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GIS-based Approach for Land-Use Analysis: A Case Study

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Abstract**—**Geographical Information Systems are an integral part of planning in modern technical systems. Nowadays referred to as Spatial Decision Support Systems, as they allow synergy database management systems and models within a single user interface machine and they are important tools in spatial design for evaluating policies and programs at all levels of administration. This work refers to the creation of a Geographical Information System in the context of a broader research in the area of influence of an under construction station of the new metro in the Greek city of Thessaloniki, which included statistical and multivariate data analysis and diagrammatic representation, mapping and interpretation of the results.

Keywords**—**Databases, Geographical information systems (GIS), Land-use planning, Metro stations

I. Introduction

GEOGRAPHICAL Information Systems (GIS) are widely known worldwide in the field of modern technical systems as an integral part of planning process. This view is further enhanced because of the fact that a large percentage of decisions are involved directly or indirectly in associated spatial information [1]. Nowadays GIS systems are often referred to as GISSpatial Decision Support Systems, as they allow synergy of database management systems and models within a single user and machine interface [2]. Therefore they are important tools in spatial planning in order to evaluate policies and programs at all levels of government administration. This paper refers to the development of a Geographic Information System in support of research data in the influence zone of an under construction station (Papafi station), located in the city centre, of the new metro line of Thessaloniki, the second most populous Greek city. The total research included inventory of the zone's land use, preparation and completion of relevant questionnaires, processing and analyzing data as well as creation of a Geographic Information System, diagrammatic representation and mapping of critical results.

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II. Research Area, Data Collection and Methodology

Exploring the impact of the impending opening of the new metro line in Thessaloniki on land use in the wider area of the station "Papafi," suggested a detailed description of its status quo, through the collection, processing and analysis of a substantial amount of primary information, the collection of which required extensive fieldwork.

These data comprise the characteristics of land use and comprehensive analysis of stated preferences and intentions of pedestrians and business owners within the station's buffer zone [3]. The questions focused on the upcoming changes that will occur in the area after the completion and operation of the metro station, and were systematized in a log sheet of uses and two questionnaires of stated preferences and intentions for the station. The inventory of land use took place throughout the defined survey area, while the two questionnaire censuses were random, and were addressed to a representative sample.

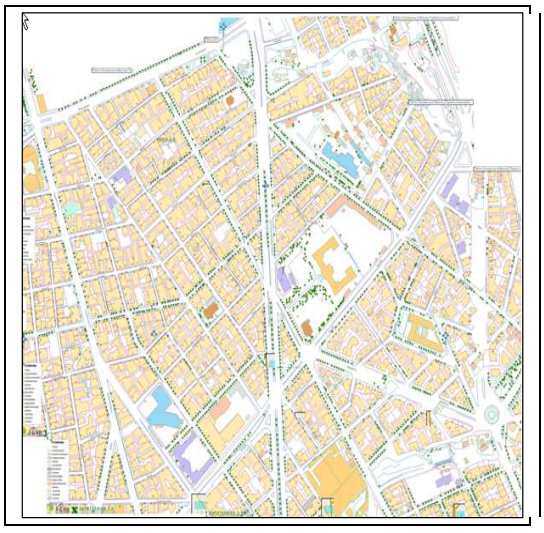

Fig. 1 The base map of the research area

III. Data base And Gis Creation

In order to examine the land use of the region, the total ground floor use of all 106 blocks that are included in the buffer zone, were recorded. These data, together with the data collected from the questionnaire surveys were included in electronic databases (DB). In particular, the data gathered from the inventory of land use and additional demographic data of the blocks from the 2001 census of the National

Statistical Service of Greece (NSSG), were enrolled in databases which have implemented a Geographic Information System (GIS) associated with the corresponding digital mapping.

Before the final inclusion of items of the inventory in the database extensive logical checks on them and coding of uncodified variables were conducted. In addition to accuracy checks of the raw data, after the completion of the data entry on the computer, more reasonable checking took place in order to identify and adapt non-compatible data.

The import of all data was reached with the aid of a spread sheet in Microsoft Excel program. The listing of Excel worksheets in the environment of Microsoft Access and the creation of the corresponding personal databases of the land use and population databases followed, under the objective of creating thematic maps to illustrate this information. Next step was the process of connecting (joining) these data bases with the layers of buildings and blocks of the study area using the platform of ArcGIS v9.3 software. This process includes the choice of a common field between the two files which plays the role of the primary key, with the aid of which the one to one correspondence of descriptive and spatial data was achieved. In the present case, the code given by NSSG for each specific block or building was chosen as the primary key for the creation of maps illustrating information for the blocks or buildings respectively.

