A MODEL OF (P-GIS) FOR HYDRAULIC PROTECTION DAMS IN NORTHERN MOROCCO

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ABSTRACT

To strengthen the quality of information, inclusion and implementation of continuous link between different categories of actors by mobilizing P-GIS as tools for participation and methodological aid to decision-making, and help to better understanding of environmental issues and challenges related to climate change, allowing regional authorities to better analyze and process. So what we've seen, that the conventional GIS does not include certain information such as social exclusion, displacement, narrative conflicts of use of land and water, cultural stories, local politics. Hence the need to find an effective method to circumvent these problems.

So this study is based on a software solution that is supported on the geographic information system (GIS) coupled with the participatory model to give the (P-GIS). By manipulating various GIS software el descriptive data collected directly from the study area of the dam Ibn Battouta. A Data Type Model was generated to model the flow of data and related information. The delineation of protection zones will then contribute to the superposition, by adding each of the identified factors. The result of this study has created a multi-source spatial data management. This produces what is appalled the demonstration model GIS-remote sensing." It is based on certain factors that use parameters observed in the field and the information collected from censuses.

KEYWORDS:

Participative Geographical Information System (P - GIS); Perimeter of Protection Zone; Management of Water Resources and Planning; Morocco.

1. INTRODUCTION

This study addresses one of the many challenges of managing water resources are increasingly endangered by human activities. To find ways to achieve the objectives, production and environmental protection, it is essential to understand the complex interactions between humans and ecosystems by integrating various information such as the georeferenced data from different disciplines, information on cultural, social and economic. also make traditional knowledge and scientific knowledge of researchers and authorities.

The integration of all these data should be designed as learning experience for all stakeholders and provide a basis for planning, negotiation and decision fair. It is also necessary that information is communicated effectively to all stakeholders and the knowledge shared equitably in order to improve transparency and responsibility-taking

The Participatory GIS (P-GIS) [1],[2], allows to combine different types of scientific knowledge and traditional in one instrument of planning and negotiation and to give them a uniform appearance. This approach gives the same validity to all knowledge, and thus enhances the knowledge and skills of marginalized communities who are generally ignored in the planning process [3].

Currently in Morocco the trends of water resources are increasingly threatened by pollution which affects the water quality. This later is in continuous deterioration due to direct discharge of waste water into natural receptors without treatment [4]. It noted that the increasing potential of surface water contamination is driven by land use change related to the different urban, agricultural and industrial activities. To avoid further problems of water contamination and ensure supply of water quality, it is essential to better understand the vulnerability of water resource. To this end, it is necessary to take all measures to ensure the quality of water intended for drinking supply [5], [6].

So the realization of water resources protection zone is an important tool to achieve the fore-mentioned goal.

Generally, three zones were provided by force of law around each catchment, constrained more or less depending to the remoteness of the resource. The delineation of these protection areas is a major work. Firstly, the data collection and tracking of various parameters are time consuming; secondly, it is a multidisciplinary work involving various expertise [7], [8].

The management and protection of water resources are sustained in the planning schemes. Protecting these resources is a paramount responsibility of state services, which need to deliver water that meets health standards. On the other hand, the establishment of protection zones interferes with other facilities, and requires consultation between all actors and stakeholders since the start of the project. To protect water resources, a different kind are necessary. This information should be structured according to themes which implies: the compilation of existing information, the new data acquisition, integration and analysis of geoscientific data in a relational database, and interpretation of results based hydrological models to facilitate the management and protection of water resource [9], [10].

So this study is based on a software solution that is supported on the geographic information system (GIS) [11]. coupled with the participatory model to give the (P-GIS) which will be play in the context of this case study as a central methodological tool for research and also as an object of research. and will be used to establish the realities on the ground, visualize and understand the dynamics of diversity and complexity of the region Dam Ibn Battuta, and thus to make the right decision, after data processing by developing a model based GIS coupled to remote sensing by using concurrent software: ArcGIS 9.2, ArcView 3.2 and ERDAS using Extensions for ArcGIS. The result is the delineation of protection areas of water resources in an innovative and effective way for Ibn Battouta dam. Safeguarding water resources available in the dam leads us to delineate purveyors of pollution that require immediate action.

Therefore, this project anticipated to add a value with respect to the use of GIS that offer multiple opportunities for analysis and simulation, to develop important applications used to manage water resources, Spatial Planning, sustainable management [12], which nowadays constitute a very important study area. Whose goal is to create what is called participatory Geographic Information Systems (P-GIS) [13], [14].

