Transatlantic Collaboration

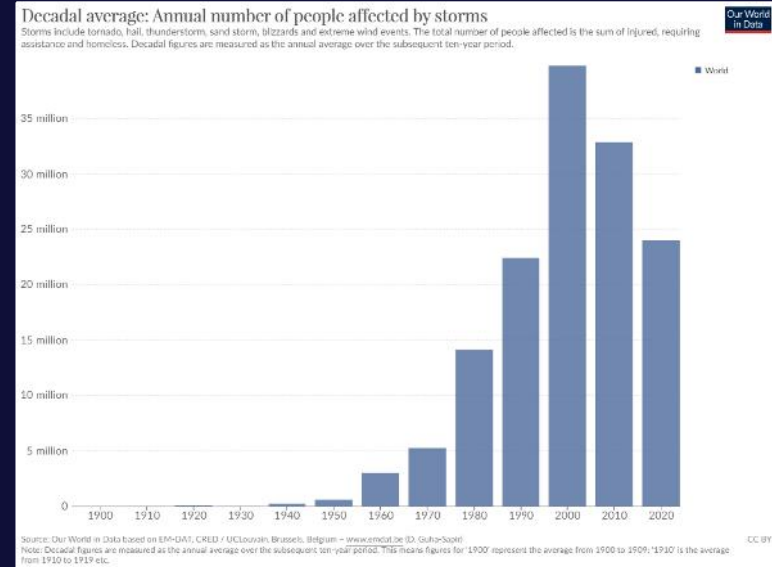# 2023 Federated Marine Spatial Data Infrastructure Pilot

Cost of Hurricanes

- The average annual economic impact of hurricanes is $352+ Million and thousands of lives are lost yearly to hurricanes across the Caribbean & climate change models suggest increasing severity of Hurricanes.

- The high winds, change in air pressure and other factors which occur during a hurricane combined with the topology of the land and continental shelf can cause the sea to inundate the land in the form of a storm surge. This causes further damage and threat to life and livelihood.

Credit: NASA, BBC, OurWorldInData, New Orleans after Hurricane Katrina (Public Domain image

Decadal average: Annual number of people affected by storms

Storms include tornado, hail, thunderstorm, sand storm, blizzards and extreme wind events. The total number of people affected is the sum of injured, requiring assistance and homeless. Decadal figures are measured as the annual average over the subsequent ten-year period.

Source: Our World in Data based on EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be (D. Guha-Sapir)
Note: Decadal figures are measured as the annual average over the subsequent ten-year period. This means figures for '1900' represent the average from 1900 to 1909; '1910' is the average from 1910 to 1919 etc.
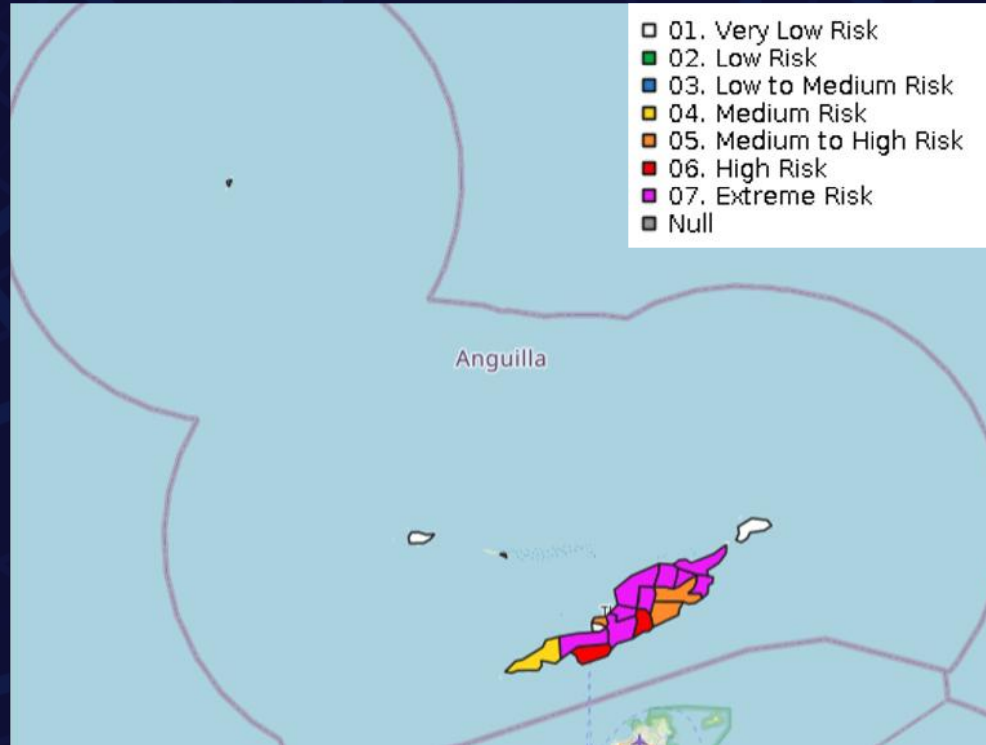
HSR. *health* ✚

