BUILDING A GEO-DATABASE FOR URBAN ROAD NETWORK ENVIRONMENTAL QUALITY

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Abstract
This research takes place in the city of Chania (GR) and its main target is to develop a Geodatabase model in order to evaluate the environmental quality of urban roads. The aim of this attempt was to define the Geodatabase rules and properties so that the Geodatabase can be user-friendly and meet the needs of the research. All the environmental indices that were registered to contribute in this modelling process were programmed in the ArcGIS system and all the data that were collected were input in the database. Important observations were made and conclusion were reached from the building process of this Geodatabase as the road network in a city is usually quite complicated.

Keywords: *geo-database, urban road network, environmental quality, environmental indices, database dictionary*

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1. INTRODUCTION

Modern societies might often feature a lack of basic infrastructures that would otherwise ensure their proper and harmonious function, thus failing to provide with warranty for development. This inevitably leads to the planning and implementation of interventions which would make up for any shortcomings and allow for the unhindered development of a society supported by its infrastructures. There might also be cases in which the quality level of the existing infrastructures is low (thus failing to meet the requirements posed by a modern society) or their organization is such that they fail to cover the citizens' needs.

The road network is a basic infrastructure in an urban society. The web of urban streets will ensure the orderly daily function of the city and its long term development, providing its residents (permanent and visitors) with a feel of convenience during their transportation throughout the city' s expanse.

Apart from the convenience and quality of transportation within the urban road web, the environmental factor plays a major role in defining the image of the city as perceived by both residents and visitors. The environmental quality of the streets is of utmost importance for local communities, especially the urban ones, whose spatial transformation year after year is evident. The city landscape is intensely urbanized at an increased rate (building density, traffic conditions, atmospheric conditions, etc).this calls for immediate targeted action through planning and substantial intervention into those positions and parameters which play a critical role in solving the subsequent problems and in achieving sustainable development.

There is therefore the need for a system that includes all the necessary data which would describe the condition of the environmental parameter of infrastructure. It should also include the tools needed in order to update and enrich the data, to carry out processing and analysis, and to achieve supervisory findings about those positions and sectors which call for immediate intervention.

Such a system could not be any other than a geodatabase in a Geographical Information System. This combination provides the user with the capacity to collect, to register, to process, to recover, to update and exit data in several forms (texts, tables, maps, graphs), while at the same time guarantees the efficiency, speed, and quality of the procedure. The geodatabase, being the core of the data, ought to be well designed and updated in order to objectively describe the research area. An appropriate awareness of the environmental parameters prevailing in urban streets allows for their spatial analysis and modeling and eventually for making appropriate decisions on subsequent interventions.

The present study describes the designing and creation of a geodatabase of the environmental parameters of urban streets. Its application on a selected part of the city of Chania was carried out in order to determine its efficacy and usefulness as well as the difficulties encountered upon its creation. It would also be possible to locate ensuing errors that need to be dealt with, which could possibly lead to redesigning the base. It is conducted in the context of a basic research project in the Department of Environmental Engineering of the Technical University of Crete.

2. GEODATABASES

2.1. Geodatabases in General

A Geodatabase is the main and most important part of the GIS as it is the data store of the system's geographic data. Geodatabases are usually organized into broad categories of data such as land base, transportation, environment, and utility infrastructure. There is no partitioning of a geographic area into tiled units. Rather, geodatabases use effective spatial indexing for continuous representation of an extent. Personal geodatabases can represent small- to medium-sized datasets.

Very large datasets can be efficiently handled with an enterprise Spatial Data Management System implementation (such as Arc Spatial Data Engine, Oracle, Informix, etc.).

2.2. Creation of a Geodatabase

2.2.1. Structure of a Geodatabase

The design framework of a geodatabase is defined by four designing stages: a)definiing the geodatabase b)conceptual design of the geodatabase c)logical design of the geodatabase d)physical design of the geodatabase

The first stage is usually the most time consuming and defines the aim of the undertaking, the actions which will serve the system, the data included in the database, the data sources and the environment in which the system will function. Furthermore, all details on which the following stages will be based upon are adjusted.

On the second stage of the conceptual design, the theoretical structure of the database is defined, as perceived by the users, and its functional framework is specified. The objective aim of this phase is the creation of a database which will be functional and effective as far as its organization and the quality of its data is concerned.

