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Development Of a GIS for The Management Of The Rice Sector In Côte d'Ivoire: a Platform For Exchanging Information And Spatial Analysis.

Arthur Brice Konan-Waidhet[1], Sidiky Bakayoko[1], Brou Dibi[1], Konan Emmanuel Kouadio[2], Issiaka Savane[3], Gabriel Lazar[4]

[1]Geosciences and Environment Laboratory, University Jean Lorougnon Guede, Daloa, Côte d'Ivoire,
[2]Science and Technology of Water and Environment Laboratory, University Felix Houphouet Boigny of Abidjan, Côte d'Ivoire ,
[3]Geosciences and Environment Laboratory, University Nangui Abrogoa, Abidjan ,Côte d'Ivoire, emmakouadio
[4]Physics Engineering and Environmental Engineering Laboratory, University Vasile Alecsandri, Bacau, Romania.

Abstract: - The rice sector in Côte d'Ivoire is facing a problem of organization and storage of information produced by its various actors. It is noted, in fact, that the volume of data produced by this sector continues to grow and also the operators of the rice sector are several links that are interdependent. It became necessary to propose the implementation of an information system through a database. This system can integrate all the forces of this sector with a view to facilitate the sharing of data in order to better assess the contribution of each other in the development of this sector. Thus, the design of an appropriate management tool is needed to organize and communicate information useful for decision making. Geographic information systems (GIS) as having fundamental capacity analysis and combination of features based on their spatial data, aid decision maps can be developed. This study proposes to develop a tool for information management on the rice sector and model the spatial distribution of rice data. The approach is that of a geodatabase, that is to say a GIS coupled with a relational database management system. The proposed prototype includes a friendly acquisition information system, consultation and data system for linking research information to the territory.

Keywords: - *Côte d'Ivoire, Data Modeling, Decision Support, Geodatabase, Prototype, Rice*

I. INTRODUCTION

The growing increase of the population is a challenge for people in developing countries who need to use quality agriculture to satisfy nutritional needs. In Côte d'Ivoire, the need to achieve security and food self-sufficiency by hedging needs for rice is a major focus of all agricultural development policies [1]. Also, the problem of food security he goes through training farmers to make them independent to protect local resources efficiently and optimally[2].To this end, many projects and programs have been launched to remedy the needs of rice that the country largely depends on exports. Also, there are many partners and actors in that sector. This justifies the existence of many data but owned by different departments both at the state level and at the level of donors and other stakeholders in the sector. Indeed, much of the data collected are common to different projects. It appears necessary to avoid the repetition of various studies and ensure better data management and thereby to limit the significant financial losses. It frequently appeared as major investments are involved in data collection that had already been completed or was in progress. It is also appeared that in the implementation of projects, much information such as: the topographic maps, the distribution of water resources and infrastructure, sensitive perimeters are required. The data collected should be utilized for different stakeholders towards the management and conservation of natural resources. Given the amount of activities conducted in different regions of Côte d'Ivoire, it seems necessary to the various groups working across the country to manage adequately the numerous data and thereby form a platform for exchange information. Thus, the analysis revealed that existing operators in rice sector are several links that are interdependent. Unfortunately, information flows difficultly between the different stakeholders in the sector. There is no specific information system to this sector. The implementation of a device to provide users with reliable, relevant information, full and usable is currently indispensable. It must allow the rapid identification of data relevant documentation. It must also allow search data by thematic and spatial criteria. Thus, the search for appropriate solutions for the use and management of these projects goes through the implementation of a Geographic Information System (GIS). Indeed, the construction of an efficient database and the combination of all relevant data in a single application projects reduced in the case of data redundancy, and the error of the latency calculation [3]. This GIS implemented will allow to analyze in real-time from each area, the rice production, the varieties used, the yields obtained by cropping system, the quantities of rice processed, milled rice stocks in transformers and distributors, demands of different operators etc. The advantage of GIS is that, it is not only to produce maps but rather to structure geographic information so as to the query according to their themes and their scale of analysis to be accessible to different users [4]. The aim of this study is to develop a tool for information management on the rice sector and model the spatial distribution of rice data. Given the spatial data, the approach adopted is that of a geodatabase which then provide the ability to quickly extract the necessary information and respondents to clearly predefined objectives [5].

