

CONTRIBUTION OF GIS AND REMOTE SENSING IN THE STUDY OF URBAN SPREAD IN FEZ

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SUMMARY

Along with the population growth, changes occur in the physical aspects of cities. Indeed, this population increase is characterized by various consequences; one of the most important is the urban spread: this is a phenomenon of development of urban areas at the periphery of cities, which generates mobility issues, finance and planning issues and so on. In environmental terms, there is an impact on the natural landscape and ecosystems. The purpose of this work was to use the possibilities offered by new technologies, including Geographic Information Systems (GIS) and remote sensing to analyze the evolution of urban sprawl of Fez (Morocco) over the last fifteen years.

On a temporal dimension, we based on multi-sources documents set at different times and sufficiently spaced in time, so we could clearly highlight the changes that occurred. This included satellite imagery, digital maps, files restitution, etc. Spatially, we studied the variations in the extent of urbanized areas, and precisely we tried to find out how changed the various influences on the ground depending on their nature and use: vegetation, water bodies, urban networks, commercial and industrial areas etc.

The spatio-temporal analysis will help to understand and anticipate the trends of urban spread in Fez, by identifying the causes: so their economic, social and environmental effects can be kept under control. Finally, this study will serve as a tool for decision support that stakeholders and decision makers, in order to make efficient choices, to better protect the heritage of Fez and to plan its future development.

RESUME

Parallèlement à l'accroissement de la population, des changements surviennent dans les dimensions physiques des villes. En effet, cette poussée démographique continue se traduit par diverses conséquences dont l'une des plus importantes est l'étalement urbain. Il s'agit d'un phénomène de développement des surfaces urbanisées en périphérie des villes. Ce qui engendre : des problèmes de mobilités, des problèmes de fiscalité, de financement et de planification etc. Sur le plan environnemental, on note des impacts sur le paysage naturel et les écosystèmes.

Le but de notre travail, vise à se servir des possibilités offertes par les nouvelles technologies, notamment les Systèmes d'Information Géographique (SIG) et la Télédétection pour étudier l'évolution de l'étalement urbain de la ville de Fès (Maroc).

Suivant la dimension temporelle, nous nous sommes basés sur des documents multi-sources établis à différentes périodes et suffisamment espacés dans le temps pour permettre clairement de mettre en évidence les changements survenus. Il s'agira notamment d'images satellitaires, de cartes numériques, de fichiers de restitutions etc. Sur le plan spatial, nous avons étudié, les variations de l'étendue des espaces urbanisés. Mais aussi dans le détail, voir comment ont changé, les différentes emprises sur le sol en fonction de leur nature et des usages : la végétation, les plans d'eau, le tissu urbain, les zones commerciales et industrielles etc.

Cette analyse spatio-temporelle permettra d'appréhender et d'anticiper les grandes tendances de l'étalement urbain dans la ville de Fès. Ceci en identifiant les causes, pour une maîtrise de ses effets économiques, sociaux et environnementaux. Enfin, cette étude pourra servir d'outil d'aide à la décision, aux acteurs et décideurs de la ville de Fès, afin de faire des choix judicieux permettant de mieux protéger son patrimoine, et mieux planifier son développement futur.

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1. INTRODUCTION

The Kingdom of Morocco, like other countries, is living strong urban change. Its urbanization is over 55% nowadays (70% in 2025) (A. Chadali, 2008). It is reel that the growth of urbanization which is the result of strong demographics, can be seen in a positive way because of the wealth-generating activities that comes from it . But, many problems can arise if a vision and a planification are not set up to rule this phenomena. The most notable are the difficulties in ensuring transport services, to offer an adequate housing supply and quality, and so on ...

One of the characteristic of a poorly managed urbanization is the phenomenon of urban growth. This is, in first degree, a progress of the city on agricultural and forest areas, processing areas "natural" built-up areas (be they buildings, roads, railway, etc..) (Von Ungern-Sternberg and Da Cunha, 2003). The understanding and the anticipation of urban growth, contribute to the establishment of a better life in the cities. It is in this sense that this study is to exploit the opportunities offered by new information technologies and communication technologies (ICTs), including remote sensing and GIS (Geographical Information System), to study the urban growth in the city of Fez in Morocco.

