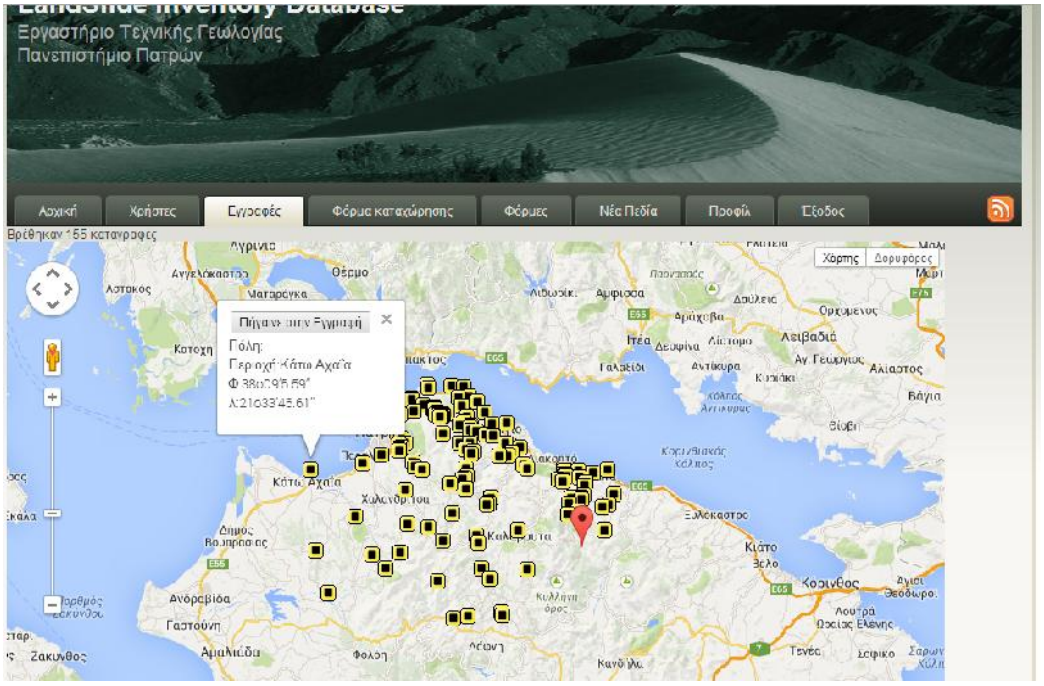

Figure 5 show the screen of a geographical google map that present a geographical query that a user gives. In this figure the user ask to take all the records of landslides inventory of Achaia.

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. GISMA are the most appropriate systems for recording landslides inventories.

REFERENCES

1 Ayalew L, Yamagishi H, Ugawa N, 2004. Landslide susceptibility mapping using GIS-based weighted linear combination, the case in Tsugawa area of Agano river, Niigata Prefecture, Japan. Landslides 1:73–81. doi:10.1007/s10346-003-0006-9

2 Chau KT, Chan JE 2005. Regional bias of landslide data in generating susceptibility maps using logistic regression: case of Hong Kong Island. Landslides 2:280–290. doi:10.1007/s10346-005-0024-x

3 Chacón J, Irigaray C, Fernández T, El Hamdouni R 2006. Engineering geology maps: landslides and geographical information systems. Bull Eng Geol Environ 65:341–411. doi:10.1007/s10064-006-0064-z

4 Clarke C., 1986. Advances in geographic information systems, computers, environment and urban systems, Vol. 10, pp. 175–184.

5 Dobrovolny E 1971. Landslide susceptibility in and near Anchorage as interpreted from topographic and geologic maps. In: The great Alaska earthquake of 1964-Geology volume. Publication 1603. U.S. Geological Survey Open-File Report 86-329, National Academy of Sciences, USA, pp 735–745.

6 Foresman T. 1997. The History of GIS (Geographic Information Systems): Perspectives from the Pioneers. (Prentice Hall Series in Geographic Information Science) Prentice Hall PTR; 1st edition (November 10, 1997), 416 p.

7 Kerner M. 2008. "PHP 4 is Dead—Long Live PHP 5". InternetNews. Retrieved 2008-03-16.

8 Kordouli M., Kavoura Kat., Nikolakopoulos K., Sabatakakis N. LANDSLIDE INVENTORY USING GISMA TECHNIQUES, 13o International Congress of Geological Society of Greece, 5-8 September, Chania, Greece

9 Fernández T, Irigaray C, El Hamdouni R, Chacón J (2003) Methodology for landslide susceptibility mapping by means of a GIS: application to the Contraviesa Area (Granada, Spain). Nat Hazards 30(3):297–308. doi:10.1023/B:NHAZ.0000007092.51910.3f .

10 Finley K., 2011. "7 Cloud-Based Database Services". ReadWriteWeb. Retrieved 9 November 2011.

11 Sabatakakis N., Koukis G., Vassiliades E., Lainas S. (2013): _«Landslide susceptibility zonation in Greece»_. Natural Hazards 65(1):523 - 543. doi: 10.1007/s11069-012-0381-4.

12 WP/WLI 1990. A suggested method for reporting a landslide. International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (Chairman D Cruden) Bull Eng Geol Env 41(1):5–12. doi:10.1007/BF02590201

13 WP/WLI 1991 A suggested method for a landslide summary. International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (Chairman D Cruden) Bull Eng Geol Env 43:101–110. doi:10.1007/BF02590177

14 WP/WLI 1993. Multilingual landslide glossary. International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (Chairman D Cruden). BiTech, Richmond, p 59

15 WP/WLI 1994. A suggested method for reporting landslide causes. International Geotechnical Societies' UNESCO Working Party for World Landslide Inventory (Chairman ME Popescu) Bull Eng Geol Env 50(1):71–74. doi:10.1007/BF02594958

16 WP/WLI 1995. A suggested method for describing the rate of movement of a landslide. International Geotechnical Societies' UNESCO Working Party for World Landslide Inventory (Chairman ME Popescu) Bull Eng Geol Env 52(1):75–78. doi:10.1007/BF02602683