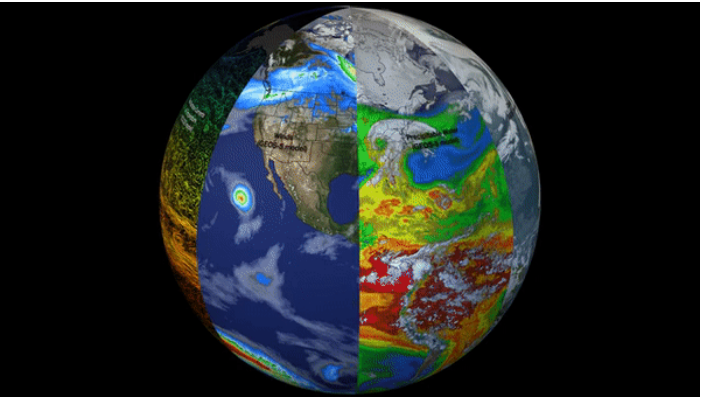

Building Digital Skills with Geospatial Technologies

Nagaraja Rao Harshadeep (Harsh)
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harsh@worldbank.org

THE WORLD BANK
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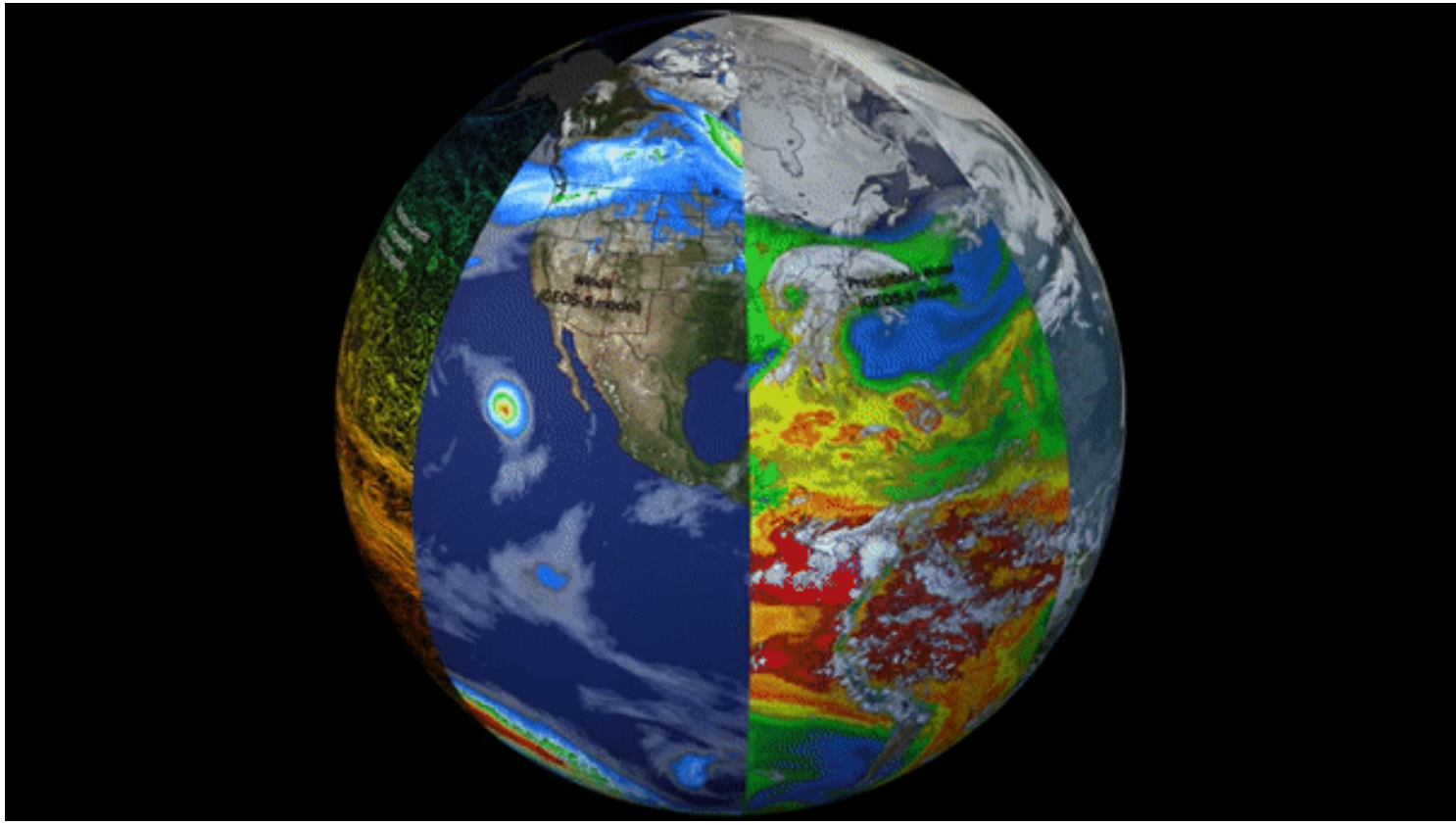
Leading-Edge Insights (LEI) Series

AfDB

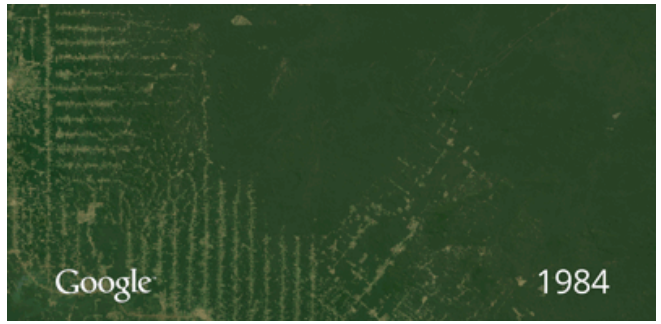
Jul 24, 2025

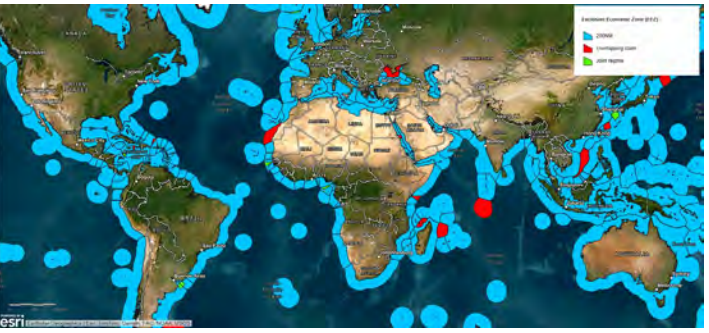
Outline

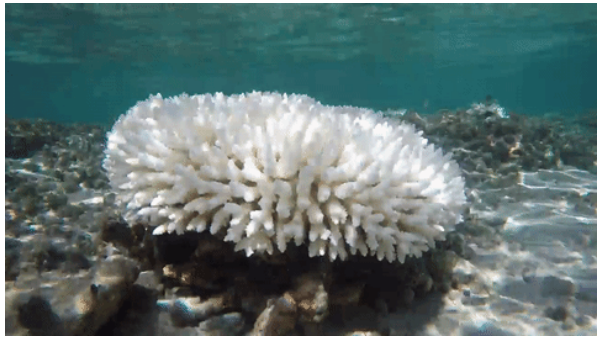
- Overview
- Case Studies
- Demos
- Application in Projects

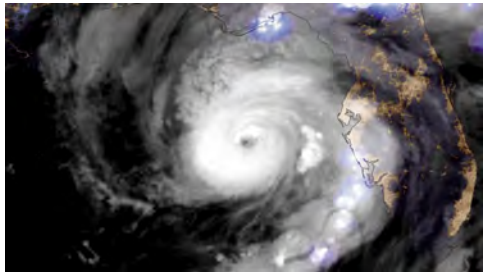


A Planet in Environmental Distress









Natural Resource Degradation

Pollution

Climate RIsks

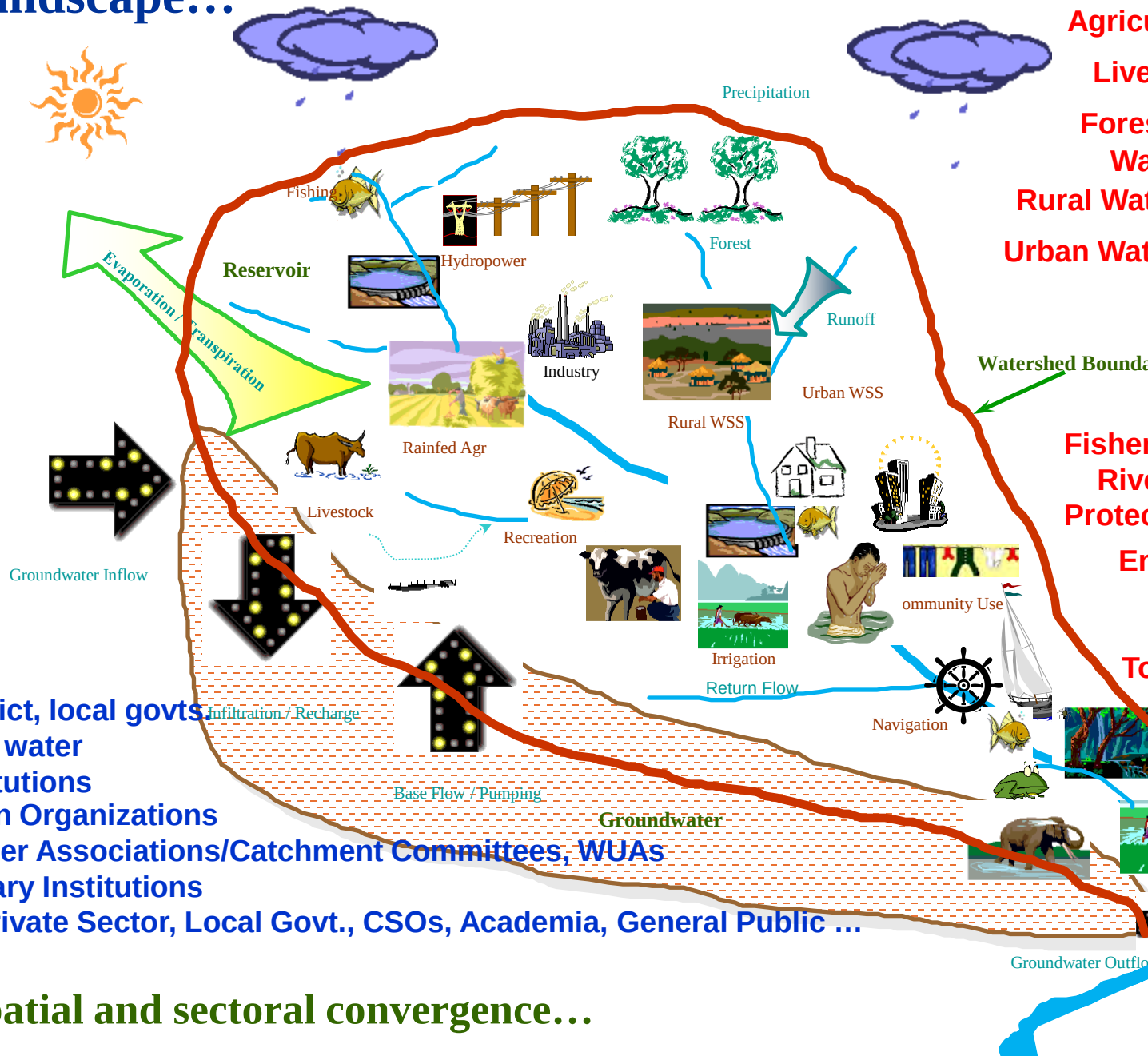
The Elephant in the Dark Room

در کف هر کس اگر شمعی بدی اختلاف از گفتشان بیرون شدی

…
Each of us touches one place
and understands the whole in that way.
…
If each of us held a candle there,
and if we went in together,
we could see it.

Multiple sectors, multiple institutions, linked by water and natural resources…

A Typical Landscape…



Agriculture Ministry/Department/Agency…

Livestock Department

Forest Department

Water Resources Agencies

Rural Water Supply Department

Urban Water Supply Department

Irrigation Department

Watershed Boundary

Power Department/Utilities

Industry Department

Fisheries Department

River Restoration

Protected Areas Mgmt.

Environment Department

Transport Department

Tourism Department

Social Development

Climate

Digital Transformation

Labor/Jobs Depts

Marine Area Depts

Central, State, district, local govts.

Surface & Ground water Investment Institutions

Basin/Sub-basin Organizations

Watershed User Associations/Catchment Committees, WUAs

Transboundary Institutions

Farmers, Private Sector, Local Govt., CSOs, Academia, General Public …

…Need for spatial and sectoral convergence…

A new world of “Disruptive Technology”

“Disrupt” data value chains

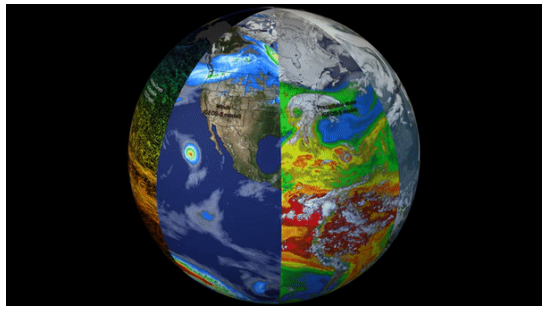
- ***Data Collection***: Monitoring/Surveys (in-situ sensors/IoT/Biometrics, earth observation (satellite, aerial, UAVs), crowdsourcing, digitization…
- ***Data Management:*** Telemetry, 5G, cloud services, open data, Blockchain, …
- ***Data Analysis:*** Big data, Geospatial/ AI/Machine Learning, modeling/ scenario analysis, script repositories, Cloud/Edge/Quantum computing…
- ***Data Access:*** Open data APIs, data visualization, gamification, mixed reality-AR/VR, …
- ***Outreach:*** Platforms/Social Media/Portals/ Apps/e-books/Competitions…

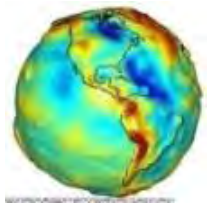
“Disrupt” production value chains

- 3D/4D printing/additive manufacturing…
- “Digital Twins”
- Automation/SCADA…
- Robotics/ Autonomous transport…
- Advanced materials/nanotech/ biotech/genomics/energy tech/ green tech, curated meats, ag tech…

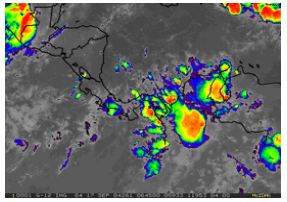
“Disrupt” stakeholder value chains

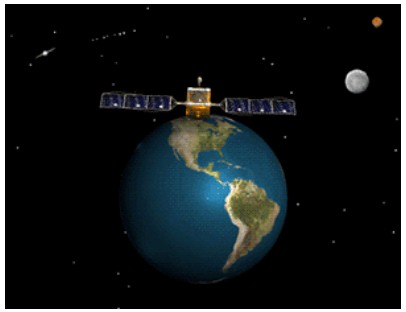
- Virtual social networks/ Digital Platforms…
- Sharing economy…
- Crowdsourcing, gamification, competitions (e.g. *hackathons*, *appathons…*)
- Mobile money, fintech, cryptocurrency…
- Blockchain enabled value chains
- Maker movement/DIY/Tech Incubators…
- Virtual learning/re-skilling…



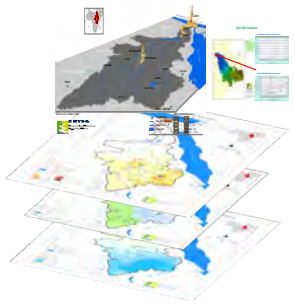


"Top-Down" Data Acquisition Syster

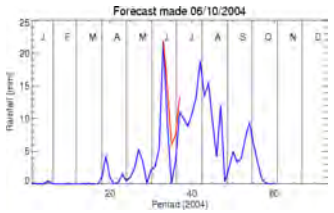




Satellite & Aerial Earth Observation



Data Rescue
GIS and other datasets



Data Management

Analytics/Models

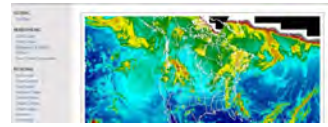
Big Data
Data Science

Platforms
APIs

Cloud Services

Machine Learning
& other AI

ChatBots
Crowdsourcing



Dashboards/Portals/Apps/e-

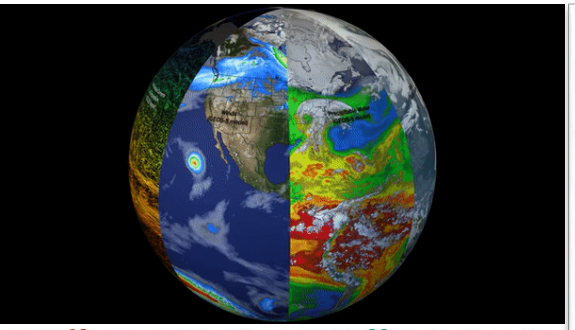
Stakeholder Alerts

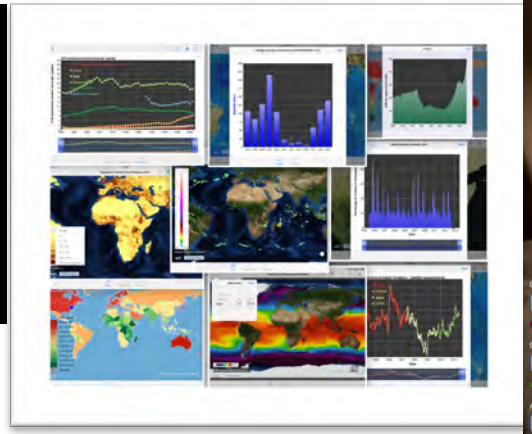
Operational Control Rooms

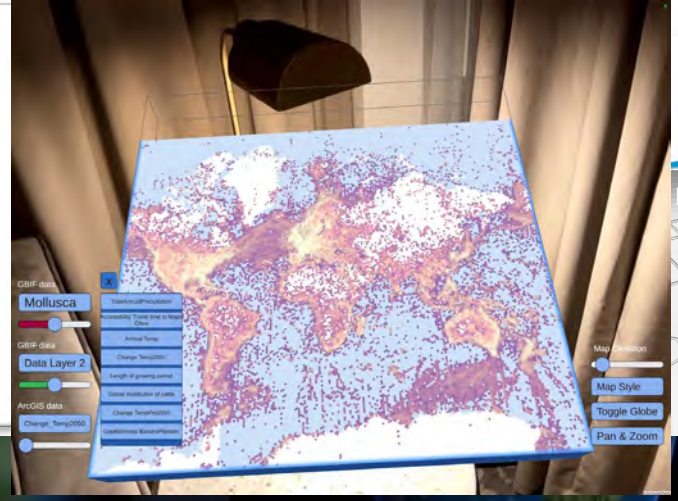
Manual Monitoring
Crowdsourcing

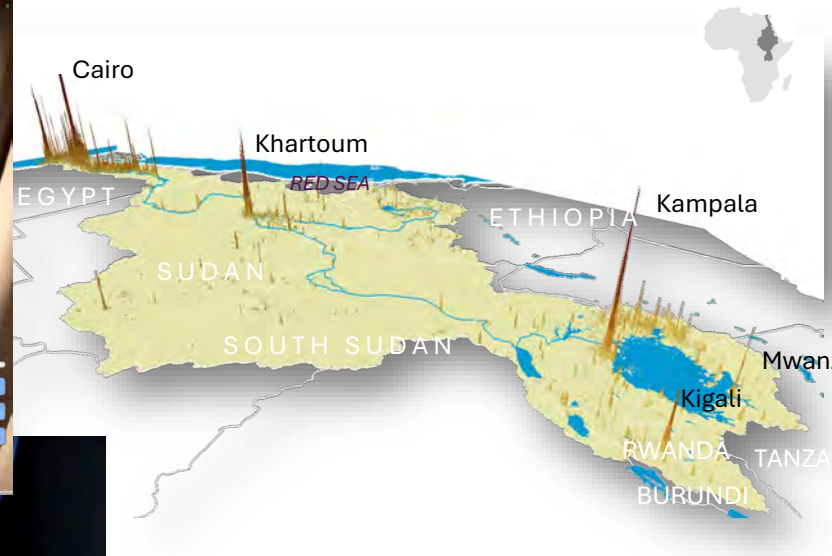
Automated Monitoring

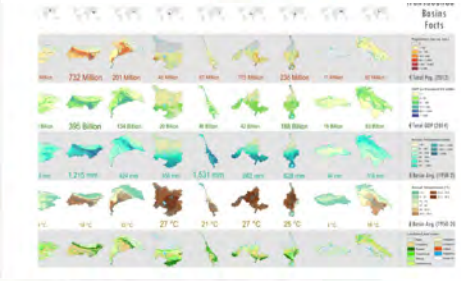
"Bottom-up" Data Acquisition System → IoT

