

GEOGRAFIA, RISCOS E PROTEÇÃO CIVIL

HOMENAGEM AO PROFESSOR DOUTOR
LUCIANO LOURENÇO

VOLUME 2

Coordenadores:
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António Amaro
António Vieira
Fátima Velez de Castro
Fernando Félix

RISCOS - ASSOCIAÇÃO PORTUGUESA DE RISCOS,
PREVENÇÃO E SEGURANÇA

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Sixty years of the development projects and combating the environment and natural resources degradation in arid and semi-arid areas in Rif mountains in Morocco

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Abstract

The development programs have been carried out to deal with the degradation phenomena since 1960 in Rif Mountains in northern Morocco. These conservation and preservation projects of natural resources implemented using either mechanical or biological techniques.

The objective of this text is to evaluate the strategy undertaken for water and soil conservation to curb poor land-use practices and to assess the investment in water and soil conservation actions adopted the administrative approach that does not involve the locals by encouraging their effective participation in the identification, formulation, programming, execution, and monitoring of the actions to be carried out.

Keywords: Development projects, degradation, management, arid and semi-arid Areas, Rif, Morocco.

Resumo

Sessenta anos de projetos de desenvolvimento e combate à degradação do meio ambiente e dos recursos naturais em áreas áridas e semi-áridas nas montanhas Rife em Marrocos. Os programas de desenvolvimento têm sido realizados para lidar com o fenómeno da degradação desde 1960 nas montanhas Rife, no norte de Marrocos. Esses projetos de conservação e preservação de recursos naturais têm sido implementados por meio de técnicas mecânicas ou biológicas.

O objetivo deste texto é avaliar a estratégia empreendida para a conservação da água e do solo para conter as práticas inadequadas de uso da terra e avaliar o investimento em ações de conservação da água e do solo adotadas, com abordagem administrativa que não envolva a população local, incentivando sua participação efetiva na identificação, formulação, programação, execução e monitoramento das ações a serem realizadas.

Palavras-chave: Projetos de desenvolvimento, degradação, gestão, áreas áridas e semi-áridas, Rife, Marrocos.

Introduction

The conservation of soil fertility and water quality has generally been a problem for all civilizations (Parr *et al.*, 1992). As soon as the population concentrates, it increases the demand for food, fiber and energy, thereby accelerating the clearing of land around settlements, compacting the soil through overgrazing, roads and settlements, and denuding and restructuring the surface. The result is an increase in runoff and the load on the soil, the stripping of the humid horizon from the soils, the gulying of slopes, increased river peak flows and bank degradation, siltation of dams, canals and harbours, and the general degradation of the environment (El Motaki *et al.*, 2019b).

Natural and environmental resources are an asset, whose degradation can be a constraint to human, economic development and often a threat to social stability. Awareness about the interactions between human pressures on land and loss of natural capacities to sustain human well-being is still often missing, although, some programs were established to reduce the degradation in the Central Rif Mountains in Northern Morocco (Fay, 1993).

This study is seeking the analysis of promising marginalized and mountain areas for new development dynamics by studying projects carried out in northern Morocco for the development of the environment and heritage, in the human and territorial development effort. Thus, the protection of natural resources and biodiversity must be accompanied by enhancement of sites of ecological interest, such as Oudka mountain, through various activities by ensuring the conservation and the sustainability of the natural environment of Rif, previously precarious.

Objectives

This study aims to:

- Identify appropriate land management strategies that minder the impact of natural events;
- Develop a methodological framework to evaluate the efficiency of adopted land management opportunities in their particular spatial context and to derive strategies for restructuring the landscape;
- Assess the socio-economic impacts of adapted land management and land use planning, considering added values for public security on the one side and additional costs or income losses for the rural population on the other.

- Implement natural and socio-economic factors into the social-ecological system to assess the efficiency of different governance instruments for improved land use with regard to behavioural responses of the local communities.

Study area

The study area located in Northern Morocco, bounded to the North by the Mediterranean Sea, to the south by the Perif zone, in the Western part is limited by the Western Rif and to the east by the Eastern Rif (fig. 1). This division was designed by several researchers based on different criteria and especially the geological structure (Morel, 1987). The Central Rif is undoubtedly the region most affected by various types of degradation, these phenomena, which have a considerable impact on the natural environment, are also a major and permanent threat to the environment and society.



Fig. 1 - Localization of study area in Northern Morocco.

Geological structure

The Rif mountain chain constituting the Southern branch of the Gibraltar arch borders the Alboran basin (SW of the Western Mediterranean). The current evolution is complex and results from multiple orogenic processes (burial, exhumation and rifting), In relation with the convergence between the Eurasian and African lithospheric plates.

