PRELIMINARY SPATIAL MODELLING OF WEST NILE VIRUS CIRCULATION IN PIANURA PADANA, NORTHERN ITALY, 2013

Introduction

West Nile Virus (WNV) is an emerging threat in Europe, with more than 800 human cases reported since 2010 in the European Union. WNV was detected in Italy in 1998 in Padule di Fucecchio (Tuscany), without human cases recorded, then, after ten years, WNV reappeared northward in Pianura Padana in 2008-2009 affecting Emilia-Romagna, Veneto, Lombardy regions where human cases were recorded. The virus was continuously detected in subsequent years until 2013, with different strains over the years and in different areas of the Pianura Padana.

The environmental surveillance, particularly based on entomological and bird sampling, is performing well in the early detection of virus circulation, before the appearance of human and equine cases. For this reason, besides the activities supported by the Ministry of Health at national level, more detailed surveillance programs were carried out in Pianura Padana at regional level starting in 2008. For the first time in 2013 five neighboring Regions of Northern Italy activated a similar entomological surveillance, allowing the monitoring of the whole Pianura Padana territory (of about 46,000 km²).

Spatial Modelling Maps and discussion

We created WNV circulation maps of Pianura Padana using two modelling approaches based on mosquito data: one exploratory analysis based on KDE (Kernel Density Estimation) and one statistical approach based on NLDA (Non Linear Discriminant Analysis) largely used on species distribution and on epidemic risk.

KDE analysis is a geospatial technique based on the kernel function (Gaussian function) used to create a surface to indicate the intensity of the events of the phenomenon. The optimal bandwidth size of 20 km was calculated using BVC (Biased Cross Validation). The area of WNV circulation was estimated by the 95% volume contour of the WNV KDE that represents the boundary of the area that contains 95% of the volume of the obtained KDE distribution, and would therefore contain, on average, 95% of the points used to generate the KDE.

NLDA is a spatial model applied to presence/absence positive pools as dependent variable correlated to about 100 environmental and climatic variables at 1 km resolution. Features of the Regional entomological plans of surveillance are elsewhere described (Calzolari et al. 2013, Capelli et al. 2013, Pautasso et al. 2013), salient characteristic are reported in table below.

The accuracy of NLDA circulation model, as judged by Cohen's Kappa (0.8285 +/- 0.0584) was 'excellent' according to Congalton's classification of kappa values (k < 0.4, poor; 0.4 < k < 0.75, good; and k > 0.75, excellent). Model sensitivity (correct presence percentage) and specificity (correct absence percentage) both exceeded 0.90. NLDA confirms statistically the circulation area of KDE, in particular of PVC 50.

The accuracy of KDE analysis is also excellent (kappa coefficient 0.9000), with 'excellent' model sensitivity (93.75%) and specificity (87.50%), both exceeding 0.90.

References


Average rank Variable

7.400 Worldclim August Mean Temperature
7.600 Middle infra-red amplitude 1
6.800 Worldclim February Mean Temperature
6.800 Worldclim June Mean Temperature
6.100 Middle infra-red variance
5.500 EVI amplitude 3
6.600 Daytime LST amplitude 3
6.700 Daytime LST minimum
4.800 NDVI amplitude 2
9.000 NDVI variance

Table A. Rank of environmental variables in Pianura Padana. Final rank is the combination of the relative importance of the variable (1) and the occurrence of positive pools (2).

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