GEO brought together world leading cloud service and geospatial players to help low- and middle-income countries.

This was only possible because of an inclusive approach to support countries irrespective of geography, technology or vendor solutions.
2019
17 COUNTRIES
$1.5m
+ $1m cap dev

2020
32 COUNTRIES
$3m
+ $1.5m cap dev

2021
18 COUNTRIES
$3m (50% cash)
+$1m cap dev
Thanks for the credits, but how do I set up an account?

OK now I have an account now, but how do I access the credits now?

Right, I’m in! But how do I integrate the credits into my own systems?
Programme experience: success

“Access to AWS cloud infrastructure and services is critical because our institutional capabilities do not allow us to host and administer the necessary environment on our own.”

Illegal amber mining monitoring project, Ukraine
Programme experience: success

“The GEO-GEE funding will enable us deliver a system that can be used to monitor forests as part of natural resources management, monitor urbanization for better planning and monitor floods/landslides in support of disaster management.”

Kenya Space Agency
“Thanks to GEO-GEE funding and training, we now have a team capable of developing and implementing advanced geospatial analytical methods that utilise world leading technology, ensuring we can have maximum social impact.”

Vulnerable settlements projects, Mexico
Sustainability aspects

More credits

New funding

GEO work programme

Other resources
GEO4NAPS

Measuring adaptation with remotely sensed data products

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Allison Lassiter, University of Pennsylvania, PA, USA
Sosten Chiotha, Leadership for Environment and Development, Southern and Eastern Africa, Zomba, Malawi
David Stevens, Independent Scientist, Vienna, Austria
Tristan Grupp, University of Pennsylvania, PA, USA
1. **Identify core sets of indicators for measuring adaptation**
   - Literature review of indicators and definitions of adaptation
   - Geospatial data downloads and database construction
   - Field visits and consultation meetings with the NAP team, local experts and other stakeholders as the pilot country and user community seek input on main adaptation risks, needs, current interventions, and indicators/metrics and methods (visit conducted in July 2022)

2. **Apply the measurement method** to Malawi
   - Develop method for measuring adaptation, focusing on Malawi
   - Update the analysis based on feedback

3. **Scale up** the measurement method to other LDCs
1. Background on adaptation indicators
2. Approach to measuring adaptation
3. SURVEY: Choosing adaptation indicators
4. SURVEY: What is the right spatial aggregation?
5. SURVEY: What is the right temporal aggregation?
6. Implementing the proposed method
7. Open discussion
8. Conclusion
1. Background on adaptation indicators
Context

• Adaptation plans are receiving more investment and attention. Progress toward adaptation is limited to countries self-reporting to UNFCCC.

• Self-reporting is often based on inputs and processes, not evidence of effective adaptation outputs.

• Are there ways to measure adaptation outcomes?
Adaptation metrics under the UNFCCC over time

**Figure 1.** Evolution of functional needs of adaptation metrics over time in relation to the UNFCCC process

- **1992 UNFCCC**: LDC Fund, SCCF, Adaptation Fund
  - Financial support for particularly vulnerable developing countries

- **2001**: Results-based management of funds
  - Accountability of projects

- **2011 Cancun Adaptation Framework**: National adaptation plans, including monitoring and reviewing of efforts undertaken

- **2015 Paris Agreement**: Global goal on adaptation

- **2023 Global Stocktake**: Adequacy and effectiveness of adaptation and support, progress towards the goal

Source: Möhner 2018
Literature review: ideas on measuring adaptation

• “How can we measure, aggregate and compare climate change adaptation needs and results across activities, countries and sectors?” (Christensen, Martinez, Naswa, 2018)

• Challenges and opportunities in measuring adaptation with metrics (Leiter and Pringle, 2018)
  • Difficulties of defining "adaptation“ and the “dependent variable problem”
  • absence of systematically collected data on adaptation actions and outcomes
  • Mismatch between the timescale over which adaptation plays out and the practical need for evaluation to inform policy
  • Studies remain overly narrow in thematic and geographic scope
  • Limited use of satellite data as a basis to obtain aggregate indicators and impacts of adaptation
  • Inadequate integrative research designs to capture aggregate impacts of adaptation interventions
Major lessons from national and sub-national experiences

• Maintain a clear picture of desired changes and outcomes and the causal
  pathway to achieve them

• Adapt indicators and metrics to local realities and to contextualize the
  results

• Stakeholder engagement is crucial: participatory discussions on metrics

Sources: IIED, 2014; Owens, 2010
Measuring adaptation

• Is it possible to use earth observation to observe evidence of adaptation?

