# A DESCRIPTIVE MODEL FOR DEVELOPING A HYDRAULIC GEODATABASE BY USING THE GIS SOFTWARE

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## ABSTRACT

*The aim of this study is developing a Geodatabase of water resources in the northern region of Morocco by using the combination of different Geographic Information System software. The approach for the realization of this project is based on the data processing by ArcView 3.2 for the delimitation of areas and to characterize the different factors, obtained data are stored in a predetermined location to facilitate the progress of the process by building a database independent. The final result is the creation of shapefiles (shp) that should be used in ArcGIS 9.2 for the design of a georeferenced database and the development of thematic maps in (ArcMap) interface.*

## KEYWORDS

*GIS, Hydraulic Geodatabse, Modelling, Software.*

## 1. INTRODUCTION

The region of northern Morocco is characterized by its double opening on the Atlantic Ocean and the Mediterranean Sea and the predominance of the relief of the Rif chain, which penetrates to the Tangier Peninsula. We can find that the distribution of water resources is consists of four major hydrological units [1].[2]:

- The area south Loukkos which covers an area 4990 km$^2$ and includes the catchments of oued Loukkos.
- The district of Tangier with an area of 2155 km$^2$ which includes the atlantic watershed of oued Hachef, M'harhar, Kharroub Ayacha and wadis of the peninsula until region Rmel Tangier.
- Region west of Mediterranean with an area of 3330 km$^2$ which includes the coastal area of Wadi El Had to Fnideq and is mainly drained by wadis Smir Martil, Amsa, Lau and El had.
- The Eastern Mediterranean region, beyond the oued El Had with an area of 3580 km$^2$, which includes small watersheds Mediterranean coastal wadis Amter, Ouringa, Mesatasa, Boufrah, Badesi and Bousicour and extends to the river slopes and wadis Rhissa Neckor near Al Hoceima.

With this wide diversity of water resources, there is a need to find an effective way for organize all the information collected and manipulate data in a way that facilitates access and use based on the computerized solutions [3].

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This study aims to elaborate a methodology of developing a database based on the geographical information system (GIS) and accurately there are three software which are: ArcGIS 9.2 ArcView 3.2. and ERDAS.

The followed approach for the realization of this project is done the following steps:

1- Data processing by using ArcView 3.2, especially for the demarcation of the zones. All the obtained data is stored in a predetermined location to facilitate the conduct of each step whose goal is to constructing a database independent.

2- The result is the creation of shapefiles (shp) that should manipulated by ArcGIS 9.2 for designing a Geodatabase.

3- Finally, the preparation of thematic maps in (ArcMap) interface whose purpose is visualizing the data processed.

## 2. MATERIALS AND METHODS

### 2.1. Advantages of GIS

A geographic information system (GIS) is a computer system that allows managing, analyzing, combining, and presenting information geographically localized contributing notably to managing of space [4]. The result is superposing different layers of information to make an optimization choice for a given use (soils, topography, vegetation, water courses, etc.) and for a good natural management resource [5].

In other hand the (GIS) are a tools well suited to integrate the study of spatial complex problems such as water resources because of their ability to combine map information from various sources and their ability simulation [6].[7].

### 2.2. The software used

Generally ArcGIS 9.2 is a software package produced by ESRI (Environmental Systems Research Institute) is intended for the design and the deployment of its features that are coupled to a Geodatabase. This architecture provides tools for assembling a system of intelligent GIS. In our study we used the software ArcGIS 9.2., ArcView 3.2, and for some cases we used ERDAS for the image processing [8].[9].

ArcView 3.2 is a powerful tool, multifunctional, developed by ESRI Company. It is one of the most used tools in the implementation of (GIS) through a simple and easy interface to produce thematic maps and to study the problems currently threatening the environment.

The ERDAS software (Image Analysis for ArcGIS 9.2) is mainly used for images processing and the management of the natural resources. This extension (Image Analysis for ArcGIS 9.2) is useful in the fields of forestry, agriculture, environmental assessment, engineering of infrastructure projects such as the location of facilities and supervision of the corridor, [10]. The imagery of the earth's surface shall constitute an integral part of mapping and (GIS), which allows a quick update in the details of the land data, the result is the maintenance and update of geographical database [11].

