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Adjusting Second Moment Bias in Eigenspace Using Bayesian Empirical Estimators, Dirichlet Tessellations and Worldview I Data for Predicting Culex quinquefasciatus Habitats in Trinidad

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ABSTRACT

Temporally weighted regression models with a spatial autoregressive component may estimate nonlinearities in spatiotemporal-sampled data of Culex quinquefasciatus, a major vector of West Nile Virus (WNV) which can help implement control strategies by determining optimal predictors associated to prolific habitats. The design of this kind of mixed model can specifically incorporate spatial autocorrelation whilst including the influence of other aspatial predictor variables. Currently, the lack of an estimation theory that allows for het- eroscedasticity and corresponding joint hypothesis testing in the presence of spatial dependence in georefer- enced Cx. quinquefasciatus habitat data is a serious shortcoming in WNV research. In this paper we used spatially lagged and simultaneous autoregressive models based on multiple predictor variables of immature Cx. quinquefasciatus and Worldview 1 (WV-1) data to help implant a remote habitat-based surveillance sys- tem in Trinidad. Initially, we used Geomatica Ortho Engine® v. 10.2 for extracting a Digital Elevation Model (DEM) from the WV-1 raw imagery. Results of the DEM analyses indicated a statistically significant inverse linear relationship between total sampled Cx. quinquefasciatus data and elevation (m) (R2 = -0.439; p < 0.0001), with a standard deviation of 10.41. Additional field-sampled information was derived using data from an or-thogonal grid-matrix constructed in an ArcInfo 9.3® and overlaid onto the WV-1 data. A unique identifier was placed in the centroid of each grid cell. Univariate statistics and Poisson regression models were then generated using the georeferenced covariates in SAS/GIS®. Coefficient estimates were also used to define expectations for prior distributions in a Bayesian estimation matrix using Markov Chain Monte Carlo (MCMC) specifications. A spatial residual trend analyses was then performed using autocorrelation indices which linked tabular data in SAS PROCLMIXED® with the egg-raft count data in ArcInfo®. The estimation matrix identified prolific habitats based on the covariate distance to the nearest house. An Ordinary kriged-based interpolator was then constructed in Geostatistical Analyst Extension of ArcGIS 9.3® based on the adjusted Bayesian estimates. For total Cx. quinquefasciatus egg-raft count, first order trend was fitted to the semivariogram at a partial sill of 5.931 km, nugget of 6.374 km, lag size of 7.184 km, and a range of 31.02 km using 12 lags. We assessed the performance accuracy of the interpolation procedures based on the magnitude and distribution of errors between observed and model-predicted values using Voroni tessella- tions. These residuals divided the space between the individual georeferenced Cx. quinquefasciatus habitats by XY coordinates in 2-dimenisional space which revealed that the geophysical parameter error residuals in the interpolation model were within normal statistical limitations. Newer GIS software and WV-1 data can generate highly accurate predictive Cx. quinquefasciatus habitat distribution models which can target prolific habitats of based on field-sampled count data. Our results suggest it may be unnecessary to manage all Cx. quinquefasciatus habitats to obtain significant reductions in incidence and prevalence of WNV in Trinidad.

KEYWORDS

Culex quinquefasciatus, Trinidad, West Nile Virus, Worldview 1, ArcGIS®

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