Implementation of Land Cover Data to Forecast West Nile Virus in the United States

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West Nile virus (WNV) is the most impactful mosquito-borne disease in the United States. Since 1999, it has caused over 2,500 deaths and has seriously harmed quality of life for thousands of survivors. With no available treatment, preventative measures are essential to limit WNV-caused morbidity and mortality, and climate-based models have historically been used to this end. In 2022, I developed a land cover-based model and argued for its superiority over climate-based models due to its advantage in long-range forecasting and ability to inform actionable policy. My 2022 model only analyzed the US's Gulf Coast region and was deterministic in nature. In this study, I significantly expanded my 2022 model by using the entire contiguous US and by probabilistically reformulating it. Six neural networks were trained as sub-models using county land cover feature percentages as inputs and Bernoulli-Gamma probability density functions for case incidences as outputs. Training data were regionalized following the habitat distributions of Culex genus mosquitos. The sub-models were highly accurate, correctly capturing 97% to 99% of test case incidences within a 90% prediction interval around the median. Counties with greater predicted WNV incidences had depressed levels of certain land cover features such as pasture and elevated levels of others such as grassland. The model projected a median case incidence increase of 14% from 2023 to 2100 across the US, with greater increases in regions including the Great Plains. The model provides a novel method of forecasting WNV incidence and shows alterable environmental factors that can be used to inhibit disease spread. These results can be used as an early warning system to inform policymakers on land usage and to curtail the impact of WNV.

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