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Urban Occupancy of Areas with Flood Risk and Territorial Dynamics: The Case of the Great Nador Agglomerations (Morocco)

Ocupación Urbana de Zonas con Riesgo de Inundación y Dinámica Territorial: El Caso de las Aglomeraciones del Gran Nador (Marruecos)

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Abstract

Flooding in the urban environment has long been a major concern for territorial actors as well as for the local population in the Great Nador region. It affects, in a recurring way, the main urban agglomerations and the peripheral zones which surround them. Due to high population growth, a trend towards urbanization and climate change, the causes of floods are changing, and their impacts are intensifying in this area. These phenomena constitute a major obstacle for development and threaten the populations, especially in the peripheral districts which are in rapid urban expansion. This article aims to analyze and inventory the economic, social and environmental consequences of the recent flood events in Nador, while explaining the elements of an integrated approach to flood risk management in urban areas.

Keywords: urban environment, flooding, territorial dynamics, Nador, Morocco.

Resumen

Las inundaciones en áreas urbanas han sido durante mucho tiempo una gran preocupación para los actores territoriales, así como para la población local en el Gran Nador. Afectan, de manera recurrente, las principales aglomeraciones urbanas y las zonas periféricas que las rodean. Debido al alto crecimiento de la población, una tendencia hacia la urbanización y el cambio climático, las causas de las inundaciones están cambiando y sus impactos se están intensificando. Estos fenómenos constituyen un obstáculo importante para el desarrollo y amenazan a las poblaciones, especialmente en los distritos periféricos que se encuentran en rápida expansión urbana. Este documento tiene como objetivo analizar e inventariar las consecuencias económicas, sociales y

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*Urban Occupancy of Areas with Flood Risk and Territorial Dynamics:
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ambientales de las recientes inundaciones en Nador, al tiempo que explica los elementos de un enfoque integrado para la gestión del riesgo de inundación en las zonas urbanas.

Palabras clave: medio ambiente urbano, inundaciones, dinámica territorial, Nador, Marruecos.



1. INTRODUCTION

The province of Nador, located in the North-East of Morocco, extends on a maritime facade of 153km and an area of approximately 3263 km²; occupying 3.94% of the whole eastern region; an area of (82820 Km²). This territory is characterized by rugged and diverse relief, which consists of 34.8% plains, 35.2% mountains and 30% plateaus. At the geological level, the province of Nador is considered as the structural term of passage between two large domains, the Rifain one which is situated on its western edge and the middle Atlas units to which belong its southern units. Except the units of the Rifain chains in the north and north-west (the volcanic massif of Gourougou and the Cape of trois fourches) and the units of the atlasic chains in the south (Kebdana and Beni-Bououyahyi massif), the territory benefits from huge depressions, bowl-shaped, in the central zone (depression of Kert and Bouareg, sabra depression). Similarly, the coast of the province of Nador has a large number of beaches that are generally located between the mouth of the wadi Kert and the Cape of Trois Fourches. The lagoon of Nador, the "Sebkha de Bou Areg-Mar Chica" is the largest lagoon in Morocco, with an area of 115 km² (Dakki, M. 2003).

The province of Nador has a Mediterranean-type climate; which is distinguished by the succession of two contrasting seasons. Rainfall is rare and often falls in the form of storms with high-intensities. The data collected, at three stations, in the Bouareg coastal plain show a succession of very dry years (143 mm in plain in 1998) contrasting with wet years (489 mm in 2008). Torrential rains, sometimes exceeding 100 mm a day, are quite common; they are at the origin of a certain number of overflows at the main agglomerations of the territory. The amounts of rains recorded on 25 / 11 / 2008(125 mm) were at the origin of the floods of November 2008.

Hydrologically, the region presents the characteristics of the Mediterranean coastal basins; it has generally temporary and short water courses, with small watersheds. Perennial rivers are few because of the arid climate and the scarcity of the mountains' groundwater. The few permanent rivers are reduced to open sewers (Selouane, Caballo, Skhoune, Akhandouk, Arkmane ...), whose floods are sometimes violent.

At the demographic level, the province of Nador counts in 2014 a population of 565426 inhabitants, of which 64.11% live in urban zones and 35.89% in rural ones, with a positive average rate of increase of 0.98% (HCP 2014). The density is the highest at the regional level, with 180 inhabitants per Km².

The Great Nador has an important territorial dynamic linked to deep economic, social and spatial changes. This phenomenon is particularly evident in the transformation of small urban centers into an urban archipelago that extends actually over more than 30 linear km. These centers evolve through a process of densification, concentration and hosting activities of all kinds (tourism projects, industrial, port, housing, tertiary sector etc...). In this territory the changes are perpetual; the urbanization is currently experiencing a spectacular spatial dynamic, generally poorly planned. This accelerated action of urban sprawl has directly led to the annexation of vulnerable areas to urban spaces, and indirectly, to a huge upheaval in the spatial organization of the cities.