On the third phase of the logical design, having already defined the entities, their features and their inter-relations on the second phase of conceptual design, the content of the database and its logical organization are designed (one or a combination of the basic structures: hierarchical, network based, relational, object/content oriented.)

The relational and the object oriented structures are more commonly used. The relational structure has certain advantages, such as flexibility. It responds to all questions that are formulated by using Boole algebra rules, mathematic orders, etc.

It allows for the search and combination of different kinds of data, as well as the comparison between them. It is also possible to add or abstract any data, which practically means adding on or abstracting from charts. It also allows for the formulation of questions concerning different relational charts, through the use of common fields. Relational systems are open, flexible and easy to use, but are often characterized by large data volume, superfluous and redundant data and prolonged searches. They are suitable for recovering entities according to their features or for the creation of new characteristics and of their values based on existing data.

Content oriented systems allow for the insert of correlations and interdependencies into the system as well as for functionality and standardization which would result in using more complex programming tools and techniques thus having increased demands in computational power. They are useful when the entities share common characteristics or interact in certain and specific ways.

Finally, during the phase of the physical design, the logical design takes place in the specific environment of the selected application. It is on this stage where every detail is decided upon so that every datum inserted into the database can be recorded in the corresponding field in a way that it reflects the nature of this datum. This also the phase of programming – in the application environment - the charts that will include the data collected for the Geo database.

The access to a database with relational structure aiming at selectively recovering a part of the geodatabase, is gained through a number of relational operators which carry out orders in the environment of the Structured Query Language (SQL). The SQL is based on the assumption that the data are classified in charts, while the recovery of data takes place using relational algebra.

2.2.2. The Potential and Characteristics of a Geodatabase

Geodatabases possess a significant potential for the management of spatial data, their safety and for a friendly search. A Geodatabase enables its user to save, recover and select data based on one or more characteristics and relations, but also separates the saving and recovery of data from their use in application programs, ensuring independence between these processes. It also offers an interface between the database and the application programs which are based on the logical description of the data. It renders the functions of data access in application and the data saving structure independent to prevent interaction in the contingency of change in the means and mediums of saving.

It allows for concurrent access to the database by multiple users while it standardizes the process of data access through homogeneity. It protects the database from illicit actions or meaningless alterations and provides strict rules which are automatically applied, governing the cohesion and consistency of the data. These rules are an excellent means of eradicating errors, omissions and inconsistencies of the database.

Some of their basic characteristics which provide with the aforementioned capacities are Consistency, Integrity, Version Control, Security, processes of Roll Back and Recovery, Independence, Distributed Base, Concurrency.

In order to achieve the principles of a Geodatabase creation, certain phases of progress ought to be attained:

- Define the method of data collection, needed for the Geo database.
- Define the kind, the structure and the quality of the data of interest.
- Design and creation of the database.
- Introduction into the Geo database of the collected data.

2.2.3. Data Processing – Database Construction

At first the necessary data were defined as well as the form they ought to have in order to be inserted into the base. Then a list was created, based on previous experience and on related bibliography, which includes all the indices that would define the environmental quality of urban roads (as defined into the categories and subcategories in our research). Usually, the available information material, does not present homogeneity, rather it differs from data source to data source (depending on the level of organization and the infrastructure existence at each data source). These differences are seen on the year the data were collected, their scale, and the level of confidence of this data collection.

The data were fully defined as far as the following features are concerned: precision, year of collection, type (spatial, non- spatial, point, line, polygon etc), the categories and sub categories they belong in this research, their possible source, possibility of substitution in case they are non-existent, necessity, priority in the investigation, their scale, etc.

The form of the data included in a geographic database may vary, depending on the subsequent role of the system [10]. In the first phase of this research the system enables to create, update and preserve the data in a database and in a later phase it can play the role of spatial, time and comparative analysis, which is the main aim of a database. The data input are spatial and in the form of points (e.g. shooting locations), lines (e.g. road network), or even surfaces and polygons (building blocks). Non spatial data also coexist which bear no relevance to a particular location but are usually characteristic of spatial data (road surface condition, paving material, existence of posters, etc) of a section of the road network. The transversal axial distance between two intersections was defined as analysis unit.

By defining the source of origin of data and their priority in the research, we avoid purposeless search, while data collection becomes organized and efficient.

In times, the existing data are more precise and sufficient than required, but due to a lack of a source of origin, the research has to turn to substitute data or to deleting groups of data, as they are justified as non existent.

