

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

NASA Public Health Review, 2012

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Chair

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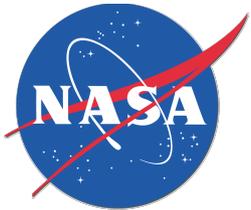


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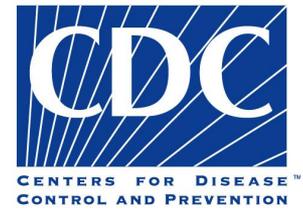
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Model Development

UPDATE ON ACTIVITIES FOR PAST YEAR (YEAR 3, 2011-2012)



Summer of 2012 notable

- Multiple Extreme Heat Alerts in each of our cities
- Hottest summer across much of U.S.
- Earlier events lacked significant humidity

Great PR

- This helps set the stage for implementation and developing further interest.
- Identified areas our cities need help with

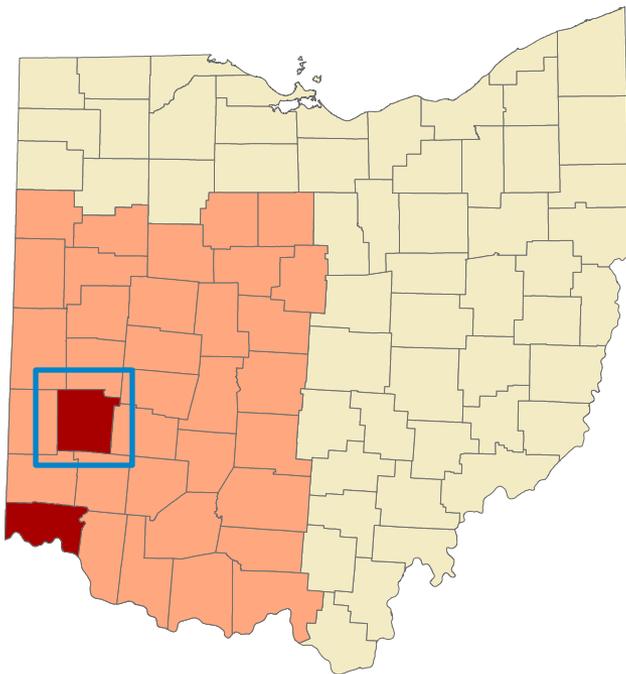


Current Heat Health Alert Systems: Overview of Deficiencies

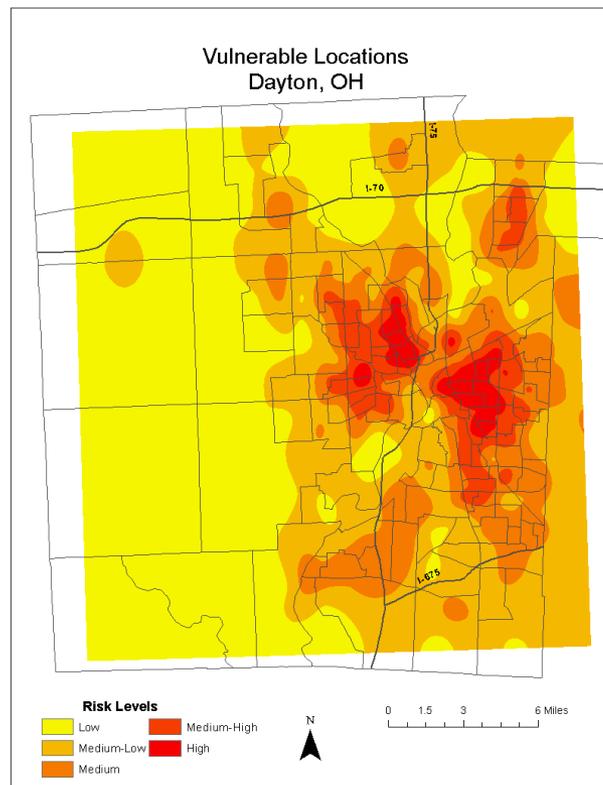
- Much of the deficiency has to do with spatial specificity. Where are the vulnerable? Where are the “hot spots”? Both thermal and health-related.
- ‘Current protocols for issuing heat alerts using synoptic weather models are very good.’
 - Current research is beginning to reconsider this statement (cf: Matte, 2010)