In the other hand, in order to strengthen state capacity to help create an innovative computerized tool that will give significant results, and as a methodological tool to help decision makers and managers to ensure that Sustainable Development Action takes place in a continuous and

uniform manner [15], [16], Because GIS is increasingly explored to address the problems related to resource management, it is a major constraint to development.

2. MATERIAL AND METHODS

2.1. The study site and constrainst

2.1.1 Geographic situation of Dam

The dam of Ibn Battouta is fed mainly by Mharhar river and located about 18 km from the city of Tangier and immediately south of Jebel Zinâk. Its drainage basin upstream to an area of 178 km2 "Fig. 1", it highest rating part is 627 NGM in the Jbel Mekhâled, while the average altitude is about 130 m.

The waters regulated by the dam and released into the bed of the river are listed in the station Bougdour which supply directly to the city of Tangier and its region. The extra-supply in the rainy season is injected into the groundwater through cracks open protected from erosion and pollution.

The dam regulates 26 million m3 per year, of which 14 million m3 would be intended to supply drinking water to the city of Tangier and its region, and 12 million m3 for irrigation of agricultural area with a total area of 1930 hectares. But considering the evidence that the dam would hardly covers the needs of drinking water [5],[6].

The watershed of Ibn Battouta belong to three main provinces; Tanger-Asilah, Fahs-Anjra et Tétouan, which principal communes are; Jouamaa, Ain lahsen, Dar Chaoui, Ezzinate, Souk Kedim, Bni Herchen, Melloussa et Anjra.

The centre Jouamaa represents the largest community in the region; it is less than one kilometer from the reservoir. The latter is subject to different types of pollution: urban pollution (liquid and solid wastes) and agricultural pollution (fertilizers, leaching of soil, etc…) and industrial pollution (the Free Zone Melloussa: platform Renault-Nissan).

The identification of different sources of threat within the watershed boundary was based on field visits. It shows the current potential pollution sources that may increase over time. These include:

- Traffic on the main road between Tangier and Tétouan, passing very close to the reservoir to the east.

- Evacuation inappropriate garbage from the urban (sewage, solid waste, etc...).

- Intensification of agriculture and irrigation (farm and forestry, use of fertilizer, using pesticides, etc...), resulting in a nutrient supply to the reservoir by runoff and leaching of soil.

