Addressing Wildfire Smoke Exposure and Vector Borne Disease Prevention Using Earth Observations

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EARTH OBSERVATIONS FOR THE SUSTAINABLE DEVELOPMENT GOALS

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Abstract

The Sustainable Development Goals (SDGs) are 17 ambitious goals for all State Members of the United Nations to reach by 2030. The ambitious nature of these SDGs requires new and innovative ways to address these issues. Goal 3 seeks to ensure the healthy lives and promote well-being for people at all ages. Two important targets for SDG 3 can be addressed by using remote sensing data: Target 3.3, which focuses on combating communicable diseases, and 3.9, which aims to reduce mortality from environmental pollution. This brief highlights the ways that end-users, such as Ministers of Health and Public Health Officials, can use Earth observation (EO) data to work towards eliminating communicable diseases and morbidity due to environmental pollution. Included are two case studies, one which looks at the benefits of using EO to address air pollution in Colorado, and another that considers EO applications to tackle malaria outbreaks in the Peruvian Amazon.

> "Countries have borders, Earth Observations don't."
>
> - Barbara Ryan, Director, Group on Earth Observations (GEO) Secretariat (2012-2018)

Introduction

The 2030 Agenda for Sustainable Development, created in 2015 by the United Nations documents 17 SDGs and 169 associated Targets. The 193 Member States, who agreed on the SDGs, are dedicated to taking the necessary measures to achieve these ambitious goals by 2030 through the use of domestic resources and international collaboration. Even though the SDGs are challenging, their achievement can help the UN Member States work towards a more resilient and sustainable world.

The UN Member States began the ambitious work towards a better world in 2000 with the creation of the Millennium Development Goals (MDGs). The MDGs focused on developing nations and social change. The SDGs include economic and environmental targets, as well as societal goals first addressed in the MDGs. The vast goals addressed in the SDGs require additional data and information to help achieve notable progress, including geospatial data and EO. The MDGs led to progress towards decreasing child and mother mortality, and turning the tide for the HIV, tuberculosis, and malaria epidemics globally.

In implementing the SDGs, a major challenge for governments is to enhance policy coherence and enable links across sectors, actors, and governance scales. EO can contribute to innovative and interdisciplinary approaches, harmonizing the interconnections among core elements of the 2030 Agenda. For example, EO can contribute toward prevention of infectious diseases by providing information regarding access to safe water and sanitation services. Health officials using EO can identify the types of conditions that correspond to a high malaria risk (i.e., high water levels, an environmental factor).

This brief highlights how EO can help predict outbreaks for communicable diseases, like malaria, cholera, and dengue fever, and help government officials take preventative measures to decrease the risk of outbreaks. It also highlights how EO-based models can help better understand air pollution and its effects on human health.

A satellite image of a wildfire in Colorado. Credit: NOAA

Why Use Earth Observations?

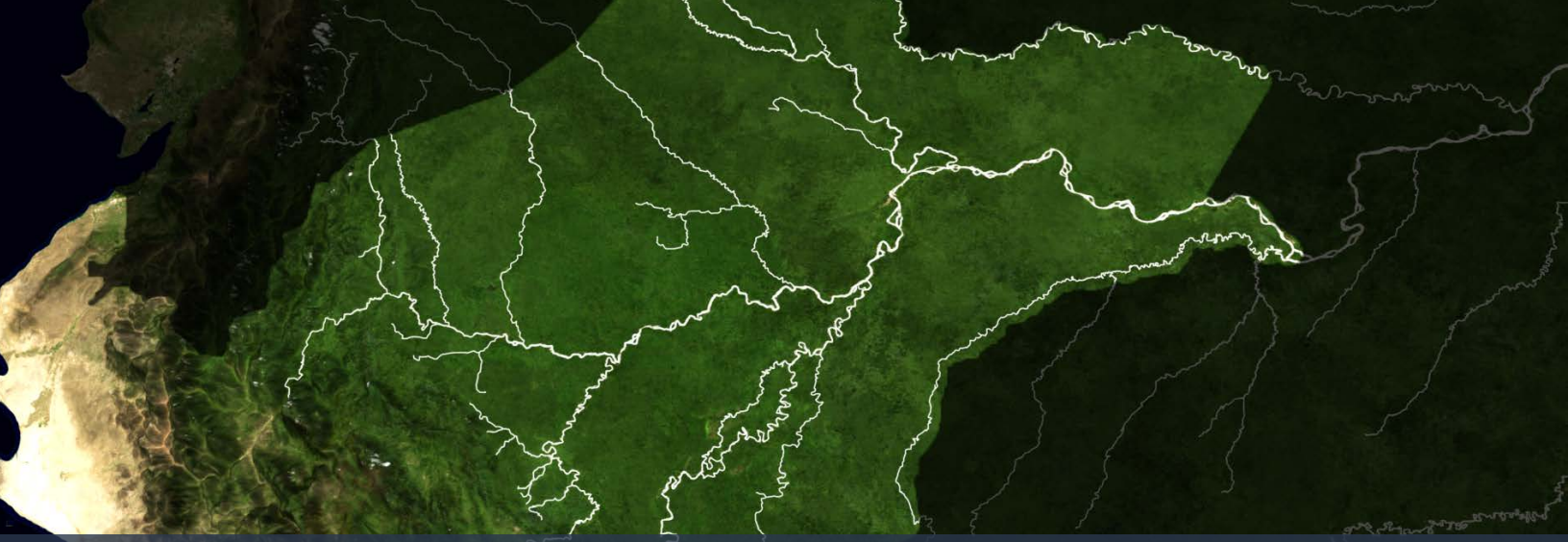
There are numerous benefits to using EO to address sustainable development issues, and ensure implementation and monitoring of the health-related SDG targets and indicators. EO are expansive, regular, cost-effective, and consistent over time and space. EO can be used to get global views of the Earth, providing the ability to monitor all aspects of our planet—from atmosphere and ocean to ice and land surface. Satellite imagery can be combined with auxiliary data on transmission of diseases like malaria to create predictive models and assist in the development of early warning systems. Since mosquito population and malaria incubation periods in vectors change with temperature and soil moisture conditions, satellite observations of seasonal climate can provide insights in changes of risk in epidemic-prone regions.