Island Nations Within Scope

Hurricane Health Risk Index

User Query: > What areas of the Anguilla are most at risk from a hurricane?

- ☐ 01. Very Low Risk
- ☐ 02. Low Risk
- ☐ 03. Low to Medium Risk
- ☐ 04. Medium Risk
- ☐ 05. Medium to High Risk
- ☐ 06. High Risk
- ☐ 07. Extreme Risk
- ☐ Null

Anguilla

HSR. health ✚

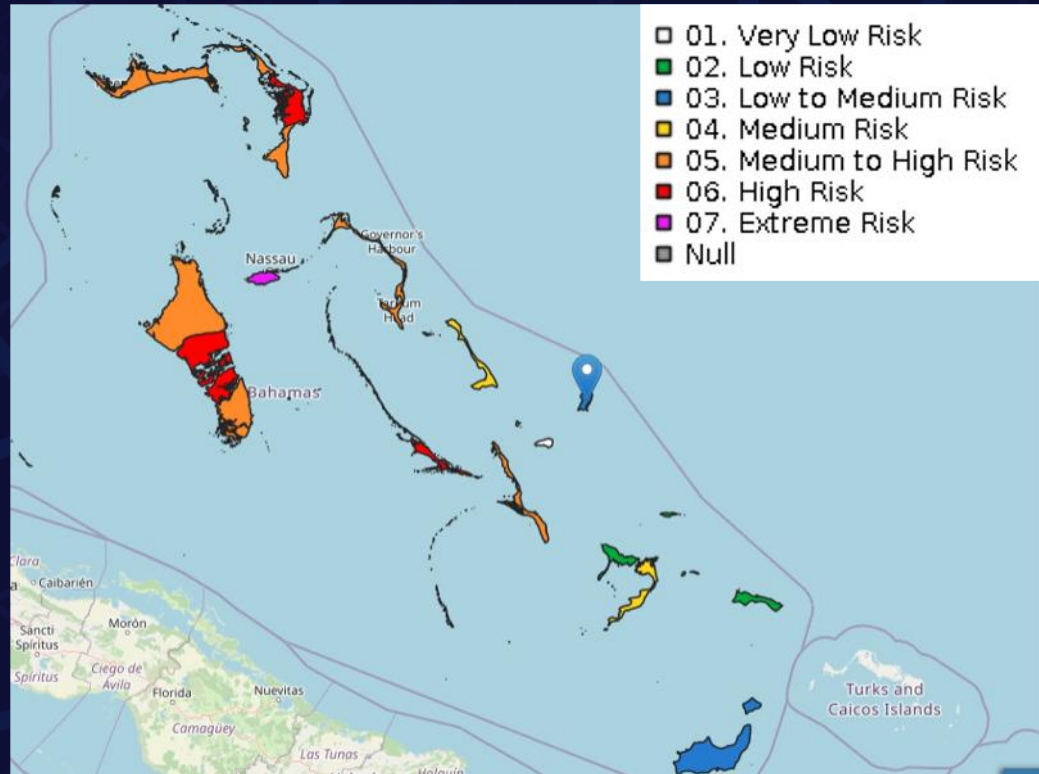# Hurricane Health Risk Index

User Query:
> What areas of the Caribbean are most at risk from a hurricane?
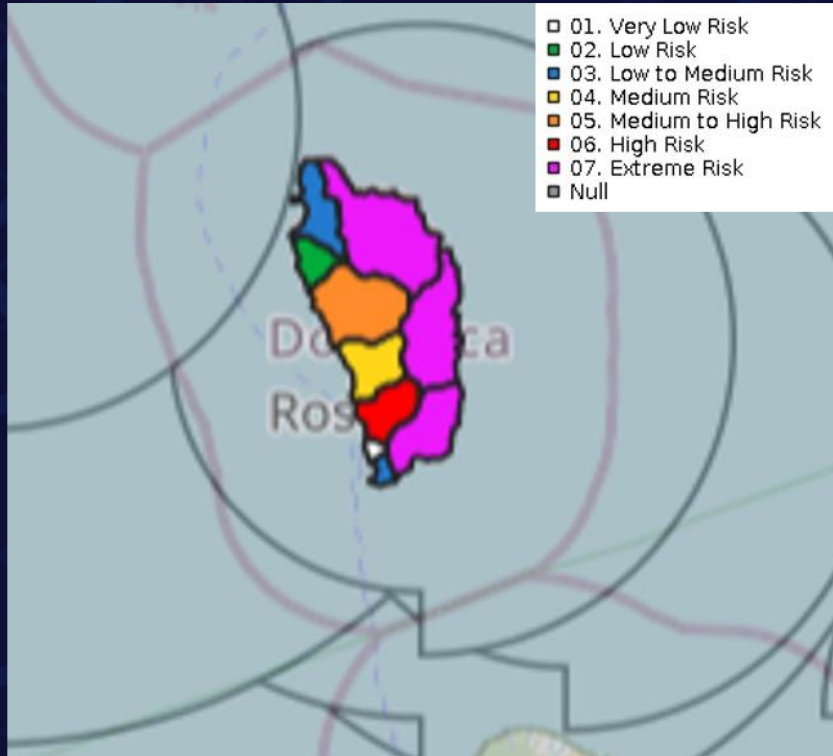
Hurricane Health Risk Index