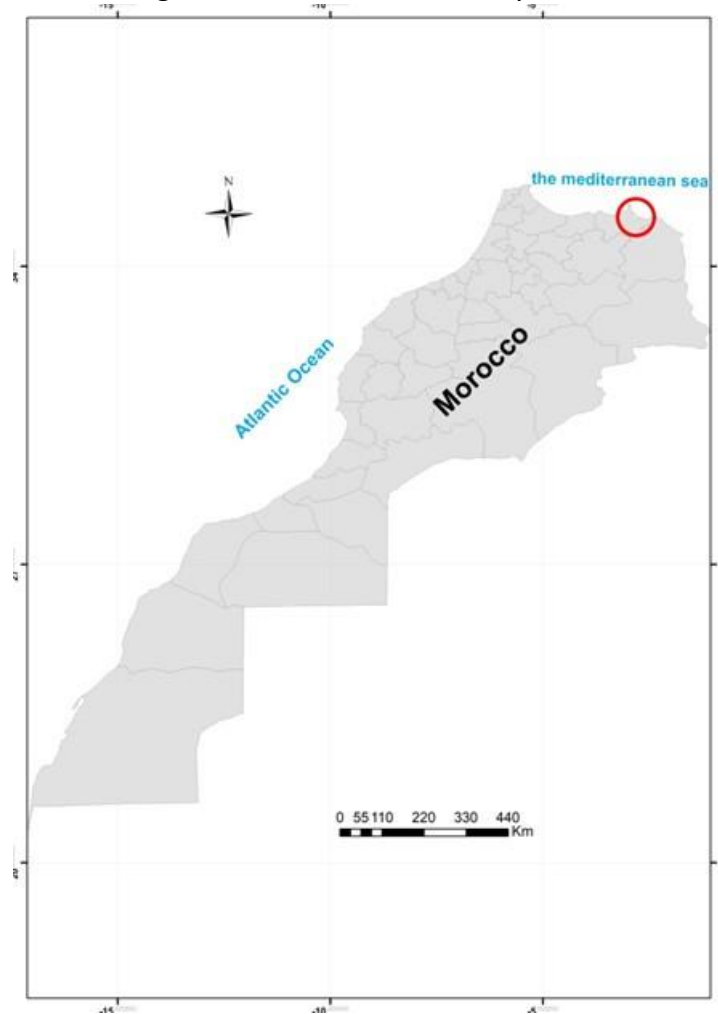
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Figure 1. Location of the study zone.



This new relationship, created between this territory and the risk of flooding is an important subject to study and examine. The aim is to understand the evolution of spatial dynamics in this fragile and vulnerable area, and to highlight this spatial phenomenon which is very useful in the process of rational urban planning.

In this sense, and in order to highlight the perpetual spatial transformations in this territory, it will be necessary to question two essential issues which, by their great importance, may call into question the logic of intervention in the territory:

- How do spatial recompositions, in the urban environment, lead to an urban dynamic that develops and extends to risk areas, while creating new vulnerabilities?
- How does the risk of flood fit into the urban dynamics and influence, at different scales, the spatial organization of the studied territory?

2. THEORETICAL AND METHODOLOGICAL FRAMEWORK

It is remarkable that the term of the risk remains associated with several domains: technological, urban, human, social, environmental, demographic, economic, and even heritage risks, (Wackermann, G. 2004). As for natural hazards, in particular, they are not always well defined, because they are immersed among other risks, with which they do not necessarily have elements in common. Geographical research on this topic is still fairly recent to highlight the similarities and discrepancies in the definitions; and it is worth mentioning that the notions used are clarified and begin to be challenged; and also too early so that researchers are interested in different aspects of risk, without being limited to immediately operational approaches, (Peltier, A. 2005).

From the beginning of this work, we have chosen a sufficiently precise vocabulary to handle this study and to institute a dialectical structuring of our problematic. This problematic attempt to study the vulnerability of the Great Nador territory to natural hazards, from the perspective of the fundamental role of the socio-anthropic factor, and to understand the dynamics of this territory linked to the risks of flooding.

To approach the subject of analysis of natural risks in the territory of the Nador province, we have necessarily recalled certain concepts and notions, which are used in this area, and which are often differently defined by researchers. Our objective is to overcome the lack of precision in terms of the definitions attributed to these concepts and which constitutes a confusing course for new researchers who are interested in natural risks. The recommended approach to lead this subject is to choose and define a vocabulary sufficiently determined, specific to the risk analysis, which will allow progressively a logical structuring in the process of handling our problematic.

In addition, a conceptual diagram is put in place to explain, as far as possible, the phenomenon of the spatial dynamics of the main agglomerations in the territory of the Great Nador. Schematically, the main objectives are, on the one hand, to show how the site of implantation of the district and its morphological development combine to increase the probability of exposure to risk, and on the other hand, how the newly created risk generates a 'reverse' dynamic towards other safer places.

Our methodological approach is based on the implementation of a set of tools and sources of information allowing a complete and integrated analysis of the problematic of natural hazards in this territory. Interviews with risk management actors and local elected representatives were one of the bases of this work. The first step was to assess the knowledge of the various types of risks present in the studied territory and to understand the main lines of their management, in order to highlight the difficulties encountered in the implementation of public policies. In addition, surveys were conducted with local populations to understand their perception of the natural risks to which they are exposed.

The historical dimension of this study was approached on the basis of bibliographic research (Taous A., et al. 2010). Administrative records and reports from the Urban Agency and the services of the Housing Ministry have been helpful in supporting our results from the field. Similarly, a systematic