Spatial Specificity in Heat-Related Warnings: The Past and the Future

Current Systems



Our Systems



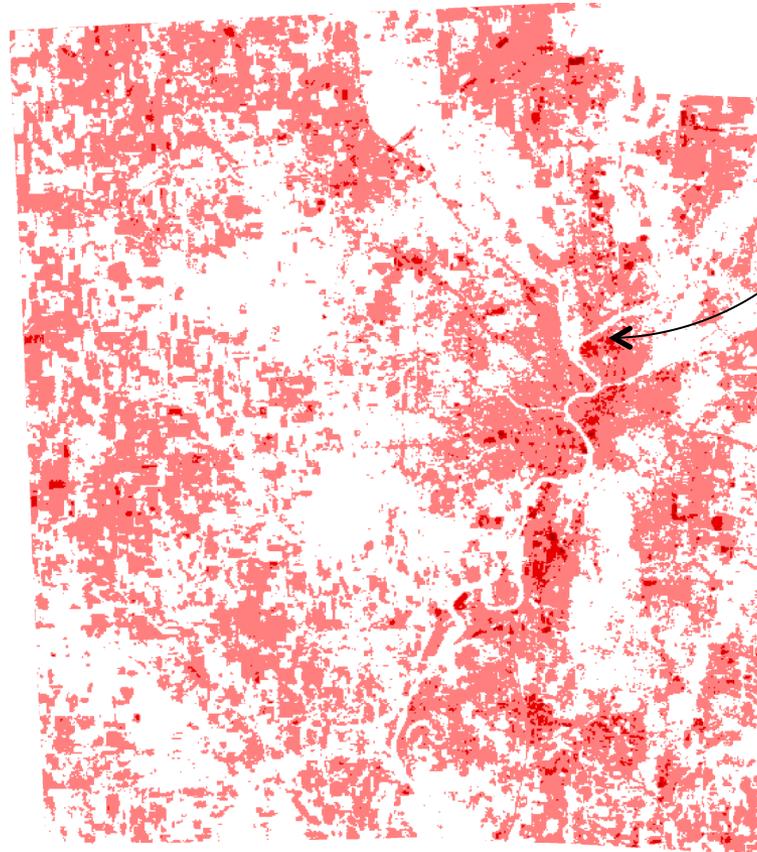
- Allow for 'polygon' alert system
- Placement of medic and cooling centers



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The “Discontinuous” UHI



The Micro-UHI Effect (Dayton)

Important Data Considerations

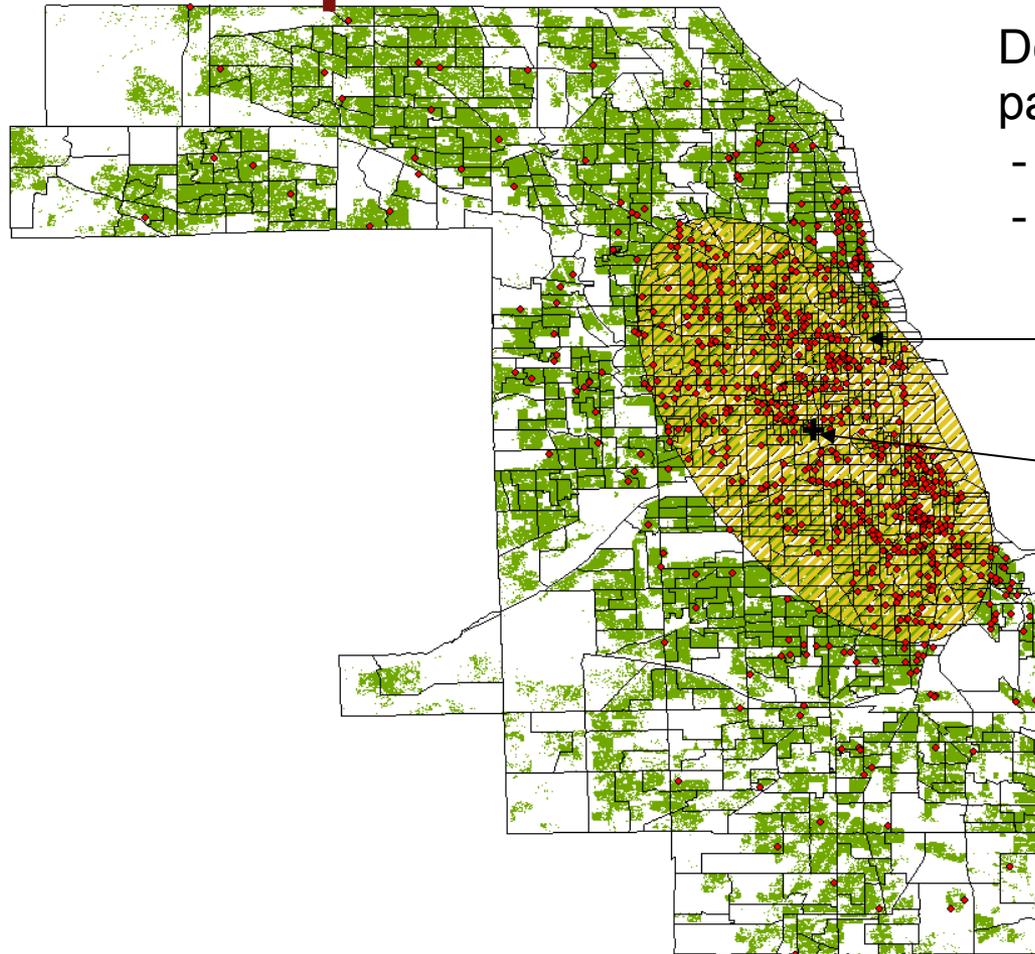
- Use census socioeconomic data at the census tract/block group level
 - Minority populations, lower income, lower educational attainment, and aged population
 - Extract residential land use for population density calculation

Population Density
Calculated by **Area** of
Residential Land Use

Future application may use EMS
'commute' variables



Important Data Considerations



Death certificates collected for past analog events

- Geocode locations of mortality
- Further explore spatial distribution

1 SDE for Mortality

Mean Center of Mortality

Mortalities have been randomly offset by 50-100 meters.

