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Strategic Environmental Assessment Vulnerability of physical, biological and human systems to global risks Region Taza as a model

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Abstract
The world is facing many environmental problems. Pollution, ecosystem and habitat degradation, biodiversity loss (sixth great extinction) are all problems that it is urgent to solve. Some of them, due to their speed and extension, can lead to irreversible damages to the environment. It is in this context that are placed impact assessments on the environment that serve as a backdrop to the analysis of environmental issues. Trends in the environmental impact assessment consist of (1) a strong penetration of the concepts and tools from the theory of information and information technology. Modeling and geographic information system increase the scope, validity and predictive power of impact studies (2) an interpretation of the dynamics of environmental phenomena that highlights the natural potential of lands, the causes of their fragility, their degradation level, and the dynamic processes that are exerted on the lands. Taking into account this dynamics allows the assessment of cumulative effects which is in turn the basis for the pursuit of sustainable development (3) an increasing participation of concerned populations. According to this international movement, the Moroccan mountain, which is densely populated, heavily exploited but extremely marginalized, should be better valued and benefit from a significant boost. The aim of this work is the environmental assessment (through its dynamics), especially research in the environmental impact areas which is among the recognized tools and essentials to foster sustainable development. An interpretation of the natural environment dynamics is able to highlight the land potential, the causes of land fragility, the dynamic processes and the state of degradation. Taking into account this dynamics can address the cumulative effects assessment which is the basis for any environmental assessment. This synthetic work attempts to examine the scope and nature of potential environmental effects and the likely importance of any adverse environmental effects.

Keywords: Environmental Assessment; Dynamic Natural; Resources; Environmental Risks; Sustainability.

Introduction
Morocco is in a phase of environmental transition, concomitant with economic and social transition. The issues and challenges that arise, and the nature and extent of environmental problems, clearly show that the degradation of the ecological heritage of the country, part of which is not renewable, has reached a critical level. Indeed, the level reached may not only undermine much of the economic and social gains of recent decades, but also may limit opportunities for prosperity and well-being of present and future generations [1]. This question is crucial in areas such as Taza region with great diversity and a low priority for biodiversity conservation.
The geographical location of Tazaregion and its major mountain chains (Middle Atlas and Rif) give it a wide bioclimatic variety (humid to saharian) and an important bio-ecological diversity. This diversity is the source of wealth of landscapes and high quality natural environments. It also gives the region a unique heritage in the field of the natural environment.

The development of an area comes primarily from existing natural and human resources, it is the starting point to consolidate gains and explore the conjectural potentialities offered[2].The Environmental assessment can be built only by using the multidimensional nature of the environment.

2. Methodology

The methodology used is based on the systematic exploitation of existing documentation. This assessment was based on qualitative and quantitative information relative to this space. Data collection and synthesis have enabled to highlight the characteristics and specificities of this territory. These documents represent a rich and diverse background of knowledge. We have proceeded to the analysis of each of the issues that define the interactions of environmental components. The choice of these components must enable to develop an answer to the question that expresses the concern.

The natural environment is defined by factors that represent the foundation for the analysis of the dynamics of natural environments. There has to be some type of study, taking into account pre-established scientific knowledge.

The determination of the environmental dynamics is the main objective in this study, which will be followed by the analysis of the current state, the development conditions and, finally, the relations with human pressure.

This analysis includes (1) a spatial dimension of the localization of phenomena and their distribution on a descriptive and / or predictive basis (2) an integration of results with ground information into a GIS to qualify a space according to its environmental abilities/resistance. The final product may be used to create scenarios about the future development of the land such as the definition for better resource management practices, policies or decision making.

3. The study area

The study area is located to the north eastern region of Morocco (Fig. 1). It materializes the junction between the Rif area (north) and Atlas (to the south). This gives it an important role regarding the connection between eastern Morocco and other parts of Morocco.

From the relief point of view Taza area can be divided into three distinct regions (Fig. 2):

i) The Rif area north (Aknoul and regions) which has a predominantly relief hills and mountain chains exceeding 2,000 meters.

ii) The pre-Rif region: extends south of Rif, to the plain of Saïs, covers the hills with small plains, located primarily in the OuedInaouen Valley, Tahla, OuedAmlil.

iii) The southern region crossed by the chain of the Middle Atlas, giving the land rugged appearance with mountain chains exceeding 3,000 meters of altitude (Jebel Bounasser and Bouiblane).

4. Results and discussion

4.1. Dynamics of the natural environment

a- *Biodiversity, vegetation cover and forests*

Taza region is a geographical unit whose ecological characters shape an original and unique natural framework. These geographical contrasts offer a wide range of bio climates ranging from arid to humid mountains and allowing the installation of a rich and varied flora through the diversity of habitats and ecosystems that reveal these areas. Taza region is experiencing a significant heterogeneity and geological and biogeographical zones of transition and presents a high and remarkable biological diversity. It indeed has a wide range of very rich ecosystems from the “flora and fauna” point of view, forming remarkable and diverse landscapes.

Taza region brings together contrasting natural conditions that make it a particularly rich and interesting environment, especially in a development perspective. The concentration of Sites of Biological and Ecological Interest (SBEI) constitutes a remarkable advantage, in addition to significant water (Fig. 5) and forestry resources (Fig. 3) which are well known and whose economic impact is obvious.

