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Gisand Remote Sensing Applied To Land Use Change Of The Prefecture Of CASABLANCA, Morocco From 1986 Until 2011

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ABSTRACT
The population and urbanization of Morocco are increasing very rapidly. They have risenin large cities due to heavy immigration rate from rural areas to accessjob opportunities, better education, and better health facilities. Casablanca has the most affected land use changes in Morocco because of the immigration. This paper presents anintegrated study of land use change in this city from 1986 until 2011 using topographic map sheets (1986) and satellite image (2011). The layers of landuse map (1986) were obtainedby digitization technique in ARCGIS 9.3 software. Supervised classification methodology has been employed using maximum likelihood technique in ERDAS IMAGINE (2011) to extract from the satellite image fourclasses, which were categorized into, built-up area, public green spaces, agricultural land and water bodies. The totalarea of each class was estimated by using geometry tools of ArcGISsoftware to compare land use changes between 1986 and 2011.
Keywords: land use change, Remote sensing, GIS, Casablanca.

I. INTRODUCTION

Casablanca or "Casa" in the ordinary sense is the metropolis of the kingdom, Morocco's economic capital and the engine of the nation. According to the High Commission of Planning this city alone had 21,3 % of the national GDP in 2004, more than that Casablanca is considered the gateway to modernity with an industrial share of 32% from the sector and 49% of overall sales[1]. Its port plays a major role in the national economy with a transit value of goods estimated at 100 billion dirhams per year [2] and its international airport is considered the first in the countrywith approximately 7 million passengers passing through the airport each year[3].

That's whyCasablanca is the biggest and the most populated city in Morocco. Its geographical position and its economic activities attract more and more foreign, urban and rural population. In 1900 the population of Casablanca represented by the old Medina was about 20 000 inhabitants dispatched on a space of 47 ha [4] while its population is about 3.3 million people in 2004 [5].That's why Casablanca has known a very big change in the land use but the researches about these changes haven't began just recently, they have been based on GIS and REMOTE SENSING and they didn't touch just a particular points.In 2010 Bachir Alami et al have simulated the flood

risk of Bouskoura river which is integrated in the Casablanca city on the segment of Nassim-Azbane[6].GADAL has worked about Urbanization and population Dynamics of Casablanca between 1994 and 2002[7].Rhinane et al, in 2011 identified and qualified slums in Casablanca in an attempt to facilitate the monitoring and mapping tasks of Cities without Slums, a Moroccan government program launched in 2005[8]. Another time, Rhinane et al. in 2012 estimated the ground temperature in order to identify theformation of is- lands of warmth or coolness which occur in the urban municipalities of Casablanca[9]. The purpose of this work is to qualify and quantify the land use changes of Casablanca between 1986 and 2011 (Built-up areas, Green spaces, Water bodies, Agricultural grounds and careers) using as the projects below GIS and REMOTE SENSING.

II. STUDY AREA

The prefecture of Casablanca is the central part of the Wilaya of Greater Casablanca (figure 1); it is located on the Atlantic coast in the northwest of Moroccoon north latitude of 33°35 and a west longitude of 7°25.

The total surface of the study area is 219,00 sq.km, its coastline stretches over 27 kilometers. Its position on the Atlantic Ocean

plays a moderatingrole in all the climatic elements. The average temperatures are 12,4°C in winter and 22,9°C in summer with a temperate and humid climate. The average annual rainfalls are between 300 and 500 mm [10].
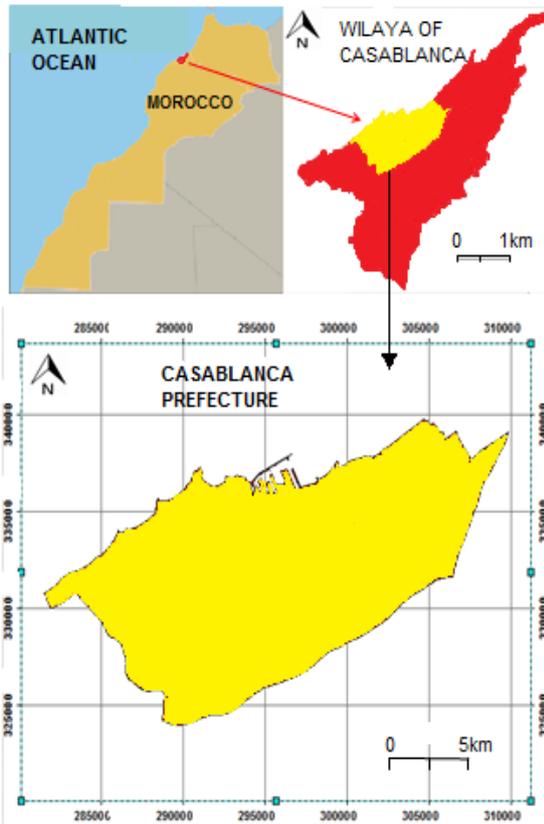
Figure 1: Study area map of the prefecture of Casablanca.

