# Socioeconomics and Climate Change in the Great Lakes Region

Data Sources and Methods, *Updated* Spring 2015

This project was jointly developed by Headwaters Economics and Great Lakes Adaptation Assessment for Cities (GLAA-C) of the Graham Sustainability Institute at the University of Michigan.

## *Economy View*

### Map – Job Dependence on Climate-Vulnerable Sectors

*Why Is This Important?*

This map shows the relative job dependence at the county level on three sectors of the economy that may be affected by climate change: tourism, timber, and agriculture. For example, warmer winters may affect winter recreation, such as skiing; warmer summers and winters may increase the incidence of diseases and pests affecting the timber industry; and increased drought conditions may negatively affect agriculture. The details of the long-term trends in these three sectors are shown in the first figure. Other sectors, such as the shipping industry, may also be influenced by a changing climate. This map and Chart 1 show only three sectors for which published statistics are available.

*Methods:*

The relative dependence is shown as the aggregate percent of jobs in these three sectors, with the darkest color indicating the highest level of dependence.

*Resources:*

The software application used to gather data for the map and the first two figures are described under the descriptions for Chart 1 and Chart 2, below.

*Data Source:*

U.S. Department of Commerce. 2014. Census Bureau, County Business Patterns, Washington, D.C.; U.S. Department of Commerce. 2014. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA25 and CA25N.

### Chart 1 – What are employment trends in climate-vulnerable sectors?

*Why Is This Important?*

Some sectors of the economy may be more affected by climate change than others. This chart shows three components of the economy that could possibly be affected by climate change: tourism-related industries (including hotels, restaurants, and others); the timber (wood products manufacturing) industry; and farming (agriculture). We report employment data over time for sectors where long-term, county-level data is available from federal agencies. Because of lack of available data, we were unable to report the long-term trends for all sectors that could potentially be affected by climate change. This includes the shipping industry that may be affected by changing water levels.

*Methods:*

Tourism is defined as sectors that provide goods and services to visitors to the local economy, as well as to the local population. There is no single industrial classification for travel and tourism under the North American Industrial Classification System (NAICS). We therefore defined tourism as consisting of these sectors (identified by 3-digit NAICS codes in parenthesis): Components of Retail Trade: Gasoline Stations (447), Clothing and Accessory Stores (448), Miscellaneous Store Retailers (453; includes Gift, Novelty, and Souvenir). Components of Passenger Transportation: Air Transportation (481), Scenic and Sightseeing Transportation (487). Components of Arts, Entertainment, and Recreation: Performing Arts and Spectator Sports (711); Museums, Parks, and Historical Sites (712; includes National Parks, Conservation Areas); Amusement, Gambling, and Recreation (713; includes Golf Courses, Alpine and Cross Country Skiing Facilities). Components of Accommodation and Food: Accommodation (721; includes ski resorts, hotels, casino hotels, campgrounds, guest ranches), Food Services and Drinking Places (722). These data were compiled from the Census Bureau's County Business Patterns.

Timber is defined as lumber and the manufacturing of wood products and paper (NAICS 113, 1153, 3211, 3221, 3212, 3219, 3222, 325191, 337129, and 337211). While there are other components to the timber industry (e.g., logging and lumber transportation), wood products manufacturing trends are representative of the trends in the wood products industry as a whole. Timber employment data were also compiled from the Census Bureau's County Business Patterns.

Farming employment data are not available from the Census Bureau's County Business Patterns. Farm data were compiled from the Bureau of Economic Analysis' Regional Economic Information System (REIS). Since REIS does not provide enough detail to isolate "Tourism-Related" and "Timber-Related" jobs, we are showing variables from two sources on one chart. Because the data come from more than one source, the chart is not ideal for comparing the percent of jobs in one industry relative to the other two. The chart is appropriate for examining long term trends in each individual industry. [Note: job numbers for some sectors may not be visible due to data disclosure restrictions.]

*Resources:*

Detailed socioeconomic reports of communities, counties, states, and regions can be generated using a free software application called EPS that runs in Excel. The reports use published statistics from federal data sources, including the Bureau of Economic Analysis and Bureau of the Census, U.S. Department of Commerce; Bureau of Labor Statistics, U.S. Department of Labor; and others. The application is available for download at http://headwaterseconomics.org/tools/eps-hdt. The EPS application can be used to produce detailed county-level reports for the tourism, timber, and agriculture components of the economy.