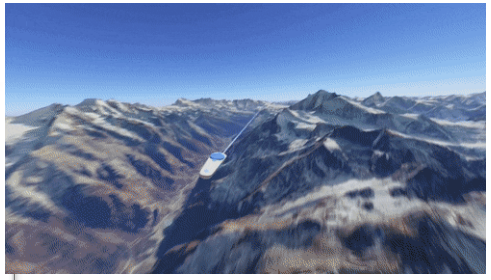


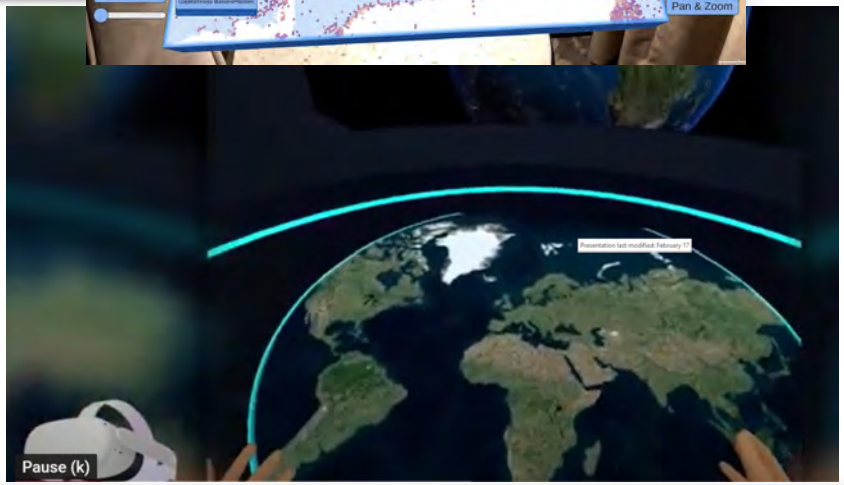


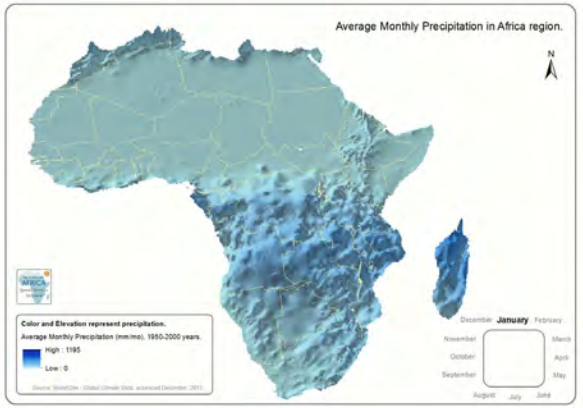


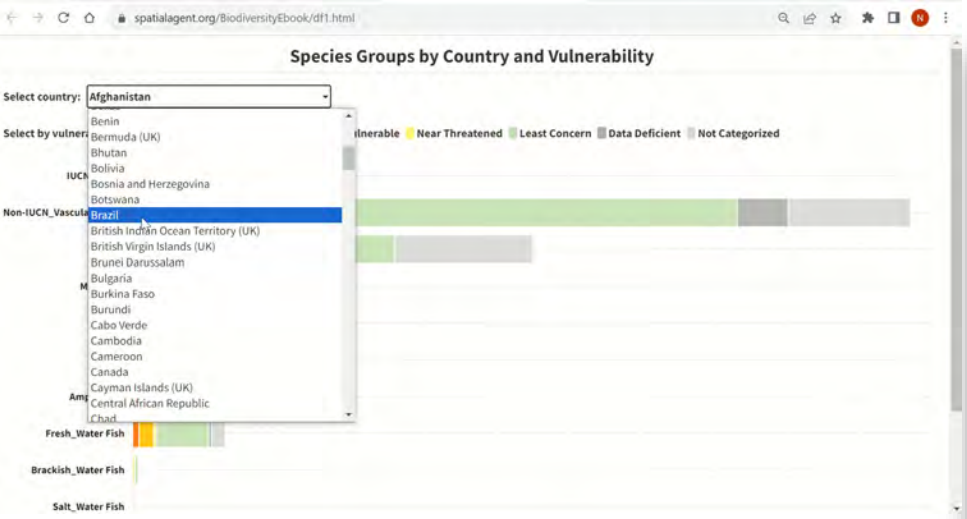


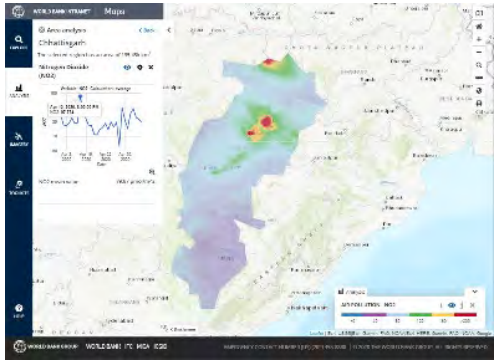












We have NO data…

Of course we have data…

Data, data everywhere…

Information & Analysis Trends

What's Out? → What's In?

Are we part of the problem?Can we be part of the solution?

Paper Records/Publication

Inadequate and Inaccessible Data

"Retail" info systems & modeling

Reliance on Websites and Pdfs

"Have you registered first?"

"Tell me why you need the data"

Online interoperable OGC data service formats/ Open APIs

Free and subscription services

"Wholesale" Cloud Analytics

Separate data services and consumption platforms (e.g. dashboards, Interactive documentation)

The "Old" Ways…

Are WE part of the problem?

"But all you need is to fill a form…"
"Please write a letter to us why you want the data…"
"That department does not share data with us…"
"I know someone who knows someone with some of the data…"
"That information is in another department…"
"Its on the website – somewhere - all you need is a password that you can get when you register for free…"
"All the data is accessible in paper reports or in a pdf format…"
"I remember seeing some of that on some website somewhere…"
"We can download and install a model to analyze the data…"
"I'm waiting to publish a few papers and then I will release the data…"
…

The “New” Ways:

Can YOU be part of the solution to reduce the barriers?

Online Analysis-Ready Data Services

- Open Data APIs (Application Programming Interfaces)
- Use common standards – e.g. Open Geospatial Consortium (OGC) formats for spatial data – especially to provide “analysis ready” interoperable data

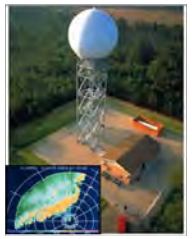
Online Analytical Services

- Cloud analytics
- Modeling services using open APIs and drawing upon online data services

“Bottom-up” Monitoring Systems

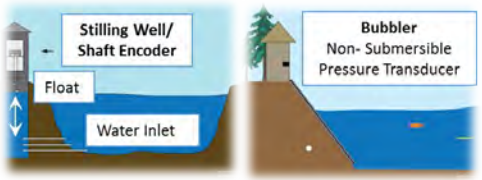


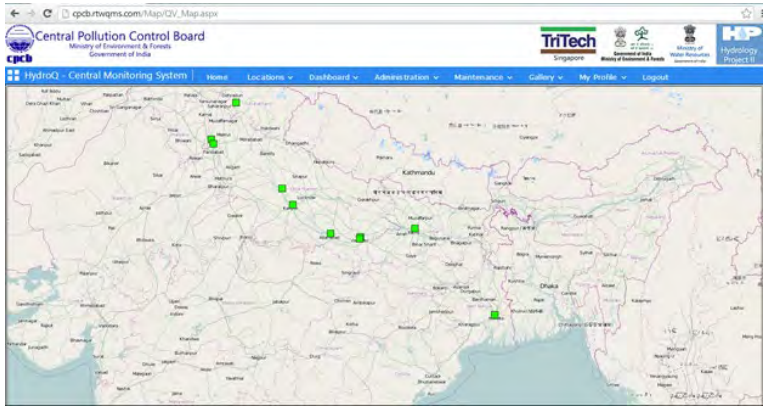
Automatic Rain Gauges


Doppler Radar



Snow Pack







Shore-mounted Radar

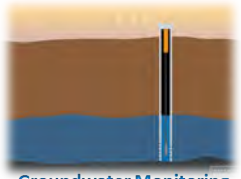
Bridge-mounted Radar



Non-Contact Measurement of Stage & Discharge


ADCP

Automatic Cableway System


Groundwater Monitoring



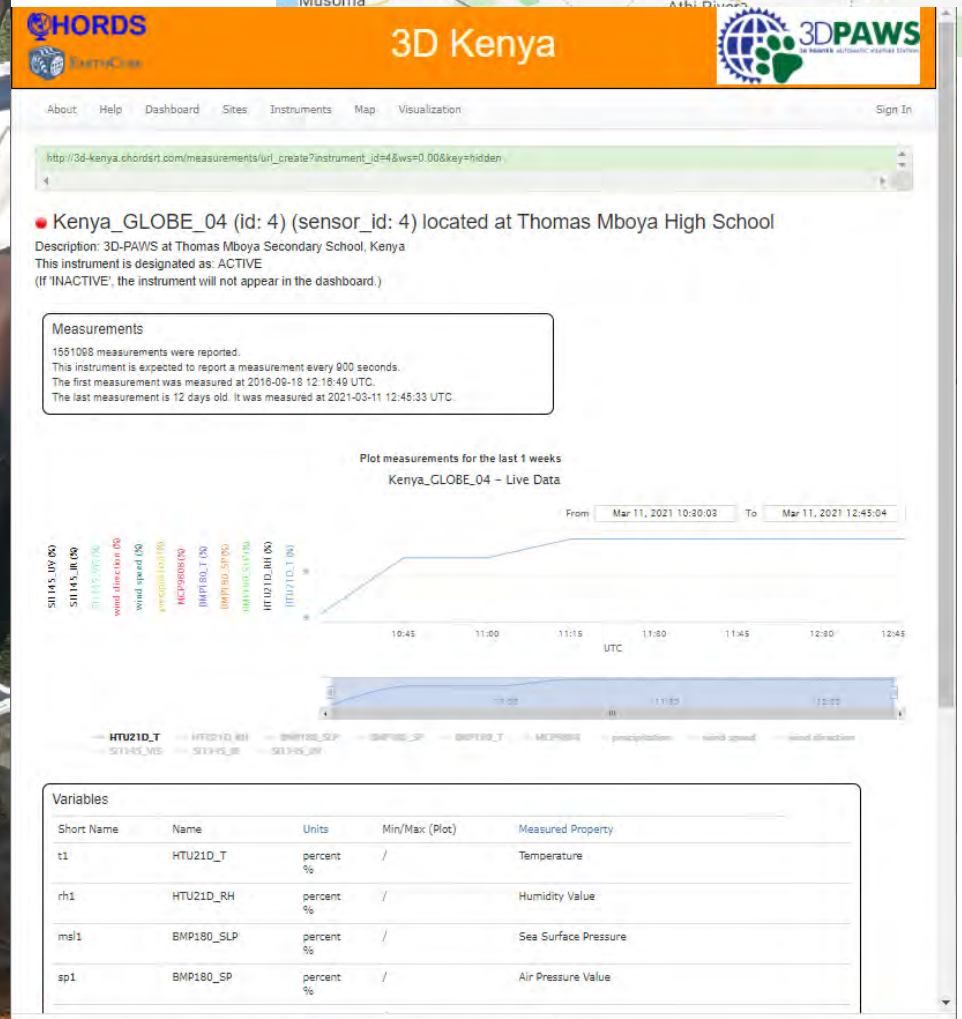
Water Quality Monitoring


Field Kits


Laboratories

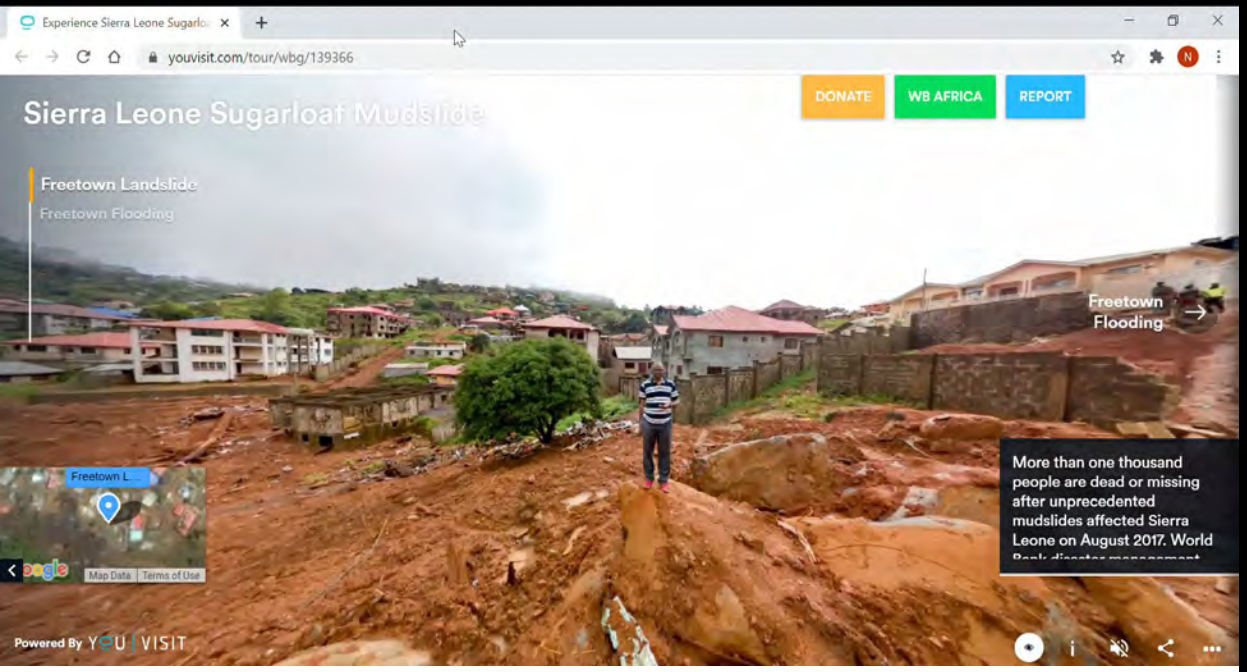


Crowdsourcing Monitoring



3D Printed Monitoring Stations, Kenya

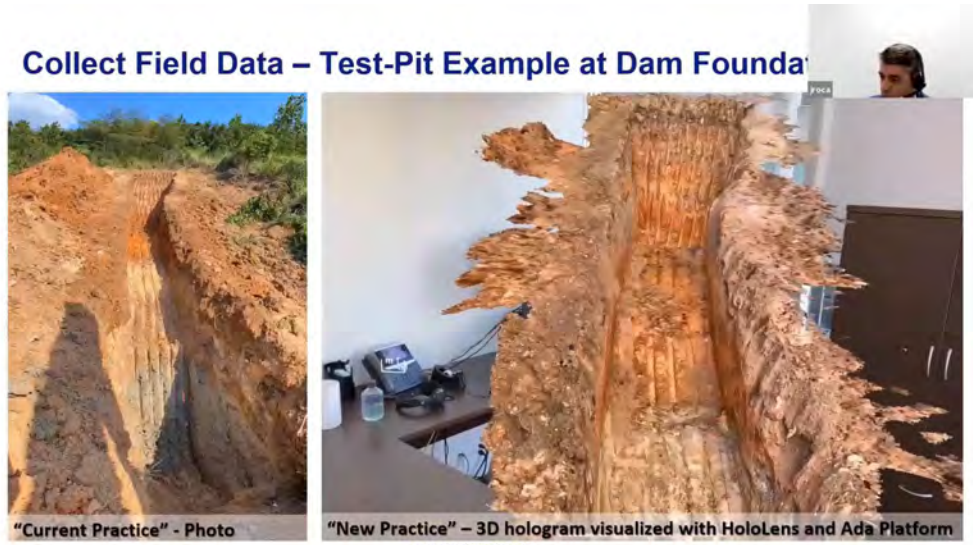
3D PAWS



360º Cameras for photos/videc

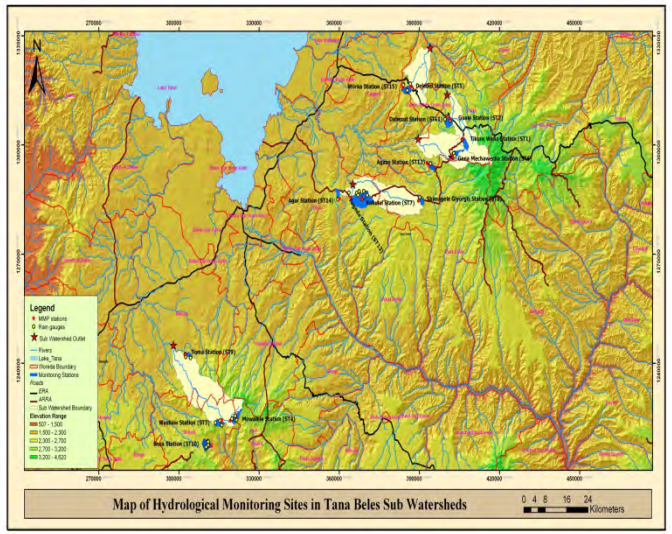
Bioacoustics

eDNA



Phone/Tablet LiDAR

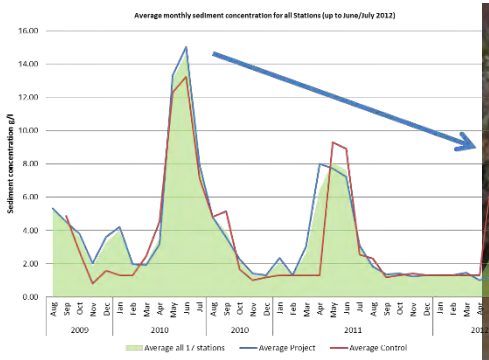
Community Monitoring



	2009	2010	2011	2012	Total
Staff	3132	11812	12409	6522	33875
Turbidity	3131	12069	12469	6624	34293
Rain	3116	>12777	>15000	>15000	>47000
Flow					>500
Sed samples	1425	4176	3139	1216	9956