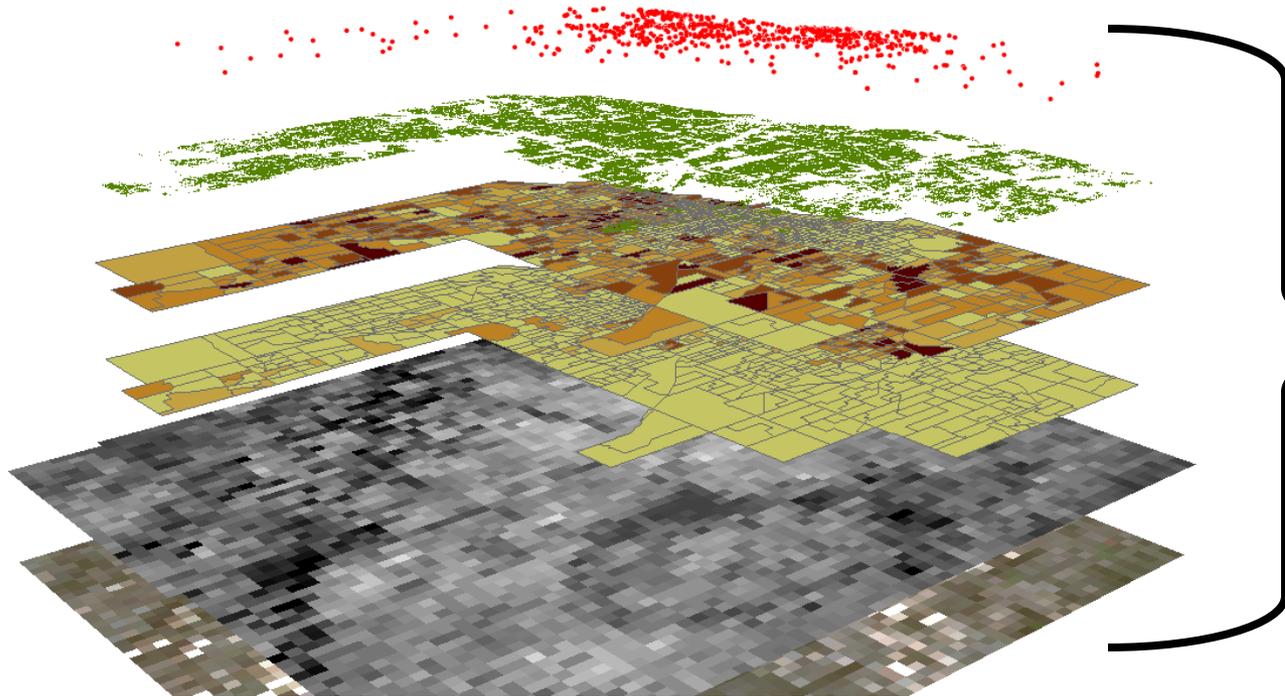
Future – 911 call



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Developing the Extreme Heat Vulnerability Index (EHVI)



