Proceedings
Eighth International Congress
International Association for Engineering Geology and the Environment

21–25 SEPTEMBER 1998 / VANCOUVER / CANADA

Editors

D. MOORE

B.C. Hydro Ltd, Burnaby, British Columbia, Canada

O. HUNGR

The University of British Columbia, Department of Earth and Ocean Sciences, Vancouver, British Columbia, Canada

OFFPRINT / TIRE-A-PART

A. A. BALKEMA / ROTTERDAM / BROOKFIELD / 1998

8th International IAEG Congress, 1998 Balkema, Rotterdam vol.III, p. 1759-1763

G.I.S. aided landslide management in Ropoto (Trikala, Greece). Raster - Vector data treatment

E.Lekkas & S.Vasilopoulou
Department of Geology, University of Athens, Athens, Greece

J.Hadzinakos
Department of Engineering Geology, IGME, Athens, Greece

ABSTRACT: The fact that landslides, along with along other natural hazards, cause significant problems in inhabited areas makes prevention planning and treatment imperative. A case study is presented in this paper, the area of Ropoto (Trikala, Greece) where extensive landslides occur. The management of the phenomena was done through the development of a GIS data base. This methodology was chosen because of its capability to correlate and treat a large number of data in different forms (raster, vector). These data can then used to form a relational database in order to acquire a proper decision-making system

RÉSUMÉ: Les glissements de terre et les autres phenomènes déstructives sont la cause d' un grand nombre des problèmes aux régions populées, c' est pourquoi le planning) et la gestion se rendent impératives. Dans cette étude on présent la cas de la région de Ropoto (Trikala, Greece), où, des glissements gravitaires importants ont lieu. La gestion du problème est basée sur le dévelopment d' une base a donnés sur GIS. Cette méthode a été choisie grace à sa capacité d' association et traitement d' un grand nombre de données de formes différentes (raster, vector). Ces données peuvent être utilisées pour former une base à données pour aider les authoritées locales à la prise des décisions.

1 INTRODUCTION

Prevention and facing of natural disastrous phenomena and processes has become essential, because of the significant social and economic impact of these effects. Geographical Information Systems (GIS) have become increasingly useful and advantageous not just for the depiction of spatial distribution of data (Lekkas 1992), but also for comparative evaluation and treatment of a large number of thematic units (Lekkas et al. 1995). The increasing power of PCs in the last decade has made this procedure possible, through the compilation of relational databases (RDB) and appropriate overlays towards the formation of decision-making systems (DMS).

Such an RDB was compiled for the area of Ropoto (Trikala, Central Greece), where acute problems related to landslides have arisen (Lekkas 1988, Lekkas et al. 1992, Lekkas 1996a,b). A large amount of data that came in different forms (raster, vector) and from various sources, including new field data were treated and created the RDB that was subsequently utilised for the compilation of thematic maps and the appropriate DMS. This paper presents the procedure followed for the compilation of a Geotechnical Units Thematic Map (Fig. 1).

2 MAP COMPILATION USING ARC-INFO

2.1 *General*

Input and treatment of data was done on a SUN SparcStation 20 (O/S Solaris 2.0) through the G.I.S. Arc-Info 7.03. Data was categorized into geographical units - coverages, where each piece of data was characterized by its geographical position (spatial information) and its descriptive attributes (descriptive information). Three categories were distinguished, namely:

- Points.
- Arcs.
- Polygons.

The procedure followed for map compilation is described in the following chapters.

