

INDIANA EXTREME HEAT VULNERABILITY
MODEL

ENVIRONMENTAL PUBLIC HEALTH TRACKING
ASTHO FELLOWSHIP REPORT

Submitted by

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INTRODUCTION

The Centers for Disease Control and Prevention (CDC) National Environmental Public Health Tracking Network (EPHTN) is “a web-based surveillance system that involves the ongoing collection, integration, analysis, and interpretation of environmental hazards and exposure data with data on health illnesses possibly linked to the environment.” Since its launch, the Tracking Network has allowed state, local, and federal agencies to rapidly detect emerging public health threats, implement and evaluate the efficacy of control strategies, and develop actions that improve public health. Currently, the CDC funds an EPHTN in 27 states and New York City. At this time, Indiana is not funded for this activity by the CDC.

In 2009, the Association of State and Territorial Health Officials (ASTHO), in collaboration with CDC, launched its Environmental Public Health Tracking: *State-to-State Peer Fellowship Program* to build capacity of non-grantee states and territories by providing opportunities to:

- Develop a pilot project that would advance EPHT in their states
- Gain first-hand tracking experience from CDC state grantee mentors
- Improve communication and collaboration between funded and non-funded states

In December of 2010, the Indiana State Department of Health’s Director of Environmental Public Health was accepted into ASTHO’s 2011 *Environmental Public Health Tracking: State-to-State Fellowship Program*. The State of Wisconsin was chosen by the review committee to be Indiana’s host state with a visit in March, 2011. Attendance at the National EPHTN Workshop in Brooklyn, NY in April, 2011 was also a valuable part of the fellowship.

Indiana’s pilot project is related to the health effects of climate change. Since climate modeling indicates that the coming decades could bring a warmer planet earth causing extreme heat waves, it was chosen to develop a heat/health vulnerability map to identify those areas with people most susceptible to the health problems associated with this weather condition.



Photo 1: Wisconsin State Capital, March 9, 2011

REPORT ON TRACKING ACTIVITIES

I. Host State Visit, March 7 – 9, 2011

A visit to the Wisconsin Department of Health Services (WI) was conducted on March 7 – 9, 2011. These particular dates were chosen because it coincided with a meeting of WI's EPHTN Technical Advisory Group (TAG), which was a very good addition to the overall benefits of the fellowship. The WI visit was highlighted with the following experiences:



Photo 2: Wisconsin EPHTN's Location

- f* Introductions and Bureau Overview – Chuck Warzecha, Director of WI's Bureau of Environmental and Occupational Health, which is where their EPHTN program is housed, presented a synopsis of his Bureau's programs and how tracking fits into the "big picture" of their operations. He also covered how the program is related to and interacts with other programs.
- f* WI EPHTN Program History – Henry Anderson, MD, State Health Officer and Principal Investigator is part of the 'mastermind" behind making EPHTN a reality in Wisconsin. Dr. Anderson has been intimately involved with the Network on a national level from the very beginning recognizing the need for ongoing surveillance and data analysis of environmental hazards, exposure, and health outcomes. This institutional background was very helpful in understanding the efforts needed to convince the appropriate state officials of the benefits of developing an EPHTN.
- f* Secure and Public Portal Demonstrations – This session, conducted by the program's Epidemiologist Jennifer Boyce and Public Health Educator Sara Ishado, focused on the current status of WI's EPHTN data portals. The program has produced a network for users to access and analyze data on asthma, heart attacks, cancer, air quality, drinking water quality, childhood lead poisoning, and reproductive outcomes.

Two websites are developed: one that is publicly-accessible and another one that provides secured access for environmental and public health professionals, including local health departments. The public website allows for data queries with table and map creation functions. The secure website uses an analysis, visualization, and reporting system (AVR) to provide more complex data functions and the creation of data that can be visualized with graphs, pie charts, line charts, and maps.

- f* Program Outreach, Marketing, and Training - This component of the EPHTN program is one that, as was learned, is not even realized to be a

necessity to an unfunded state. Often concerns of an unfunded state surround information technology and data collection issues, but that is only the first step. Outreach, marketing, and training are not only important long-term matters, but also integral in the development phase of the network. Sara Ishado shared their outreach plans for marketing and training, which has had four phases since its inception.