II. MATERIALS AND METHODS

2.1 Area of study

Côte d'Ivoire is located in West Africa in intertropical wetland (Fig. 1). Covering an area of 322,460 km ², it is bounded to the south by the Gulf of Guinea on a coast of 550 km; to the west by Guinea and Liberia, to the north by Burkina Faso and Mali, and the east by Ghana. The relief consists essentially very pronounced plateau (100-400 m). To the west, a few peaks over 1,000 m just break the monotony. Coastal sedimentary basin (3 percent of the territory) and the crystalline basement (97 percent) are the main geological formations. There are the lateritic soils, ferruginous soils (lateritic cuirass) occupying areas of tropical climate, and hydromorphic soils in the marshland and some plains of rivers. Arable land is estimated at 21 million hectares, or 65 percent of the total land area. In 2002, the area under cultivation represented about 6.9 million ha, or 21 percent of the total land area and 33 percent of the cultivable area. The agricultural sector was the main motor of the Ivorian growth during the years namely economic prosperity, since independence until the early 1980s, with the spectacular development of cash crops promoted by the State (cocoa, coffee, cotton, bananas, pineapple, oil palm, rubber, etc.). Agriculture is now more diversified, with an emphasis on food production. It still plays a vital role in the Ivorian economy and contributed almost 28 percent of GDP in 2003, generating about 60 percent of export earnings and occupying 45 percent of the workforce. However, the political crisis that hit the country since 1999 has had a devastating impact on its economy, once the beacon of prosperity in sub-Saharan Africa. On the food front, the overall situation is satisfactory. Imported (for a total of 350 million U.S. dollars in 1997) commodities mainly include rice (450 000 tonnes), vegetables, wheat, meat, milk and fish (100 000 tonnes).

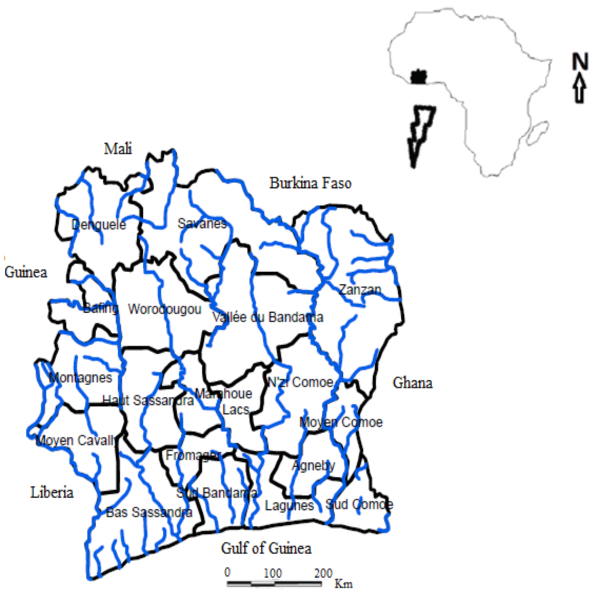

Figure 1: Location of the Ivorian territory

2.2. Materials

The material consists of data and software. The design of the GIS required the use of a topographic map at 1/200, 000, provided by the Centre of Cartography and Remote Sensing (CCRS) in Abidjan and descriptive data from previous work available at the Ministry of Agriculture and the National Institute of Statistics from 2002 to 2009. The software used is Microsoft Access 2007 for the treatment of descriptive data and ArcGIS 9.3 for the implementation of the geodatabase and mapping of spatial data.