It is therefore considered essential to track down the sources with on site visit, be updated about the issue and analyze the required data. On some occasions public offices may not possess the required data, but may be aware of their origin. A first approach to the public offices (data sources), could actually record statistical material and render it available. This would facilitate the collection of data and the research in general. It would also finalize the list of the data which are yet collected, their sources, the necessary procedures for their collection and the time in which they are available.

The collection of data, which as mentioned above is hindered in Greece due to difficulties in providing information, is one of the most time consuming and costly parts of the research. Public offices are informed of the aim of the research, of the data collected and decide which ones exist, which ones could be found and which ones can be provided.

A member of the research team is required at the public office during the collection of data to provide explanation concerning the form of input data, possible encoding of them, any shortcomings and the controlling of their credibility.

During this procedure it is not uncommon to find out that the data are incomprehensible, incomplete, or are not the ones required. Such problems are dealt with more easily and efficiently during the collection phase rather than later [10].

Data processing is an equally important part of the research, as it is the intermediate level through which the primary collected data "feed" the consequent stages of analysis to achieving successful conclusions. This stage requires being attentive and thorough with the precision, the quality and the credibility of the collected data.

In the present research, the processing is divided into several consecutive phases which aim at producing a result after processing:

- Evaluation of the primary material and select what is appropriate.
- Its modification in order to be input in the database and the Geodatabase
- Data input
- Check the correctness of the data input procedure.
- Correct any mistakes and rectify possible omissions or deficiencies.
- Description and consolidation of the database through a DATA DICTIONARY.
- Check the functionality of the base and of its data in their new form, in subjects of analysis. (TESTS).

These phases are, as mentioned above, consecutive and the last one can lead back to even the original one.

It is evident that data can be found in many different forms, which have to be checked. Then, moving to the processing stage, there is a division of data according to their form. The data required in this research are found on maps, in charts, in graphs, histograms, in a passage or in a bibliography. They could also be on paper, in digital form, (DIGITAL DATA), on an interview recording tape as well as in every possible available form.

The material which is gathered should be "cleared up", the double data should be excluded, data copies should be made for safety reasons and then explained to the members of the research team who undertake the processing. The material is thus presented in a clear form and is suitable to be modified into a particular input format.

The next phase of the processing is the transformation of the material into a different format.

Following on, the input of data takes place as long as the database is programmed to accept these data (programming of the database).

On programming the database one has to pay close attention to present a data input screen (e.g. field names etc) which would explain thoroughly where each datum is input, in what order, as well as avert any possible input mistakes, thus minimizing the need to type (e.g. data encoding). Data input screens are pre-designed and basically define almost automatically the structure of data into the files. The next step would be to program the database according to the screens, so as to accept the primary material.

The input of data begins and should be carried out with care, method and consistency in order to avoid mistakes. It is unavoidable though for members of the research team who have no previous experience in inputting data to have questions, which are usually answered at that moment.

With the data input screens, the user of the database (data input inserter) does not have to have any knowledge of programming one. The database is used rather as a registration tool.

During the procedure of the data input or alternatively at the end of it, a check is carried out on the correctness of the procedure. This is a necessary step to take, as there is always the possibility of omission or distortion of data during its transferring. In this way we are able to locate any mistakes and correct or fill in for any omissions.

When the database is completed, it has to be checked for its functionality. Before actually using the base for analysis and as a deductive procedure, we have to ensure that it is functional and reliable as it constitutes a solid foundation for further research and Information Systems development. The functionality and reliability of the database can be tested with the application of a pilot project. Testing on this phase is essential so as to avoid hold-ups when we later analyze data and establish conclusive facts. As soon as the functionality of the base is established, it can be used for research and analysis of any phenomenon of interest.

3. URBAN ROAD NETWORK, ENVIRONMENTAL QUALITY AND INDICES

It is considered essential to design a Geo-Database in a GIS, where environmental quality indices are developed. This Geodatabase enables us to provide a specific and detailed description and analysis of the environmental parameters of the urban roads. Also it will become a convenient tool in combination with the GIS tools, in the hands of specialists and of the representatives of the state authorities, by facilitating their decision making on a number of issues concerning measures and interventions in the urban web. At the same time it will enable continuous observation and updating of the urban environment. Local communities which lack such a tool can attempt only occasional interventions which are difficult to evaluate as far as their effectiveness is concerned.