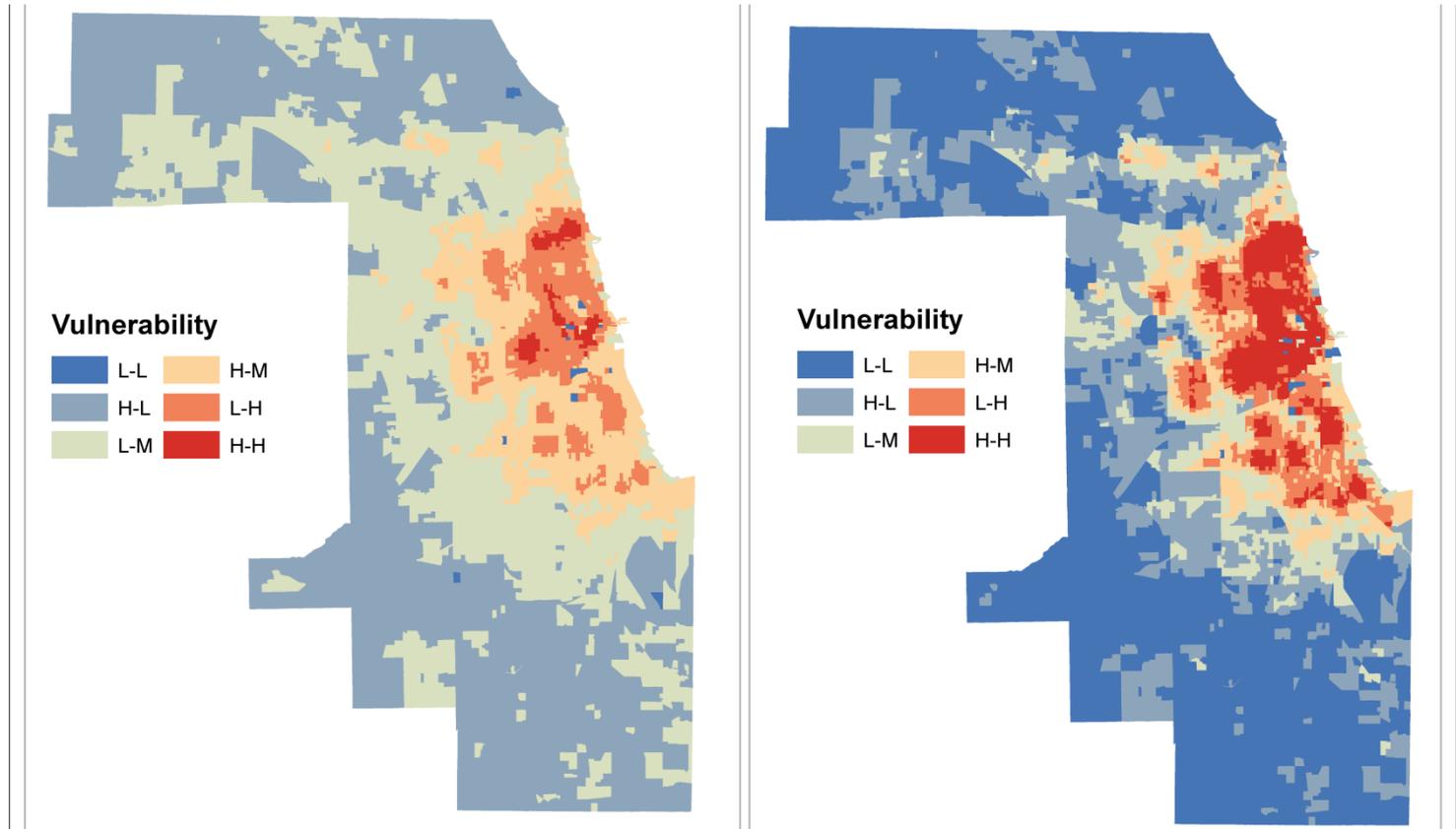
**Risk to
Extreme Heat is
Hyper-dimensional**



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Extreme Heat Vulnerability Index





EHVI Tested with Neural Networks

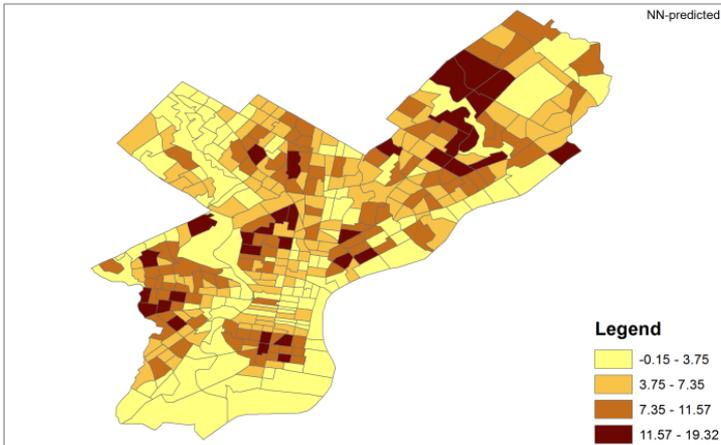
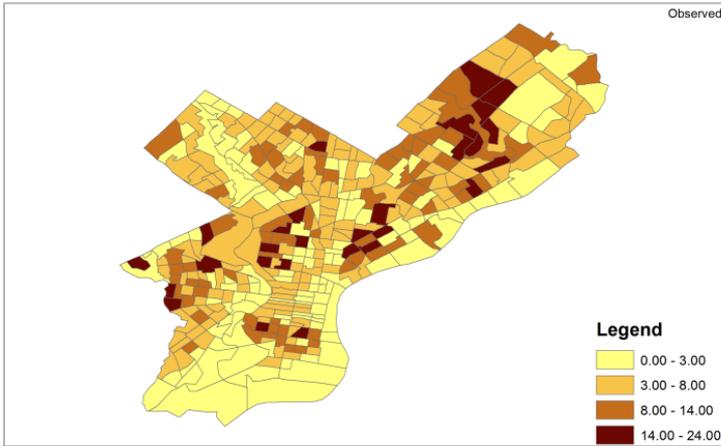
- All outputs from 12-3-1 Multilayer Perceptron (MLP)[†]
- Different architectures need to be tried.
 - With different number of hidden nodes.
 - With different input variables.
 - Combination of both?
- Different networks need to be tried.
 - Self Organizing Maps (SOM)
 - This can also improve our EHVI