2.3. Design methodology of the Geodatabase

GIS developed during this study focuses on a databases management system (DBMS) with semantic data and GIS software including graphical data. Semantic data in the DBMS can be classified into two categories: those relating to the management and monitoring of projects on the one hand and those who are described as useful to be spatialized on other hand. They are actually all potentially spatialisables, but only the second category contains useful information for the development of thematic maps. These attribute data are related to the graphic data through the geodatabase. The methodology adopted for the development of DBMS is inspired by MERISE method. From this work, a prototype DBMS has been developed and tested, allowing to adapt and change. Fig. 2 summarizes the organizing principle of this GIS. Geodatabases have the functionality of relational databases while integrating spatial data [6-7]. They thus offer the possibility of treating both spatial and descriptive information in a single application. The success of a geodatabase necessarily involves data modeling.

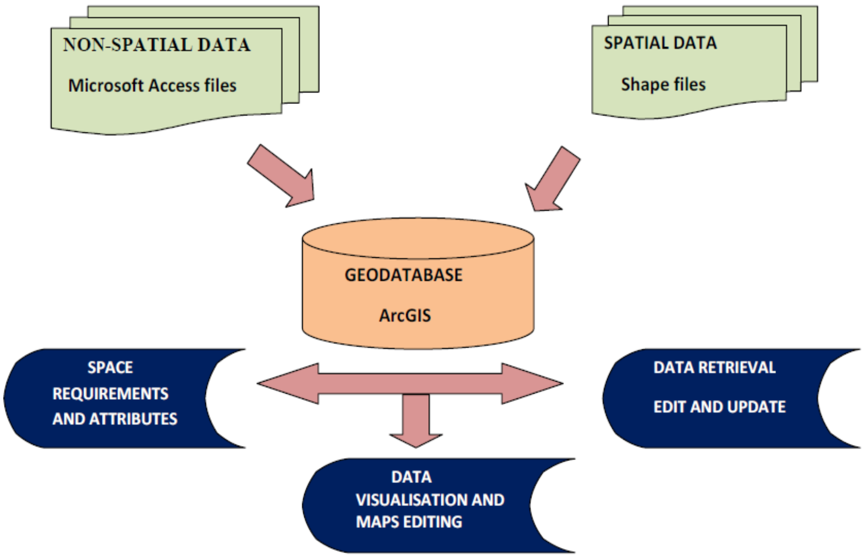

Figure 2: Conceptual Flowchart of the geodatabase

2.3.1 Data Modeling

Modeling is an essential prerequisite in the context of a development or the study of computer applications. This is true with geographic databases which are also organized and structured. A model is a representation of reality used to simulate a process, predict an outcome or analyze a problem.

2.3.2 Conceptual model

The Conceptual Data Model (CDM) has defined geometry, attributes and logical relationships (spatial and temporal) between the objects studied. Thus, the entities have been determined taking into account the contents of the geodatabase that can distinguish objects in the real world as entities having two types of attributes: alphanumeric attributes and graphical attributes. The conceptual model has been designed according to the Entity-Relationship formalism. A first approach to the work has an inventory of existing data being acquired and available on each region of the country. Only relevant and existing data to develop a database management system (DBMS) on the topic concerned but likely to be collected were retained.

2.3.3 Logical Model

The logical data model (LDM) organizes data in tables, while allowing to keep existing relationships. The most common logical structures are hierarchical models, networks, relational and in recent years, the object-oriented model. Among the four basic logic models listed above, the relational was chosen as the most appropriate for the purposes of the geodatabase [8]. The table “project” is the central element of the database management system. In the latter are attached relating to the management and monitoring of the rice program tables. Tables corresponding to the administrative districts allow a possible link with other data (population, living standards, field distribution), often available at the scale of an administrative unit.

2.3.4 Development of a prototype

After defining the overall system using modeling a prototype is proposed. This is an exploratory system involving a limited set of analysis functions. Using a prototype is an efficient way which helped to clarify concepts, test and make strategic choices. The prototype was crucial to see the possibilities and limitations of the model and the selected software. It implements various usage scenarios of the information system. The prototype has been built on the Microsoft Access software. It is a tool easy to handle, which forms allow a quick and clear data entry. Data retrieval is also a focal point for users.

2.3.5 Integration of spatial data

Geographic information is composed of geometric, topological and descriptive information. Its integration goes through georeferencing and digitization. This will show spatially different localities affected by various projects to characterize and plan scientific, economic and social activities. The ArcGIS environment was used to implement the spatial database. From the processing of this information for understanding the structure and functional relationships of objects distributed geographically, will emerge cards synthesis.

