Mapping Areas at Risk of Forest Fires Using the GIS and Remote Sensing in the Hinterland of the Tangier Med Port (Morocco).

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Abstract- Moroccan natural environments have undergone in recent decades considerable degradation related primarily to the development of populations and the pressure they have exerted on natural resources.
One aspect of this degradation lies in fire drills that are selling fire to forest in an accelerated to an alarming way. The studied area belongs to the forest zone of Tangier DPEFLCD which spreads over an expanse of 42.000ha.
This latter is known for its sensitivity to heat especially because of the nature of the vegetation cover, weather conditions (chergui frequent and strong wind) and high population density.
This work aims to prioritize the parcel study area according to the fire risk level using the method DAGORNE Y.DUCHE To achieve this goal, the application of GIS and REMOTE SENSING is needed to develop a fire risk map in the hinterland of Tangier Mediterranean port.

Keywords- fire, SIG, remote sensing, Tangier Med port.

1 Introduction

The analysis of the forest fires situation in Morocco displays that during the last fifty years-from 1960 to 2009-nearly 12912 fires have damaged 149292 hectares of forests; that is to say, an average of 2986 hectares annually; with a maximum in 1983 and the minimum was in 2002.This annual average surface represents 0.05 percent of the total surface of forests in the country.

The amount of fires and the burnt surfaces were assessed as relatively high, when compred with the very low rates of tree planting in the country, and to the aridity of the climate and the constraints making extremely difficult the regeneration of the wooded spaces (reforestation regeneration).

The study area is located on the upstream of the axis of the Mediteranean port and Ksser Sghir river. It belongs to Tangier's peninsula, located in the north-west of Morocco. It covers a surface of 193km2; it includes three ponds (Qued Rmel pond, Ksar Sghir River, Qued Ghlala pond, restricted to the north by

the Mediteranean Sea, in the east by Tetouan city, in the west by Tangier city and in the south by Arache city

2. The Methodological Approach:

The appraisal of the forest fire risks made the object of many research documents and many indexes of fire risks have been established.

The index that concerns us in this work is realised by Dagorne & Duche on the Mediterranean forests.

The index of the paradigm is given by the following formule:

$$IR = 5IC + 2IH + IM$$

IR : fire risk index
IC : combustibility index
IH : human occupation index
IM : Topomorphological index

2.1 Topomorphologial Index (IM):

The slope has a significant influence on the pace of the spreading of fire, and on the glowing necessary to the spread of fire which is important, in fact, to the rise of fire. The powerful push of the fire exerted vertically to an angle by the direction of fire extention, and more bounded than the slope is rigid, so we can observe the flow of the hot gazes of fire towards the vegetation which is unburned yet.

The implemented morphological settings on the topomrophological model are: the slope, the exposition and the

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height. The combination of those three settings is expressed by the following equation:

$$IM = 3p + (m+e)$$

p: Slope.
m: Topomorphologial.
e: The exhibition.

2.2 Combustibility Index (IC):

In order to estimate the combustibility, we adopt the paradigm developed by MARIEL, whose combustibility index is in the form bellow:

$$IC = 39 + 0{,}23BV\ (E1+E2-7{,}18)$$

BV : the biovolume of Vegetation
E1 : the combustibility grades for high woody
E2 : the combustibility grades woody heights.

2.3 The Human Occupation Index (IH) :

To assess the effect of human influence on the risk of forest fires, the following model is adopted:

$$IH = IV + 2ID$$

IH : the human occupation index
IV : the neighborhood index.

3. Results and Discussions:

The fire-risk index, first objective of this research is considered as a model giving each parameter a coefficient of balance according to its inference in fire spreading.

3.1 Topomorphological Index Card:

Elaboration of the topomorphological index card as the 2nd illustration shows is done by the superposition the three cards made according to the Tomorphological Index formula.

The distribution of the topomorphological categories shows a dominance the classes (not much favorable) and (fairly favorable) which are everywhere in the area. As for the favorable class, it is located over some pieces of land in the north-west, north-east, hanging pieces of land favorable to fire is rare.

The topomorphological index card data (figure2) show that over 61 % of the area doo rot have conditions that give prominence to fire, followed by fairely favorable conditions with 30% whereas favorable and very favorable areas make only 7% and 1% respectively.