Taza region has natural areas that attract naturalists and promote green tourism: Tazekka National Park, Friouato Cavern, Ras el Ma, JbelBouiblane, JbelTidghine which culminates at 2,456 meters altitude,

Azilastation (mountainous area covered by cedar forests), TiziIfri resort with mineral source and mountains and further game-rich forest areas of Taounate Province (wild boar, hare, dove, pigeon and partridge)[3].

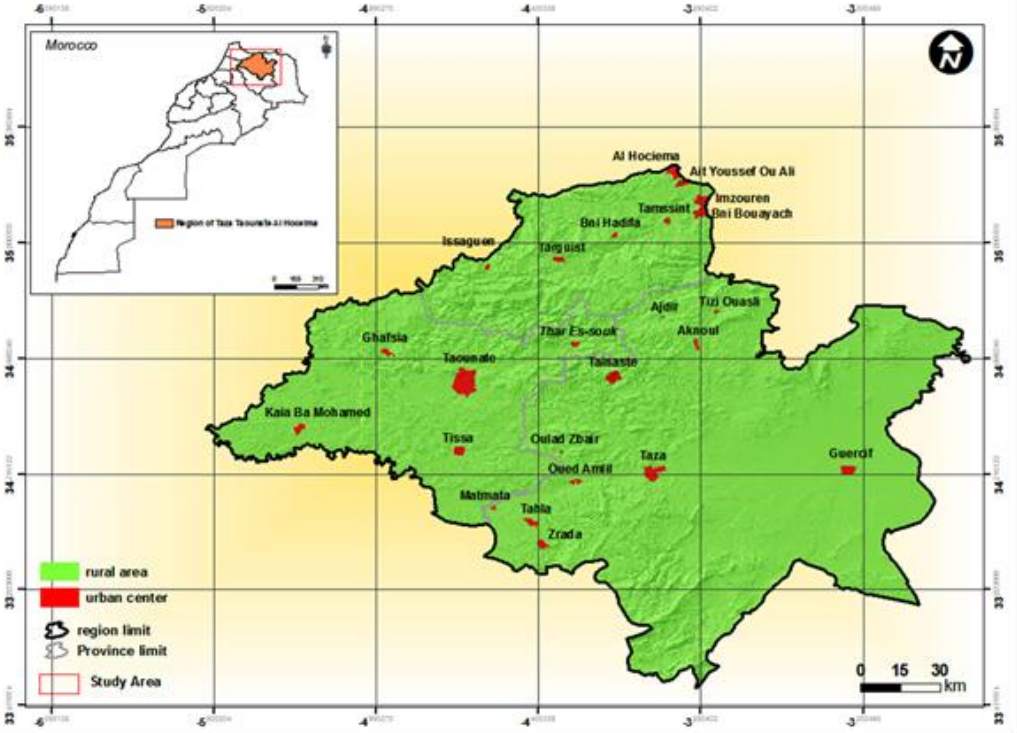

Figure 1: Location of the study area

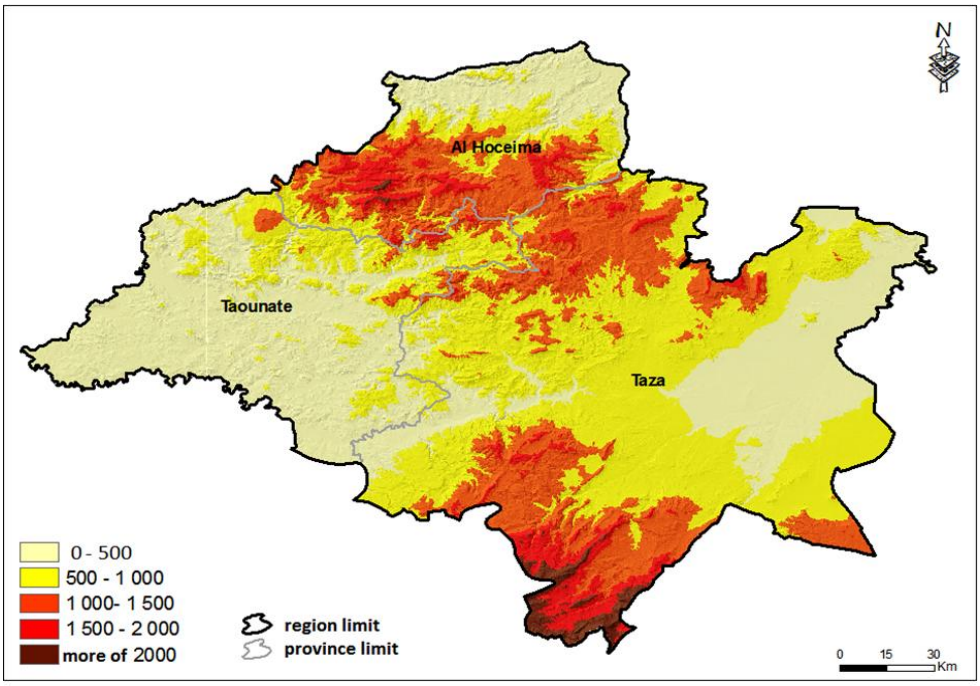

Figure 2: Sketch map of the study area

The rich flora of the region is largely marked by the heterogeneity of ecological habitats. This allows installation of various species with a very marked endemism.

