Using NASA Data and Models to Improve Heat Watch Warning Systems for Decision Support

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Extreme Heat Events (EHE)

- Number 1 Weather Related Killer
- Significant Past Events

  Philadelphia, 1993

  Chicago, 1995

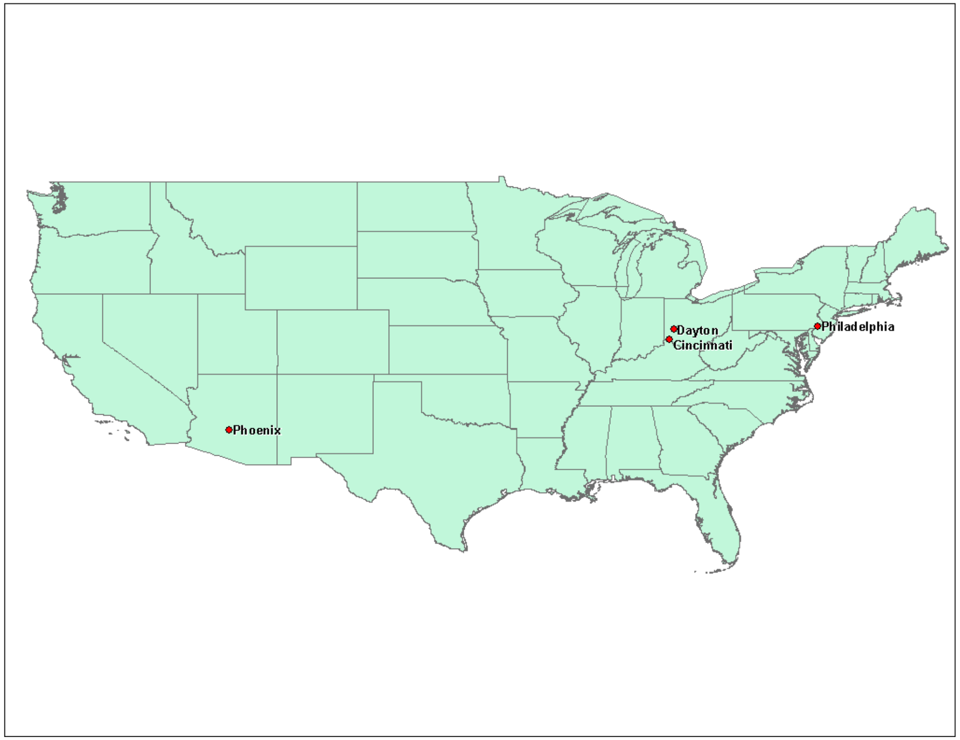
  Europe, 2003

Current Surveillance / Early Warning

- NWS Heat Watch Warning System
- Currently Implemented in ~20 U.S. Cities
- Uses an advanced method employing PCA to determine climatological characteristics of “deadly” air masses
- Lacks spatial specificity beyond the county level

Our Approach

- Utilize meteorological, mortality, remotely sensed, and sociodemographic data from 1995-2005
- Assume that increased surface thermal characteristics lead to an increase in risk
- Model variables using logistic regression and artificial neural networks
- Create spatially specific risk maps for the cities in the study area(s)



