Geospatial Modeling of Asthma Population in Relation to Air Pollution
A Decision Support for Health Administration

KETHIREDDY, Swatantra R.[1], TCHOUNWOU, Paul B.[2], YOUNG, John H.[3], LUVALL, Jeffrey C.[4], AL-HAMDAN, Mohammad.[5]

[1]Environmental Science PhD Program, Jackson State University, 1400 JR Lynch St, Jackson, MS 39217. [2]Molecular Toxicology Research Laboratory, Jackson State University, 1400 JR Lynch St, Jackson, MS 39217. [3]Trent Lott Geospatial and Visualization Research Center, Jackson State University, 1230 Raymond Rd, Jackson, MS 39204. [4]Global Hydrology and Climate Center, NASA-Marshall Space Flight Center, 320 Sparkman Dr, Huntsville, AL 35805. [5]Universities Space Research Association, National Space Science and Technology Center, NASA Marshall Space Flight Center, 320 Sparkman Dr, Huntsville, AL 35805
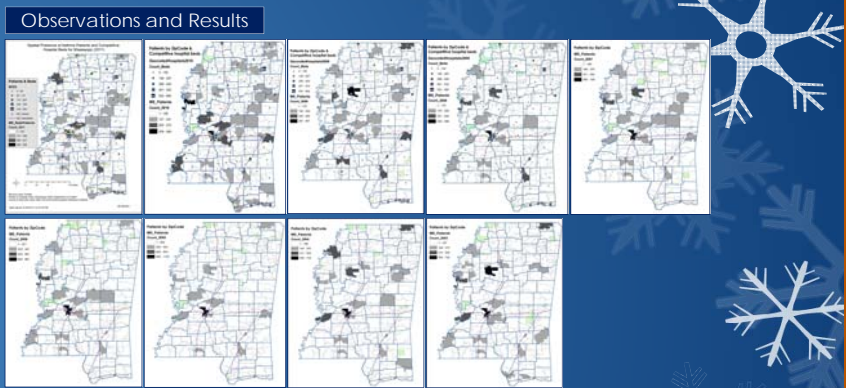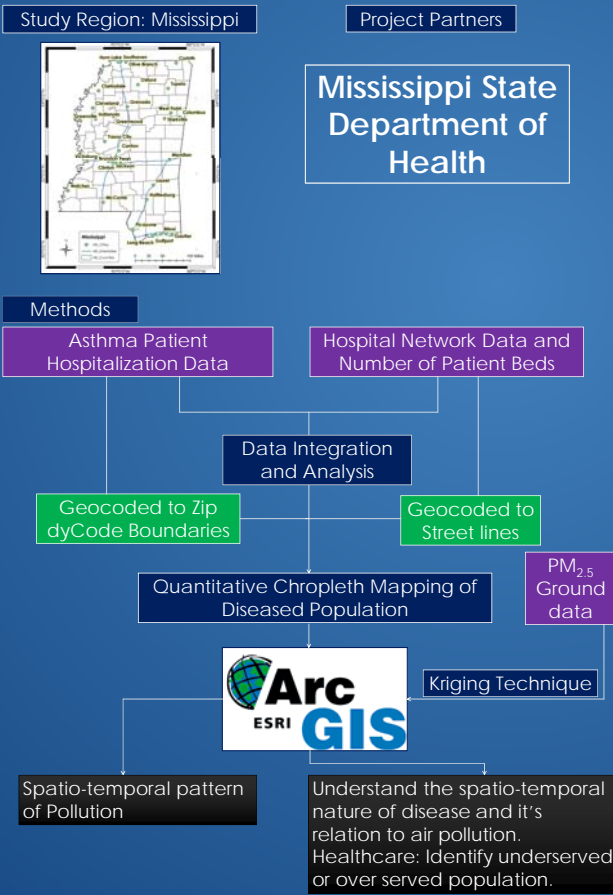
Abstract