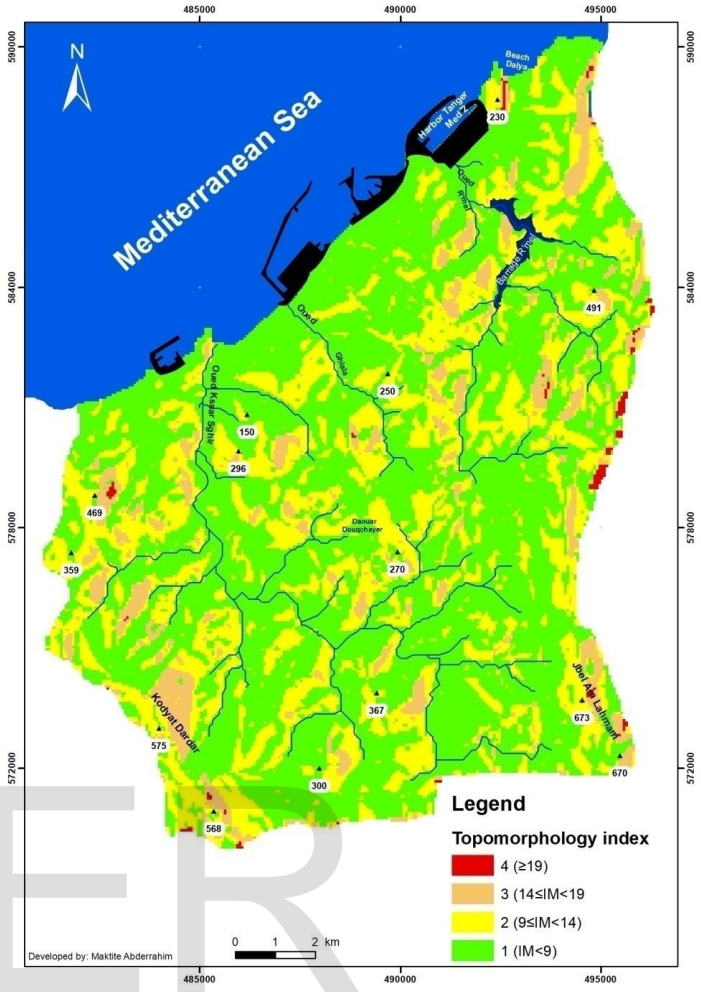


Figure 2: Topomorphological Index Card.

3.2 Combustibility Index:

The combustibility card was made after the NDVI card of the water and forests improvement plan in Tangier (2004). The plant cover density presented by the combustibility structure (BV: plan by biomass) besides its flammability (water… percentage) are two important factors for forests fire expansion. These two factors are calculated according to the vegetation card database by following the combustibility index formula show, by the methodology.

The combustibility was determined according to satellite images and caloric intensity grades of species (E1 and E2) were taken from that made by (CEMAGBEF).

The combustibility index card was divided into 4 classes according to resistance to fire. The distribution of the difference of ground occupation (figure 3) answers the conbined influence of a multitude of ecological parameters (climate, soil type, altitude, slope exhibition, slope etc) and anthropogenic actions (wood sampling etc…)

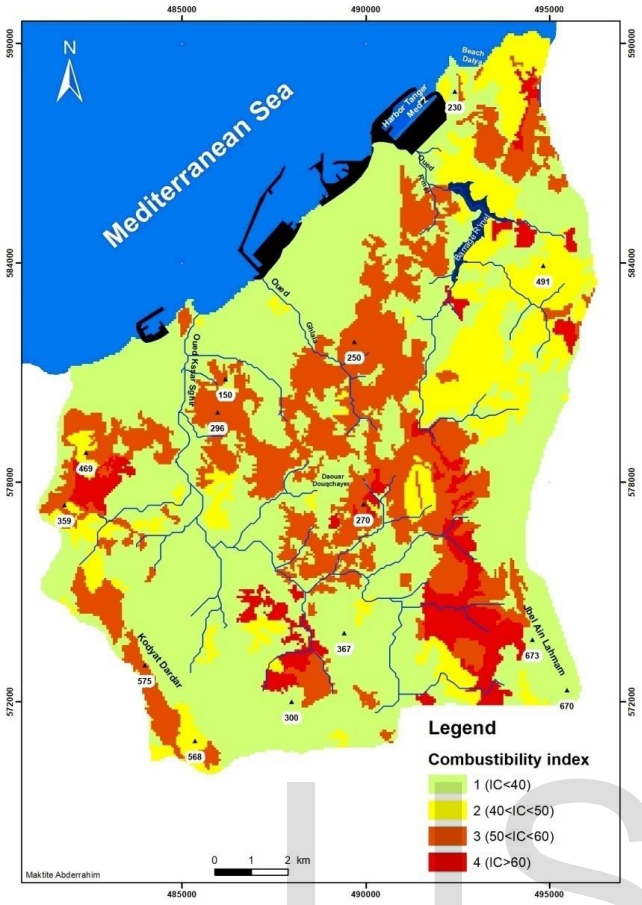
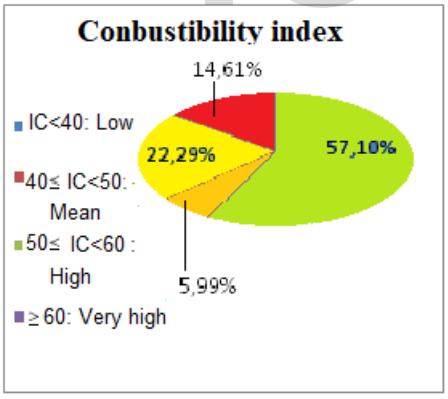