Study Areas

Philadelphia, Dayton/Cincinnati, Phoenix

Identifying Past EHEs

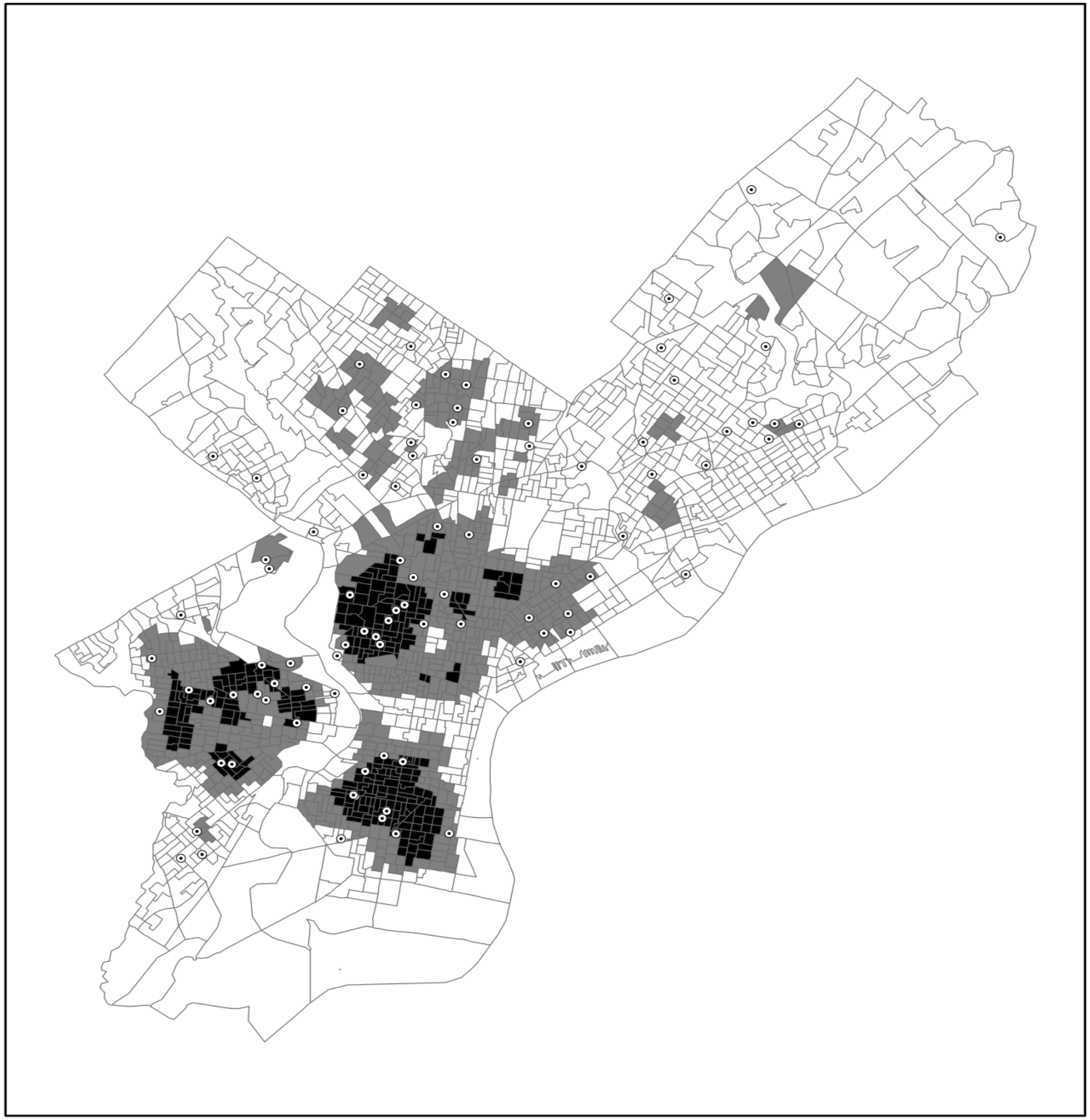
- Utilize a 9 day moving average of temperatures from May – September
- Days which exceed the climatological normal by at least 8 degrees F for five consecutive days or by 12 degrees for three consecutive days are identified as EHE days
- Down selection using mortality data from the respective cities

Important Variables

- Estimate land surface temperature (LST) utilizing remote sensing assets (MODIS, ASTER, Landsat TM, Landsat ETM+)
- Use census socioeconomic data at the census tract level
  - -Minority populations, lower income, lower educational attainment, and aged population
  - -Extract residential land use for population density calculation
- Death certificates collected for past events are also useful
  - -Geocode locations of mortality

Modeling the Events: Predictive Analytics

- Proceeds three separate ways
  - -Utilize logistic regression to determine initial risk of each census tract
  - -Feed the variables identified as statistically significant (through logistic regression) into an artificial neural network
  - -Mine all the variables using an artificial neural network