The factors and indices that are used to evaluate the environmental quality of the roads are selected and designed after research into related bibliography, on site visits and interviews with representatives of the local authorities. On the whole, 124 indices are selected, classified into twenty categories and generalized into eight groups, concerning the urban planning, the geometry of the roads, construction materials, road equipment as well as traffic, climatic, financial, and parameters that concern the use of land, pollution and hygiene (Table 1).

Table 1: Categories and Sub-categories of the Selected Parameters - Indices

A. URBAN PLANNING AND ARCHITECTURAL	1. Urban planning indices 2. Architectural indices 3. Road geometry
B. CONSTRUCTION MATERIALS	4. Road surface materials 5. Paving materials
C. ROAD EQUIPMENT	6. Street equipment 7. Street facilities
D. ROAD TRAFFIC	8. Static road traffic indices 9. Dynamic road traffic indices
E. LAND USES	10. Commercial uses 11. Services 12. Communal spaces 13. Other uses
F. POLLUTION	14. Air pollution indices 15. Noise pollution indices 16. Visual pollution indices
G. CLIMATIC	17. Climatic indices
H. OTHER	18. Economic indices 19. Hygiene indices 20. Other indices

4. THE GEODATABASE OF CHANIA TOWN

4.1. The Study Area

Fig. 1: Urban complex of Chania and Study Area (source: Google Earth)

The study area is decided to be in the town of Chania. The municipality of Chania is the largest in population in the Prefecture of Chania, with 53373 inhabitants, (records: year 2001) and has an expanse of 1250 hectares. Figures 1 depicts the urban complex of Chania. The municipality is divided into five urban units which diversify in terms of their building permit, building density, building system, height of buildings, their distance from the city centre and the different uses of land. There are further diversifications as to the morphology of the ground, and the geometrical, functional, financial and traffic characteristics of the roads. In order to record the parameters which contribute to the environmental quality of roads, especially those of the urban complex of the municipality of Chania, a part of the city of approximately 50 hectares is selected, including parts from sections I, II, III, IV. Of these, some are part of the city centre (sec.I, II), others border the city centre (sec.III), while sec.IV represents a more remote part of the city.

The task of conducting research on the entire municipality of Chania was not feasible given the budget and time limits of this particular research project. It was additionally recommendable to conduct a pilot scheme, to make observations, to reach certain conclusions and based on them, to re-organize the investigation and improve it where it is necessary, and if feasible, to re-conduct the investigation on a larger part of the city, or throughout the city as well.

4.2. Data Collection

A part of the conduct of data collection and measurement of the indices values for the selected area was enabled through public bodies, while it was based on already existing research and mainly on site recording. The Urban Planning Directorate of Chania provided a map of the town with all the urban units and elements. Data on the noise and parking patterns were obtained from the traffic planning department of the municipality. Data on the commercial value coefficient were derived from the Tax & Revenue Office of Chania.

Most of the indices were recorded by site recording. At the same time analytical photographical shootings were taken for every junction, facing all directions. Some of the indices were measured through the use of a designing program (such as the length and the area of building blocks). Measurements of some other indices though were practically impossible either because the access to some of the files of certain public offices was impaired (i.e unknown date of building construction) or because there is a lack of relevant research, which leads us to insufficient data (i.e analytical traffic loads).

From the group of 124 indices that were designed, 8 of them were obtained from public offices, 3 of them were calculated through a designing program and 25 of them did not get a value as no sufficient data was found, while the rest of them were recorded during on site measurements. Files have been kept on the means and dates of data collection.

4.3. Designing and Creating the Geodatabase

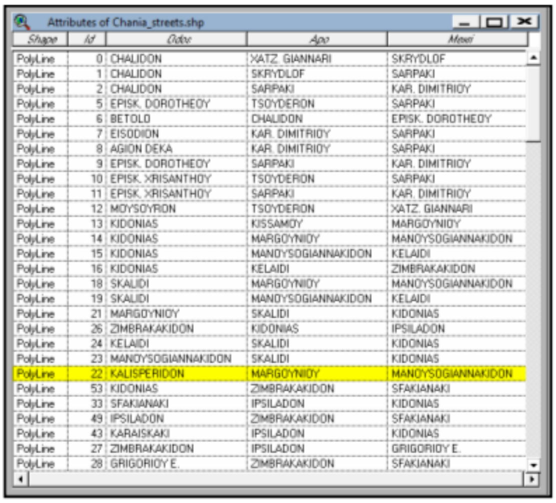
As it has already been mentioned, the database plays a major role in a GIS while it directly affects its cost. A database is the foundation of the use of a GIS enabling its user to do programming, develop an application, analyze and derive secondary data, which will in turn help in decision making.

