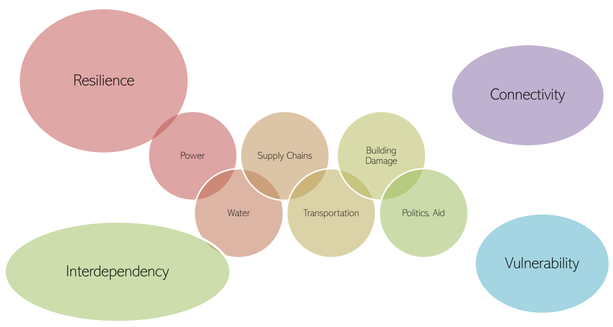
Applications of the Global Economic Disruption Index (GEDI) in Multi-Hazard Disaster Response, Mitigation, and Planning

Shubharoop Ghosh, Marina T. Mendoza, Paul Amyx, ZhengHui Hu, Michael Eguchi, and Charles K. Huyck of ImageCat, Inc., and Greg Yetman of The Center for International Earth Science Information Network (CIESIN)

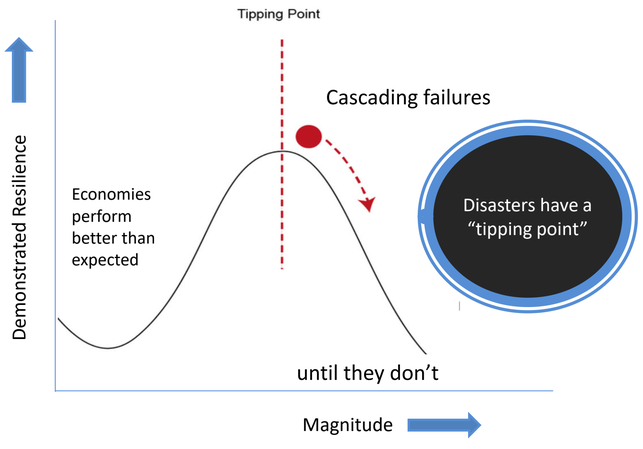
A Challenge

Risk models fail to answer: "How long will it take to get back to normal?" Emergency managers, businesses, and the general public need an effective, simple metric to communicate potential economic disruption and restoration. The lack of a clear way to communicate overall impact has led to an underutilization of risk management technologies for early warning and disaster response as well as for the development of adaptation/mitigation strategies for climate change.



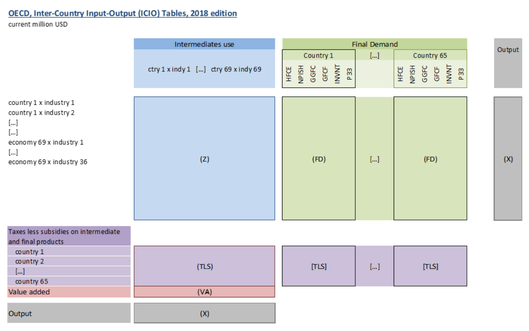
The Moonshot

Google defines a moonshot as a project that address a huge problem by proposing a radical solution using breakthrough technology. A novel approach of predicting economic impact from Earth Observation (EO), CAT models, and economic modeling was envisioned as a potential way to bypass the complexity of traditional modeling technologies and provide a simple index for widespread use. A GEO Google Earth Engine award and support from the NASA Disasters program provided an opportunity to explore the innovative hypothesis using cloud-based EO technologies (grant# NH18ZDA001N001N).



Economic Modeling: I-O Analysis

Economic data source: OECD Inter-Country I-O Tables
64 countries (others included as rest of the world, "ROW")
19 sectors considered
Taylor expansion of I-O model (Rose & Wei, 2013) to propagate impacts to sectors in all countries