III. RESULTS

3.1 Presentation of the Interface

To make the consultation and input of information on the rice sector, a friendly interface was created (Fig. 3).

Figure 3: Main screen of the database

Form design allows an easy use of the software and is accessible to all. The application offers four distinct modes of interrogation namely: the "partner organizations", mode the "Projects" mode, the "Actors of Connection" mode and "Production" mode.

-the "partner organizations" mode allows to query the database according to NGOs, various national and regional services, associations and donors. This allows the identification of active organisms in the study and the spatial distribution of their business scope. The objective is to determine their action on the territory for spatial analysis or determination of financial flows in different regions. This item has been kept in the model also to facilitate the search for donors to organizations wishing to integrate into regions. The amount paid to agencies as well as the costs of activities were held at the request of managers of the database.

- the "Projects" mode allows to formulate queries to assess the duration and impact of the various programs and projects implemented in the development of rice in Côte d'Ivoire to food self-sufficient.
- the "Actors of Connection" mode allows to formulate queries on all stakeholders in the sector. They can be grouped by producers, processors, buyers, importers, research centers, mentoring and institutional framework for the organization of this sector structures.

-the "Production" mode takes into account the developed areas and the needs of the population and archive productions obtained by regions based on management structures and activities of national and international partners.
In order to maximize the data, many requests can be made and viewed from the ArcMap module of ArcGIS software. Thus, spatial analyzes illustrate the ability of GIS to support access to geographic information.

3.2 Spatial Analysis of area's production
A precise analysis of these spatial information was used to assess the production of different regions. Fig. 4 shows the average spatial distribution of rice production in 2009. Productions are between 1066 and 152 063 tonnes.

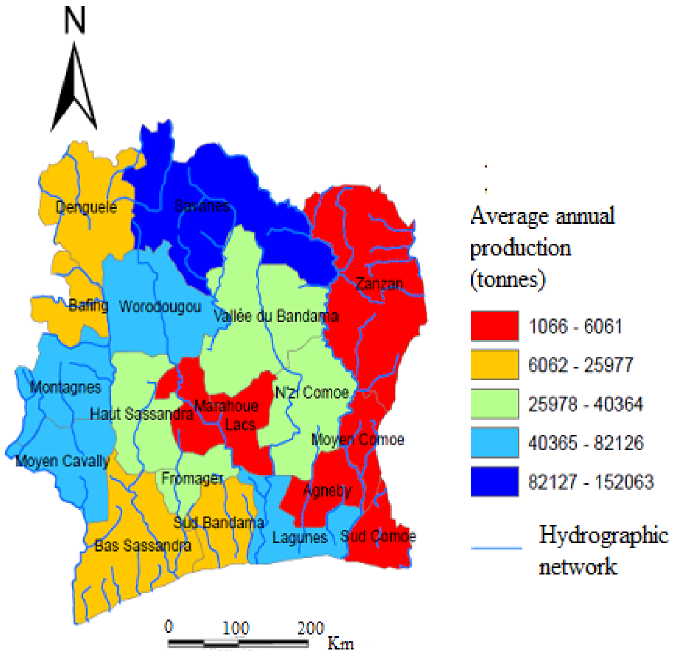

Figure 4: Map the spatial distribution of the average annual production of rice production (2009)

Overall, all regions of Côte d'Ivoire produce rice and mainly in the area namly Savanes, *Montagnes*, *Moyen Cavally and Lagunes*. Rice is first produced for home consumption. Production during the year 2009 amounted to 666,065 tonnes.