4.3.1. Structuring the Spatial Section of the Geodatabase

The use of a Geographic Information System contains by definition at least one spatial information layer which depicts the research area while it is directly connected to the descriptive (non spatial) data of the geodatabase. In this research, three spatial information layers are used:

- A Topographic map of the research area (which results from field measurements in combination with an existing background map of a large scale).
- A map of Chania city (a section within the administrative boundaries of the Chania Municipality) of a scale 1:2.000
- Axes and major intersections of the road network of the research area

The topographic diagram which is being used resulted from a combination of on site measurements and of a mapping background of large scale, which only covers the research area and depicts the building and street lines. As a reference system, the national GGRS87 was used.


Attributes of Chania_streets.shp

Shape	Id	Odos	Apo	Mexri
PolyLine	0	CHALIDON	XATZ. GIANNARI	SKRYDLOF
PolyLine	1	CHALIDON	SKRYDLOF	SARPAKI
PolyLine	2	CHALIDON	SARPAKI	KAR. DIMITRIOY
PolyLine	5	EPISK. DOROTHEOY	TSOYDERON	SARPAKI
PolyLine	6	BETOLO	CHALIDON	EPISK. DOROTHEOY
PolyLine	7	EISODION	KAR. DIMITRIOY	SARPAKI
PolyLine	8	AGION DEKA	KAR. DIMITRIOY	SARPAKI
PolyLine	9	EPISK. DOROTHEOY	SARPAKI	KAR. DIMITRIOY
PolyLine	10	EPISK. XRISANTHOY	TSOYDERON	SARPAKI
PolyLine	11	EPISK. XRISANTHOY	SARPAKI	KAR. DIMITRIOY
PolyLine	12	MOYSOYRON	TSOYDERON	XATZ. GIANNARI
PolyLine	13	KIDONIAS	KISSAMOY	MARGOYNIOY
PolyLine	14	KIDONIAS	MARGOYNIOY	MANOYSOGIANNAKIDON
PolyLine	15	KIDONIAS	MANOYSOGIANNAKIDON	KELAIDI
PolyLine	16	KIDONIAS	KELAIDI	ZIMBRAKAKIDON
PolyLine	18	SKALIDI	MARGOYNIOY	MANOYSOGIANNAKIDON
PolyLine	19	SKALIDI	MANOYSOGIANNAKIDON	KELAIDI
PolyLine	21	MARGOYNIOY	SKALIDI	KIDONIAS
PolyLine	26	ZIMBRAKAKIDON	KIDONIAS	IPSILADON
PolyLine	24	KELAIDI	SKALIDI	KIDONIAS
PolyLine	23	MANOYSOGIANNAKIDON	SKALIDI	KIDONIAS
PolyLine	22	KALISPERIDON	MARGOYNIOY	MANOYSOGIANNAKIDON
PolyLine	53	KIDONIAS	ZIMBRAKAKIDON	SFAKIANAKI
PolyLine	33	SFAKIANAKI	IPSILADON	KIDONIAS
PolyLine	49	IPSILADON	ZIMBRAKAKIDON	SFAKIANAKI
PolyLine	43	KARAISKAKI	IPSILADON	KIDONIAS
PolyLine	27	ZIMBRAKAKIDON	IPSILADON	GRIGORIOY E.
PolyLine	28	GRIGORIOY E.	ZIMBRAKAKIDON	SFAKIANAKI

Fig. 2: Spatial Units of the Research (left)
Fig. 3: Non Spatial Data in a Geodatabase Table (right)

After examining the map of the city of Chania - of a 1:2000 scale – it was found that there have been alterations in relation to the present reality. These alterations were noted on the research area. This map has orientation purposes (orientation map), while the included details do not affect the research. The method of the georeferencing of the map was followed, using a GPS.

Using as a base the topographic diagram - which depicts street lines, among other - we were able to digitize the axis of the road network of the research area. The digitization was based on the method of dividing the road network into sections - units which include the axis between two main junctions. These sections of axes of the road network constitute the basic spatial unit of this research. The digitization was carried out thoroughly and in full compliance with the procedure rules to achieve the maximum precision (Fig. 2).

