Water resource management in oasis systems

Agroecological zones

Oasis

Introduction

Source: INAT, Tunisia

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The oasis systems of North Africa, located in arid and semi-arid zones, are man-made ecosystems and can be considered as a world cultural heritage testifying to man's ingenuity. These regions are characterized by hot, dry climatic conditions, with low rainfall and high evapotranspiration. The oases therefore depend on irrigation, and a number of ancestral practices and innovations have been developed to preserve the scarce water resource and manage its distribution.

As water resources decrease, due to overexploitation of groundwater and climate change, a number of old and new practices can contribute to the sustainable management of this common good. These practices may be applied in traditional oases, where water is managed collectively, as well as oasis and peri-oasis farms with individual boreholes.

Objectives of rational irrigation water management

Rational irrigation management aims to **optimize the use of water** to meet agricultural needs without depleting non-renewable water resources, and to **reduce water wastage** by using efficient technologies and methods. The rational management of irrigation water also **minimizes environmental impact**, notably soil salinization, erosion and ecosystem degradation. Finally, it strengthens the **economic sustainability** of farms, by reducing the costs associated with irrigation.

Reasoned irrigation practices at farm level

Irrigation methods used in oasis systems often depend on the nature of the water resource (collective or individual), its availability, flow rate, desired efficiency, investment capacity and cost of use. Several practices can be implemented:

- **Practices to improve flood irrigation in basins**: In traditional oases, submersion irrigation consists in bringing water to the basins around the palm trees via seguias or canals dug right into the ground. These arrangements are associated with significant water losses through infiltration, evaporation and consumption by weeds. Practices such as concreting the seguias or replacing them with pipes (in plastic, polyethylene terephthalate - PET, etc.) significantly reduce these losses.
- **Localized irrigation**: The main aim of localized irrigation systems is to improve water distribution and reduce water losses through evaporation or run-off from the root zone in the spaces between palms. Wherever possible, these practices should be combined with improved irrigation splitting and the implementation of a reasoned irrigation schedule. Various options exist in oases, such as the use of micro-sprinklers, perforated pipes, high-flow drippers (bubbler technology), or integrated drip lines.
- **Irrigation management using soil moisture sensors**: Irrigation can be controlled according to soil moisture. **Moisture sensors** or **intelligent irrigation management** systems can be used to determine when and how much water should be applied, thus reducing the risk of overuse. Different types of sensors are available on the market, from the simplest such as tensiometric probes to capacitance probes that can monitor soil water content at different depths and conductivity in real time. This information can be important in regions at risk of salinity, as is the case in many oases in North Africa.
- **Building water basins** can improve water use efficiency when combined with better management of the irrigation schedule, particularly by reducing irrigation volumes and increasing frequency. This type of management can partially compensate for the transient water deficit of palm trees in collective perimeters, where water turns are often increasingly spaced, in a context of dwindling water resources. However, these arrangements also result in significant water evaporation, particularly when installed in areas that are highly exposed to sun and wind.

Practices to reduce losses and improve water use efficiency

- **Water transport**: Particularly for collective water-sharing systems in oases, water transport and distribution can lead to significant losses, especially when using wadis and seguias. Khettaras are traditional underground installations in many Moroccan oases that allow water to be transported underground to the farms, considerably reducing evaporation losses. The value of Khettaras is demonstrated by recent efforts to recharge these collective galleries by pumping, in certain oases where natural springs have dried up. Solar-powered pumps can be used to recharge Khettaras, although care must be taken not to accelerate the over-exploitation of water resources.

- **Creating oasis microclimates**: Ancestral practices of multi-layered cultivation in oases, where palm trees coexist with herbaceous crops and arboriculture create natural shade and a humid microclimate that helps reduce evaporation. These practices activate and stimulate the small water cycle (localized feedback loop).
- **Use of drought-resistant crops**: The introduction of drought-resistant herbaceous crops, such as certain varieties of cereals (particularly barley), legumes (lentils and chickpeas) and fodder plants (alfalfa), reduces water demand and limits competition with date palms.

Collective and individual rainwater harvesting practices

Climate change is accentuating the stormy nature of rainfalls. Highly erratic and often torrential rainfalls cause temporary flooding of the wadis. A number of both ancestral and recent practices have been developed to optimize the capture of this rainfall for irrigation and groundwater recharge. It should be noted, however, that a participatory and territorial approach should be implemented in the decision-making process, as these developments can reduce access to water for downstream communities and ecosystems.

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In the oases of southern Algeria, projects encourage rainwater harvesting. Facilities such as hillside reservoirs, collector wells (known locally as '*Ouaroura*') and the construction of dams, of varying sizes, enable the collective recharging of water tables.

Unconventional water mobilization through wastewater treatment and recycling

Using **treated wastewater** for irrigation can be an option in areas where water resources are limited. This can reduce pressure on resources and encourage sustainable recycling. However, the use of treated wastewater for irrigation depends on the water being sufficiently treated to ensure a level of sanitary safety compatible with agriculture.

Improving water efficiency

- **Mitigating the effects of water salinity**: In oases, located in arid and semi-arid regions, irrigation water from phreatic or deep aquifers is often saline. In these agrosystems, irrigation can cause secondary salinization. Managing irrigation by including leaching fractions, where possible, is a practice that helps reduce the impact of water salinity. Oases are also often subject to rising saline water tables, and collective drainage schemes, often state-built, are needed to evacuate surplus water.

- **Mitigating the effects of soil salinity**: In oases, several practices have been developed to improve soil fertility by increasing organic matter content, thereby reducing the impact of soil salinity. The integration of livestock into the oasis facilitates access to manure. Composting oasis residues and by-products also helps (**see Composting crop residues in agroecology leaflet**). Sand amendments are a common practice in oases, particularly in Tunisia. It consists of adding sand taken from the dunes adjacent to the oasis, mixed with manure prior to amendment.

Challenges and limitations

Rational irrigation management in Mediterranean oasis systems is essential to ensure **sustainable** water **use**, while maintaining agricultural productivity and preserving local ecosystems. Oasis-wide irrigation management often requires collaboration between **local stakeholders**, **governments**, **non-governmental organizations** and **research institutions**. **Water governance** must be transparent, inclusive and guarantee **equitable access** to water for all users, especially small-scale farmers. **Integrated water planning** must also include other users from different sectors (agriculture, livestock, local population, etc.). This holistic vision is threatened by the proliferation of individual boreholes.

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