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

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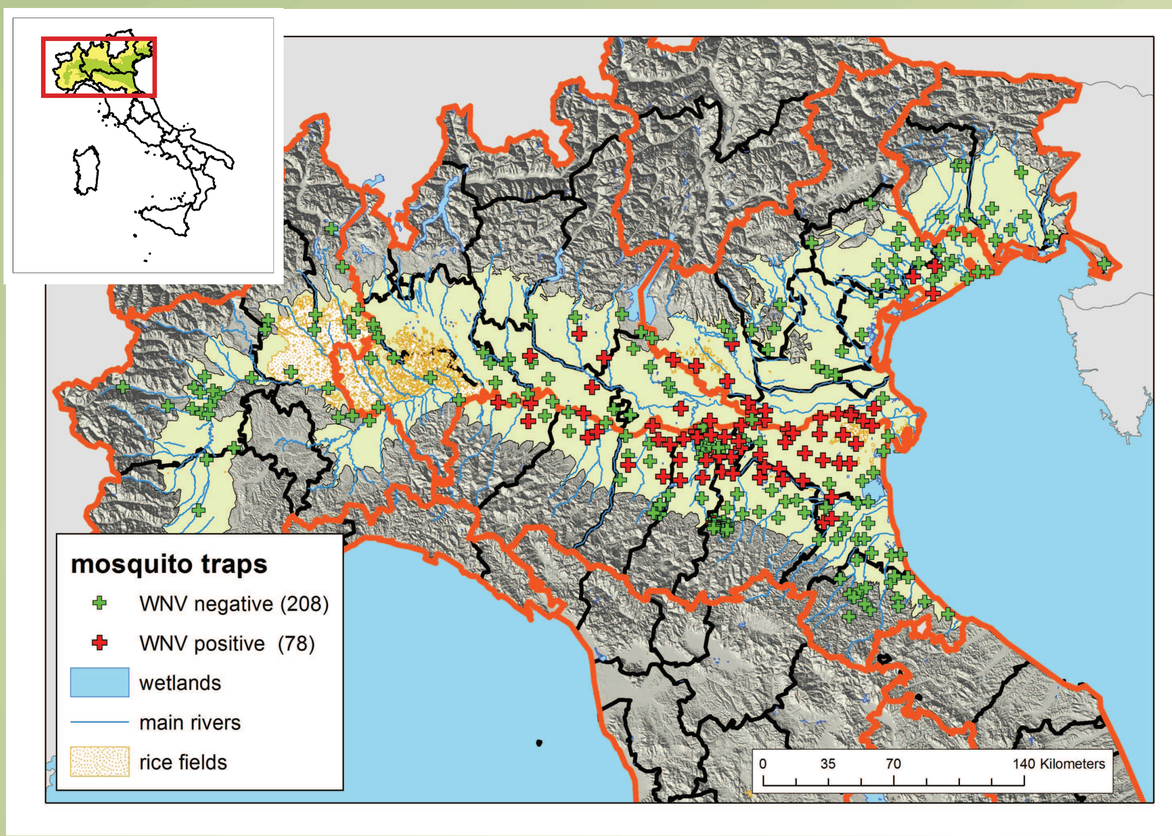
Introduction

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, Lombardia 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 Km^2).

Spatial Modelling Maps and discussion



286 mosquito sampling stations activated in the summer 2013 in five regions (Veneto, Emilia-Romagna, Lombardia, Friuli-Venezia-Giulia, Piemonte) of Pianura Padana (green area)

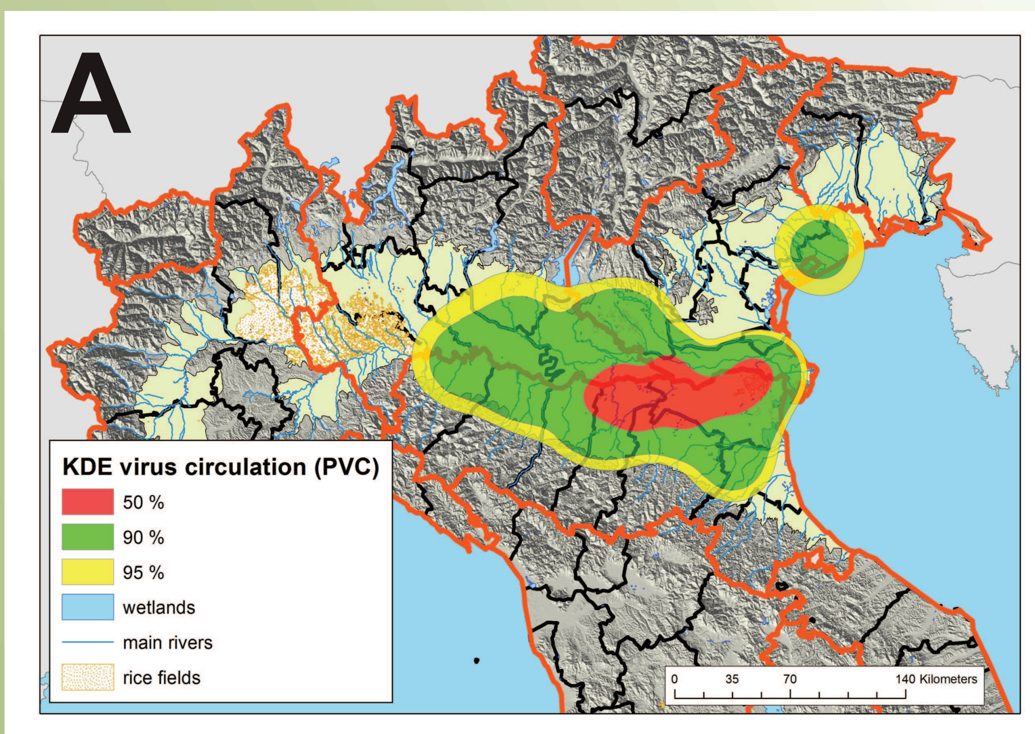
We created WNV circulation maps of Pianura Padana using two modelling approaches based on mosquito data: one exploratory analysis based on KDE (Kernel Density Estimation) and one statistical approach based on NLDA (Non Linear Discriminant Analysis) largely used on species distribution and on epidemic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