Due to the diversity of its reliefs and bio climates, Taza region offers significant wild specific and original flora, including aromatic and medicinal plants (*Artemisia herba-alba ; Capparisspinosa ; Cedrusatlantica ; Citrus*

aurantiumvaramara, Eucalyptus globulus, Lavandulaofficinalis, Lawsoniainermis ; Menthapulegium ; Menthaspicata ; Myrtuscommunis ; Rosmarinusofficinalis ; Tetraclinisarticulata ; Thymus sp ;…) [4].

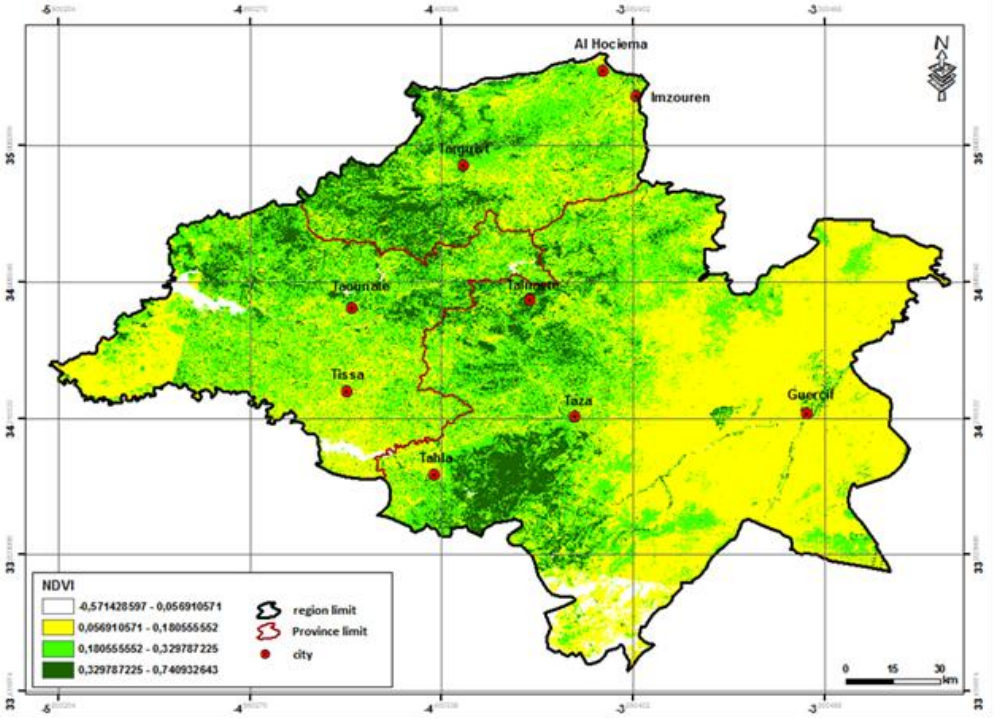

Figure 3: NDVI map

The main forest products are fuel wood, timber, industrial wood. Globally, wood is managed by cooperatives involving residents of surrounding communities of the concerned forests.

a.1. Main pressures on natural resources

Ecosystems and resources are under high pressures of various origins acting on the environment and threatening the maintenance of bio-ecological balance and renewal of natural resources. Overall, there is a degradation of environments and landscapes which is accompanied by a loss of soil and a narrowing of the vegetation and forest cover.

The area is subject to various pressures whose negative effects affect its biodiversity status. The acceleration of industrialization, urban development, intensive agriculture, massive use of fertilizers, desertification, deforestation (to expand agricultural land and/or to exploit forest species), overgrazing, firewood collection, illegal timber cutting, fire and proliferation of pests and diseases of plant cover, are the main agents. These pressures of economic and urban development have led to a steady degradation of natural sites in the region such as forests and SBEI (problems particularly affecting rangeland and forest areas used for livestock feed). All these activities, which do not respect environment, will gradually produce a great loss of green space and cause the destruction of natural habitats, threatening the diversity of ecosystems and the survival of endangered species [5].

Unlike punctual pollution, the diffuse one generally results from the spreading of fertilizers (fertilizer and manure), and / or treatment of crops by phytosanitary products (pesticides, herbicides, insecticides ...). Because of its diffuse nature, this pollution remains so difficult to control; and its evaluation and treatment pose particularly serious problems. The problem of diffuse agricultural pollution arises especially in irrigated agricultural areas[6].

The risk of contamination depends on many factors: climate, soil type, depth of the water table, quality of irrigation water, and above all intensity of use of fertilizers and pesticides. Some of these products, including nitrates that are very mobile in the soil, are either leached in depth by irrigation water, resulting in the deterioration of groundwater quality, or driven by the runoff and contribute to the pollution of rivers and dam

reservoirs, creating a significant risk of eutrophication and human health problems. The impacts on water are usually manifested by an increase in nitrate levels and salinity. Because of the increaseduse of pesticides in order to satisfy the economic needs in the agriculture production which is more and intensive. Many studies are done on the consequence of these pesticides on the soil and their pollution treatment [7].
Local populations (Fig. 4) are forced to increase the exploitation of available natural resources, thus accelerating environmental degradation. In the long-term, these practices contribute to local economic activities, inducing rural migration.

