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Fighting climate change:
Human solidarity in a divided world

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Sustainable Management of the North African Marginal Drylands

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Introduction

Drylands – areas with primary productivity limited by water – cover about 40% of the land surface and contain about one fifth of the human population (Millennium Ecosystem Assessment, 2005). This population is typically convergent on areas with relatively lower aridity, further intensifying the stresses on these marginal lands. The concept of marginality applies to these drylands in a socio-economic sense, where the inhabitants commonly suffer poverty and lack of resources. These areas are often politically marginalized as well. A number of driving factors underlie the difficulty of people living in drylands and the generally degraded condition of ecosystem services – a condition described in general as desertification. Anthropogenic activities are almost entirely responsible for these factors. The impacts of these factors on the human society are quite profound and often lead to trans-migration to other eco-regions as well as social and political strife. Thus approaches for management of drylands resources must be viewed in the broader socio-economic context by providing the opportunities for local communities to explore viable, alternative livelihoods while maintaining their own cultural and societal fabric.

The choice of solutions for the problems of dry lands depends on the analysis of causes. There is no one set of solutions for all dry lands. Each dry environment and each dry-land culture needs its own mix of policies. The first requirement in any plan is for careful study of the local situation, and careful sampling of the opinions of those who live and work in the local environment. Effective restoration and rehabilitation of drylands requires a combination of policies and technologies, and close involvement of local communities.

Biodiversity in drylands generally often rated as poor and less valuable compared to the biodiversity in other biogeographic regions (Ayyad 2000). This rating is based on the commonly applied structural criteria of forms of life (plants, animals and microorganisms), and the levels of organization, (genes, species and ecosystems). It emphasizes biodiversity structure, and does not follow that any one number of species or biomass conveys more value on an ecosystem than another, nor can the value of species be ranked on strictly taxonomic grounds. Real situations can obviously involve many important considerations, including measures of the relative values of species. For example, in arid ecosystems, species preserving “ecosystem services”, or those possessing unusual behavioral or ecological properties, or acquiring unique genetic traits of adaptation to serve environmental stresses. Thus, any assessment and quantification of biological diversity in arid lands needs to go beyond mere species counting and move towards developing a “calculus of diversity.” The diversity of biotic systems across scales from genes to landscapes, and the ecosystem services they generate, provides the basic foundation on which social and economic sustainable development depend. Sustainable ecosystem development is about creating and maintaining our options for prosperous social and economic development. Sustaining this capacity requires understanding and managing feedbacks and interrelations among ecological, social economic and political components of systems across temporal and spatial scales. Human society is part of the biosphere and societies are embedded in ecological systems. The transition to sustainability derives from fundamental change in the way people think about the complex systems upon which they depend. Thus a fundamental challenge is to change perceptions and mind-sets, among actors and across all sectors of society, from the over-riding goal of increasing productive capacity to one of increasing adaptive capacity, from the view of humanity as independent of nature to one of humanity and nature as co-evolving in a dynamic fashion within the biosphere. Humanity receives many ecosystem services (such as clean water and air, food production, fuel, and others). Yet human action can render ecosystems unable to provide these services, with consequences for human livelihoods, vulnerability, and security. Such negative shifts represent loss of resilience. A growing number of case studies have revealed the tight connection between resilience, diversity and sustainability of social-ecological systems. Building social-ecological resilience requires understanding of ecosystems that incorporates the knowledge of local users and the complex connections between people and nature. Traditional knowledge systems harbor an enormous and, for the most part, untapped wealth of information that is acquired and constructed within a wide range of cultures. It is also acknowledged that these unique knowledge systems are increasingly weakened in the face of globalization and the growing dominance of a single view of the natural world as espoused by science. To assure mutually beneficial and enriching exchanges between these two distinct knowledge systems requires the development of a way forward that is based on recommendations for action within the scientific community to raise awareness about the unique values of traditional knowledge systems, and establishment of a foundation upon which to build partnerships that can constructively couple science and traditional knowledge.