4.3.2. Structuring the Non-Spatial Section of the Database

The values of indices vary. Others are quantitative (i.e. building permit limit, height of buildings, area of building blocks, coverage percentage etc), while others are qualitative as for example telephone booth existence (yes or no), pavement surface condition (satisfactory – medium - poor) [10]. The indices that will be used and for which data have been collected for the current research, are classified into twenty (20) tables, which correspond with the 8 main categories of quality environmental indices that have already been mentioned.

The tables of the geodatabase are designed and programmed based on the collected data and the requirements of this research. A basic common characteristic of these tables is the existence of a field which records the codes of the axes sections of the road network in their digital form. The codes in this field constitute the primary key (KEY) which interconnects the tables while it also connects the tables and the thematic layers (spatial information) of the geodatabase [10].

When the tables are designed and programmed, they are then updated with the collected data. These data may be encoded before actually being inserted into the tables if need be, (according to the rules of data collection and the creation of a geodatabase.) After the tables are updated, they are then spatially checked (by connecting them with the spatial information layers of the geodatabase), so as to locate any input mistakes and correct them. Finally, the tables are ready to be used by the research team (Fig. 3).

4.4. Geodatabase Dictionary

A Geodatabase Dictionary fully and thoroughly describes the nature of all the data that have been input into the geodatabase, their form, the onomatology that is used during the programming of the geodatabase, or the possible values of a variable in the geodatabase. It is therefore a tool for any one outside the research team that wishes to use the geodatabase. In this dictionary one can find information such as, the category of indices under which every datum can be found (8 main categories of indices), the table (TABLE) of the geodatabase that has to be used in order to withdraw certain data, necessary data in order to update the database and for any possible intervention into it, confirmation of the validity, the reliability, the nature, the form and the connection between data that are input into the geodatabase (Fig. 4).

The Geodatabase Dictionary constitutes a tool in the hands of the database user and makes it feasible to explain the data structure in the indices that are included, as far as their content is concerned, the way the indices are stored in the base (e.g. integral number of N digits, decimal number of N overall digits and of ν decimal digits, data of N digits consisting of characters and numbers, etc). It is also inclusive of the database table (Table) and of the main index categories they belong to (which of the 8 main categories).

5. VARIOUS USES OF THE GEODATABASE

5.1. Development of the Geodatabase

The system as developed in this specific research (GIS), can be helpful to the urban and local administration offices (for example Municipalities and / or Prefectures of urban areas), by supporting them in decision making, in action planning and in taking measures.

The system has the capacity - by taking full advantage of its features – to process spatial and non spatial information, to illustrate the indices that record the environmental quality of the streets on a map layer, thus enabling the administration offices to observe and supervise within the boundaries of their administration at any given time. [10].

This stage comprises the processing of data which are in the form of primal material in the database and the creation of subsequent data in the form of indices in tables, on simple geographical maps and in thematic maps. This material then constitutes the foundation which supports decision making on matters concerning the development of the prefecture. The same material illustrates the picture of the environmental quality indices of the streets of a city as well as indicates which index category is in need of improvement. Causes and interdependent facts which create an overall negative and unattractive image of the urban environment can then be located.

Right at this point, the Geographic Information System plays its major role. The tools it provides for analysis, its direct linking to the base of non spatial data (Interactive) and the enormous load of information it can administrate at the same time, render it necessary to researchers in order to reach conclusions.

Its sections, which can combine spatial with non spatial data, its capacity to turn layers of information (Layers) into a system of interrelated parts creating new subsequent data with different methods of interference and interconnection in conjunction with methods of retracting information used by the database, make the system an integral part of such research. Its role also covers the diachronic monitoring of a phenomenon (Monitoring) and the update of the base with new data (Updating).

5.2. Usage of the Geodatabase

As soon as it is completed, the system enables one to:

- Directly map the spatial distribution of the indices of the geodatabase.
- Have a comparative inspection of the categories of the indices in the form of diagrams (histograms, pies, graphs etc), distributed in the area within the administrative boundaries that are being examined.
- To search for certain sections of the area which adhere to certain criteria, spatial or not.

- The product of the analysis can be apparent and understandable provided that different mediums / forms of results presentation are used, and should be supervisory, easily understandable and provide with the capacity to compare and contrast between the results. Maps are such mediums of results presentation.

