



## How to Enhance Resilience for Oasis Ecosystems in Maghreb?

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Oases ecosystems dominate zones of about 30 % of the grounds emerged along the large arid scarf which links Africa to Asia; from the Sahara to Mongolia. They shelter about 150 million people in areas where other forms of life spurt out with difficulty.

They are formed by a rigorous management of rare water and ground resources in a strong alliance with the date palm tree. Oases are ecosystems patiently worked out by the societies which inhabit them in arid areas, in the form of a very complex social, ecological and economical constructions. These actual processes are those of an optimization of the interactions between cultural references, engineering constraints, economical limits and ecological potential in regards to the climatic adversity of a hostile environment to forms of life. Within this framework, oases constitute verified and alive experiments of durable development as well as an incomparable resource of expertise. Similar to other achievements actually protected, oases form part of the inheritance of humanity.

In these areas considered by IPCC with high level of risk concerning climate change impacts, oases permit to settle down populations, provide employment, host intensive food production system and are relay for nomadic populations whose livestock is 50% of world resources. All these characteristics contribute to local food security. In this way, oases conservation secures a part of food security which cannot be replace by others farming systems. Finally, oases can be considered as a part of solution face to climate change contributing at the same time to combat poverty.

### Oases are Fighting Desertification in the Front Line

Oases are agro systems constructed and preserved by man. For nearly 4000 years, in both arid and semi-arid regions throughout the arid belt stretching from North Africa (Maghreb) to China, they have constituted one of the most effective human adaptation strategies in an environment challenged by both pronounced temperature variations and low precipitation.

It is estimated that oases shelter approximately 150 million people throughout the world, mostly in Asia and Africa, and some also in America.

Oases have the capacity to fix populations and their economic and social livelihood through rigorous ecosystem management practices that use rare local land and water resources to the best advantage. Their elaboration rests upon a traditional organizational structure articulated around rigorous vegetation layering rules and the perfect harnessing of water and shade. These practices create the 'oasis effect': in effect, a hot and humid microclimate, perfectly favorable to diversified agricultural production. It is thanks to this organization and management of life that oases are able to protect themselves against climate aggressions.

Oases are covered by date palm trees that spread out their leaves at a height of 100 to 130 feet, protecting the underlying layers of vegetation from the sun's ardors. These underlying layers are comprised of fruit trees, vines, shrubs or plants such as pomegranate or henna, and subsistence, market or forage crops. Irrigation is achieved by flooding, thereby ensuring that the entire ecosystem benefits from water infiltration and storage.

### The Science of Adaptation is Valuable Expertise

Underlying the existence of oases throughout the centuries is a practical, multi-folded science of adaptation to climatic variations. At the heart of this science lie social and economic organizational capacities that have successfully worked with and integrated natural resource management pressures in an aggressively arid environment.

- The marriage of intensive agriculture within the oasis, and extensive husbandry over large areas of pasture outside the oasis, has always preserved fertility.

- Traditional surface water gravitational irrigation, abiding by deep-rooted social water sharing – or « duty of water»
- Traditions, adjusted to the needs of land plots and vegetation, make oases valuable water governance and engineering models.
- ‘Territorial respiration’ based upon very precise floodwater spreading expertise. In years of good rain, floodwaters are spread so that vast areas can be cultivated, while in years of drought, cultivation is brought back within a more confined irrigation perimeter.
- In many cases, has been crafted a science of groundwater catchment and gravitational water conveyance over several kilometers to cultivated areas. All with no fossil energy use like khettara systems.
- The development throughout the centuries of a diversity of life forms adapted to such diverse climatic conditions constitutes a genetic reservoir of local species that is indispensable for adaptation to climatic change.

Oases therefore offer very real potential for very arid zone development and for viable preservation of their populations. They are characterized by flexibility in the face of climatic hazards.

At the very edge of hyper arid deserts, oases also help preserve the transitional areas that act as buffer zones. The evolution of this « pre-Sahara » strip is an indicator of the interaction between deserts and slightly or significantly more humid regions. Oasis preservation is essential to the preservation and rehabilitation of these transitional areas, which are however showing visible signs of degradation on a global scale.

#### **Oases in Crisis**

Oases today face a variety of crises, some of which are caused by changes brought about by globalisation. In particular, oases struggle with a loss of income caused by changes in long distance trading and the decline of trans-Saharan caravan trade. Another crisis is caused by population migration to cities and coasts.