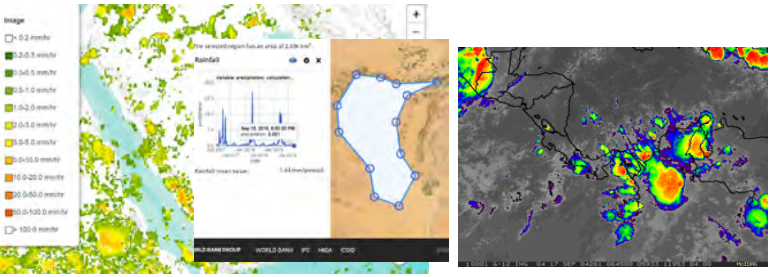
Secchi Jug for turbidity

Sediment Concentration Analyses

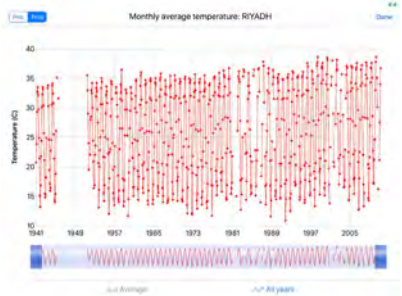


"Top-down" Earth Observation & Other Global Analytics Services

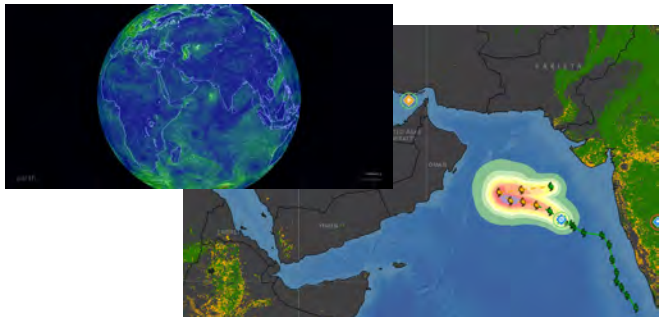
Climate



Precipitation & Forecasts

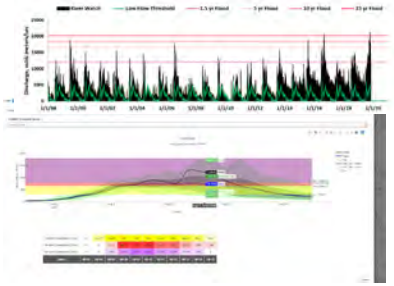


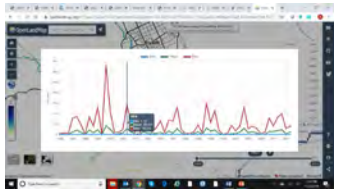
Temperature



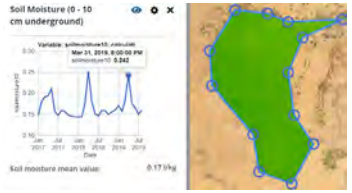
Storms

Hydrology

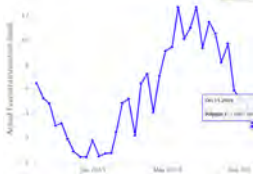


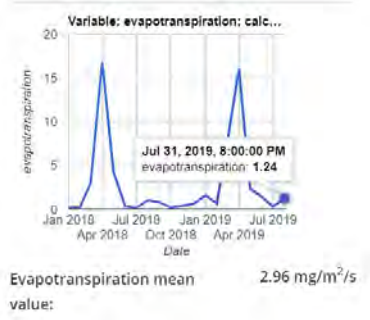


Levels, Flow & Inundation & Forecasts



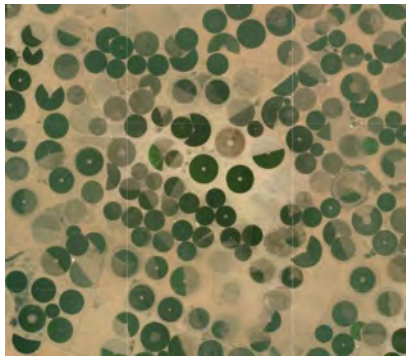
Soil Moisture



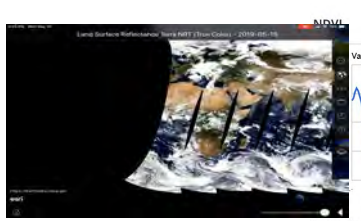


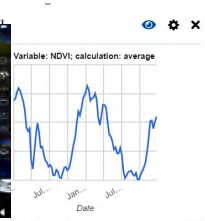
Evapo-transpiration

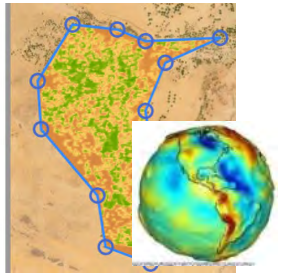
Other



Land Cover



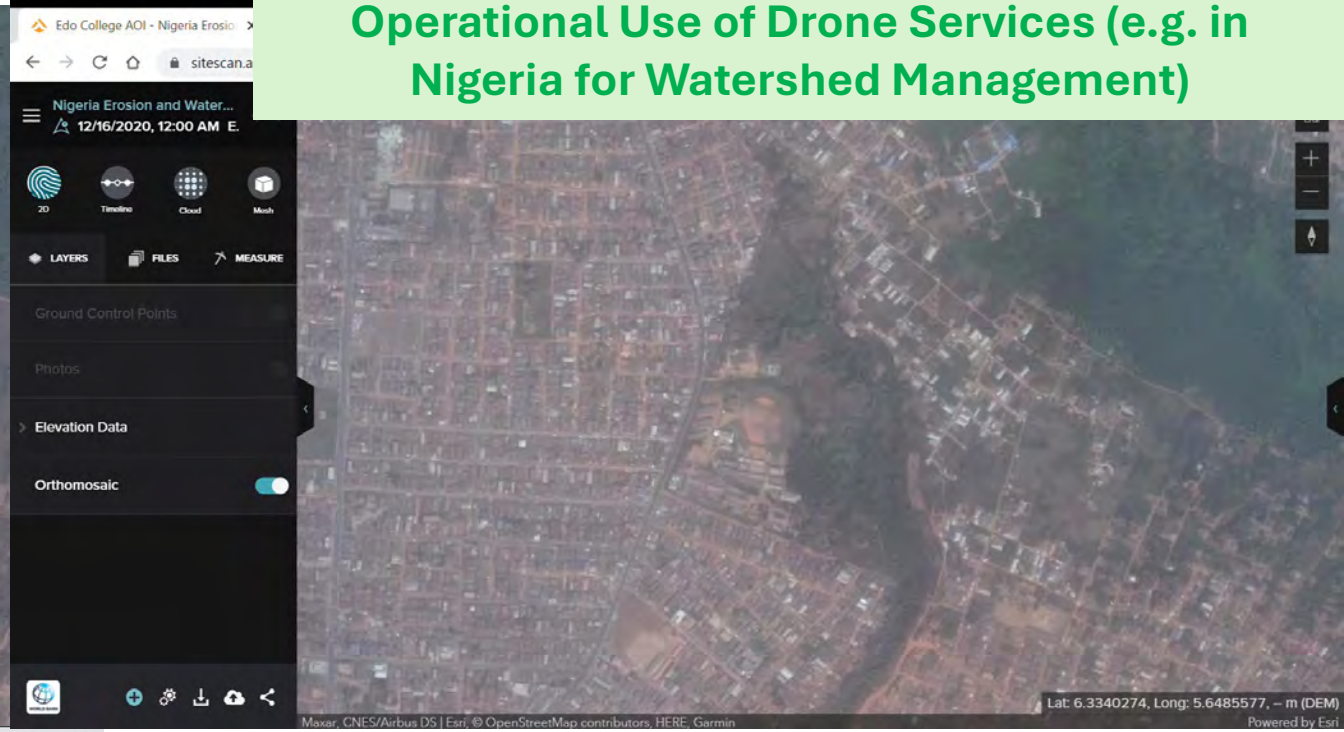


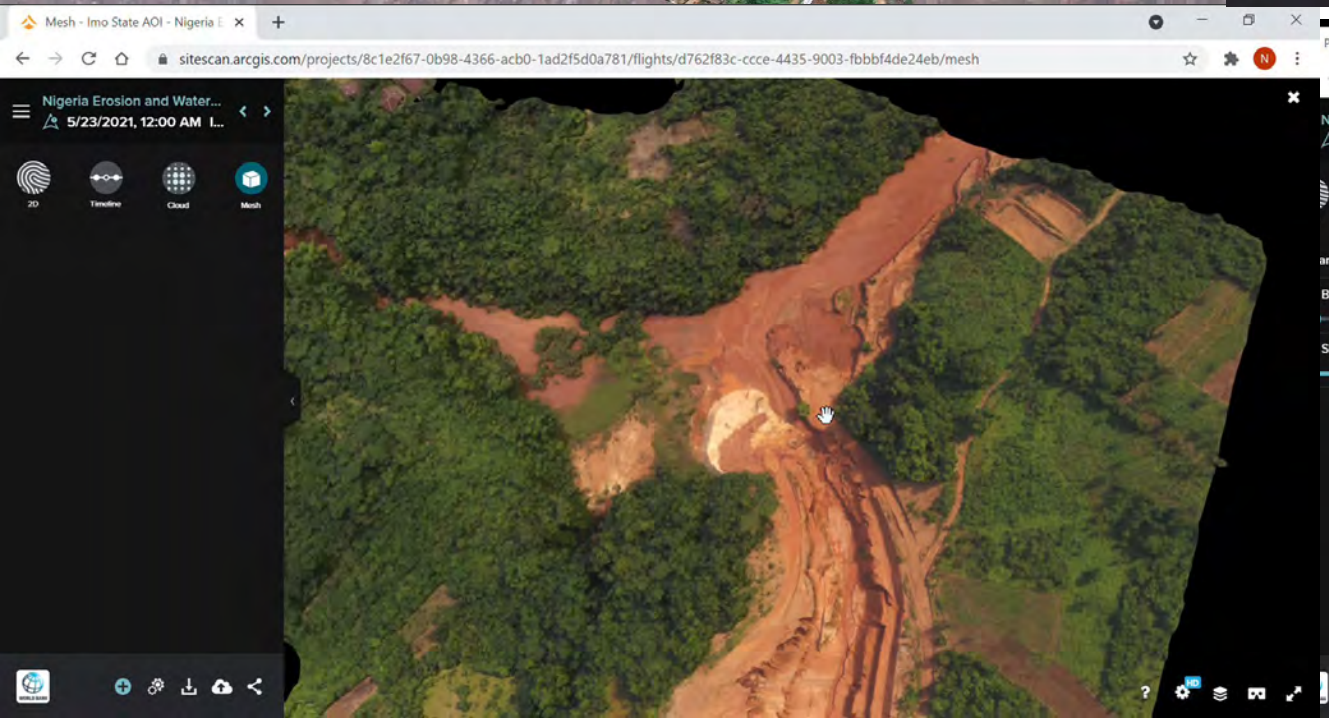


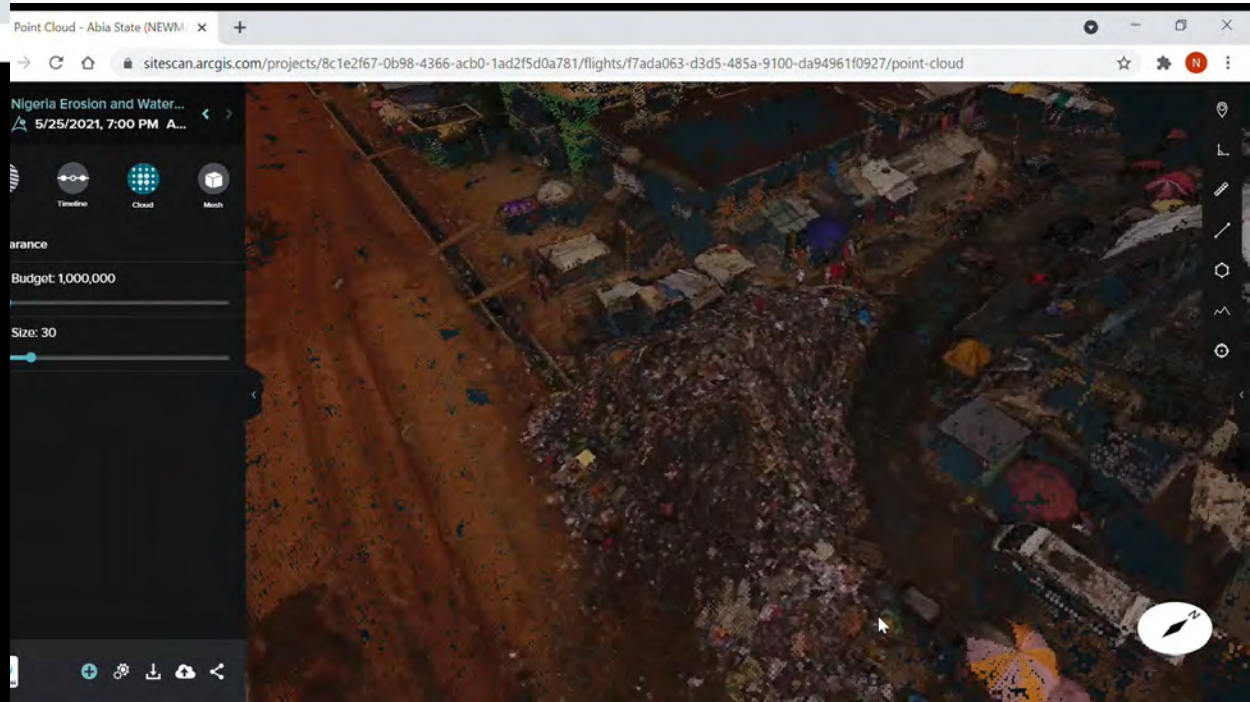
NDVI, EVI, GRACE, etc.

Social, Economic, Environmental, etc.

Operational Use of Drone Services (e.g. in Nigeria for Watershed Management)







AI AI AI AI AI

Automate Repetitive, Routine Tasks

Improving Efficiency

Cheaper, faster, better Services

Improved Estimates/Forecasts

New Jobs

Continuous learning

Wearable AI

Powering Robotics/Automation

Help address global challenges

Hallucinations

Bias

Privacy

Misinterpretation

Cybersecurity

Intellectual Property

Digital Divide

Human Rights

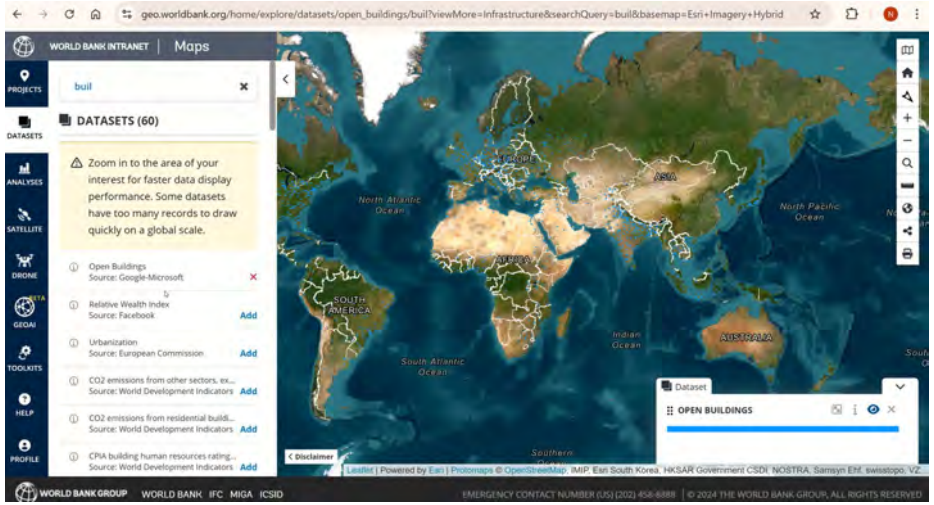
Job/Skill Obsolescence

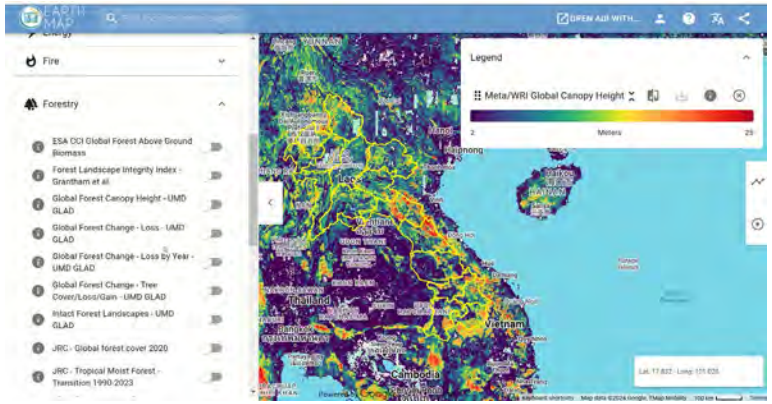
Energy/Water Needs

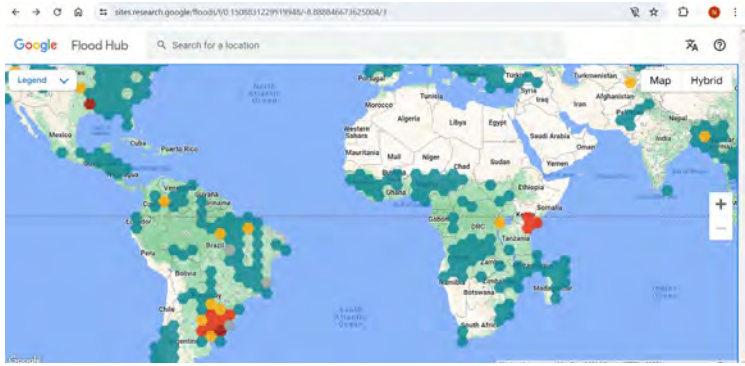
Existential Threat

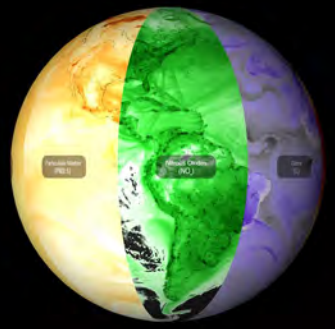
AI-facilitated data/analytics

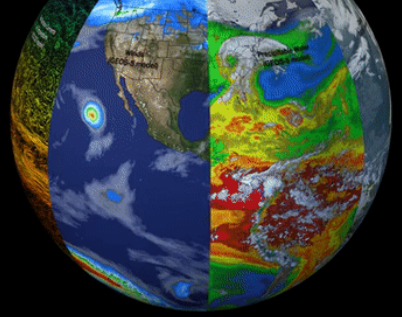
(e.g. building/farm footprints, high-resolution forests/landcover, elevation, flow estimations/forecasts)