It will be a question of confirming the existence of an urban growth of the city of Fez, the directions in which it occurs, quantitatively evaluated, identifying the causes and the various associated phenomena.

2. AREA OF STUDY

Centuries-old city with its ancient medina a World Heritage Site by UNESCO, spiritual and cultural city known in the worldwide; city of Fez is located in the northern part of Morocco (Figure 1). Administratively, Fez covers an area of 105 square kilometers and has two urban districts (Figure 2). The city of Fès contains six sections: Agdal, Fez Medina, Jnane WARD EL, Zwagha the Mériniyines, Saïss. And the town of Fez Jdid Mechouar which contains three rural municipalities: the rural municipality of Oulad Tayeb, Sidi Harazem and the rural village of Ain Bida.

According to the last general census of population and housing environment of 2004, Fez has 977,946 inhabitants. The city of Fez is characterized by high population density. This reflects a high urbanization: for 7 out of 10 residents live in urban areas against 5 of 10 at national level (PDES, 2000-2004).

But, like in other cities of Morocco the urban development is suffered instead of managed (F. Ouzzine, 2006). The main causes are: a high rate of rural exodus to the city (slums), the multiplicity of laws governing town planning, the non-compliance, complex procedures, and lack of respect of the value of the heritage legacy.

Urban growth characterizes the phenomenon of growth of the urbanized area in a little control, producing a very loose urban, increasingly distant from the center of the urban area of which it depends on (G Pulliat, 2007). The result is a significant consumption of important and superior level of space wanted by the public and compatible with long-lasting development of the territory. In many developing countries, urban sprawl has two main different characteristics within the same city: one is characterized by the formation of large suburban areas where patterns of land use and illicit informal predominate; the other aspect is the growth of suburbs, where residential areas include categories of population in high-income and middle business centers and retail easily accessible by private transport rather than collective (SOWC10, 2010).

This phenomenon is more widespread, as since 2008, for the first time, more than half of the world's population lives in urban areas (UNFPA, 2007) due to high population growth and rural exodus. More spontaneous colonization dynamics of this space is part of a group of syndromes of global change that have taken a rapid and dangerous way. (Ludeke et al., 2004).

This phenomenon cause for concern is on the economic (property speculation anarchic scattering of tax collection, infrastructure needs heavier and expensive ...), social (emphasizes the urban divide, promoting social segregation based on economic categories and resulting in geographical differences in wealth and quality of life between the various parts of cities and metropolitan areas, inner-city dilapidated and increasingly suburban) and environmental (pollution, destruction of ecosystems ...). The result is the need to characterize and evaluate urban sprawl.