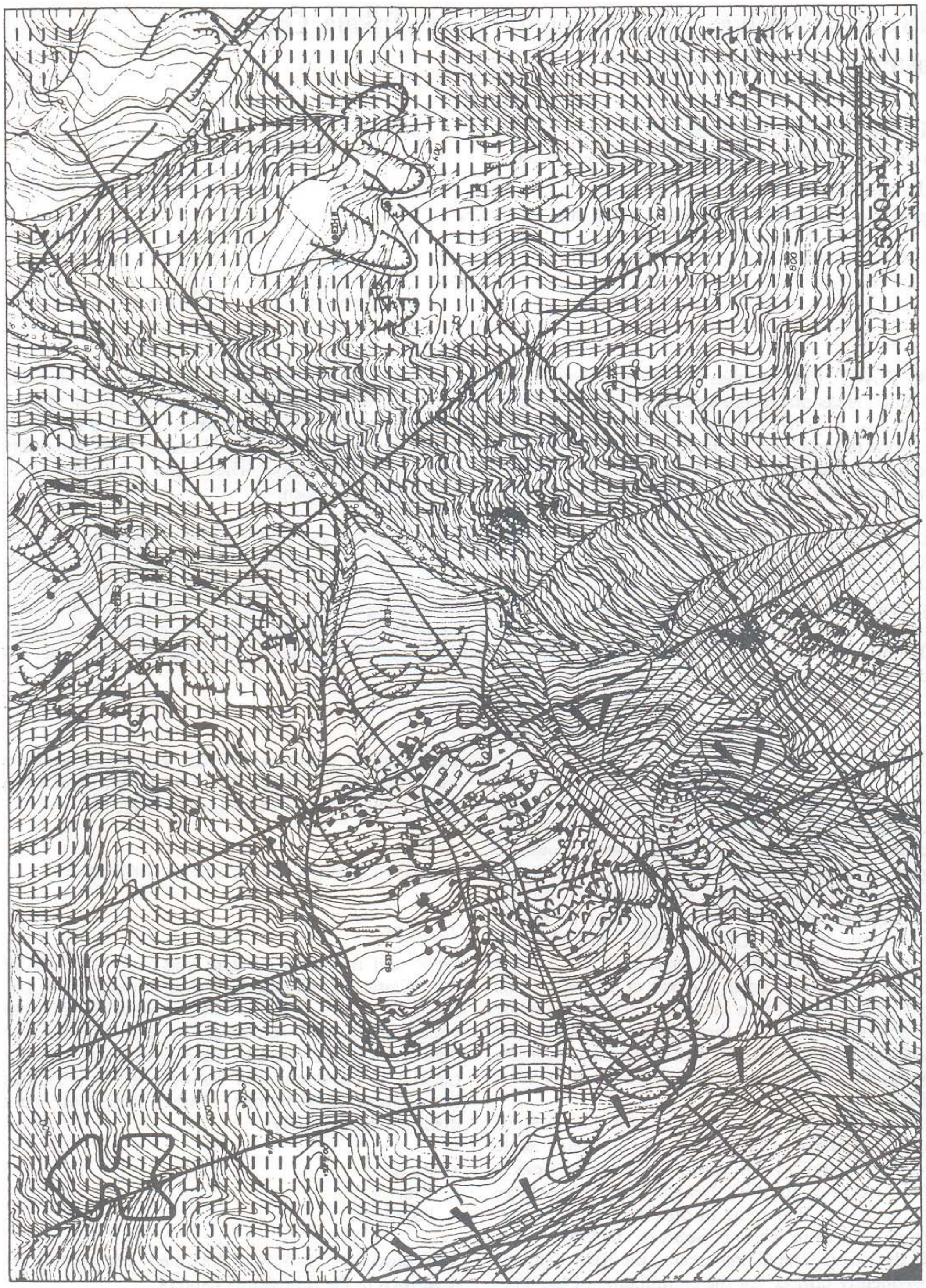

Figure 1. Map showing the geotechnical units of the area

2.2 *Raster and Vector Data Input - Coverage Compilation*

The topography, in the form of 1/5,000 scale maps was scanned and saved in Tagged Image Format (TIF), which was transformed, through *'register'* and *'rectify'* procedures, into 'grid', using the '*imagegrid*' function and the geometrically corrected 'trikalgt' was acquired. Input of the rest of the data was done through Arcedit, after they had been digitized (Altec digitizer, mod. ACB48C) for every coverage. During the digitizing process of each layer a common ID was assigned to homogeneous data, so that they could easily be split into sub-categories. The following coverages were created:

- dgtricalor: Boundaries of the geotechnical units (in arc form) as distinguished in the process of geological mapping.
- dgtricalor2: Positions and boundaries (in arc form) of the interventions suggested by the investigation.
- dgtrikall1: Landslide boundaries, distinguished in active and inactive, major fractures and faults and the boundary of the sliding area, all in arc form.
- dgtrikall2: The limits of suggested interventions.
- dgtrikalp: Spring locations (points).
- dgrtikalp2: Locations - limits of suggested interventions.

2.3 *Error Correction*

After the digitizing process and before any kind of analysis, all digitized data were corrected in Arcedit.

2.4 *Conversion of co-ordinates in map projection system*

The process included the creation of a new layer/coverage that initially contained only tics, as many as those existing in the coverage to be transformed. (Note that the numbering of individual tics must be identical in both coverages) The correlation of real (x,y) co-ordinates -UTM., etc., depending on map projection- was done on tables. Subsequently, through the 'transform' command the initial coverage was transformed (co-ordinates given in digitizer inches) into the new one that bore the co-ordinates of the map projection system.

2.5 *Relational Database Compilation*

After digitizing, every coverage contained only spatial information. In this stage the topology of each coverage/layer was separately built, that is spatial relationship between geographical data were established. Using the 'clean' and 'build' commands the following files were created and updated:

AAT	Arcs Attribute Table (Table of characteristic linear data)
PAT	Polygons Attribute Table (Table of surface data)
PAT	Points Attribute Table (Table of point data)

Updating of these files was done through the introduction of some codes common to the homogeneous data of every category/coverage. Regarding the linear and point data, the IDs had been assigned during digitizing. After the corrections, labels were assigned to polygons and the following updated layers/coverages were obtained:

- ctricalor: Geotechnical units (in polygon form) that had been distinguished during field work in the following seven categories: a. river-bed deposits; b. weathering mantle; c. scree; d. clastic sediments (Flysch); e. transitional deposits; f. carbonates (L. Cretaceous); g. clastic-II sediments ('first flysch'). Each polygon was assigned a certain label, common to the category. Included in the same coverage are, in arc form, the polygon boundaries, which when they are not normal geological contacts have a certain ID, while for all other types of contact (i.e. faults) their IDs were different, common to all categories. The latter are not called out during ArcPlot map compilation.
- ctricalor2: Locations-boundaries of suggested interventions for landslide prevention (in polygon form). They were classified into: a. terrain to be smoothed and/or unloaded, or cracks that should be sealed; b. artificial incisions, c: small retaining dams; d. plantations. Each polygon was assigned a certain label, common to the category.
- dgtrikall1: Boundaries of: a. recent landslides; b. older landslides; c. major fractures; d. overall boundary of the sliding area, and e. slid and turbid material.
- dgtrikall2: Boundaries - locations of suggested interventions: a. collection - redirection of srping water; b. locations of draining channels; c. 'fishbone' draining channels; d. chaneling pipes; e. locations of collecting - channeling trenches; f. rock-and wire check retaing walls . In this case too, each category is characterized by a certain ID.
- dgtrikalp: Spring locations, all under a common ID.
- dgtrikalp2: Locations of suggested interventions, as: a. induced recharge; b. draining wells; c. draining well with lateral drillholes. Each data-point was assigned a certain ID, common to the category.

The compilation of this DB is necessary not only for map creation, but also is a prerequisite for the exploitation of GIS capability to treat and manipulate data. For this purpose, the addition of some items in AAT and PAT files was necessary. Thus, the following items were added to the linear data coverages:

'character'	data characterization (i.e. fracture)
'strike'	the strike/azimuth of the item
length'	its length

The following items were added to the geotechnical coverage unit (ctricalor):

'formation'	the name of the geotechnical formation
'lithology'	description of lithologic composition
'age'	
'thickness'	

In addition, the following items, related to geotechnical parameters of the formations were added:

'geotechnic'	overall attributes of rock-mass (good, average, bad, etc.,)
'disasters'	occurrence of destructive phenomena
'response'	response of the formation under seismic stress
'classify'	area classification according to Earthquake Code

After the RD has been updated with sufficient amount of data, its analysis and management can provide solutions to certain target-oriented queries. besides, the RDB can constantly be updated with new data, depending on the current needs.

3 MAP PRESENTATION

In order maps containing thematic information to be presented, they have first to be processed with ArcPlot. As mentioned above, the files AAT, PAT and PAT are used for each coverage and a series of commands is then followed so that the required items appear on the map, with the symbol or colour selected for each. All line or point symbols are built-in, but creation of new ones is also possible, All of them are contained in the files trikal.shd, trikal.lin and trikal.mrk and are called out during map compilation.

3.1 *Map of geotechnical units*

This constitutes a complex process, as it requires printing the topography (4 m. contour interval), along with all data (polygons, lines, points), all of them in solid colour. The following procedure was followed:

- The digitised ctrikalor coverage is transformed into grid through the *polygrid* command and the ctrikalg file is acquired.
- The scanned topography (trikalg1) and ctrikalg are combined (*con* command) and ctrikalg1, in grid form, results.
- The symbols field is added in the vat file of ctrikalg1; each record under a certain ID is given the appropriate colour, chosen form the available palette.
- Ctricalg1 includes all polygons of geological formations and topographic contour lines. All the other data are either lines - arcs or points-symbols included in dgtrikall1 and dgtrikalp coverages and added through the usual compilation procedure in ArcPlot.
- The aml file is created trikal1.aml, containing all data available in the Map of geotechnical units.

4 OBSERVATIONS - CONCLUSIONS

Geographical Information Systems can prove not only valuable, but they can also play a key role in natural disaster management. The Ropoto landslide phenomena constitute such a case. A large number of existing data and field observations that come in different forms (raster, vector) can be combined and treated.

The result is not only the compilation and presentation of some thematic maps, but also the creation of a decision making system, through the organization, analysis and management of a relational database that can be constantly updated and improved.

REFERENCES

Lekkas E. 1988. Geological structure and geodynamic evolution of Koziakas mountain, Western Thessaly. Thesis, Dept. of Geology University of Athens, *Geological Monographies* No 1, 281p.

Lekkas E. et al. 1992. Study of the landslide phenomena of Karditsa region (Monitoring, Classification, Causes, Consequences, Measures). Research project, University of Athens, 230p., Athens.

Lekkas E. 1992. Mass movements hazard map of Magnesia region (Central, Greece). 29th

International Geological Congress, Kyoto Japan, Abstract, Vol. 3, p. 950.

Lekkas E., S. Lozios, G. Bertakis & S. Vasilopoulou 1995. Management of Geoenvironmental problems (Natural Hazards). A method for landslide hazard assessment using Geographical Information Systems (G. I. S.). XV Congress of the Carpatho-Balkan Geological Association, *Special Publications of the Geol Soc. Greece*, No 4/3, p. 998-1001.

Lekkas E. 1996a. *Natural and Technological disasters*. Ed. Access Soft, 278p., Athens.

Lekkas E. 1996b. Facing of landslide phenomena in the village of Ropoto, county of Trikala (Central Greece). Research Project, University of Athens, 74 p., Athens.