The study area of Central Rif mountain is divided into three big geological categories (Asebriy *et al.*, 1987; Maurer, 1968). In the Northern part, we find the Intrarif zone in direct contact with the flysch zone limited by Mediterranean Sea, in the southern part there is the Prerif area and in the middle, part the Mesorif domain (fig. 2).

Ghomarids. However, they are involved in contacts of Ghomarid nappes and based on their petrographic characteristics (many conglomerates and sandstones which imply important reliefs and intense erosion), they are also involved in the contact of Ghomarid nappes.

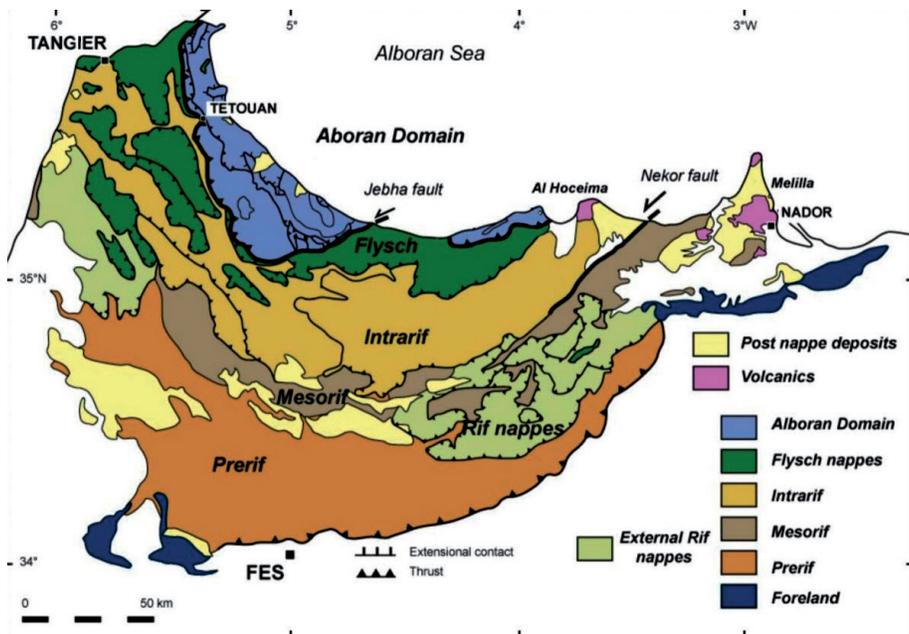


Fig. 2 - Geological structure of Central Rif mountain
 (Source: Extracted and adapted from Suter, Mattauer, 1964).

Climate: Dynamic Generator Factor

The Rif Central Mountain is subjected to Mediterranean influence in the North, oceanic on the West and continental in the centre. The available rainfall data shows that the quantity rises in parallel with the altitude from the hills of the Prerif in the south to the Rif mountains in the North of the study area toward the Mediterranean Sea. The rainfall annual average of the study area varies between 600 mm/year and 1500 mm/year (TABLE I).

The variability of the annual rainfall in the study area reached more than 100% between the two stations localized in two extremes borders of the study zone (fig. 3 and 4).

TABLE I - Characteristics of climatic stations in the study area.

Climatic Station	Altitude in m	x	y	z	Serie	Annual average in mm
Jbel Oudka	1115	4.433	4.49	1115	1979-2013	1472
Galaz	214	4.333	4.47	214	1980-2013	654

Source: ABHS, 2014.

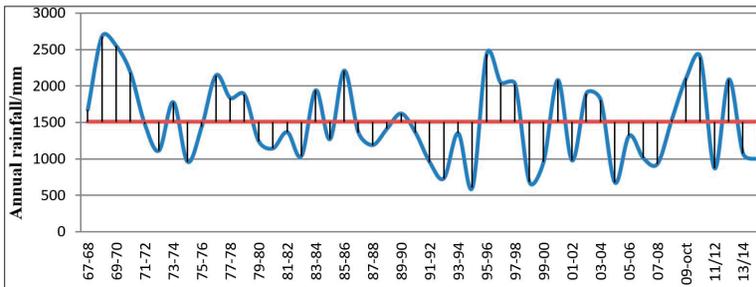


Fig. 3 - Variability of the annual rainfall at Jebel Oudka climatic station in the North of the study area zone.