An analysis of the spatial distribution (Fig. 5) allows noting that the *Savanes* region alone accounts for 22.83% of the production areas. It is followed distantly by regions *Worodougou* (12.33%), *Montagnes* (10.49%) and *Lagunes* (10.45). Then come the regions of *Moyen Cavally* (8.08%), *Fromager* (6.06%), *Haut Sassandra* (5.35%), *Nzi Comoe* (4.51%), *Vallee du Bandama* (4.4%), *Denguele* (3.9%), Bas Sassandra (3.66%), Bafing (3.32%) and *Sud Bandama* (2.05%). Other regions (*Zanzan*, *Lacs*, *Marahoue*, *Sud Comoe*, *Moyen Comoe and Agneby*) occupy 2.58% of the production areas.

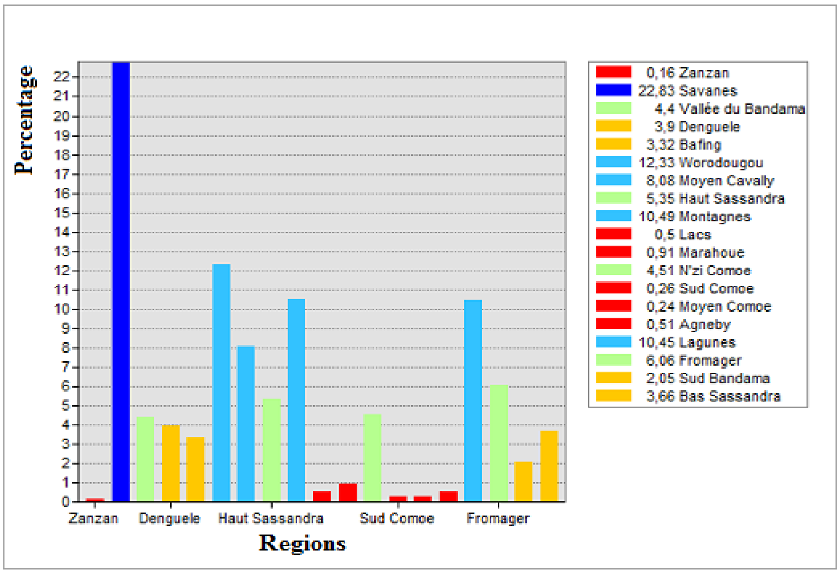

Figure 5: Histogram representing the percentage of rice production for each region

Côte d'Ivoire was for many years a country of upland rice. Wetland rice began to grow gradually in importance. Fig. 6 shows the area developed to increase the production of irrigated rice for a total of 31101ha. The most important improvements are in the areas of *Montagnes, Vallee du Bandama* and *Lacs*. Overall larger areas are in the West and Centre.

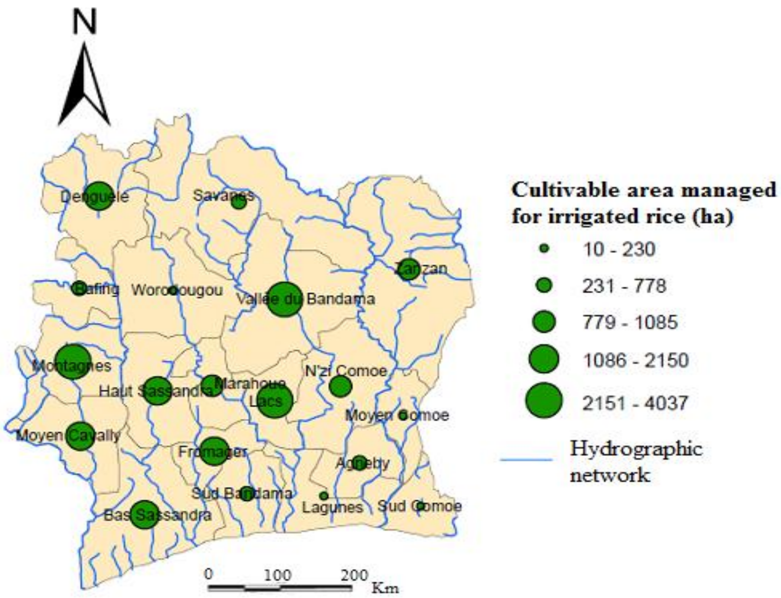

Figure 6: Area managed for irrigated rice

The National Rice Program (NRP), created in 2003, whose mandate is national, launched seed programs in 2007 which helped to provide farmers with seeds covered departments performing short-cycle varieties, fertilizer and agricultural tools (Fig. 7). This reflects the action of industry partners on the ground.

