Evaluating the Effects of Urban Expansion on Social and Environmental Vulnerability in Guatemala and Panama

ú



Abstract

Central America is experiencing rapid and unregulated urban expansion, which is contributing to an increase in socioeconomic and environmental risks including inequities in infrastructure and housing accessibility, biodiversity loss, vulnerability to natural disasters, and negative health outcomes. NASA DEVELOP, in partnership with NASA SERVIR, Sistema de la Integración Centroamericana (SICA), Secretariat of Central American Social Integration (SISCA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and Centro de Coordinación para la Prevención de los Desastres en América Central y República Dominicana (CEPRENEDAC), examined changes in urban extent, characterized roofing material type, and analyzed vulnerability within urban areas in two Central American cities, Guatemala City and Panama City. The team used Google Earth Engine's LandTrendr to map urban extent, and Earth observation data from Maxar Worldview to identify roofing material types. Socioeconomic and environmental data were used to assess vulnerability. Results depict how the two cities have expanded from 2000 to present day and highlight areas of greatest vulnerability within each urban area. The supervised classification of roofing materials performed well but could be improved with a few enhancements. Findings can help partner organizations improve monitoring of urbanization and inform their planning and decisionmaking while prioritizing disaster prevention, public health, and environmental integrity. Additionally, these case studies can be used to inform future, similar work elsewhere in Central America to aid in understanding urbanization and its associated challenges.

Earth Observations



Study Area

The study area includes Guatemala City and Panama City throughout the years 2000-2022.



Objectives

- Analyze and map the rate of urban expansion in Guatemala City and Panama City using GEE's LandTrendr algorithm
- **Develop** a methodology to identify infrastructure vulnerability to natural disasters by analyzing roofing materials
- Evaluate social, economic, and ecological vulnerabilities using Earth observations and remote sensing data sets with the goal of improving local policy maker's decision-making

Methodology

Urban Extent Maps



Roof Materials Classification



Vulnerability Assessment

Cumulative vulnerability based on four-equally weighted factors: steepness of slope, presence of electricity, total population density, and elderly population density



Team Members





Aaron

Whittemore

Jennifer Ruiz Project Lead





Coral del Mar Valle Rodríguez

Maxar-imagery-derived roof classifications overlaid on Esri basemap image

Conclusions

- Guatemala City has expanded outward and become denser since 2000. Panama City has also expanded, but not at the same rate as Guatemala City.
- Greatest vulnerability in Guatemala City and Panama City was found to be in the northern and northwestern parts, respectively.
- Supervised classification of roofing materials performed well but could be improved with a few future enhancements.

Project Partners

- NASA SERVIR Science Coordination Office
- Centro de Coordinación para la Prevención de los Desastres en América Central y la República Dominicana (CEPREDENAC)
- Sistema de la Integración Centroamericana
- Secretariat of Central American Social Integration
- Deutsche Gesellschaft f
 ür Internationale Zusammenarbeit

Acknowledgements

We'd like to thank our project partners, advisors, and Node Fellow for their guidance.

- Lauren Carey
- Eric Anderson
- Ronan Lucey
- Ricardo Quiroga
- Dr. Emil Cherrington

Dr. Robert Griffin

Dr. Jeffrey Luvall

Brianne Kendall

Betzy Hernández

- Jorge Cabrera
- Yanira Quiteño
- Dr. Abner Jiménez
- Claudia Herrera





This material is based upon work supported by NASA through contract NNL16AA05C. Any mention of a co. nercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organization

DigitalGlobe/Maxar data were provided by NASA's Commercial Archive Data for NASA investigators (cad4nasa.gsfc.nasa.gov) under the National Geospatial-Intelligence Agency's NextView license agreement.