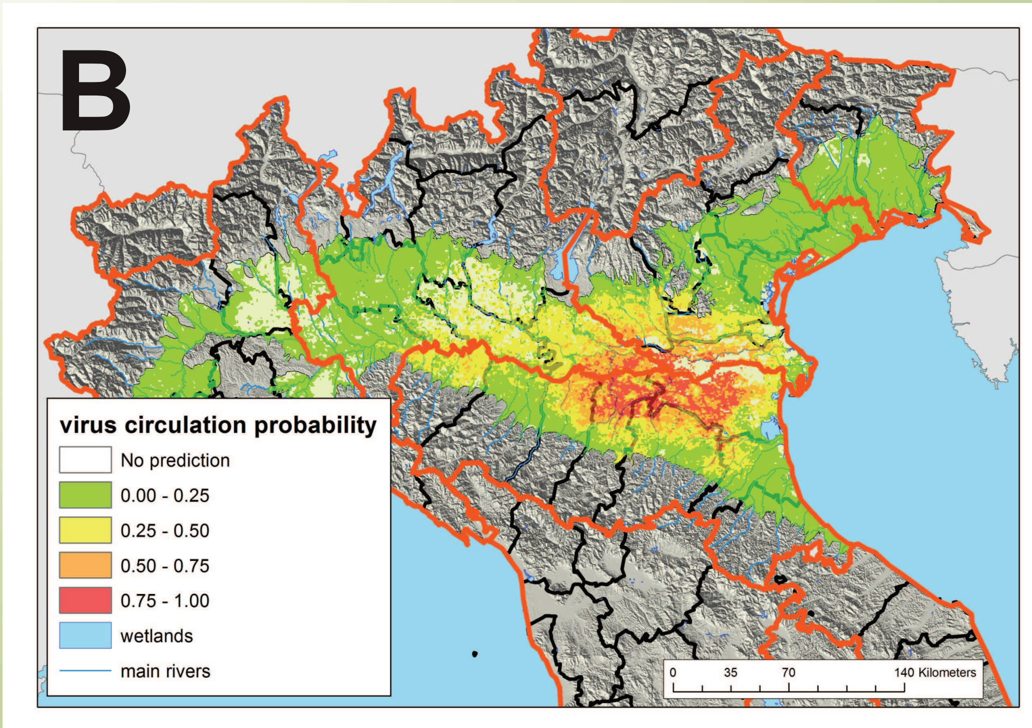
KDE analysis is a geospatial technique based on the kernel function (Gaussian function) used to create a surface to indicate the intensity of the events of the phenomenon. The optimum bandwidth size of 20 km was calculated using BVC (Biased Cross Validation). The area of WNV circulation was estimated 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.

Region	Activity period	N. Sites	Sampling interval	trap Model	Specimens per pool
Emilia-Romagna	June-September	157	2 weeks	CDC-CO2;GT	200
Lombardia	June-October*	30	2 weeks	CDC-CO2	200
Veneto	May-October**	54	1 week	CDC-CO2	50
Friuli Venezia-Giulia	May-October**	12	1 week	CDC-CO2	50
Piemonte	July-October	33	2 weeks	CDC-CO2;GT	200

* 23 traps were operated from September
** WNV testing starts in June





A) KDE Percent Volume Contour Map of WNV circulation; B) NLDA Map of WNV circulation at 1 km resolution

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.

Best performing 10 key variables for NLDA models were reported in the table on the right. Average rank of each variable was calculated on 100 bootstraps. In general thermal variables (monthly mean temperature and LST - Land Surface Temperature) resulted the most important in determining the virus circulation followed by vegetation variables (NDVI and EVI), while no correlation was observed with rainfall variables.

KDE identifies two areas of virus circulation: a more intense and extended area (20,000 km^2) in Veneto, Lombardy and Emilia-Romagna regions and a smaller (2,013 km^2) and less intense in the north east of Veneto; this last area has already been confirmed by spatio-temporal analysis (Mulatti et al. 2014). KDE 50 Percent Volume Contour (4,388 km^2) covers the area of lowland provinces of Ferrara, Modena, Bologna and Reggio-Emilia (Emilia-Romagna), the south plains of the province of Rovigo (Veneto) and the plain to the south-east of the province of Mantova (Lombardy).

Average rank	Variable
7.400	Worldclim August Mean Temperature
7.600	Middle infra-red amplitude 1
8.000	Worldclim February Mean Temperature
8.000	Worldclim June Mean Temperature
8.100	Middle infra-red variance
8.500	EVI amplitude 3
8.600	Daytime LST amplitude 3
8.700	Daytime LST minimum
8.800	NDVI amplitude 2
9.000	NDVI variance

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