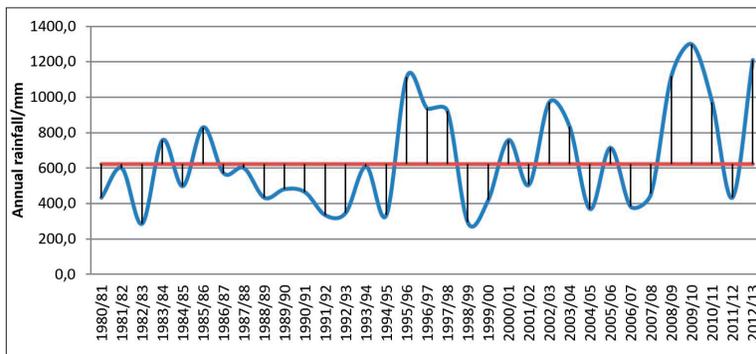


Fig. 4 - Variability of the annual rainfall at Galaz climatic station South of the study area zone.

The lowest values of the precipitation are observed in the southern zone and more precisely in the Prerif, on the other hand, the highest values are observed in the heart of the Rif chain, particularly at Jbel Oudka station where the precipitation exceeded 1500 mm/year. This statistical study series show that the coefficient of variation of annual rainfall generally increases from the South to the North. It is strongly influenced by relief nature.

Relief and morphology

The objective of the analysis of these parameters is, to characterize the factors of degradation of environments and natural resources, and the topographic factor remains the most relevant. Because the relief plays a very important role in the spatial distribution of precipitation and highlights the influence of altitude, and consequently aggravates and / or reduces the risk of deterioration of natural resources depending on surface morphology.

The altitude of the study area varies between 76 in the bottom of the Ouerrha valley and the summit of the Tidrine mountain in which the altitude reached 2456m. Based on the available data, the distribution of the relief has a relevant influence on the rainfall (fig. 5).

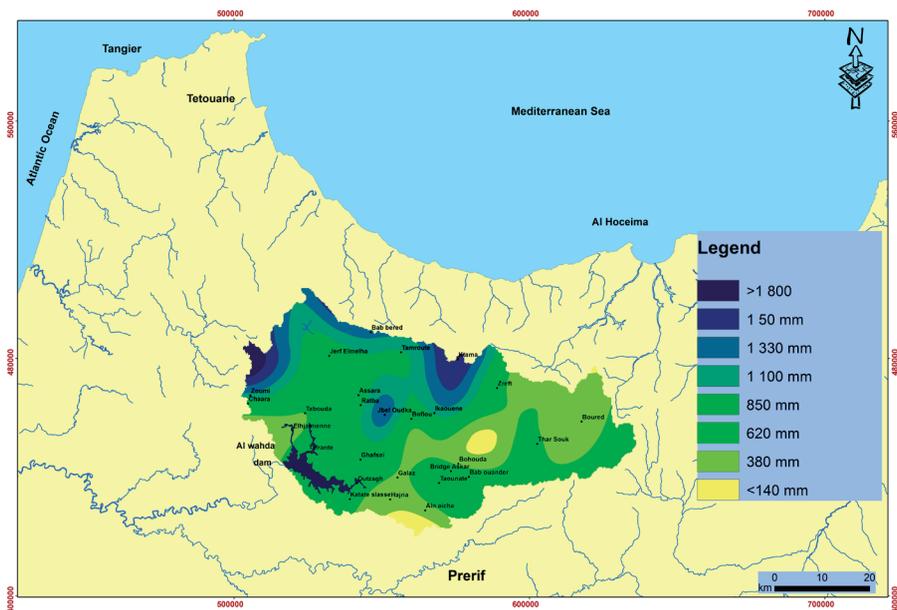


Fig. 5 - Relationship between the relief and precipitation in Rif mountain in Ouerrha watershed. (Data source: Topographic maps of Rif mountains 1/50000).

Central Rif: Marginalized and populated area

Northern Morocco includes: The Tangier-Tetouan-AL-Hoceima region, the provinces of Taza and Taounate belonging to the region of Fez-Meknes and the province of Guercif which is part of the Oriental region. These regions were created by the Decree n°2.15.10 of 20 February 2015 (fig. 6).

The Tangier-Tetouan- AL Hoceima region is located in the extreme North-West of Morocco. It is bounded to the North by the Strait of Gibraltar and the Mediterranean Sea, to the West by the Strait of Gibraltar and the Mediterranean Sea. the Atlantic Ocean, to the south by the Fes-Meknes region and the Rabat-Salé-Kenitra region and to the east by the Oriental region. The capital of the said region is the Tangier-Assilah prefecture.

The two provinces of Taza and Taounate are now part of the region of Fez-Meknes. The latter is bounded to the north by the Tangier-Tetouan-Al Hoceima region, at the East by the Oriental region and the West by the Rabat-Sale-Kenitra region. As for the province of Guercif it is located in the Oriental region in the North-East of the country.