III. DATA AND METHODS
DATA

In this study two different data's were used in order to estimate the land use (LU) changes of the prefecture of Casablanca from 1986 until 2011: Topographic map sheets (1986) and a SPOT5 satellite image with a resolution of 4 m (2011). The information was extracted from the topographic map sheets using digitizing tools in ARC-GIS 9.3, the layers of built-up area, public green spaces, water bodies and agricultural lands were compared to the results given by the supervised classification applied to the satellite image of Casablanca. Many other data's were used in order to verify and validate the exactitude of the given information.The used data's are listed in the following table

DATA TYPE	YEAR	PROCEDURE	OUTPUT
Topographic map sheets of Casablanca, Berrechid, Birjdid, Oulad ziane and Mohammedia 1/50000	1986	Digitizing	-Built-up area. -Agriculture lands. -Green spaces. -Water bodies.
Administrative division of the prefecture of Casablanca	2013	Scaling cards	Administrative limits of Casablanca
Land sat TM image of Casablanca (30m)	1986	Observing and comparing	Agriculture limit in 1986
Topographic map sheets of Casablanca 1/10.000	2006	Observing and comparing	Green spaces and water bodies
SPOT 5SAT image of Casablanca (4m)	2011	Supervised classification	-Built-up area. -Agriculture lands. -Green spaces. -Water bodies.
Topographic map sheet of Casablanca 1/25 000	2011	Observing and comparing	Green spaces and water bodies

Table1: The used data's of the study area.

3.2METHODS
3.2.1 Geo-referencing and Image subset

Five topographic maps of 1986 of scale of 1/50000 ,represents Casablanca and surrounding areas (Casablanca, Berrechid, Birjdid, Oulad ziane and Mohammedia), were required to cover the entire study area. Allmaps were georeferenced according to the geographical coordinate system of Merchich-Zone 1 and the Lambert Conformal Conic projection. The quadratic average error was verified and it matched well the norms.

After georeferencing topographical maps, the mosaic option is used in the arc toolbox in order to gather these maps on a one raster imagine extension. Then the data management tools and the spatial analyst tools were used to cut the maps on the actual administrative division of the prefecture of Casablanca.

For the satellite spot image which is projected in the WGS 84 geographical system, it was georegistered to a common coordinate reference system with topographic sheet (Merchich-Zone 1) using the reproject option in the ERDAS IMAGINE 2011. Then it was

exported into ARGIS 9.3 where it was cut on the zoning of the prefecture of Casablanca.

3.2.2 Heads-up digitization

      Heads-up digitizing is similar to manual digitizing tracing the features by computer screen using the scanned raster image as backdrop. Five classes detailed in the table below were digitized on the topographic sheet of 1986 and stored on a shapefile.

| Class Description	Description
Built-up area	Includes all residential, institutional, commercial, and industrial building, Airport, port etc…
Green public spaces	Includes all the public parks, gardens, urban green spaces and sport and leisure equipment's
Water bodies	Includes lakes, rivers and wetlands
Agricultural grounds	Including agricultural and pasture grasslands in addition to arable lands....
Careers	Including careers which existed in 1986 and are till now.

Table2:Land use classes and description

**3.2.3 Supervised classification**

      After importing the satellite image in the ERDAS IMAGINE 2011, it was classified, and the same classes as above were generated: built-up areas, agriculture lands, green spaces and water bodies. The classification technique that was usedis The Gaussian Maximum Likelihood classifier (GMLC) it quantitatively evaluates both the variance and covariance of the category spectral response patterns when classifying an unknown pixel, assuming the distribution of data points to be Gaussian. The distribution of a category response pattern can be completely described by the mean vector and the covariance matrix. The statistical probability of a given pixel value being a member of a particular class are computed. After evaluating the probability in each category, the pixel is assigned to the most likely class (highest probability value) [11].This method was used in many papers in order to study the urban sprawl of cities[12,13,14]. The results given by this classification were verified within the topographic map sheets of 2006 and 2011.