† Modern Applied Statistics with S (2002) by W. N. Venables and B. D. Ripley

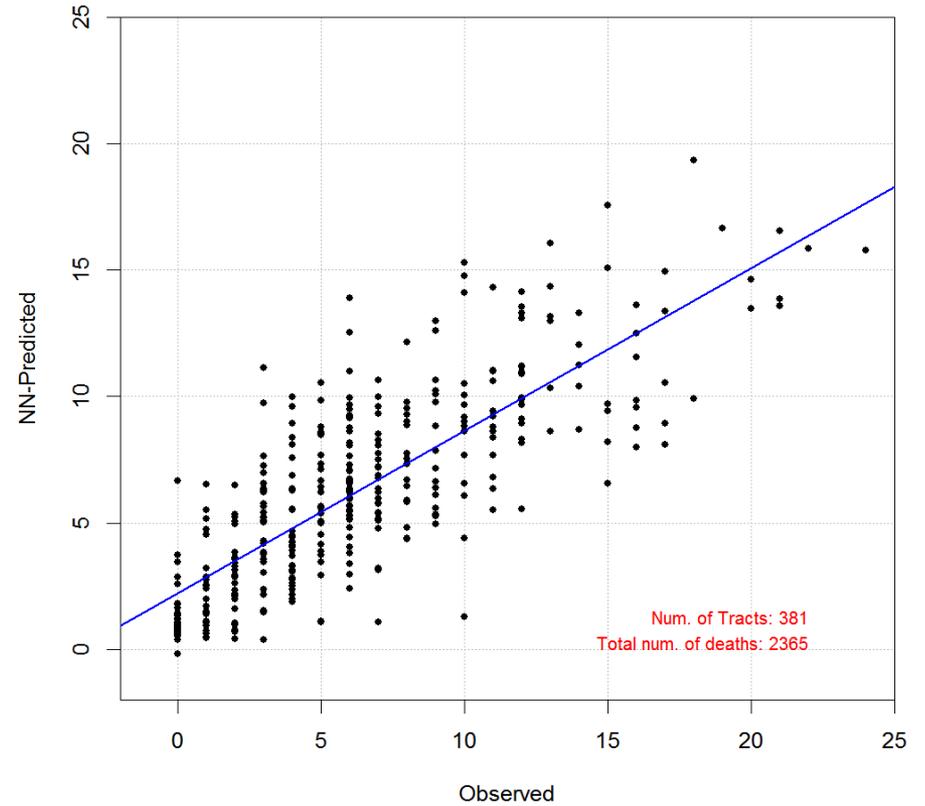


EHVI

PHILADELPHIA (Census Tracts)



Philadelphia (Census Tracts)
Observed vs NN-predicted





Issues with Census 2010 data

- Lack of continuity between the 1990, 2000, and 2010 census has caused multiple problems
- 2010 data that is useful for our project is categorized differently.
- Most indicators are in the American Community Survey; which is a survey.
- Different variables for a few of the vulnerability indicators
- We have had to validate many 2010 variables with past 2000 and 1990 variables to ensure consistency.
- Therefore the 2010 model is not the same as the 1990 and 2000 model in the variables used.