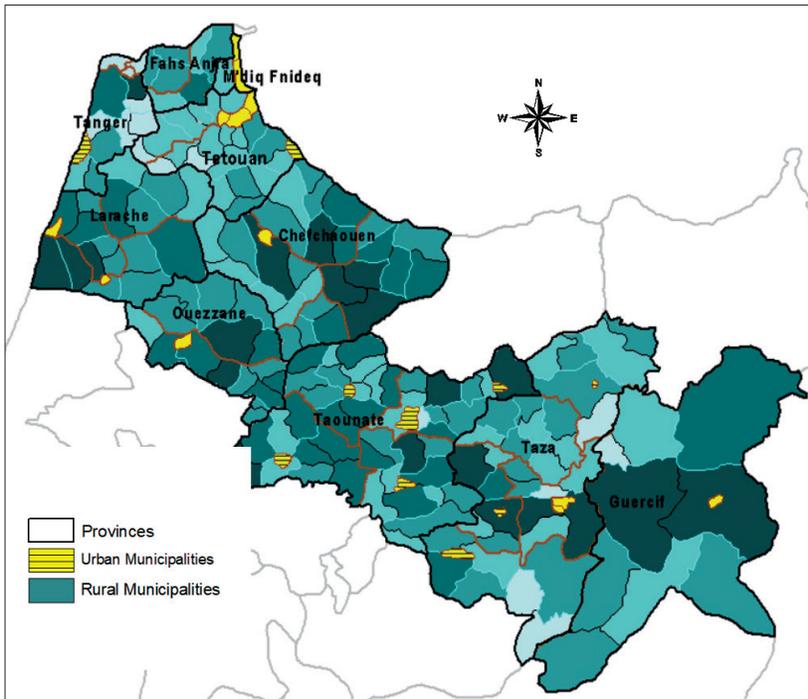


Fig. 6 - Geographical location of the territorial entities of the Rif regions in the north of Morocco (Source: APDN 2015, non-published report).

Demographic and Spatial Imbalance

Administratively, the Rif region was divided in 2014 into two parts (in 2009 there were more than 4.8 million inhabitants constituting 14-15% of the total population of the country) (TABLE II). The estimated population of the Tangier-Tetouan-AL Hoceima region was estimated in 2014 at nearly 3.5 million inhabitants. As for the provinces of Taza, Taounate and Guercif, the total population was estimated in the same year at nearly 1.4 million inhabitants (RGPH, 2015).

TABLE II - Population Distribution in the Rif Regions of Northern Morocco in 2010.

Region/Provinces	Total Population	Rural Population	Urban Population
Taza - Al Hoceima - Taounate	1844	1384	460
Al Hoceima	412	284	128
Taounate	678	606	72
Taza - Guercif	754	494	260
Tangier - Tetouan	2976	1285	1691
Chefchaouen	563	499	64
Fahs-Anjra	108	108	-
Larache	484	248	236
Tangier-Assilah	846	49	797
M'Diq-Fnideq	105	2	103
Tetouan	562	139	423
Ouezzane	308	240	68
Total Nord	4820	2669	2150
% Nord/National	15,3	19,8	11,9

Source: RGPH, 2015.

Very high density and concentration of the population

The average population density exceeds 200 inhabitants/km², i.e., five times the national average (it should be noted, however, that the national average is pulled down by huge territories...).

While the average density exceeds 600 inhabitants/km² in the heavily urbanised cities of Tangier, it does not reach 120 inhabitants/km² in the province of Chefchaouen. However, the rural communes of the Northern region maintain population densities above the national average (37 inhabitants/km²) (Pateau, 2014).

According to the Directorate of Statistics, the city of Tangier receives 40% of regional migration movements, Tetouan 30%, Larache 20% and Chefchaouen 10% (RGPH,

2015). The municipalities of Chefchaouen and Larache welcome new inhabitants, despite the strong attractiveness of Tangier and Tetouan, which are the most dynamic cities in the region.

The provincial capitals remain attractive for their hinterland, at least in a first stage of rural exodus. Nevertheless, with six out of ten departures involving inter-city travel, migration no longer rhymes with rural exodus, far from it. Followed by Tetouan, Tangier remains the main destination for migration in Tangier (Berriane , Moizo, 2014). Larache does not have sufficient job opportunities to attract a significant proportion of migrants, while Chefchaouen is located further away from the regional driving forces in rural mountainous areas.

A fragile economy destroys environmental assets

Over the past few decades, cannabis (illegal drug) cultivation has expanded from the Central Rif where it is historically tolerated. This specific agriculture feeds a major international drug trafficking (Afsahi, 2017).