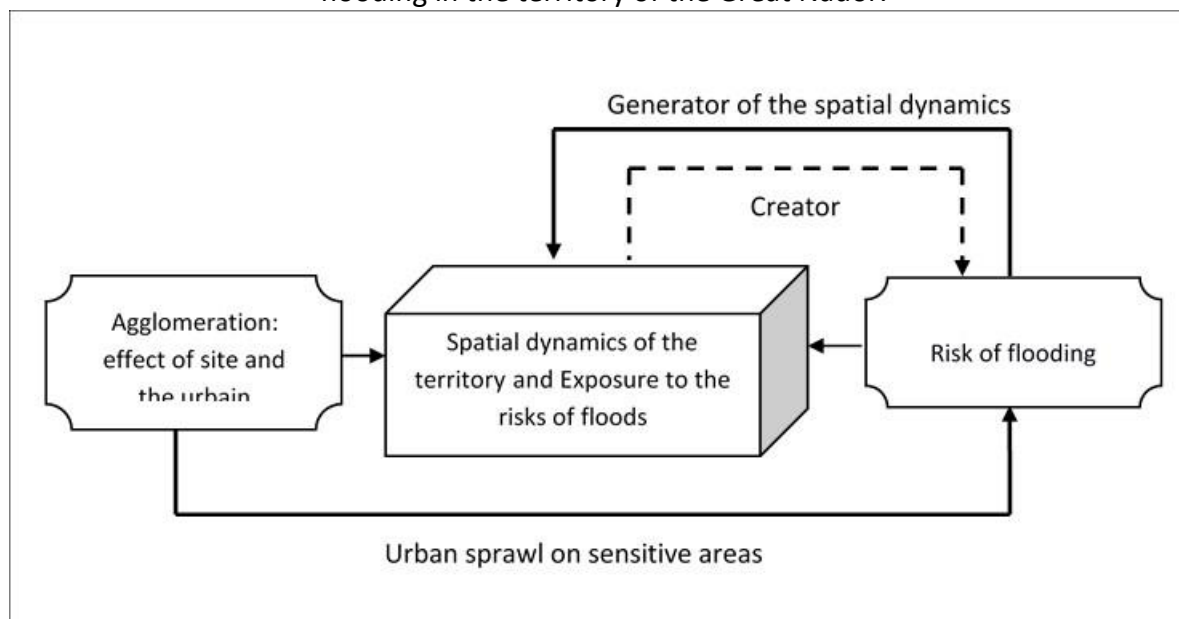
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Figure 2. Conceptual diagram relating to the territorial dynamics and exposure to the risks of flooding in the territory of the Great Nador.



Source: Personal work.

collection of press articles pertaining to natural hazards was conducted in local and national dailies. This work has been supplemented by more spatially and thematically focused field research. The exploitation of aerial photographs from different missions allowed us to map and grasp the evolution of the built space during the last decades.

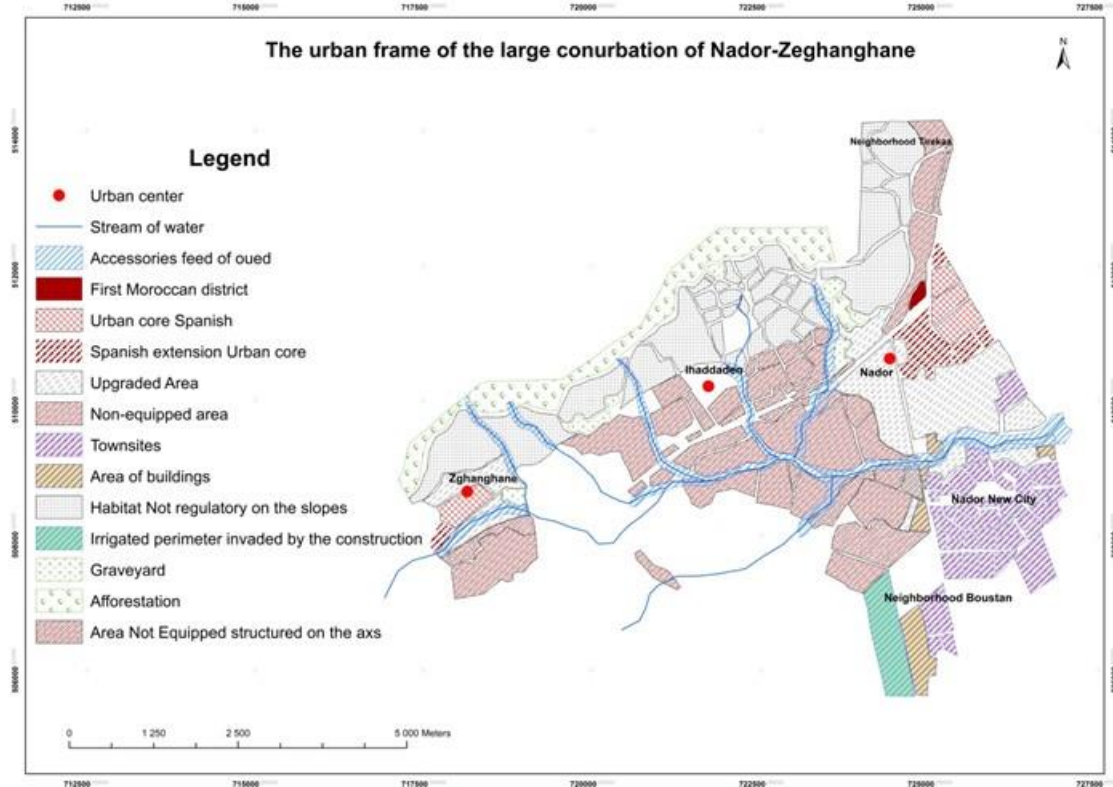
3. RESULTS AND DISCUSSION

The urban environment of the Great Nador territory is still growing with a rather fast and exacerbated pace, by spreading in all directions following several logics. This has resulted in a fairly complex urban fabric containing all forms of non-regulatory and under-equipped habitat that presents enormous challenges for urban management (ABOUHANI et al 1988). The constraints of the topography, the landscape peculiarity of certain sites and their vulnerability have not been taken into account in urban manufacturing. Currently, this space has a complex morphology, where the implantation of more than 60% of neighborhoods has not been planned (Naji, O.2014) Development trends occur in a random way, generating spatial transformations that are not very reversible, with a very high degree of artificialisation of the soil (Figure 3).

This urban landscape does not offer a living environment, decent, pleasant and aesthetic. The sprawling and anarchic development of neighborhoods following the logic of the cheapest land, could not give a clear picture of the big future city. In reality, local actors responsible for urban planning, under the effect of multiple pressures, social, political and speculative; continue to adopt an approach that is still curative and punctual for the treatment of urbanization cases, recognizing of course the mistakes of the past, while just trying to manage the crisis (D'Ercole, R., 1994). Even

after the approval of planning documents for urban centers, their implementation and their applicability does not exceed 10%, (MHUAT 2008).

