Evaluation of the feasibility of integrating NASA imaging data for exposure estimation and assignment in air quality-asthma tracking efforts

Prepared by
Tulane University Center for Applied Public Health
Academic Partner of Excellence for Public Health Tracking

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Exposure estimation and assignment is one of the more difficult components to incorporate into the Environmental Public Health Network. A consistent theme in the EPHT Data Linkages Report, as well as in the scientific literature, pertains to the uncertainty introduced when assigning exposures to individuals or areas when limited hazard monitoring information is available. Limited ground-based monitoring sampling sites requires the estimation of hazard concentrations for unsampled locations, based on the observed values taken from these limited sites. While a number of techniques are available to estimate exposure, including the use of buffer zones, distance methods, Bayesian surface smoothing, and other interpolation techniques, the levels of uncertainty introduced by these methods need to be considered when interpreting the results.

One of the Tulane Academic Partner of Excellence EPHT projects, in conjunction with EPHT partners, was to examine the viability of incorporating NASA data into EPHT. Our goal was to assess the feasibility of integrating NASA imaging data into air quality-asthma tracking efforts. In conjunction, we proposed to evaluate the ability of NASA's moderate resolution air chemistry data to estimate air quality at unsampled locations with the aim of enhancing exposure estimation. In addition to validating interpolation methods against the NASA gold-standard, an assessment of its ease of use and cost was also planned.

Our partnership with NASA began with an invitation to attending a workshop in 2003 with CDC, NASA's Earth Science Enterprise, Public Health Applications Program, EPHTN grantees and ATSDR. The goal of the Public Health Applications Program is to apply NASA's unique ground, air- and space-based Earth science, technology and data assets to enhance the ability of public health decision support systems (e.g., disease surveillance and response systems) to predict and report trends in environmental risk factors and consequent public health outcomes. In other words, NASA's goal for integrating geospatial and public health data is to "represent" more accurately these environmental risk factors in terms of the *populations* potentially affected by them.

One of the objectives of the workshop was to exchange information and discuss partnership collaborations around the development EPHTN. This workshop started Tulane's collaboration with NASA to better define and understand priorities and requirements around specific environmental media. These meetings also refined our project goal of validating remotely sensed data; specifically ambient air quality, particulate matter, aerosols and pollutants. An additional outcome was to work with NASA scientists to identify specific sensors and sensor products that have the potential to be incorporated into EPHTN.

Our collaboration with NASA's Public Health Applications Program evolved over a series of conference calls to further develop common goals and objectives. This led to

a joint proposal in response to a Cooperative Agreement is to integrate NASA Earth science research results into partner-owned and operated decision-making tools and systems. The focus of the application was the transition of research results from NASA and other Earth science organizations to the public health community, such as Environmental Public Health Tracking.

Anticipated results from this proposed public health solutions network were to:

1. Identify, analyze, and understand collaborative interactions and effectiveness among earth science and public health organizations.
2. Assess the adequacy and applicability of earth observation data and earth science and technology to EPHTN.
3. Identify, prioritize, and disseminate appropriate earth science results that can be integrated to add value to public health tracking applications.

We specifically outlined three objectives to investigate:

1. Evaluate CDC requirements of the Environmental Public Health Tracking Network (EPHTN) for Earth system science results and technologies, and begin verifying these science results and technologies as potential EPHTN solutions.
2. Work to bridge the Earth science and public health research and practice communities' awareness and management of confidentiality issues in the use of geospatial data for public health purposes.
3. Develop and implement a collaborative plan to promote the use of remote sensing technology and Earth science results in public health research and practice with the public health academic and practice communities.

Since the focus of many of our EPHT projects center on cardio-respiratory conditions and air quality, we anticipated combining sensor data with ongoing air monitoring data for air pollutants. The projected outcomes were to determine how to use sensor data to better characterize exposures; design better exposure models incorporating sensor and environmental data; how to validate NASA data for use in EPHTN. Additional topics for demonstration projects included: characterization of pesticide/herbicide burden to determine long-term pesticide exposure and examining how NASA data could be used to fill in missing values in our Mississippi River Water Quality database.

Tulane staff spent time reviewing NASA's Atmospheric Composition Data and Information Services Center (ACDISC) portal to gain understanding of the sensor data. NASA has created a tool called Giovanni, Web-based application that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data. Additionally, the TOMS (Total Ozone Mapping Spectrometer) visualization tool was reviewed for its potential use in EPHTN. We enlisted the assistance of a NASA scientist to explain these tools and how they measure atmospheric composition. While the NASA Atmospheric Data holds great promise as a data source, the feasibility study showed that it will take extensive resources to implement. The type of data available requires a very high level of expertise to use and interpret. Specialized personnel would be needed to access, analyze and interpret the data in relation to other air monitoring data sources.

Furthermore, the computing technology needed for these analyses are not readily available outside of NASA and other agencies; the size and power of computing resources needed for storing and analyzing these data are beyond those available in agencies and most universities. Any projects using this data must be conducted in partnership with NASA scientists and use their large computing resources.

A proposal was written and submitted to advance such a partnership. A partnership composed of NASA Goddard Earth Sciences Data and Information Services Center, Department of Energy (DOE), Oak Ridge National Laboratory, US Department of Health and Human Services (DHHS), Secretary's Command Center (SCC), Tulane University, School of Public Health and Tropical Medicine, NASA Stennis Space Center, Public Health Applications Team, US Department of State, Humanitarian Information Unit (HIU) and US Department of Homeland Security, Federal Emergency management Agency (FEMA) was assembled and prepared a proposal to: 1) Evaluate the validity of NASA earth science observations in enhancing public health emergency preparedness and response decision support functions and demonstrate the assimilation resulting technical solutions using the DHHS Secretary's Command Center; and 2) Design and implement an innovative approach to evolve a sustainable network of organizations around the Earth science community-of-practice focused on public health emergency preparedness and response, and to "benchmark" the performance of NASA earth observations and predictions integrated into public health decision support tools among the network of users. Unfortunately the proposal was not funded.

In conclusion, NASA atmospheric composition data may have utility in enhancing exposure estimation and assignment for EPHT in the future. The complexity of the sensor data and learning how to use and interpret it is an activity that must be done in close collaboration with NASA scientists. Consideration also needs to given to personnel effort and financial support.