The Northern natural resource ecosystems are currently experiencing an increasingly critical situation as a result of human pressures. These pressures have caused forest stands to shrink and their density to decrease both spatially and temporally (Mohamed *et al.*, 2018). These pressures are the result of the increase in population in a mountainous region and the scarcity of land for agriculture. The lack of activities other than subsistence agriculture and extensive livestock rearing with low productivity leads the population to undertake uncontrolled logging and clearing of wooded areas (Chouvy, 2018).

Development Projects since 1960

Some of the plans and programs cited above have a clearly stated sectoral scope. Others, which are rarer, aim rather at a horizontal mission of integrated development, involving several actors.

The concepts of sustainable development related to Agenda 21 and those underlying the implementation of the programmes to combat the desertification are increasingly becoming references and the rule in the revision and adaptation of various existing plans and strategies (Sabir *et al.*, 1999).

With regard to internal mechanisms and sources of financing, several initiatives to reform and adapt existing mechanisms to the requirements of local development have been taken or are in the process of being undertaken (Ghanam, 2003). These measures concern the rural development fund, the road fund, the employment fund, and so on of young people, the communal equipment fund, as well as the reform of the agricultural credit and farmer credit scheme and the orientation of investment by Moroccan Nationals Abroad in economic and service activities in the rural world.

The Water Resources Mobilization Program

Morocco is a country with an essentially semi-arid climate in most of its territory. Rainfall remains low. The rainfall regime is dominated by a strong irregularity in space and time.

Rainfall contributions over the entire territory are estimated at nearly 150 billion m³. The part that forms the underground and surface runoff represents only about 20% of this rainfall, or nearly 30 billion m³ (Bouzidi *et al.*, 2015).

Overall, Morocco has a water potential that can be mobilized under acceptable technical and economic conditions, in the order of 20 billion m³. The per capita water supply is already close to the threshold of 1,000 m³ /inhab/year commonly accepted as a critical threshold indicating the emergence of water shortages and water crisis (Balaghi *et al.*, 2007). The efforts made in terms of design and construction of hydraulic infrastructures have enabled the construction of more than 90 large dams with a total capacity of around 14.3 billion m³.

Major inter-basin water transfer had been carried out to balance the distribution of water between basins with surplus water resources and those with little. As a result, nearly 10 transfer projects are currently being carried out. These structures, which have a total flow rate of about 175 m³/s and a length of 875 km, allow the transfer of an annual volume of 2,185 Mm³ of water, mainly for irrigation (Laouina, 2001).

While the need for water continues to grow at an ever-increasing rate in line with the country's rate of development, there are major constraints on the development of water resources such as the increasing scarcity of dam sites, the use of deeper and deeper groundwater resources, the silting up of dams, water pollution and climatic hazards.

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To meet the water needs of all sectors of the economy, the water resources development plan studies recommended an ambitious program, by the year 2030, to build 60 large dams and around 100 small and medium dams at a rate of 2 to 3 dams per year (Laouina, 2001).

The National Plan to Combat Desertification

The National Plan to Combat Desertification was elaborated in 1986, in accordance with the recommendations of the United Nations Conference on Desertification held in Nairobi in 1977 (Chaker, 1997). This plan was prepared by a commission of experts composed of representatives of the Departments of Agriculture, Public Works, Interior and Energy. The report of the commission was validated by the ministerial departments concerned and included in the orientation note of the economic and social development plan of the time.

The plan had two main objectives relating to the analysis of achievements and constraints encountered in the implementation of programs to combat desertification on the one hand, and to the proposal of a strategy to combat desertification on the other hand.

The actions proposed in the national plan to combat desertification are multiple. They have focused on two sectors considered as priorities in the fight against desertification, namely pastoralism and wood fuel supply. Thus, actions have been proposed for each of these two sectors and homogeneous intervention zones have been identified (Ghanam, 2003).

The achievements of the national plan to combat desertification appear more at the level of the originality of its approach that led to its elaboration than at the level of its actual achievements. For the first time, a concerted and holistic approach is engaged on the issue of natural resource degradation in the country. However, it should be pointed out that no mechanism for implementing and following up on the recommendations of this plan has been put in place.

The National Watershed Management Plan

The National Watershed Development Plan, finalized in 1996, assessed Morocco's experience in watershed development, made recommendations to improve the quality of development projects, identified priority watersheds to be developed, and identified

financing mechanisms. The plan's conclusions concern the classification of watersheds according to the severity of erosion and the approach to watershed management. They also take into account the financial consequences of the extremely costly inaction, particularly at the agricultural level, in terms of the lifespan of the dams and more generally on the economic and social development of the country (Bensaleh *et al.*, 2012).