The Index

	Description	Economic Disruption	Scale of Disruption	Possible impacts to Critical Infrastructure
I	Slight	Rapid restoration on the order of a few hours to a few days expected	Minimal interruption to most economic activities and no long-term impact..	Intermittent interruption in power and communications
II	Moderate	Economic activities typically resume in less than a week	Minimal long-term impact..	Short term disruption of essential services such as water, power, and communication.
III	Major	Economic activities are likely to rebound on the order of weeks, with occasional dire consequences to vulnerable small businesses.	Interruption in services expected to primarily affect the local economy.	Major damage to one or more of the following is to be expected: the electrical supply, water supply, internet access, sanitation, or the fuel supply
IV	Severe	Economic rebound expected after months of restoration.	Significant economic impact to local retail and small businesses. Economic effects will extend beyond the local economy. Regional economic consequences are to be expected and may affect national GDP.	Widespread power outages effect large regions of the population- potentially for weeks. Disruption in essential services impedes recovery. Manufacturing and/or transportation disrupted on the order of months.
V	Catastrophic	Major disruption in economic activity requires years of recovery. Regional economic consequences are widespread and may significantly affect national GDP in some countries.	Widespread exodus of businesses and small business closure. Local economy likely to recover to "new normal" with diminished activity.	Severe disruption to infrastructure and basic services will result in migration of a significant portion of the population. Transportation corridors, ports, power plants, sub stations, and manufacturing expected to experience long term outage.

Applications with GEM Data

GEDI does not include any hazard modeling technologies within the framework itself. Wind fields, flood depths, or earthquake ground motions are loaded into GEDI, and are generally developed by partners, research institutions or government agencies, including the GEM earthquake catalog. Partners like GEM are critical for modeling a GEDI Exceedance Probability curve for pricing parametric insurance products or for understanding the economic risk to a given sector by area.

Mean Hazard on Rock 500-year RP

Mean Hazard on Rock 2500-year RP

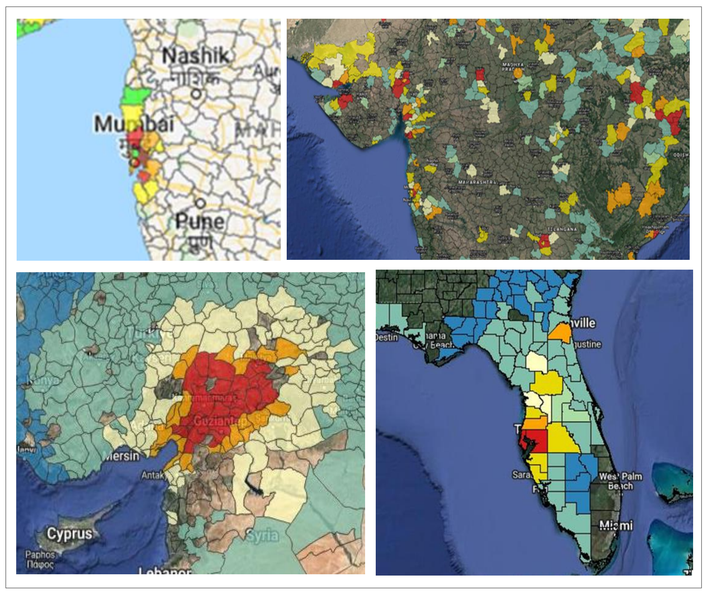
Figure showing GEM's gridded return period hazard curves utilized in the GEDI framework to identify vulnerable infrastructure that could trigger cascading impacts in Tunisia.

Applications include:
1) Realistic Disaster Scenarios (RDSs)
2) Identification of accidents waiting to happen
3) Parametric triggers for insurance products
4) Regulatory disclosure and ESG (TCFD and SEC)
5) Regional Resilience Assessments
6) Expansion of BCA to include community impacts for equity

Partnership with GEM

ImageCat has partnered with GEM to offer GEM's global seismic hazard information through ImageCat's multi-hazard risk management decision support platforms Inhance® and FacFinder. GEM is a global public-private partnership and non-profit foundation that develops and disseminates open data, models, and tools to assess earthquake risk and promote earthquake resilience worldwide. GEM provides high quality global seismic hazard data and risk products that are key for ImageCat's platform clients in the commercial and public sectors. Clients managing catastrophe risk benefit tremendously from this partnership by accessing seismic hazard, exposure and risk information as well technology tools to solve exposure management and underwriting problems.