GEODATABASE					
CATEGORY	URBAN PLANNING AND ARCHITECTURAL INDICES				
PATH DEFINITION OF DATA LEVEL IN THE GEODATABASE: /PINAKES/POLEODOMIKOI DEIKTES.dbf					
SUB-CATEGORY:			URBAN PLANNING INDICES		
SPATIAL DEFINITION TYPE OF SPATIAL DEFINITION			LINE		
TYPE OF DATA NAME OF DATA FILE			SPATIAL / SPATIAL UNIT (PART OF URBAN ROAD)		
DATA FILE TYPE					
FIELD DESCRIPTION					
NAME	FIELD TYPE	FIELD NAME ON SCREEN	VALUES	FIELD DESCRIPTION CODE DESCRIPTION	REMARKS
id	sh3	sh3	No	Serial No	Spatial Unit Unique Code
SYNT_DOM_A	f3.1	f3.1	Number		Building Permit Limit(L)
SYNT_DOM_D	f3.1	f3.1	Number		Building Permit Limit(R)
POSO_KAL_A	sh3	sh3	0-100	Percentage %	Plot Coverage Percentage(L)
POSO_KAL_D	sh3	sh3	0-100	Percentage %	Plot Coverage Percentage(R)
SYS_DOM_A	sh1	sh1	Code 1 2 3	Former Terraced Deviations Former Detached	Building System(L)
SYS_DOM_D	sh1	sh1	Code 1 2 3	Former Terraced Deviations Former Detached	Building System(R)
PROKIPIA_A	sh1	sh1	Code 1 2	Yes No	Entrance Gardens(L)
PROKIPIA_D	sh1	sh1	Code 1 2	Yes No	Entrance Gardens(R)

Fig. 4: A part of the GeoDatabase Dictionary

Figure 5: Map – Building Permit Limit on the Left of the Road (left)
Figure 6: Map – Commercial Uses and Index (middle)
Figure 7: Map – Percent Distribution of Commercial Uses and Services (right)

One of the targets of this research is, as previously mentioned, to provide with a scientific framework which enables one to record the existing level of the environmental quality of the streets in an area of the Municipality of Chania, to locate, which parts seem to differentiate in relation to the rest and define the volume of intervention that has to take place in order to remove this differentiation in the level of environmental quality.

The simplest way presenting results through a map is to depict indices as they are recorded and stored in the database (Fig. 5). This form of mapping presentation enables researchers to observe the indices they are interested in and form a view on their spatial distribution. Observing this distribution leads to identifying the homogenous zones that are created and the spatial differentiations that appear.

Maps are another form of depiction as they enable us to contrast comparable indices. The comparison is feasible and through it one can identify the existing similarities and differences, through the charting of index groups in the form of histograms or pie- charts (Figures 6, 7).It is worth noting that the indices that are to be included into a group to be mapped must be comparable among them. For example, one can choose to chart the index group concerning the commercial activity, some of them being the index of retail and wholesale transfers, of department stores, etc.
In the event of indices being charted in the form of histograms then the comparison is full (indices directly comparable between them), while in the form of pie-charts the comparison is relative and on a per cent basis.

The third way of depicting analysis products on a result map, is the creation of maps of multiple criteria search (spatial or not). This type of charting reflects the logic of GIS since a search is conducted either on the spatial database or on the descriptive (non spatial) one [10]. The search for parts of the research area which meet certain criteria (simple or complex) , helps the researchers to locate any occurrences –or lack of them- or even foresee any eventualities. The criteria could be so complex that it would be practically impossible to process without the use of a GIS.

5.3. Contribution of the Database to Decision Making

The maps (geographic and thematic ones) and the comparison indices that are created in a forward and dynamic manner by the GIS are not an aim in itself in this research system. The geodatabase has to constitute a policy tool in decision making, as predefined in this research. In order for such a tool to be complete, it has to be accompanied by a framework of criteria which will lead and direct the researcher objectively in decision making.

These criteria will function both as a model and as a restriction for the user of the geodatabase and will lead him / her to reach the right conclusions in his decision making for the political improvement and ceaseless development of the urban network. The environmental quality of the streets is an important parameter for the standard of living of the residents, especially in big cities.

It should be noted that in order to achieve correct planning and fill in any omissions and improve areas of low environmental street quality, one should follow the model given:

- What is there in every area
- What should there be in every area
- What is missing from every area

The difference between “what there is” and “what there should be” reveals any shortages (or surplus).

This research can assist in all three phases of this model by providing the information for the descriptive stage, the tools for analysis, the several forms of analysis that can be applied on the “what should there be” stage as well as some form of locating omissions / shortcomings and priorities in the “what is missing” stage.