The economic and social costs of global warming have recently been identified, with Africa as one of the areas to be most negatively affected. There are uncertainties with regard to the climate changes predicted by different global climate models and emissions scenarios, with the arid region proving to be one of the most difficult regions world wide to model. Despite these limitations, many regions of Africa are predicted by most climate models to undergo very negative climate changes by the end of the 21st century, though there are some regions where positive changes may occur, with enhanced rainfall and improved crop growing conditions. The negative changes predicted include enhanced drying in association with rising temperatures and actual rainfall reductions, as well as an increase in extreme climate events.

Desertification affects the poorest farmers most severely. Climate change is widely considered to impact most negatively on the poorest groups of society, and creates major equity and justice issues Various efforts are proposed to buffer the impacts of dangerous climate change, ranging from improving forecasting for farmers, empowering adaptation options, creating alternative livelihoods, use of renewable energy resources (mainly sun energy)…etc.

SUMAMAD Project

The sustainable management of marginal drylands (SUMAMAD) project aims at enhancing the sustainable management and conservation of marginal drylands in Northern Africa and Asia. The project uses a harmonized methodological approach for selected study sites in the countries involved to compare results and share knowledge. Focusing on developing countries in dry areas – particularly the region comprising Northern Africa, Middle East, Central Asia and China – the following Projects objectives have been identified:

- Improved and alternative livelihoods of dryland dwellers.
- Reduced vulnerability to land degradation in marginal lands through rehabilitation efforts of degraded lands;

- Improved productivity through identification of wise practices using both traditional knowledge and scientific expertise

The project comprises several tasks, as follows:

Task 1: Assessment of the current status of integration between the conservation of natural resources, community development and scientific information; this task requires baseline studies on various disciplines to fill up the gaps in data and information about the exiting state of OBR and its hinterland. The following activities are essential for this task.
Task 2: Identification and implementation of practices for sustainable soil and water conservation, aimed at combating environmental degradation involving a combination of traditional knowledge and modern expertise; This task involved among others, Strengthening the cooperation between the management team of the reserve on one hand, and the local inhabitants and related administrations in Matrouh Governorate and EEAA on the other hand, Assessing the positive and negative impacts on the environmental physical and biological resources and the behavior of the local inhabitants towards conserving these resources.
Task 3: Development of income generating activities based on sustainable use of dryland natural resources; this task involved providing technical and financial training for the development and management of the income generating activities incorporating environmental awareness which explain the conservation objectives behind these activities.

SUMAMAD site in Egypt:

Egypt is one of the north African countries that was selected for the project implementation. The site of implementation is a representative area in the Western Coastal Desert of Egypt. It is the Omayed Biosphere Reserve (OBR) and its hinterland.

The western coastal desert of Egypt and its hinterland is renowned by its wealth of natural resources .This region has been a point of attraction for development projects due to this richness in natural resources, fine location ,good weather ,and pleasant conditions. Water resources are scarce and variable. As a result the local community has developed a wide range of strategies for managing water resources in this region. Traditionally, they move around for water, pasture and croplands, based on the rainfall pattern (SUMAMAD Proceeding, 2004). But recently and after being sedentary, together with population growth, overuse of water resources, over grazing and uprooting of indigenous vegetation, climate change, and other political and social forces, there has been an increased pressure on land resources that affected its performance and provision of goods and services.

From the hydrometeorologic point of view, the northwestern Mediterranean coastal zone occupies a portion of the semi-arid belt south of the Mediterranean Sea. The climate of this region is characterized by a rainy unstable winter and a stable warm and dry summer. The other two seasons are also characterized by unstable climatic conditions. The mean monthly values for air temperature are more or less in the same range allover the area which reflects regional identity. The maximum and minimum values of air temperature are generally recorded in August and January being 26oC and 12.4oC respectively. During spring season, the temperature is variable where Kamasien storms raise the temperature to about 40oC. The mean monthly values of relative humidity are relatively high in summer months. The maximum and the minimum values of relative humidity are recorded in August and October, being 72% and 61%, respectively. The values of relative humidity decrease gradually southward. Generally, the relative humidity plays an important role in the amount of evaporation, evapotranspiration and dew condensation.