IV.   RESULTS AND ANALYSIS

The final output is an overview of the land use of the prefecture of Casablanca for 1986 and 2011 (Figure 2 and3).
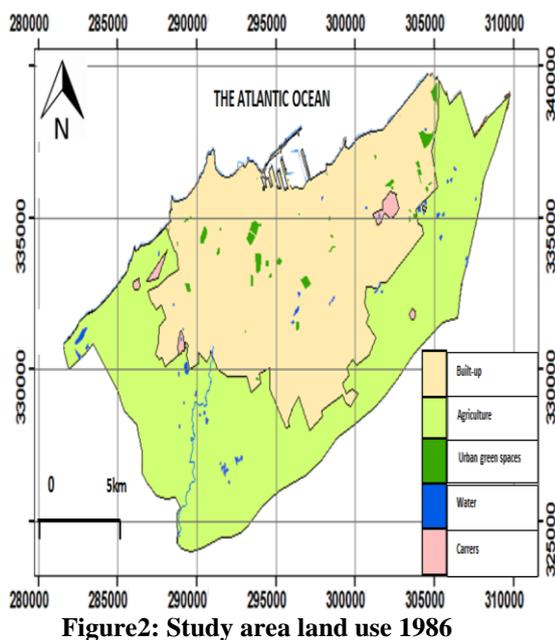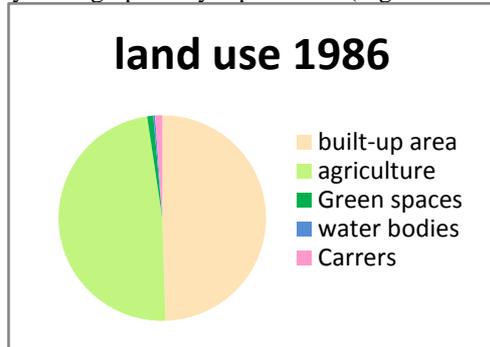

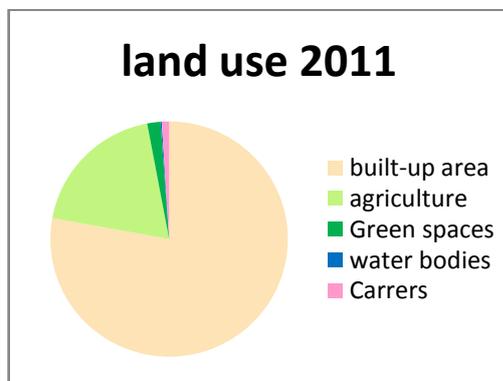**Figure2: Study area land use 1986**
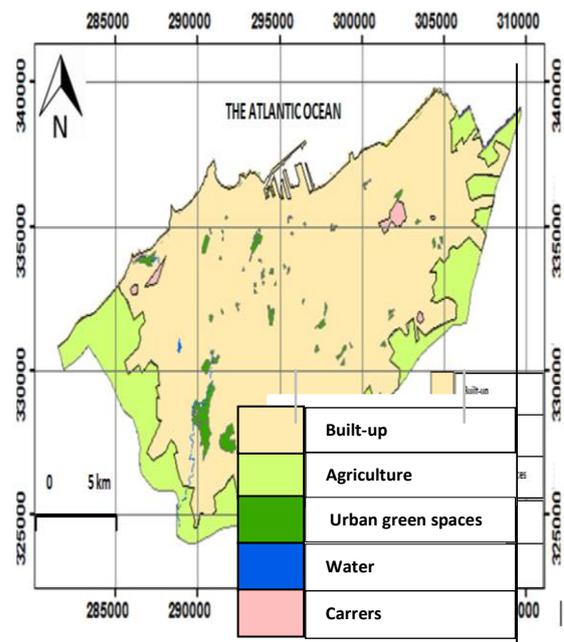
Figure3: Study area land use 2011

The surfaces of all classes were calculated and they were graphically represented (Figure 4 and

5).

Figure4:Distribution of Land usemap 1986

Figure5:Distribution of Land usemap2011

The statistics of change of land use are showed inTable 3.

Land use class	Land use 1986 (sq.km)	Land use 2011 (sq.km)	Difference (sq.km)	Change %
Built-up area	107,16	168,47	61,31	57,21
Agriculture	104,17	41,5	-62,67	-60,16
Urban public green spaces	2,04	3,9	1,86	91,17
Water bodies	0,61	0,36	-0,25	-40,98
careers	2,42	2,17	-0,25	-10,33

Table3: Summary of land use classification area statistics for 1986 and 2011.