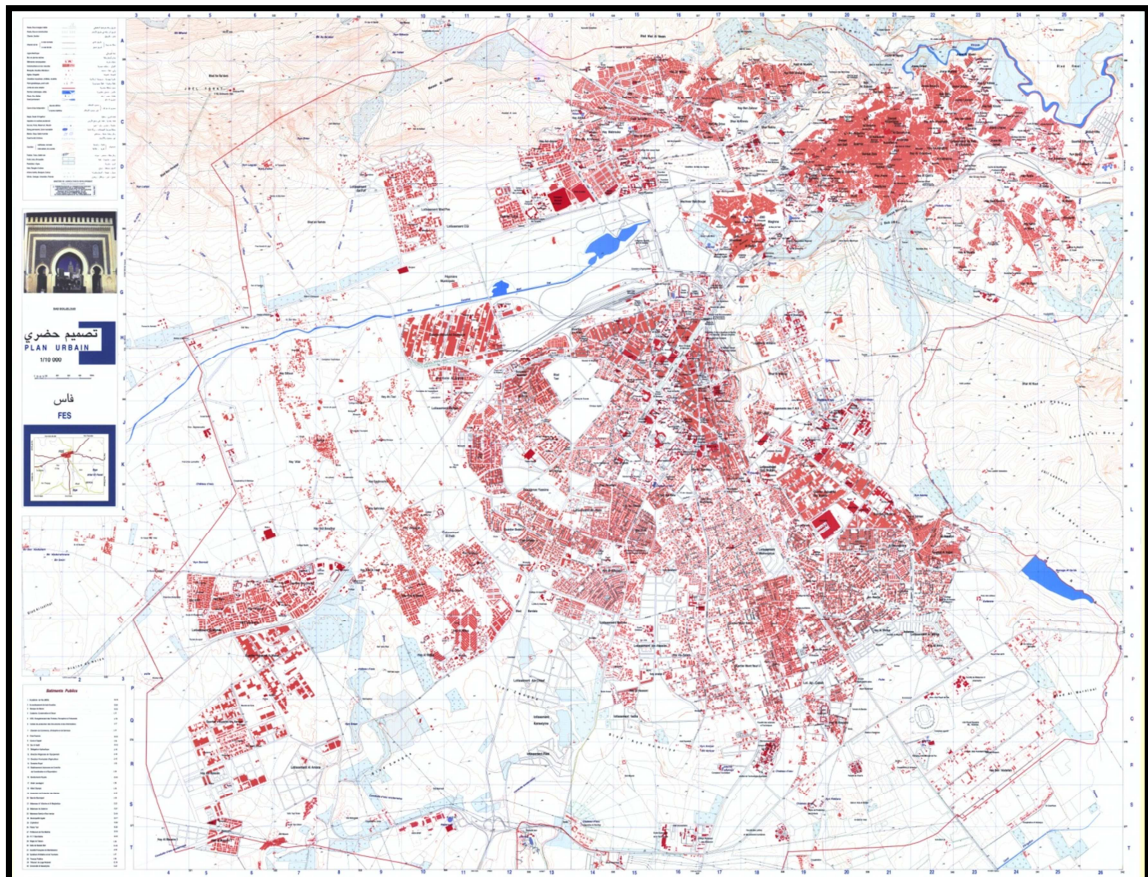
3. METHODOLOGY

How to measure the spreading of a city and analyze the effects of sprawl? Remote sensing, because it provides continuous data permitting to characterize and to follow the evolution of the territories is naturally questioned (MT Demaze, 2010). In this view, remote sensing with high spatial resolution is used to evaluate urban sprawl, that is to say how the city is structured (or range land base) and evolves either by densifying by increasing the frame, either by nibbling the peripheral areas (urban sprawl, suburbanization) (MT Demaze, 2008).

3.1 Data available

As part of our work we have following data:

- Urban Plan of the city of Fez, digitized and geo referenced since 2002.
- Two satellite images including a suite of Google Earth image (www.earth.google.fr) since November 2009 and August 2011.