The Mediterranean coastal zone of Egypt receives noticeable amounts of rainfall especially in winter (October through February). In summer, no rain is recorded, while in autumn, occasional heavy rain may occur. The rainfall shows a general steady decrease from north to south ranging from 168.9 mm/year at coast (Burg El-Arab) to 16.2 mm/year at Siwa Oasis to the south. Precipitation is considered as the main source of recharge of groundwater aquifers in the northwestern Mediterranean coastal zone and affects greatly the amount of water stored in such aquifers.

In this coastal zone, many crops of great economic importance (e.g. wheat, barely, olive, fig, rangeland plants, etc) have been planted and agricultural expansion is in progress. Irrigation of such crops depends mainly on rain water falling in the winter season. On the other hand, great a number of Bedouins settlements depend in their drinking and other domestic activities on rain water which is collected by means of underground Roman cisterns.

The El-Omayed Biosphere Reserve (OBR), the study site of SUMAMAD project, belongs to the semi-arid belt south of the Mediterranean Sea (UNESCO 1977). The area has been declared nationally as a biosphere reserve by a prime minister decree in 1982. Currently OBR is managed by the nature Conservation Sector of the Minster state of Environment. It receives most of the rainfall in winter. It receives about 151.8 mm/year which accounts for 106.26 × 106 m3 of water. The catchment would receive rainfall volume of about 140.415 × 106 m3 which contributes to water resources within the catchment. About 98% of this volume recharges the groundwater aquifer system during heavy storms and 2% goes back to the atmosphere via evapotranspiration. The formation and persistence of soil cover in the El Omayed area are strongly influenced by the arid climate. The scarcity of water for reactions within the soil and for the leaching of soluble components from the soil itself restricts the extent of soil formation processes. All soils in the area are considered to be very young and immature, and as highly influenced by the geological and geomorphological conditions of their formation. These soils are sandy loam to sandy clay loam and often at least 1m deep; salinity problems are frequent in the lowest lying areas. Generally, the chemical analysis of these soils indicates that they are characterized by low salt content. Organic matter and total nitrogen contents are relatively higher in the cultivated (olives and figs) soils than in unmanipulated areas, calcium carbonate is generally very high in the coastal areas.

In the North Western coastal desert in general, and particularly in Omayed biosphere reserve and its hinterland the local community is a nomadic and semi-nomadic which tended to be sedentary due to the government policy to sedentary nomads. The local community of the households lived in the area for as long as they can remember and the process from semi-nomadic to sedentary within the region began about 30 years ago when the Bedouins began to build stone house. This does not mean that the mobility of house dwellers for grazing is affected nor that the entire family of tent. The population of Northern Omayed is the most sedentary, a fact which is probably promoted by registered land holdings .The degree of the sedentary decrease towards the hinterland where some Bedouins may be up to half are still semi-nomads. The community is characterized by holding their inherited lands, water wells, traditions and values, which is of both materialistic and non- materialistic nature. Bedouin law, or "URF" means custom law in the community, which plays an important role in the community, and make a control and harmony between people. This social way of settling problems is more effective and faster than going to the police and referring to national laws. "URF" implementation is carried out through meetings and approvals of a set of rules and procedures for resolving disputes and dealing with acts and agreements.

