

## Chapter 12

# Climate Change and Its Impacts on Oases Ecosystem in Morocco

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### ABSTRACT

*Today, the international community agrees that climate change is one of the most important threats to the equilibrium of ecosystems. For its part, Morocco is not immune to this phenomenon because of climatic disturbances that the country has known for several years. Moroccan oases are among the most affected ecosystems by climate change, which has resulted in reduced yields of agricultural production, poverty, and deterioration of natural resources. The reports showed that in Morocco the area of palm groves has been significantly reduced during the last decades resulting from the upsurge of drought phenomena, soil salinity, and the spread of “Bayoud.” Therefore, the deterioration of the socio-economic and environmental importance of the date palm is well established. Aware of these issues, many actions have been initiated by the Moroccan government to preserve this ecosystem. The aim of this chapter is to provide an overview of how climate change affects different levels of oases ecosystem in Morocco and to propose sustainable strategies to limit degradation of this vulnerable area.*

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## **INTRODUCTION**

The oasis is an ecosystem known by its complexity and fragility. It has always existed in areas characterized by an arid climate with scarcity of rainfall, elevated temperatures and elevated evaporation. The structure of this ecosystem relies mainly on the structure of desert-oasis-river components (Yang et al., 2010). The palm grove survived despite the harsh environmental conditions due to groundwater and irrigation practice. The presence of date palm symbolizes water in the desert (Grenade, 2013). Therefore, the existence of palm groves depends on the availability of water resources and especially underground water potential. Oases have played, for centuries, an important role in the development of local economies and in ensuring ecological security. Effectively, the oasis secure many ecological functions and afford large ecological goods besides natural, economic and social services (PNUED, 2013). In Morocco, the sustainability of the oasis ecosystems is increasingly threatened. Over the last century, the oasis ecosystem has deteriorated clearly due to multiple natural and anthropogenic constraints: drought, salinity, Bayoud disease and lack of rehabilitation programs (Botes and Zaid, 2002; Meddich et al., 2018). From the 15 million date palm trees which inhabited the south Atlas oases and whose majority was represented by good cultivars, only 4 million trees, much of which are seedlings of variable and low quality, and thus the total area of the oases has been reduced from about 150,000 to 44,000 ha (Saadi, 1992). At the end of the 19<sup>th</sup> century, Morocco was ranked third worldwide among dates producing countries and possessed an international remarkable portion of dates trade, due in particular to the quality of its harvest (Haddouch, 1996). Almost a century later, Morocco, which was considered as a major exporter of date palm products, has become an importer (Khardi, 2003).

Even if several researches reported that the ecosystems degradation in arid regions was mostly affected much more by irrational human exploitation than climate change (Huo et al., 2008; Jarsjö et al., 2008; Aus der Beek et al., 2011; Dong et al., 2014; Ma et al., 2014), Moroccan oases figure among the most affected area by climate variation (Karmaoui et al. 2015). This situation has caused reduced farmlands yields production, poverty and scarcity of essential natural resources (Kuhn et al., 2010; Ben Salem, 2014; Johannsen et al., 2016; Ait Houssa et al., 2017; Lamqadem et al., 2017)

In this chapter, we will examine climate change status in Morocco with a focus on the possible impacts of the projected global climate change on oases with its different components. We will also discuss the ways forward to ensure the sustainability of this ecosystem considering the challenges posed by climate change.

## **PREVIEW OF CLIMATE CHANGE IN MOROCCO**

### **Recent Climate Data**

Located north-west of the African continent, Morocco opens on both the Atlantic Ocean and the Mediterranean Sea, making it a total of about 3,500 km of coastline (Fertah et al., 2017). With a latitudinal extension from the 37<sup>th</sup> to the 21<sup>st</sup> parallel. It covers an area of 710,000 km<sup>2</sup>, from the Strait of Gibraltar to almost the southern reaches of the great African Sahara (Almeida-Garcia and Chahine 2015). The country is characterized by a well-diversified geography: the plains, high mountain ranges where many massifs exceed 3,000 meters (Rif and Atlas mountain ranges) and the desert (Driouech, 2010). Three

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