



Distribution pattern of anthroponotic cutaneous leishmaniasis caused by *Leishmania tropica* in Western Afghanistan during 2013-2014



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ABSTRACT

Anthroponotic cutaneous leishmaniasis (ACL), caused by *Leishmania tropica*, is the main cause of cutaneous leishmaniasis (CL) in the Herat province, Western Afghanistan. We investigated the role of environmental factors on ACL distribution in Herat. Epidemiological data from 2457 patients were retrieved from the local WHO sub-office. Shapefile layers of districts, cities, villages, land cover, soil type and digital elevation model (DEM) of the Herat province were used to assess, by logistic regression modelling, the effects of land cover, soil types, elevation, and proximity to the Harirud river on the distribution of ACL.

The key determinants of distribution were: (i) close proximity to the Harirud river, (ii) elevation between 700 and 1200 m, (iii) intensive and intermittent irrigated cultivated land, and (iv) Haplocalcids with Torriorthents and Torrifluvents soil types. No ACL cases were found below 700 m, and a few cases were present at > 1200 m in irrigated areas around the Harirud river. These findings suggest that moist soil and the humidity from irrigated areas found between 700 and 1200 m provide suitable breeding sites of *Phlebotomus sergenti*, the main sandfly vector of *L. tropica* in Afghanistan. The effect of elevation also explains the predominance of ACL over ZCL in this region. The present study showed that distribution of ACL is strongly associated with environmental factors in West Afghanistan where the political and socio-economic conditions may also affect the epidemiology of CL.

1. Introduction

Leishmaniasis is a vector-borne neglected parasitic disease, with a wide spectrum of manifestations caused by the *Leishmania* spp., which is transmitted by sandflies. Cutaneous leishmaniasis (CL) is the most common form of disease. Anthroponotic cutaneous leishmaniasis (ACL) and zoonotic cutaneous leishmaniasis (ZCL) are the most common types of dermal leishmaniasis. Worldwide, the annual incidence of CL is estimated at 0.7–1.2 million cases in 82 countries, with 70–75% of cases occurring in 10 countries, including; Afghanistan, Syria, Iran, North Sudan, Algeria, Ethiopia, Brazil, Peru, Colombia and Costa Rica (Alvar et al., 2012). CL remains a major public health problem in 14 of the 22 countries of the Eastern Mediterranean Region (EMR) of the World Health Organization (WHO), especially Afghanistan (Postigo, 2010).

The true burden of CL is largely unknown, partly because the most affected people live in remote areas with no access to treatment (Alvar et al., 2012).

CL in Afghanistan is either ZCL, due to *Leishmania major*, or ACL due to *Leishmania tropica*. *L. tropica* accounts for most of the CL burden, and there has been a prolonged epidemic of ACL in eastern Afghanistan since 1987 (Faulde et al., 2006). Humans are the main reservoir of *L. tropica*, and the great gerbil *Rhombomys opimus* is the principal reservoir of *L. major*; the rodent *Meriones libycus* is of secondary importance (Faulde et al., 2008b; Nadim et al., 1979a). *Phlebotomus sergenti* and *P. papatasi* are the main sandfly vectors for ACL and ZCL, respectively (Killick-Kendrick, 1999).

The current ACL epidemic in Afghanistan is due to several factors, including a breakdown of vector control, the destruction of the public