• An evidence-based approach that leverages globally available remote sensing data products and earth observations has the potential to overcome existing hurdles:
  
  • Unclear outcomes or definitions of adaptation → define adaptation
  
  • Overly locally specific definitions of adaptation (not generalizable) → define indicators applicable to many contexts
  
  • Overly broad measures (not location-specific) → measure adaptation outcomes with high-resolution, local data
How do we know we’ve observed adaptation? What are the desired changes and outcomes?

- Which adaptation outcomes can we observe with aerial imagery?
  - Reduce risk and vulnerability
  - Enhance social well being
  - Improve environment
  - Increase economic resources
  - Strengthen institutions

- Some outcomes are directly visible, some may be indirectly visible, and some may be very challenging to perceive
Since the early 1990’s, farmers in Niger have re-greened approximately 5 million hectares of degraded land, an area the size of Costa Rica. This has increased crop yields, soil fertility, as well as sequestered carbon.

THE SAHEL REVOLUTION
INDIGENOUS TECHNICAL KNOWLEDGE

• Smaller-scale traditional practices to improve water scarcity and heat management

• May be able to indirectly observe because the community is more prepared to withstand greater environment conditions
  • i.e., even with heat, the acres of cropland persists

Some adaptations are difficult to observe directly in imagery

Source: Grant, 2015
Questions for today

• Which indicators can/should we observe over time to track adaptation outcomes?

• What is the best spatial resolution for evaluating these indicators to measure adaptation outcomes?
  • Sub-district, district, national, multi-national

• What is the best temporal resolution for evaluating these indicators to measure adaptation outcomes?
  • Daily, monthly, seasonally, annually
2. Approach to measuring adaptation
A location is adapted if it has stable or improving biophysical and socioeconomic conditions, regardless of climate stress.

1. For this to be true, a place that is adapted can withstand or recover from extreme events: there is no observed change to the system, regardless of climate stress.

2. Conversely, a place that is not adapted shows declining conditions after an extreme event: systems decline in response to climate stress.
Do extreme events (heat, drought, flood) lead to changes in biophysical and socioeconomic responses represented by available data products?

1. Create a database of extreme events
2. Identify how indicators change after the extreme event
3. What are the best spatial and temporal resolutions for measuring change?
Change in land cover after an extreme event

Devastation of Hurricane Maria to Puerto Rican Landscape

by C. Zhang   1 February 2021
Categorizes land cover daily with 10 meter resolution
Daily landcover change in Okavango, Botswana
Change in luminosity (nighttime lights) -- available approximately every 2 weeks, 30 meter resolution

3. Choosing adaptation indicators
Indicators from Earth Observations

1. What are earth observations?
   • They are data related to activity on the earth’s surface
   • This data can be collected through satellites, on the ground sensors, geolocated surveying, citizen/local participation with recorded latitude/longitudes, and more

2. Why have we chosen earth observations as the basis for the indicators?
   • Many high-quality earth observations are available globally, allowing for standard models and frameworks of measuring adaptation
   • Global availability allows comparison of models across countries and regions
   • They are related to a location, so can be tied to other data such as country administrative boundaries or the location of disasters and more data
A location is adapted if it has stable or improving biophysical and socioeconomic conditions, regardless of climate stress

1. Biophysical
   - Water
   - Land
   - Biodiversity

2. Socioeconomic
   - Water
   - Land
   - Human health
   - Energy access
   - Economic and community stability
<table>
<thead>
<tr>
<th>Water</th>
<th>Land</th>
<th>Human Well-being</th>
<th>Biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water area</td>
<td>Cropland area</td>
<td>Electricity access</td>
<td>Forested area patch size</td>
</tr>
<tr>
<td>Groundwater availability</td>
<td>Number of crops growing per year</td>
<td>Road access</td>
<td>Wetland area</td>
</tr>
<tr>
<td>Snow/ice area</td>
<td>Crop productivity (net primary productivity)</td>
<td>Share of paved roads</td>
<td>Surface water greenness</td>
</tr>
<tr>
<td></td>
<td>Soil moisture</td>
<td>Road within floodplain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Built area (buildings, roads)</td>
<td>Built area within floodplain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forested area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inundated (flooded) land area</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial indicators of biophysical and socioeconomic adaptation over time.
Survey on adaptation indicators
4. What is the right spatial aggregation?
Spatial Aggregation

• What is the most appropriate spatial aggregation?
  • District
  • National
  • Regional

• Is a certain spatial scale more appropriate than another depending on the shock or the indicator?