The outreach plan outlines program goals, objectives, key messages, target audiences, and communication strategies. Activities include increasing awareness to their target audiences, which include: local health departments, policy makers, non-profit health related organizations, universities, librarians, and other state agencies. To accomplish this WI staff have staffed booths at conferences, created newsletters, made numerous presentations, written articles for various publications, and included links to their website on partner websites. Also, to increase usage of the network by their target audience WI staff have provided training and incorporated EPHTN projects into university classes.

Further outreach that WI conducted involved creating a summary profile report for each county. The reports display data for each of the network's core topic areas in tables, maps and graphs. The purpose of these county profiles is to provide the local health department with information to use when communicating with the general public and their stakeholders; and also provide instant access to summarized data that can be compared across counties.

- f* Program Evaluation – The information for this part of the site visit was provided by WI Program Evaluation Specialist Meredith Mueller. She explained the process the program went through to conduct usability testing, which is an important element of this process to evaluate usefulness, utility, and functionality. Assessing usability involves getting feedback from a select group of the target audience to garner any issues present and solicit suggestions for improvements to the network.

WI also conducted an online survey and phone interviews of local health department staffers to determine if county health indicator data provided by the program are useful, whether there is any additional indicators needed, will adding indicators increase usage of the data, and how the indicators will be used. This type of program evaluation ensures the network is on track to being the useful tool it is designed to be.

- f* Data sharing and partnering with data stewards – WI EPHTN Program Manager Marni Bekkedal, Ph.D., discussed the various intricacies of this process. Apparently, this is one of the most difficult components of establishing the network. Since the concept of the EPHTN is to have a

comprehensive system taking surveillance, exposure, and disease data and exploring relationships with environmental data, the data comes from various sources. These various sources collect and maintain their own data. The network then electronically imports this data into one central system for assessment by the target audience users. Relationships have to be developed with the many data stewards, which are the data owners, to generate participation. Marni has been very successful in this endeavor, which has also led to some “spinoff” projects for the agency that her program has been instrumental in assisting with. One of these projects included an interesting assessment of private well drinking water quality datasets that could be included on the program’s data portal. This information then could be used to help reduce exposure to water contaminants.

- f Technical Advisory Group (TAG) – As previously stated, the fellowship site visit was coordinated with WI to coincide with their semi-annual TAG meeting. As the committee’s name implies, the TAG is to serve as the program’s professional consulting, advice-giving, and counseling team to provide recommendations. The TAG includes advocacy group



Photo 3: TAG Meeting, March 8, 2011

representatives, health and environmental data stewards, local health department staff, academic participants, and a communication specialist.

This was a particularly good TAG meeting to attend as they were conducting an evaluation of their experiences with the group and how it is structured. This was accomplished using a “focus group” approach with a moderator helping move the discussion. Below are some, but not all, of the major topics covered.

They started by talking about the need to bring any other representatives on board with the group. Some of the suggestions included adding a legislative or policy liaison, planner, built environment expert, and data users. They also discussed whether the current structure is effective since the purpose is to provide guidance and recommendations. Ideas on this topic surrounded having some focused sub-groups to investigate matters between regular TAG meetings, having subject matter experts give presentations to the group, and giving the members homework to complete before the next meeting. Another important matter questioned was whether group members received appropriate information between meetings to keep abreast of significant issues and developments. Solutions for improving this included the preparation of a summary after the meetings, and possibly getting regular updates between meetings. The final question involved the training of new TAG members. This brought the recommendation of developing a member guidebook containing the resources to help someone get oriented.

All-in-all, I cannot say enough about how valuable this site visit was. As outlined above, the variety of exposures to the different aspects of WI's program will be an exceptional experience for Indiana when the resources become available to create an EPHTN. The professionals working for WI are "top-notch" and their dedication and knowledge are proof of the quality of the program. When Indiana does develop a network, we will want the exact same caliber of staff to make it reality.

II. National Environmental Public Health Tracking Workshop, April, 2011

As an integral part the fellowship, the Environmental Public Health Tracking 2011 Workshop held in Brooklyn, New York City, NY on April 25 – 28 was attended. This annual meeting of the CDC's tracking state grantees was definitely a valuable component of the fellowship. Since the meeting was held near the Brooklyn Bridge, the workshop theme was appropriately titled, *Bridging the Gap*, which is where the tracking program is in some states that are trying to put all their pieces together to get networks up and running.