Generally, one of the most common forms of land use is animal husbandry. It is seldom found that any one family is engaged either in cultivation or in herding usually there is a mixture of these activities. In such region the yield and nutritive value of consumable range plants are highly dependent upon rainfall. However, the condition of the pasture and vegetation performance also depends upon rainfall. There are three major land uses in the dry lands: rangelands 88%, rain- fed cropland 9% and 3%`irrigated land. Recently and after the extension of a supplementary irrigation canal from the Nile, the extent of irrigated areas have increased to about 8% in the area of Omayed only, using drip irrigation. The products of these lands are renewable; thus the ranges are capable of providing continuous goods and services such as forage, fiber, meat, water and areas for recreation. These resources are considered by many people to be an integral part of the traditional heritage, which adds special importance to their value. Concomitantly, rangelands are now in a poor condition due to pressures that have either altered or destroyed as a result of overgrazing, uprooting of plants and off-route use by vehicles. This resultant of such activities that were and are taking place since 25 years is an almost complete removal of vegetation cover, a speeding up of the desertification process and the destruction of wildlife habitats.

SUMAMAD project in Omayed Biosphere Reserve works directly with the local community and helps them too understand the goods and services of their ecosystems, and how they are prone to degradation due to irrational uses, and that these goods and services could be execrated due to climate change. The idea of climate change is quite difficult to understand by the locals; nevertheless SUMAMAD team is trying to explain the idea of climate change and its consequences through analogy to existing local problems, e.g. prolonged drought, and sometimes severe weather events. In this respect, the project compliments the governmental strategies to adapt to climate change. It has to be noted here that these strategies need to be strengthened and directed to feed in with the national strategies to combat desertification. Examples would be efforts on rehabilitation of degraded ecosystems and afforestation. There is an urgent need also to focus on management of natural rangeland that are currently under threat due to overgrazing and wind erosion. Through SUMAMAD project, open discussions with the local community, particularly the poor ones are carried out regularly to illustrate to them different rotational grazing schemes and concepts of carrying capacity.

Effects and adaptation of climate change

As climate change is a global phenomenon, appropriate responses are often sought within the global and national institutional levels. It is nevertheless important that we find ways to ensure the functioning of local institutions and their articulation within the wider institutional frame. It seems quite accepted that a major consequence of climate change would be the increase in drought frequency and severity. Climate change-related dynamics are likely to also increase oprtions for other ecological risks such as land degradation, floodings, and conflict over resources. Adaptation to climate change has the potential to reduce the adverse effects, but will incur costs, and will definitely not prevent all damages. Communities vulnerable to climate change in the study area are currently under pressure from many environmental problems, among which are land degradation due to mi-uses to the resources, depletion of natural resources, and poverty. There is a need for initiatives to design and build adaptive capacities to these communities. More emphasis has therefore to be allocated on enhancing pastoralists' capacity to claim their rights and satisfy their needs, rather than in looking at technical solutions. The reason is that the capacity to respond to critical situations is closely linked to one's economic status and one's ability to claim the attention and resources of government or other agencies

1)Pastoralists: Animal husbandry and firewood as an energy source are two major basic needs of the inhabitants in the western desert of Egypt. These needs are considered by local community to be an integral part of their traditional. Bedouin heritage and the number of animals is considered as the prestige of the family, which adds special importance to their value. There perception of the number of stock they owe is in analogous to Petrol (as they say), i.e. it is their wealth and insurance of welfare. Local community from pastoralists are among those that are likely to suffer most due to climate change, despite the fact the they are certainly not amongst the main contributes of the problem. The main reasons for vulnerability of pastoralists to climate change stay in their reduced mobility, their integration into market-mechanisms, growing population and privatization of critical pastoral resources.

However, pastoralists have their own traditional capacity to respond and adapt to climatic risks. They are used to drought events, and extreme climatic conditions of heat and wind. They also can cope with different precipitation regimes, i.e. more or less frequent or intense rain conditions, as well as timing which greatly affect the phenology of the wild plant species. But, it is likely that the current adaptive capacities of these communities become eroded and they may be more susceptible to climate change than other communities. In order to support the livelihood of these communities, more efforts are to be put in strengthening and improving their capacity to adapt to changes in climatic patterns, rather than technical advices. The traditional knowledge of the local community pertaining to grazing involves the following:

a) Livestock migration: The grazing period in the coastal region is divided into 2 periods: wet period and dry. In the dry period is associated with shortage in the natural forage. Consequently, the livestock migrate to a more vegetated areas; either to the Nile Delta region by the relatively rich communities or Moghra Oasis (hinterland of Omayed site), which lies further south of OBR by the poorer communities. The traditional knowledge of the herdsmen enables them to travel for about 4 days on foot to Moghra (avoiding land mines spread in the region) and settle there in a complete traditional life for about 4 months.

