# Weather conditions and West Nile virus in Illinois

## Background

West Nile virus causes illness in birds, humans, horse, and some other mammals. At its worse, WNV can result in encephalitis in humans and other mammals, or even death (Hays et al. 2005). It is carried by a mosquito vector, with birds being the primary host. A mosquito that becomes infectious from feeding on a bird can subsequently infect a human, horse or other bird but feeding on that other host. Illinois first experienced equine and bird cases of illness from WNV in 2001, and the largest outbreak to date was in 2002 (Illinois Department of Public Health: http://www.idph.state.il.us/envhealth/wnv.htm). The Chicago, IL, area was especially hard hit. A smaller but significant outbreak was seen in 2005.

Because it is carried by a mosquito vector, the risk of WNV transmission is strongly related to the feeding habits of the particular type of mosquito that carries it and the mosquitoes' success in reproducing. WNV in the Midwest of the United States is carried by *Culex* species mosquitoes. These mosquitoes need stagnant water in which to deposit their eggs and tend to feed at dusk, with a preference towards birds as bloodmeal hosts . These mosquitoes increase in numbers toward the end of July and remain high until cold weather sets in. The conditions needed for large populations of *Culex* mosquitoes tend to be tied temporally to weather. Some evidence suggests that a period of drought during which stagnant water becomes more common is one precursor to an outbreak of illness from WNV (Shaman, Day and Stieglitz 2005).

The spatial pattern of West Nile virus presence in the northeast part of Illinois is clustered and shows strong association with certain housing and environmental characteristics. However, places with similar settings have different rates and temporal patterns of the virus as measured in mosquito testing and in human cases. In this project, we examine the effect of variations in temperature and rainfall across the greater Chicago region in the years from 2002 and 2005 in order to assess the contribution of weather to the presence of WNV. The analysis is carried out at the level of watersheds, and uses interpolation of weather variables across time. After the data are brought into a common geographic framework using ArcGIS, statistical methods help to assess the relationships among the variables.

## Data and Methods

Precipitation is measured as number of inches of rain per week recorded at 75 different weather stations in eight counties in and near Chicago, Illinois. The stations are maintained by various agencies and the majority are data reported to NOAA NESDIS National Climatic Data Center
http://cdo.ncdc.noaa.gov/CDO/cdo. Of the 75, 25 stations are from the Army Corps of Engineers was provided by the Illinois Water Survey. Additionally, 14 personally maintained stations were found on the Weather Underground (http://www.wunderground.com/weatherstation/index.asp).

Data on precipitation was summarized by week, with weeks defined as starting on a Saturday and following the weeks defined the CDC Mortality and Morbidity Weekly Report. The sum of the precipitation for each week and for each station point was interpolated using an inverse distance weighted interpolation routine. During each week, only stations that had data for that week were included in the interpolation. Data from the years 2002 and 2005 is the focus of this paper.

The HUC12 watersheds as defined the U.S. EPA were used as the geographic unit of analysis. There are 59 watersheds in the study area. The raster maps of precipitation by week were then summarized to find the average number of inches of precipitation in each watershed in the study area for each week. In addition, the average amount of precipitation was calculated cumulatively across the spring and summer (weeks 13 to 38).

Temperature did not vary as much as precipitation across the study area and was considered to be constant across space. The stations that measured temperature were used to calculate an average temperature by week.

To measure the presence of WNV, we used point maps of cases of human illness from WNV during 2002 and 2005. These cases were summed for each watershed.

## Results

Precipitation varied considerably across the region of interest and different patterns were apparent in 2002 compared to 2005. Overall, 2005 was drier during the thirteenth through thirty-eighth weeks than was 2002. A relationship can be seen between areas that have less accumulated precipitation and the presence of WNV in humans (Figure 1). By the end of the season, places with relatively less rain had considerably more cases of illness from WNV in humans (Figures 2 and 3).

This project is still underway and at this point the direct evidence for a pattern of drought and subsequent WNV activity has not been revealed. The fact that the areas with more cases in both 2002 and 2005 were also places with less rainfall overall is suggestive of such a relationship, however. Work on discerning the patterns of rainfall, temperature and WNV activity is ongoing.