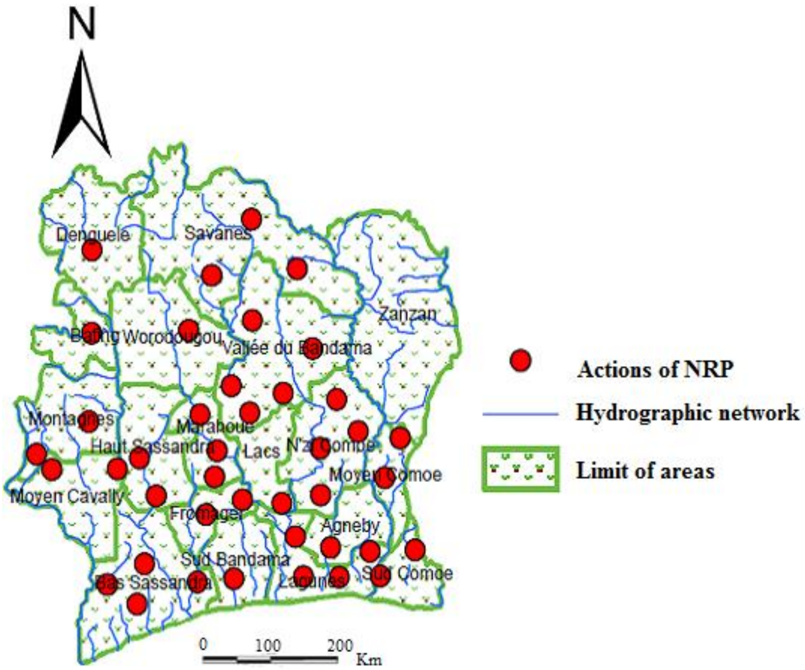

Figure 7: Location of area affected by seed programs of National Rice Program (NRP) in 2007

IV. DISCUSSION

This study demonstrated the value of implementing a GIS application coupled with a relational database management system with data of different nature. Microsoft Access software was chosen to design the database, because it allows taking conclusions about the success and functionality of small-scale pilot project. The information contained in the database can be viewed, sorted, handled, collected and printed in various ways and gives users the flexibility to obtain data in multiple formats. This ability to extract information elements based on criteria specified by the user made the Relational Database Management System an excellent computer technology for decision support. The design of the model and its location are such that the system can be modified at any time. The description of certain types of data (data collected in the field or thematic data) should be complete according to the user needs. The research modules and programming functions and interactions among forms can be improved. This SIG, without providing a ready-made solution, let’s get a first idea of the spatial distribution of rice projects and interactions between the different components of this sector. Ivorian rice production is dominated by upland rice which represents 90% of Cultivated surfaces. It is mainly produced in the West, Midwest and Southwest. As for irrigated rice culture began in 1955 under the initiative of the Department of Agricultural Engineering, in north particularly in the city of Korhogo and Ferkessedougou. Also in the actions of partners on the ground, it should be noted that humanitarian agencies have implemented programs to revive agriculture which benefited more than 22,000 vulnerable households in the west and north. Moreover, the recent socio-political crisis that crossed the country, has hurt the agricultural sector in general and the Information Technology and Communication in particular. Thus, all services located in the Centre, North and West of the country controlled by the former rebels, had their tools of information and communication destroyed or looted, requiring large financial and material resources for their reconstitution. This could explain the declining trends of rice production in some regions. The difficulty in this work lies mainly in the collection of data that may not exist and even when they exist, they are virtually inaccessible mistakes means reliable archiving. One of the advantages of having geographical information in digital form is able to access a variety of information [9]. Thus, the performance of decision of such an application is received through the proper use and user satisfaction [10]. To this end, the feedback from users about the quality of decisions and their effectiveness reflect the extent of confirmation of their expectations. Satisfaction is influenced by the quality of information and quality of the system [11]. The quality of information, system reliability, and speed of production were identified as dimensions of a good decision support system [12]. To ensure a better success rice projects in the region, a monitoring and evaluation should always be accompanied by a tool for decision support such as GIS achieved in this study. However, all functions of the access rights, writing and editing are yet to be realized and to be determined by system managers. Data acquisition remains an important part of the work to be done. Thus, an improvement in the quality and quantity of data will facilitate the flow of information between the various actors in the sector.

