

Management of an Urban Development Map: Design and Development of a GIS Interface to Solve Technical Problems

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Key words: Urban Development Map, GIS, database, CDM, user interface, note of information

SUMMARY

In order to prepare a good aesthetics of a city and ensure a better framework to inhabitants' life, it is necessary to make a good planning of the urban space. In Morocco, the management of this space is based on the Urban Development Map (UDM). This UDM is composed of different kind of data, so that its exploitation raises several technical management problems.

Knowing the data of a UDM, the present article tries to develop solutions to these technical problems using GIS technology. First, a Conceptual Data Model of the components of the UDM is designed using the Entity Relation model. Then, data are prepared and a prototype database is established. Finally, a GIS user interface is developed using VBA language within the ARCGIS 8.1 environment.

The developed user interface proposes solutions to the following functions:

- Acquisition of spatial and descriptive data as well
- Data updating, processing and analyzing
- Spatial and non spatial requests formulated on the UDM concerning: the position of a title, requests of opposition, disposition of a note of information, favorable and unfavorable opposition, and projects of allotments
- Classification of data based on specific criterion
- Searching spatial information concerning the UDM areas touched by flooding.
- Displaying and printing thematic maps, with layouts, related to road network, public equipment, and population.

The developed interface was tested using data from the Urban Agency of Settat and seems to meet most professional users' needs.

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1. INTRODUCTION

In Morocco, the Urban Agency (UA) is in charge of designing and establishing the Urban Development Map (UDM). The management and planning of the urban space of a city is based principally on this document. The UDM is composed of different kind of data, so that its exploitation raises several technical management problems.

Knowing the data of a UDM, the present article tries to develop solutions to these technical problems using GIS technology. First, a methodology of data preparation is elaborated, then, a Conceptual Data Model of the components of the UDM is designed using the Entity Relation model. Subsequently, a prototype database is established. Finally, a GIS user interface is developed using VBA language within the ARCGIS 8.1 environment.

2. DOCUMENTS OF THE URBAN AGENCY

The urban agency manages several types of urban documents: the sketch of planning and urbanism, the zoning map, and the Urban Development Map (UDM).

The sketch of planning and urbanism is a fundamental reference document of urbanism for a territory; it is established based on global economical, commercial and social studies (Basri, 1993). The zoning map is another type of document of urbanism that specifies the distribution and the affectation of land for a territory. The sketch of planning is the authorized urbanism document that defines the right of land use. It is established on the basis of the zoning map and considers the orientations of the sketch of planning and urbanism.

The note of information is a certificate delivered by the Urban Agency on the demand of the owner of a property. This piece encloses most information on the use reserved to his property in accordance with the documents of urbanism. It indicates the public or private facilities to be respected in accordance with the dispositions of the documents mentioned above. The note of information is delivered to the petitioner accompanied by the set of rules to be respected, and an extract of the UDM showing the position of the petitioner's property

Up to know the establishment of this note is done manually, what raises several technical problems because of the multiplicity of documents to be consulted. In this article, we try to solve these problems via GIS user interface.

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3. DATA PREPARATION METHODOLOGY

The necessary data for the realization of this survey are composed of spatial data and attributes data. Attributes data constitute the whole descriptive information related to the geographical space. Spatial data are constituted of a set of drawings layers (files in dwg format). These dwg files present some insufficiencies: graphical data are not well distributed on the layers, for example, one type of urban detail can be found on several layers. Because of this, it is necessary to adopt a methodology for restructuring the urban data contained in these files before their integration into the GIS interface.

In addition, spatial data hold several kinds of digitizing errors, some polygons are not closed, certain label points are doubled, there are some dangling nodes and pseudo nodes, some labels are missing,...etc. In order to prepare these data, we have to make the following corrections (ESRI, 2001):

- construct the topology,
- identify errors,
- fix the errors,
- reconstruct topology.

Figure 1 summarizes the methodology adopted for the preparation of the data prior to their integration into a unique database.

4. DESIGN OF A PROTOTYPE DATABASE

Designing a database consists in describing data and their associations, independently of the physical aspects. First, a Conceptual Data Model (CDM) is established to represent data without taking into account economical aspects. Our database is designed using the Entity Association formalism (Flory, 1987). The CDM represents data as entities, which are associated using well defined relations; each relation is defined by the number of cardinalities. Then, the CDM is transformed to a Physical Data Model respecting the rules of passage (Bisson, 1997).

To establish the CDM of the Database we make an inventory of entities and their attributes. This CDM contains 12 entities, 11 associations, each association is defined by the number of cardinalities as shown in figure 2. The following entities and their attributes are defined in the CDM: Province, Township, Property, Note of Information, Boundary-marks, Allotment, UDM, Habitat zone, Industrial zone, Leisure & Green Spaces, Roads Network, Public Equipments.