b) Supplementary feeding: Due to increase the price of the wheat, barley herders are used the remains of onion (dry scaly leaves and hay) as a source of supplementary food. According to the traditional knowledge of the local community, onion is a good nutritive source, of food and is considered to be a fattening agent to the herds.

c) Partition of the livestock: Traditionally, local inhabitants divide their livestock into 2 groups; a small group of folks consisting of old, pregnant animals and those that just gave birth, and a larger group consisting of the rest of the folk. As the former group is more vulnerable, and require extra care, they move for grazing with their owner and close to the owner's house. The second group move away from the house in cultivated areas by a labor herder.

d) Controlling and flock direction: The livestock composed of different ages of animals. The herder with his traditional knowledge puts a plan for the grazing flock e.g. in the morning he move with his herds to the lands where he recognizes plant species types as nutritive and therefore useful for young animals (lambs). In the afternoon, he moves the flock to other places where plant species are useful for the old animals.

e) Moghra Oasis, As Rangeland Alternative: Moghra is a small uninhabited Oasis (30o 14- N, 28o 55- E), about 45 km south of Omayed. This Oasis is considered as one of two places, where most of Bedouin flocks (mostly camels, sheep and goats) migrate in dry season (summer) during the shortage of natural forage. The Oasis is characterized by: 1) suitable water for drinking, 2) presence of some range species, and 3) prevailing similar environment and occurring of shadows of the trees as (e.g. Phoenix). It is a considered a wet land in the hinterland of OBR. Locals traveling to Moghra roam freely in the area and their herds graze wherever vegetation is dense. There are no legal rights or land ownership in this oasis. The only property that exists in Moghra is the property of water wells and springs. Such properties are inherited within the owner families and are controlled between families by ”URF”. However, these wells and springs are open for use by anybody as long as he is a non foreigner to the area.

2) **Annual Cultivation and Saving irrigation water by cultivation of drought tolerant crops:** Wheat production in drylands is below average due to the prevailing adverse climatic conditions. The major obstacles encountered are low fertility, drought and salinity. Therefore the Agriculture research center, Ministry of Agriculture has concentrated its efforts to produce a new wheat genotype that is tolerant to water stresses and adapted to salinity. After several studies and experiments, a new cultivar of wheat was produced that is drought resistant. It is a bread of two wheat cultivars, Sakha 8 (an Egyptian cultivar), and the Nesser produced by ICARADA. This cultivar has been cultivated in a soil of similar physical and chemical characteristic as the study area. It requires only two irrigations one at sowing and the second at 30 days after planting, and then left to rainfall conditions. Fertilizers scheme is also indicated in terms of type and time of application. Seeds of the above cultivar have been distributed to two selected Bedouin in OBR in September 2004 who cultivate wheat in their lands. They were asked to cultivate this new cultivar beside the cultivar that they normally cultivate. In April 2005 at the harvest time, the experiment

using the new cultivator proved to be successful, and the wheat grains emerged with almost 100% success. However, the production level observed was relatively lower than the cultivater used in their lands. It was therefore recommended then to use this wheat grain in rain-fed farm since it requires low water supply for irrigation, and that the production would be used as fodder for the animal husbandry. This recommendation was accepted by the local community, as they preferred to use the wheat cultivars the already use in irrigated farms.