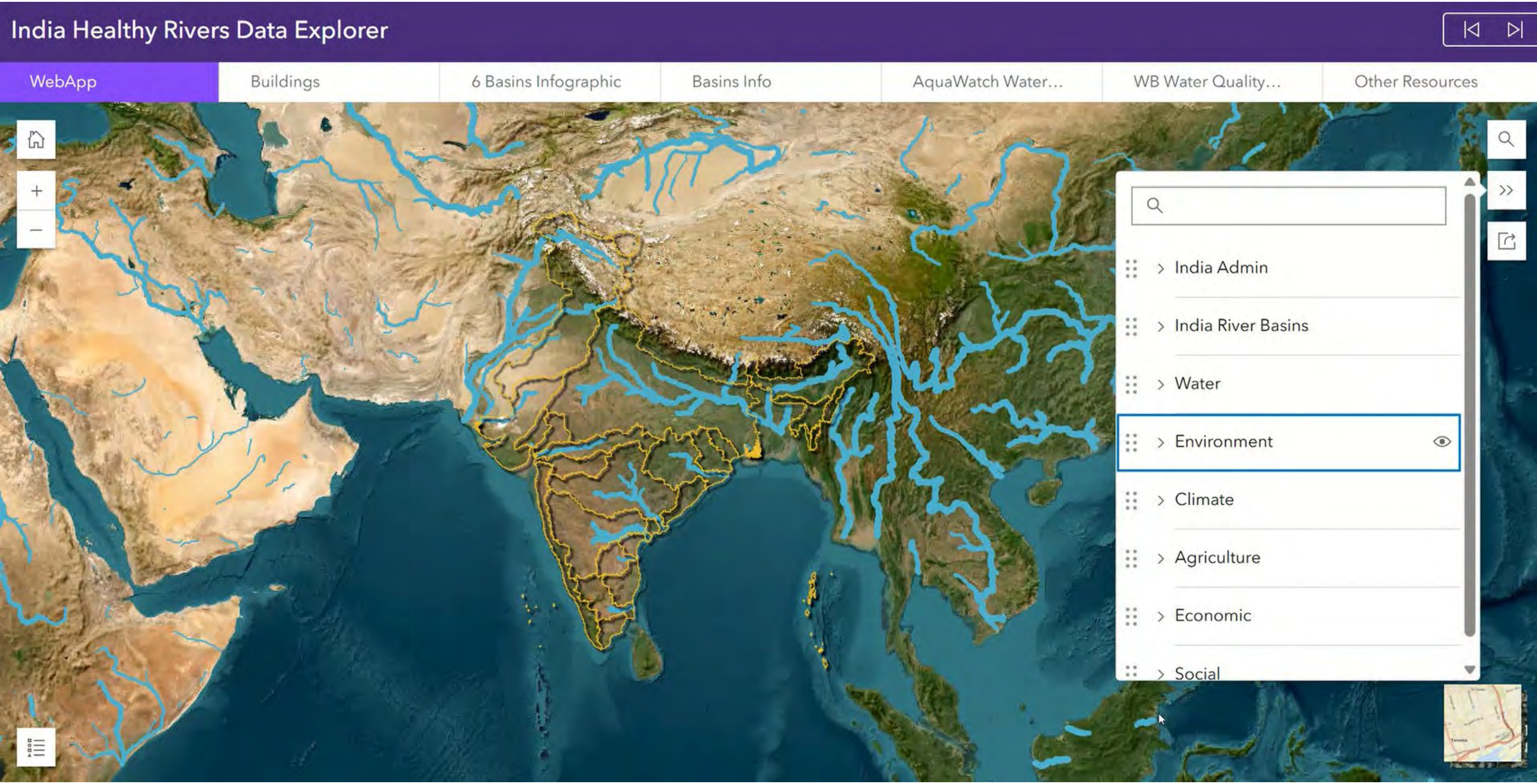






CO_2

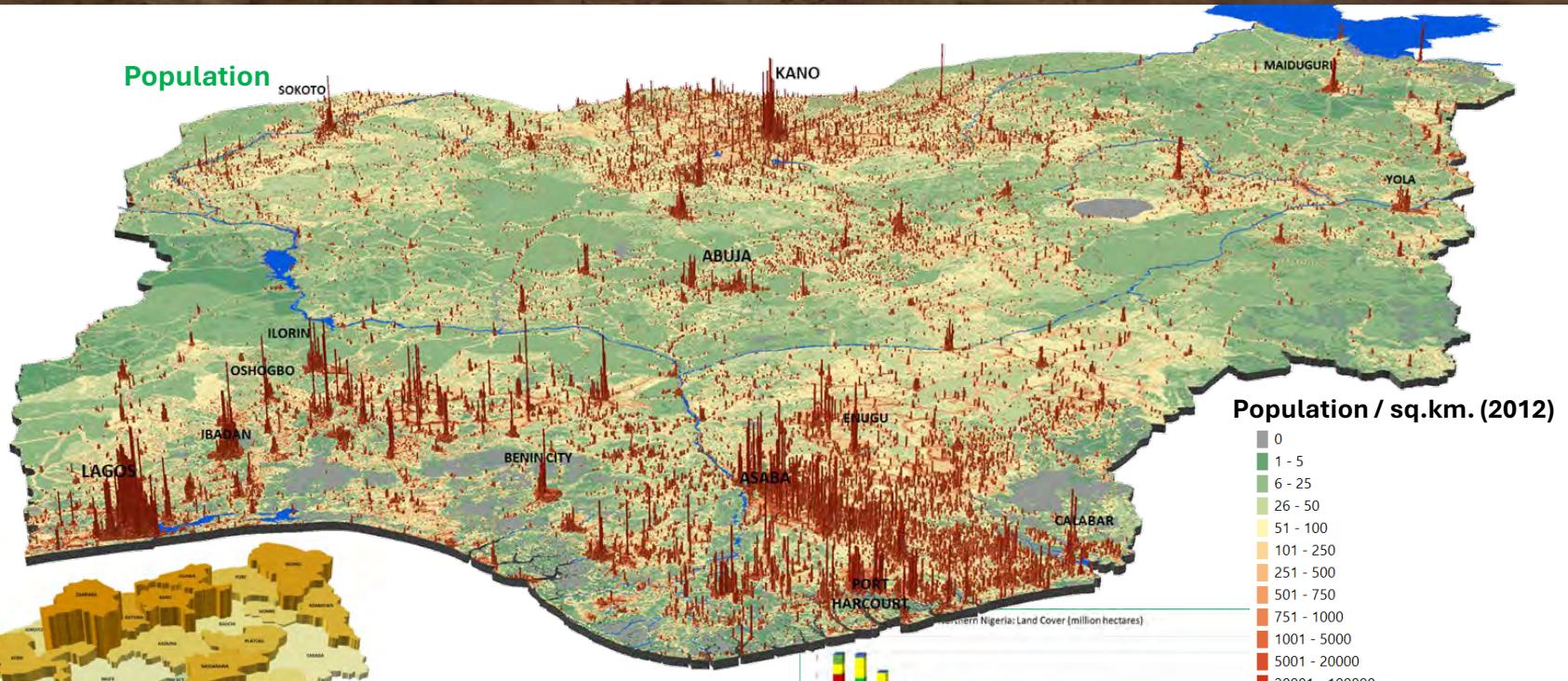
24 Jan 2020 03:00:00.000



Rainfall

Aridity

Population



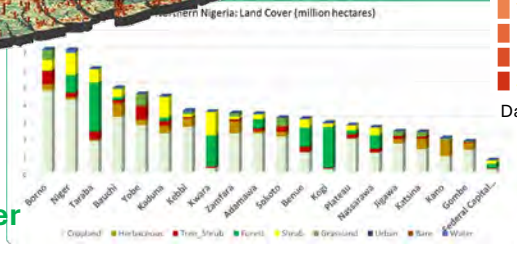
Population / sq.km. (2012)

- 0
- 1 - 5
- 6 - 25
- 26 - 50
- 51 - 100
- 101 - 250
- 251 - 500
- 501 - 750
- 751 - 1000
- 1001 - 5000
- 5001 - 20000
- 20001 - 100000

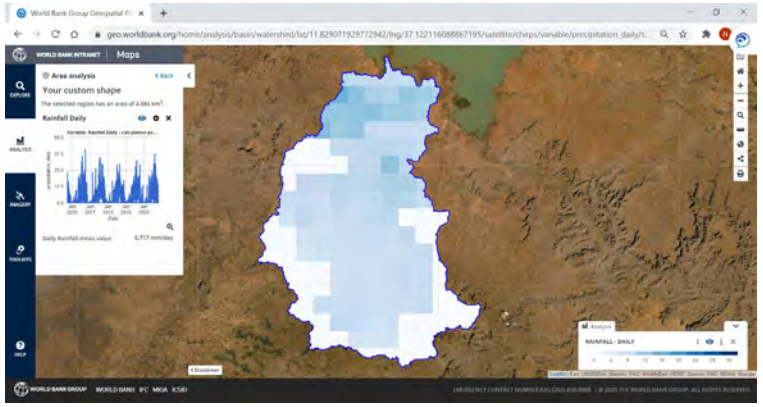
Data Source: Landscan, Columbia University, 2012

Livestock

Landcover

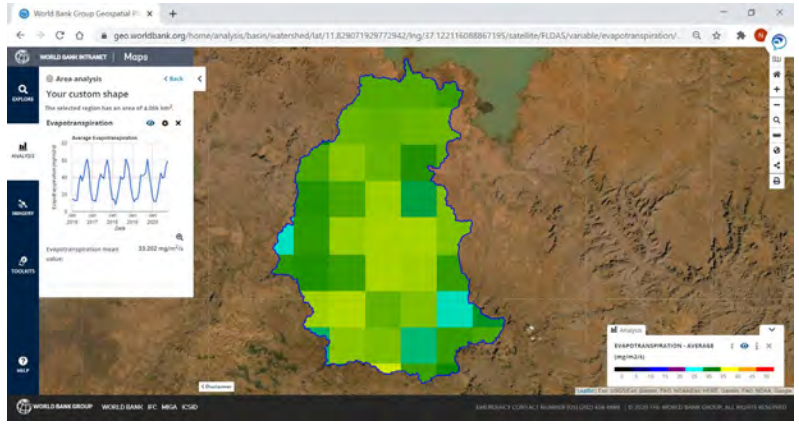



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth



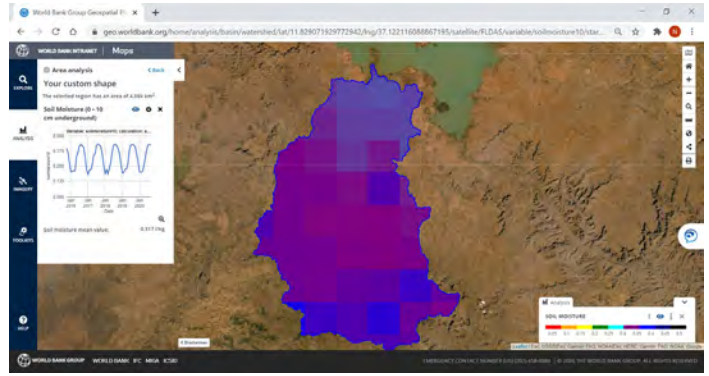
Precipitation

Evapotranspiration



Streamflow

Soil Moisture



Groundwater

Land Cover & Management

Soil Erodibility

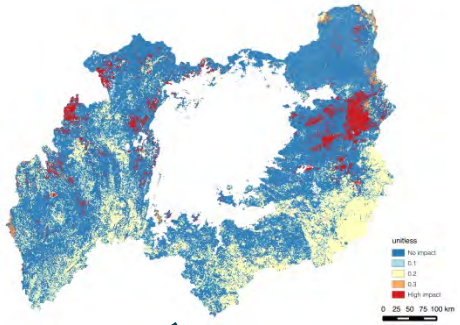
$$K = \left[2.1M^{1.14}(10^{-4})(12 - OM) + 3.25(s - 2) + 2.5(p - 3)\right]/7.59$$

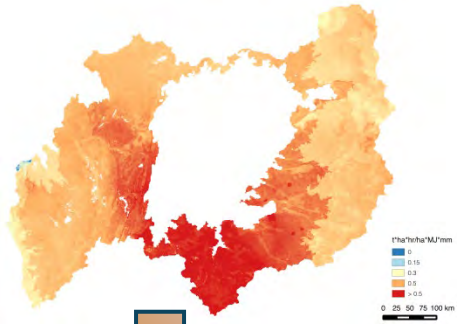
Slope Length/Steepness

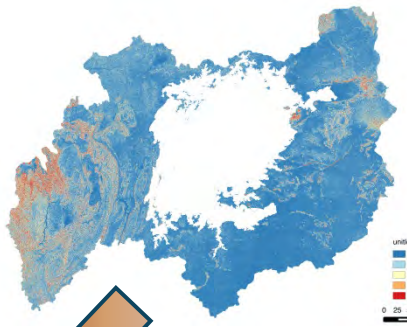
$$STCI = (m+1)\left[\frac{A_s}{22.13}\right]^m \left[\frac{\sin\beta}{0.0896}\right]$$

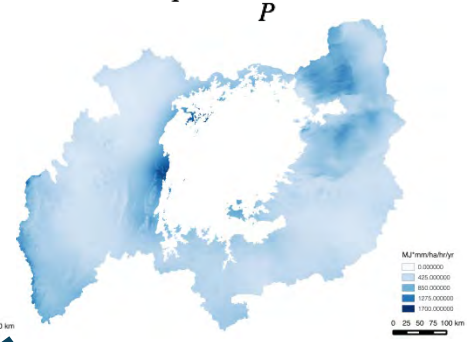
Rainfall-Runoff

$$F = \frac{\sum_{k=1}^{12}(p_i^2}{P}$$

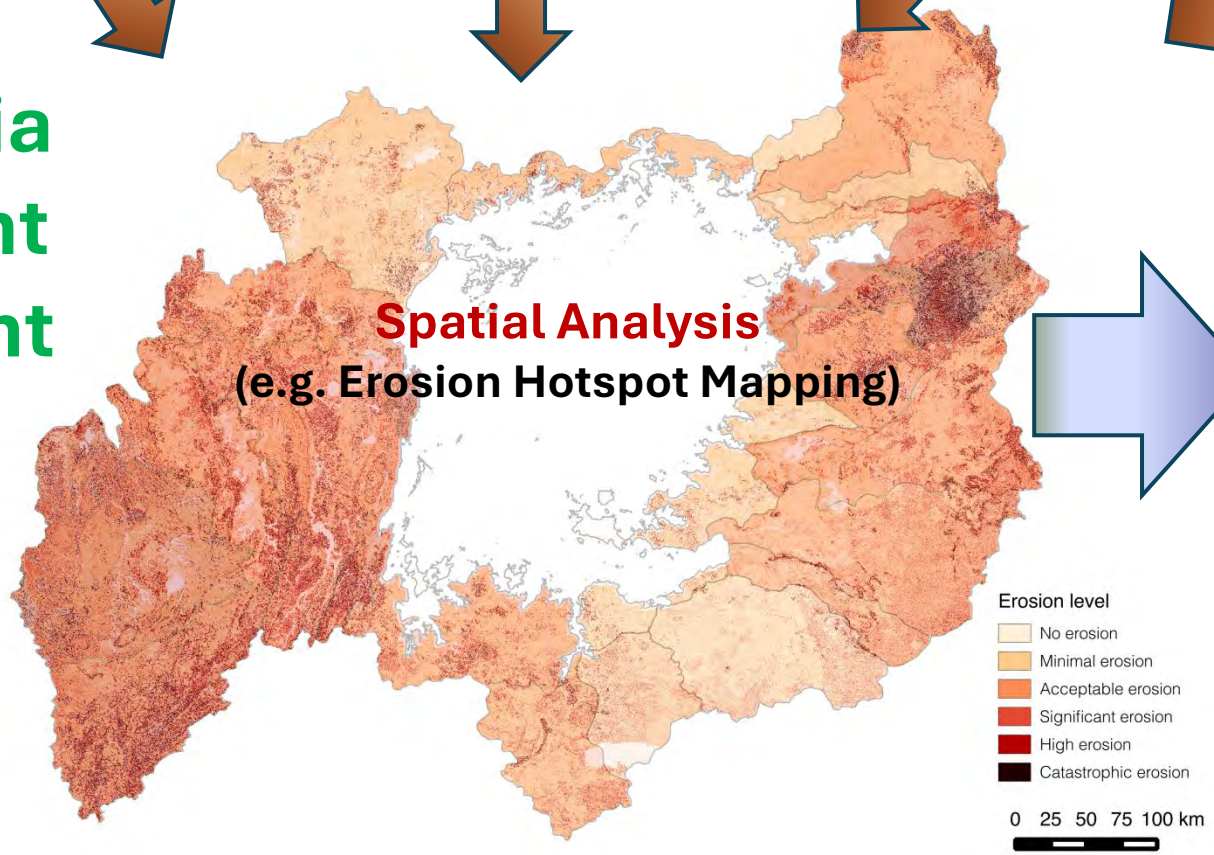


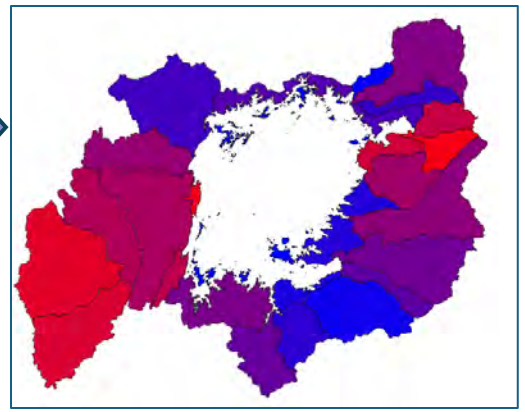






Lake Victoria Environment Management Project





Soil Erosion estimate at watershed level

Complex Water Systems Models

Scenario Analysis (e.g. climate, investments)