*Data Source:*

U.S. Department of Commerce. 2014. Census Bureau, County Business Patterns, Washington, D.C.; U.S. Department of Commerce. 2014. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA25 and CA25N.

## CHART 2 – WHAT INDUSTRIES ARE CURRENTLY CONTRIBUTING THE MOST JOBS?

*Why Is This Important?*
This chart shows a detailed view of the share of jobs contributed by specific industries. Recent employment data (2001 to present) offers great detail, particularly with regard to services related industries. This is especially useful since in most geographies the majority of new job growth in recent years has taken place in services related industries, which encompass a wide variety of high and low-wage occupations ranging from jobs in accommodation and food services to professional and technical services. Mouse-over the chart to display industry-specific data.

*Methods:*
This chart describes the percent of employment in various industries. The data source used for this chart (Bureau of Economic Analysis, Regional Economic Information System) provides a useful overview of the economy since it includes industries in non-services, services, and government. However, this data source does not provide enough detail to isolate "Tourism-Related" and "Timber-Related" jobs, which are shown on Chart 1. [Note: job numbers for some sectors may not be visible due to data disclosure restrictions.]

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*Data Source:*
U.S. Department of Commerce. 2014. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA25N.

## CHART 3 – HOW HAVE CLIMATE-RELATED FACTORS CHANGED OVER TIME?

*Why Is This Important?*
The data displayed on this chart are relevant to recreation, agriculture, forestry and natural systems. Summer temperatures can have a wide array of impacts including energy use, ecological processes, and infrastructure design. Winter temperatures affect heating demand, vegetation resilience, snow depth, and are critical or constraining outbreaks of pests that impact timber and other industries.

The seasonal timing and year-to-year variability of precipitation strongly influences snowpack, flooding, water supply, and soil moisture, affecting socio-economic and natural systems throughout the Great Lakes region. Over time periods from 3 years to a decade, persistent dry periods are associated with widespread drought, which can be exacerbated when these periods occur together with warmer temperatures.

It is important to note that the 60-year time period considered here is short with regard to identifying longer-term changes, trends and variations in the climate system.

*Data Source:*
National Oceanic and Atmospheric Administration, Climatic Divisional Database, National Climatic Data Center. Available at: ftp.ncdc.noaa.gov/pub/data/cirs.

## *Infrastructure View*

### MAP 1 – INFRASTRUCTURE SPENDING BY LOCAL GOVERNMENT (PER CAPITA)

*Why Is This Important?*
Local governments are largely responsible for services and infrastructure that make communities more resilient to climate change, including basic infrastructure such as roads, water and sewer systems, emergency services, social services, land use planning and zoning regulation. Climate change may increase the need for local government expenditures in response to extreme events. Cities and counties will also require additional funds to plan for and implement adaptation actions over time.

Adaptation efforts at the local government level will require integrating climate change into existing services and infrastructure budgets and planning, and a shift toward fiscal policies that discourage activities that reduce adaptive capacity, and provide incentives to those that promote ecosystem resiliency. It is generally accepted that communities with fewer resources and a less robust planning culture are more vulnerable to climate change impacts. Measuring per capita spending on services and infrastructure associated with climate adaptation may be an early indicator of potential vulnerabilities and opportunities across the region.

*Methods:*
The map shows per capita local government expenditures on services and infrastructure associated with community resilience to climate change impacts and potential adaptive capacity. The U.S. Census of Governments is conducted every five years (years ending in '2' and '7'). A sample of state and local governments is used to collect data in the intervening years.

*Resources:*
The outcomes of the national recession, declining state and federal assistance to cities and counties, and growing fiscal austerity at the local level—for example due to the fiscal restrictions imposed taxation and expenditure limitations (TELs)—are stressing local fiscal capacity. Many states track local government fiscal health as a way of identifying fiscal crisis that may require state assistance. These resources provide a more detailed and state-specific characterization of fiscal capacity and health across the Great Lakes Region.

Haveman, Mark, and Terri Sexton. “Property Tax Assessment Limits: Lessons from Thirty Years of Experience.” Lincoln Institute of Land Policy (2008), http://www.lincolninst.edu/pubs/PubDetail.aspx?pubid=1412.

Adelaja, Soji, William Rustem,Gary Sands, Richard Jelier,Jeff Horner, Rex LaMore, Jason M. Mayland, Faron Supanich Goldner, and Amy Spray “State of Michigan Cities: An Index of Urban Prosperity.” Land

Policy Institute, Michigan State University (2007),
http://www.landpolicy.msu.edu/modules.php?name=Pages&sp_id=310.