During our work we have classified the difference (Table 1) between the (GIS) software used in this project; based on the variant of installed extensions, methodology of creating database files, and structure database type.

| proprieties / software | Proprieties used for protection perimeter | Extensions installed | File used | task according to order |
|---|---|---|---|---|
| ArcGIS 9.2 | GIS | ArcGIS Spatial Analyst | Shp | Spatial Analysis |
| | administration and geo-databases managing | | | Environmental Analysis |
| ArcView3.2 | Geo-referencing | Santi tools | Dxf | Spatial Analysis |
| | | Spatial analyst | | Environmental Analysis |
| | | Hydrology application | | |
| ERDAS imagine | image Treatment | Image Analysis for ArcGIS | Image file: Tiff, Raster | Environmental Analysis |
| | Tele-detection | | | |
| | Geo-treatment | | | |

TABLE 1. THE DIFFERENCE BETWEEN THE USED SOFTWARE

We have to know that the ArcGIS 9.2 consists of three main modules:

*File management (ArcCatalog):* offer an integrated all data files, GeoDatabase, and maps. It allows also documenting and managing Metadata.

*Map edition (ArcMap):* is the main ArcGIS application for all cartographic functions and update based on analysis.

*Geo-processing (ArcToolbox):* is the main module of geo-treatment infrastructure in ArcGIS, used for special analysis [12].

Each of these different software is based on common on the (DAO) and GIS files such as AutoCad form(DWG), Alphanumeric database files as tabular (DBF) files, image files form ERDAS, and (DXF) files [6].

## 2.3. Definition and generalities about the Database

In computing, a database (DB) is a lot of information stored in a computer device, taking into account the existing technologies used to organize and structure the database ,so we can easily manipulate the content [13] [14].

A management System Database (DBMS) is a set of programs that enables the management and access to a database. It generally hosts multiple databases, which are designed with various software by themes [15].[16].

Generally for distinction between (DBMS) and relational management System Database (RDBMS), the (DBMS) is characterized by description model which is supported by data described as a (DDL) model [15].[17].

Once the database is specified, we can insert data, retrieve, and modify it. Not only data can be manipulated by a specific language of data manipulation (DML), also by conventional programming languages [18].[19].

## 2.4.  Types of Geodatabases

There are three types of ESRI Geodatabase. We must choose the one that best suits the project design. There are:

*The file Geodatabase:* Dataset can "weigh" up to 1 To. This database can be encrypted and secured.

*The personal Geodatabase:* the data is stored in an Access database (MDB). The maximum size of this database is 250 to 500 MB.

*The ArcSDE Geodatabase:* the data is stored in external databases and much more cumbersome to manage but also more efficient as Oracle, DB2, SQL Server [20].[21].[22].

The Geodatabase can contain classes of entities (Feature Class), sets feature classes (Feature dataset), and classes of objects (Object class) also called tables and raster files. A (feature class) is a homogeneous set of entities that have the same geometry (point, polyline, polygon) and the same attributes. These attributes are stored in the table of the (feature class). The notion of class of entities is similar to the concept of file formats (Shapefile).

A table can be stored in a Geodatabase it is characterized by a set of fields and records. The tables of a Geodatabase can be linked or attached in same time to tables or feature classes [16].[23].

## 2.5. The types of data acquired

### 2.5.1. The Data ''raster''

A data where space is divided evenly into rows and columns, each row or column value is associated with one or more values describing the characteristics of space [24].

### 2.5.2. The data  ''vector''

For data "vector" the sources are indirect, map, photograph, satellite image, or either directly with surveys, we use the (GIS) for represent the objects types that are geometric point, line and surface [24].

| Data Type | Features |
|---|---|
| Point | The simplest object, it can represent large-scale trees, fire hydrants, garbage collectors, but at small scales. |
| Line | The line may represent : a sanitation network,  the axis of a road, etc. |
| The surface and the complex object | It can materialize by an abstract entity like the surface of a house or geographic entities having an existence as a forest, a lake, etc. |

TABLE 2. DIFFERENT TYPES OF DATA

## 2.6. Acquisition from data image

It is based on the scanned photo ortho-rectified to obtain the vector data which is leading source for accurate scanning of large areas. The accuracy of the data is related to the accuracy of the photo. Such acquisition requires the field surveys and crosses with other resources to verify the data. [25].

