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Geospatial Analysis in Impact Evaluation

Taking a closer look at impact from thousands of kilometres above the earth

Technology is constantly transforming our lives and the way we work, including in the field of global development. With recent rapid advancements in access to geospatial data and remote sensing (e.g. satellite imagery), and increasingly sophisticated methods to analyse them, we now have novel and innovative ways to evaluate intervention *impact* – that is, the changes in outcomes of interest that can be causally attributed to a specific intervention.

Over the past decade, there has been a growing focus on impact evaluation because of its potential to guide investments towards interventions that are most likely to work, to produce the largest benefits, to reach the most people and to do so at the lowest cost. The growing volume and availability of geospatial data, combined with improvements in the ways we analyse them, enables multiple improvements to impact evaluations: from making data collection more efficient to ensuring more rigorous quality control to increasing precision in existing data.

There is an increasing demand for **geospatial analysis in impact evaluation** (i.e. using geospatial data to measure the impacts of interventions, to improve quality control of ground surveys and more). For example, satellite and airborne imagery offer a unique, cost-effective resource for collecting a wide range of data. This type of data is gradually reducing the need to rely on data collected by means of less precise and more subjective methods, such as self-reports or enumerator observations.

Remotely sensed observations, in conjunction with other types of geospatial and non-geospatial data, can be used to accurately estimate the intended or unintended effects of policy interventions, whether positive (e.g. improvements in agriculture land productivity and food security, urbanisation, economic development or improved access to fresh water) or negative (e.g. deforestation, fragmented ecosystems, or air and water pollution) and their development outcomes.

Geospatial analytical techniques can be used to extrapolate survey data across space and time, providing a wide array of insights that would not have been available using conventional data collection methods.

Addressing important impact evaluation challenges and threats to validity

Enabling richer analysis of critical global issues

While geospatial analysis can enhance impact evaluations for a wide variety of topics, it is particularly valuable for interventions and/or outcomes that are detectable and measurable through remotely sensed observations. Once the data have been collected, these sources can be computationally processed and joined together to allow for the intervention, outcome and covariate information to align across spatial units.

Econometric tools can then be used to analyse these data while accounting for spatial uncertainty, spillovers and variation in effects. Economic evaluation can be used to compare intervention costs to outcomes and assess value for money. On-the-ground qualitative and quantitative methods for data collection are still required for context-informed analysis and conclusions.

Environment
Climate change adaptation, pollution control, water resource management, urban heat islands, natural disaster preparedness, etc.

Health
Infectious disease transmission, mosquito surveillance, food deserts, physical activity, demography, etc.

Agriculture
Crop productivity, deforestation, land use changes, etc.

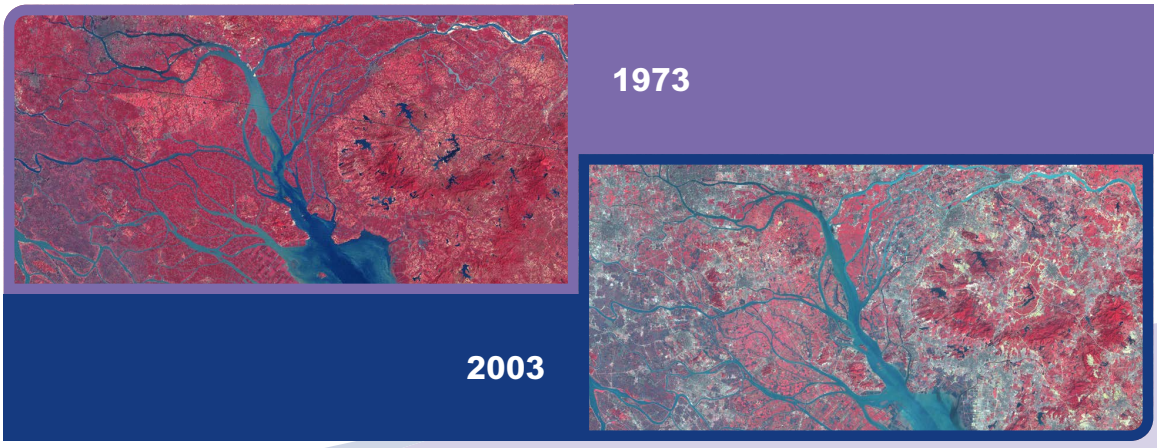
Infrastructure
Transportation networks, electrical grids, etc.