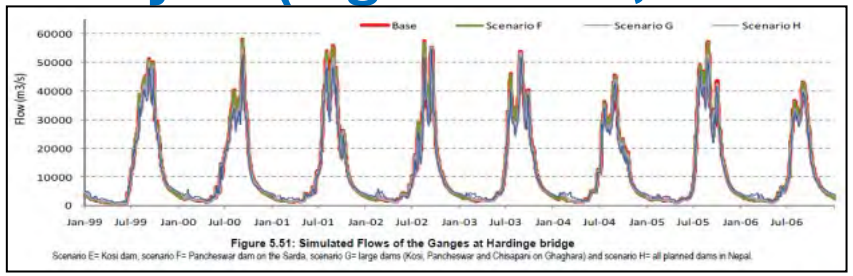
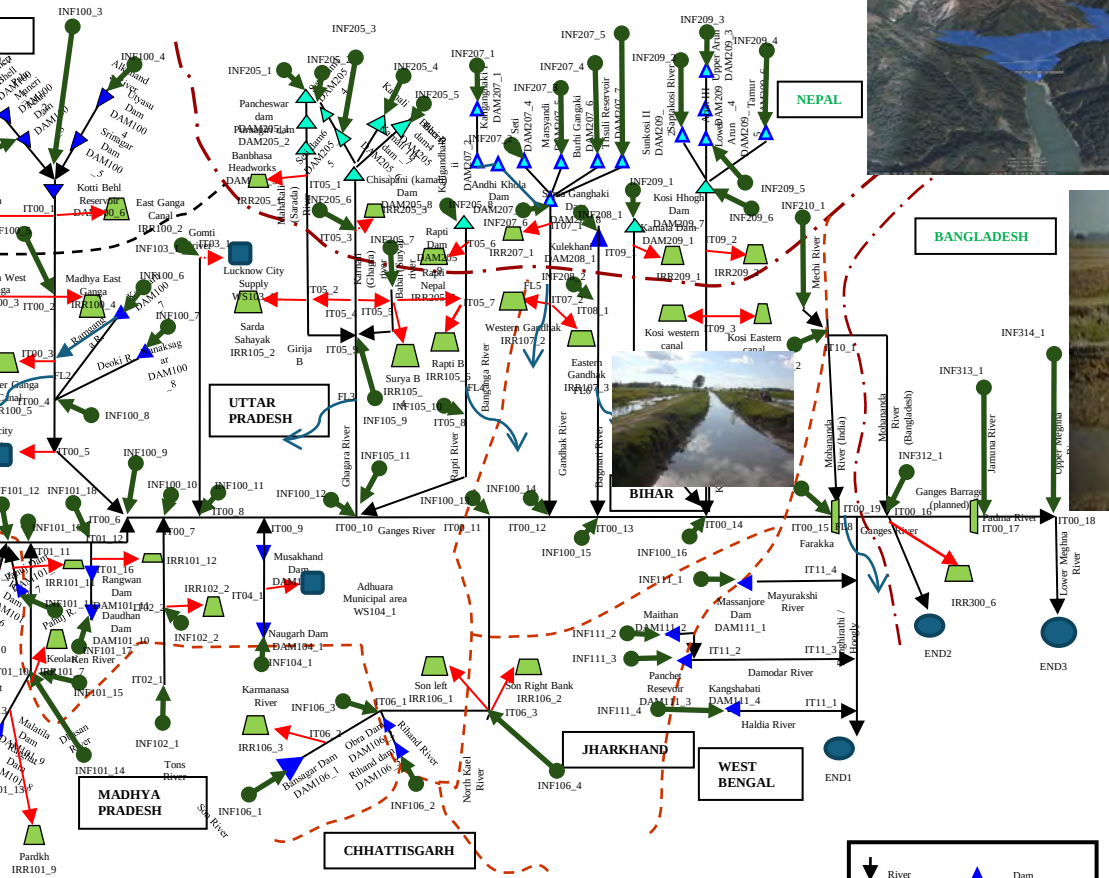
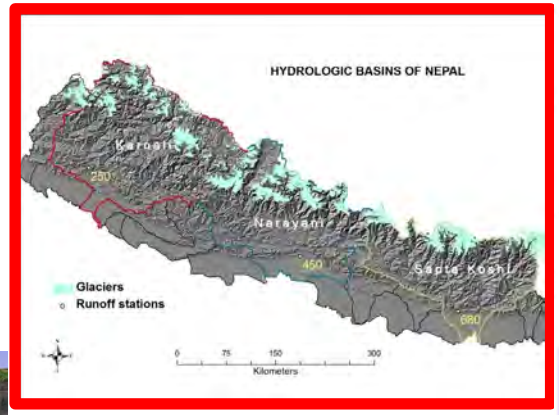


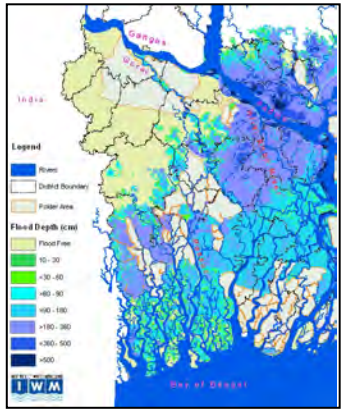
Figure 5.51: Simulated Flows of the Ganges at Hardinge bridge

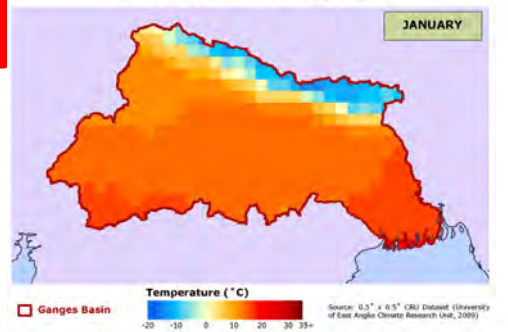
Scenario E= Kosi dam, scenario F= Pancheswar dam on the Sarda, scenario G= large dams (Kosi, Pancheswar and Chisapani on Ghaghara) and scenario H= all planned dams in Nepal.

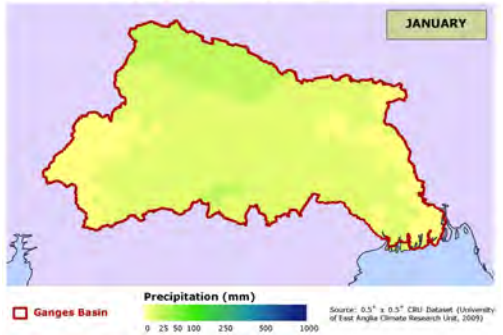


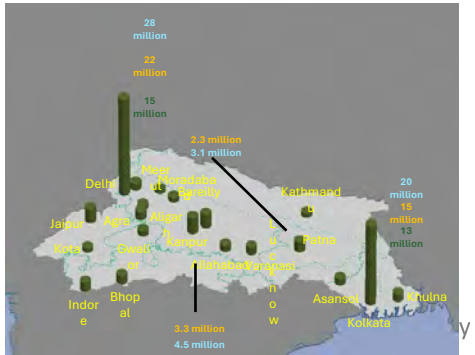
1025 Structures



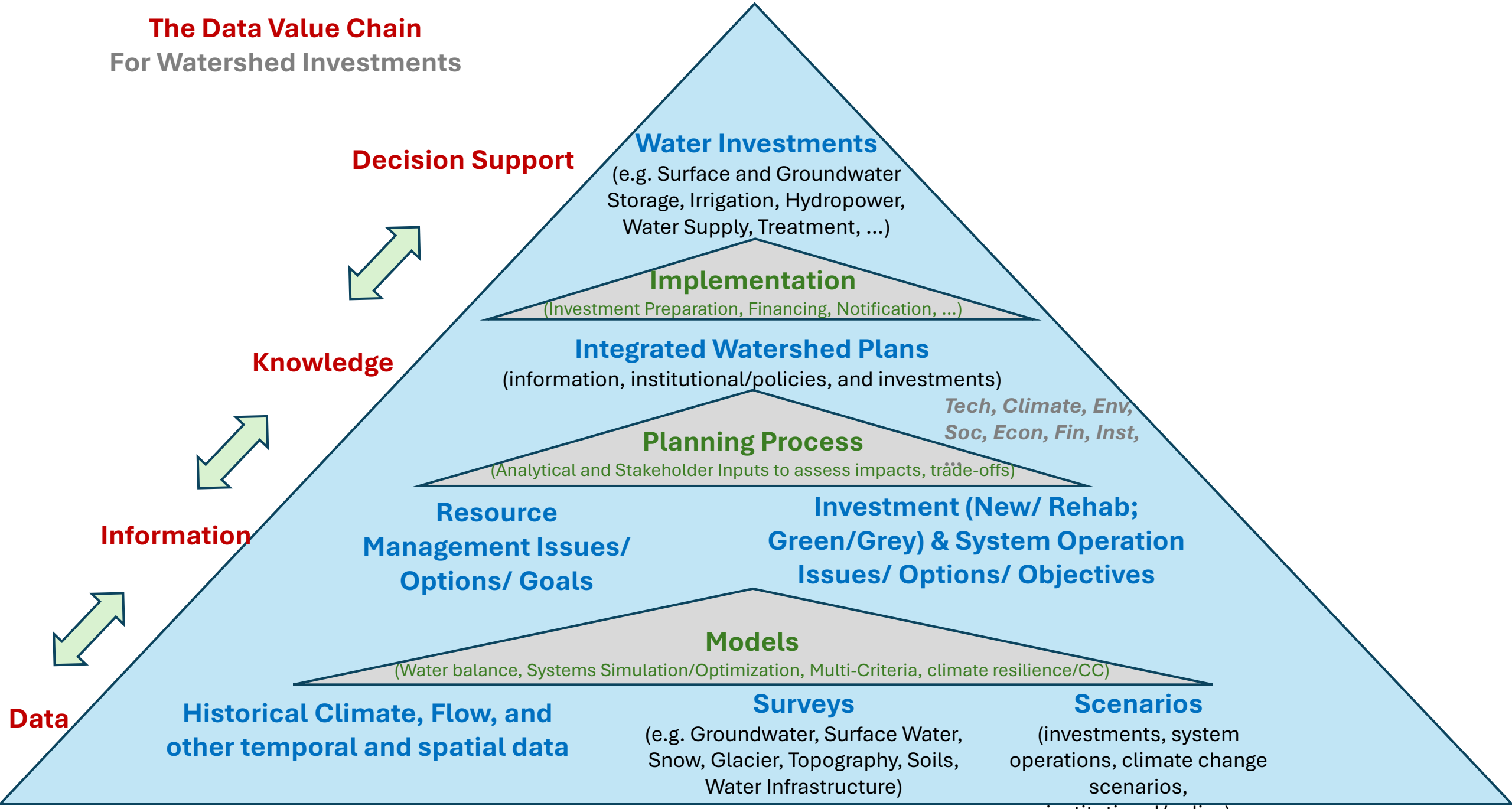






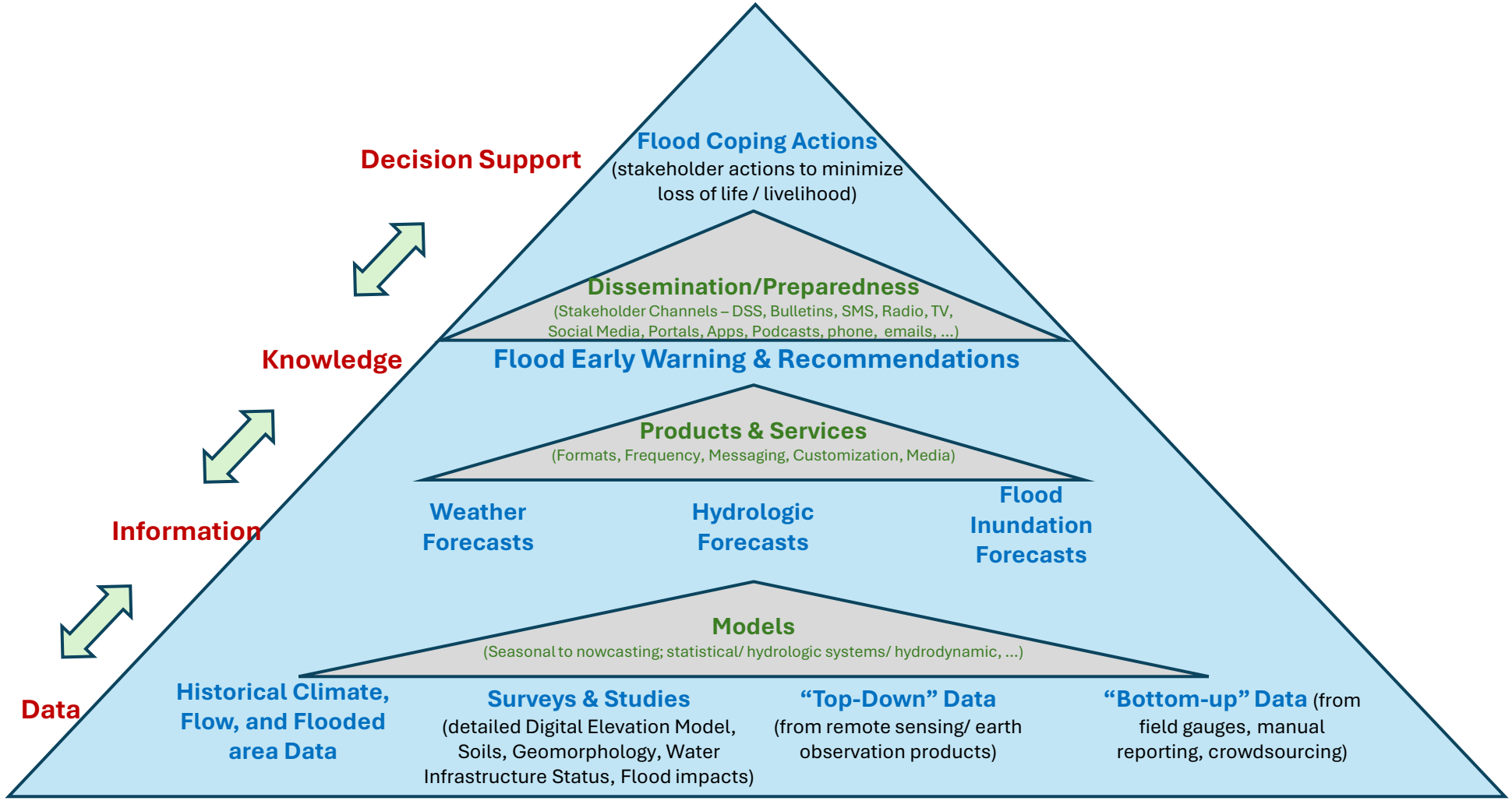


The Data Value Chain
For Watershed Investments

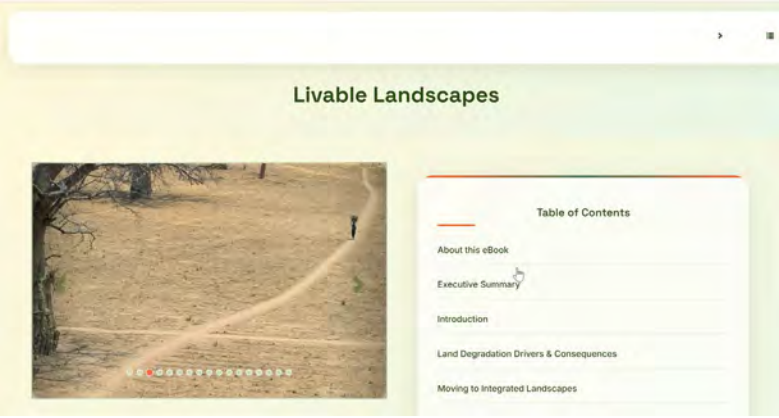


The Data Value Chain

Example: Deciding on Coping with Floods



AI-enabled Landscape/Watershed/Catchment/Basin Profiles

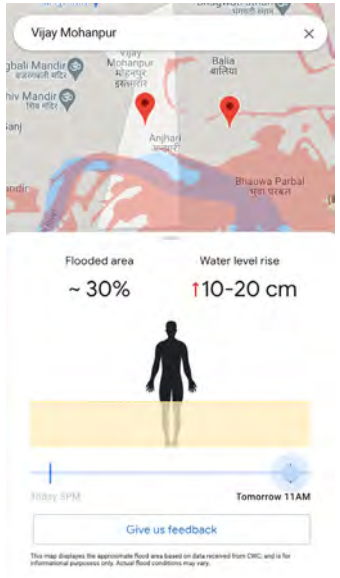


Digital MRV (Measurement, Reporting & Verification)

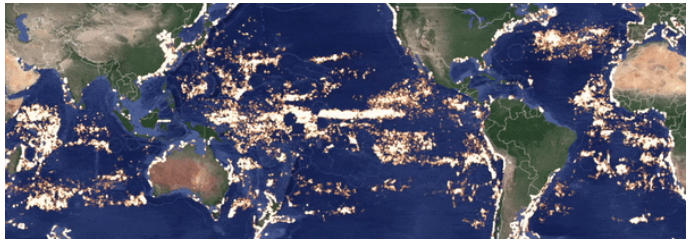
ePackaging

Stakeholder communications

Decision Support Systems (Planning & Real-time)