- Increased levels of phosphorus resulting from agricultural activities and industrial activities in the soil and then introduced into the reservoir through runoff causes the appearance of the phenomenon of eutrophication [17].
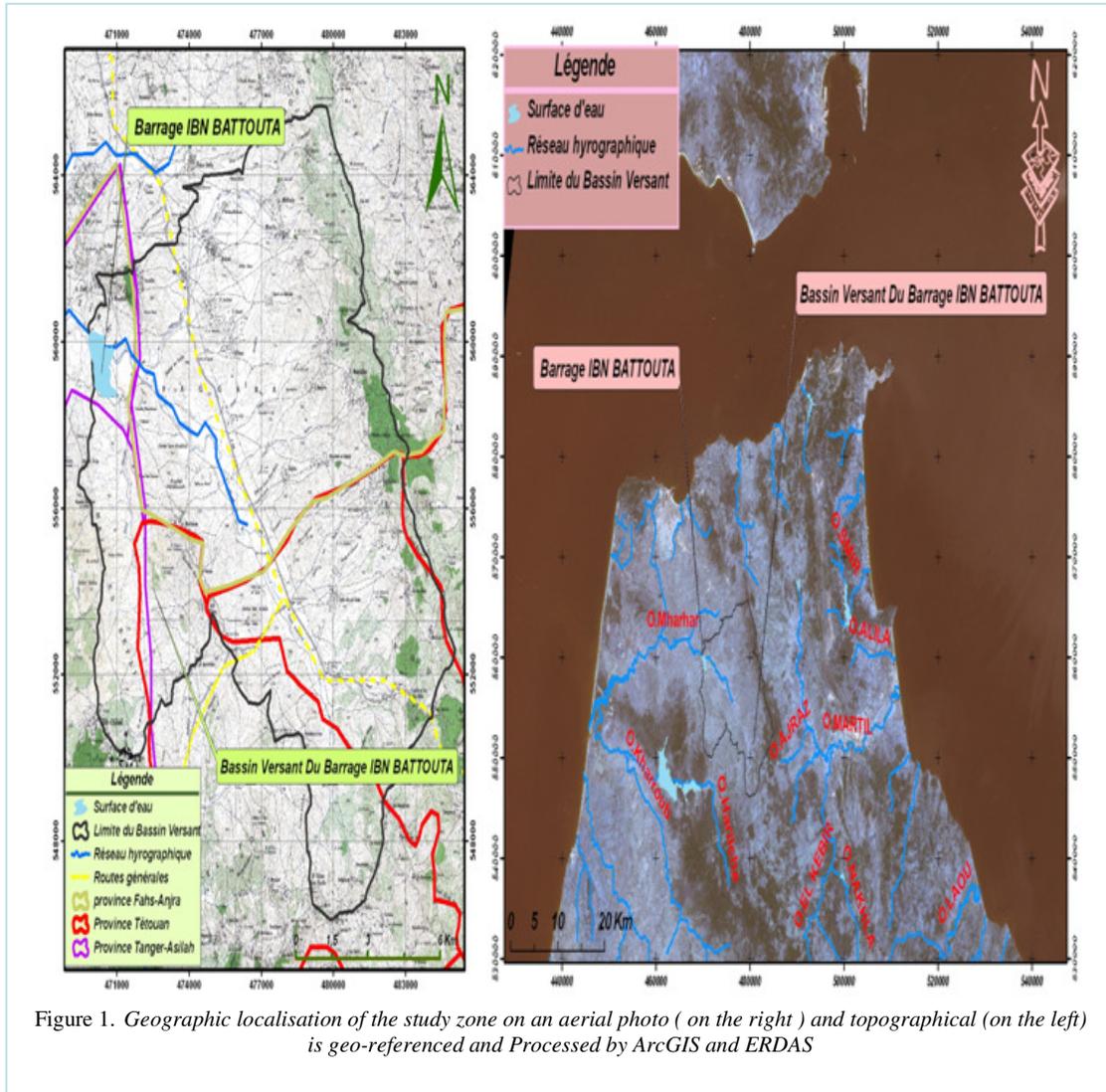
Figure 1. *Geographic localisation of the study zone on an aerial photo (on the right) and topographical (on the left) is geo-referenced and Processed by ArcGIS and ERDAS*

2.1.2. Climate:

The study area is located between Asilah and Tangier. It has a climate characterized (Fig. 2) by a subhumid with an annual average rainfall of 800 mm and an average temperature of +17°C. Water resources of the region consists mainly Mharhar River and Charf El Akab groundwater. This layer is also a reservoir which is supplied by both infiltration and its impluvium injection after treatment of surpluses collected in decision-Bougdour and Hachef.

The development of the city of Tangier, has led to a rapid increase in water demand, already notable simply because of its increasing population and improving living standards, prompting the government to achieve by 1977 the dam Ibn Battouta [5], [6].
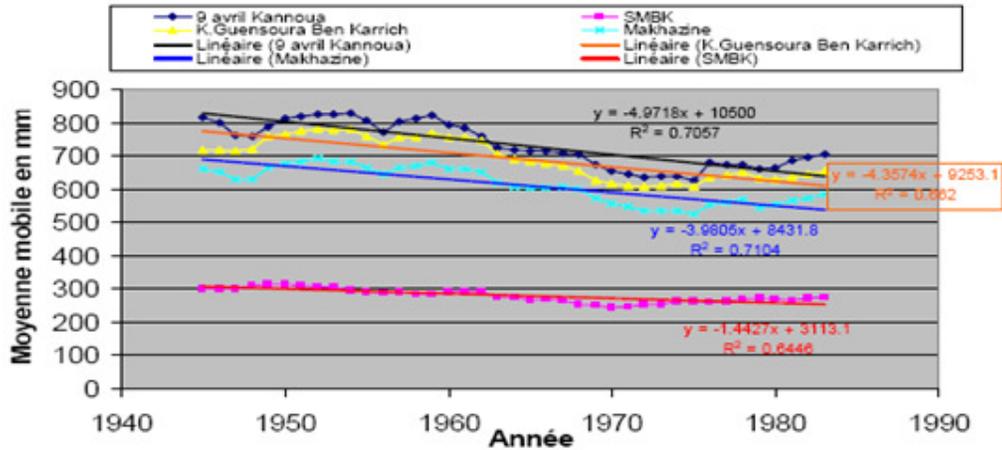
Figure 2. Annual average rainfall by different models

2.2. Concept of P-GIS

Participatory GIS are the GIS developed   in part by the public in order to encourage public participation in processes of local territorial management (data collection, mapping exercises, etc ...). The (P-GIS) is a discipline that appears, developed from participatory approaches to planning and management of geographic information and communication [3].