Figure3: Combustibility Index Card



The database processing contributed to the realization of this table in which the surface percentages of the different combustibility index classes are rendered.

The elaborated results of the card show that 57% of the pieces of land have low fire risk with a surface up to 110.6 km2, followed by high risk areas with 22%, whereas the areas with average fire risk were only 14% and 6% respectively.

3.3 Human activity index :

In order to evaluate human effect on fire risks, we have digitized the different roads, paths and housing zones using goode Easth with an influence zone of 100m over each element and finally, we encoded them from 1 to 4 according to the distance between the forests.

3.4 Fire risk index card:

Three layers intervened in the realization of the fire risk index, like the topomorphological index, the combustibility index and the human index according the following formula:

$$IR = 5IC + 2IH + IM$$

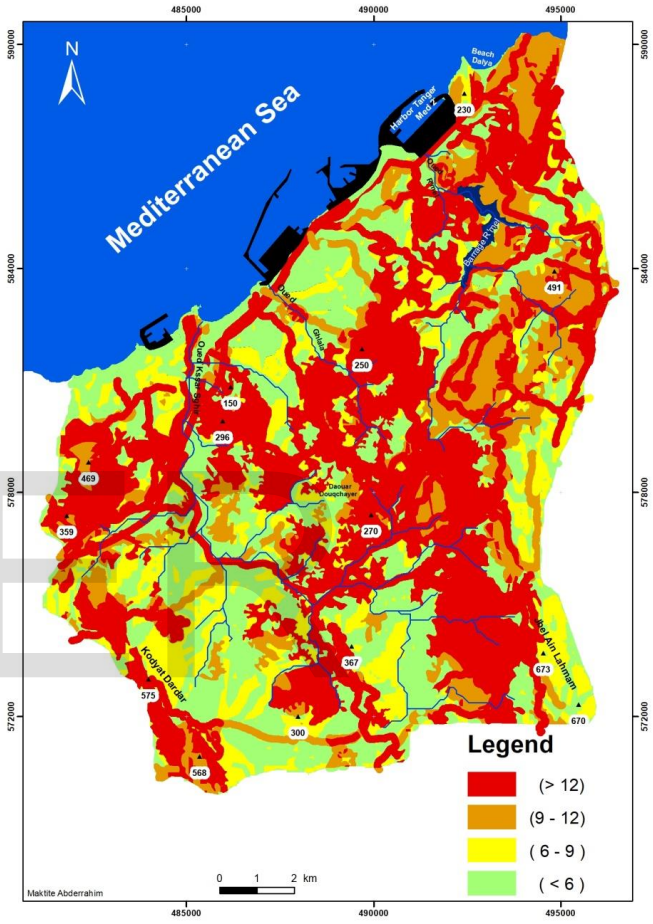


Figure 4 : Fire risk index card

Class	Meaning	Area	%	Coded
IR < 6	Low risk	1,43	1%	1
6 ≤IR<9	Medium risk	80,53	42%	2
9≤IR<12	High risk	17,3	9%	3
IR ≥12	Very hih risk	94,42	49%	4
		193,68	100%	

Table 1: For risk index classes.

The table shows that the very high and average risk zones are and the most dominant with a percentage up to 49 % and 42%, (respectively) as for (low and high) they represent very low percentages in comparison to other zones.

4. CONCLUSION:

Forests fires are due, not only to some natural causes but also to different human intervention in proportion to the size of human activity in any given area especially to the series of groupings located on different roads sides.

The fire risk card made by this method is defined as the sum total of many parameters, it is not going to help fight fire , but it remains a medium through which we get more information about the area's most vulnerable to fire in order to intervene on the spot with a sustainable managment.

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