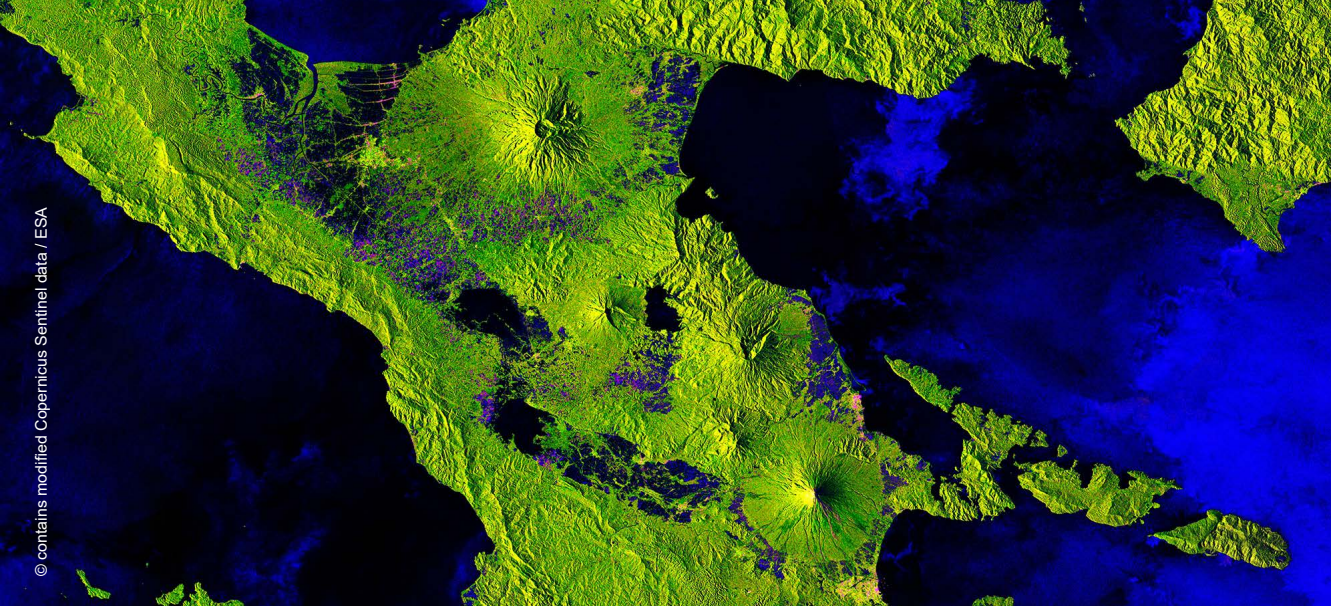
Several key advantages of geospatial data can help address common impact evaluation challenges and threats to validity. For instance, a growing number of satellites capture locations around the globe at ever-improving resolutions and wider range of frequencies. Many of these data sources are made available for free, making it possible to establish pre-intervention trends for certain types of variables (e.g. land use, forest cover) when baseline data are otherwise unavailable.

The geographic ubiquity of satellite-based measurements makes it possible to predict the values of some variables that would otherwise require on-the-ground data collection (e.g. crop yields, electricity access), reducing data collection time, cost and bias (e.g. response bias, recall bias).

The ability to identify and quantify spatial clustering of variables makes it possible to account for them in analyses, thereby enhancing causal inference retrospectively and prospectively. Being able to measure the spatial-temporal diffusion of disease, information and goods helps us to understand modes of transport and transmission.

Pearl River Delta, China





Illustrative table of geospatial solutions to address impact evaluation challenges

Impact evaluation challenge	Example	Threats	Geospatial solution	Benefits
Missing or inaccurate georeferenced information	Paper-based household surveys that lack location information	Collected data do not match sampling plan	Georeferencing for all survey data collected	Higher-quality data; enables spatial analysis; data mapping
Missing variables or measurement error in key variables that have a spatial component	Verbal or subjective reports of forest coverage and deforestation or agriculture land productivity	Error or bias issues with the variable or poor-quality data	Remotely sensed observations that capture relevant variables (intervention, outcome or covariate, retrospectively and prospectively)	Higher proportion of variation in data explained by the model; higher confidence in effect estimates
Small sample size (barriers to collecting large or sufficient sample data)	Limited data on livestock or animal husbandry (e.g. herd headcount) due to time and budget constraints	Insufficient sample size, biased data, etc.	Using satellite or airborne imagery to capture a wide range of variables of interest, also related to non-sampled population	Opens door to large-scale and more reliable study designs that otherwise would be prohibitively expensive or time-consuming
Drawing causal inferences about phenomena that vary in space and time	Limited understanding of potential effects of specific interventions related to disease transmission (e.g. COVID-19, Ebola), traffic patterns, etc.	Not feasible with traditional non-geospatial econometric methods	Gather and incorporate real-time geospatial data into dynamic models	New possibilities for drawing insights about complex phenomena, including pandemics

Collaboration between 3ie and NLT

The International Initiative for Impact Evaluation (3ie) is a leader in impact evaluation, with an emphasis on the use of theory and mixed methods to contextualise results. New Light Technologies (NLT) is a leader in geospatial data collection, management and analysis, including remote sensing and satellite imagery. 3ie and NLT have partnered to enhance the generation, use and transparency of geospatial analysis in impact evaluation, with an emphasis on informing development decision-making and strengthening research capacity in low- and middle-income countries.

3ie International Initiative for Impact Evaluation

NLT New Light Technologies

To learn more about how geospatial analysis can be integrated into impact evaluations, or to commission geospatial impact evaluations, contact data@3ieimpact.org or rs@nltgis.com.

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