Results



GEDI produces a disruption index with hazard data representing:

Scenarios

- the ShakeMap scenario catalog
- Dam Inundation scenarios

Probabilistic return

- Los Angeles 475-year event - GEDI IV
- Los Angeles 2,475-year event - GEDI V
- 100-year floods in India (top right)

Actual events

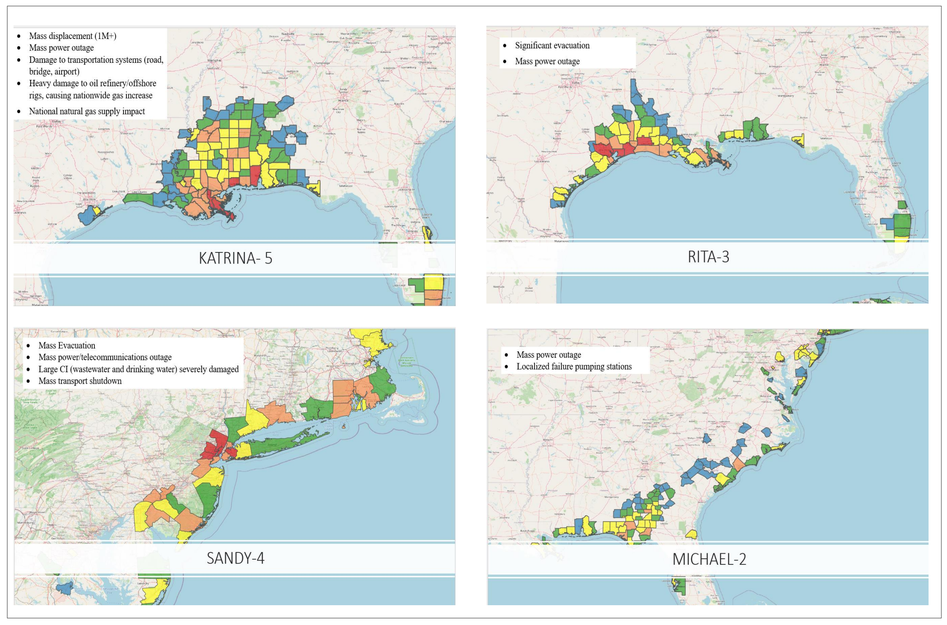
- Hurricane Ian- GEDI II (bottom right)
- The Mw 7.8 Turkey/Syria- GEDI V (bottom left)
- Hurricane Katrina- GEDI V

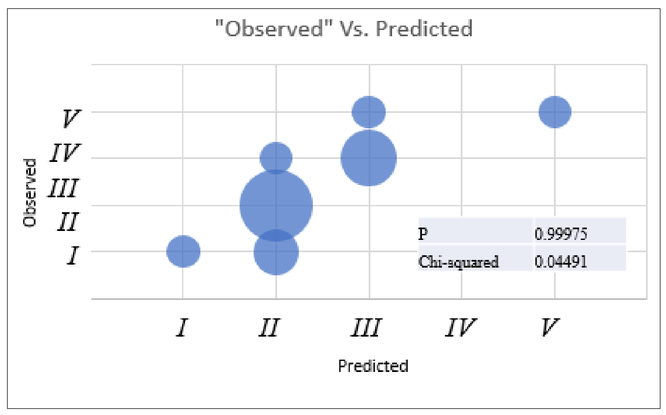
Climate conditioned events

- Sea Level Rise and coastal hazards to Western India (RCP 8.5, 2050) (top left)

Validation

The maps below illustrate that GEDI can be provided by an EO-based economic modeling platform. The results provide a more intuitive basis for decision making, for example Katrina registers as a 5 on the GEDI scale, whereas the event made landfall as a CAT 2 hurricane on the Saffir-Simpson Scale, arguably downplaying the potential severity.





GEDI was tested with US hurricane hazard data provided by Kinetic Analysis Corporation for major events in the historic catalog and independently determined GEDI classifications gleaned from the historic record. The model correctly predicted the observed GEDI classifications with a maximum difference between predicted and observed of one increment and a correlation coefficient of 0.8.

Example Workflow and Output Delivery

GEDI applications and workflows are being developed for multiple hazards including earthquake, flood, hurricane wind and surge. We envision GEDI results will be delivered through various online platforms including Inhance.