This migration has come about because of a combination of factors, in particular: the lack of priority given to oases by governments, resulting in an absence of land reforms leading to an ever greater fragmentation of land plots, the absence of agricultural policies designed with such small areas in mind and enabling the creation of added value, as well as oasis enclosure and isolation, and in some instances the shortage of public health and education services.

#### **New farming systems for more pressure on natural resources**

Face different crisis, oasis population created new farming systems around historical areas based on individual pumping system. These systems promoted water access allowing being free from collective rules and they offered possibility to respond to land tenure restriction with the access to new areas. Although these dynamics built resilience capacities, they have been generalized and consequently have stimulated resources decrease by intensification of pressure.

Finally, in the Maghreb, successive droughts and resource overexploitation have progressively aggravated another major crisis: the water crisis. The Mediterranean region, severely hit by water shortage, already holds 60 % of the world's so-called «water poor» populations, and several Mediterranean countries are now in a dangerous situation in which water consumption has exceeded annual inflows. Since the 1970s, this has resulted in significant depletion of the aquifers that traditionally provided for oases, and this depletion has been worsened by the increase in individual wells and associated drawdown. This is what has happened for example to the Djérid aquifer in Tunisia and to the oases that it feeds.

#### **Climate change issues for oases systems**

In addition, oasis areas situated in arid zones will be strongly impacted by climate change forecasts. They will suffer from an important decline in their water resources as a combined effect of rainfall changes and evapotranspiration increase. In 2060, a decrease in rainfall of up to 50% is forecast for these areas.

Finally, the occurrence of extreme events such as prolonged droughts, heat waves or recurrent heavy flooding will become more frequent due to climate change, with various consequences (increased scarcity of water resources, degradation of soil quality, and decline in agricultural yields). The degradation of natural resources and the diminution of agricultural yields will mean that the supply of cereals, the basic food of North Africa, will plummet between now and 2050. In conclusion, the changes in climate forecast for the coming years will send shock waves across North Africa, especially in the agricultural sector. The challenge faced by the region is to continue to produce sufficient quantities but with increasingly scarce resources. Oasian ecosystems are being directly impacted and their existence is threatened.

### Which perspectives for building oasis resilience?

In order to improve resilience of oases ecosystems faced with actual issues, it's necessary to look for local initiatives.

Water resource management appears like a priority. Essential for development and sustainability of oasis ecosystems, it's necessary to target global sustainable management at the different scales of territory. Dissemination of drip irrigation systems offers opportunities for an economical use of resource however it's necessary to conserve submersion irrigation for soil lixiviation. Traditional water systems conservation bring some interests for both resource access and flooding control like system of khettara or allocation water system in M'Zab in Algeria. Finally, formulation of integrated water management plan at the territorial level enhances management and allocation of water resource.

The state of uncertainty created by climate change projections need to improve capacities of reaction of authorities and population. Therefore, implementation of monitoring and warning systems like observatories aims to build capacities of reaction and allow adaptive management of oasis ecosystems. Face to climate constraints, agricultural works have to offer capacities of adaptation. In this way, agro ecology constitutes a real opportunity for a much better resistance to the effects of climate change. However, it demands a change of vision in agricultural development approach. Farmers' preoccupations and local constraint need to be introduced into the reflection and implementation. Without that dimension, the dissemination will fail.

With multiplication of issues, it's necessary to improve capacities of innovation of populations. Networking appears like a way to support exchange and mutual learning. It constitutes a way of advocacy for adoption of appropriated public policies. Public policies have to integrate sustainable management necessity face the emergency of the situation. They need to include specificity of oases ecosystems and at the same time to promote collaboration between the different actors of development.

At least, some problems need increase cooperation between the countries. Saharan water-bearing which aims to create a consultation mechanism including Algeria, Tunisia and Libya, and supported by Saharan and Sahelian Observatory (OSS), appears like an initiative to share.

### Conclusion

Actual crisis requires supporting adaptation dynamics to improve resilience capacities of oases. Obviously it's necessary to set up a sustainable management articulating traditional expertise, technology, monitoring and information systems. Information exchange and networking are an obligation to build appropriate reactions face to strongest events. Finally oases have to be recognized like vulnerable ecosystems and water has to be the focus resource to ensure sustainability.

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