6. REMARKS – COMMENTS - SUGGESTIONS

The aim of this research was to design and develop a geodatabase which would include all the elements relevant to the quality of the urban roads, so that the local administration bodies are facilitated in handling the urban environment and in their decision making. This database was designed and could serve as a pilot study for the local administration offices. The 124 indices cover the whole spectrum of the environmental factors. The potential for processing and analyzing is endless; charting, classification of areas according to their homogeneity, environmental evaluation based on multiple criteria, and the diachronic updating and observing of the urban environment.

One of the problems encountered was that for some of the indices no data was obtained. This is a problem that occurs frequently throughout Greece and is owed to the fact that every municipality have conducted their own projects, which means that the conclusive data is quite diverse. This particular database though, includes fields for those indices that haven’t been recorded so far, so that when more data becomes available, the base can be updated.

Another obstacle was that in some cases the available data were in relation to the city as a whole (i.e climatic indices, temperature, rainfall, etc). The variations throughout the city though, are unknown, which is why it is recommended that new research should be conducted, based on recording every individual street.

Yet another problem is the specialization of the people who take part in on site recordings of data. Certain indices - such as colour variety, harmonious mixture of colours- should ideally be carried out by an architect. In such cases, the research team should consist of researchers from all related sciences.

References:
[1] Zivas, D. The public space of the city. Its formation, function and educative mission. *The aesthetics of cities and the policy of intervention – contribution to the regeneration of the urban space*, Unification of the Archaeological Sites of Athens S.A., Athens 13-14 October 2003 (in Greek).
[2] Aisopos, G. The Greek public space. *The aesthetics of cities and the policy of intervention – contribution to the regeneration of the urban space*, Unification of the Archaeological Sites of Athens S.A., Athens 13-14 October 2003 (in Greek).
[3] Vlastos, Th., Siolas, A. The contribution of transport networks to the strategy for articulating and reuniting urban entities in view of restructuring the city. The case of western Athens, *Technika Chronika,* vol. 14, no. I, 1994 (in Greek).
[4] Nikolopoulou, M. Planning of open urban areas with bio-climatic criteria, RUROS KAPE 2004 (in Greek).
[5] Yannas, S., *Bio-climatic principles of urban planning*. Chapter 4, "Environmental design of cities and open areas", Environmental technology, Hellenic Open University (HOU), Patras, 2001 (in Greek).
[6] Aravantinos, A. *Urban Planning*, Symmetria, Athens, 1997 (in Greek).
[7] Beckman E.P., *Principles and methods for planning open areas and means for improving the micro-climate of structured environments*. Chapter 3, "Bio-climatic design of buildings and the environment. Restoration problems on the small scale of the urban space. *Bio-climatic design of open areas,* HOU, Patras, 2001 (in Greek).
[10] Masters G.M. *Introducing Environmental Engineering & Science,* Prentice Hall International Editions, 1991.
[18] Gehl Ian, *Public spaces and public life,* Adelaide , 2002.
[X] Koutsopoulos K., Geographic Information Systems and Spatial Analysis, Papasotiriou Publications, Athens, 2002.
[X] Tsouchlaraki, G. Achilleos, Z. Nasioula, A. Nikolidakis, "Designing and creating a database for the environmental quality of urban roads, using GIS", *7th WSEAS International Conference on ENVIRONMENT, ECOSYSTEMS and DEVELOPMENT (EED'09)*, Puerto De La Cruz, Tenerife, Canary Islands, Spain, December 14-16, 2009.
[X] Arctur D., Zeiler M., Designing Geodatabases, Case Studies in GIS Data Modeling, ESRI Press, Redlands – California, 2004.
Burrough P.A., Principles of Geographic Information Systems for Land Assessment, Oxford University Press, New York, 1986.
[X] Demers M., Fundamentals of Geographic Information Systems (second edition), John Wiley & Sons Inc., USA, 2000.
[X] Longley P. A., Goodchild Michael F, Maguire DJ, Rhind D., Geographical Information Systems and Sciences (second edition), John Wiley & Sons Inc., New York, 2005.
[X] Longley P. A., Batty M., Advanced Spatial Analysis, The CASA Book of GIS, ESRI Press, Redlands – California, 2003.
[X] Mitchel A., The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns & Relationships, ESRI Press, Redlands – California, 1999.
[X] Zeiler M., Modeling Our World. The ESRI Guide to GeoDatabase Design, Environmental Systems Research Institute Inc., Redlands California, 1999.

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