Once the CDM is established, the Physical model is obtained using the Power AMC software, and the tables of attributes are generated. Then the user GIS interface is designed to solve technical problems met by the Urban Agency of Settat.

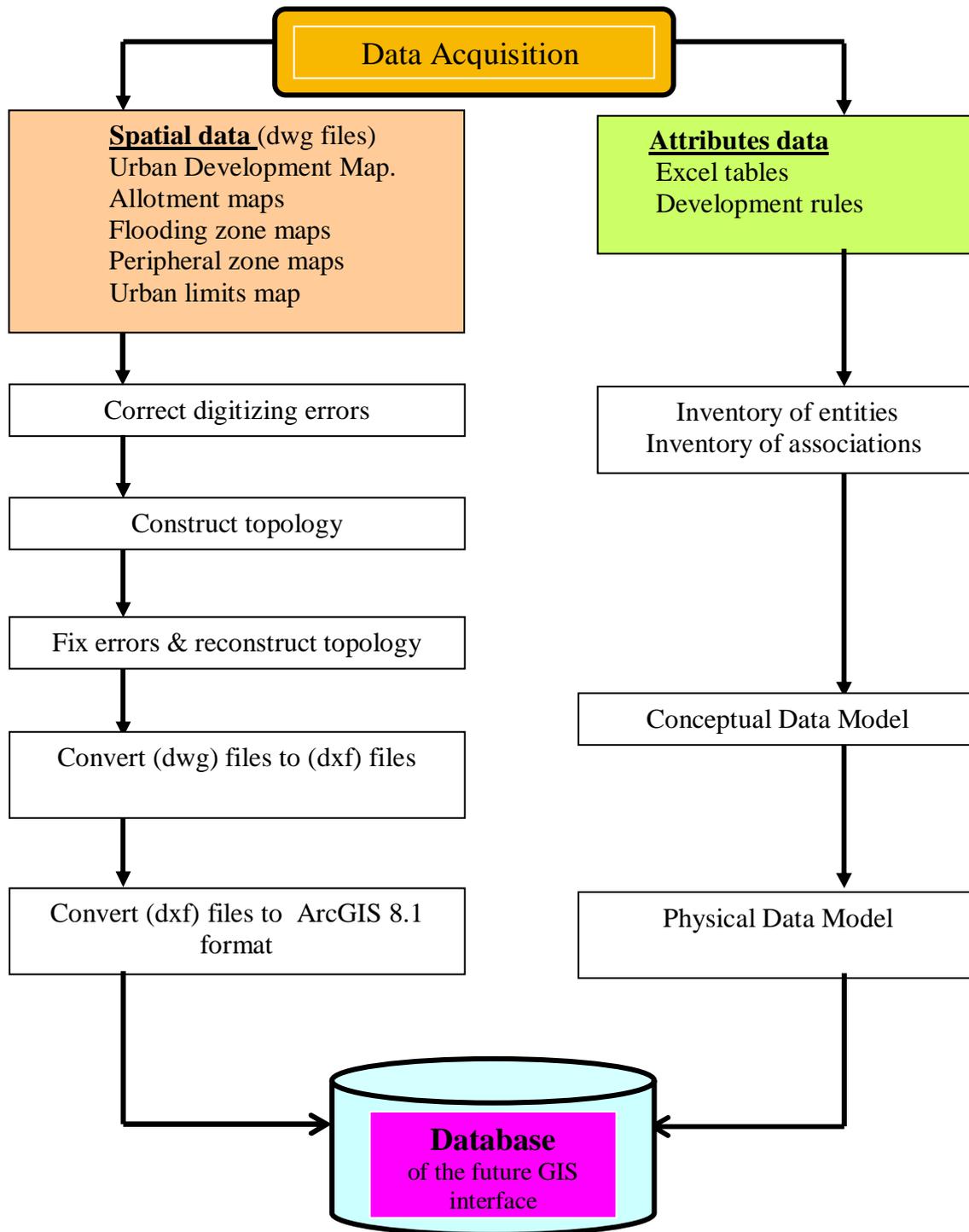


Figure 1.Methodology used to prepare data (modified from Ait Lakhraz & Hamel, 2004)

5. MAIN FUNCTIONALITIES OF THE USER GIS INTERFACE

The main functionalities offered by this user GIS interface are:

- Acquisition of spatial and non spatial data as well
- Data updating, processing and analyzing
- Spatial and non spatial queries formulated on the UDM concerning: the position of a title, requests of opposition, disposition of a note of information, favorable and unfavorable opposition, and projects of allotments
- Classification of data based on specific criterion
- Searching spatial information concerning the UDM areas touched by flooding,.
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6. BRIEF DESCRIPTION OF THE COMPONENTS OF THE USER INTERFACE

This application permits the automation of the Note of Information and the execution of some queries via an interface developed within the ArcView 8.1 environment and Visual Basic programming language.