Deller, Steven C., et al. "Do Tax and Expenditure Limits Hinder the Condition of Public Infrastructure? The Case of the Nation's System of Bridges." Public Works Management & Policy (2013).

*Data Source:*
U.S. Census of Governments, State and Local Government Finance. FY 2012.
http://www.census.gov/govs/.

## CHART 1 – WHAT ARE TRENDS IN INFRASTRUCTURE SPENDING BY LOCAL GOVERNMENT?

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U.S. Census of Governments, State and Local Government Finance. FY 2012.
http://www.census.gov/govs/.

## Chart 2 – What is the breakdown of land cover?

*Why Is This Important?*
The mix of land cover influences a range of socioeconomic and natural factors, including: potential and suitable economic activities, the potential for wildfire, the availability of different recreation opportunities, water storage, and other cultural and economic factors.

*Methods:*
NASA's MODIS Land Cover Type data was selected because it is publicly available across the globe and has a relatively small number of general classes that are easily summarized.

*Resources:*
For more socioeconomic information or to create a land-use profile for any county in the country, see the Economic Profile System-Human Dimensions Toolkit (EPS), free software developed by Headwaters Economics in cooperation with the U.S. Forest Service and the Bureau of Land Management: http://headwaterseconomics.org/tools/eps-hdt.

*Data Source:*
NASA MODIS Land Cover Type Yearly L3 Global 1km MOD12Q1, 2006.

## Chart 3 – How has population and residential development changed?

*Why Is This Important?*
Growth can benefit the local population, especially by providing economic opportunities, but it can also stress communities and natural resources. In the past decade, despite the downturn in the housing market, the conversion of open space and agricultural land to residential development has continued to occur at a rapid pace in many counties. The popularity of exurban lot sizes has exacerbated this trend (low density development results in a larger area of land converted to residential development). This pattern of development reflects a number of factors, including demographic trends, the increasingly "footloose" nature of economic activity, the availability and price of land, and preferences for homes on larger lots.

Land conversion to residential development can have many implications for conservation and land management. For example, human-wildlife conflicts and wildfire threats may become more serious issues. In addition, there may be new demands for recreation opportunities and concern about the commodity use of the landscape. Geographies with a large percent change in the area of residential development often have experienced significant in-migration from more urbanized areas. Counties with a small percent change either experienced little growth or were already highly urbanized in 2000.

*Methods:*
This chart shows the rate of growth in population and in the land area used for residential development. Areas with mean lot sizes smaller than 40 acres were considered residential. Lot sizes greater than 40 acres are more typical of working agricultural landscapes and were not considered residential. The data were derived from the Decennial Census.

*Resources:*
For more socioeconomic information or to create a land-use profile for any county in the country, see the Economic Profile System-Human Dimensions Toolkit (EPS), free software developed by Headwaters Economics in cooperation with the U.S. Forest Service and the Bureau of Land Management: http://headwaterseconomics.org/tools/eps-hdt.

*Data Source:*
Theobald, DM. 2013. Land use classes for ICLUS/SERGoM v2013. Unpublished report, Colorado State University.

U.S. Department of Commerce. 2014. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA30.

## *Vulnerable Populations View*

### Map 1 – Heat Vulnerability Index

*Why Is This Important?*
Heat waves can result in increased deaths and illness. Epidemiologic studies have identified population and community characteristics that mark vulnerability to heat waves. Due to climate change, concern over the link between heat and health risks is increasing. Vulnerability indices such as this once can be validated using health outcome data, and effectively used to target intervention at the most vulnerable populations.

*Methods:*
The heat index shown on this map was calculated by replicating methods described in the following peer-reviewed scientific paper: Reid C, O'Neill M, Gronlund C, Brines S, Brown D, et al. (2009) Mapping community determinants of heat vulnerability. Environ Health Perspect 117: 1730–1736.
The manuscript is available on-line: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2801183/.

