An Early Warning System for Human West Nile Virus Disease

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Zika confirmed in South Dakota, local officials still focused on West Nile Virus

The CDC reports a woman is suffering Zika related symptoms

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The objectives of our NASA Health & Air Quality Applications Program are to improve WNV surveillance in South Dakota by:

1. Developing a new mosquito information system that collects and integrates mosquito trapping data, mosquito testing data, and weather data
2. Generating weekly risk assessments and forecasts during the WNV season
3. Creating an improved WNV risk map highlighting persistent foci of infection across the state of South Dakota
Project Team

- **PI:** Mike Wimberly, SDSU Geospatial Sciences Center of Excellence
  - Postdoc: Justin Davis
  - Research Technician: Diane Narem
  - Research Technician: Brianna Lind
- **Co-I:** Mike Hildreth, SDSU Department of Biology and Microbiology
  - Ph.D. Student: Geoffrey Vincent
- **Cooperator:** Yi Liu, SDSU Department of Electrical Engineering and Computer Science
- **Public Health Partners**
  - Lon Kightlinger, South Dakota Department of Health
  - Denise Patton, City of Sioux Falls
  - Mark Hoven, City of Aberdeen
  - Other local mosquito control programs in South Dakota (~ 100)
Why do we need to forecast?

- Mosquito control tends to react to public complaints about the abundance of vectors.
- But mosquito density is a very poor predictor of WNV transmission risk
  - Vector versus nuisance species
  - Amplification of WNV in vector mosquitoes
- Human cases are a lagging indicator of WNV transmission risk
Integrating mosquito surveillance with environmental models constrains predictions and increases forecast accuracy.
The South Dakota Mosquito Information System (SDMIS) facilitates data management to support West Nile virus control activities in South Dakota.

- **Web portal for uploading mosquito testing and count data**
- **Automated acquisition of environmental data from NASA satellites**
- **Data analysis to predict statewide mosquito abundance and WNV risk**
- **Geocoded locations of human WNV cases**
- **Tools and reports to provide value-added information to public health and mosquito control professionals**
Our modeling approach used meteorological data from NLDAS combined with mosquito data collected through our website and human case data from the SDDOH.
Results were disseminated as a series of West Nile Weekly reports.

- An initial report with a seasonal forecast was released on May 18th.
- During the WNV season, 16 weekly reports were produced from June 8th through September 20th.
- In these reports, forecasts and ancillary data were presented as maps and charts.
- Accompanying text provided interpretation of these graphics along with recommendations for mosquito control and disease prevention.
- We also produced information sheets on topics such as mosquito ecology, WNV modeling, and Zika virus.
Forecasts were initially based on meteorological data and updated with mosquito infection data as it became available.
Risk maps were developed to highlight which counties were most likely to report cases, and where per-person risk was highest.

Figure 3: Estimated per-county risk for the week of July 11th - 17th. Brown County continues to have the highest risk of any cases.

Figure 3: Estimated per-person risk for the week beginning August 29th, still mostly concentrated in the Prairie Pothole Region.
Additional information about climatic patterns and mosquito abundance and infection was also used to provide context for the predictions.

**Figure 1:** Mean daily temperatures in SD (line) with min/max over 2004-2016 (band). Circles indicate a new record high was set in 2016.

**Figure 1:** Observed (red) and estimated (blue) positive pool rate for 2016 and other years (black), based on all data available Aug. 8th.
Our two-week ahead predictions have generally been accurate throughout the season.

Note that entire red curve will likely slide up and toward the left once we receive the final case data for 2016.
Our overall seasonal forecasts were accurate, correctly predicting that this year would be considerably worse than 2015 (40), but not as high as 2012 (203).

Our reports in July recommended aggressive mosquito control and prevention measures despite low mosquito numbers and a lack of human case reports.
A new static risk map was developed using 10 years of Landsat data obtained from the Weld project.

We found that areas with low mean surface water, but high interannual variability in surface water, had the highest probability of WNV disease occurrence.
Plans for the upcoming year.

- Write a paper documenting the forecasting results for the 2016 WNV season
- Write a paper documenting forecasting model selection and testing several new ideas for model improvement
- Obtain feedback from end users through focus group at the 2016 South Dakota Mosquito Control conference in October
- Revise and improve the strategy for communicating forecasting results
- Complete the statewide risk map
- Begin planning for transferability/sustainability
Other Project Information

• Starting ARL: 6
  – Prototype application system beta-tested in a simulated operational environment

• Current ARL: 7
  – Application Prototype in Partner’s Decision Making

• Target ARL for project: 8/9
  – Application Completed and Qualified
  – Operational Deployment and Use in Decision Making

• Budget
  – Charged through August 31, 2016: $278,607
  – Remaining balance for Years 1-2: $169,440