Figure 3. The urban frame of the large conurbation of Nador-Zeghanghane.



Source: Restitution and development plan of Nador 2016.

3.1. INCREASING VULNERABILITY TO FLOOD RISK

Due to climate instabilities, significant population growth and a blatant trend (tendency) to urbanization, the causes of floods are changing and their impacts are intensifying in this territory. For a long time, the city of Nador has been the scene of a succession of large-scale flood events that have generated disasters and disruptions to the rhythm of everyday life. The exceptional climate event of 25-11-2008 caused disastrous floods, leading to the destruction of many houses, while breaking the record in terms of the affected population, and flooded infrastructure. A daily rainfall of 125 mm has resulted in catastrophic floods, (ABHM,2009) endangering people and their property, especially in rapidly expanding urban areas.

Today, the territory of the Great Nador lives at the rate of spatial dispersion of urbanization and the invasion of sensitive areas, which results in a growth of amorphous and fragmented urban fabrics, where the risk of flooding is a crucial problem for the actors. The impacts of floods are not evenly distributed, they are very important in populated and high-stakes areas and less important in less populated areas. (Laroussi, B., 2008). The uncontrolled expansion of the agglomeration during the



Figure 4. Impacts of floods on roads infrastructures in Nador (November 2008).



Source: Personal work.

Over the last decades in the risk zones accentuates its vulnerability to the phenomena of floods. The analysis of the ancient aerial photos and historical documentation shows that the Great Nador area, specially near the main rivers, was almost empty of any type of construction until the end of the fifties. Indeed, there were only small localities composed of a few scattered houses of native inhabitants (hamlets on Nador, Ait Ansar, Selouane,...). The area of the plain and "Sebkha de Bouareg" has been strictly safeguarded and reserved for agricultural activities and fishing.

Table 1: Damage to the building in the great Nador in 2008.

Province	Commune or municipality	Totally destroyed housing	Partially destroyed housing	Total
Nador	Nador	05	60	65
	Zeghanghane	00	35	35
	Alaaroui	01	20	21
	Beni Bouyafrou	00	43	43
	Iksane	00	30	30
	Selouane	03	79	82
	Bouarg	20	33	53
Total	07 communes	29	300	329

Source: Provincial flood committee, 2008.

The analysis of these images shows profound transformations that have occurred over the past 50 years in the territory of the Grand Nador due to the dynamics of space and the expansion of urbanization in the flood zones (Khattabi, A., 2007). The current urban landscapes are archipelago-shaped, which has developed along roadways, despite physical, natural and ecological constraints. This human settlement has developed, for the most part, in a marshy and floodable zone, by encumbering the beds of the rivers. The urban fabric has been inserted by force, between several remarkable areas (Figure 5). At the North and the north-west, the Mount Gourougou and the cape of trois fourches (two sites of biological and ecological interest), in the south and south-west the

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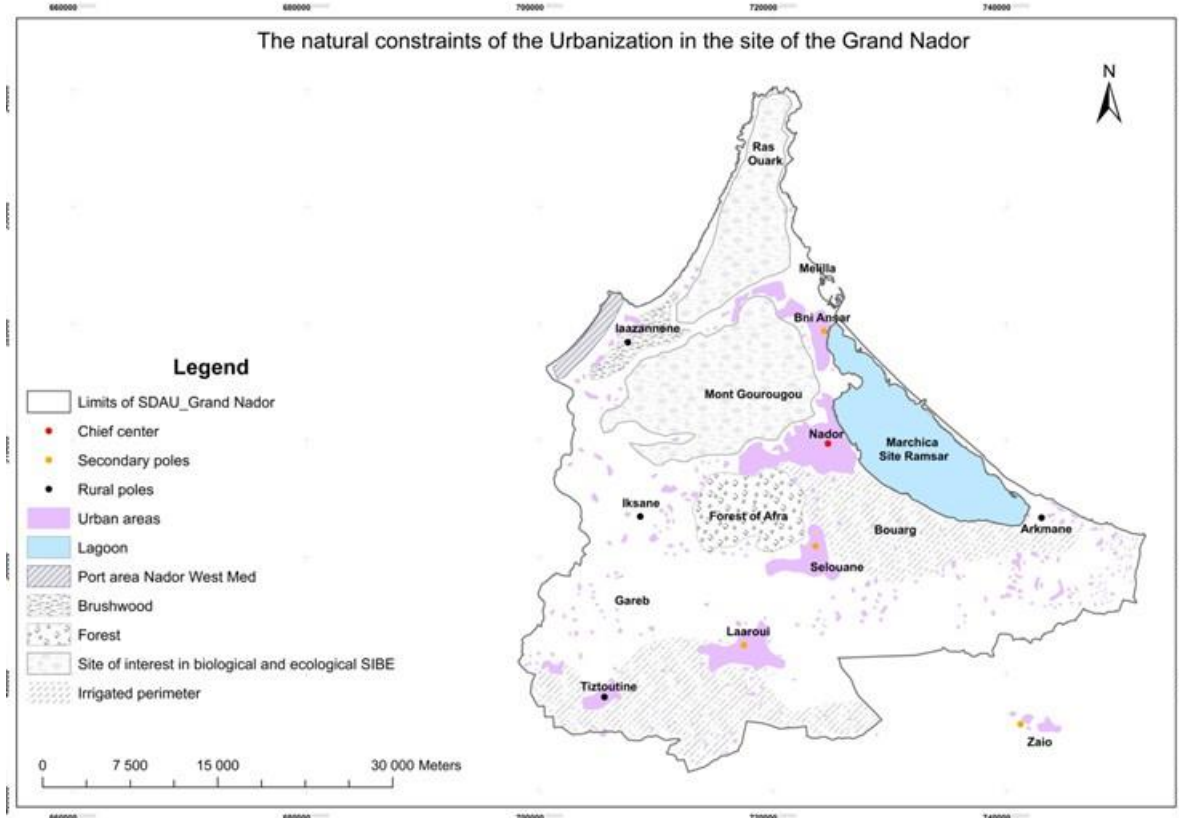
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irrigated perimeter and the forest of Afra, in the East the site Ramsar of the Marchica Lagoon. It is certain, therefore, that the south was the only outlet for a more and more urgent expansion.