The user interface is composed of the following menus :

- Spatial data.
- Tables
- Note of Information.
- Update
- Query.
- Thematic maps.
- Graphs
- Printing
- Help

The Menu Spatial data is conceived to load necessary layers to a project, it is constituted of two sub-menus : Load and Unload.

The Menu Tables proposes several choices: Visualize, Add a Field, Suppress a Field, update and Export files to Excel. The sub-menu Add Permits to add a field to the table of attributes of the selected layer.

The menu Update permits to modify or suppress a registration in the table of attributes.

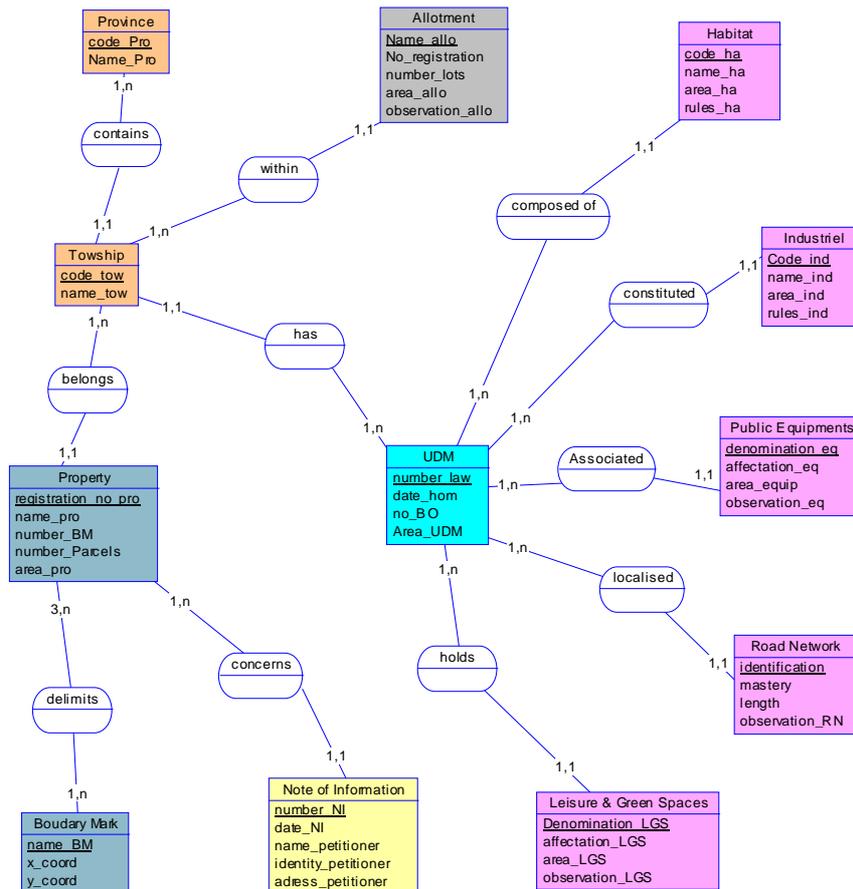


Figure 2. The Entity Association CDM of the database

The Menu Note of Information is an important menu of this application. It is conceived to allow the superposition of the UDM to the property object of the Note of Information, and the automatic extraction of the descriptive and geographic data as well as the rules applied to the property.

This menu is constituted of two choices, the first choice called New NR permits the user the acquisition of data related to the demand of the Note of Information (number of the demand, attributes of the property, number of parcels,...etc), and to the petitioner (name, Identity card Number, address,...).

The second choice called Create Report, permits to draw the property using its coordinates; the property is then displayed within the UDM. Therefore, the user can determine the land use of the property object of the Note of Information. Finally, the area of the property is calculated and compared to that existing on the certificate of property.

The Menu Update is constituted of three menus: Add Polygon, Add Line and Draw. The Add Polygon sub-menu offers the possibility to add a plot or a flooding zone while introducing the corresponding coordinates.

The Menu Query is conceived to allow the user to accomplish different types of queries, such as by Intersection, by Localization, by Attributes, and Buffer.

Through The menu Thematic maps, the user can either visualize some thematic maps according to their importance in the urban management space, or produce other types of maps using the menu Classification.

The Menu Graph is designed to allow the user to create some graphs from attributes data tables and visualize preset graphs.

The Menu Print permits the user to select the data to be printed, indicating the following parameters: layout, legend, north, title, and the scale.

7. RESULTS

The user interface was tested using sample data from the Urban Agency of Settat. The provided data concern the city of Berrechid located at about 30 Km south of Casablanca city. Spatial data are constituted of the following dwg files:

- The UDM of Berrechid
- Authorized allotment maps
 - Map of the city of Berrechid
 - Thematic flooding zone maps
 - Peripheral zone maps
 - Urban limits of the region

The following figures show some results obtained using the developed GIS interface; they give an idea on the usefulness of this interface in the management of urban data.