Urban plan of the city of Fez in 2002



Satellite image of the city of Fez in 2009



Satellite image of the city of Fez in 2009

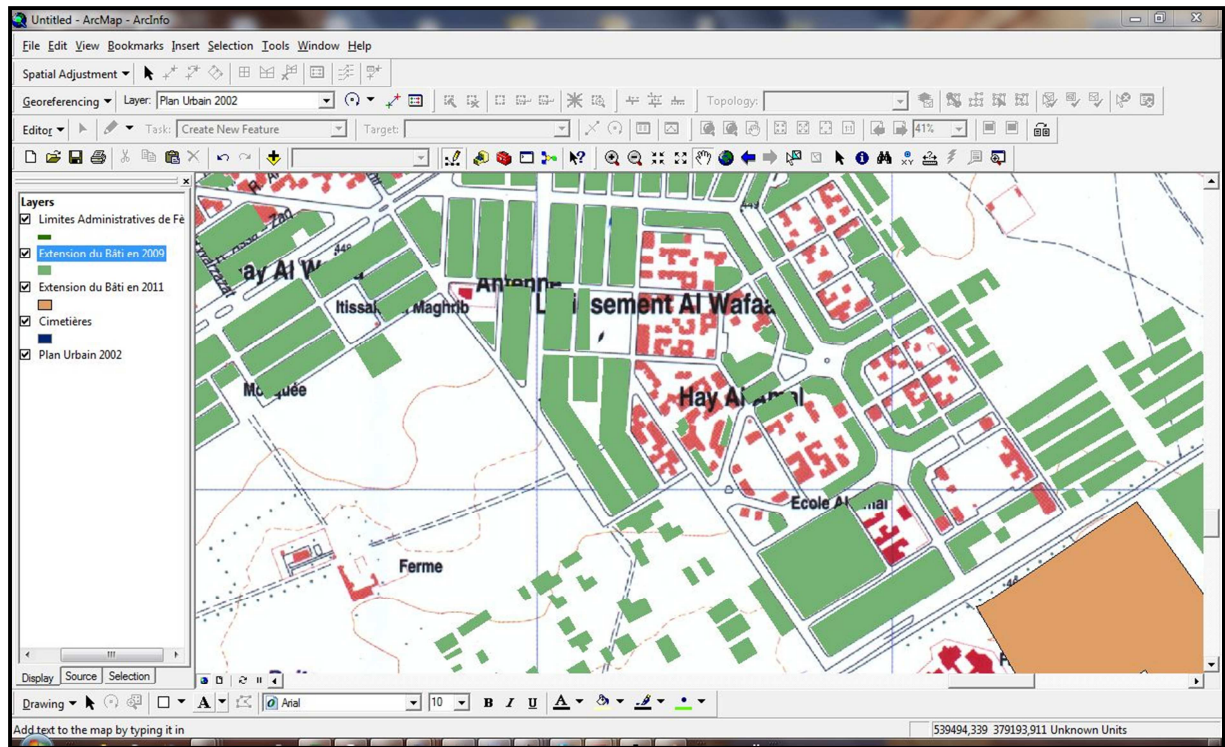
3.2 Data processing

The main approach of this study is mainly cartographic. For this reason, the urban plan (the oldest data) served as a starting point. All data were geo-referenced; we superimposed the 2009 satellite image of the urban plan. With ArcGIS, we applied the transparency and so we were able to scan the frame which is not on the city plan but which is observed on the image. The result was exported as the shapefile format.



Overlap between the urban plan and satellite photo

The second step was to superimpose the image of 2011 over that of 2009. The latter remained opaque and the second transparent. For digitalization, we extracted the frame formed between 2009 and 2011.