Photo 4: Brooklyn, NYC sign, site of national workshop, April, 2011

The meeting brings together state and academic staff to discuss and exchange successes and lessons learned; to learn about the latest technology and research in the field; and to coordinate network plans amongst the various sub-workgroups, which included break-out meetings for these sub-workgroups that

cover content; standards and network development; geographic location mapping; and program marketing and outreach.

The workshop also included plenary sessions. One of these plenary sessions was presentations from the five academic partners that have had tracking projects recently funded to be included as part of the EPHTN. These academic partners will work to advance the science needed by improving the understanding of environmental risk factors related to human health. One of these university partners is the University of Illinois – Chicago, which is collaborating with Indiana, and other Midwestern states, for their tracking project concerning birth defects and its relationship to agriculturally caused water contamination from atrazine and nitrates.

Other interesting plenary sessions touched on: 1) the latest Geographic Information System software becoming available in the marketplace that will benefit tracking program's efforts to geo-code and map tracking activities. This is one area of the EPHTN world that continues to improve the available tools for environmental health practitioners; and 2) the evolving importance of Health Impact Assessments (HIA) was discussed by tracking academic partner Emory University. Emory's project involves the health impacts of ambient air pollution on the rates of emergency room department visits and hospitalizations for asthma and heart attacks. HIAs are becoming an important evaluation of the effect that human activities, such as urban development and industrial and agribusiness projects, has on human health. The EPHTN is becoming the tool of choice for HIAs since they fit right into the tracking mission "To provide information from a nationwide network of integrated health and environmental data that drives actions to improve the health of communities."

Another educational piece of the workshop was the portal demonstrations from various tracking states. This was exceptionally helpful in that it not only demonstrated the particular states' tracking websites and associated features, but also the presenter discussed some of the successes and hurdles that took place to get the site up.

Attending this national workshop, and having attended the National EPHTN conference in 2009, has been a remarkable exposure to what goes into developing a network portal. Being amongst all the staffers that make these state portals into a national system, learning about what it has taken to get data and other resources, and seeing how the funded states work together to make all this happens really proves that the national EPHTN is more than just an electronic system bringing health information and records together with related environmental data, it also is a human resource network of professionals from federal and state governmental agencies, along with university academics, that are all engaged in it, that care about the network, and work very hard to make it a reality.

III. Fellowship Project – **Indiana Extreme Heat Vulnerability Model**

Introduction

Extreme heat is the number one weather-related cause of mortality in the United States. These events are typically punctuated by brief 3 to 7 day periods of extreme temperature and humidity. Most climate projection models indicate a strong likelihood that extreme heat events are likely to increase in duration and intensity in the coming decades; with the Midwestern U.S. being especially susceptible. The thermal stress applied to individuals during these periods can quickly overcome the human body's ability to thermoregulate and lead to heat syncope and/or heat stroke. Further, the level of vulnerability to these events is highly disparate among different populations and their physical environment. Typically, older individuals living in highly urbanized areas are the most at-risk. However, undereducated, minority populations in varying levels of poverty within urbanized spaces are similarly vulnerable to the effects of extreme heat events. Further influencing the level of risk within these urbanized areas is the effect that development has on the thermal environment of a city. This phenomenon is known as the urban heat island (UHI) and can cause temperature differences on the magnitude of 20 degrees Fahrenheit between the city and the contiguous rural area. Therefore, determining the areas where the UHI effect is coincident with vulnerable population groups leads to the development of models effectively illustrating the most vulnerable locations.

This project is a collaboration with the Indiana University Center for Urban Health and the Indiana University Center for Health Geographics (IU) under the direction of Daniel Johnson, Ph.D., Assistant Professor, with research assistance from his graduate assistants.

Methods

The UHI effect is readily observable using satellite-based technologies. Using the current Moderate Resolution Imaging Spectroradiometer (MODIS) sensor available from the NASA Earth Observation System (EOS) it is possible to image the entire thermal surface of the United States daily. This is done at a sufficient enough spatial resolution to determine intra-county level variability in surface temperature. This project activity also utilized socioeconomic data from the U.S. Census Bureau at the census tract level. This census data along with a summer monthly composite of MODIS imagery for the state of Indiana was used in order to determine the overall level of vulnerability to extreme heat within the state.

This then provided indications to the numbers and locations of the most vulnerable areas within Indiana.

$\frac{3}{4}$ **Data**

Census Tract Level Data (2000): Caucasian, African American, Asian, Hispanic, age 5 and under, age 65 and older, median household income, total population below poverty, age 65 and older below poverty, age 5 and under below poverty, persons with less than a high school education, and age 65 and older living alone and those living in a nursing home.