Risk from Extreme Heat During the 1993 Philadelphia EHE

N

Legend

⊙ Decedent Location

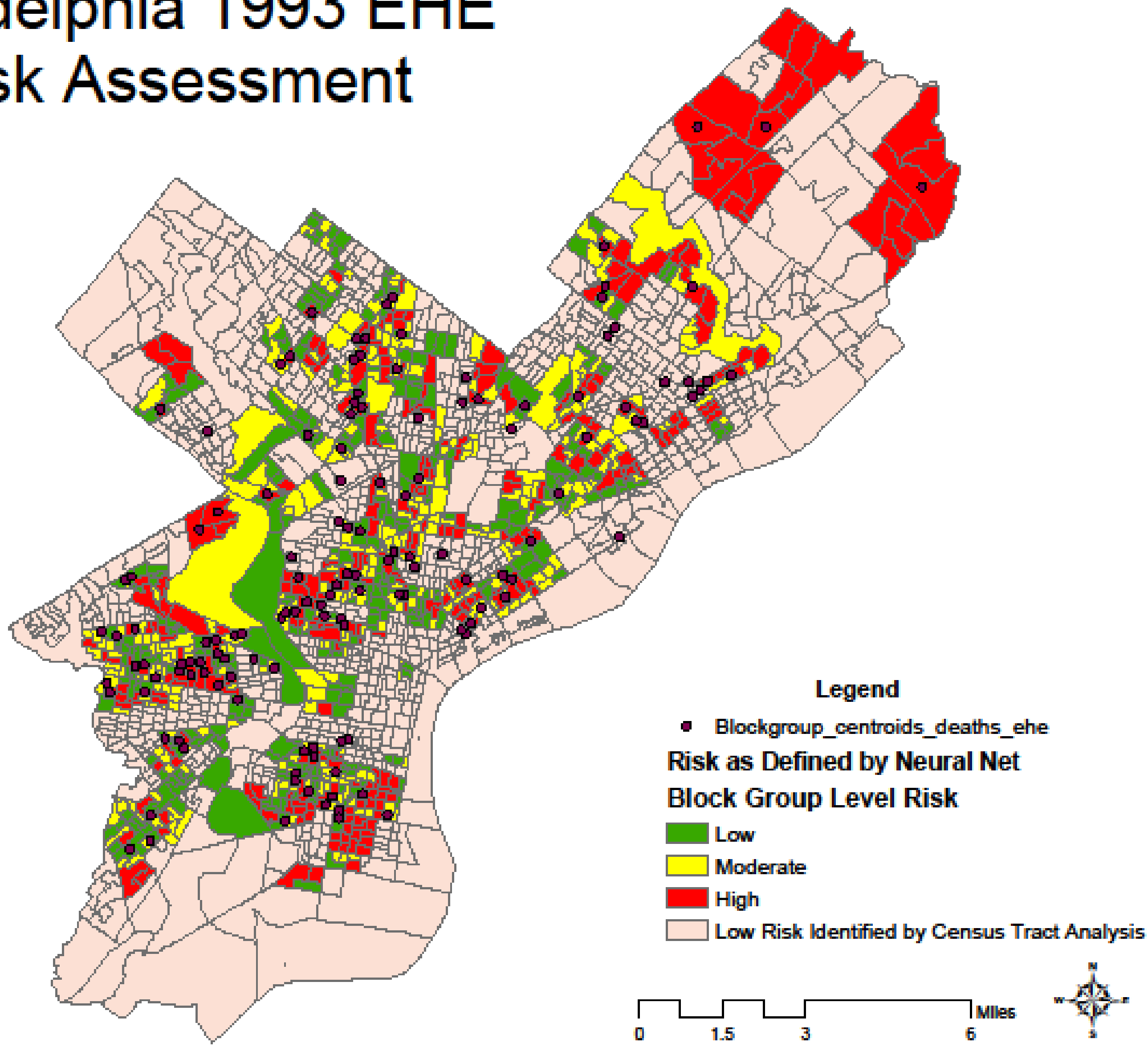
Predicted Death Density per Square Kilometer