Figure 5. The natural constraints of the urbanization in the site of the Grand Nador.



Source: Personal work.

Historically, the processes of urbanization of the natural site of Great Nador (currently half SIBE) go back to the Spanish colonial period 1909-1956, where it appeared the first district with a very organized urban look. Nevertheless, the human settlement at that period was purely military and the urbanization of this site was influenced by this militarization, far from other urban logics. Very quickly, during the years following the independence of Morocco (1956), the area of the Great Nador experienced a visible urban chaos. In fact, since 1950 the town of Nador has developed without order, when the outer quarters are scattered to the south, between the road to Selouane and the coast, which was precisely the perfect zone for a rational extension (Bravo A.N., 2005). Today the territory is reaching a saturation of land, where the urban planning faces an endless process of spatial extension (Figure 8). Indeed, following the accelerated rate of all dynamics, the accumulated capital from the period of prosperity due to the counter-gang and immigration, were invested in the purchase of unserviced land (Naji, O.2014). This commercial dynamism was accompanied by a massive influx of rural population attracted by employment opportunities (Naji, O.2014). The first result of this phenomenon was a high human concentration in the most environmentally sensitive areas; this has favored urban conurbation at varying rates.



This galloping disorganized urbanization has been accompanied by several fatal phenomena on the urban and environmental plans:

- A very significant development of suburbs and illicit peripheral areas in zones less favorable to the reception of the population (flood zones, sensitive areas).
- The integration of rural mergers into the urban fabric, which poses the problem of requalification and recovery.
- The creation of an amorphous and fragmented urban fabric requiring several support and intervention operations for the upgrade (leveling).

This alarming situation is currently raising several questions about the relationship between this exacerbated urbanization and the future of this wetland. Similarly, urban settlement in this area, ecologically rich, raises questions about the reasons for such a historic choice as well as the factors of uncontrolled urban sprawl and its encroachment on areas of floods.

3.2. URBAN SPRAWL TOWARDS RISK AREAS: THE FACTORS OF SUCH A DYNAMIC PROCESS

The urban territory of the Great Nador has a dynamic urban process, characterized by excessive spatial growth, which has become difficult to control. It continues to spread out of town planning measures, encroaching on sensitive and risky areas. This urbanization is motivated by endogenous and exogenous driving forces that animate urban sprawl in sensitive areas:

- A poor knowledge of the land to be built in the development plans of all the urban agglomerations of the great Nador: The newly approved development plans show limited effectiveness as they face a complex reality of the already built centers and a strong land pressure. During their development, technical errors are sometimes made. For example, in the absence of hydrological and hydraulic studies by the Basin Agency, the proposal for the non-aedificandi zone (ZNA) where any type of construction is prohibited is often underestimated; and therefore, their areas poorly represented in the urban plans. This situation means that several buildings are located and authorized in the center of these risk areas.

-A preference to be closer to downtown: Being closer to the city center in order to take advantage of the functions is considered a major issue for a large population. This desire has triggered several operations of illegal division in sensitive urban areas left in a natural state by the original inhabitants who are, really, aware of the existence of the risk. Unfortunately, these operations proliferate especially taking advantage of moments of decline of the state (Arab Spring Period 2011, election period).

-An increase in the price of land: The territory of the Grand Nador lives at a rate of exacerbated land pressure, characterized by a significant imbalance between supply and demand. This situation was generated by fierce land speculation. As a consequence of this phenomenon, the price of land has tripled in recent decades. Actually, financially accessible building land for many people is very rare. Faced with this situation, a large, destitute population finds refuge in the marginal areas of the agglomeration where the price of land is still affordable.

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-The impact of cognitive and perceptual factors: Self-assessment of the degree of exposure of persons to the threat is desirable in the context of integrated natural risk management. Nevertheless, the analysis of the intervention measures at the level of the territory of the Great Nador shows an inefficiency of the policy of awareness and sensitization to the natural risks. As a result, population has a tendency to be fatalistic in the face of recurring risks. For a large population as well as for local actors, the occurrence of a harmful phenomenon is something to undergo and accept. Thus, the few sensitization initiatives carried out show that the quality of the popularized information cannot, under any circumstances, improve a good perception of the risk.

-An attachment of the population to their place of residence: The desire to locate the home near relatives and parents is a fairly common behavior in the Rif region. The young natives of the region as well as the diaspora are very attached to the region of origin. For a long time, some buildings have been installed in areas, despite the frequent threat of natural hazards. At this territorial scale, this behavior calls into question the policy of orientation of the urbanization opted by the local authorities. Indeed, while urbanization is much accelerated in risk sites, subdivision areas are stagnating and live in a situation of latency

3.3. FLOODS: CREATIVE PHENOMENA OF TERRITORY DYNAMICS

It is obvious that the risk of flooding is nowadays a constituent element of the urban entity of the Great Nador territory. It actively contributes to the process of creating the urban landscape of the territories (November, V., 2003). Indeed, the events experienced at this territorial level could change the concepts. Increasingly the risk of flooding is identified and named in the speeches of local actors, showing a certain maturity in this field.