The connection is generally a lengthy process because it is extremely sensitive and must be done carefully, as it is very easy to be unsuccessful in case there is any dissonance between the primary key fields in the two files. The more the records the two files contain, the more likely is that problems occur not leading to successful connection by the first attempt. After the successful completion of the join process, the construction of the comparative thematic maps of the collected data became possible [4].

IV. Data Analysis And Production Of Thematic Maps

The base background map used to record land use consists of a combination of several images of the area investigated by the Cartographic portal of Thessaloniki [5]. In these images the street names and addresses of buildings are shown. Several images were used in order for all the required data to be visible. The merging of images was performed using the program Adobe Photoshop. On this background there were codes for the blocks involved in the registration and serial numbers of buildings in order to match with the spatial information in the narrative.

The digital base map used for the production of thematic maps was purchased by the Department of Cartography of the Greek Statistical Authority (EL. STAT. - former NSSG) which has created and developed a database of geographic information and digital base maps.

Through the website of ELSTAT there are available digital cartographic base maps of scale 1: 5000 for 485 cities and settlements in Greece with a population of over 2,000 residents and for 124 villages under 2,000 inhabitants.

The Greek Geodetic Reference system EGSA 87 was selected as the geodetic reference system for this work. The digital cartographic assigned and corresponding proportional diagrams are also in scale 1:5.000. The information provided through digital mapping for each settlement is as follows:

i. The axes of the roads and nomenclature (where possible).
ii. The outlines of city blocks and numbering.
iii. The outlines of buildings numbered within the block.

The base map that includes the study area was developed by the Municipality of Thessaloniki. The files used belong to the category of shapefiles (shp). Shapefile is a file in which non-typological geometry and information related to the spatial elements of a data set is stored. The geometry corresponding to each element is stored as a shape that encloses a set of vector data.

As shape files do not contain the procedural form of typological data, they have advantages over other storage formats, such as faster drawing and data editing capability. They may also identify and monitor individual elements that overlap or are not continuous. They occupy little disk space and both their recording and management can be done easily [6].

The Municipality of Thessaloniki consists of four files (shape files). The first includes the blocks, the second one the buildings, the third one the road axes and the last one the topography of the area. Each file has a list of features (attribute table) which contains some information about spatial data, such as codes and the internal numbering of buildings that has been assigned by NSSG in each block. The base map of the project was developed to reconcile the cross-information from the different sources, while the total amount of raw raster data used were reported in the Greek territorial Geodetic Reference system EGSA 87, which is the reference system of layers of the application.

Except from the aforementioned sources, in the implementation of layers the program of visualization of the earth named Google Earth is used, for reproduction and updating of the spatial data. Also GPS receivers were used for storing spatial and descriptive information of the street net.

The codification of the land use was made following extensive consultation study of the corresponding coding held in the Metro Development Study (M.D.S). The land use codes used for inventories in the preparation of M.D.S. with the formal double-digit detailed categorization of the NSSG. In M.D.S., 31 land use categories are used for the recording and integration of existing uses in the respective groups. In this study, the coding was done in line with that of M.D.S, but without following it exactly, mainly because of the different scale and scope of the two surveys. Therefore, while the classification was initiated in this model, the necessary

consolidation and simplification in certain user groups took place and other it was considered appropriate not to be included in the coding, because of their complete absence from the study area.

The completion of these procedures allowed querying the database and the development of layers for the spatial performance of the informative data. These levels were saved in layer form in order to maintain the symbology in case of extending the application in the near future.

Listed below are some synthetic maps of the survey (Fig. 2, 3, 4, 5, 6, 7)

The distribution of land uses of ground floor space is shown on map X.2 (Fig.2).

The distribution of the prevalent use of the rest storeys of the buildings is illustrated on map X.3 (Fig.3).

For the cartographic display of spatial population density (map X.6, Fig. 4) 4 classes were used: 0 to 2000 inhabitants per hectare, 2001 to 4500, 4501 to 6500 and 6500 to 10000.

The map X.7 (Fig. 5) depicts the number of households per building, based on the number of door bells in the entrance of buildings.

The map X.8 (Fig. 6) shows the distribution of ground floor uses around the station zones. These zones are concentric circles with a radius of 100m and their center is the location of the upcoming metro station.