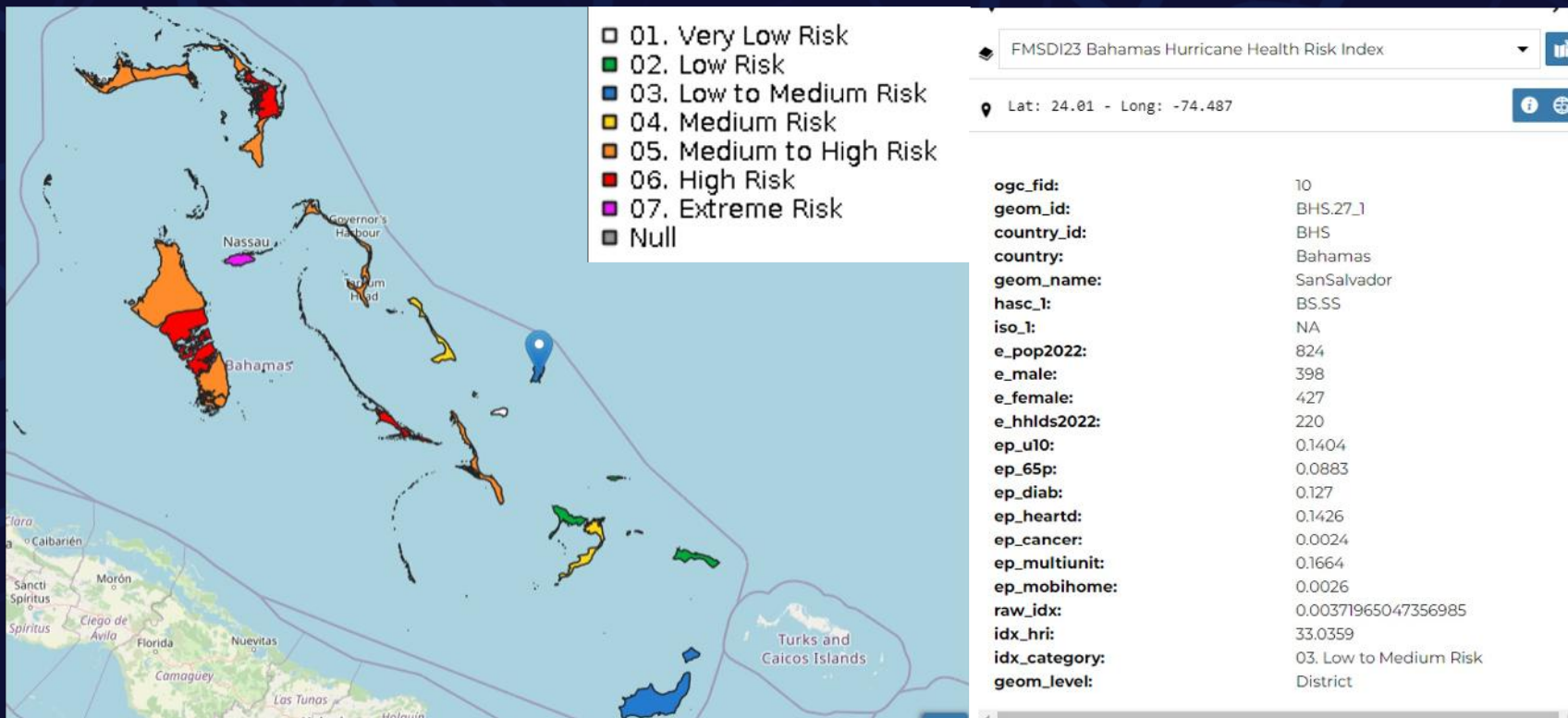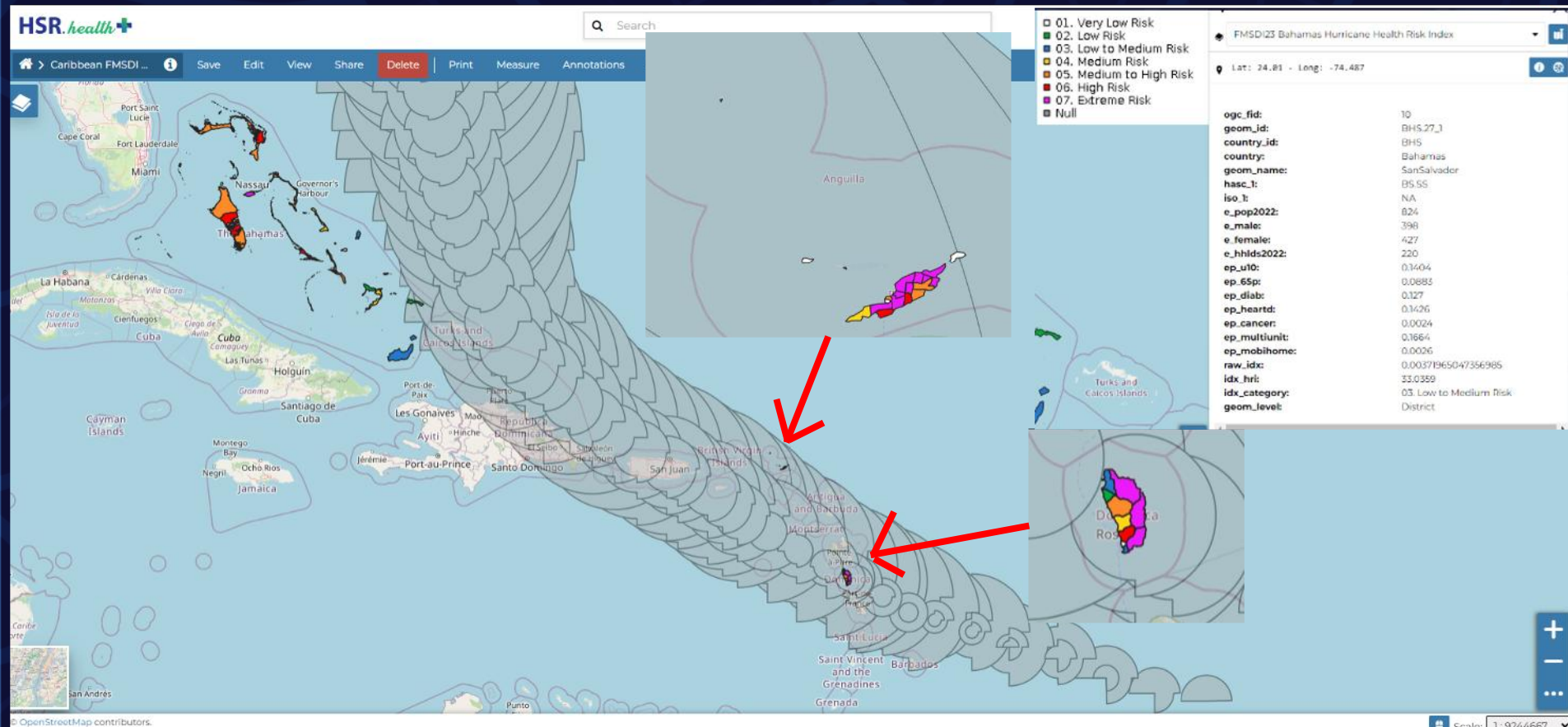User Query: > What is the risk exposure for The Bahamas from a hurricane?