Example of digitizing Buildings with ArcGis

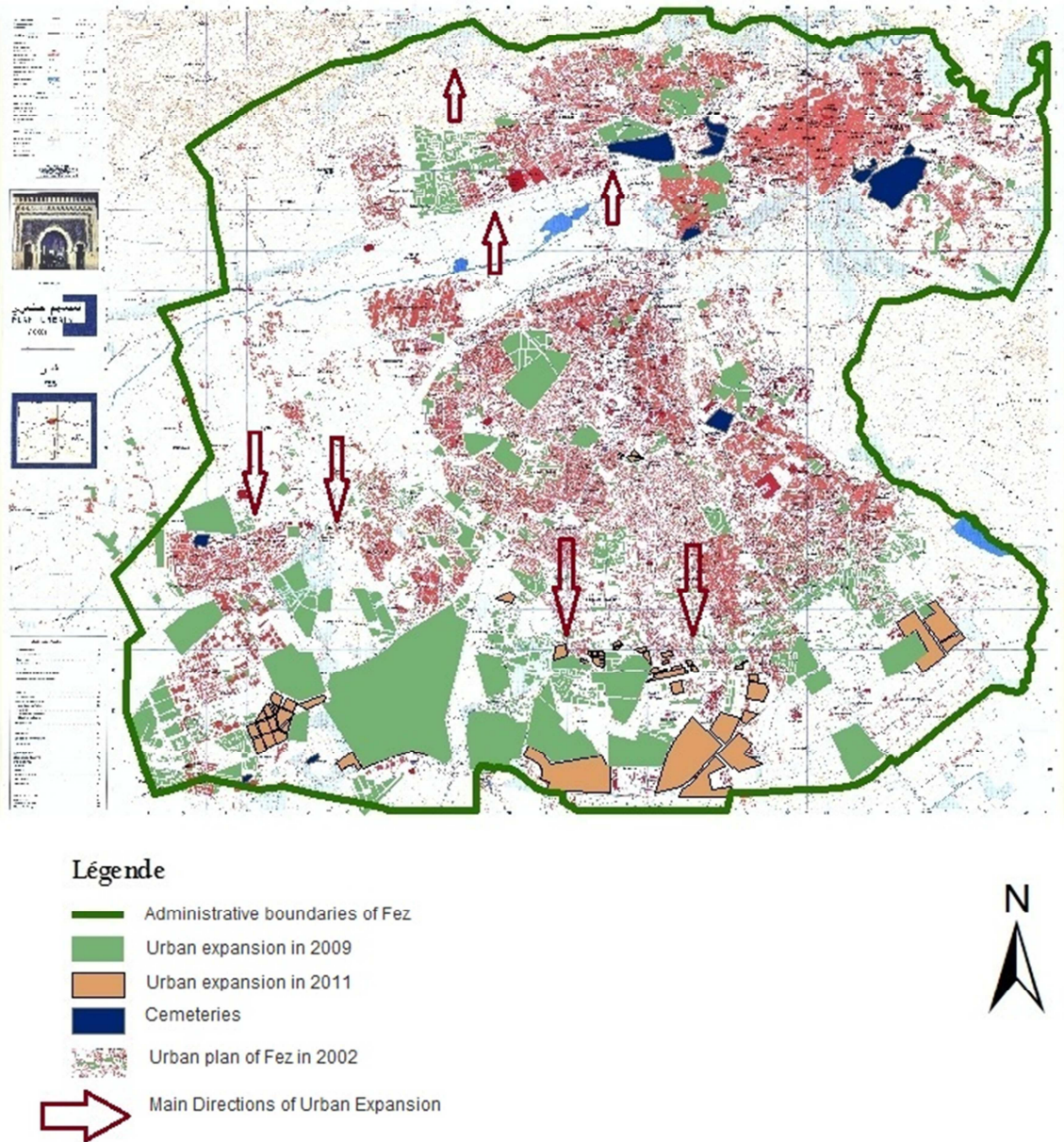
4. RESULTS

It is seen that several phenomena occur regarding the frame (Picture). There is a densification of the city center. There is also a spread which occurs towards the south and the north. It should be noticed that the spread towards the north is low because of a natural obstacle: the Jbel Zalagh which stops the growth of the town. One towards the south, the most important towards Saïss is favored by the existence of vast plain.

Between 2002 and 2009, the frame increase of 698.09 ha. And between 2009 and 2011 we notice 204.75 ha of buildings. (Obtained by calculation ArcGis).

There is an accelerating pace of construction between 2009 and 2011, because of the many building projects that have emerged in the southern part of the city.

Urban growth in Fez between 2002 and 2011



Picture

5. CONCLUSIONS

This study shows that urban sprawl is a reality in Fez. Yet urban development represents a major challenge for Morocco. Urban management, respect for heritage and respect for the national environment ensuring the creation of wealth and offer a pleasant living environment (F. Ouzzine, 2006).

Sprawl is preferentially towards the south of the town towards the Plain of Saiss. This spread has accelerated in recent years due to a housing boom. Nevertheless, the situation is not yet alarming: the administrative boundaries of the city are not yet obsolete, there is still room for the valuation of such spaces on the banks of Oued Fez and in the east and west areas of the city .

In this work, the prospective dimension will be dealt through the integration of more precise data: high precision satellite images, demographic data, and so on ... All controlled by a multifunction GIS, integrating the best techniques for image processing. Thus, the city of Fez has at its disposal a tool for analysis and monitoring of urbanization, which will contribute to its economic and social development.

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