3) **Using solar energy for the desalination of water and provision of fresh drinking water:** Since some winter seasons in OBR is rainless, another source of drinking water is needed to compensate in the dry seasons and years. A water desalinization system based on solar energy is a suggested practice for water conservation in Omayed Biosphere reserve. The system uses untreated water from wells, rivers, lakes or the sea. It is composed of solar stills that were locally manufactured and a very small electronic monitoring system with a solar sensor to regulate the quantity of the untreated water. The system produces around 50% fresh drinking water and 50% remains as brine which could be used to support fish farms or extract pure salts for tanning of leather as an additional source of income. The cost of the above system is relatively low, and if compared with the cost of transporting water by trucks from far away by the local community for twenty years (the life time of the system with no maintenance), the cost will be almost nil. There are three pilot installations of this solar system, two in selected houses in different villages, and the third is placed in Moghra Oasis to support the drinking water supply of the herdsmen there. In July, 2006, a Bedouin who is the head of a community of 35 individuals in contacted the SUMAMAD coordinator and explained the disparate need of his community for fresh drinking water due to the scarcity of fresh drinking water in the vicinity. The water normally use is transported via trucks and is of very low quality. The situation has lead to the infection of all the children in this community with intestinal diseases, skin and eye allergies. The medical analyses of the children have been examined and it was proved that these children suffer from water-born diseases. Water needs of this community were studied by SUMAMAD team, and it was found that a water 5 units of solar desalination units could be installed in the roof of the house and would suffice safe drinking water for this community.

Scenarios and Consequences of Different Development Techniques

As mentioned above, the current ecological conditions in Omayed BR and its hinterland indicate that there is a significant deterioration of the environment and this calls for an urgent plan for conservation and development. The primary aim of this section is to present a tentative model which would contribute information to planners, and indicate consequences of implementation of various scenarios. The consequences of different scenarios are:

(a) Impacts on main ecological features,
(b) Effects on the future of resources, and
(c) Results concerning socio-economic situation of land-users.

The proposed model simulates trends of variation in ecological conditions due to different land uses and environmental conditions.

Level 1: Full protection, which is unrealistic, but is proposed only for the comparison of economic values with other scenarios. This scenario implies the prohibition of ploughing and stopping on a short term basis of all human practices including wood cutting and all activities related to grazing and animal production. It is assumed that such scenario could be implemented in the core areas of the Biosphere reserve, and would call for established of more core areas in the biosphere, since there is only one core area (only 1m2), which is currently functioning, and would not suffice such scenario.

The consequences of this scenario of full protection are as follows: In such case each unit evolve according to its regenerative capacity. Steppic units evolve mainly through an increase of their cover. The rate of such evolution is low in the cases where units are already under a very low level of human pressure but also in the cases where the native flora and vegetation are so destroyed that it seems to have no capacity for regeneration. Units where agricultural practices are suddenly abandoned are progressively invaded by plants of the type which gradually rebuild the native vegetation cover corresponding to the ecological conditions. This type of vegetation is sometimes difficult to visualize in the areas which are now under regular ploughing. This hypothesis is not necessarily a good way for managing the vegetation production of the ecosystem, even at medium or long term time scales.

Level 2: Rangeland development and limitation of the ploughed fields, this scenario implies that annual crops cultivation and tree plantations would be limited only to suitable areas, i.e. areas with negligible, low or medium degree of vulnerability of natural plant cover and of soil that have to be ploughed, and areas where the topography allows for run-off harvesting and which consequently have better yield, mainly of cereals. This scenario implies also the adjustment of stocking rate on the ranges to the present grazing capacity, and to ensure the recovery of the plant cover by rotation in depleted areas. In this case, it becomes necessary to have supplementary feed during the transitional period of preceding the complete restoration of ranges.

The consequences of such scenario with rational use of rangelands, is a biological recovery and satisfactory control of degradation. This is an aspect which is rarely taken into consideration by economists. This scenario goes with the traditional practices carried out by the local community before sedentarization. The roaming life of Bedouins was driving such scenario to exist naturally. Nowadays with the Bedouin sedentarization and the growing environmental pressure that occur, this scenario will be face resistance from the local community particularly in the coastal are. However, there is a good opportunity to adopt this scenario in the hinterland, where the main land use is grazing, and very limited cultivation practices.