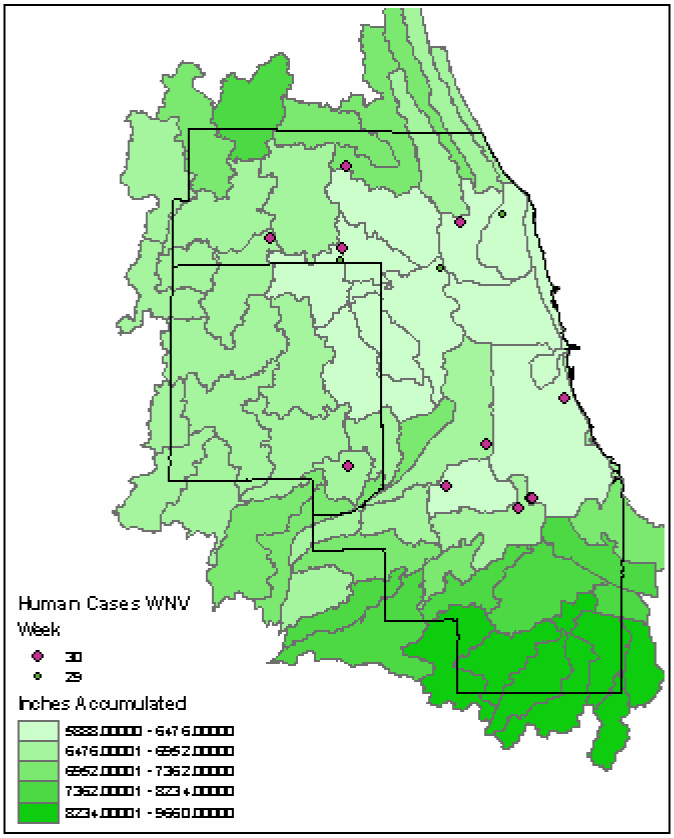


Figure 1. Accumulated rainfall in 2005 for week 30 starting in week 13 by watersheds for the counties of Cook and DuPage in Illinois. Human cases of illness were first seen in week 29.

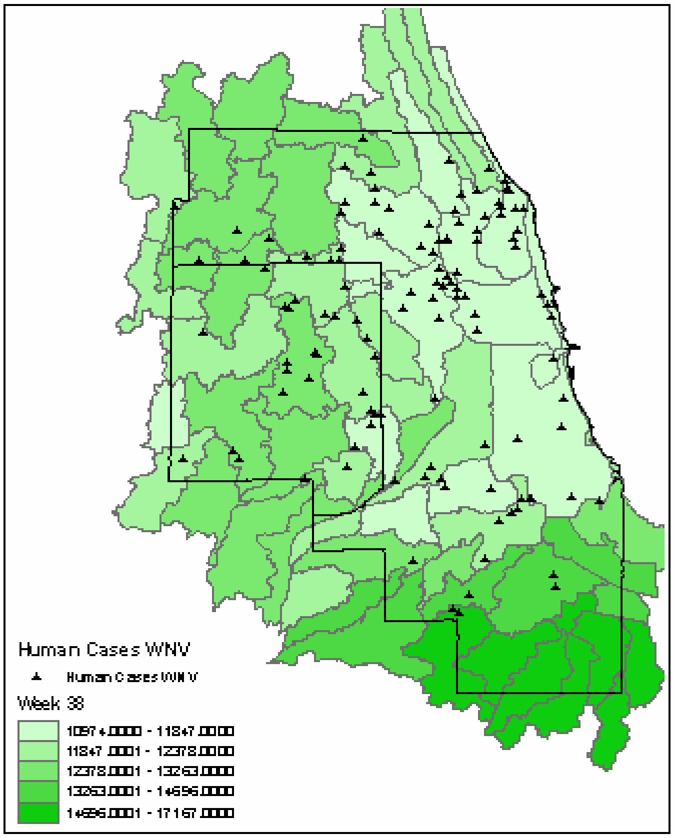


Figure 2: Accumulated rainfall in 2005 for week 39 starting in week 13 by watersheds for the counties of Cook and DuPage in Illinois. All human cases of illness from WNV are shown with the last cases seen in week 39.

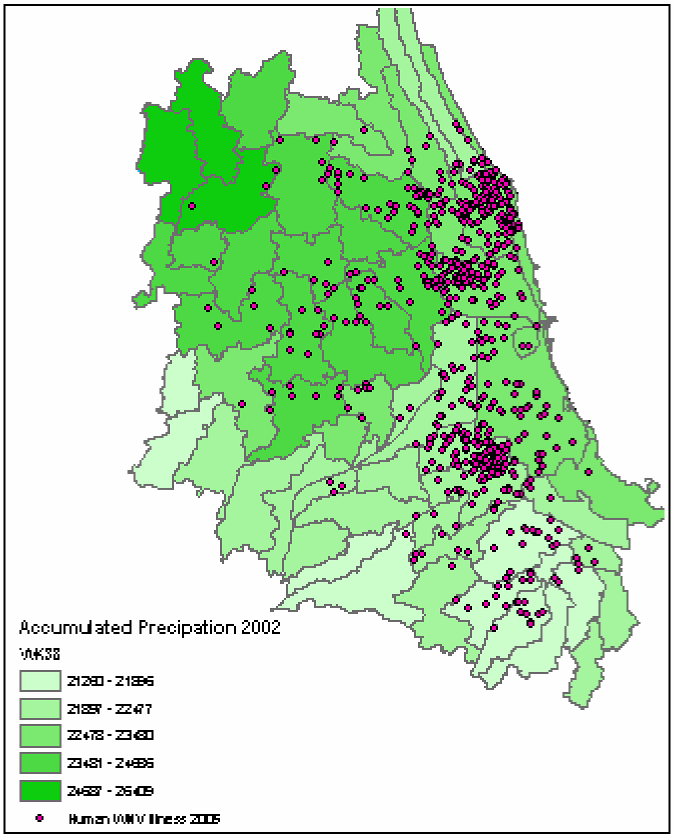


Figure 3. Accumulated rainfall in 2002 for week 39 starting in week 13 by watersheds for the counties of Cook and DuPage in Illinois. All human cases of illness from WNV are shown.