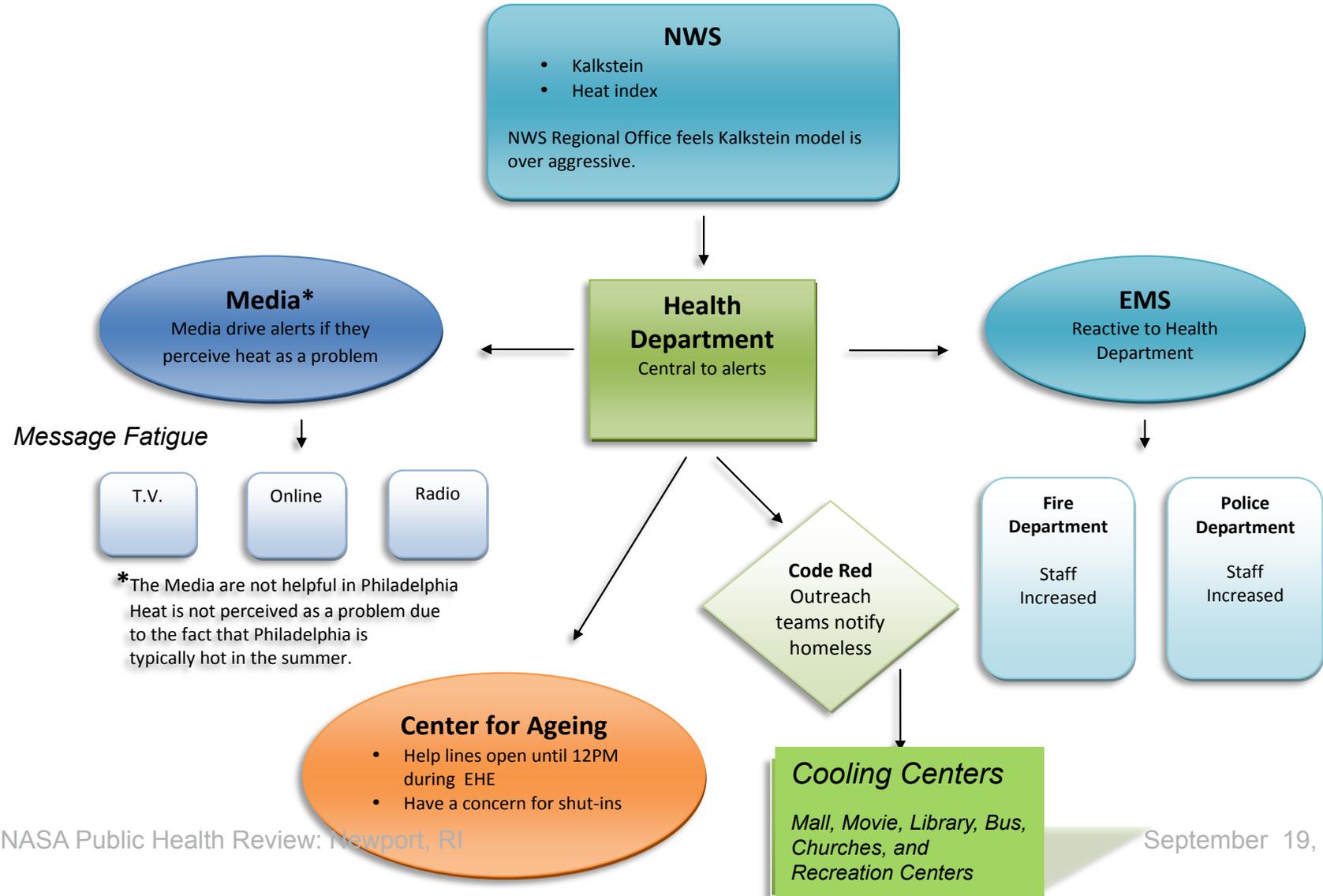


Community Outreach

- Series of focus groups for each city with appropriate organizations/personnel were conducted in person
 - Dayton
 - Phoenix
 - Philadelphia
- Other interest:
 - Indianapolis, Chicago, New York, Tampa Bay...