Payment for Ecosystem Services

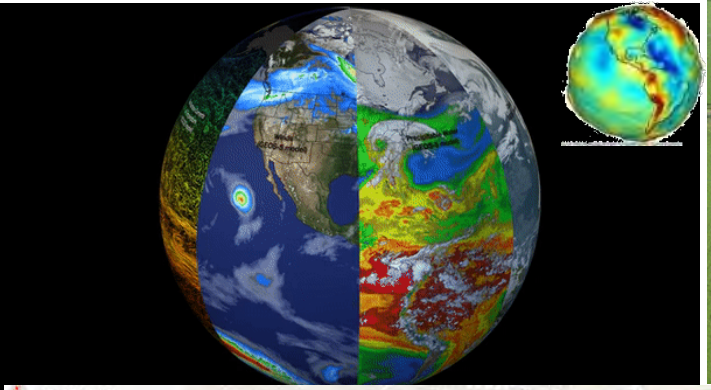


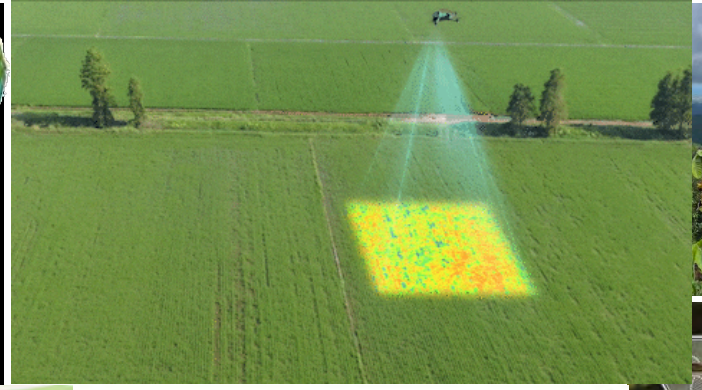
Open Data/Analytics/ GeoAI

Open Science

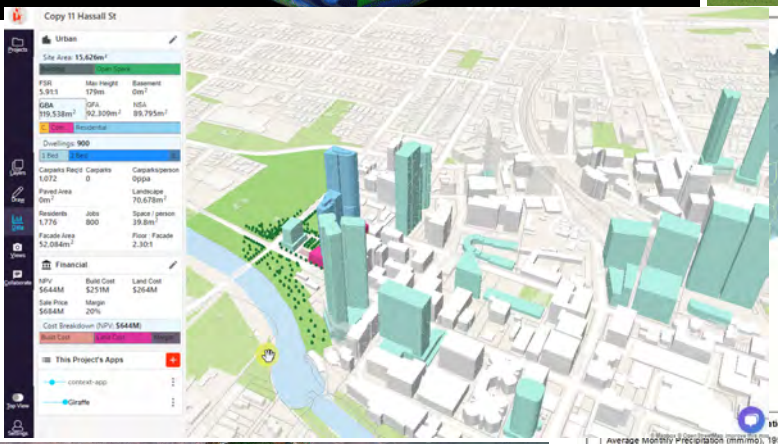
Early Alert Systems

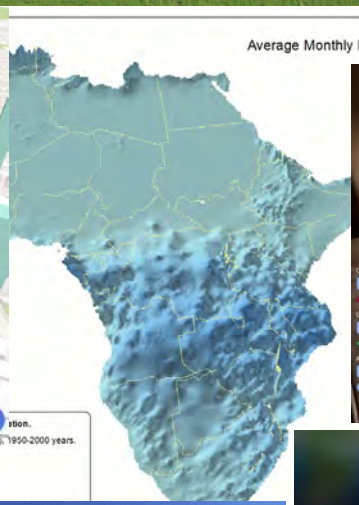
Digital Twins

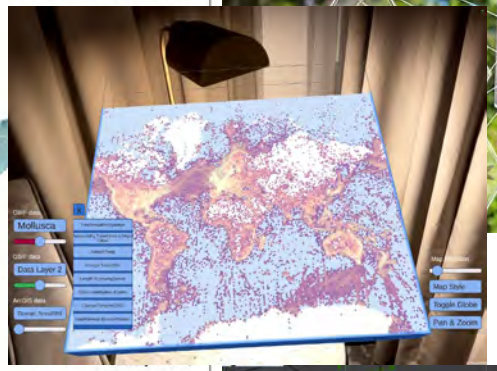


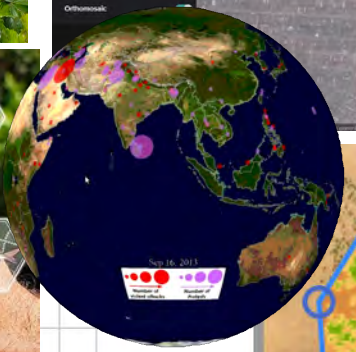



Elevation Data
Orthomosaic

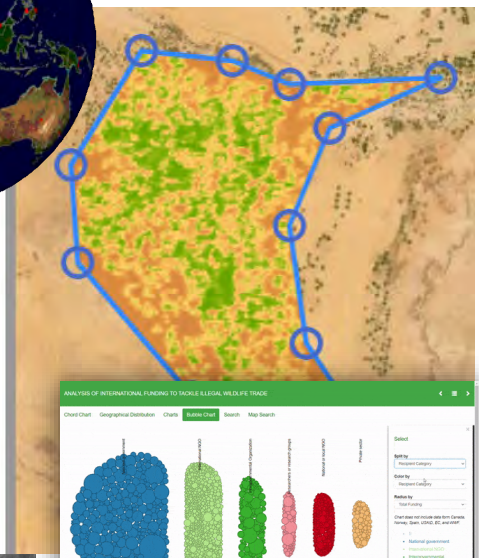

Copy 11 Hassall St
Urban
Financial
This Project's Apps

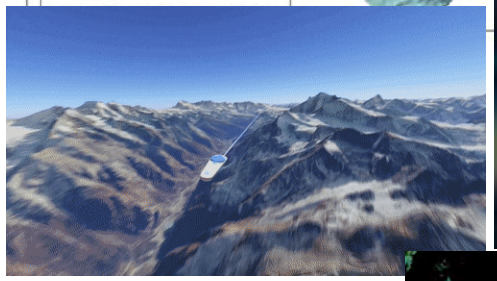

Average Monthly Precipitation in Africa region.
Average Monthly Precipitation (mm/mo), 1950-2000 years.
High : 1195
Low : 0

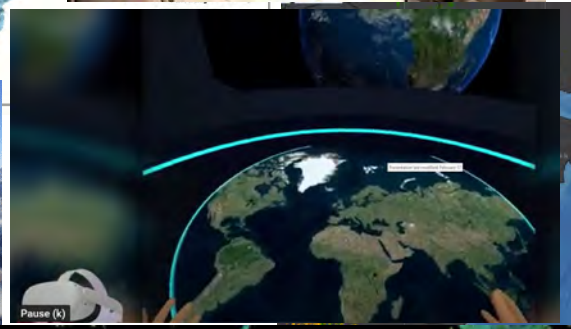

Molluscs
Data Layer 2

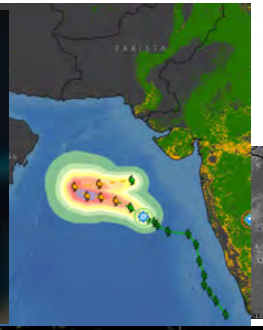


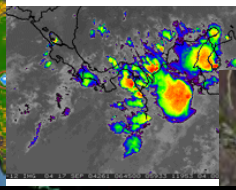

0.22
0.20
Jan…
Jul…
Jan…
Jul…

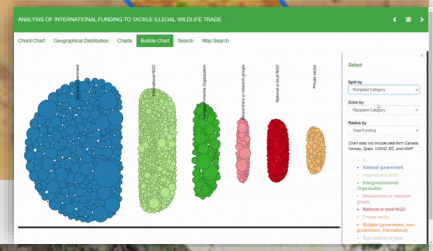




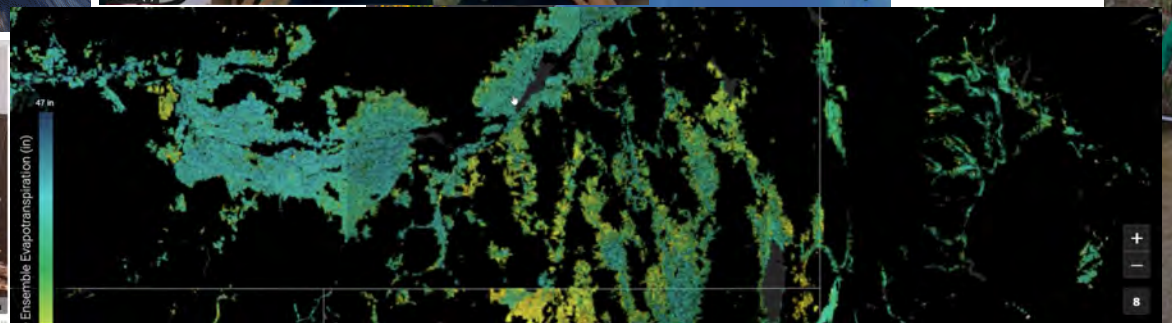

Pause (k)

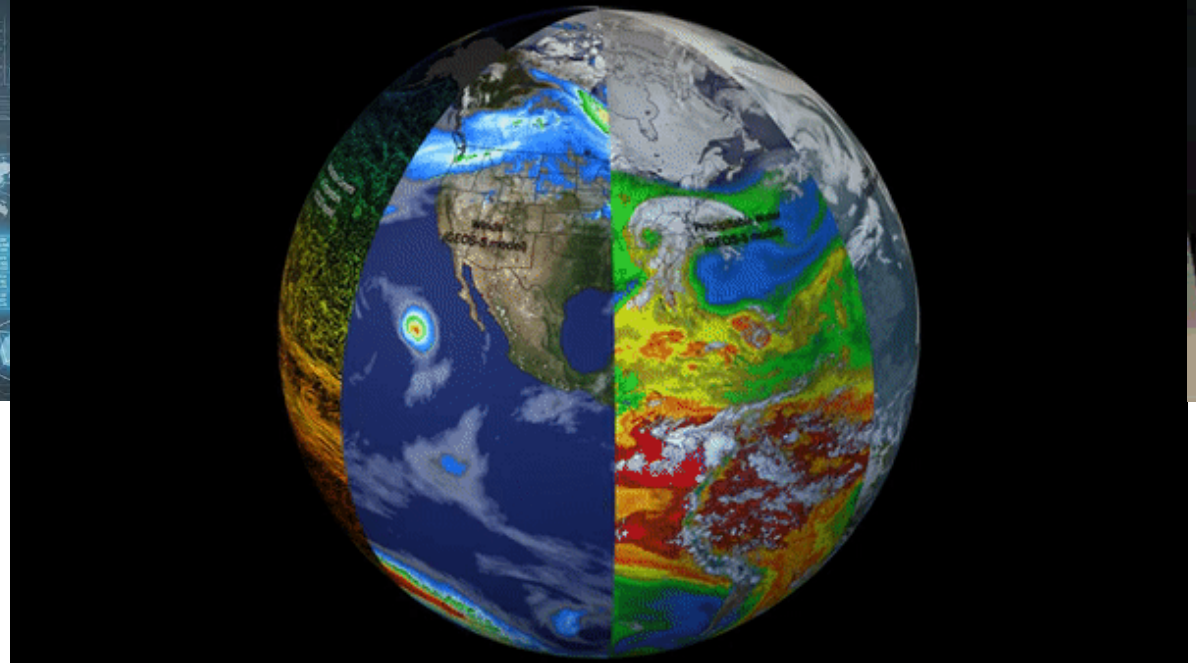


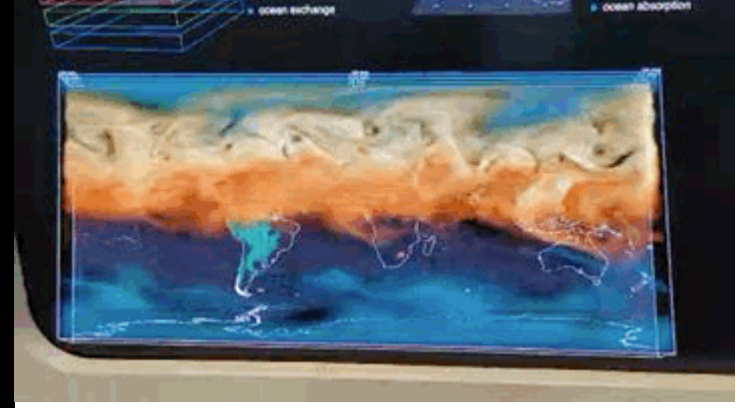



ANALYSIS OF INTERNATIONAL FUNDING TO TACKLE ILLEGAL WILDLIFE TRADE


"Current Practice" - Photo
"New Practice" – 3D hologram visualized with HoloLens and Ada Platform

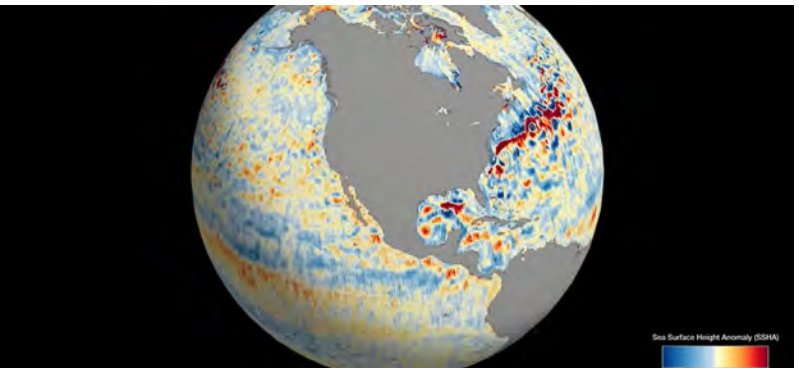

Ensemble Evapotranspiration (in)
47 in





Livable Planet Observatory

https://www.worldbank.org/en/programs/livable-planet-observatory



Meet the KIDS

Data/Analytics

Platforms/Dashboards

Knowledge ePackaging

Outreach

Capacity Building

Operational Support

https://spatialagent.org/KIDS/

Evolving Livable Planet Observatory Resources

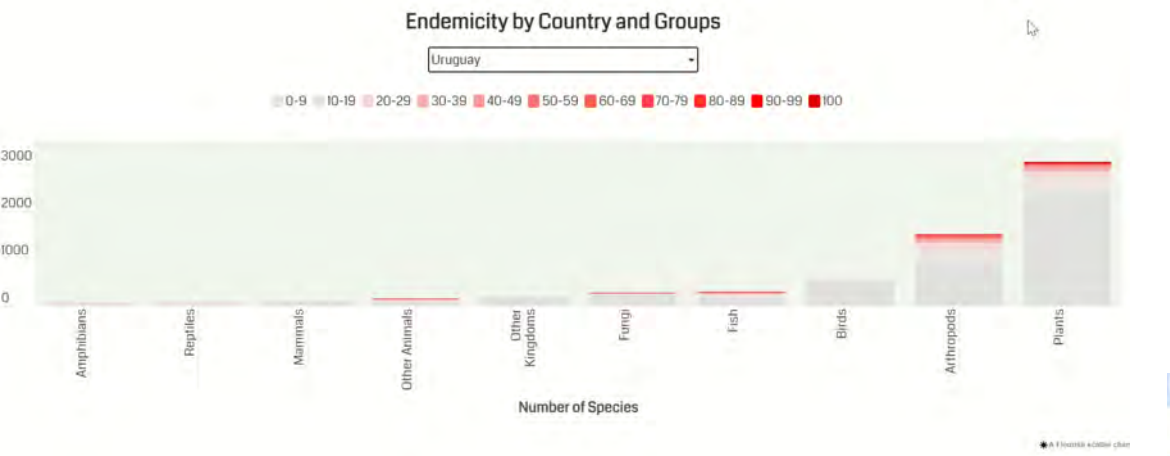
World Bank Geospatial Platform:

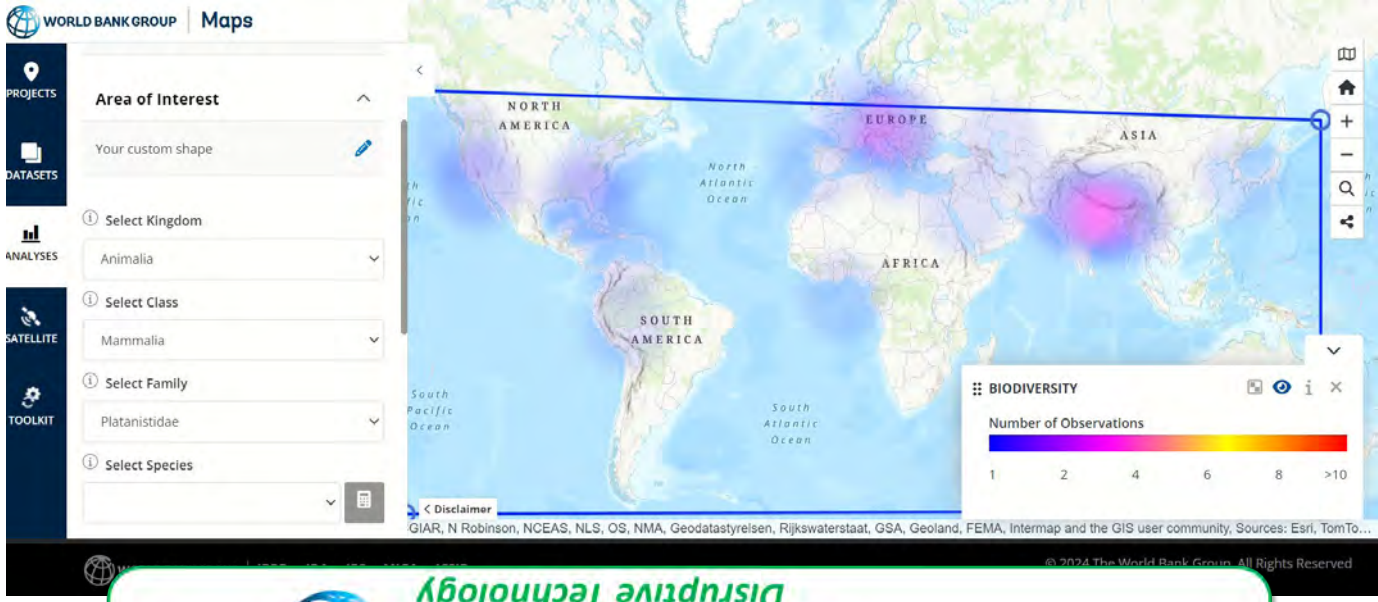
Internal: http://geo/

External: https://maps.worldbank.org/

Spatial Agent mobile app (iOS, Android)

KIDS Catalog: https://spatialagent.org/KIDS/

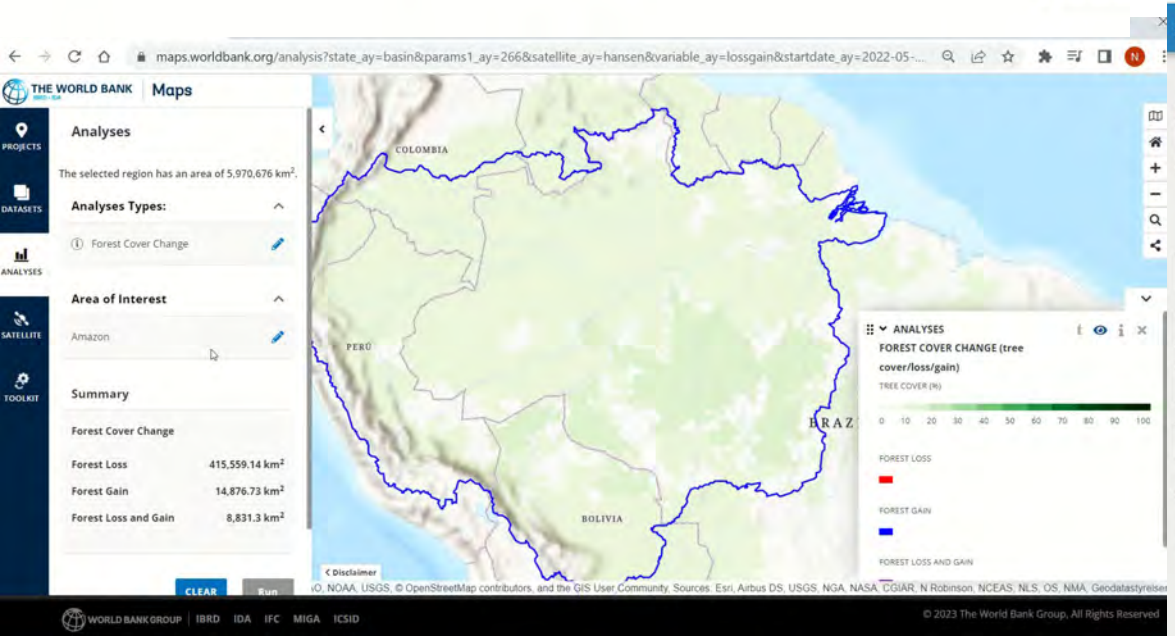


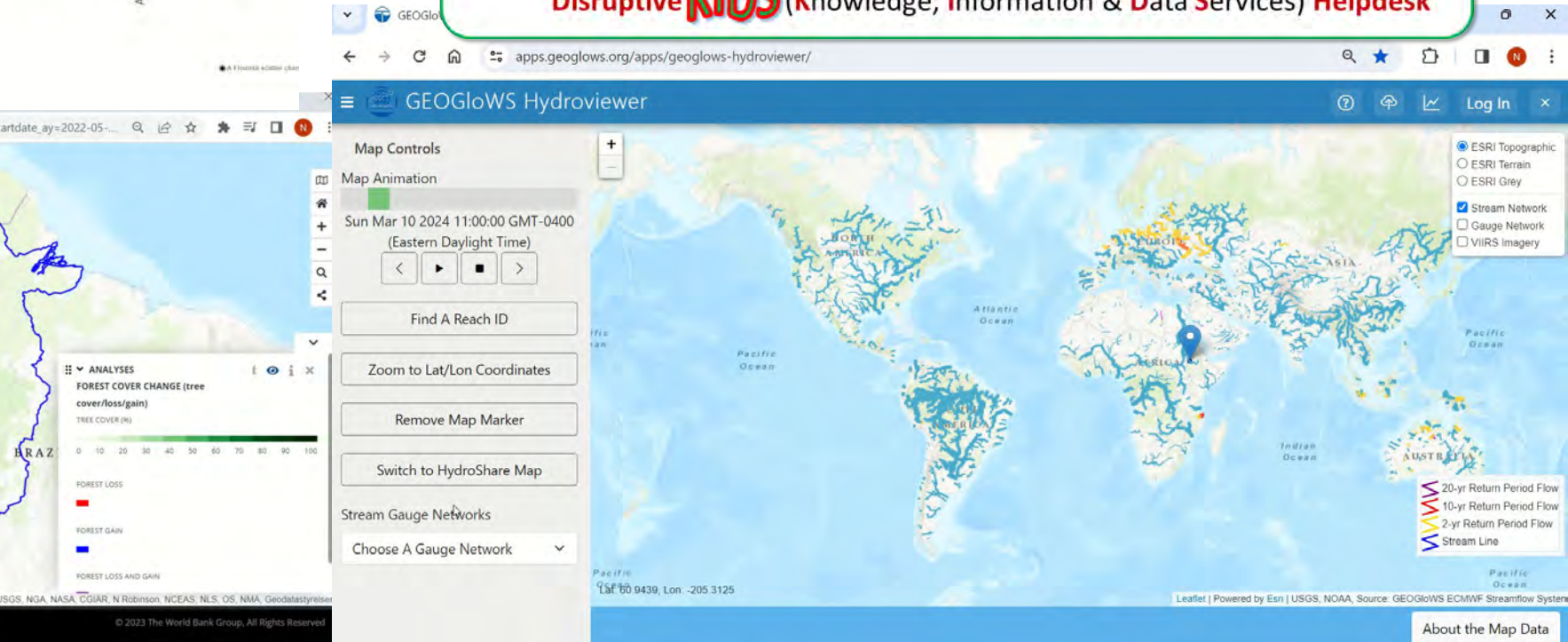


Disruptive Technology

WORLD BANK GROUP

Disruptive KIDS (Knowledge, Information & Data Services) Helpdesk





KIDS: https://spatialagent.org/KIDS/

spatialagent.org/KIDS/

KIDS Products Catalog

WORLD BANK GROUP
Disruptive KIDS (Knowledge, Information & Data Services) Helpdesk
Disruptive Technology