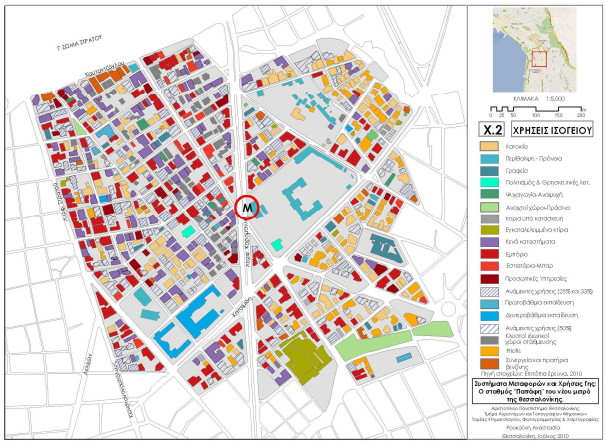

Fig. 2 Map X.2 Distribution of ground floor space

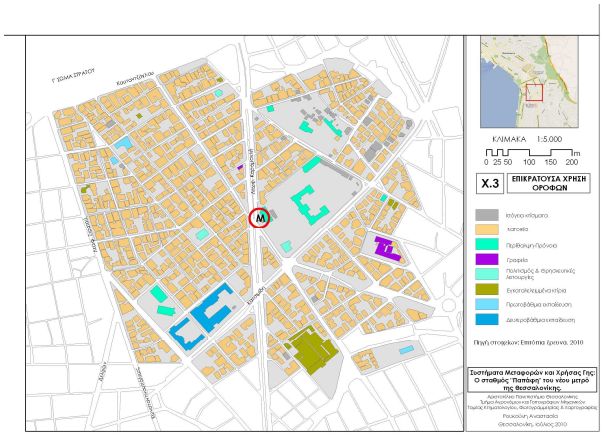

Fig. 3 Map X.3 Distribution of upper floor space

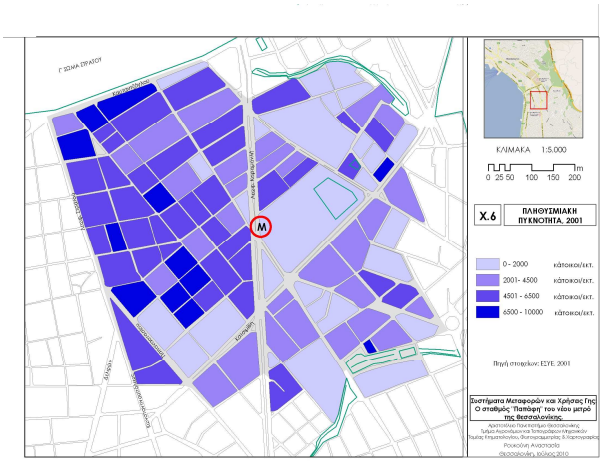

Fig. 4 Map X.6 Spatial population density

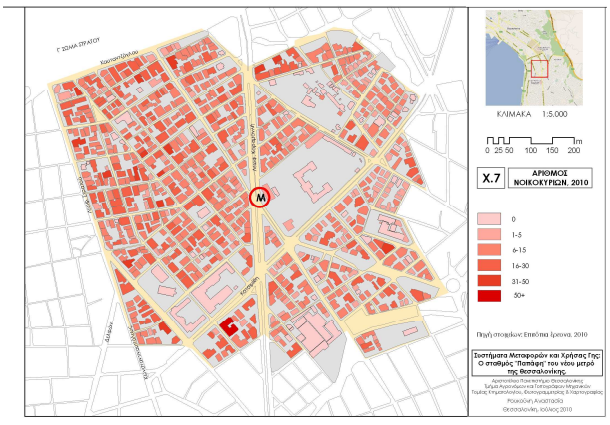

Fig. 5 Map X.7 Households per building

V. Conclusions

i. The Geographic Information System developed in this paper allowed immediate responses on both descriptive and spatial queries of the application.
ii. Furthermore, the spatial definition of survey data and the cartographic representation developed, highlighted the characteristics of the area and allowed researchers to gain in a short time a complete overview of the study area.
iii. Finally, the scope for comparative analysis and the enhancement of relationships among survey variables were very useful analytical tools for the researchers.

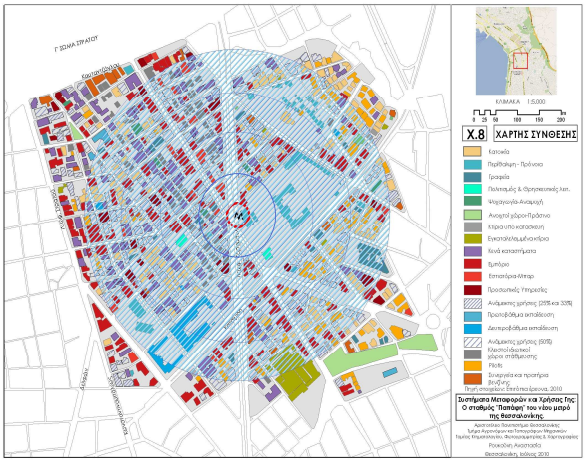

Fig. 6 Map X.8 Distribution of ground uses around the station zones

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