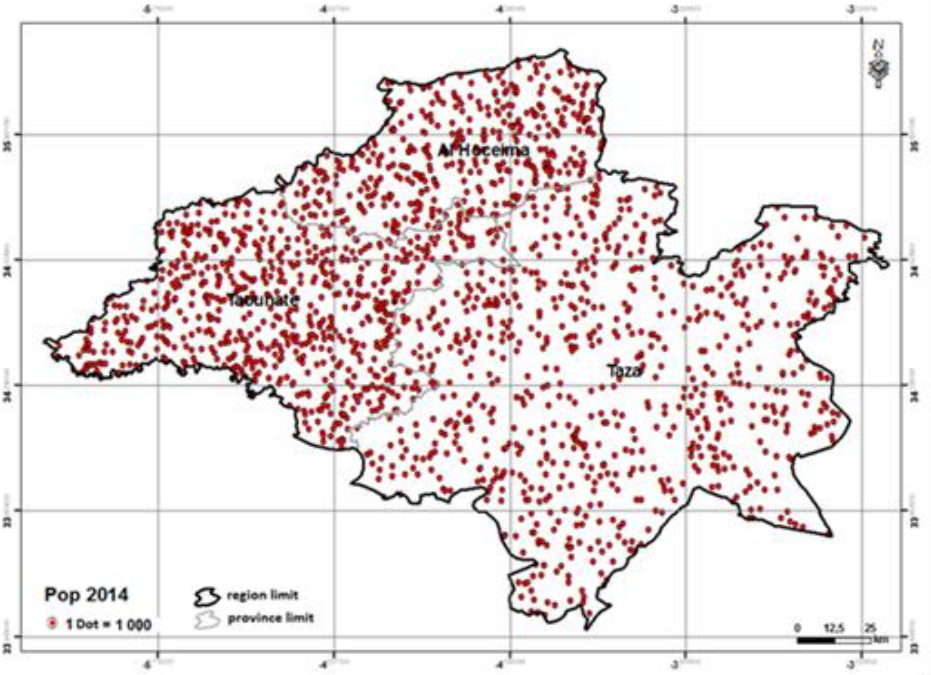

Figure 4: Map with dots marking population concentrations

a.2. Forest fire risk

The forest area occupies 30% of the territory of Taza Province. The plant diversity of this region is such that we meet all vegetation from Morocco except the Fir tree and the Argan tree. These forest communities, as well as reforestation species, form a forest mosaic that is to be related, firstly with their great biogeographic, climatic and topographic heterogeneity, and secondly, with their instability and vulnerability (due both to the Mediterranean environment and human activity). However, this forestry potential of the Province is subject to many natural and anthropogenic constraints. The forest fire is one of the causes of forest degradation. Its assessment over a period of 9 years (1999-2008) indicates the occurrence of 184 cases of fire that have destroyed nearly 2,862 hectares. This risk occurs every month of the year with a higher frequency in the dry season, from June to September [8]. The risk of forest fire concerns all the forests of Taza Province areas. Municipalities of Bouchfraa, Saiaa and Gueznaia El Jaanoubia are the zones of most risk, followed by those of Tazarine and Tamjjilt. Despite its low to medium intensity, the frequency of this risk remains quite high, especially in the Municipality of Bouchfaa. The risk of fire in these wooded areas varies according to their location, the nature of planted species and their attendance.

b. Climate and Water Resources

Climate change constitutes a great environmental threat the world has to face. Climate change represents more and more a reality to master and whose impacts are important and it's a necessity to limit them. On a global scale and particularly in Morocco [9].In Morocco it resulted in drought and rainfall aggressiveness, causing big floods (due to the failure of the natural progression of rivers) with human and material damage. Taza region is characterized by its dense hydrographic network (Fig. 5). Flooding has repeatedly threatened local populations along riverscausing significant material and human damage. The climate study allowed the characterization of

the climate of Taza region with its spatio-temporal variations. Interestingly, the global warming appears to be reflected in Taza station by a sudden jump of rainfall amounts and not by a drought. This analysis shows that rainfall intensity in recent years explains clearly the exceptional floods Taza has recently known. Ultimately, due to the climate of Taza, to the rainfall amounts as well as the geological structure of the city, the winter period presents favorable conditions for the acceleration of morphodynamic processes [9].

b.1. Flood risk

The geological nature of land (Fig. 6), relief and rainfall regime coupled with uncontrolled urbanization and development, make floods a major risk.

The main causes of this vulnerability are linked to:

- climatic conditions and nature of the flows of the main river;
- construction of housing in the river bed or to threatened and vulnerable areas;
- landslides from land geology and to the almost total absence of trees or vegetation in watersheds surrounding the centers.

b.2. Water resources

Due to its topographic, climatic and geological conditions, Taza region offers great potential in terms of surface water. However, the underground water stock remains relatively modest given the dominance of impermeable geological formations. Nevertheless they constitute a significant part of the hydraulic heritage of Taza region. Indeed, they play an important role in the regional economic and social development by ensuring drinking water supply (to some urban and rural centers) and the development of several irrigated perimeters.