The (P-GIS) combines a range of management tools and methods of geospatial information such as satellite images, aerial photography, GPS, in order to represent local geographic knowledge [18].

It should differentiate Participatory GIS (P-GIS) of Public Participatory GIS (PPGIS), the former are more destined to local development and management of natural resources in the South. Unlike (PPGIS) projects that involve more planning and urbanism in the northern countries [19].

2.3. Objectives of the P-GIS

The main objective of participatory GIS techniques is to enable development practitioners, government officials and local people to work together to plan appropriate programs. This approach "Draws Heavily Developed concepts are" under the Broad development of GIS in terms of data access, data representation, and structural distortion KM and community empowerment as Being Legitimate and Significant Issues in the implementation of community development projects. This approach relies heavily on concepts developed in the context of overall development in terms of GIS data access, data representation, knowledge and the structural distortion and the empowerment of communities as legitimate and important questions in application of community development projects.

2.4. Concept of Protection Zone

The effect of pollution decreases gradually as fare as the water sources are situated on a safe guard distance or adequately protected from the resource of pollution. Therefore fighting against such pollution requires a splitting of the region that feeds the dam into three main zones in accordance to Moroccan law: the Immediate Protection Area (Zone-I), Close Protection Zone (Zone-II) and the Remote Protection Zone (Zone-III) [7], [20].

The dam protection zones aim to protect the immediate environs of the reservoir and its surrounding area, and to prohibit or regulate activities that might affect the quality of water collected.

In Zone-I, there must be protection against water pollution in the reservoir and prevent spills or leaks of pollutants occur within or near the catchment. The size of this area should enable it to intervene appropriately in case of accident, remove each human influence and implement a forest or vegetated area to its protective mission area must not exceeded 1 hectare [21], [22], [23].

In Zone-II, we should give priority to protection against pollution and other damage resulting from human activities and amenities, including proximity could endanger the watershed. To delineate this area some parameters have to be considered including; the duration and speed of water transfer between the emission points of pollution and possible detention; the binding and degradation of soil and subsoil regarding pollution and its size varies between 1 and 50 hectares [21], [22], [23].

Finally, Zone-III, possibly extending the previous one, should protect against extensive water damage, especially persistent or difficult pollution to clean such as chemical or radioactive pollutions. The establishment of this zone is conditioned by an insufficient application of general rules or by the existence of a potential risk that the ground type does not reduce safely, despite the distance from the point of sampling. For easy identification, the boundaries of this (as well as the area of close protection) will follow as much as possible the cadastral and its geographical range in size from 50 to 1000 hectares [21], [22], [23].

3. EXPERIMENTAL DESING

There are several methods for determining The Scope of Protection of Water Resources.The reference [24] found that as the method allows the integration of environmental factors and characteristics, it is more accurate. The main problem in establishing zones of protection is to choose a method that provides a realistic determination of these areas from a minimum of information and for a minimal cost for concrete construction [25].

The approach used in this pilot project for the delineation of protection areas is to combine the techniques of remote sensing image processing and the possibilities offered by the GIS to refine the analysis of satellite data to exploit the field data, also the development and structuring of a database are needed.

3.1 The followed approach

A Data Type Model (M.T.D) has been produced to simulate the data and corresponding information flows "Fig.3", along the following procedure:

3.1.1. Database project :

Database modeling could be resuming in two main phases: the first phase concerns typical data modeling meanwhile, the second is based on logical /physical data modeling.

3.1.2. Typical data modeling:

We chose the Entity-Relationship model to make a Data Type Model (M.T.D). The themes and entities database are defined by three classes of entities: Entities without a spatial dimension, spatial entities and cartographic objects necessary to locate them.

3.1.3. Logical /physical data modelling:

Is to make a representation of data according to the relational model which is the logical model. The physical model expresses the logical structure of the database and 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 (M.T.D), by making the necessary adjustments to suit the needs of our prototype GIS.

3.1.4. Database Conception:

The database of this project is performed by the following procedure:

The data of the delineation of protection zones are created by the ArcView 3.2, so each factor treated beside the attribute data 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".

The starting software is ArcView 3.2 for the creation of shape-files to be operated by the ArcGIS 9.2 with the processed images on the ERDAS imagine. These different operations take place simultaneously, the result is a range of files developed for each project (see Table 1) at the "independent GeoDatabase".