V. CONCLUSION

The geodatabase model was adopted in this study to facilitate the storage and management of geographic and descriptive data in order to meet the need for information management in the rice sector in Côte d'Ivoire. The results of this study highlight the integrative power of the dynamic link between Microsoft Access and ArcGIS. The resulting application allows an easy use of different data available. The application form consists of four distinct modules namely: "Consultation" module and "Partner Organizations" module, the "Projects" module, the "Actors of Connection" and "Production" module. The prototype was designed to incorporate key elements of the consultation and data acquisition. It consists of a menu that takes the user to capture, modification or consultation data documented. The prototype provides a flexible structure and can therefore be modified according to future needs. A spatial representation of acreage and crop yields can see the strengths and weaknesses of projects carried out in the rice fields across the country. The vast majority of the production comes from the north and west of the country. The regular updating of data will enrich the GIS and have a successful management tool to facilitate the evolution of an inventory of projects and their assessments for a better distribution of future projects in the regions of Côte d’Ivoire.

VI. ACKNOWLEDGEMENTS

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REFERENCES

[1] D. Konvaly (1997), Dévaluation et auto-suffisance alimentaire : le cas de la filière riz en Côte d’Ivoire. Africa spectrum 32(1), 49-69.
[2] T. Oswari, E.S. Suhendra, E. Haryatmi, F. Agustina (2013), Prototype Geographic Information Systems Mapping of Crop Products Featured Local. Journal of Geographic Information System, 2013, 5, 193-197.
[3] P.H. Martin, E.J. LeBoeuf, E.B. Daniel, J.P. Dobbins, M.D. Abkowitz (2004), Development of a GIS-based Spill Management Information System. Journal of Materials B112 : 239-252.
[4] F. Laurent (1996), Outils de modélisation spatiale pour la gestion intégrée des ressources en eau application aux Schémas d’Aménagement et de Gestion des Eaux. Doctorat de l’Ecole Nationale Supérieure des Mines de Saint-Etienne et de l’Ecole Nationale Supérieure des Mines de Paris, 357p.
[5] P. Barazzuoli, M. Bouzelboudjen, S. Cucini, L. Kiraly, P. Menicori, M. Salleoni (1999), Olocenic alluvial aquifer of River Cornia coastal plain (southern Tuscany, Italy): Database design for groundwater management. Environmental Geology, 39(2): 123-143.
[6] K.L. Courtney (2005), Visualizing nursing workforce distribution: Policy evaluation using geographic information systems, International Journal of Medical Informatics, vol.74, pp. 980-988, 2005.
[7] P. Wojda, S. Brouyère, J. Derouane, A. Dassargues (2010), HydroCube: an entity-relationship hydrogeological data model, Hydrogeology Journal (2010) 18: 1953–1962.
[8] D. Kaimarisa, S. Sylaioub, O. Georgoulac, P. Patiasc (2011), GIS of landmarks management. Journal of Cultural Heritage 12 (2011): 65–73.
[9] A. De La Losa (2000), Modélisation de la troisième dimension dans les bases de données géographiques. Thèse de doctorat, Université de Marne la Vallée, Institut Géographique National, Laboratoire COGIT, p. 174.
[10] S. Jarupathirun and F.M. Zahedi (2007), Exploring the influence of perceptual factors in the success of webbased spatial DSS, Decision Support Systems, 43, 933-951.
[11] DeLone W.H., McLean E.R., (1992), Information systems success: The quest for the dependent variable, Information Systems Research, 3, 60-95.
[12] D.L. Goodhue (1998), Development and measurement validity of a task-technology fit instrument for user evaluations of information systems, Decision Sciences, 29, 105-138.