Philadelphia Response Flow Chart



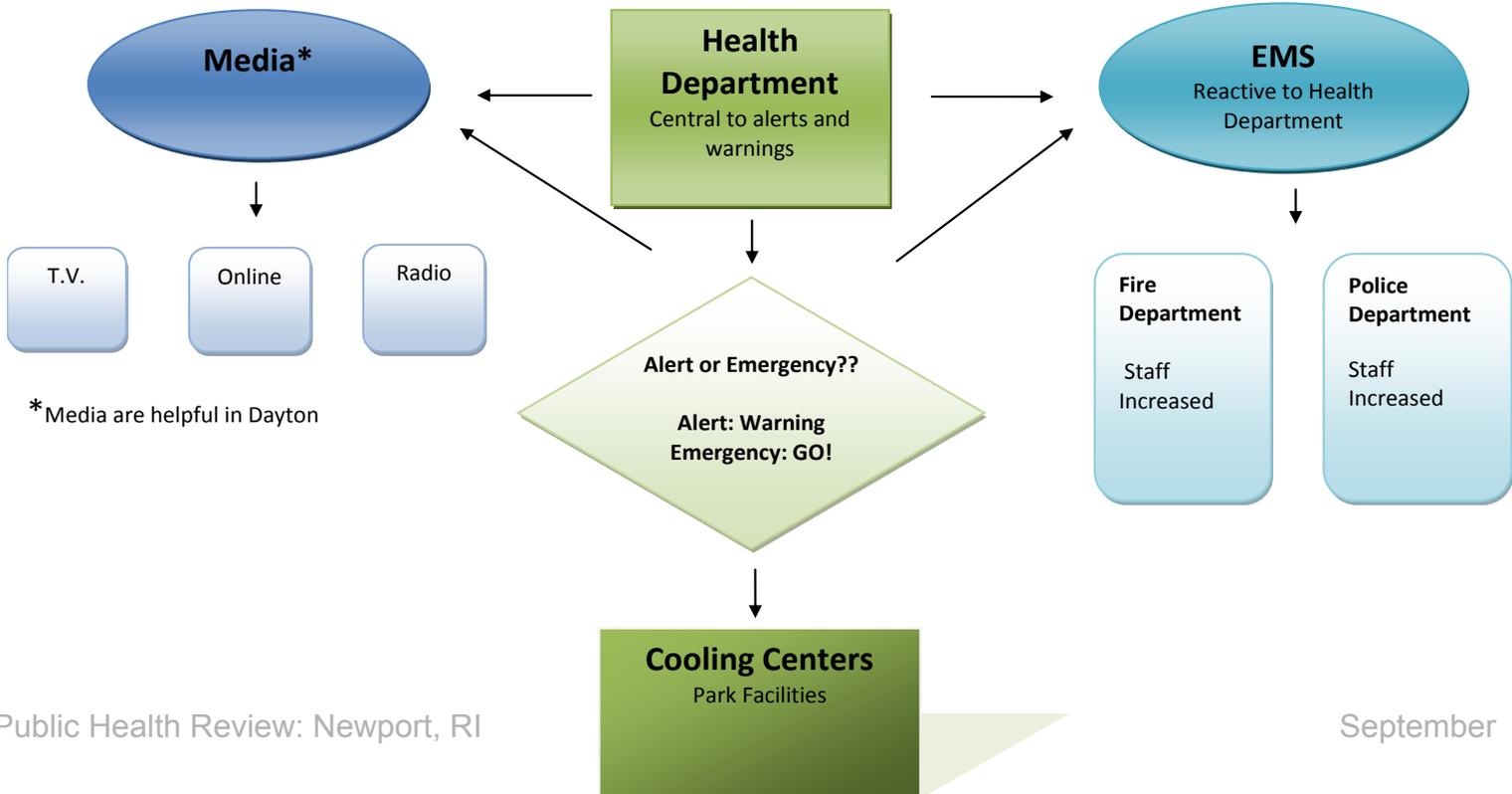


Dayton Response Flow Chart

NWS

- Temperature, Dew Point, and Heat Index based Models used
- Models Seven Day Outlook

Discrepancies between weather models among agencies create confusion as to when to issue an alert or emergency



*Media are helpful in Dayton



Community Outreach

- Dayton: 7 agencies / 18 participants
- Phoenix: 5 agencies / 15 participants
- Philadelphia: 5 agencies / 18 participants

EMS, Police, Fire, NWS, Health...

- Follow-up calls
 - ITEC Interns call Summer 2012
 - Soon to conduct conference calls with each agency.



Community Outreach Summer call

- 27/27 (**100%**) felt that community preparedness made a difference in the ability of emergency officials to respond after a disaster.
- 22/27 (**81.4%**) would not consider purchasing EHVI
 - 4/27 (**14.8%**) might consider buying it
 - 1/27 (**3.7%**) were not sure.
- 5/27 (**18.5%**) did not use any geographical information system
 - they do not need one.
- Only 3/27 (**11.1%**) currently had a heat wave vulnerability assessment system. Of these, only 1/27 (**3.7%**) would consider switching.
- Misunderstanding, calls thought we were selling a ESRI Arcmap replacement



Anticipated Uses in Emergency Response Capacities

- Improved identification of the “hottest” areas of individual cities and the surrounding municipalities.
- Time-Distance information from central emergency response locations to the most vulnerable areas within a city. *Some cities want this some don't...*
- Intelligence-led location of cooling centers



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System and Interface Development

WEB-BASED SPATIAL DECISION SUPPORT SYSTEM



Extreme Heat Event Project

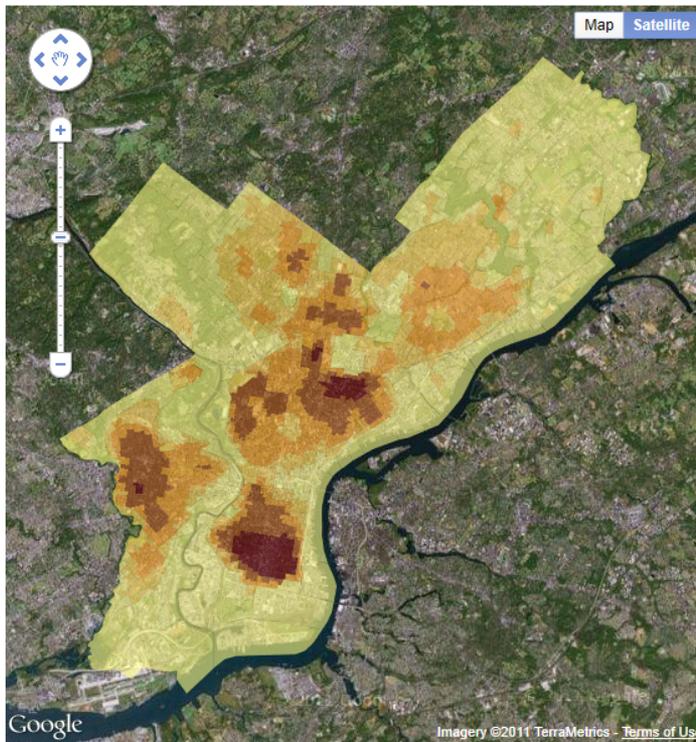
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Navigation

- [About Us](#)

Philadelphia

Some more info about Philadelphia heat waves!



User login

Username *

Password *

- [Request new password](#)