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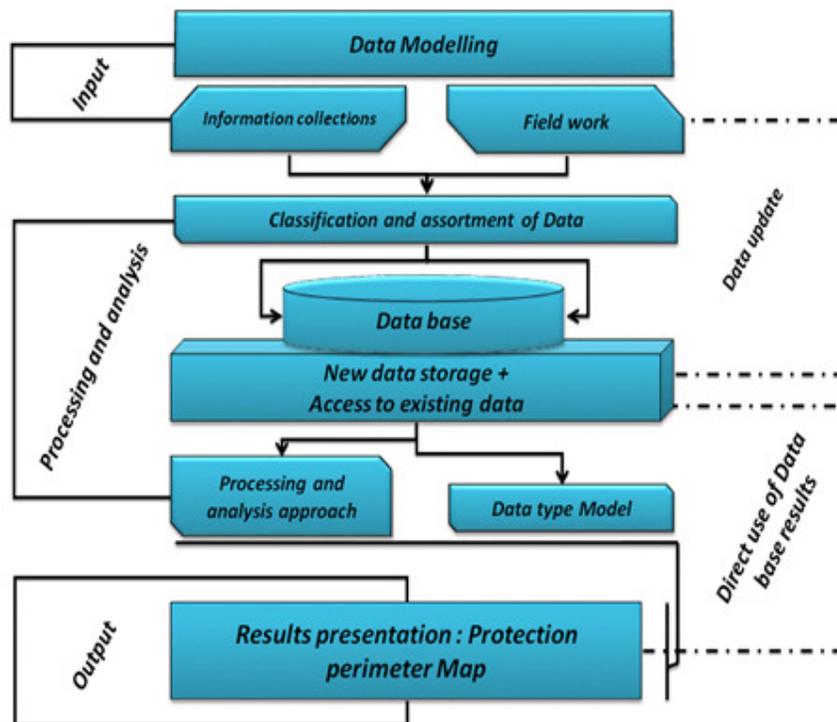

Figure 3. *Data Type Model (M.T D.)* represent the logical operation array realized by GIS

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.

Regarding the joint, we find that it's allows to add a data layer, table to table or the selected layer. So two means to designate the joint, based on attributes of a relationship class

GeoDatabase predefined, or depending on the location or 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.

The steps proposed in the framework of the analytical study and typically cover all points of making both in terms of working tools at the modeling level as well as the typical of corresponding data.

The results of this study led to the creation of a multi-source spatial data management system. This produces what is called "the demonstration model GIS-Remote Sensing" "Fig. 4". It is based on certain factors that use parameters observed in the field and the information collected from previous surveys and censuses conducted.

3.2 A technical note for used software

According to ESRI and others editors ''the users have the opportunity to develop their own custom extensions to ArcGIS Desktop that provides a suite of applications for working with GIS''. And because there is no proper application to manipulate the process to elaborate a protection area of water resources, thus the need to find a cheap, les complicated and reliable application.
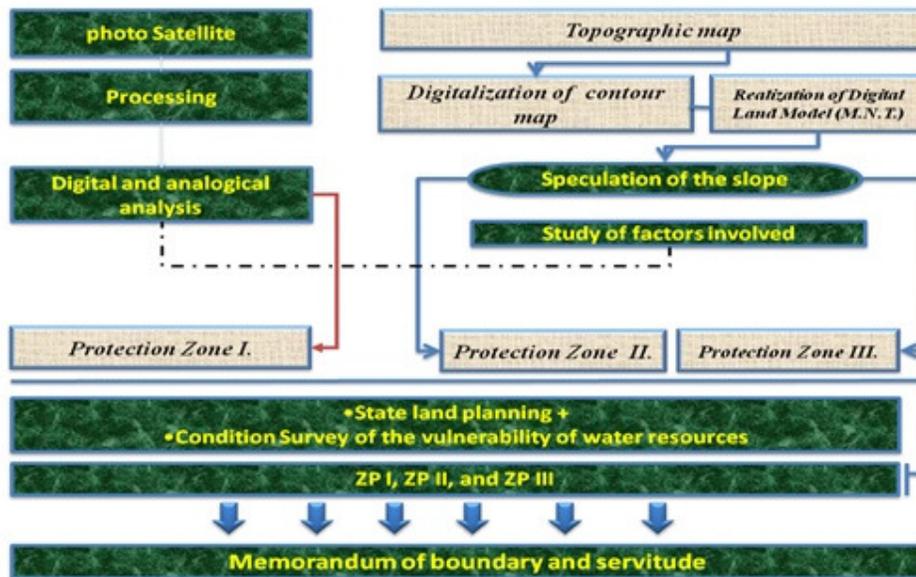