## 2.7. Acquisition from satellite imagery

The satellite imagery is the main source of information for land use through remote sensing, it is the major technique used to determine the physical and biological objects by measurements at a distance. Usually the satellite imagery obtained from the sensors embedded in observation satellite orbits, each picture shows solar radiation reflected from ground objects in the visible or near infra-red. It should be exposed to undergo several treatments radiometric and geometric before being used in a (GIS).

## 2.8. Acquisition from the alphanumeric data

The attributes or alphanumeric data or semantic character information helps to highlight the spatial distribution of an object, its spatial-temporal analysis also to characterize the phenomena present in considered territory.

## 2.9. Acquisition from the field data

Generally, it is used for small construction sites with coupling to other techniques, as the GPS (Globe positioning system) and the total station, based on a set of satellites.

## 2.10.  The archiving

The acquired data must be stored and easily retrieve them. It depends on the software architecture with the presence or absence of an integrated management system database; relational or oriented object.

## 2.11. The analysis

### 2.11.1. Spatial analysis from the semantics

The qualitative and quantitative description of a space is determined from alphanumeric data stored at the geometric object or an external database via a link. This analysis can be done by mapping calculation.

### 2.11.2. Spatial  analysis Geometric

This analysis is based on the position of the object, its shape, and relationships that might exist. The distance between objects is a simple functionality of spatial analysis. The obtained data can manipulate by a various operations.

## 3.  RESULTS AND DISCUSSION

To modelling a database can be summarized in two main phases, the first phase involves the modelling of typical data, while the second is based on modelling the logical / physical data.

## 3.1. The model developed: Data Type Model  (M.T.D)

In typical data modelling us chose the entity relationship model and model typical data (M.T.D) (Figure 1). The entities of database are defined by various types, such as the entities at spatial dimension and the spatial entities that are necessary to locate the map objects [6].
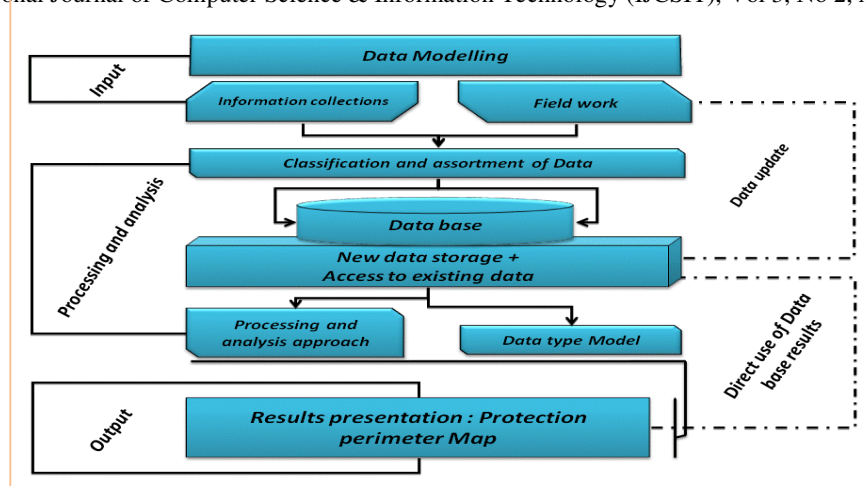
FIGURE 1. DATA TYPE MODEL (M.T D.) REPRESENTS THE LOGICAL OPERATION ARRAY REALIZED BY GIS

## 3.2. Modelling Logical / Physical

The aim is representing data according to the relational model that based on logical model; the physical model expresses the logical structure of the database that is a typical passage from the description to the physical implementation of the database. This model has been generated automatically from the Data Type Model (MTD), by making the necessary adjustments to suit the needs of our prototype (GIS).