• Aggregating disasters by maximum/minimum values or means over spatial scales

• Capturing disaster exposure?
Spatial Aggregation - High Temperature

National

District

Sub-District

2020
These images show the maximum pixel value within each spatial unit, or the largest observed number of hot days in each geography for one year.
Spatial Aggregation - High Temperature

These images show the mean pixel value within each spatial unit, or the mean number of hot days in each geography for one year.

- **National**: max range: 98, mean range: 33
- **District**: max range: 1-98, mean range: 0-67
- **Sub-District**: max range: 0-98, mean range: 0-73
These images show the maximum pixel value within each spatial unit, or the largest observed number of heavy rainfall days in each geography for one year.
For particular indicators or disasters, are they best understood in terms of exposure?

This map shows city extents in Malawi.

Does an urban spatial aggregation work better to capture certain responses to disaster?
Spatial Aggregation

• What is the most appropriate spatial aggregation?
  • National
  • District
  • Sub-District

• Assessing disasters in terms of maximum/minimum values or means over spatial scales
5. What is the right temporal aggregation?
Temporal Aggregation

• Slow onset change

• What is the most appropriate temporal resolution?
  • Hourly
  • Daily
  • Monthly
  • Seasonally or Yearly

• Is a certain temporal scale more appropriate than another depending on the shock?

• Methods of identifying events: clusters, consecutive events, yearly/seasonal sums
Temporal Aggregation: Slow Onset Change

Our modeling for disasters look at climatic shocks within a year.

Before we begin discussing within-year dynamics, we would like to call attention to the fact that slow onset change is occurring alongside climatic shocks.

Response to a series of very hot days is more easy to measure. There is a single observable event.

Slow onset change is a more complex process to measure a response. It is nevertheless a shock that needs to be adapted to.
Temporal Aggregation: Daily

- Flooding: Single Events
Temporal Aggregation: Daily

- Flooding: Single Events
Temporal Aggregation: Monthly

• Flooding: Clusters of High Precipitation Days
Temporal Aggregation: Monthly

- Flooding: Clusters of High Precipitation Days
Temporal Aggregation

Drought: Count of Dry Days in a Growing Season

National Level, Count of Dry Days in a Growing Season

- Year
- Count of Days

Not an Outlier
Outlier
Temporal Aggregation

Malawi National: Sum of Dry Days in a Year (2000-2022)

- Drought: Count of Dry Days Yearly
6. Implementing the proposed method
Shock and Response

- Each dot represents a geographic unit (district, sub-district)
- All orange dots represent a potential disaster
Shock and Response

Identify disasters in database
Shock and Response

Identify disasters in database

![Graph showing count of days vs. year with outliers marked]
Shock and Response

Identify disasters in database

Determine Response in that Area

Count of Days

Year

Outlier
False
True

Indicator Value

Time
Shock and Response

Identify disasters in database

Determine Response in that Area

Not adapted:
Shock and Response

Identify disasters in database

Determine Response in that Area

Not adapted:

Adapted:
Identify disasters in database

Determine Response in that Area

Not adapted:

Adapted:
Shock and Response

Identify disasters in database

Determine Response in that Area

- Not adapted:
  - Indicator Value
  - Time

- Adapted:
  - Indicator Value
  - Time
7. Open discussion
Open Discussion - Share Experience

1. How have you used available “Earth Observations” in your climate change work? Not only in adaptation but also in Mitigation and perhaps now Loss and Damage

2. Reflecting on what was presented in this session, what support do you need from your country to successfully incorporate and use earth observations data to monitor adaptation? Would you consider applying this method to evaluate your NAP performance?
8. Conclusion
Survey on adaptation indicators
• Grant Program: GEO-Microsoft Planetary Computer Credits Program

• Funder: Group on Earth Observations (GEO) partnering with the World Meteorological Society (WMO)