All | Data Portal | eBook | Story Maps | Illustrative Visualizations | Useful External Sites | Web Applications

GEF and the WB

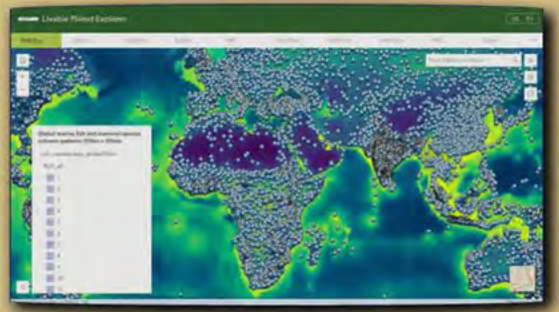
BlueTech eBook

HydroInformatics eBook

Green Tech eBook

Global HydroInformatics

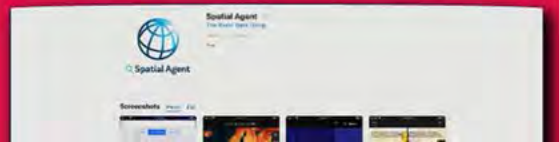
Livable Planet Explorer



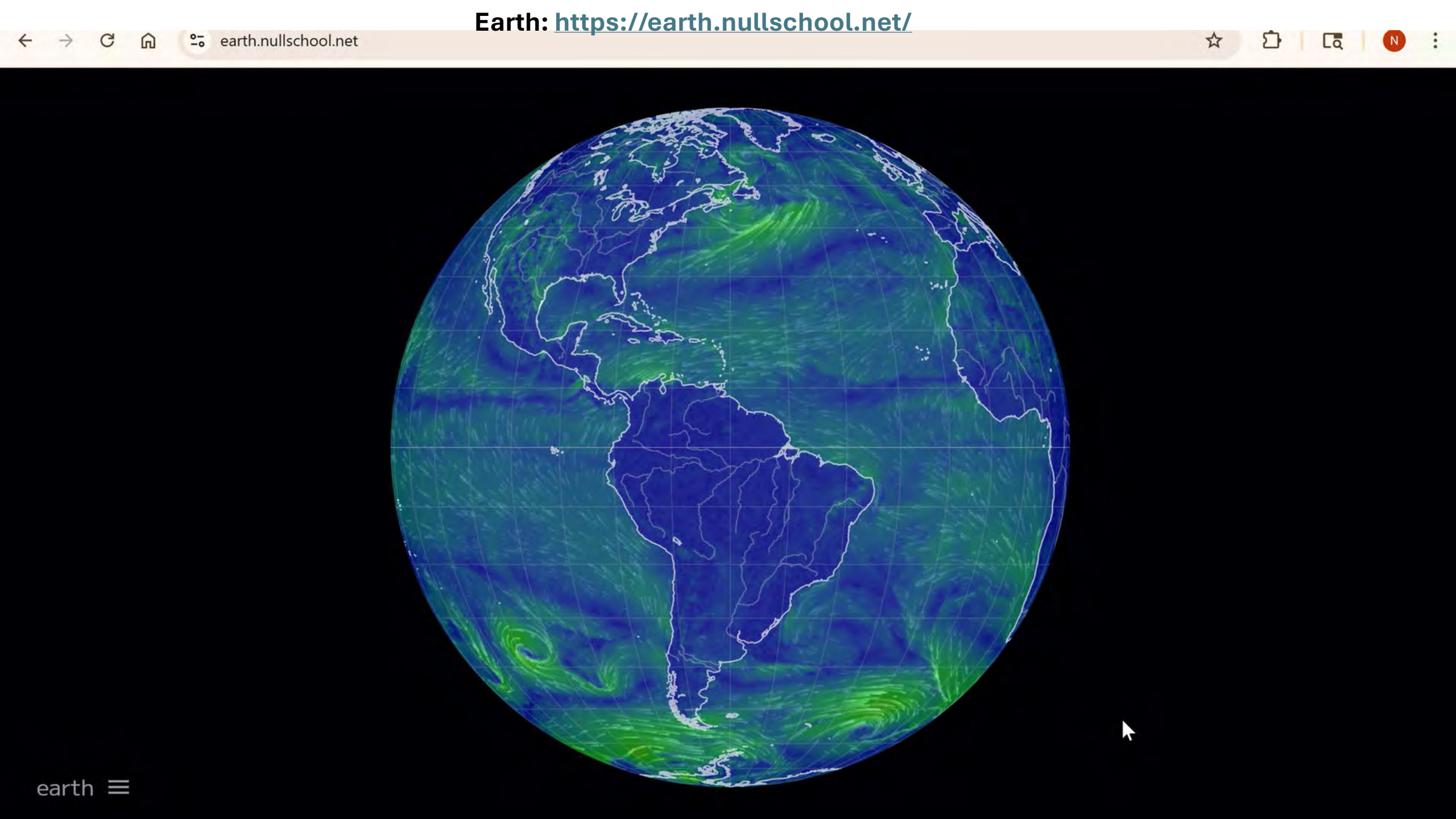
Congo Basin

Disruptive Technology

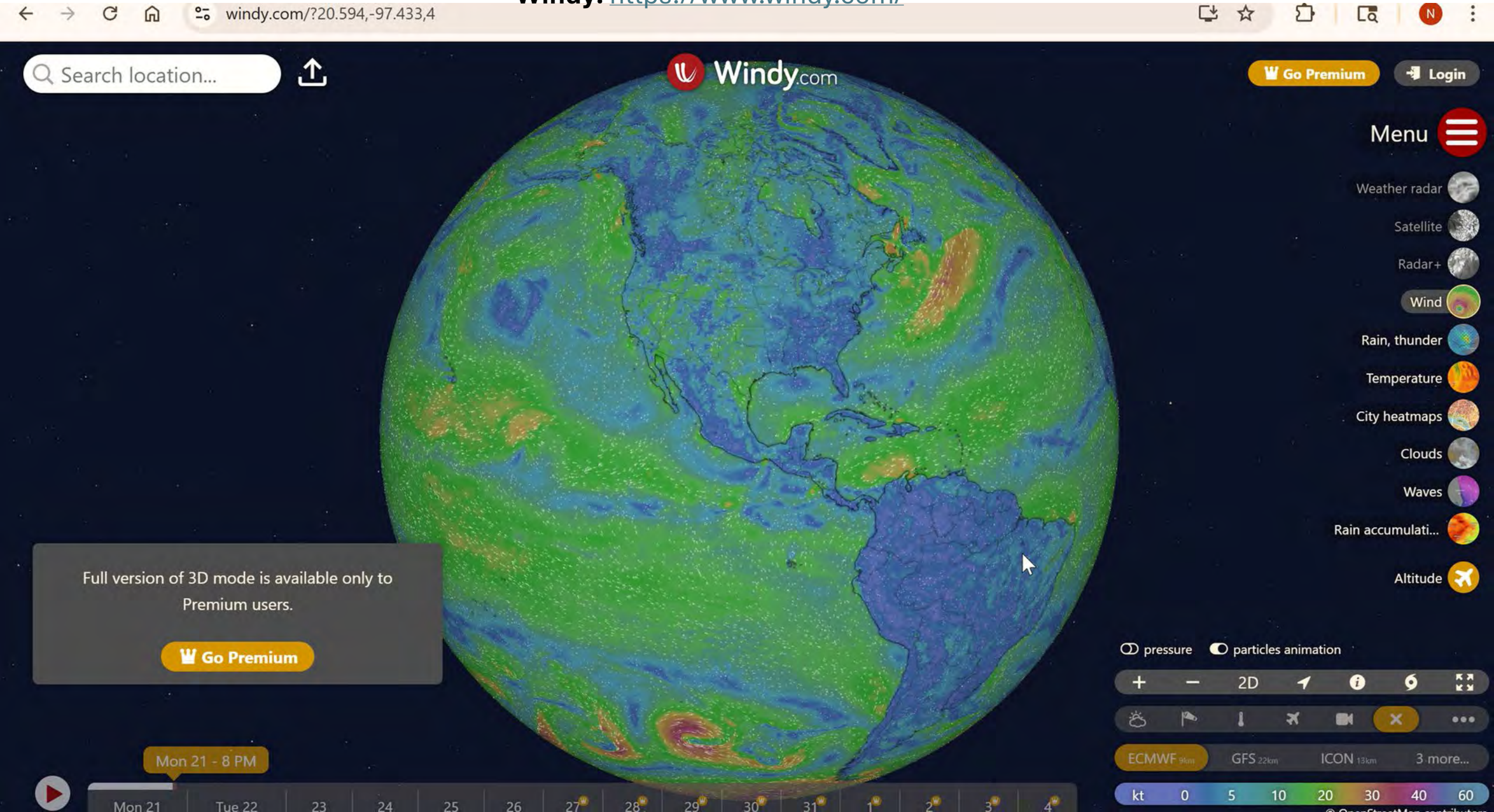
Spatial Agent



Earth: https://earth.nullschool.net/



Windy: https://www.windy.com/



hydroviewer.geoglows.org/#lon=-0.36&lat=32.37&zoom=2.21&definition=

GEOGLOWS River Forecast System

FFI

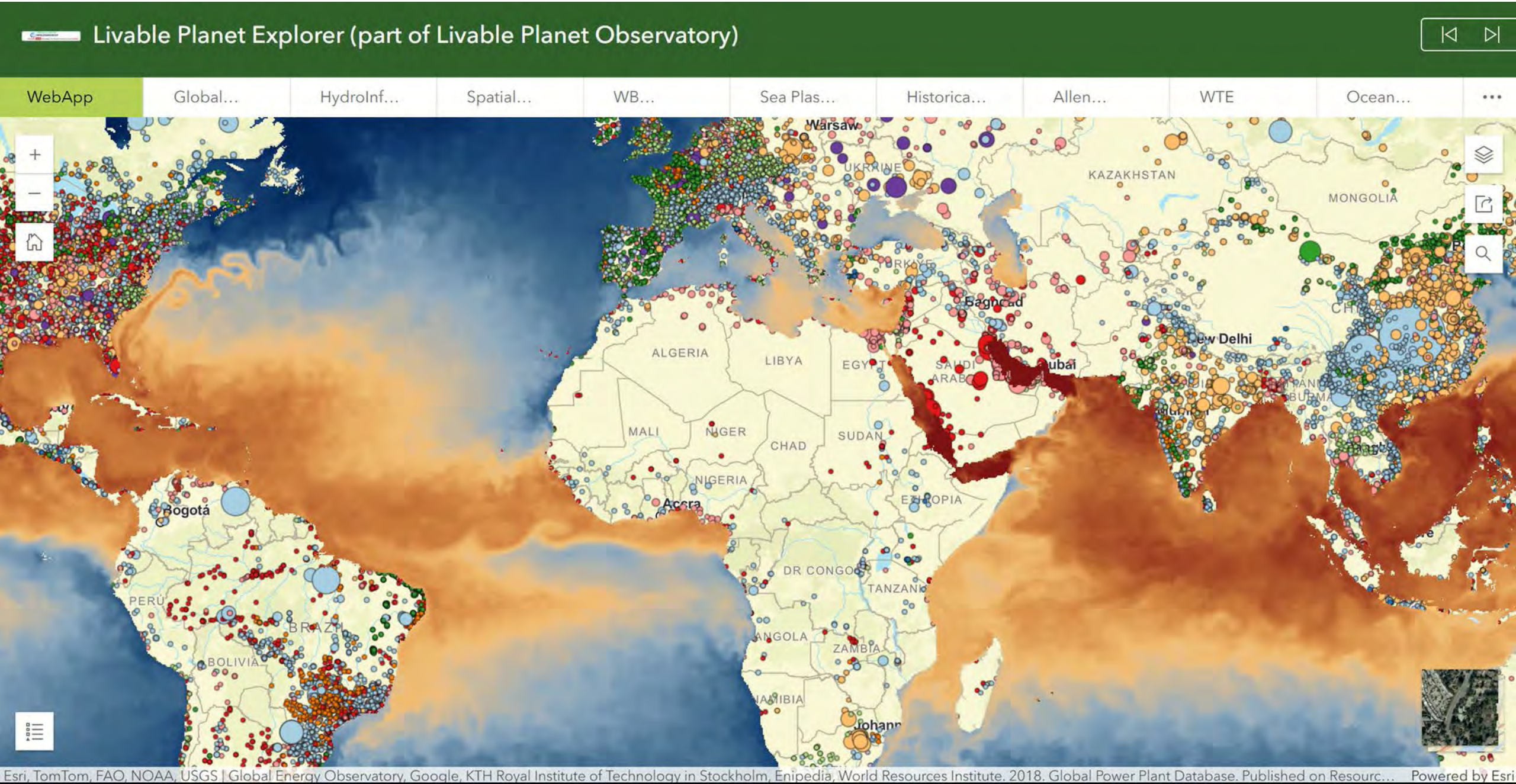
SOS

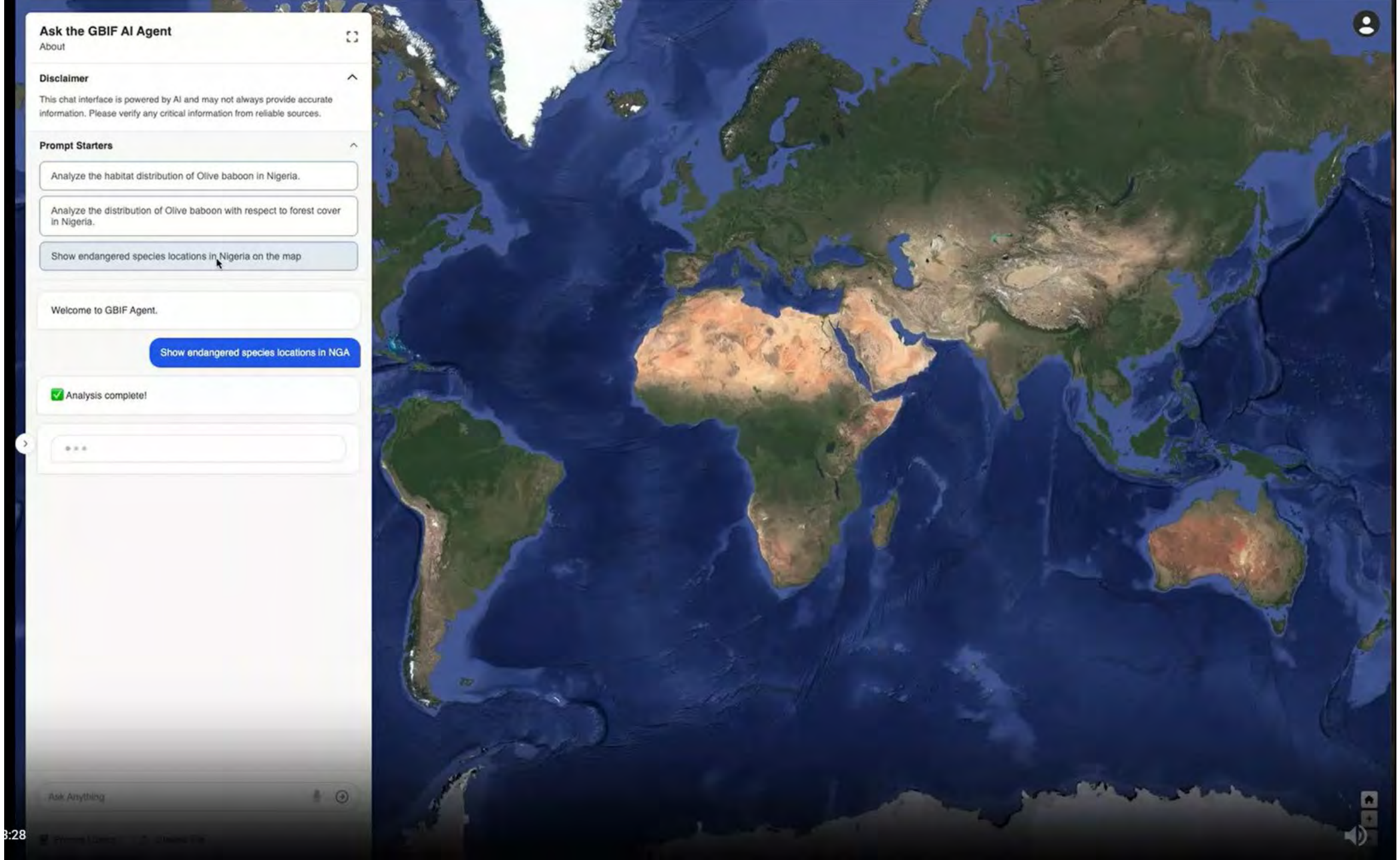
5,000 km
2,000 mi

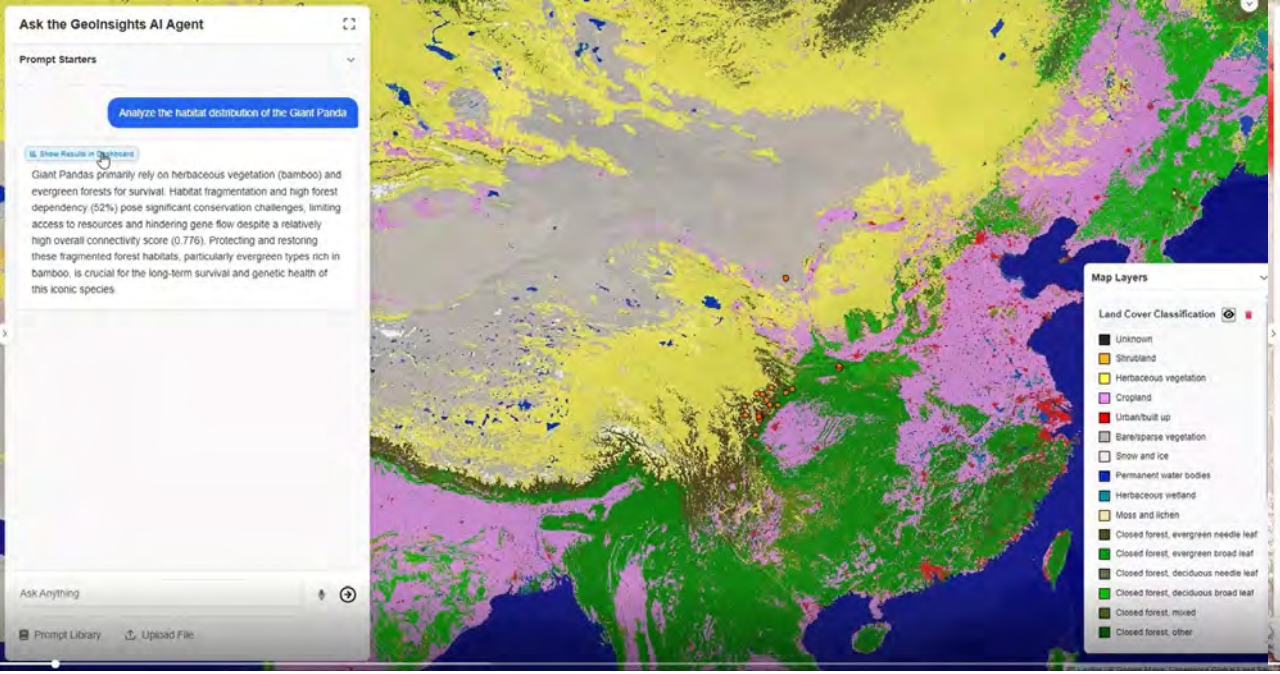
Esri, USGS | Esri, TomTom, FAO, NOAA, USGS

