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R0-modeling as a tool for early warning and surveillance of exotic vector borne diseases in Denmark

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Title: R_0 -modeling as a tool for early warning and surveillance of exotic vector borne diseases in Denmark

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Modelling the potential transmission intensity of insect borne diseases with climate driven R_0 process models is frequently used to assess the potential for veterinary and human infections to become established in non endemic areas. Models are often based on mean temperatures of an arbitrary time period e.g. a monthly temperature mean. Temperature decreases with latitude, and in the Nordic countries periods of suitable temperatures, the windows of opportunity for transmission, may be very short and only appear in odd years. While average monthly temperatures are likely to be suitable for predicting permanent establishment of presently exotic diseases, mean temperatures may not predict the true potential for local spread and limited outbreaks resulting from accidental introductions in years with temporary periods of warm weather.

We present a system for continuous risk assessment of potential local spread of exotic insect borne diseases of veterinary and human importance. R_0 models for various vector borne diseases are continuously updated with spatial temperature data to quantify the present risk of autochthonous cases ($R_0 > 0$) and the present risk of epidemics ($R_0 > 1$) in case an infected vector or host are introduced to the area.

The continuously updated risk assessment maps functions as an early warning system allowing authorities and industry to increase awareness and preventive measures when R_0 raises above the level of 'no possible transmission' and target active serological surveillance to these limited periods of potential risk, thus dramatically reducing the number of samples collected and analysed. The risk estimated from the R_0 modelling may be combined with the risk of introduction from neighbouring countries and trading partners to generate a truly risk based surveillance system for insect borne diseases.

R_0 models for many vector borne diseases are simple and the available estimates of model parameters like vector densities and survival rates may be uncertain. The quantitative value of R_0 estimated from such models is therefore likely to deviate from the true R_0 . However assuming the models are qualitatively able to rank the estimated R_0 correctly, a period resulting in a relatively high estimated R_0 will also be a period with a relatively high true R_0 . This allows the estimated R_0 to be used for targeted surveillance by focussing the surveillance on periods and areas with high R_0 estimates even if the actual value of these estimates are difficult to interpret. Furthermore running R_0 models on historic outbreaks in Europe may be used to fit estimates for R_0 for these data. When comparing the model R_0 to the observed value of R_0 a correction factor is obtained that may be used to adjust the model estimates in Denmark, and thus allowing a more quantitative interpretation of the estimated R_0 .

We here demonstrate the system for bluetongue using 2008 climate data and compare the predicted R_0 with the actual spread of bluetongue in Scandinavia i 2008.