Current observations indicate that asthma is growing every year in the United States, specific reasons for this are not well understood. This study stems from an ongoing research effort to investigate the spatio-temporal behavior of asthma and its relatedness to air pollution. The association between environmental variables such as air quality and asthma related health issues over Mississippi State are investigated using Geographic Information Systems (GIS) tools and applications. Health data concerning asthma obtained from Mississippi State Department of Health (MSDH) for 9-year period of 2003-2011, and data of air pollutant concentrations ($PM_{2.5}$) collected from USEPA web resources, and are analyzed geospatially to establish the impacts of air quality on human health specifically related to asthma. Disease mapping using geospatial techniques provides valuable insights into the spatial nature, variability, and association of asthma to air pollution. Asthma patient hospitalization data of Mississippi has been analyzed and mapped using quantitative Choropleth techniques in ArcGIS. Patients have been geocoded to their respective zip codes. Potential air pollutant sources of Interstate highways, Industries, and other land use data have been integrated in common geospatial platform to understand their adverse contribution on human health. Existing hospitals and emergency clinics are being injected into analysis to further understand their proximity and easy access to patient locations. At the current level of analysis and understanding, spatial distribution of Asthma is observed in the populations of Zip code regions in gulf coast, along the interstates of south, and in counties of Northeast Mississippi. It is also found that asthma is prevalent in most of the urban population. This GIS based project would be useful to make health risk assessment and provide information support to the administrators and decision makers for establishing satellite clinics in future.

Introduction

1. Asthma is a serious health and economic problem, it's an expensive disease. Costs the United States $56 billion each year (CDC, 2009).
2. It's increasing every year in United States.
3. A GIS based research conducted by Rob., 2003 has found that there is a good correlation between Asthma and poverty, they also found that inner city population have higher prevalence of Asthma than those live in suburb regions.
4. Foody, 2006 has pointed that the long term focus on disease surveillance is the identification of spatial clusters of disease, which is significant to plan and provide health care needs to a cluster of diseased population, he also said that time and space are important dimensions for health GIS studies.
5. Relationships between Disease and Environmental Factors: A critical review on public health and GIS ,Rushton., 2003 concludes that establishing relationships between disease rates and exposures to environmental factors is an area of increased interest in GIS and spatial analysis of health data.
6. Al-Hamdan et al., 2009 has estimated daily $PM_{2.5}$ levels combining both Moderate Resolution Imaging Spectroradiometer (MODIS) data and Environmental Protection Agency (EPA) ground data.

Main objectives for this research were ,(1) Identify the Asthma disease spatial clusters, (2)Identify promising areas for locating the satellite clinics,(3) Any number of patients are over served or underserved?, (4) Investigate the correlation between poverty and respiratory health of population, (5) Percent increase in air pollution lead to what percent increase in hospitalization.

Study Region: Mississippi

Project Partners

Mississippi State Department of Health

Methods

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Asthma Patient Hospitalization Data        Hospital Network Data and Number of Patient Beds
                     │                              │
                     └──────────┬───────────────────┘
                          Data Integration and Analysis
                     ┌──────────┴───────────────────┐
         Geocoded to Zip dyCode Boundaries     Geocoded to Street lines
                     │                              │
                                                  PM2.5 Ground data
         Quantitative Chropleth Mapping of Diseased Population
                     │
                   ArcGIS ESRI          Kriging Technique
                     │
Spatio-temporal pattern of Pollution    Understand the spatio-temporal nature of disease and it's relation to air pollution. Healthcare: Identify underserved or over served population.
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Observations and Results

Conclusions

- At any point of a year between 2003 -2011, zip code regions of Jackson urban area have at least 500 to 700 Asthma related hospital admissions, and this is the highest rate when compared to rest of state.
- Along with increase in population count, the spatial richness of Asthma is also increased in state over the years and can be inferred from above data.
- Asthma is observed in the populations of Zip code regions in gulf coast, along the interstates of south, and in counties of Northeast Mississippi. It is also found that asthma is prevalent in most of the urban population.
- This GIS based project would be useful to make health risk assessment and provide information support to the administrators and decision makers for establishing satellite clinics in future.

Future Work

1. Identify seasonal patterns in pollution and hospital admissions.
2. Establish a quantitative relationship between $PM_{2.5}$ and Asthma related Hospitalizations.
3. Find the underserved and over served clusters of diseased population.
4. Use remotely sensed data (MODIS AOD)to fill the gaps between ground monitors, and estimate the accurate levels of pollutant over study region

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Acknowledgements