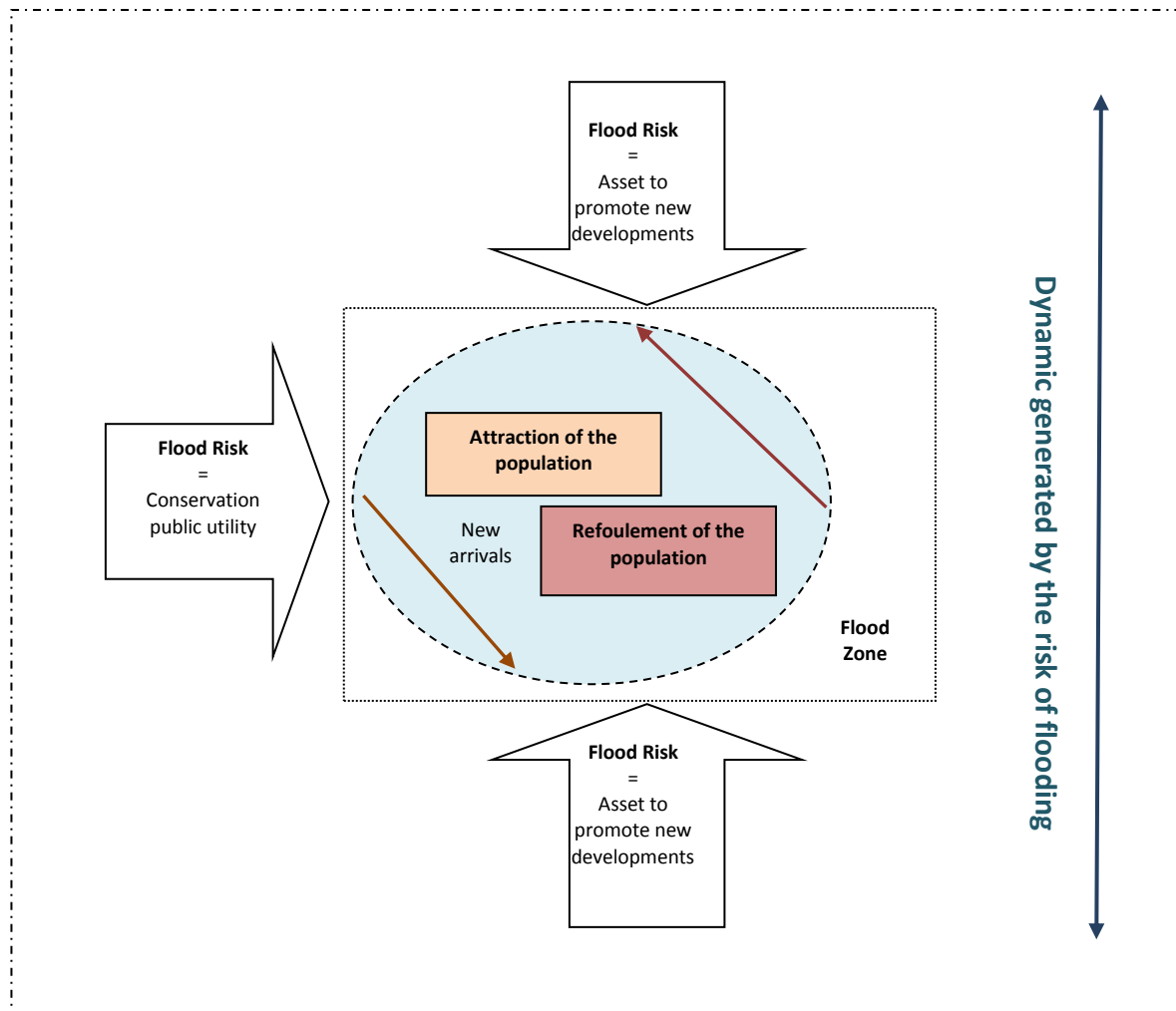
In relation to this dynamic generated by this risk in the Great Nador territory, this axis will aim to identify, through cases, the main spatial and decisional phenomena which give this risk its transformative capacity to create new actions. This could help us to identify mechanisms that have helped to shape the identity of this space.

It is important to underline that the risk of flood has allowed the emergence of new urban forms in the territory of Great Nador. Indeed, the spatial study of this phenomenon shows a paradox in terms of urban management. While the authorities are providing colossal efforts to relocate the affected population following the tragic events, we find that several flood plains are still attracting a population in search of affordable housing. These areas become a refuge for a low-income population (Figure 7). The location of several hectares of flood plain near major rivers has led to a reduction in property prices. Today these floodplains overgrown with habitat constitute more than 10% of the territory of Great Nador. This figure can increase at any time in the absence of a concerted and directed urban policy.

In addition, flood risk is an opportunity to promote rational management of risk areas. In fact, given the increasing degree of exposure of several neighborhoods to the risk of flooding, it is no longer a



Figure 6: Prototype on the relationship created between the flood zone and the urban dynamics.