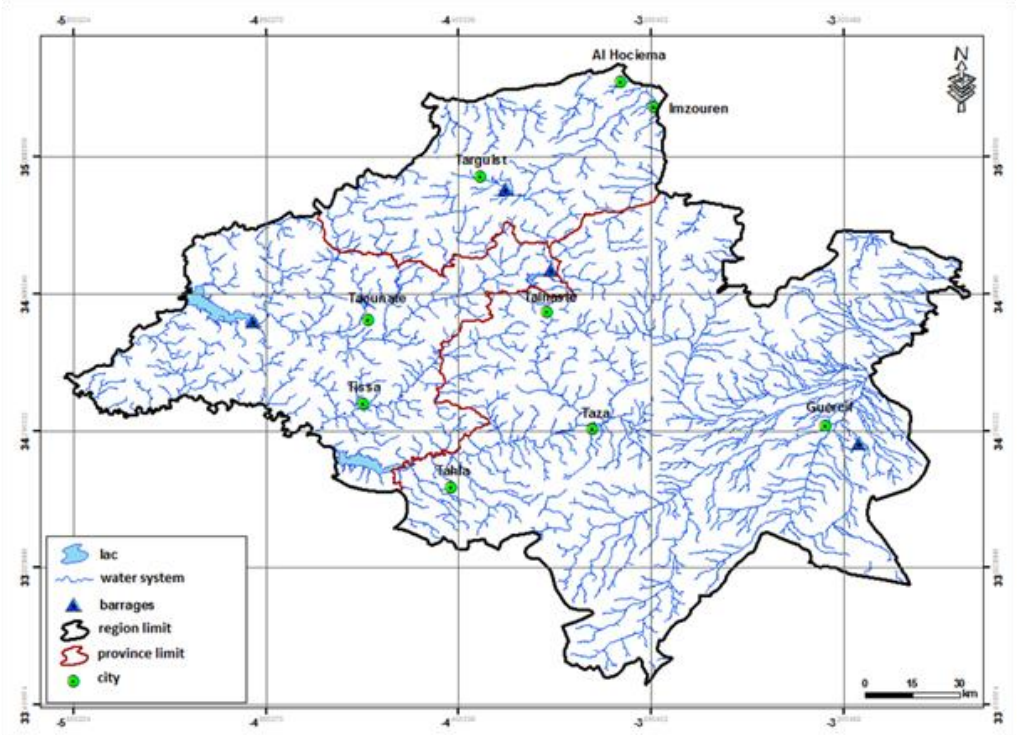

Figure 5: Hydrological map

b.3. Quality of Water Resources

Universal access to water is one of the main challenges to sustainable development in the 21st Century. Therefore more effort is required to achieve the millennium development objectives in water and sanitation sectors in order to provide sustainable services for all [10].

The main sources of water pollution, generally, are agricultural, domestic, industrial or from solid waste. Poor management and lack of treatment of wastewater exacerbate environmental pollution, and in particular the water resources. Domestic and industrial wastewaters are rejected without any treatment everywhere in the natural

environment provoking water resource pollution. Food industry is responsible for releases of olive crushing and canning. This activity is highly polluting and generates waters with high organic matter concentrations (called margins). Taza Province produces 27,010 tons / year of margins(67.1% are produced by the units of the city and its environs). Most of margins (86%) are discharged into rivers and the rest (14%) is dispersed in nature without treatment. Furthermore, 74.1% of margins produced are directly discharged into the Inaouen River and its tributaries. Taza Province is among the high-risk provinces with regard to water-related diseases, mainly typhoid and hepatitis A, particularly affecting large partially sanitized agglomerations. In addition, the irrigation of vegetable crops by wastewater around Taza city constitutes a great threat of spreading these diseases. River waters in the region of Taza are of very poor quality due to the different releases and to the land nature. According to this situation, it becomes important to develop an action plan to reduce or eliminate negative impacts of water pollution, in order to preserve the quality of dams' water that remains an important source for drinking water supply in the region of Taza[11]. The main question is whether or not the management of the water sector is sustainable. Indeed, to be sustainable, management must consider the three pillars of sustainability: (i) cost recovery as an economic objective, (ii) polluter-payer as an environmental objective, and affordability of water as a social objective [10].

c. Geomorphological Study

The analysis of the dynamics of the natural environment in the environmental assessment, as well as the study of resources and environment, are of high importance. The morpho-pedological analysis helps to understand the environment dynamics (mechanisms of pedogenesis, land erosion agents) and thus defines the conditions offered to the land use through soil (limestone crust, salinity ...) or morphodynamic (soil slaking) constraints. Hydrology and land hydrodynamics highlight fragile sites, either for natural risks they face, or for progressive degradation potential they can record. The theme of land degradation is in itself a major priority, since it is a dynamics with serious consequences on the rational use of resources and environment in fragile ecosystems [12].

The geomorphological risks in Taza and in its hinterland refer to the risks induced by the natural dynamics, but aggravated by societal practices. These risks are related to the amounts of water (during the period of excess rainfall events) and their mode of circulation (surface and sub-surface). These risks represent those related to the dynamics of catchment (gully erosion) and those related to the dynamics of current floodplain. The aspects of land degradation (rill and gully erosion) are very marked in the landscape [13].

The vulnerability of flood plains can be summarized by the degradation of vegetation in the watershed, the rainfall intensity, the marl-clay lithology favorable to runoff, the form of the watershed as well as the obstacle effect (dams, bridges, housing, embankments, etc).

The current dynamics, disturbed by human interventions on the slopes, is characterized by the degradation of ecosystems, watershed dynamics (erosion, gully erosion, landslide) and dynamics of bottom valleys (alluviation and floods).

Damages due to erosion and soil loss are numerous. They concern the loss of fertile land (surface stripping, gullies and badlands), the silting of dams and plugging of wells and retention basins and lower crop[13].

The combination of these natural phenomena can lead to significant damages or compromise the socio-economic development of the region.