MODIS Terra / MOD11A2: This product is an eight-day composite period. The dates of the image files represent a Land Surface Temperature (LST) of an eight-day average from the MODIS sensor.

$\frac{3}{4}$ **Modeling**

MODIS thermal imagery was downloaded from Glovis (USGS Global Visualization Viewer). The initial value recorded by thermal infrared sensors is a top of atmosphere radiance (TOA). The digital number recorded for each pixel value in the delivered product reflects the coefficients of the calibration which has to be converted by the end user to obtain a LST value. To do this IU used the raster calculator in ERDAS Imagine 9.2 to multiply each pixel value by a scaling factor of 0.02 which converts the pixel value to Kelvin.

For this study, IU calculated mean temperature at the Census Tract Level. This was accomplished using the Spatial Analysts tools in the geographic information system (GIS) software ArcInfo 10. IU then used Census Tract level data as the enumeration unit to calculate mean values. 2000 Census data were joined with 2000 Census Tract shapefiles and converted to a GIS point by having each point represents the center of their census tracts. After further post processing and analysis by IU, the resulting dataset was separated by standard deviation into levels of extreme heat vulnerability risks for each census tract.

Results

The resulting state-wide map visualizes the high-heat event vulnerability results across the state (Reference Section, Map 1). The map depicts not necessarily areas with vulnerability for high heat as in UHIs, but actually areas with residents that have heat-related health risk vulnerability.

Furthermore, the results are a statistical calculation of heat and socioeconomic variables, which prior research has demonstrated as being related to vulnerability during extreme heat events. Some of the variables include: age, education level and economics. It should be noted that at this time IU cannot definitively state how much more vulnerable an area might be (e.g., it cannot be said that red is two times as vulnerable as a blue). The equations used in the analysis are not that specific and the diverse environments and communities across the state would not support such a specific answer. The equations, however, do accurately demonstrate areas which are statistically more vulnerable or less vulnerable.

Also interesting, though unfortunate, is that Indiana experienced two “official” heat-related deaths this past summer. These deaths occurred on the edge of a Medium-High heat-health risk zone, and very close to a High risk zone within Indianapolis (Map 2), thus, in a sense, validating the concept of this model.

Conclusion

This heat vulnerability model, and the resulting maps, is a tool that can be used for more effective communication of heat as a cause of health concern and lead to effective delivery of relief efforts in the event of a major extreme heat episode in Indiana.

Also, the outputs from this project can be utilized to enhance public perception of the risk from extremes in temperature and to drive communication efforts. As has been shown in many recent natural disasters the knowledge of vulnerability prior to an event is of central importance in the protection of life and property.

PLANNED ACTIVITIES

Until a funding opportunity becomes available for unfunded states, Indiana plans to continue dialogue amongst stakeholders that would be involved in a TAG or be data stewards. The main purpose behind this is to keep potential EPHTN partners engaged in the network concept as they interact with their counterparts across the country that already are funded by the CDC.

Also, we currently are taking the next with the project. We are in the process of creating a webpage that will make variations of the maps included in this report, details regarding extreme heat, and other health effects of climate change information available to the public. At this time, the skeletal website should be up by early fall, 2011 as we

are still ironing out some issues with the web server. Another goal for outreach is establishing a mechanism for interested parties to register for Twitter or text alerts. Regarding the dataset that the vulnerability model is based on, IU is also working with their informatics group on mining additional clinical data from the state-wide epidemiological surveillance system, which will further define and validate the results.