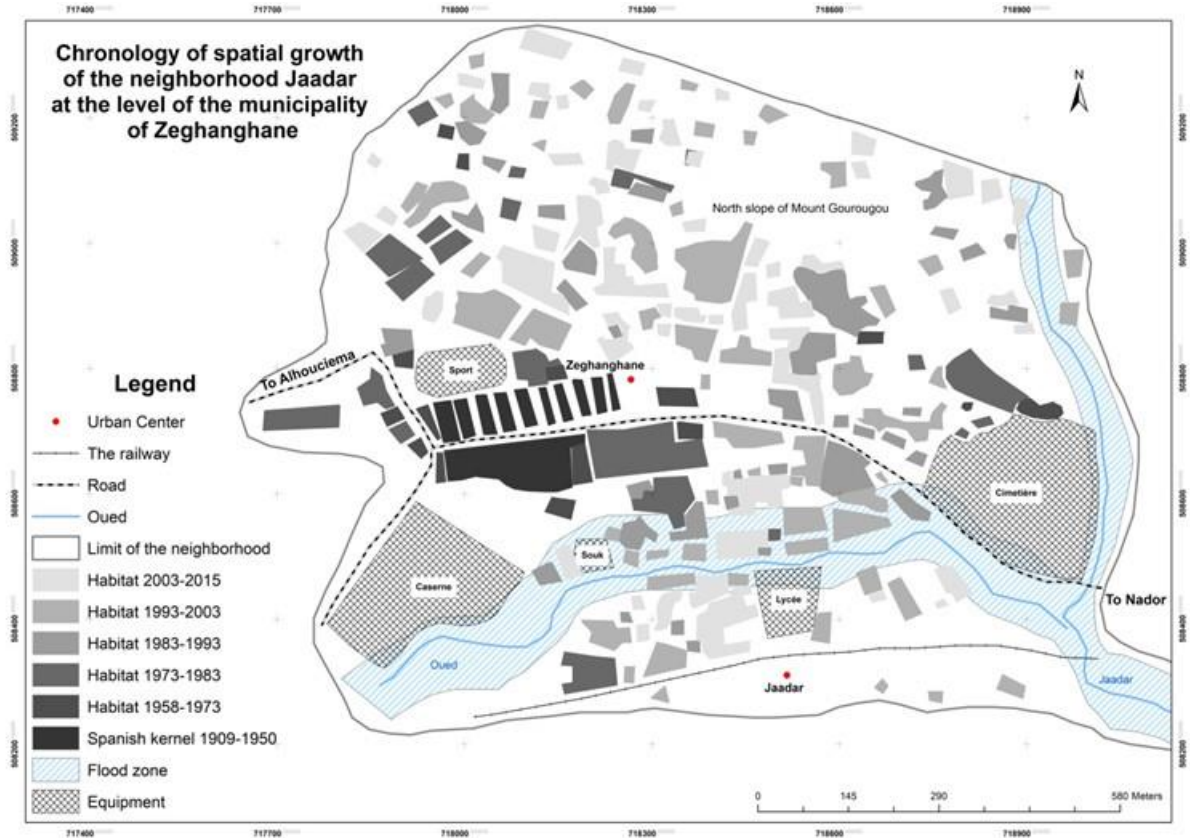
Source: Personal work.

question of conceiving the risk as an external constraint to these neighborhoods, but rather as an intrinsic component of this territory (Reghezza, M., 2007). In this context, some specific event intervention methods, such as engineering protection works or cleaning operations of major watercourses, have been carried out. These actions, unfortunately, have not been able to totally annihilate the flood phenomena whose recurrence generates actually, significant damages, following the increase of the stakes in these zones. In order to overcome this situation of permanent threat, the public authorities are currently obliged to move towards passive interventions to mitigate the effects of floods and reduce the vulnerability of threatened neighborhoods (Thouret, J.CL., et al 1996). In this context, several initiatives in the direction of urbanization, land use and urban innovations began to emerge in the territory.

Similarly, the alarming frequency of floods, in major rivers, has raised awareness among local actors and a certain mobilization upstream of urban planning process, in order to implement more effective protections. In this sense, a remarkable technical, decisional and strategic evolution



Figure 7: Spatial evolution of the peripheral district of Jaadar.



Source: Orthophotos 1999-2012 - SDAU 2009 and field works.

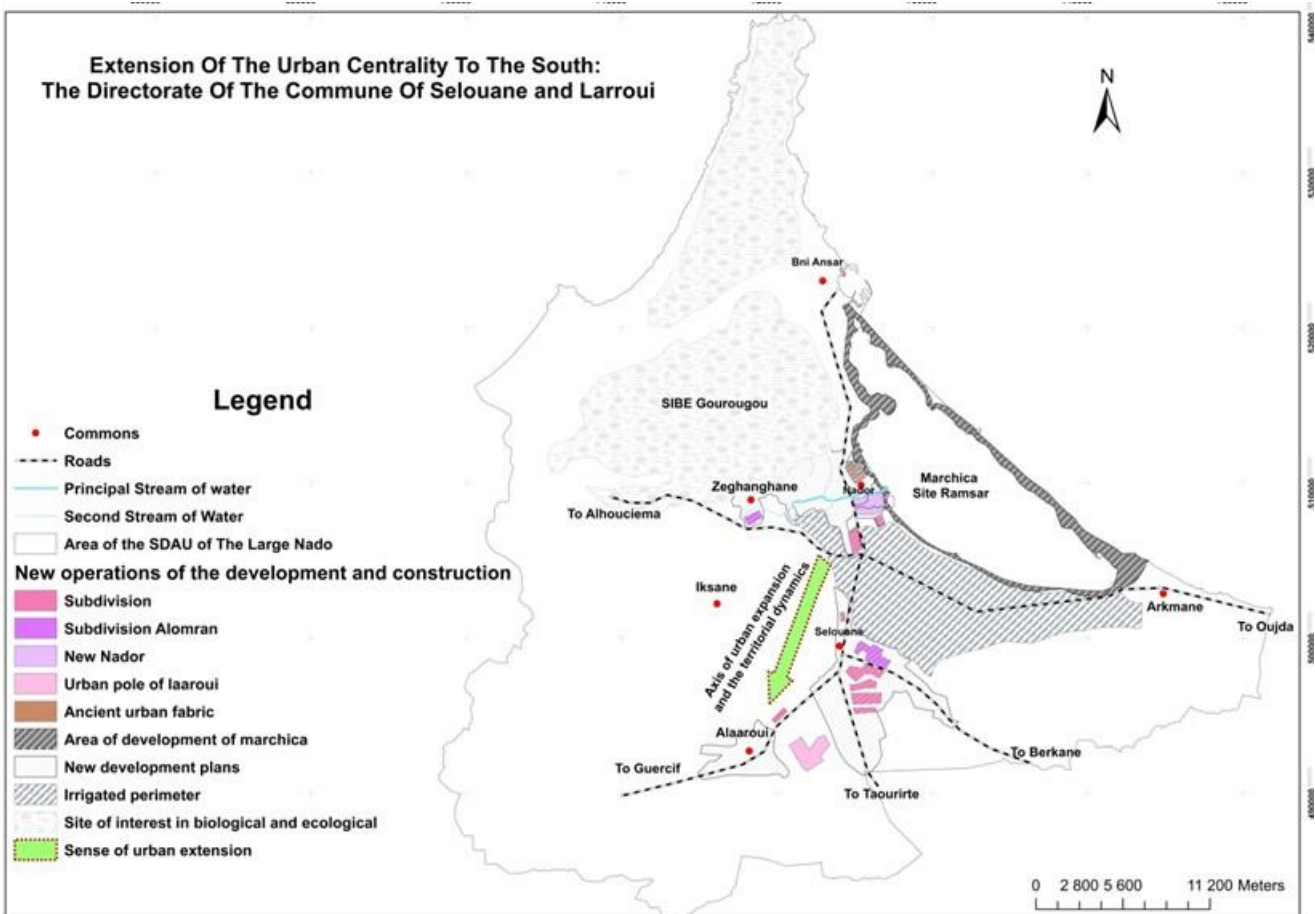
characterized the entire urban landscape of this territory. The urban transfer of the gravity center of the Great Nador, to the municipality of Selouane and the city of Zeghanghane, is today considered as the main action of this administrative awareness. This spatial reality is explained by a new territorial dynamic created following the decisions taken after the exceptional events of 2008. Indeed, since that date, several subdivision operations have quickly emerged to offer a choice for a large affected population. However, the lack of land mobilized at the level of the cities of Nador, Beni Ansar and Zeghanghane, have pushed urbanization to the municipalities of Selouane and Alaroui, which are experiencing a very spectacular urban development due to the availability of land (Figure 8). As a result, two major urban centers are being built over more than 100 km².