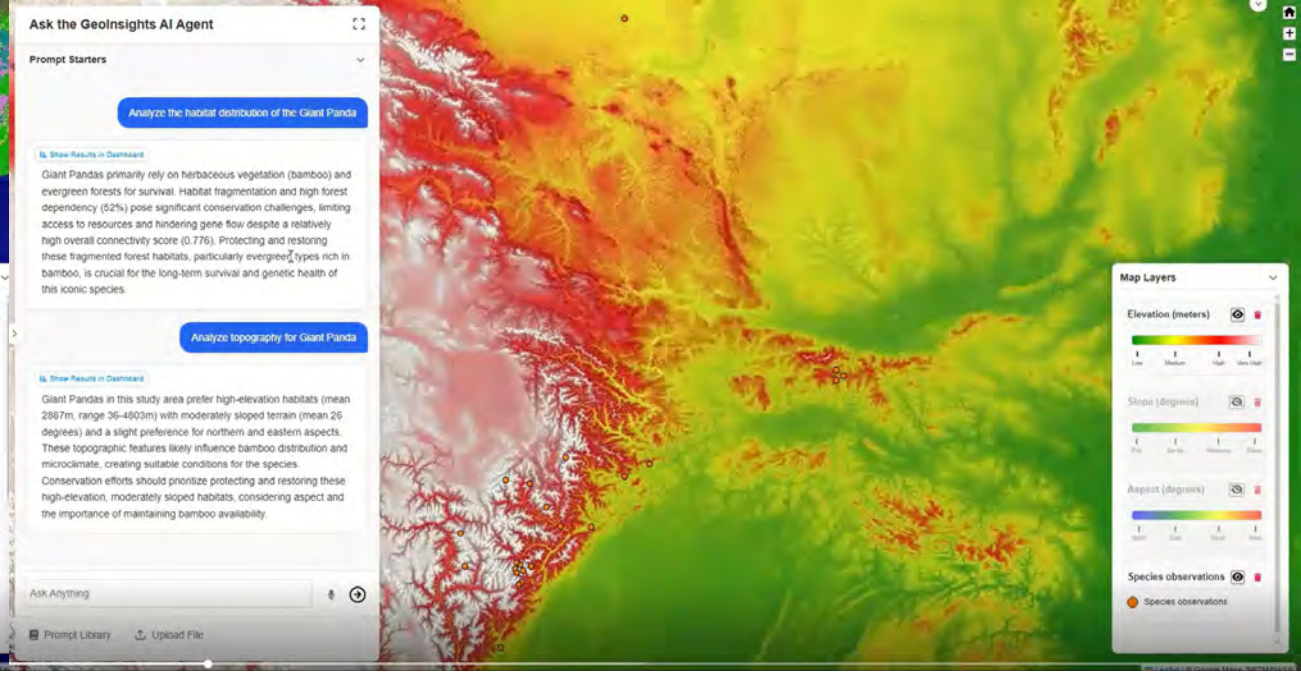
Official Use Only

Livable Planet Explorer https://bit.ly/LivablePlanetExplorer




Ask the GBIF AI Agent
About
Disclaimer
This chat interface is powered by AI and may not always provide accurate information. Please verify any critical information from reliable sources.
Prompt Starters
Analyze the habitat distribution of Olive baboon in Nigeria.
Analyze the distribution of Olive baboon with respect to forest cover in Nigeria.
Show endangered species locations in Nigeria on the map
Welcome to GBIF Agent.
Show endangered species locations in NGA
Analysis complete!
Ask Anything


Ask the GeoInsights AI Agent
Prompt Starters
Analyze the habitat distribution of the Giant Panda
Show Results in Dashboard
Giant Pandas primarily rely on herbaceous vegetation (bamboo) and evergreen forests for survival. Habitat fragmentation and high forest dependency (52%) pose significant conservation challenges, limiting access to resources and hindering gene flow despite a relatively high overall connectivity score (0.776). Protecting and restoring these fragmented forest habitats, particularly evergreen types rich in bamboo, is crucial for the long-term survival and genetic health of this iconic species.
Ask Anything
Prompt Library
Upload File
Map Layers
Land Cover Classification
Unknown
Shrubland
Herbaceous vegetation
Cropland
Urban/built up
Bare/sparse vegetation
Snow and ice
Permanent water bodies
Herbaceous wetland
Moss and lichen
Closed forest, evergreen needle leaf
Closed forest, evergreen broad leaf
Closed forest, deciduous needle leaf
Closed forest, deciduous broad leaf
Closed forest, mixed
Closed forest, other


Ask the GeoInsights AI Agent
Prompt Starters
Analyze the habitat distribution of the Giant Panda
Show Results in Dashboard
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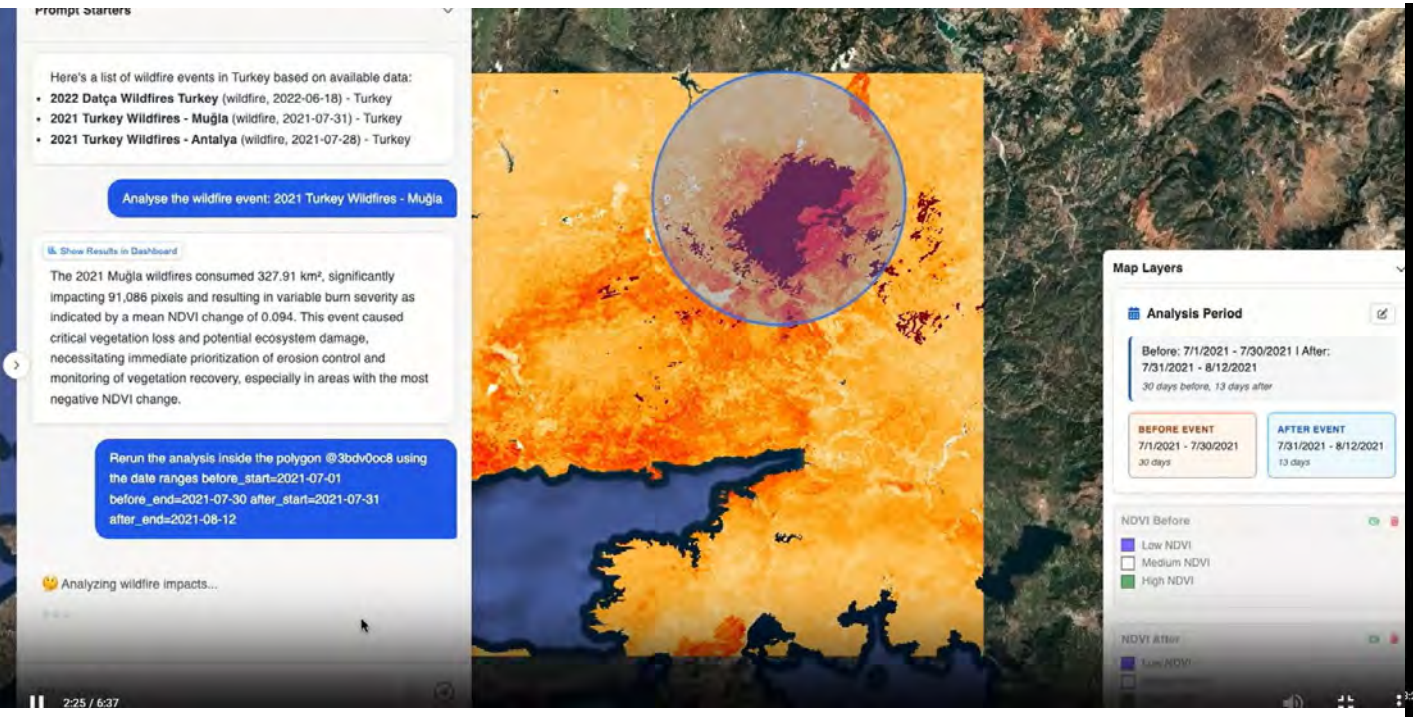
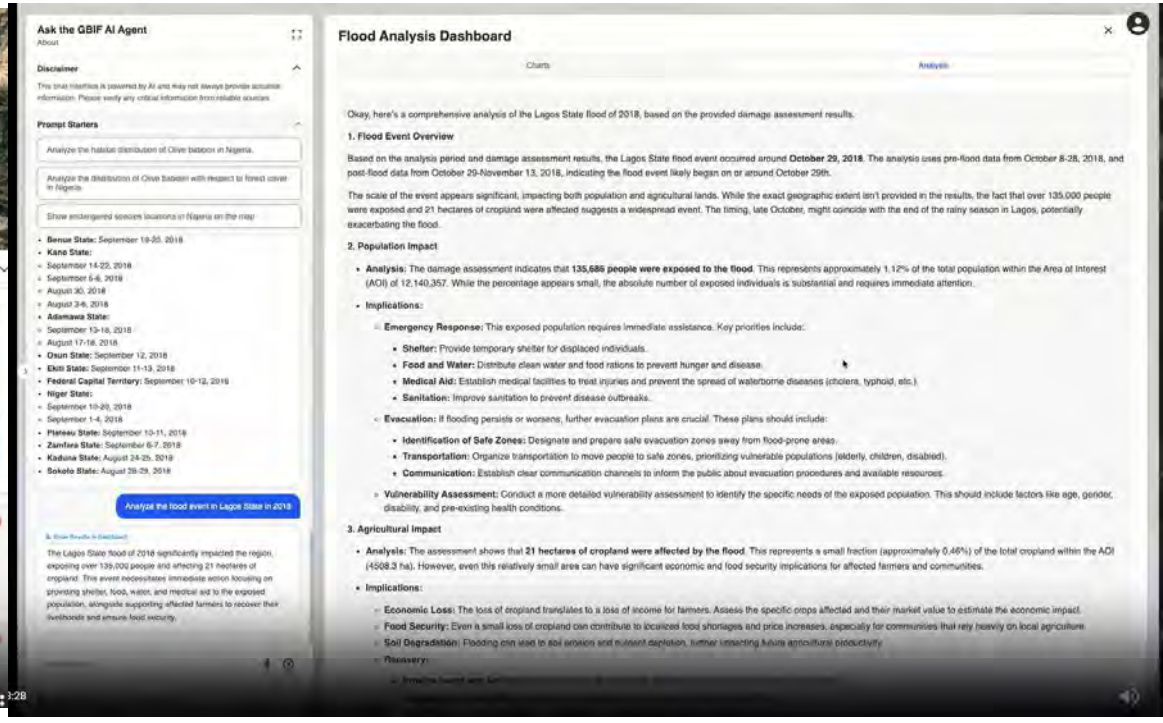
Analyze topography for Giant Panda
Show Results in Dashboard
Giant Pandas in this study area prefer high-elevation habitats (mean 2887m, range 36-4803m) with moderately sloped terrain (mean 26 degrees) and a slight preference for northern and eastern aspects. These topographic features likely influence bamboo distribution and microclimate, creating suitable conditions for the species.
Conservation efforts should prioritize protecting and restoring these high-elevation, moderately sloped habitats, considering aspect and the importance of maintaining bamboo availability.
Ask Anything
Prompt Library
Upload File
Map Layers
Elevation (meters)
Slope (degrees)
Aspect (degrees)
Species observations
Species observations


Prompt Starters
Here's a list of wildfire events in Turkey based on available data:
2022 Datça Wildfires Turkey (wildfire, 2022-06-18) - Turkey
2021 Turkey Wildfires - Muğla (wildfire, 2021-07-31) - Turkey
2021 Turkey Wildfires - Antalya (wildfire, 2021-07-28) - Turkey
Analyse the wildfire event: 2021 Turkey Wildfires - Muğla
Show Results in Dashboard
The 2021 Muğla wildfires consumed 327.91 km², significantly impacting 91,086 pixels and resulting in variable burn severity as indicated by a mean NDVI change of 0.094. This event caused critical vegetation loss and potential ecosystem damage, necessitating immediate prioritization of erosion control and monitoring of vegetation recovery, especially in areas with the most negative NDVI change.
Rerun the analysis inside the polygon @3bdv0oc8 using the date ranges before_start=2021-07-01 before_end=2021-07-30 after_start=2021-07-31 after_end=2021-08-12
Analyzing wildfire impacts...
2:25 / 6:37
Map Layers
Analysis Period
Before: 7/1/2021 - 7/30/2021 | After: 7/31/2021 - 8/12/2021
30 days before, 13 days after
BEFORE EVENT
7/1/2021 - 7/30/2021
30 days
AFTER EVENT
7/31/2021 - 8/12/2021
13 days
NDVI Before
Low NDVI
Medium NDVI
High NDVI
NDVI After


Ask the GBIF AI Agent
About
Disclaimer
Prompt Starters
Analyze the habitat distribution of Olive baboon in Nigeria.
Analyze the distribution of Olive baboon with respect to forest cover in Nigeria
Show endangered species locations in Nigeria on the map
Benue State: September 18-20, 2018
Kano State:
September 14-22, 2018
September 5-6, 2018
August 30, 2018
August 3-6, 2018
Adamawa State:
September 13-18, 2018
August 17-18, 2018
Osun State: September 12, 2018
Ekiti State: September 11-13, 2018
Federal Capital Territory: September 10-12, 2018
Niger State:
September 10-20, 2018
September 1-4, 2018
Plateau State: September 10-11, 2018
Zamfara State: September 6-7, 2018
Kaduna State: August 24-25, 2018
Sokoto State: August 28-29, 2018
Analyze the flood event in Lagos State in 2018
The Lagos State flood of 2018 significantly impacted the region, exposing over 139,000 people and affecting 21 hectares of cropland. This event necessitates immediate action focusing on providing shelter, food, water, and medical aid to the exposed population, alongside supporting affected farmers to recover their livelihoods and ensure food security.
Flood Analysis Dashboard
Charts
Analysis
Okay, here's a comprehensive analysis of the Lagos State flood of 2018, based on the provided damage assessment results.
1. Flood Event Overview
Based on the analysis period and damage assessment results, the Lagos State flood event occurred around October 29, 2018. The analysis uses pre-flood data from October 8-28, 2018, and post-flood data from October 29-November 13, 2018, indicating the flood event likely began on or around October 29th.
The scale of the event appears significant, impacting both population and agricultural lands. While the exact geographic extent isn't provided in the results, the fact that over 135,000 people were exposed and 21 hectares of cropland were affected suggests a widespread event. The timing, late October, might coincide with the end of the rainy season in Lagos, potentially exacerbating the flood.
2. Population Impact
Analysis: The damage assessment indicates that 135,686 people were exposed to the flood. This represents approximately 1.12% of the total population within the Area of Interest (AOI) of 12,140,357. While the percentage appears small, the absolute number of exposed individuals is substantial and requires immediate attention.
Implications:
Emergency Response: This exposed population requires immediate assistance. Key priorities include:
Shelter: Provide temporary shelter for displaced individuals.
Food and Water: Distribute clean water and food rations to prevent hunger and disease.
Medical Aid: Establish medical facilities to treat injuries and prevent the spread of waterborne diseases (cholera, typhoid, etc.).
Sanitation: Improve sanitation to prevent disease outbreaks.
Evacuation: If flooding persists or worsens, further evacuation plans are crucial. These plans should include:
Identification of Safe Zones: Designate and prepare safe evacuation zones away from flood-prone areas.
Transportation: Organize transportation to move people to safe zones, prioritizing vulnerable populations (elderly, children, disabled).
Communication: Establish clear communication channels to inform the public about evacuation procedures and available resources.
Vulnerability Assessment: Conduct a more detailed vulnerability assessment to identify the specific needs of the exposed population. This should include factors like age, gender, disability, and pre-existing health conditions.
3. Agricultural Impact
Analysis: The assessment shows that 21 hectares of cropland were affected by the flood. This represents a small fraction (approximately 0.46%) of the total cropland within the AOI (4508.3 ha). However, even this relatively small area can have significant economic and food security implications for affected farmers and communities.
Implications:
Economic Loss: The loss of cropland translates to a loss of income for farmers. Assess the specific crops affected and their market value to estimate the economic impact.
Food Security: Even a small loss of cropland can contribute to localized food shortages and price increases, especially for communities that rely heavily on local agriculture.
Soil Degradation: Flooding can lead to soil erosion and nutrient depletion, further impacting future agricultural productivity.
Recovery:
3:28

Live Demos

World Bank:

- World Bank Geospatial Platform: https://maps.worldbank.org/
- Livable Planet Observatory: https://bit.ly/LivablePlanetExplorer
- KIDS Catalog: https://spatialagent.org/KIDS/

External

- Google Earth Pro/ http://earth.google.com/
- Watershed Delineator: https://mghydro.com/watersheds/
- FAO EarthMap: https://earthmap.org/

Geospatial in Projects

Corporate Scorecard: https://scorecard.worldbank.org/
GEF Portfolio
GEF-WB Storymap

Nigeria: https://bit.ly/NigeriaWebApp
India: River Health

Disrupt or Be Disrupted!

Thanks!

External LPO

Disruptive Technology

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Disruptive KIDS (Knowledge, Information & Data Services) Helpdesk