CONCLUSION

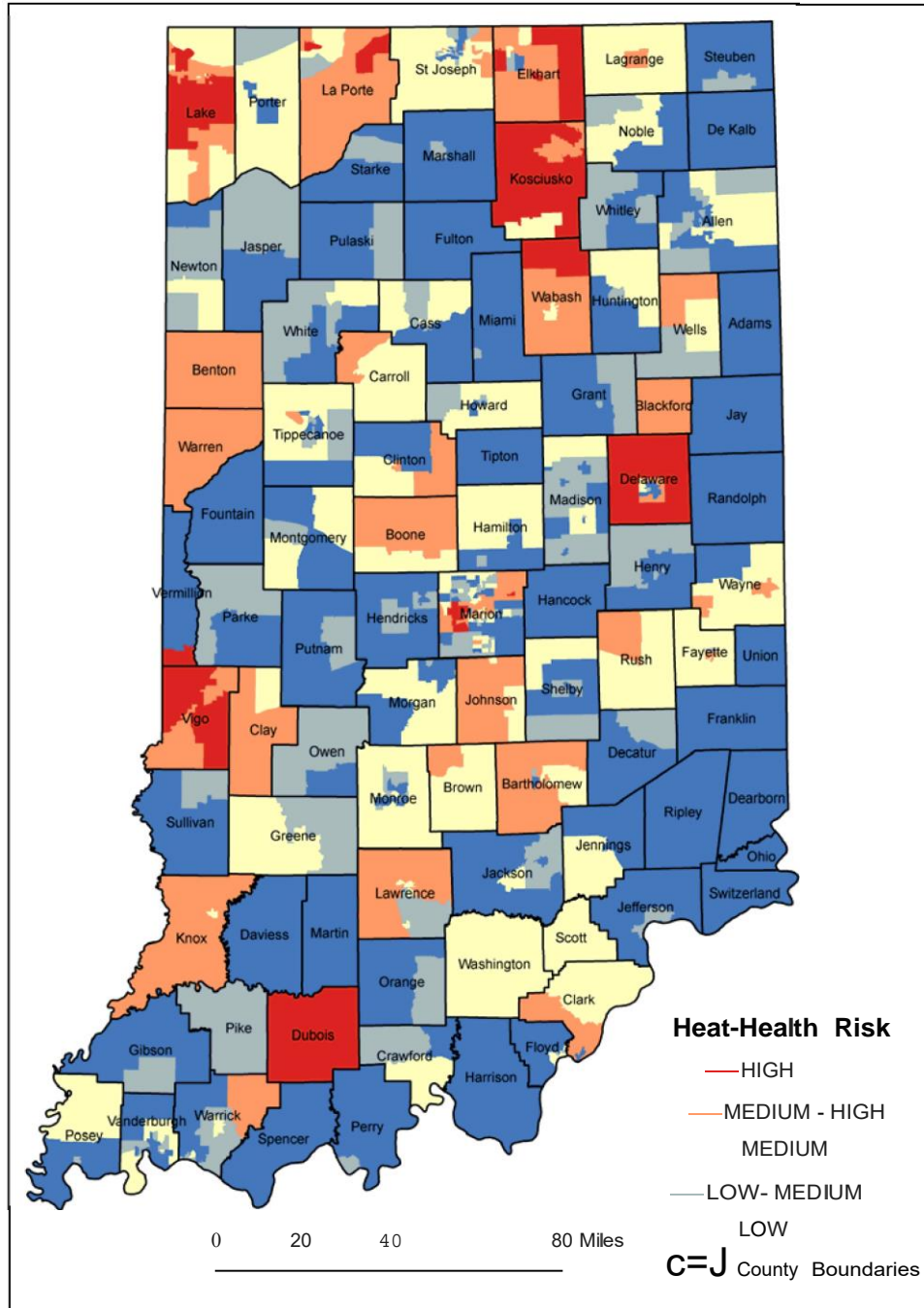
If the overarching benefit of the ASTHO tracking fellowship could be summed up in one word it would be “preparation,” but more specifically the experience has been a process of becoming exposed, immersed, educated, and as a result, prepared for taking on the task of establishing an Indiana EPHTN. This procedure would not have been possible without the resources obtained from ASTHO and the CDC.

The lessons learned have been many. The host state visit to Wisconsin, which was the centerpiece of the fellowship, turned out to be the biggest component of these lessons because it included details about the ins and outs of building and operating an EPHTN. One very valuable lesson, of which the difficulties was mentioned briefly above, involving getting data owners onboard was to get a sample of their data and then run a demo for the steward to show what the network can do with the data. After all, in most cases, the public has paid to gather the data they then should be able to have it made available in a manner that brings meaning to everyday decision one makes about how and where they live. WI is also rightfully proud of the real-world success they obtained by modeling ambient air quality data collected for a partner agency and linking it with cancer and other adverse health risk details for a particular air pollutant emitted by a factory in the southeastern part of the state. Then, with the details of this connection, WI presented the results to the manufacturer with the recommendation that they reduce their emissions, which they agreed to do. Learning about this type of intervention first-hand showed what the potential benefit that such a network could bring to Indiana. The bottom line message here is that critical to making data-driven decisions will be establishing a network to share and analyze pertinent environmental public health data.