The natural risk is the result of a natural cross between natural alea (storms, forest fire, flood, mudslide, landslide, earthquake,...) which can be altered or destroyed by the realization of the risk. The region of Taza, due to its geographical location, is exposed to climatic, meteorological, geological or biological phenomena that may generate major risks. Exp: Landslide: [14].

- Rapid and discontinuous movements: cave-ins, collapses and rock falls and mudslides.
- Slow and continuous movements: subsidence and landslides.

We talk about major risk when the damage and the number of potential victims are important. The region of Taza has experienced in recent times several natural disasters: the Al Hoceima earthquake (2004), Taounate floods (2009) and locust invasions (2005) in Guercif Province.

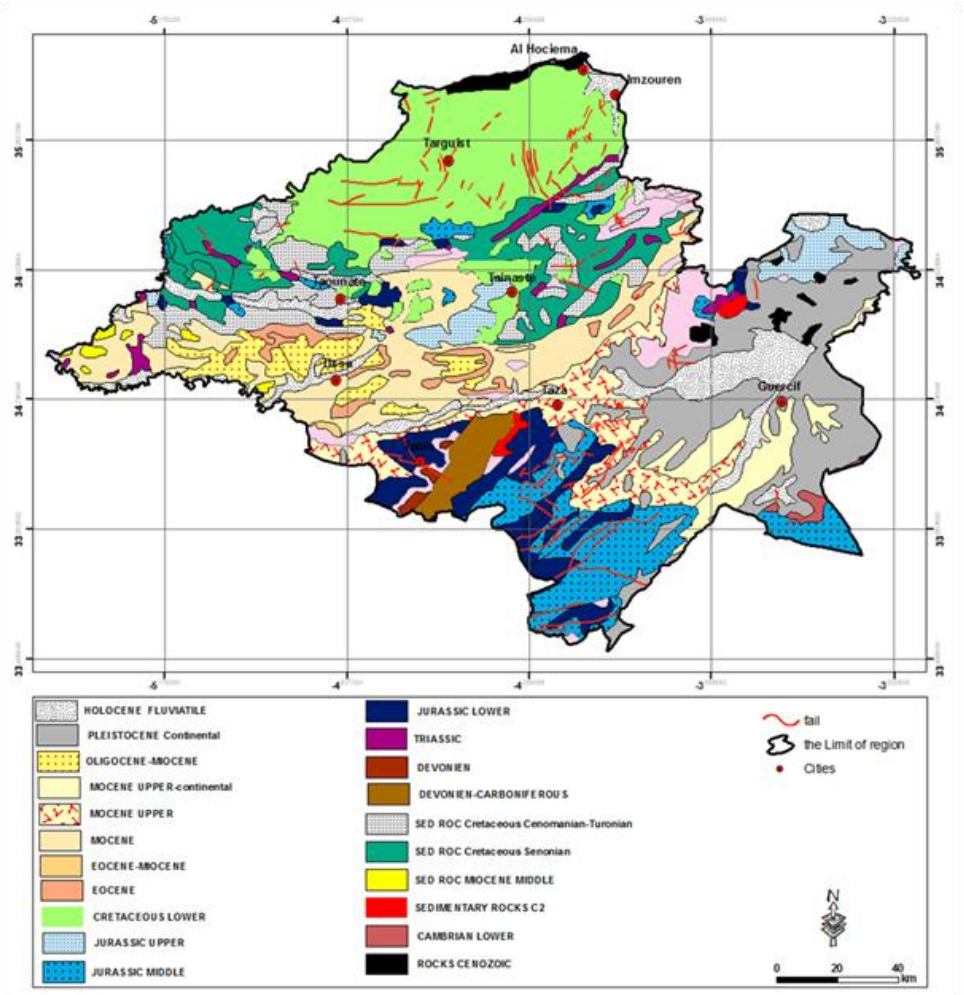

Figure 6: Geological map of the study area

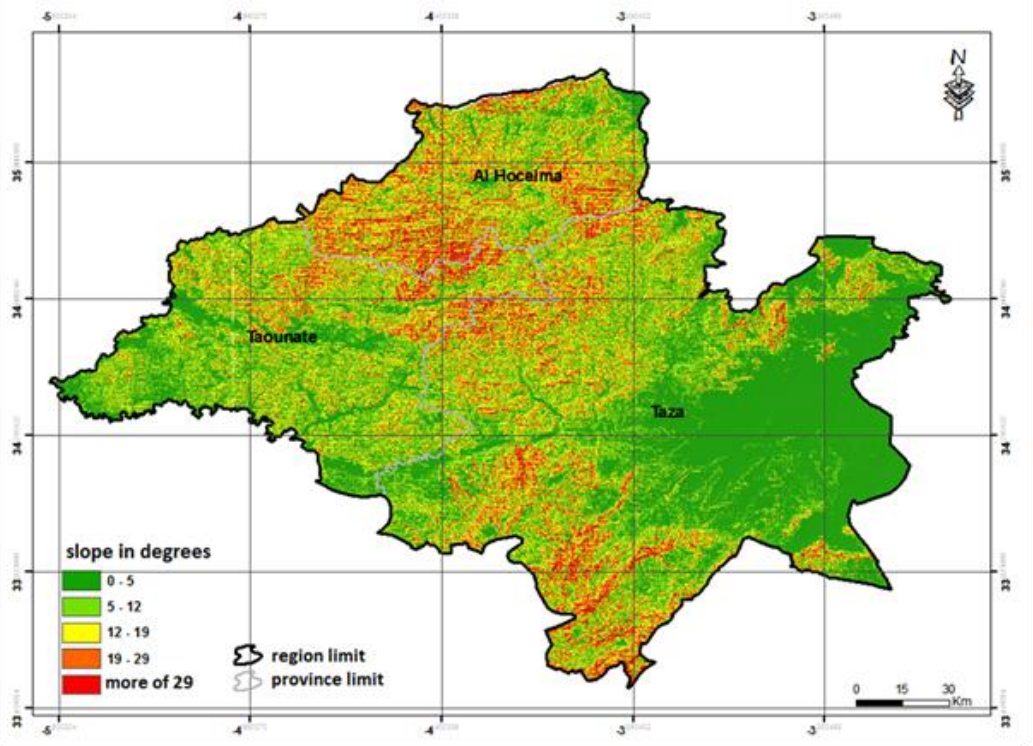

Figure7: Slope map

Landslides

In Morocco, the areas subject to landslides are mainly Rif and to a lesser extent Atlas, due to the existence of contrasting reliefs, crumbly geological lands (clays, flysch, marl, etc.) and severe weather conditions. When the geological and climatic conditions are met, we can observe in some regions landslides on slopes (Fig. 6), collapse of quarry and natural cavities (Fig. 7). Land movements (topple, flow, slump, creep, slide, rock fall) are widespread within the urban centers of Tazaregion as at certain points of the highways. Floods are very frequent (OuedAmlil, Taza, SebtBouQualal, Had Msila, ..)[12].The heavy rainfall and topography contribute to the instability of slopes and can trigger the mass movement.