Level 3: Continuation of present practices and maintenance of present land-use system, Current practices indicate that with the present system of annual crop cultivation and tree plantation yields will remain low. Locations used for grazing will be gradually overgrazed and will decrease in area. Continuation of the present practices means in fact more ploughing for cropping and extension of orchards and annual cropping of cereal and vegetables, particularly after the extension of the supplementary irrigation canal from the Nile. This scenario means also an increase in the number of animals and means no planning management of rangelands (e.g. limitation of stocking rate according to the level of production of rangelands). Although this scenario is the most probable, it will result in immediate limitations for land use .For instance, the harvesting of large areas of low yield cereals by hand is a bottleneck, since it will be difficult at present to visualize the introduction of mechanized harvesting in such low yield conditions.

The Consequences of this scenario is a realistic hypothesis according to the actual degrees if attractivity of different units for grazing (and wood cutting) and ploughing. It may also result in an acceleration of the clearing of more attractive areas for ploughing. An associated constant decrease of areas used for grazing provokes permanent overgrazing during certain periods. Extension of cereal and vegetable farming and fig plantation in addition to overgrazing and severe uprooting promote an increase of degradation processes.

Level 4: Intensification of present practices. This scenario postulates that:
(i) the recent fast extension of orchards for economical reasons will still increase during the next twenty five years ,
(ii) that socio-demographic conditions necessitates new extension (due to possibility of mechanization) of cropping for human consumption and for feeding of animals and
(iii) that investments are made for promoting the use of resources (e.g.) increase the number of watering points) with no acceptance by population of the principle of rational range management (stocking rate, rotation etc…….)

The Consequences of this scenario is all possible misuses of the area accumulate with the mechanization of ploughing and other agricultural practices, and the creation of watering points without limitation of size of herd or of grazing period. Regeneration of vegetation becomes low or negligible everywhere, and the progressive reduction of the yield of all types of production leads necessarily to heavy investments for reclamation, less employment opportunities, and to limiting rural depopulation. At this level, we consider that the sensitivity will reach what we have referred to as the potential sensitivity; all areas being at their highest level of attractivity for grazing and ploughing.

Level 5: Extension in land reclamation using the supplementary irrigation canal as a source of irrigation water, such scenario of development must be evaluated according to the environmental potentials and availability of the local labour force. This scenario may provide a possibility for regional development if good yields are attempted for cereals and various feeder crops, and if a limitation of animal stocking rates on rangelands is achieved. Simultaneous environmental conditions must be considered very carefully in order to avoid salinization and water logging.

The consequences of this scenario are the use of heavy investments for introducing such level of intensity of human pressure. Such pressure should be conceived as rational management taking into account possibilities of irrigation according to soils and water resources, and according to the restriction of cereal and trees farming to suitable areas which benefit from direct run-off water as a result of natural topographic conditions. This system has the same results as those of level 2, but with the highest agricultural production due to the extension of irrigation.

In reality, according to the soil resources map we can have two possibilities:

(a) Extension of irrigation to suitable soils without any sensitivity and,

(b) Extension also to soils which need some precautions for controlling wind deflation and possible salinization.

Such approach is given here for providing possibilities to test the different levels of human pressure proposed according to the understanding of the effect of grazing and other agricultural practices on the dynamics of the ecosystem (possibilities of regeneration), and on the future of renewable resources. It is important to take into account that there are several inter-correlated factors: predictable increase of population, socio-economic changes, trends in land management, variability in dynamics of ecosystems, evolution of renewable resources, and variability of rain. It is difficult to take care of such various factors at the same time. It appears however, that an optimum level of land use intensity should be determined on the basis of ecological considerations (in order to maximize resources, and to ensure a progressive recovery of soil and vegetation. Meanwhile, the management must take care of two main factors:

- (a) traditional life style of local population, and
- (b) socio-economic needs of the population, looking for progressive improvement in their standard of living.