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Indiana Heat-Health Vulnerability

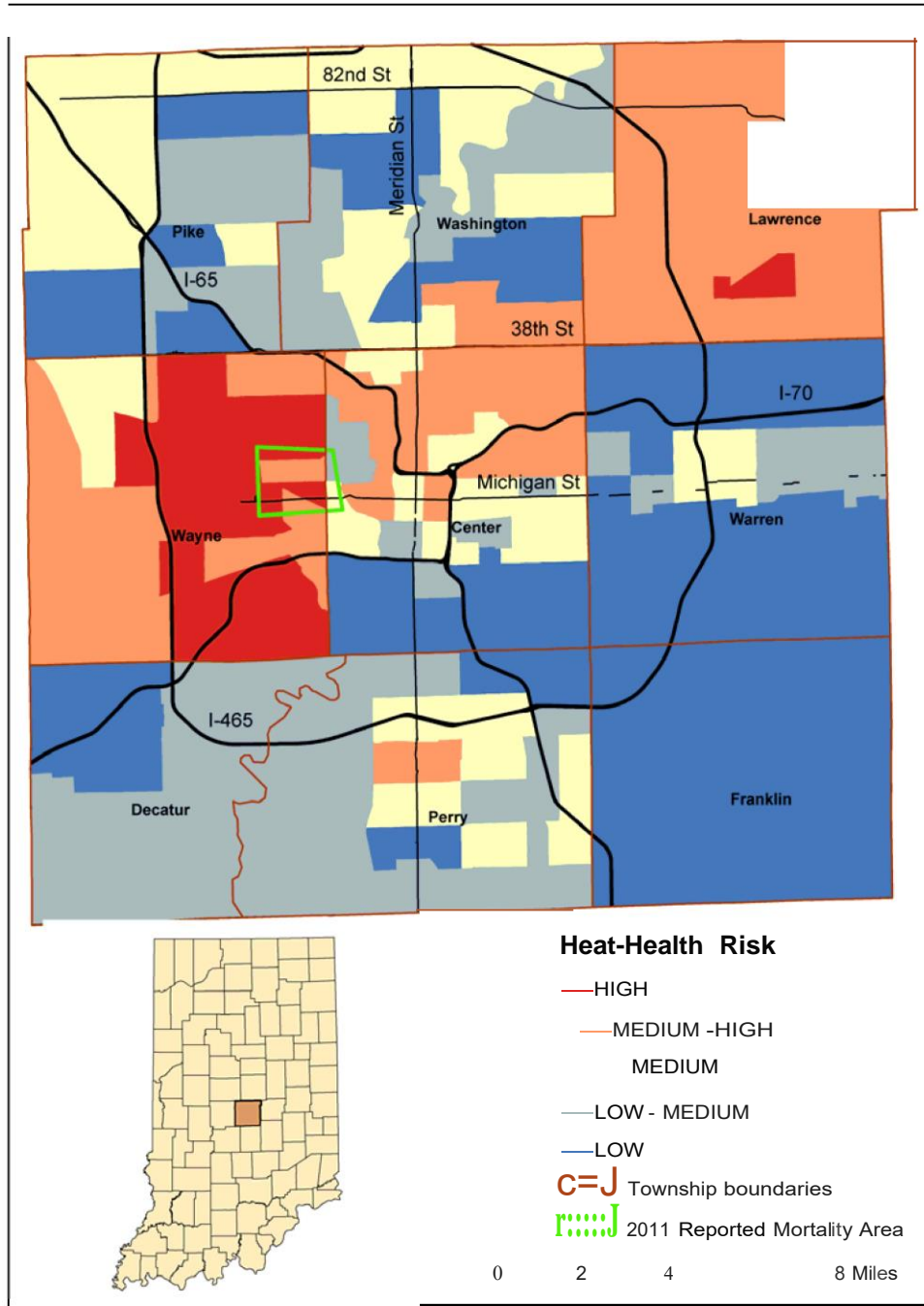


Socio-economic data retrieved from the 2000 Census

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Map 1: State-wide Heat-Health Vulnerability Map

Marion County Heat-Health Vulnerability



Socio-economic data retrieved from the 2000 Census
 MODIS composited imagery was acquired July 2009

Institute for Research on Social Issues
 IU school of Liberal Arts

Map 2: Heat-Health Vulnerability Map for Indianapolis, Marion County, Indiana

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