## 3.3. Implementation of our Geodatabase

### 3.3.1. The first approach

#### 3.3.1.1. The creation of the Geodatabase

First we execute (ArcCatalog) to initiate the project whose goal is to creating the Geodatabase; we must check and select the host folder. At this level, there will be a new connection that is chosen with a specific extension (.gdb), it should be noticed (.gbd) for file Geodatabase and (.mdb) for the personal Geodatabase (Figure 2).
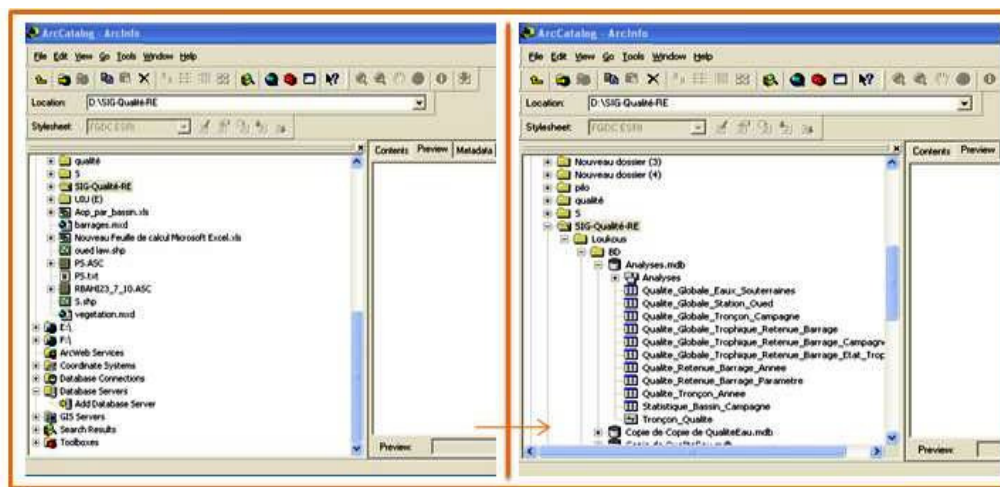


FIGURE 2. THE STEPS FOR CREATION A GEODATABASE

### 3.3.1.2. Importing Vector Data

After importing a shapefile in the created Geodatabase, it must be projected and displayed if we have not already done, and check the spatial reference by clicking the (Metadata). To define the spatial reference of shapefile we must use the (ArcCatalog) and (ArcToolbox). And to verify that the definition of the spatial reference was successful; we need to verify at the (Metadata), (Figure 3).
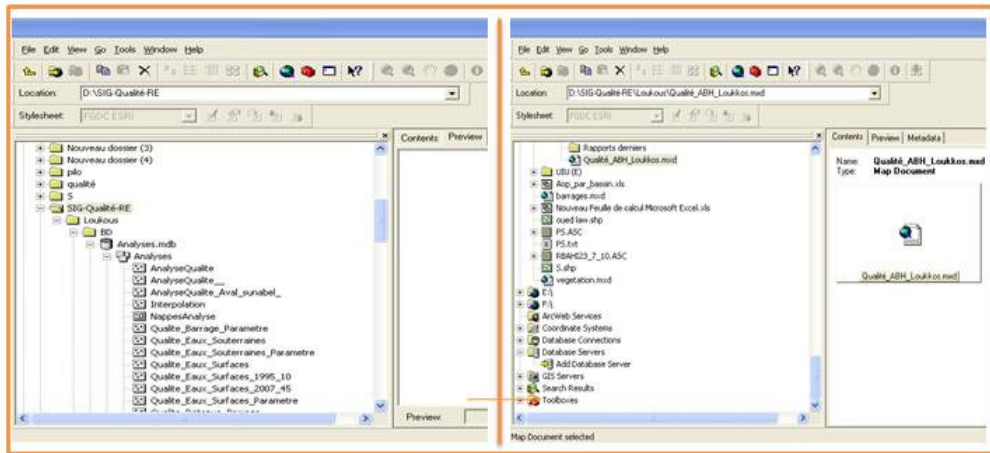


