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Incorporating NDVI in a gravity model setting to describe spatio-temporal patterns of Lyme borreliosis incidence

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Lyme borreliosis (LB) is the most common tick-borne disease in Europe and incidence growth has been reported in several European countries during the last decade. LB is caused by the bacterium Borrelia burgdorferi and the main vector of this pathogen in Europe is the tick Ixodes ricinus.
LB incidence and spatial spread is greatly dependent on environmental conditions impacting habitat, demography and trophic interactions of ticks and the wide range of organisms ticks parasite. The landscape configuration is also a major determinant of tick habitat conditions and -very important- of the fashion and intensity of human interaction with vegetated areas, i.e. human exposure to the pathogen. Hence, spatial notions as distance and adjacency between urban and vegetated environments are related to human exposure to tick bites and, thus, to risk.
This work tested the adequacy of a gravity model setting to model the observed spatio-temporal pattern of LB as a function of location and size of urban and vegetated areas and the seasonal and annual change in the vegetation dynamics as expressed by MODIS NDVI. Opting for this approach implies an analogy with Newton's law of universal gravitation in which the attraction forces between two bodies are directly proportional to the bodies mass and inversely proportional to distance. Similar implementations have proven useful in fields like trade modeling, health care service planning, disease mapping among other.
In our implementation, the size of human settlements and vegetated systems and the distance separating these landscape elements are considered the 'bodies'; and the 'attraction' between them is an indicator of exposure to pathogen. A novel element of this implementation is the incorporation of NDVI to account for the seasonal and annual variation in risk. The importance of incorporating this indicator of vegetation activity resides in the fact that alterations of LB incidence pattern observed the last decade have been ascribed to changes in vector habitat induced by a changing climate. Hence, the incorporation of dynamic covariates in epidemiologic modelling schemes is necessary.
Preliminary results of this on-going analysis reveal the great potential of this modeling approach to base the incorporation of remotely sensed information of the environment in monitoring shrinkages and expansions of risk zones in this – and probably other – vector-borne disease.