- 0
- 0.1 - 1.06
- 1.07 - 3.96

7 3.5 0 7 Kilometers

Johnson & Wilson, 2009

Philadelphia 1993 EHE Risk Assessment



Points are Centroids of Block Group Deaths

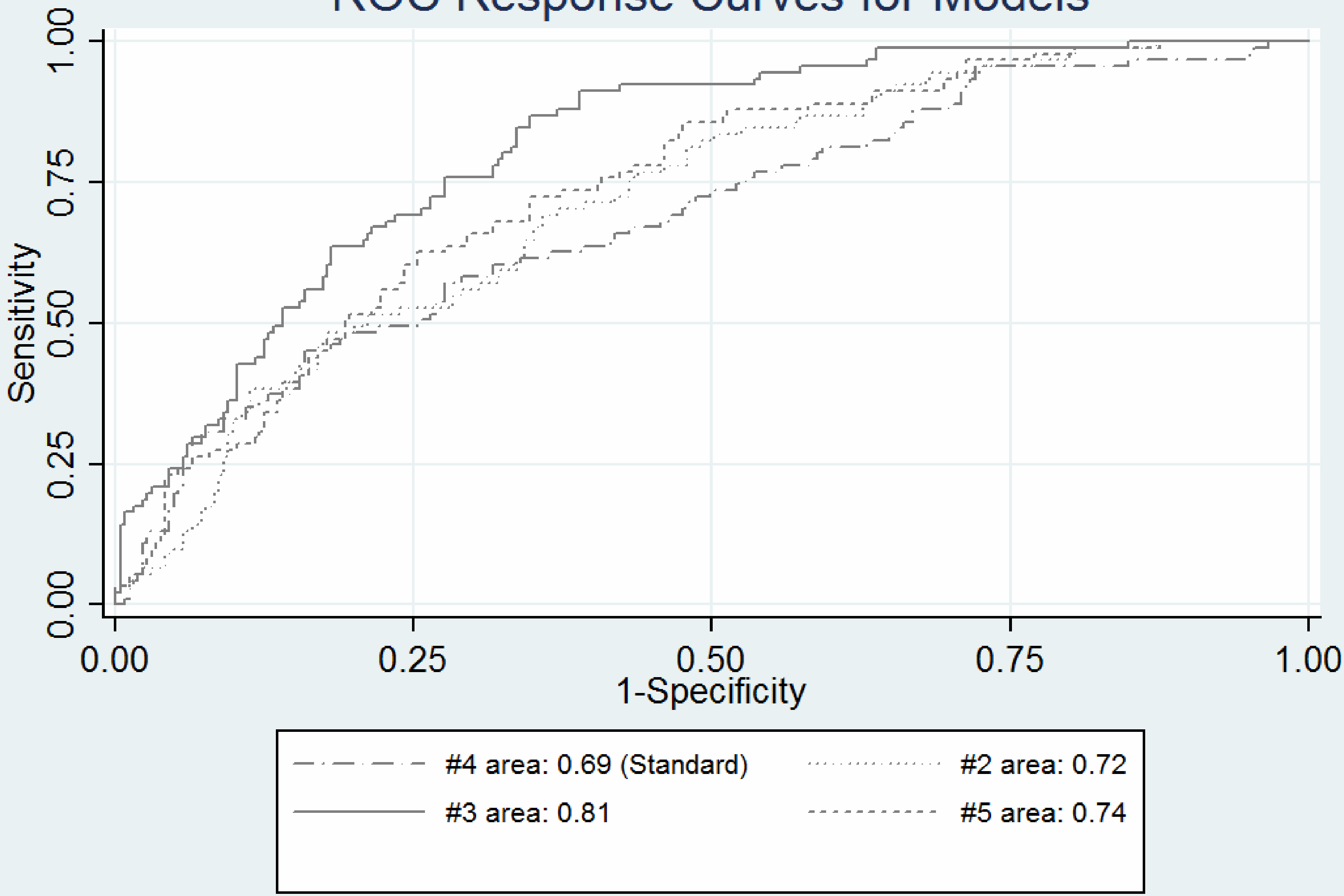
Validation

- Test the models with the realization of each event

  -Kappa Hat statistics

  -Receiver Operator Characteristic (ROC) curves

ROC Response Curves for Models



Johnson, Wilson, and Luber, 2009

Evaluation of System Effectiveness

- Phone surveys in the summer of 2010
- Phone surveys after implementation (anticipated 2012)
- Compare surveys from 2010 from those of 2012
- Compare mortality before implementation to that afterward
  - -Calculate value of statistical life (VSL); enables monetary calculation of the number of lives saved
  - -Already conducted for current system in Philadelphia (Ebi, et al. 2004)

First Year Timeline

- Fall 2009-Winter 2009/2010
  - -Collection of census, thermal imagery, death certificates
  - -Identify residential land use
- Spring 2010
  - -Geocode decedents
  - -All important variables ready for initial analysis
- Summer 2010
  - -June 30th Issue progress report
  - -Begin first round of phone interviews
  - -First end-user meeting
  - -Begin initial logistic analysis

Collaborators

- Daniel Johnson, Ph.D. (PI) Indiana University
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Sources

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