# The potential of climatic suitability indicator for Leishmania transmission modelling in Europe: insights and suggested directions

Shlomit Paz

School of Environmental Sciences, University of Haifa, Haifa, Israel

The Lancet Regional Health - Europe 2024;43: 100995

Published Online xxx

https://doi.org/10.1016/j.lanepe.2024.100995

Leishmaniasis is a disease caused by infection by one of several species of parasites of the genus *Leishmania*. Various factors increase the transmission risk, such as low socioeconomic levels, malnutrition[1] and changes in land use.[2] Additionally, climate parameters such as temperature, precipitation and humidity impact leishmaniasis transmission in multiple ways, whereas the temperature is the most significant factor. Leishmaniasis has been associated with climate change that rapidly leads to warmer conditions which attract sand flies towards temperate regions where habitat become warmer and therefore more suitable.[3,4] Climatic models predict an increase in the geographical regions suitable for the survival of vector species parallel with degradation of other interconnected systems such as water and soils that also influence disease ecology.[5] Prediction of climatic suitability that increase transmission risk of vector-borne diseases is of crucial importance since efficient intervention can reduce disease transmission.[6]

Yet, modelling of leishmaniasis spreading is challenging as its epidemiology is complex with nonlinear relations between various parameters and since the availability of reliable surveillance data is limited.[1] During recent years, modelling has been done for population dynamic of leishmaniasis vectors, mainly for large-scale projections of habitat suitability based on laboratory experiments and/or on field observations combined with climate–driven parameters or using ecological niche modeling.[7,8] Yet the possibility of an early detection of leishmaniasis outbreak signals based on bioclimatic parameters as a basis for a better decision-making for the public health is still absent.

In this issue of *The Lancet Regional Health – Europe*, Carvalho et al. report a new climatic suitability indicator that considers the complex nonlinear relationship between various bioclimatic indicators and leishmaniasis vectors, based on machine learning approach.[9] The indicator application was verified for Europe, that parallel with significant changes in its climate, experiences a gradual expanding of leishmaniosis northwards and towards higher altitude areas.[3,4] The suitability indicator was assessed for the two past decades and demonstrated successfully its predictive ability to track spatiotemporal changes in climate and environmental suitability parallel with positive association with leishmaniasis cases among the human population. Apart from climate parameters, poor living conditions also increase the risk of infection.[1] Therefore, projection should consider not only climatic variables but also socioeconomic conditions since populations at high social vulnerability are especially at risk. While previous models did not consider the socioeconomic inequalities as a predictive parameter for disease suitability, the outputs of the suggested model[9] were aggregated across different levels of socioeconomic conditions and showed that regions with high vulnerability had higher values of climatic suitability for leishmaniasis. This finding highlights the urgent need for interventions targeted to the most vulnerable populations.

Unlike previous large-scale projections[7] another strength of the indicator[9] is its high spatial resolution, and the outputs that make it adjustable for different subregions that are characterized by both different conditions and health administrative systems. These contribute to an appropriate decision making which is adapted to the local conditions.

In order to further develop the modelling study,[9] several directions are proposed: the first is its adaptation to non-endemic areas. For the current indicator, data from non-endemic European countries were not used in model calibration to avoid the inclusion of imported cases. However, while global warming contributes to the invasion of vectors and pathogens to new non-endemic regions,[5,10] recent spreading of other vectors and pathogens in Europe northward and along elevational gradients as the West Nile virus and *Ixodes ricinus* tick,[4] showed that an endemization process in new regions is a possible risk. Therefore, adapting the indicator to non-endemic areas will contribute to a better preparedness in the coming years.

Another direction for further research is to develop the indicator for other regions except Europe. This is expected to be challenging since the available reliable data worldwide is limited.[1] Yet such an attempt is important particularly in areas that suffer from poor socioeconomic conditions parallel with the effects of the climate crisis. Thirdly and highly important, while the indicator[9] showed its projecting ability based on retrospective prediction, a significant development should be

*E-mail address:* shlomit@geo.haifa.ac.il.

climatic suitability projection for the near future which is currently a knowledge gap, mainly for high spatial resolution. This goal was noted by the authors who aim to incorporate future updates by adding climate change scenarios.

A better understanding of the factors leading to large and small-scale spatial distribution of sand fly vectors is needed for a better intervention to control vector populations.[3] A prediction of the climatic suitability for leishmania vectors based on indicators that track disease risk is an important and innovative step towards better disease control and prevention in the near future.

#### Declaration of interests

The author declares that there is no conflict of interest.

#### References


1 WHO. Leishmaniasis. https://www.who.int/news-room/fact-sheets/detail/leishmaniasis#:~:text=Leishmaniasis%20is%20caused%20by%20a,in%20over%2095%25%20of%20cases; 2023. Accessed June 10, 2024.

2 Waitz Y, Paz S, Meir D, Malkinson D. Effects of land use type, spatial patterns and host presence on Leishmania tropica vectors activity. *Parasites Vectors*. 2019;12:320.

3 ECDC. Phlebotomine sand flies - factsheet for experts. https://www.ecdc.europa.eu/en/disease-vectors/facts/phlebotomine-sand-flies; 2020. Accessed June 12, 2024.

4 Semenza JC, Paz S. Climate change and infectious disease in Europe: impact, projection and adaptation. *Lancet Reg Health Eur*. 2021;9:100230.

5 Paz S. Climate change: a driver of increasing vector-borne disease transmission in non-endemic areas. *PLoS Med*. 2024;21(4):e1004382.

6 Wilson AL, Courtenay O, Kelly-Hope LA, et al. The importance of vector control for the control and elimination of vector-borne diseases. *PLoS Negl Trop Dis*. 2020;14(1):e0007831.

7 Koch LK, Kochmann J, Klimpel S, Cunze S. Modeling the climatic suitability of leishmaniasis vector species in Europe. *Sci Rep*. 2017;7(1):13325.

8 Erguler K, Pontiki I, Zittis G, et al. A climate-driven and field data-assimilated population dynamics model of sand flies. *Sci Rep*. 2019;9(1):1–5.

9 Carvalho BM, Maia C, Courtenay O, et al. A climatic suitability indicator to support Leishmania infantum surveillance in Europe: a modelling study. *Lancet Reg Health Eur*. 2024. https://doi.org/10.1016/j.lanepe.2024.100971.

10 Carlson CJ, Bannon E, Mendenhall E, et al. Rapid range shifts in African Anopheles mosquitoes over the last century. *Biol Lett*. 2023;19(2):20220365.