Figure 4. *Demostration model GIS-Remote Sensing to perform analysis and assessing critical zones (ZPI, ZPII, et ZP III).*

To this aim, it is necessary to translate the idea of coupling applications of the three GIS software. We base our choice on major differences (see Table 1); the installed variant extension, method to create basic files, and structure and type of database.

Therefore, various essays were run to find appropriate prototype which ensure the goal. To do so, we should know that ArcGIS is constructed with 3 main modules:

- File management (ArcCatalog): offer an integrated and unify view to all data files, GeoDatabase, maps, globes and services GIS. It allows also documenting and managing of Metadata.

- *Map edition (ArcMap):* it is the main ArcGIS application for all cartographic functions and update as well as "requites" and map based analysis.

- *Geo-processing (ArcToolbox):* it is the corner stone of geo-treatment infrastructure ArcGIS, used for function auto-running and special analysis.

ArcGIS is available at 3 functional levels (complementary optional module):

- *ArcView :* is a complete GIS tool dedicated for utilisation, cartography and data analysis.

- *ArcEditor :* allows the creation and advanced update of GeoDatabase .

- *Arc Info:* is a professional and complete GIS tool for office, it offers complete GIS functions and various geo-treatment tools. Each GIS site has to be equipped at least with one ArcInfo copy to have privilege to such extended functionalities [27].

ERDAS Image Analysis for ArcGIS is main tool to manage infrastructure of natural resources. This extension is useful for forestry, agriculture, environmental assessment, engineering, and infrastructure project such as corridor monitoring, land surface imagery is indeed a part of GIS and cartography, which allows updating easily land use change database as well as of geographic data [28].

Each of these different software handle in commune competitive DAO and GIS files such as; AutoCad form DWG, Alphanumeric database files as tabular DBF files, image form ERDAS files, and DXF files.

3.3 Selection of Factors and their Moderators

Since this study is conducted at a regional scale, only identifiable factors at this scale are selected. It is found that the parameters and factors required for delineation of protected areas have been the results of an operation of moderation. According to reference [29] and [30], we used a moderate scale to evaluate the importance of a criterion in function of another. Indeed, each of the selected factors is moderated by it importance in the process of protection areas delineation.

Project		SBX	SBN	DBF	TFW	PRJ	JGW	AUX	RRD	AutoCad compile Form	AutoCad source Form	Document XML	APR	Proprieties used for protection perimeter	Extensions installed	File used	task according to order
ArcGIS 9.2	Delineation Project	X	X	X						X	X			GIS	Santi tools / Spatial analyst	shp	Spatial Analysis / Environmental Analysis
	hydrographical Network Project	X	X	X		X				X	X	X		administration and GeoDatabase managing	Hydrology application	shp	Spatial Analysis
ERDAS	geo-referencing images project				X		X	X	X					image Treatment / Remote-sensing / Geo-treatment	Image Analysis for ArcGIS	Image file: TIFF, jpg.	Environmental Analysis
ArcView3.2	ArcView3.2 Project	X	X	X						X	X		X	Geo-referencing	Santi tools / Spatial analyst / Hydrology application	dxf	Environmental Analysis

TABLE I. **THE FILE CLASSIFICATION '' INDEPENDENT GEODATABASE'' FOR EACH PROJECT AND DIFFERENCE BETWEEN THE THREE SOFTWARE**

3.4 Use of GIS for linking and development of factors mapping:

For this step we processed the data obtained by use of ArcGIS 9.2 and ArcView 3.2, the first step involves geo-tagging maps of all kinds after the digitalization of various factors thematic necessary.

The approach is based on integration of comparable data which can link the risk factors while remaining closer to reality. The delineation of protection zones will then contribute to the superposition, by adding each of the selected factors.

It should be noted that operation of the of protection area around the reservoir is based on different data speeds up after a series of press releases and comments directly from the field study. We made some adjustments and taking into account the multi-criteria analysis each time a number of parameters such as "demonstration model GIS- Remote Sensing presented by Fig. 5 ". Handling system in place is provided by well-structured utilities offer the user all the options for managing GIS data entry until the publication of results by'' MTD'' Fig. 3 ", [31].