The surface layers of soil in urban and peri-urban environments of Tazaare submitted to forms of post-seismic landslides or to a combination of climatic, topographic and soil type, as well as the dysfunctions related to human action. The risks of landslides, although outside the current urban area, are more or less generalized with hilly reliefs and marl liquefaction

The hydrological regime that combines the lithological "marl" conditions constitutes the condition or threat of collapse for much housing at the breakout scars (Fig. 8). The marl substrate - seat of a generally active geomorphological evolution - allows sliding or generalized solifluction which may guide future land use proposals.

Although the gully and runoff are specifically rural, anarchically formed peri-urban areas are under these threats which can bare (or destroy) constructions and urban infrastructures. Sloping constructions still keep forms of natural runoff that constitute a future threat to stability.

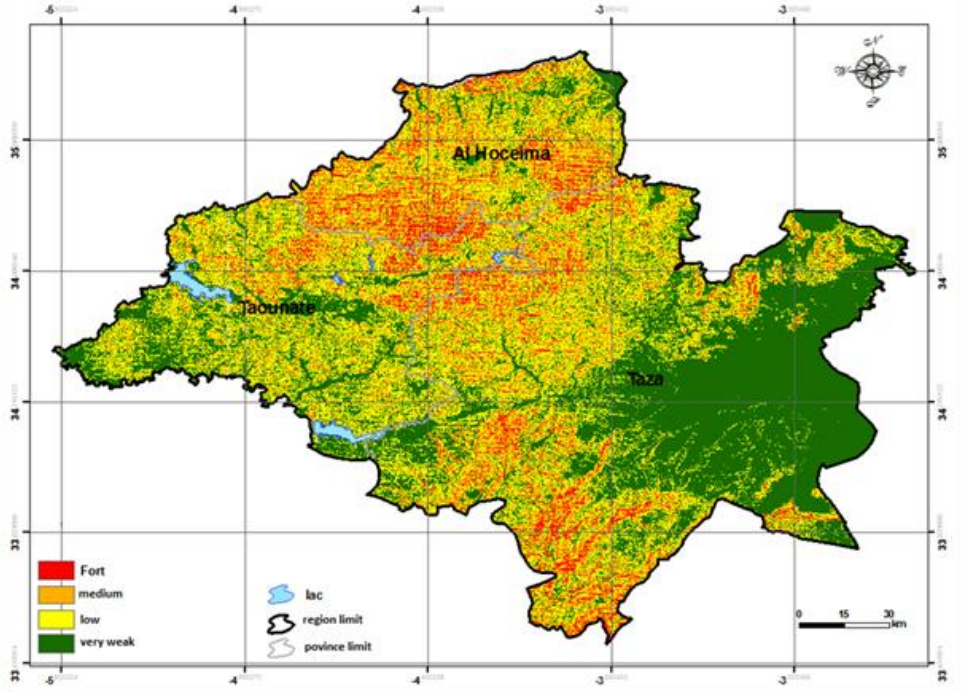

Figure 8: Erosion potential map

b. Mining, quarrying and material extraction

The region is characterized by a very complicated geological structure. It enjoys the privilege of having significant geological resources constituting an important development factor of socio-economic sector. The region contains 134 quarries representing 7% of the national global, 55% are located in the Province of Taza, 22% in the Province of Al Hoceima, 17% in the Province of Guercif and the rest in the Province of Taounate. About half (44%) of materials extracted in the region are gravetts, one third (32%) of all-comers [15].

Mining potential: the basement of the region has varied mineral and useful substances. The region contains about 86 mines in particular in the Province of Taza.