The priority ranking for the 22 watersheds upstream of the dams, covering an area of 15 million hectares, reveals that 11 million hectares are considered at risk, while 3 million hectares are in urgent need of development. Furthermore, the plan suggests the need to replace the narrow concept of watershed management with a broader concept of mountain area development, based on participatory, small-scale, long-term programs.

The financial means necessary to finance the watershed management plan are estimated at 150 million dirhams per for an area to be treated of 75,000 hectares per year for a period of 20 years (Tahiri *et al.*, 2017).

The Master Plan of Conservatory of Dry Land Management

The elaboration of the Master Plan for the Conservatory Management of Land in Dry Zones is part of the new policy of the public authorities, more attentive to the requirements of the development of rain-fed agricultural areas. Preliminary studies led in 1995 to the formulation of a master plan for the conservatory management of land resources in dry zones (Gauché, 2010).

The implementation of this plan is based on the creation of the Dry development perimeters and the implementation of certain complementary actions, the main ones of which are (i) the establishment of viable farms, (ii) the guarantee of stable conditions for farmers, (iii) the implementation of land improvement operations, (iv) the rehabilitation and conservation of agricultural land, (v) the programming of support actions, and (vi) the protection of productive land threatened by urbanization (Roose, 1974).

The National Reforestation Plan

The National Reforestation Plan (PNR) was drawn up in 1970 to provide the elements to meet the country's needs in terms of wood production, soil protection against erosion and recreation space.

The plan proposed to meet the above-mentioned needs by planting 662,000 ha over 30 years, distributed between 355,000 ha of production forests and 115,000 ha of mixed reforestation. This objective has only been partially achieved and has just been included in the framework of the Reforestation Master Plan (Boujrouf, 1996).

The pace of reforestation to achieve the PNR objectives has been revised repeatedly to adjust it to the assumptions regarding production levels on which the original estimates were based. These assumptions, which were considered too high, were revised downwards on two occasions.

The Reforestation Master Plan

The elaboration of a Reforestation Master Plan (RMP), finalized in 1997, as a revision of the above-mentioned NRP, responds to a recommendation made in the forest development strategy. As part of a long-term vision, this plan aims to provide a sustainable response to priority needs for forest products.

The plan recommends the achievement of this ambitious objective through the development of a partnership, allowing the multiplication of reforestation actions by a greater number of public and private stakeholders, and the contribution to local programs on a participatory basis. The reforestation master plan finally suggests reforestation for wood production and biomass fuel, protection, recreation and sylvo-pastoral purposes (Ghanam, 2003).

The plan is seen as a medium-term (10 years) strategic planning tool with a long-term perspective (30 years) in order to regain an optimum ecological balance. The proposed programs concern the reforestation of 1.5 million hectares in 30 years and 500,000 hectares in 10 years (Fay, 1993).

The Master Plan for Protected Areas

The Master Plan for Protected Areas in Morocco was drawn up in 1995. This plan identified and mapped sites of biological and ecological interest (SIBE), classified these sites according to international nomenclature, and proposed management methods for these sites that would guarantee their conservation and development.

The plan identified 168 SIBEs, spread over 8 national parks and 146 nature reserves. It has also inventoried endangered animal and plant species. Thus, it has been reported that 1,600 plant taxa are classified as rare or threatened with extinction, while on the

fauna side, the inventory of rare or endangered taxa concerns 180 terrestrial vertebrates, 22 mammals, 110 bird taxa and 49 reptiles (Fay, 1993).

Finally, the plan defines three categories of priorities in terms of the entry into force of the protected area status. The first level sets at 5 years the deadline for the implementation of the protection status and concerns 51 SIBEs. The two other deadlines were set at 8 and 14 years and concern respectively 44 and 59 SIBEs.

Evaluation of the Sustainable Land Management Practices

The land conservation programs, essentially involving the implementation of anti-erosion actions have been defined and implemented within the framework of development and reclamation projects in Rif areas based on an administrative approach that does not involve the local people by encouraging their effective participation in the identification, formulation, programming, execution and monitoring of the actions to be carried out.

The benches

This is the oldest and well-known form of runoff water collection and recovery systems. They are now located in our study area in the mountains of the Rif Mountains (Roose *et al.*, 2012). This very ancient and laborious form of gully terracing is used for the cultivation of olive, fig, and carob trees. Cereals and vegetable crops are partially intercropped in small areas.

This technique was the basis of the DERRO project (El Motaki *et al.*, 2019a). Fruit benches are contour ditches about 50 cm wide and deep, at the bottom of which fruit trees are planted (photo 1).