The built-up area changed from 107, 16 sq.km in 1986 to 168, 47 in 2011, an increase of 57, 21%. This increase in the built-up area is due to the rapid demographic growth and to the rural exodus. In additionto the metropolization and the mobilization of the inhabitants to the secondary urban centers located in the immediate proximity of Casablanca.

According to the statistics given by the World Bank report of 2011Casablanca will know an increase of 1, 5 million inhabitants in the horizon of 2030, and a need of housingbetween 750 000 and one million, as a resultthe rise of the built-up areas will be more and more important Thing that will affect directly the agricultural area that is already ravaged by the urbanization sprawl[15].

Urban expansion from 1986 to 2011 revealed that urbanization mainly occurs on the account of agricultural soils that doesn't represent more than 41,5sq. km in 2011 instead of 104,17 sq. km in 1986, it means a percentage change of 60,16%.

The agricultural lands are a victim of the urbanization sprawl of the city of Casablanca thing that can be even worst in the future.

Many urban parks exist in Casablanca we can say as examples the most important that of la LigueArabe (28 ha), l'Hermitage (15 ha), Murdoch (6 ha) and Sindibad park(40ha) adding to this some parks which are next to administrative prefectures like Hay Hassani, Ben M'Sick and Ain Sebaa. From 1986 until 2011the total surface of public green spaces increases from 2,04 to 3,9 sq. km in a total surface of 219,00sq.kma percentage change of 91%. However, the number of   sq.m/inhabitant   doesn't   exceed 1.3sqm/inhabitant,   largely   low   to12 sq.m/inhabitant given by the IOH (International organization of health)[16]. The public authority are in conscience of the actual problem as it was declared in a speech with one of the Casablanca responsibles[17] and this explains the efforts and the launch of several projects in some provinces aiming at achieving several parks and green spaces for the benefit of citizens.

The water bodies has known a decrease of 40.98%,from 1986 to 2011. Period during which several wetlands have disappeared.The most known ones that exist in 2011 areSindibad Lake, Dayat El oulfa, the source of Sidi Bernoussi and the river of Bouskoura for which the flow section in its passage through the town is very small. The work of Bachir Alami etal. in 2011on the river, has allowed to carry out a flood map and thus locate areas at risk. InCasablanca,   the majority of ancient sources identified in 1986 as AînDiab,   AînSebâaand AinChokdisappeared,Some are being engaged in the sanitation network like the source of Sidi Bernoussi,results that are in accordance with the results given by the economist source[18].

Regarding careers, they are about 91 in the greater Casablanca including those which are active and also the non-active ones, they have played an important role in the demographic development of Casablanca which required a huge need of construction materials (aggregates, cement, stones ...). In 1986, the majority stood on the edge of the town, while in 2011, they are in an urban setting. Besides the career of SidiAbderrahman, that of Thomas, and Ahl al Oughlam, which currently constitute the "archaeological park of the city" some have been transformed into landfills such as Mediouna, others for the majority witnessed the proliferation of slums around the site by a population from the rural exodus.[19]

V. CONCLUSION

In this paper, land use changes in Casablanca, Morocco were evaluated using GIS and remote sensing based on 1986 topographic sheet and Spot image sat of 2011.The results indicate that the changes observed on public green spaces, water bodies and careers are not significant reduced to the total area of the city (219 sq.km).But the main changes observed for this time period is that of urban area and agriculture. Indeed, in 1986, urban area and agricultural land was divided almost the entire surface of Casablanca respectively 107 and 104sq.km. In 2011, urban area was dramatically increased about 61sq.km, in contrast agricultural land was decrease about62 sq.km. In other words, for a quarter century more than a quarter of land use of Casablanca changed corresponding to half of the area for agriculture in 1986 which was converted into settlements. The most significant reason for this is the establishment of a steering urban development scheme in 1985 which define over a period of 25 years the major axes of the future development of Casablanca and extend the urban area with 215,00 sq.km in the great Casablanca at the expense of the rural area. To this is added the launch in 1998 of the program of 200,000 homes per year to absorb the growing demand for social housing and give houses to slum residents.

In the future, the development planned for the city of Casablanca by SDAU2010is that of urban growth from peripherique poles. Therefore, future studies of land use of the city of Casablanca should include satellite towns like provinceNouaceur, Mediouna,prefectureofMohammedia and Dar Bouazza.

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