Assessing risk of vector-borne diseases as a combination of hazard and exposure in Wallonia

Raphaël Rousseau*†[1], Mathilde De Keukeleire[1,2], and Sophie Vanwambeke[1]

[1]Earth and Life Institute (ELI), Georges Lemaitre Center for Earth and Climate Research, Université catholique de Louvain (UCL), Louvain-la-Neuve, Belgium – Belgium

[2]Pôle Epidémiologie et Biostatistique, Institut de Recherche Expérimentale et Clinique (IREC), Faculté de Santé Publique (FSP), Université catholique de Louvain (UCL), Bruxelles, Belgium. – Belgium

Abstract

Ticks are a major threat for both human and animal health because they transmit diseases that affect these populations. Risk of vector-borne diseases results from the combination of hazard and exposure. Hazard represents the strength of the zoonotic transmission cycle, and is determined by the ecological conditions that influence the lifecycles of the pathogens, the vectors and the hosts. Exposure represents the intensity of contacts that susceptible human or animal populations have with places where infected ticks are present, in relation to their activities and preferences. It is largely determined by land use, for example the accessibility and attractiveness of places where infected hosts/vectors are found. Landscape has thus an influence on both hazard and exposure.
Distinguishing the effects of some landscape variables on hazard and on exposure can be challenging, especially as many variable implementation use proxies of tick habitat suitability or of landscape attractiveness. This challenge is further compounded by the data used to understand vector-borne disease data. Only data on infectious vector abundance can represent hazard, but due to the difficulty of collecting such data in a large number of places, other data sets are often used. Epidemiological data, in the form of human or domestic animal disease cases, is found attractive in this context, as they tend to correspond to systematic, spatially exhaustive reporting. However, such data does not allow a straightforward distinction between hazard and exposure as a disease case is the result of both. Still, a number of landscape factors are not exclusively attributable to one or the other components of risk, and interpretations found in the literature are often considering primarily hazard. Comparisons of empirical studies across the literature is further complicated by the use of heterogeneous data sources on the landscape, with different semantic contents on land cover, different resolution, and diverse landscape indicators.

In this study, we use a single set of environmental data to analyze different indicators of risk. Two datasets were analyzed according to one set of independent variables extracted from the same source, meaning that results are directly comparable, unlike most of what is found in the literature.

The first data source assesses Scouts-ticks contacts during summer camps in Wallonia. Because of their numerous outdoor recreational activities, children participating in scouting

*Speaker

†Corresponding author: raphael.rousseau@uclouvain.be

activities are particularly exposed to a risk of contact with ticks and tick-borne diseases. These contacts are affected by both hazard, as rural and forested environments are highly suitable for ticks, and exposure, depending on whether these are attractive and accessible to the scouts. A survey was carried out in 2009 in 27 scout camps, during which volunteering groups inspected themselves for tick bites and recorded them in a customized notebook. The incidence of bites (per 1000 person-day) was computed for each camp. We assessed the effect of landscape-level environmental variables related to hazard and exposure on tick-bite incidence.

The second data set concerns infection with *Anaplasma phagocytophilum,* for Walloon cattle in 2010 and 2011. *A. phagocytophilum* is a tick-borne bacterium that causes *bovine ehrlichiosis* in cattle, which is associated with influenza-like symptoms and decreases the production of milk. 2089 herdswere tested for the presence of IgG antibodies to *A. phagocytophilum.* The pastures used by the farm are geolocated. It was then possible to analyze the environments where cattle graze using the same set of independent variables as used for the Scout-tick contacts dataset.
While the environments most favourable to ticks are fairly well known, the heterogeneity of data sources used in the literature, both for the dependent and independent variables, makes comparison across study cases and regions challenging. This is especially true for habitats of intermediate quality, for which results are less coherent. By using various indicators and a single set of independent variable, we identified habitats favourable to ticks and to tick-borne pathogens circulation, and landscape variables associated to exposure to infected ticks. Both hazard and exposure are important factors in understanding and predicting the risk of contacts between ticks and susceptible populations of humans or animals. This can also help to manage risks for humans and cattle more efficiently.

Keywords: risk, hazard, exposure, landscape, tick, borne diseases