The field works and the discussions we had demonstrated that the benches contribute to erosion control because they trap runoff water and facilitate its infiltration, at least initially. They are more effective during short, intense thunderstorms than during periods of long rains. On the other hand, in the long term, their effectiveness is only guaranteed if they are maintained regularly (photo 2).

In terms of erosion control, farmers and practitioners all believe that the tree has a direct effect on erosion thanks to its canopy and roots, but this effect is nevertheless weak. On the other hand, the indirect effects of the shift from rainfed cereal cultivation to tree cultivation on erosion are considered important.



Photo 1 - Disappearance of the benches implanted in the eds of the slopes and trigger erosive dynamics again within the DERRO program in the Rif Mountains (Situation of August 2020).



Photo 2 - Bench technique established within the DERRO project in Morocco in the '70s (Bellefontaine *et al.*, 2003).

The local population, whatever their category, are aware of the phenomenon of erosion. “The gullies are digging up my land” they said. However, when it comes to erosion control, for most of them, benches are not the most effective means and they find stone walls and gabions more efficient and better adapted to their problems (Ater , Kassout, 2016). After this experience with the DERRO program, the public authorities canceled this technique for the current projects after the 2000s, as in the case of the current programs (photo 3).

This technique has encouraged arboriculture, and therefore there is a strong dynamic for the development of arboriculture. The degree of acceptance of the fruit tree is high, but it is important to dissociate it from the acceptance of the bench itself by the local population.



Photo 3 - The cancellation of the bench technique in ongoing anti-erosion projects in the Rif Mountains (Situation of July 2015).

The gabions

Gabions are metal cages filled with stones. The purpose of this technique is to combat water erosion by allowing water to pass through these structures while retaining the material contained in the soil. It is a semi-permeable barrier that, placed downstream of a gully, prevents water erosion. Also, their flexibility allows them to avoid breakage.

In this technique, the stone sill is a structure built using uncemented stones but is well anchored to the banks to increase cohesion and rigidity (Gartet, 2010). The stones must be placed carefully so that the structure is stable. The use of dry stone makes it possible to have a filtering structure, allowing part of the runoff water to pass through the walls (Photo 4). The excess water is evacuated through a weir set up in the central part of the structure (0.30 to 0.50 m deep and 1 to 1.20 m wide on average for a 4 m wide weir) (fig. 7).

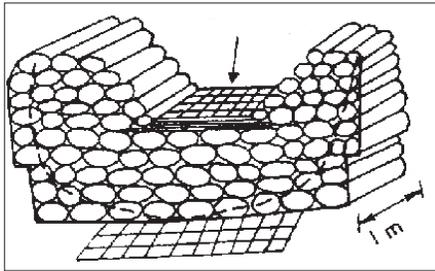


Fig. 7 - The model and designs of the technical process of the gabion.



Photo 4 - Dry stone gabion for the correction of the ravine in the watershed of Oued Aoulai in the Central Rif (Situation of August 2020).

The dry-stone threshold is very vulnerable in the Rif mountains where the slope is very steep, in this context the dry-stone thresholds that suffer a total dysfunction are the thresholds that are found where the slope is exceeded at 20%; also, the geometric shape of some thresholds that are not adequate to their environment. Some thresholds have amorphic shapes, and this situation is very frequent in the Rif mountains.

To solve the problem of the dysfunction of the Gabion development process, the public authorities proceeded to the construction of a channel to ensure the drainage of excess water and also to decrease the slope degrees by the re-sloping technique.

Given the fragility of the marl bedrock, the design of the concrete channel and the weight of the gabion increased the vulnerability of the precarious environment and caused the deformation of the gabion and the degradation of the channel (photo 5).

Forest Management Assessment

The lifestyle of rural populations and the agro-sylvo-pastoral balance depend to a large extent on the benefits in kind derived from forest rangelands (17% of national fodder production) and wood fuel (87% of needs).



Photo 5 - The failure of the gabion technique realized in the region of Oulad Salah in the Central Rif (Situation of July 2018).

The contribution of Moroccan forests to the agricultural Gross National Product (GNP) is estimated at 5% and 1% of the total GNP. However, these rates give only a partial idea of the real importance of the forestry sector (Ghanam, 2003).

The most important contribution of Moroccan forests to the national economy is certainly the protection of the environment and more particularly the protection of soils against erosion, the preservation of water resources in watersheds, the reduction of silting of dams, and the protection of the environment downstream infrastructures.