3.5 Manipulation of Remote Sensing Data

The completion of this step is based on the combination of certain information to multi-source data, obtained through analysis of satellite imagery "Fig. 5 and 6" allowing the effective exploitation of remote sensing data through a geographic database based coupled factors obtained by GIS.

So the satellite image must be geo-referenced by the projection of Lambert and calibrated according to the reference coordinate system of the area Merchich. These pre-treatments have geometric integration of satellite images in the GIS area and conduct the necessary analysis.

After the various treatments coupled with GIS based on applications of ArcGIS 9.2, ArcView 3.2 and ERDAS Extensions for ArcGIS, we obtain the map of land use, [31].

4. RESULTS AND DISCUSSION

The use of conventional GIS does not include certain information such as social exclusion, displacement, narrative conflicts of land use, cultural stories, and local politics.

It is found that (P-GIS) allows to make maps very detailed descriptive and could be trusted to know the region was studied in an effective and ideal way better than the satellite images or aerial photos we suggest, we defined, in agreement with the local people collecting different information to identify all factors involved such as local factors, social, institutional, political and cultural. [32].

Secondly the knowledge of the physical environment has led to the creation of a parameters database that characterizes the environment. And remote sensing imagery has revealed different classes of land uses "Fig. 5".

The interpretation of aerial photographs, topographic maps and field observations has established the reality on field compared to the results of image processing.

The organization adopted Geographic Information System includes a set of software (ArcGIS 9.2 and ArcView 3.2) to achieve the various tasks required for the delineation of protection zones. These tools enable retrieving data from different sources (topographic maps, satellite images, aerial photos...), the management of database operations simulation on the watershed, and publishing results [33].

The system has helped to integrate and process data at different scales. The accuracy of results is related to the scale of maps used and data collected from the field.

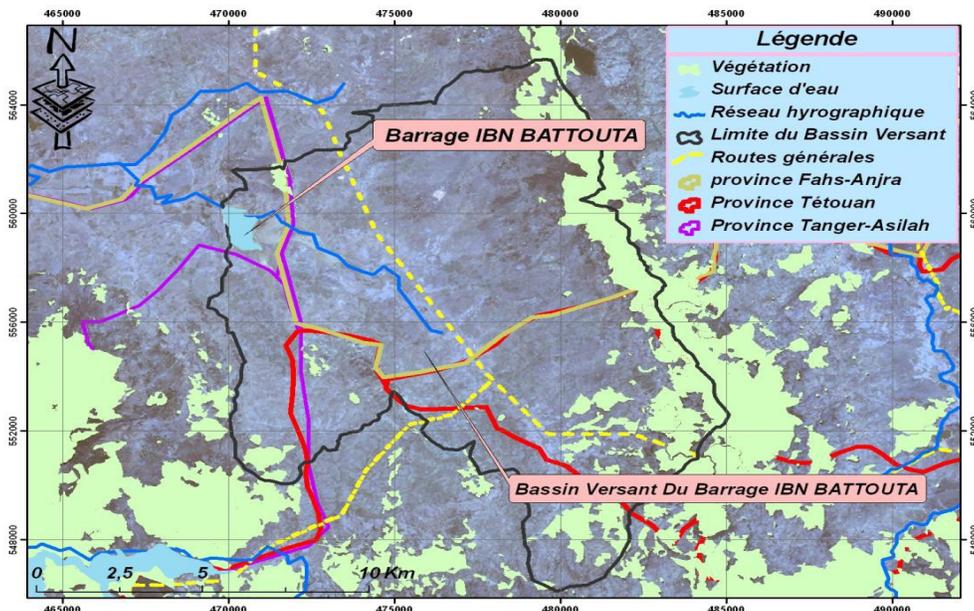After analyzing the existing settings in the database, we found that factors such as:

Figure 5. Map of land use realised the stellite image processing by coupling Extensions for ArcGIS of ArcGIS 9.2, ArcView 3.2, and ERDAS software.The results of various treatments of remote

Hydrogeology, morphology, degradation of vegetation cover, runoff, industry and agriculture are important for delineating protection zones [34].

Indeed, much of the area is swept along by synclines Numidians sandstones of the Eocene. The rest of the dam basin Ibn Battouta consists mainly of Quaternary alluvial wide valleys with a very limited hydrogeological potential. This makes the geological structure of the region does not cross significant nutrient inputs. Linking factors mentioned above led to the delineation of three areas of protection such that they are presented in "Fig. 6".