Figure 3 shows the result of searching the areas of the UDM touched by flooding.

Figure 4 illustrates the result of printing a thematic map representing the collective equipments of Berrechid.

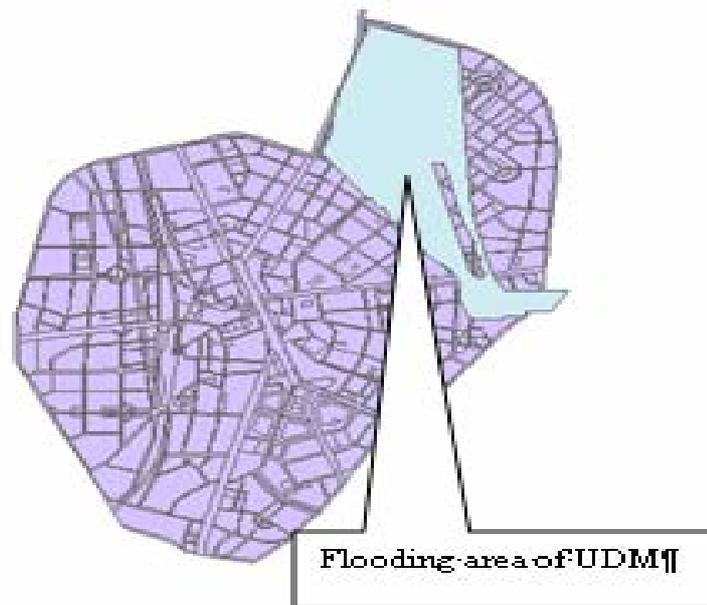


Figure 3. The UDM zones touched by flooding (Ait Lakhraz & Hamel, 2004)

8. CONCLUSION

Through this paper we have developed a GIS solution to some pertinent technical problems anticipated by the Urban Agency of Settat. They concern the management and planning of the urban space while exploiting different urban documents. We have proposed a methodology to integrate different kind of urban data into a unique database. A CDM is established taking into account all urban data managed by the Urban Agency. Finally we have developed a GIS interface that meets most professional users' requirements. This interface was tested with a sample data of the city of Berrechid, the obtained results are very satisfying.

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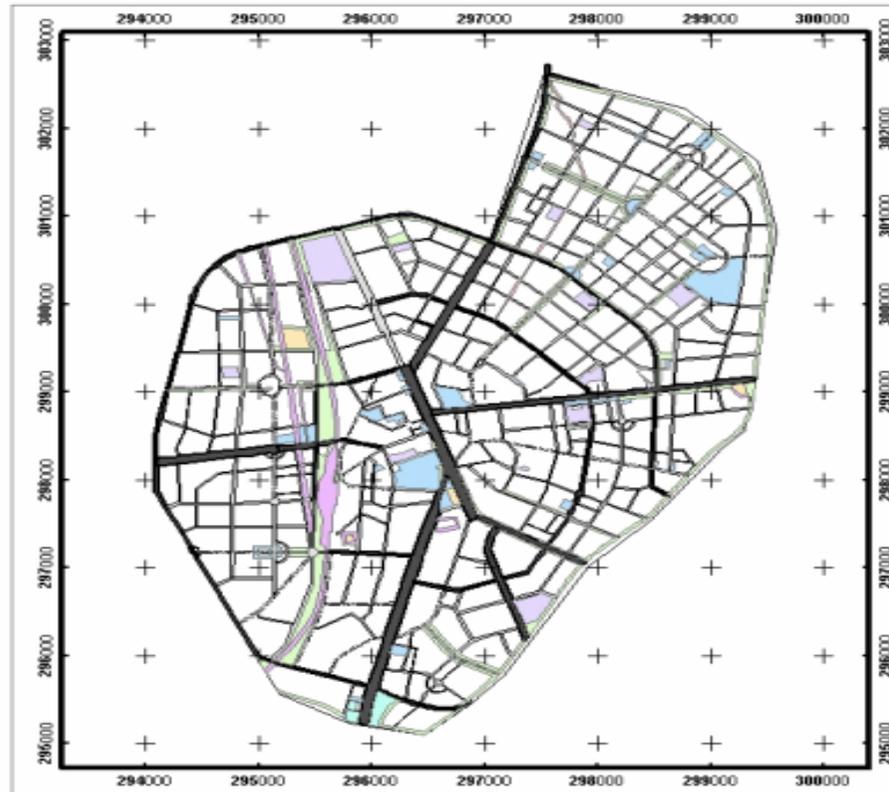


Figure 4. Thematic map of the collective equipments of Berrechid (Ait Lakhraz & Hamel, 2004)

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