Many management projects have been carried out in the Rif region for better management of forest resources, but essentially aim to:

- Controlling the reduction of forest capital, both in area and content, to preserve the heritage for its local and national, even international values;
- The enhancement of the forest potential in terms of wood and cork raw material, non-wood products, biodiversity for ecotourism, and forest services;
- The satisfaction of forest users, to balance the balance sheet production/ consumption of firewood, optimization of the “load” relationship pastoral - balance of the forest” and the uses of forest ecosystems in the global management of the terroirs;
- Improvement of the economic efficiency of the sectors, in particular, the sector cork from the perspective of the development of the international demand for cork. cork market, and the cedar sector for its economic and cultural value;
- The valorization of the various functions to reinforce the role of the forest in the environment and the national economy.

The causes of the degradation of forest areas are mainly external to forestry activities themselves. To maintain their low standard of living, rural populations are falling back on the forest, harvesting fuelwood and grazing land that far exceeds the capacity of the forests (Gartet, 2001).

The management of water for the benefit of the agricultural plains and urban populations is strongly modifying the natural balance upstream of the dams in the Ouerrha basin (Hmamouchi *et al.*, 2020). These considerations make it necessary to intervene on these causes through projects based on a rural and mountain policy whose aim will be to improve the standard of living of the rural population, especially in the mountain areas most affected by poverty. This will result in the implementation of projects for the integrated development of forest and peri-forest areas.

The development projects undertaken in northern Morocco, particularly in the Rif, have not been sufficient to stem the spread of cannabis cultivation in the Rif, quite the contrary. Thus, the DERRO project, initiated in 1960 as the first integrated project carried out in mountain areas since independence to combat erosion and fight against emigration by improving living conditions, has had modest results (photo 6).



Photo 6 - Olive planting project to improve the living conditions of the local population in the Prerif Mountains (Situation of August 2020).

In 1995, a royal Dahir created the ‘Agency for the Promotion and Economic and Social Development of the Kingdom’s Northern Prefectures and Provinces’ (APDN), which aimed mainly to open up the northern territories and optimize the exploitation of their natural resources and productive systems (Bouggar, 2017) . More than 25 years after its creation and despite notable achievements, the APDN has not had the expected success in terms of reducing or even limiting the areas under cannabis cultivation.

The area of the cannabis is still growing up and more forests have been destroyed to spread the agriculture of cannabis (photo 7). The study we had to compare the superficies of the Oudka forest (TABLE III) demonstrated that in the last 30 years, the forest area of the Oudka massif has deteriorated in terms of areas and species (El Motaki *et al.*, 2019a).

TABLE III - Forest degradation in Oudka mountain massif between 1986 and 2016.

Forest species	Area in ha in 1986	Area in ha in 2016	Evolution 1986-2016	Interval in 30 years 1986-2016 in %
Other hardwoods	1240	639	601	< 48.46
Cork oak	7860	6321	1539	< 19.58
Reforestation	411	795	384	> 48.30
Pine	23	00	23	< 100
Matorral	1762	00	1762	< 100
Agriculture land	00	873	873	>100

Source: El Motaki *et al.*, 2019a.



Photo 7 - The intensification of Cannabis cultivation in the Oudka forest Mountain (Situation of August 2020).

Conclusion

The majority of natural resource management techniques within the different programs since 1960, in the semi-arid mountains are primarily aimed at water management, capture, storage, and valorization, but at the same time as it protects the soil, the captured runoff brings suspended matter and improves soil fertility.

In the semi-arid zones of the Rif, crop production is not only limited by water availability, but also by the soil's deficiencies in nutrients, mainly phosphorus and nitrogen, which are continuously exported by the crops.

To restore the productive capacity of the land, locals practice a range of traditional techniques: rotation or combination of cereals and legumes, manure, various composting systems, pasture fallow, agroforestry systems (cereal rotation, beans under olive, almond or fig trees), and salvo-pastoral systems. These complex systems help to maintain a minimum level of production, but a complementary supply of mineral fertilizers is essential to enhance water inputs if production is to be intensified.

In the Rif Mountains, the problem of cannabis cultivation has caused a serious problem for the natural environment and human society. Taking into account the accumulated

experience of socio-political changes in northern Morocco, the concepts, objectives, methods, and scale of intervention in the fight against erosion, and the fact that erosion is a phenomenon that results from a set of factors related to both the physical and socio-economic environment, the methodology consists in drawing up development programs that take into account the balance that may exist at the scale of each geographical unit of intervention, but also other units that depend on it taking in concertation the experiences of target locals to accept the approach and techniques.

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LUCIANO LOURENÇO VIAJANDO PELO AMAZONAS AO PÔR DO SOL, EM 15/06/2012.

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