The impacts generated by these quarries are multiple and affect all components of the environment (quantitative and qualitative degradation of water resources and forests, destabilization of land, particularly in the Rif region that presents a very high vulnerability rate to land sliding, degradation of coastal dunes and beach erosion, changing the topography and bathymetry, remobilization of heavy metals stored in sediments and harmful to the environment).
Some old quarries exist in the region and can constitute particularly degraded sites with potential risks to the population and environment security.

c. Seismicrisk

The region of Taza is located in an area of seismic instability characterized by the recurrence of several earthquakes that have profoundly marked the structural and geomorphological changes of the geological built of the Rif area in general. It involves a constant network of active faults, the most important and most active in the region are already passing through the eastern Rif in different places, including the Nekor, Ajdir and Rouadifaults[16]. The historical importance of the seismicity in the area deserves a special attention. Taza region is located on a strong probable seismic zone, which history retains earthquakes with variable damage depending on the intensity. This constitutes a potential security risk since the geological situation of the region is in a transition zone. The indexes of this risk are reactivations of different trending faults. These faults have caused in the past multiple earthquakes that are expressed by the formation of sediment disturbance in the process of sedimentation, called seismites. They are responsible for the configuration of the existing drainage system and the genesis of the great landforms.
Vibrations suffered by the slopes and valleys during an earthquake induce many mass movement phenomena such as landslides, subsidence and liquefaction of some sandy soils. The destabilization of the slope results from the dynamic loading of the slope by seismic waves. This loading may, even if limited, only produce changes in underground natural flows, the effect of which is deferred. The channels may indeed be blocked and induce a gradual increase in pore pressure, which subsequently will cause landslides or aggravate existing landslides[17].

4.2. Sustainable development of the "Taza region"

When dealing with the issue of sustainable development of the "Mountain" decisional concern is not to measure the degree of slip of land or climate change, but rather the degree of impact this type of variation could have. An assessment that would be limited to rates and degrees would be of no use in decision making. The map overlay of geo referenced information layers - on a descriptive and / or predictive basis - of various kinds allows qualifying a space based on skill or environmental resistance. The results allow the identification of areas where interventions are needed.
The analysis of the dynamic process where the interactions of the environment components are defined should allow developing a response to the question that expresses the concern, "the challenge".
Environmental dynamics that present the most serious impacts are those that have a direct and immediate feedback on the economy, society and man (Table 1). These are the ones which must first draw attention, although safeguarding the natural heritage in general represents a challenge for humanity that it is urgent to address.

Table 1: Event types of cumulative impacts and their main characteristics.
Adapted from [19]

Types of impact	Characteristics	Examples
Space addition	High concentration of impacts in the same environment.	When geological and climatic conditions are met, we can observe in some regions landslides on slopes, collapse of quarries, of natural cavities and also of the basement of some cities.
Time addition.	Frequent and repeated impacts in the same ecological environment. The	Minor forms of erosion are expanding as a result of rains, while paving stones become permanent

Iterative effects.	impacts are so close together in time that the environment cannot recover between episodes, creating a nibbling effect (gradual loss of an environment, or a soil, or a habitat by the action of various contiguous impacts).	and more and more apparent as no tillage inhibits the action of diffuse runoff.
time lags/ indirect effects	Long-term impact / secondary impacts caused by a primary impact.	The changes affecting the rainfall patterns have led to a change of the ground work schedule, which is causing an increase in the sensitivity of cultivated land in diffuse and concentrated runoff.
Remote impacts	Impact from a source that is far from the location of the impact event.	The degradation of the vegetation cover causes the migration of surface formations towards dams.
Synergistic impacts	Interactions between two environmental impacts giving rise to an impact of greater magnitude than an addition of impacts.	Watershed degradation, due to stripping and gullies, combined with water balance, results in reduced plant diversity. Most brown fields are characterized by an irreversible and regressive dynamics of evolution.
Triggering and tolerancetreshold	The combined effects induce the resistance limit to be exceeded and cause a fundamental change of the ecosystem characteristics and behavior.	Farmers tend to limit the number of plowing to one per year in fallow, it has the disadvantage of reducing the erase frequency channels which are created in the fields. These gutters then deepen because of the cumulative effect of rains, and reach the threshold i.e the transition to the form of erosion that is no longer erasable by plowing.

Conclusion

Due to its geographical location, the Moroccan mountain is exposed to climatic, meteorological, geological and biological phenomena that can lead to major risks such as floods, flash floods, earthquakes, landslides and forest fires. The combination of these natural phenomena coupled with the growing disinterest of the local population for agricultural activities, contributes to the failure of the agro-pastoral system and the land degradation as a result of reduced acreage and quality of soil work. This can lead to significant damages or compromise the socio- economic development of the exposed regions, and then the sustainable development.

The environmental degradation and its direct consequences constitute a topic of deep concern.

Particular efforts must be undertaken to implement their rational management, their better promotion and their effective rehabilitation. Of great importance are essentially water and soil resources. (1) The protection of water resources is a priority because the mountains are the "water tower" of the piedmont and lowland areas. The region has relatively sufficient water resources in terms of availability and mobilization potential. However, the loss of these waters is considerable. (2) Soil resources are exposed to various degradation factors, including water erosion. This results in losses in arable land, a decrease in cultivated areas, a discontinuity of vegetation cover and drought symptoms. Currently, the development of the region is driven in a piecemeal approach: development issues are sectorally addressed and do not reflect an integrated approach. Moreover, today there are no strictly specific approaches with regard to region issues but rather a generic approach that assumes no distinction between the national policies.

The natural heritage of the mountains is a resource for the whole country. Its protection and enhancement surpass the framework of these spaces to be a global issue.

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