FIGURE 3. THE IMPORTING OF VECTOR DATA

### 3.3.1.3. Importing a raster

At the Geodatabase a GeoTIFF files will be exported by selecting the target file (Figure 4).
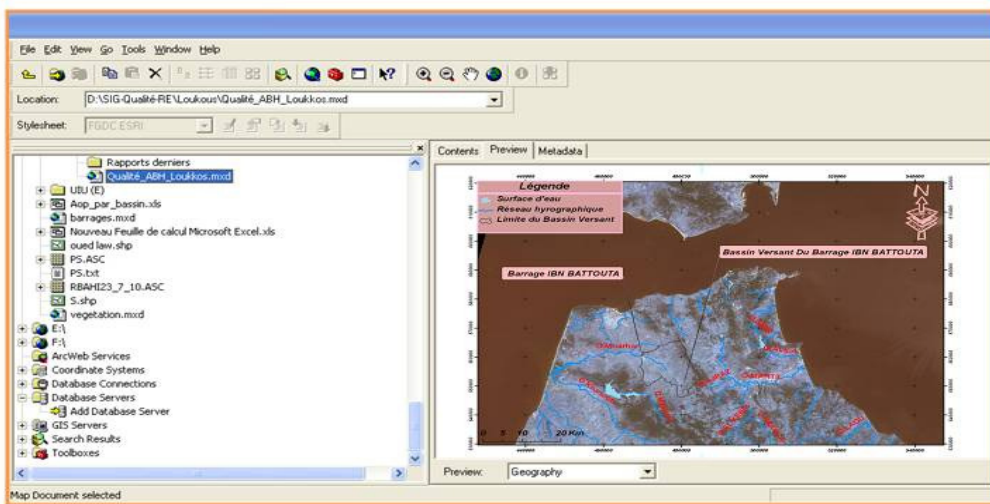


FIGURE 4. the IMPORTING a raster FROM GEODATABASE TO ARCMAP

### 3.3.1.4. Importing data from the Geodatabase in ArcMap

The displaying of thematic map that derived from the Geodatabse is performed at the (ArcMap) according to set procedures. It should be noted the advantage of the Geodatabase is the ability to import multiple data types simultaneously. The steps are as following:

At the ArcMap (F1), choosing « a new empty map ». Then click « ok » (F2, F3) en Second click « Add Data » (F4, F5) (Figure 5). Then moving the folder in the Geodatabase at this level by selecting our data. First we note that the ability to import multiple data types simultaneously. At the end clicking « Add » (F6, F7) at this level all data are now present in (ArcMap). It should be noted that to import a table by placing the tab «Source» table of contents does not change the display order of layers. To do this, we choosing the tab «Display» to display the table of contents for the layer that will be visible (F8) before saving our project by opening the table to view in (ArcMap ), (F9,F10), (Figure 6).
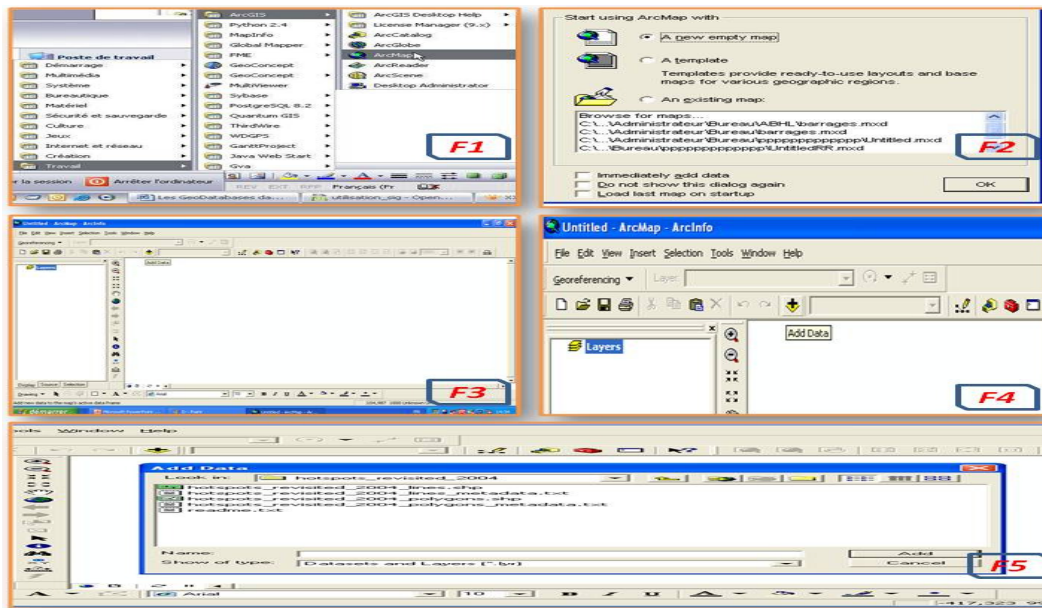