- Zone-I includes the reservoir and its islands, mostly justified by the requirements of the protection against pollution directly. Pollution directly. It is limited to an It is limited to an area less than 1hectare in the projection orthogonal to the normal level. area less than 1hectare in the projection orthogonal to the normal level.
- Zone-II is defined as a first step to adjacent land with slopes greater than 3 degrees and a surface between 1 and 50 hectares.
- Zone-III is connected to the outside of Zone-II and includes land with slopes of less than 3 degrees. The ranges of these areas may increase or decrease in involving other parameters such as cadastral boundaries and geography and settled between 50 and 1000 hectares "Fig. 3, and 6".

After the demarcation of different areas of protection, protocols of servitude must be formulated for each zone. Under the Water Act 10-95 of the Kingdom of Morocco, enacted in September 1995, the indications and regulations for different areas of protection have been identified [35].

The recent installation represents an opportunity to effectively protect water resources and extend the duration of their operation this also leads to greater profitability of investment and infrastructure made. However, the evolution of the soil, some human activities and climatic variations may alter some factors considered to define them. The GIS allows to easily updating the established delineation [36], [37], [38].

So at the end of the field workers (researchers, engineers and technicians) observe and revise their initial hypothesis and establish a comprehensive protocol combining participatory mapping refer their findings to the authorities responsible for the design of the project. For they initiate the process of project implementation on the ground. [39].
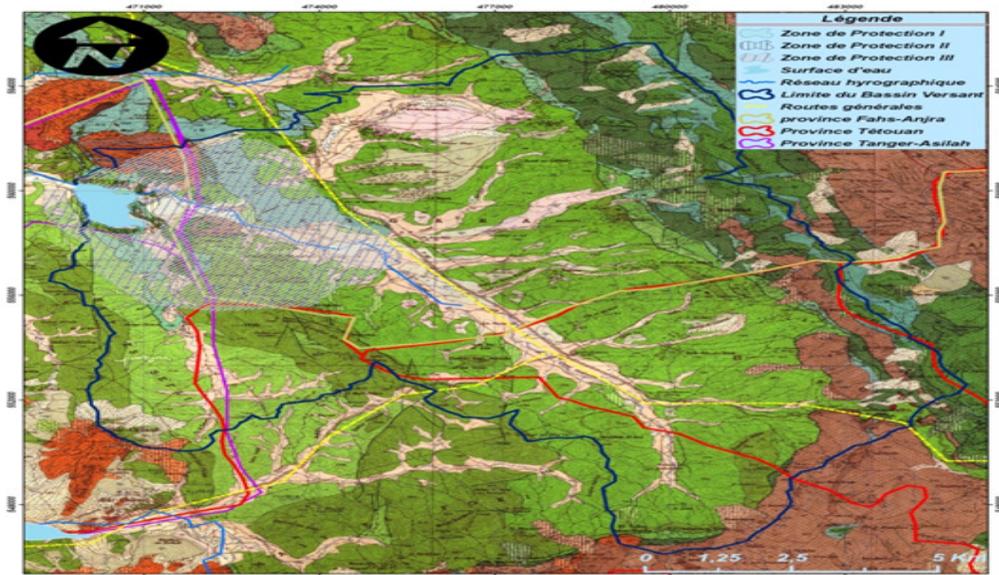

Figure 6. *The geological map of delimitation protection zones around the Dam Ibn Battouta*

5. CONCLUSION

This study aims to give a value added with regard to the use of GIS, which offers multiple possibilities for analysis and simulation, to develop important applications used to manage water resources, Spatial Planning and sustainable management and who now constitute a very important area. Whose goal and create what is called participatory geographic information systems could protect the traditional knowledge and wisdom of an external operation, placing the hands of those who generate the access control and use of geographic information culturally sensitive

Thus all available data, both those of GIS and those collected from field work, were modeled and included in a database managed by the GIS.

This method has delineated three zones of protection around the dams Ibn Battuta (areas of immediate protection (ZP.I), close (ZP.II) and distant (ZP.III).

Our study shows that the various aspects of the problem concerning the safeguarding of water resources were assessed and the needs of managers have been identified.

 In other hand, the goal is to strengthen state capacity to help create an innovative computerized tool that will give significant results, and as a methodological tool to aid decision makers and managers of all kinds for the action for sustainable development is conducted in a continuous and uniform manner.

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