Modelling the Impact of Human and Climate Change on *Stipa tenacissima* Distribution in the Arid and Semi-Arid Rangelands of North Africa

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Introduction

Rangelands in the Southern part of Tunisia are characterized by the extent of the impact of human induced activities in particular overgrazing and encroachment of cultivation into best rangeland sites (Ouled Belgacem et al., 2008). Furthermore, climatic changes are expected to increase the inter-annual variability of rainfall for many locations and to raise annual mean temperatures globally (IPCC, 2012). In fact, the scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) project a further increase in global mean surface temperature of 2–6 °C above pre-industrial levels by 2100, increased incidence of floods and droughts, and spatial and temporal changes in precipitation patterns (IPCC, 2007). However, these projections provide little information on how this might affect rangeland plant communities at the local scale. The purpose of this study is to assess the vulnerability of the ecologically and economically important native rangeland plant species *Stipa tenacissima* L. This research is needed to develop strategies for climate change adaptation. The adaptation measures should focus on building and strengthening the resilience of these fragile ecosystems.

Materials and Methods

The study was conducted in the southern part of Tunisia. The climate of the site is characterized by an extreme irregularity. The long term mean annual rainfall is ranges between 100 and 220 mm/year. *Stipa tenacissima* L. is a perennial grass considered as one of the last barriers against the encroachment of the desert thanks to its highly developed root system that protect soil and limit erosion.

Modeling the climate envelope is a tool used to quickly assess the potential impact of climate change on the distribution of species and ecosystems. This type of modeling uses species occurrence environmental data to predict its climatic niche. The methodology involves the use of thematic layers. The modeling is performed with ARC GIS software and Maximum Entropy (MAXENT) Model (Phillips et al., 2006).

Climate projections were made for the years 2020 and 2050 using the average of predictions about global circulation model widely used (HADCM3) under the scenario A2 of CO2 emission (Ouled Belgacem and Louhaichi, 2013).

Results and Discussion

The vulnerability of *Stipa tenacissima* to climate change in the current situation and that expected for 2020 and 2050, show that the predictions are highly pessimistic since the situation can be considered as catastrophic in the future because the entire area of this ecosystem is classified as vulnerable to highly vulnerable. The results of modeling showed that both classes of none and slightly vulnerable will disappear by 2020. This will induce a high decrease of the range production both in biomass and in forage

unit to more than 75%. Consequently this will further increase the deficit of feeding balance already marking the area. In addition to the reduced quantitative indicators (cover, density and biomass), this vulnerability will also lead to qualitative and physiognomic (species composition and diversity) changes resulting in the scarcity of the key species *Stipa tenacissima* in all parts of its current range with the exception of those which are more favorable and may benefit from a supplement water runoff. Other undesirable species (low palatability) such as *Haloxylon scoparium* and *Reaumuria vermiculata* which are more adapted to high temperature and drought stresses may have the opportunity to dominate and invade the area.

Conclusions and Implications

The combined effects of climate change and animal pressure on *Stipa tenacissima* rangelands located in southern Tunisia are having significant adverse impacts on this species under high CO_2 emissions scenarios. Already threatened, the species appears to be, coming under greater threat and present a very high vulnerability to climate change. These results suggest that without improved management, these sensitive communities could experience further degradation. An adaptation strategy is needed to increase the resilience of the most vulnerable species through proper grazing management, the selection of more drought tolerant taxa and the establishment of other mitigation measures, such as water harvesting techniques.

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