Nevertheless, the policy of the reorientation of the urbanization remains modest today to speak of a real shift of the center of gravity of the Great Nador towards the municipalities of Selouane and Alaroui; the administrative center is always at the level of the Nador city. However, subdivision operations (social, economic, villa ...) show a real awareness not to increase vulnerability in flood areas. The authorities in charge show, the will to put in place a choice in front of a population who is looking for a comfortable accommodation with an affordable price.

Finally, it should be noted that flood hazards are also a public utility easement and, as a result, present a real obstacle to the spatial development of the Great Nador's urban landscape. From now on, environmental concerns lead to making this flood risks an essential element of cities planning. The various actors are aware of this situation; so the new generation of development and planning takes into consideration the principle of respect for the free space of watercourses, which is strongly introduced in the process of urban planning. This principle consists in spatially materializing the river's expansion field to dissipate its energy so that it overflows into areas where human security is not threatened. It also consists in ensuring the natural mobility of the bed of the watercourse and avoiding implanting human activities in the immediate vicinity.

Today, considering the risk of flooding as an intrinsic component of this territory, has actively contributed to changing the vision of planners and their partners as to how to take this phenomenon into account in the process of flood control and territorial construction. In fact, the analysis of urban planning documents that are newly developed or under study gives an idea of another vision of dynamics created following past events.

Figure 8. Extension of the Urban Centrality to the South of Nador City.



Source: Personal work.



4. CONCLUSIONS

The diverse landscape of the Nador territory between the mountain and the coast, with specific geomorphological and hydrological characteristics, are all natural factors that generate numerous hazards. Nevertheless, the latest flood events experienced by the local population have made it possible to detect the importance of the anthropogenic factor in terms of the genesis and proliferation of these hazards. In fact, the human interventions in this area have profoundly modified, over time, the hydrological regime of the wadis by shoreline and watershed developments, favoring the acceleration of downstream transfers. The punctual operations have caused significant impacts on the magnitude of the flood, and their combination will eventually worsen the situation in the long term.

Faced with such a sensitivity, we note that this territory is undergoing profound economic and social changes (phenomena of densification, concentration of activities), which are reflected in a rather significant spatial dynamic. This dynamic is inevitably accompanied by a spectacular imbalance following an uncontrolled land demand, in which the areas at risk of flood attract a large population. Indeed, several urban sectors have developed on the field of action of natural phenomena generating risk. This urban situation will have direct consequences on increasing the multiplication of risk zones in urban areas. This spatial phenomenon will further aggravate the degree of vulnerability in several neighborhoods.

On the other hand, although the vulnerability of the Great Nador territory to the risk of flooding is mentioned in the speeches of the local actors, the devoted knowledge on this subject is, until now, diffused; likewise, the culture of risk remains almost absent. Indeed, there is not yet an archive that is both permanent and homogeneous on the reality of the flood hazard at the level of the territory. All the data and information held by the actors are mostly qualitative and scattered. Moreover, the common memory relating to the knowledge of the risk is absolutely non-existent; the population has a tendency to quickly forget past events

The current situation of these dysfunctions explains the delay experienced by the province in setting up an integrated provincial strategy for flood risk management. Initiatives in this context are still basic and are characterized by the punctuality of intervention while being limited to the implementation of sectoral action plans in a context of lack of synergy

The current approach to flood risk management in this province has shown flagrant deficiencies. Indeed, the local authorities are far from ensuring the minimum protection of the districts exposed against floods; the situation is only getting complicated.

Today, following to a political will, this territory lives to the rhythm of great spatial and territorial recompositions. In the face of these changes, it has become of great importance for the concerned actors to rethink traditional systems of spatial planning. This requires the implementation of a bold strategy to address the past urban errors, to prevent the increase of human settlements in areas at risk. the recommended approach must include the evaluation, prevention, intervention and



reconstruction phases in a process of continuous improvement that takes into account past experiences. In our view, this approach should encourage the participation of users, planners and decision makers at all levels, around an open, transparent, global and communicative approach. This would allow a decision-making initiative, including public consultation and stakeholder participation in planning and implementing rational management processes.

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