**FIGURE 5. THE FIRST STEP FOR IMPORTING THE DATA FROM THE GEODATABASE IN ARCMAP**
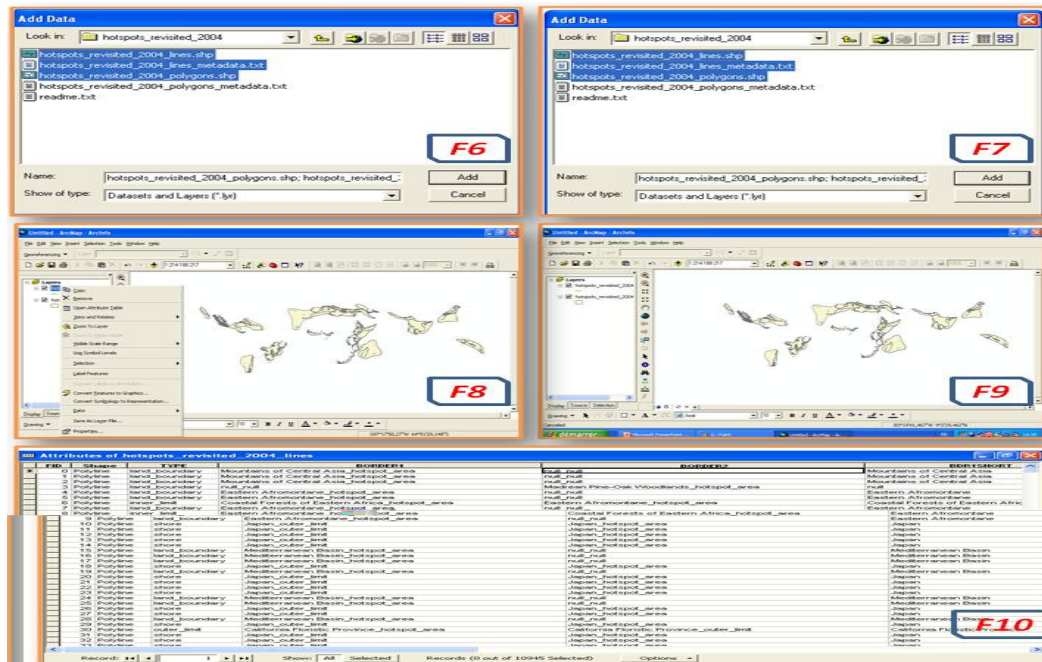


**FIGURE 6. THE SECOND STEP FOR IMPORTING THE DATA FROM THE GEODATABASE IN ARCMAP**

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### 3.3.2. The second approach for the construction of the independent Geodatabase

According to ESRI: "The users have the opportunity to develop their own custom extensions to ArcGIS Desktop that provides a suite of applications for working with (GIS) [8].[9].

The data of the delineation of protection zones are created by the ArcView 3.2. Each factor treated taking into account the attribute data which are stored in a predetermined location to save processing time and facilitate the operation on the steps that follow after. Also for a smooth and easy handling which aims to build a so-called "independent Geodatabase" [6].

The software of beginning is ArcView 3.2 for the creation of shapefiles to be operated by the ArcGIS 9.2 with the processed images on the ERDAS if necessary according to the case. These different operations take place simultaneously; the result is a range of files developed for each project (Table 3) at the "independent Geodatabase '' [6].

After completion of the project, we have some possibilities in terms of relational database offered by the ArcGIS 9.2 or there were two types of relationships between data, this is called ''the junction" that occurs from table to table by selecting or by topological relations.

| project \ file type | SBX | SBN | DBF | TFW | PRJ | JGW | AUX | RRD | AutoCad compile Form | AutoCad source Form | Document XML | APR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Delineation Project | X | X | X | | | | | | X | X | | |
| hydrographical Network Project | X | X | X | | X | | | | X | X | X | |
| geo-referencing images project | | | | X | | X | X | X | | | | |
| ArcView3.2 Project | X | X | X | | | | | | X | X | | X |

TABLE 3. THE FILE CLASSIFICATION '' INDEPENDENT GEODATABASE'' FOR EACH PROJECT

The other type is the "relationship", which can account for a more complex relationship between a target table and a table source or multiple records. The commands for creating or deleting join or linking tabular data are accessible at the table of contents, [22]. [26]. [27]. [28].