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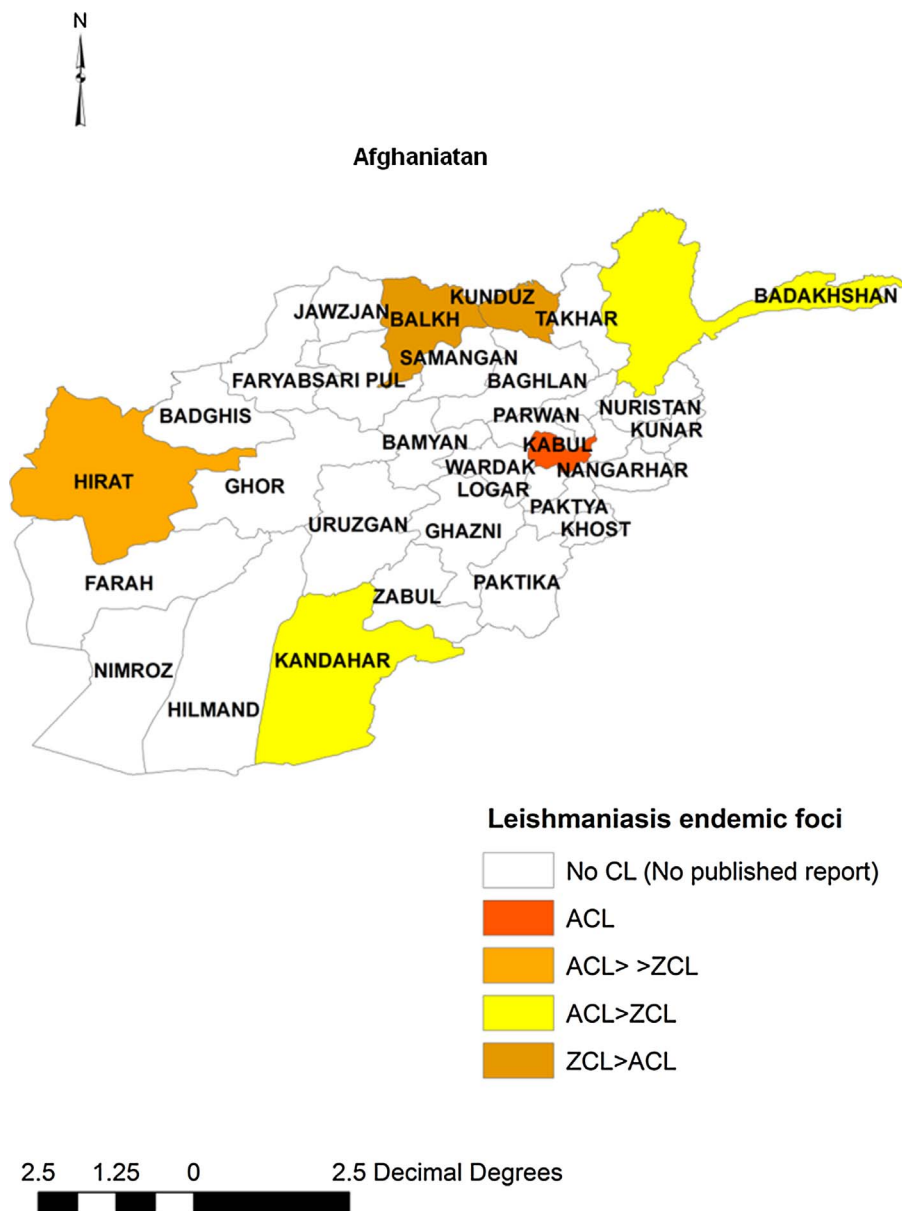


Fig. 1. The proven endemic foci of CL in Afghanistan based on the published papers. Type of CL was inferred from clinical and molecular evidence of studied cases. Some data were obtained from studies with small sample size (Plourde et al., 2012; Faulde et al., 2008; Nadim et al., 1979; Nadim and Rostami 1974; Reithinger et al., 2003; Faulde et al., 2008b).

health infrastructure, resulting in poor access to treatment, and internal displacement of people from non- to endemic areas in consequence to decades of war (Reithinger et al., 2003). The main endemic foci of CL include the provinces of Kabul, Parwan (no data on CL type), Kandahar, Kunduz, Balkh, Badakhshan, and Herat (Plourde et al., 2012; Faulde et al., 2008a,b; Nadim et al., 1979a,b; Nadim and Rostami., 1974; Reithinger et al., 2003). ACL predominates in most provinces except for Kunduz and Balkh (Fig. 1). Endemic foci of CL in Western Afghanistan are distributed in different parts of the Herat province (Nadim et al., 1979b), where the incidence of ACL has increased in some districts in recent years (Fakhra et al., 2016). The province is surrounded by some well-established and newly defined foci of ACL in Afghanistan, including Kabul in eastern and Kandahar in southeastern Herat, and in Iran, such as Mashhad in northwest, Birjand in west and Bam and Kerman (and also Shiraz, the more distant focus) in southwest of Herat (Plourde et al., 2012; Reithinger et al., 2003; Nadim et al., 1979b; Izadi et al., 2016; Ghatee et al., 2013; Ghatee et al., 2014; Karamian et al., 2016).

The identification of CL in Afghanistan is based on clinical criteria and the microscopic detection of *Leishman* bodies (amastigotes) on a Giemsa stained slide; a limited number of studies have used

molecular methods to identify the species from Mazar-e Sharif (Balkh province) and various locations in Herat and Kandahar (Faulde et al., 2008b; Plourde et al., 2012; Fakhra et al., 2016).

The epidemiology and war associated risk factors of CL in Afghanistan have been characterized previously (Faulde et al., 2008a) but the role of climatic and environmental factors have not been studied. Geographical information systems (GIS) are valuable tools for studying the environmental and climatic factors and modelling the control of vector-borne diseases over time (Chaves et al., 2008; Hongoh et al., 2011). We recently studied the epidemiology of CL in patients in Herat province and found that *L. tropica* was responsible for 98% of the CL burden (Fakhra et al., 2016). In the present study, we report on the role of environmental factors in the distribution of ACL in the Herat province using GIS.

2. Materials and methods

2.1. Study area

Located in the mountainous area of Central Asia, Afghanistan has a surface area of approximately 653'000 km², and a population of ~26.5

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