Clearing the Smoke

Colorado is among the handful of states in the Western United States afflicted by wildfire smoke. As associate professor at Colorado State University Dr. Jeffery Pierce says, “recently, smoke has become the dominant source of particulate matter, pollution, especially in the summer.” Thanks to regulatory measures in recent years, “industry and car emissions have drastically decreased.” However, frequency and intensity of wildfires have increased in the United States. Through his work, Dr. Pierce hopes to use EO to help health officials work towards reducing health impacts from environmental pollution.

During wildfire season, citizens of western states do not have access to accurate information about air quality, even when the location of a wildfire is known. Smoke shifts with the winds, meaning that even cities that are not in the direct path of the fire can experience high levels of smoke. This causes frustration for citizens, and health officials are trying to change that.

A NASA Applied Sciences-funded project on the health implications of smoke exposure focused on engaging with officials from the Colorado Department of Public Health and the Environment to create tools to help those affected by wildfire smoke exposure. A website created by the EPA, AirNOW, lists the asthma risks of exposure to smoke. This project also created a beta website



A map showing the rivers in the Peruvian Amazon and surrounding areas. Precipitation and other environmental conditions affect river height, which can impact the number of mosquito breeding along the banks.
Credit: NASA Scientific Visualization Studio (Visualizations by Cheng Zhang released on July 24, 2017)

for health agencies, providing a forecast with expected hospitalization rates based on smoke levels. Health agencies can use this information to warn the public when particulate matter pollution is high.

This project will give health officials the information needed to make policy decisions to benefit the health of their communities. Using the tools created by this project, health officials can inform the public when the air quality is too poor to go outside. The improved information about changing air quality due to wildfire smoke will allow the community to make changes to their behavior, limiting exposure to poor air quality levels.

New Ways to Track Malaria

In the Peruvian Amazon, malaria outbreaks are a major public health problem. As stated in a 2017 article by the NASA Scientific Visualization Studio, Peru had the second highest rate of malaria cases in South America from 2012-2017. Without accurate predictions of mosquito location, government health and other officials cannot make effective decisions to address outbreaks.

Accurate knowledge of situations conducive to malaria epidemics can improve resource allocation and assist in the reduction of malaria morbidity and mortality. Without such knowledge, resources can be wasted, and disease outbreaks may grow. It is difficult to predict where people are actually contracting malaria. This is caused in part by the difficulty of identifying the location of large amounts of mosquitos that transmit malaria in relation to the migratory seasonal workers that move along the river for work.

According to the World Health Organization, outdoor air pollution caused ~ 4.2 million deaths worldwide in 2016.

An image of a mosquito net over a bed, an example of the resources distributed to prevent malaria outbreaks. Credit: U.S. Peace Corps

A NASA-funded team of scientists led by Dr. William Pan, assistant professor at Duke University, has developed a multifaceted approach to the problem of malaria outbreaks in Peru. The scientists used the Land Data Assimilation System (LDAS)—a land-surface modeling effort supported by NASA and other organizations—to estimate environmental factors, such as precipitation, soil moisture, air temperature, and humidity, in an effort to prevent the spread of malaria in the region. Further, they employed a human population density model to estimate population at risk, and a statistical model to identify instances and areas where malaria cases had exceeded the predicted ones.

The Malaria Project aims to have long-term health impacts in Peru. Capacity building is always a major challenge. Pan and his team hold regular meetings every year with key end-users to guarantee that their inputs are incorporated into the project, and that they understand how the products can enable targeted interventions and control strategies, i.e., in the distribution of health resources (treatments, diagnostics etc.). For the sustainability of this product's use, Dr. Pan hopes to get the product on the Peruvian national budget so that it will have continuous funding after the project ends.

> **"One of the key challenges is better integration of geospatial and statistical information"**
>
> **- Wu Hongbo**

Conclusion

EO are extremely valuable in informing the development of health-related policies, and in improving the capacity to predict, respond, and decrease environmental-relevant, health risks. Highlighted through the projects led by Dr. Jeffrey Pierce and Dr. William Pan, EO, when integrated with auxiliary data sources, enable health officials and other relevant stakeholders to work towards a healthier society in innovative and expansive ways, by providing information necessary for decision-making, management of public health surveillance, and control of diseases.

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