Chapter 19
Climate Impact on Seasonal Distribution of Zoonotic Cutaneous Leishmaniasis in Southern Morocco

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ABSTRACT
As in most arid and pre-Saharan North Africa regions, the local population is especially rural, socio-economically vulnerable, and exposed to vector-borne disease like cutaneous leishmaniasis. Information on geographical and seasonal distribution of this disease can be helpful in the control of this disease. In this context, four sites were used to identify the seasonality of zoonotic cutaneous leishmaniasis (ZCL) in Middle Draa Valley (MDV). The seasonal occurrence of this disease was correlated with some climatic and hydrologic variables. The findings show that the most part of patients (86%) were from rural areas with a bit high rate of affected people is female gender (54%) and children less than 9 years (51%). The distribution of cases shows a prevalence of affected in the upstream area than in downstream where the climate is more and more arid. The highest number of cases were detected in the winter season (from December to March).

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INTRODUCTION

There is a wide bibliographic data about leishmaniasis infection through the world, mainly in Mediterranean region and central Asia. Favorable bio-physical conditions (climate and environment) affect parasite-vector-reservoir increasing the transmission risk of leishmaniasis (Ready, 2008; Cardenas et al., 2006). In the pre-Sahara of Morocco, Zoonotic cutaneous leishmaniasis (ZCL) is the dominant type of leishmaniasis. It is caused by *L. major* and transmitted from the rodent *Meriones shawi* via the vector *Phlebotomus papatasi*. The parasite is therefore transmitted to humans. In this region, the lesions appear generally in autumn, if left untreated, it leaves persistent scars.

Many researches explored the impacts of climate variables such as rainfall, temperature, and humidity on zoonotic ZCL infection (Toumi et al., 2012; Bounoua et al., 2013). According to Shirzadi et al., 2015, the relative humidity variable is the most significant factor; and the infection increases in area with higher temperature, and lower relative humidity. However, few studies have dealt with the subject of leishmaniasis on the scale of Morocco and the pre-Sahara (Bounoua et al., 2013; Karmaoui, 2018), and no studies have been carried out especially on the seasonality of infection of the ZCL in the Middle Draa Valley (MDV) from upstream to downstream at sub-catchment scale. In the Moroccan pre-Sahara, due to the impact of drought and flood, the government-built dams in upstream basins (Karmaoui et al., 2015a), for example, Hassan Edakhil in Tafilalet and Mansour Eddahbi in Draa basin. These dams change the watercourses from the permanent rhythm to the seasonal rhythm, which leads to favorable climatic and biological conditions for the growth and proliferation of vertebrates as reservoirs (hosts supporting the leishmaniasis transmission) and also the insect vectors. While the reservoir *Psammomys obesus* is frequent in the arid region (Mili et al., 2012) its food preference *Salicornia* and *Atriplex* lives in sandy and salty soil (Fichet-Calvet et al., 2003).

Observation along the oases shows the densification of rodent galleries in the outskirts of palm groves along Wadis or vegetation and abundant especially halophilous plants. The changes in vegetation and agricultural production are linked to the water availability, which impacts the cycle of the insect vectors. The drought impacts the water quality and quantity and then influences the vector borne disease. In addition to parasite-vector-reservoir presence, the incidence of cutaneous leishmaniasis depends on several factors like climate, altitude, urbanization, socio-economical conditions. The leishmaniasis vectors are sensitive to wind, daylight, and winter (temperate regions) (Abonnenc, 1972).

In this paper, the study was conducted in the middle part of the Basin of the Draa, the Middle Draa Valley (MDV). The MDV has known to be among the most endemic areas for ZCL for more than a decade. It is an oasean zone, in which the human population is located largely in the province of Zagora, one of the poorest regions of Morocco. In this context, this article sets out the following objectives:

- Determine the distribution and physical and anthropogenic characteristics of this disease in four sites from the MDV;
- Explore the seasonal transmission rate of this disease in the four sites and correlate it with the main climatic parameters;
- Examine the transmission following the upstream-downstream situation of the sub-basin.

This paper used real seasonal data of ZCL cases, climatic, hydrologic, and biologic variables in 2005 and also from upstream to downstream sites. Pearson correlation coefficient was used to depict the as-