Predicting and mapping human risk of exposure to Ixodes ricinus nymphs in northern Europe using climatic and environmental data

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In recent years, focus on tick-borne diseases has increased as diseases such as Lyme disease and tick-borne encephalitis have become more common and represent a health problem in many parts of Scandinavia. More effective prevention of infections requires a better understanding of the factors affecting the vector abundance as well as human exposure to the vectors. Hence, there is a great need for analyses and models that can predict how vectors and their associated diseases are distributed now and possibly in the future.

As a part of the ScandTick Innovation project, we surveyed tick nymphs at 159 sites (forests and meadows) in Denmark, southern Norway and south-eastern Sweden. At each site we measured presence/absence, and used the data obtained along with environmental data from satellite images to run Boosted Regression Tree machine learning algorithms to predict overall distribution in southern Scandinavia. Together with the predicted distribution maps, we used human density maps to identify and plot areas with high risk of exposure to ticks.

The predicted distribution and the spatial variation found corresponded well with known distributions of ticks in Scandinavia (sensitivity: 91%, specificity: 60%), and we found that the model was predominantly temperature-driven. Because presence was strongly correlated with forested habitats the risk areas were much larger in Sweden and Norway compared to Denmark. When combining these distribution maps with human population density maps, we were able to quantify the proportion of people living in areas with tick presence in Scandinavia. We found that although tick nymphs were restricted to a small proportion of the modelled area, high proportions of the human populations (67-79%) lived within these same areas. The model suggests that a potential future range expansion of *I. ricinus* in Scandinavia is likely but may only affect a relatively small additional proportion of the human population.