Regarding the junction, we find that it allows to add data to a layer or table to table or the selected layer. So two means to designate the joint, based on attributes of a class of relations of Geodatabase depending on the location, types of joints are:

- Joins attribute and relationship classes by creating a relationship of tubular junction.

- Tubular joints by topological relations by creating a join by location.

- linking tables by creating a link type relationship

## 4. CONCLUSIONS

The (GIS) is the ideal tool which allows collecting and exchanging spatial-temporal data. It is one of the tools that can achieve their full potential if we offer an adequate set of digital geographic information that can be analyzed, processed and finally displayed to clearly identified needs.

We find this work gives a clear idea about the construction methodology of a Geodatabase through the use of (GIS) software, which allows us to manipulate the various (shp) layers and themes of digitization of different factors to develop the various thematic maps that reflect all the data on the water at the north of Morocco (Figure7).
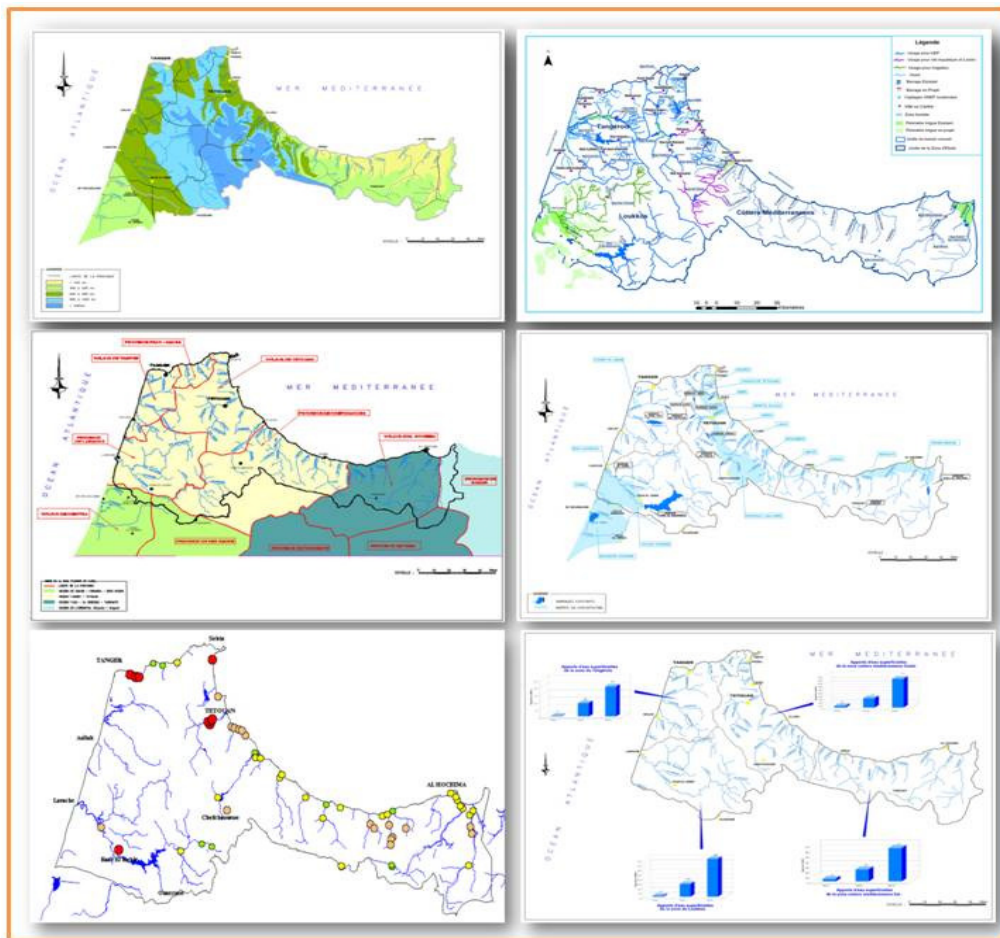


FIGURE 7. THE DIFFERENT MAPS DERIVED FROM PROCESSING DATA ORGANIZED IN THE INDEPENDENT GEODATABASE

Finally, this study providing a new view regarding the databases in the world of geographic information systems our approach is based on a comparison between the conventional model and our own model that is developed what is called a " independent Geodatabase " based on the same data source for this project. The result is reliable especially in technical and economic aspect.

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