The following variables were included in the Reid et al. (2009) heat vulnerability index:

1. Percent population below the poverty line
2. Percent population with less than a high school diploma
3. Percent population of a race other than white
4. Percent population living alone
5. Percent of total population who are ≥ 65 years of age
6. Percent population ≥ 65 of age who are living alone
7. Percent census tract area not covered in vegetation
8. Percent population ever diagnosed with diabetes
9. Percent households without central AC
10. Percent households without any AC

Whereas the paper used demographic variables from the 2000 Census, we collected these same variables from the 2010 Census' American Community Survey which summarizes average characteristics within the 5-year time period from 2006 to 2010. For our calculations, the percent of the county not covered in vegetation was derived from NASA MODIS 2006 imagery rather than 2001 NLCD imagery. We also updated the Diabetes prevalence data to the latest available year, 2007. Finally, we did not incorporate AC prevalence data from the U.S. Census Bureau's American Housing Survey because these data are only available for urban areas. Reid et al. (2009) found that the AC prevalence variables had a minimal affect on their estimates of heat vulnerability; i.e., when they calculated the vulnerability index without the AC variables overall changes were minimal with some decrease in vulnerability for the Pacific Coast and the Northeast.

The variables were used to calculate three factors using the weights shown in Table 4 of the Reid et al. (2009) paper. Whereas Table 4 shows four factors, one is predominantly driven by AC variables with no other variables contributing significant loadings on that factor. This factor was not included in our calculations since the AC variables were unavailable for rural counties. Following Reid et al.'s methods, the calculated factor scores were normalized to have a mean of 0 and a standard deviation of 1. Each factor was then divided into six categories based on standard deviations. Scores were assigned to each category, with 1 corresponding to the lowest vulnerability and 6 to the highest. These values were summed, creating a cumulative heat vulnerability index value for each county.

*Resources:*

- A summary of heat vulnerability: http://www.c2es.org/docUploads/ebi-social-vulnerability-risk.pdf
- Another summary of heat vulnerability that explains the connection with chronic health conditions further: http://www.cdc.gov/climateandhealth/effects/heat_related.htm
- The CDC health indicators mapping project, which includes data on vulnerability: http://ephtracking.cdc.gov/showIndicatorPages.action
- A summary of the economics of heat adaptation: http://ehp.niehs.nih.gov/1206025/

*Data Source:*

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The manuscript is available on-line: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2801183/.

Data sources used by Headwaters Economics to replicate the heat vulnerability index for Great Lakes counties include:
U.S. Department of Commerce. 2014. Census Bureau, American Community Survey Office, Washington, D.C.; NASA MODIS Land Cover Type Yearly L3 Global 1km MOD12Q1, 2006; Centers for Disease Control and Prevention. Diabetes Interactive Atlases Web site http://www.cdc.gov/diabetes/atlas/.

## Chart 1 – What are county characteristics that affect heat vulnerability?

*Why Is This Important?*
This chart shows the values for each of the variables used to calculate the heat vulnerability index:

1. Percent population below the poverty line
2. Percent population with less than a high school diploma
3. Percent population of a race other than white
4. Percent population living alone
5. Percent of total population who are ≥ 65 years of age
6. Percent population ≥ 65 of age who are living alone
7. Percent census tract area not covered in vegetation
8. Percent population ever diagnosed with diabetes

*Methods, Resources, and Data Sources*
See "Map 1 – Heat Vulnerability Index".

## Chart 2 – How do these county characteristics differ from their respective state's?

*Why Is This Important?*
This chart shows the difference in values between the county and it's respective state for each of the variables used to calculate the heat vulnerability index:

1. Percent population below the poverty line
2. Percent population with less than a high school diploma
3. Percent population of a race other than white
4. Percent population living alone
5. Percent of total population who are ≥ 65 years of age
6. Percent population ≥ 65 of age who are living alone
7. Percent census tract area not covered in vegetation
8. Percent population ever diagnosed with diabetes

For example, if 10 percent of individuals living in Brown County, WI are below the poverty line, and 15 percent of individuals living in the state of Wisconsin are below the poverty line, the chart will how -5 percent (i.e., that, when compared to the state of Wisconsin, Brown County, WI has 5% fewer individuals living in poverty).

*Methods, Resources, and Data Sources*
See "Map 1 – Heat Vulnerability Index."

## Chart 3 – How have summer temperatures changed over time?

*Why Is This Important?*
Summer temperatures determine energy use, affect human behavior, and impact ecological processes. This graph of average summer temperatures provides detail in the year-to-year change or variability of climate. Some counties exhibit multiple years in which temperatures were repeatedly warmer or colder than the average and some counties display a warming tendency over time.

*Data Source:*
National Oceanic and Atmospheric Administration, Climatic Divisional Database, National Climatic Data Center. Available at: ftp.ncdc.noaa.gov/pub/data/cirs.

## Contact

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