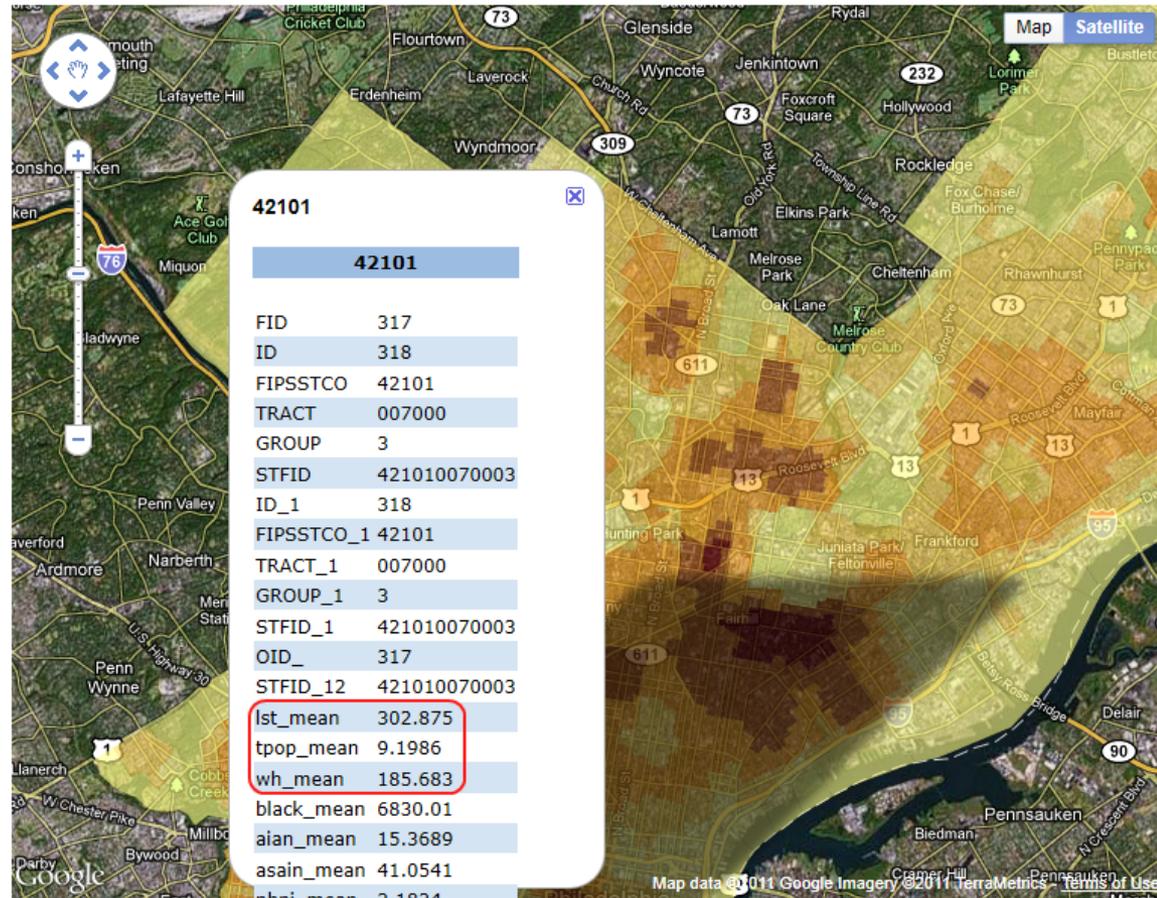
Not even in Beta test phase



Some more info about Philadelphia heat waves!

Improvements:

- *Daily temperature with 97th percentile*
- *Roads, Identifiers...*
- *LST map tab*
- *Neural Network tab*
- *Address locator*
- *Additional systems...*
 - *Cold, flood, burn...*





Important Data Considerations

- Currently exploring downscaling MODIS to Landsat ETM+ and TM resolutions. Having varying levels of success...
- This will give us the ability to provide daily guidance to each city
- Re-calibrate on each “good” Landsat ETM+, Landsat TM, or ASTER as we can find it available or task the sensor?



Anticipated Improvement in Emergency Response Capacities

- Improved identification of locations that are particularly vulnerable
- Improved ability to mitigate the health-related impacts. Especially, when coupled with currently developing heat-health communication toolkits.
<http://www.bt.cdc.gov/disasters/extremeheat/>
- Improved communication of events to especially vulnerable individuals/communities
- Disaster prevention funding documentation



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Anticipated Activities for Coming Year

- Continue interaction with focus groups
- Implement the ensemble of models and begin full implementation in each city
- Automation of process
- Collect mortality/911 data for this past summer; further enhance interface for model re-runs



Anticipated Activities for Coming Year

- Continue work on MODIS downscaling for daily guidance in each city
- Explore new cities that would be very good test areas for spatial expansion of the system (Indianapolis, Chicago have already been identified, NYC, Oklahoma City are future possibilities)
- Explore expansion spatially to statewide system...



Anticipated Media Change

- Social Media
 - Information outlet
 - Warning 'tweet' or text
 - Information portal
 - 'check-in' at cooling centers
 - Connect groups
 - Share ideas
 - What works, what doesn't
 - Learn from one another
 - 'City Bus'
- Help us design the product



Publicity

- Multiple peer review publications
- 2 text book chapters
- Showcased on FOX and NBC affiliates in Indiana in summer 2010, 2011, and 2012.
- Live radio interviews
- Multiple newspaper articles
 - They searched us out
- We plan a more aggressive press release initiative with each of our cities (and potential users) before summer season which will highlight our system



- ARL
 - Tested in a real world application, prior models are being used by cities.
 - Next summer 'up to date' systems implemented in mitigation plans
- Budget
 - Completion of no cost extension
 - Plan to exhaust remaining funds



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A Special Thanks to Our Collaborators

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