Legend:
- ☐ 01. Very Low Risk
- ☐ 02. Low Risk
- ☐ 03. Low to Medium Risk
- ☐ 04. Medium Risk
- ☐ 05. Medium to High Risk
- ☐ 06. High Risk
- ☐ 07. Extreme Risk
- ☐ Null

HSR. health +

Hurricane Health Risk Index

User Query: > What is the risk exposure for The Bahamas from a hurricane?

Legend:
- 01. Very Low Risk
- 02. Low Risk
- 03. Low to Medium Risk
- 04. Medium Risk
- 05. Medium to High Risk
- 06. High Risk
- 07. Extreme Risk
- Null

FMSDI23 Bahamas Hurricane Health Risk Index

Lat: 24.01 - Long: -74.487

| Field	Value
ogc_fid:	10
geom_id:	BHS.27_1
country_id:	BHS
country:	Bahamas
geom_name:	SanSalvador
hasc_1:	BS.SS
iso_1:	NA
e_pop2022:	824
e_male:	398
e_female:	427
e_hhlds2022:	220
ep_u10:	0.1404
ep_65p:	0.0883
ep_diab:	0.127
ep_heartd:	0.1426
ep_cancer:	0.0024
ep_multiunit:	0.1664
ep_mobihome:	0.0026
raw_idx:	0.00371965047356985
idx_hri:	33.0359
idx_category:	03. Low to Medium Risk
geom_level:	District

Hurricane Health Risk Index with Storm Path

Scenarios for Storm Surge Risk Mapping

- Scenario 1 of an approaching Category 5 hurricane with a predicted path through The Bahamas Islands. (From NOAA, based on Hurricane Dorian-2019).

- Scenario 2 of an approaching Category 5 hurricane with a predicted path close to Anguilla and The Commonwealth of Dominica. (From NOAA, based on Hurricane Irma-2017).
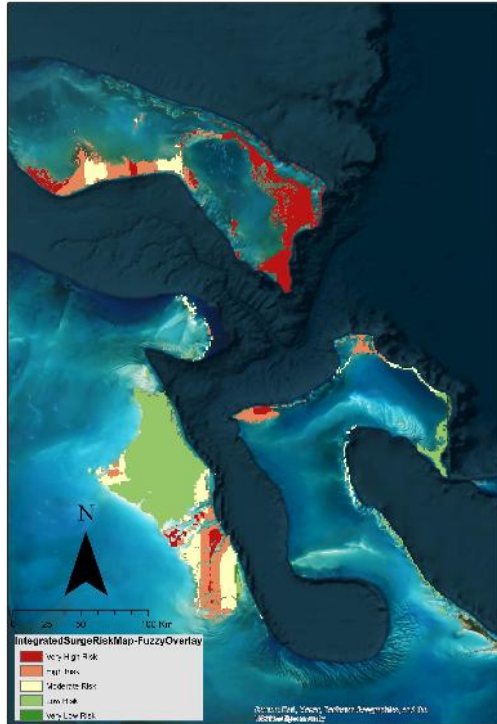
Implementation
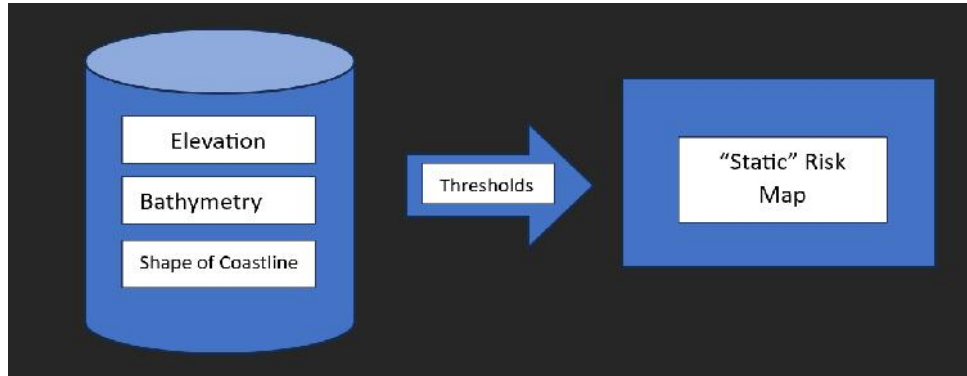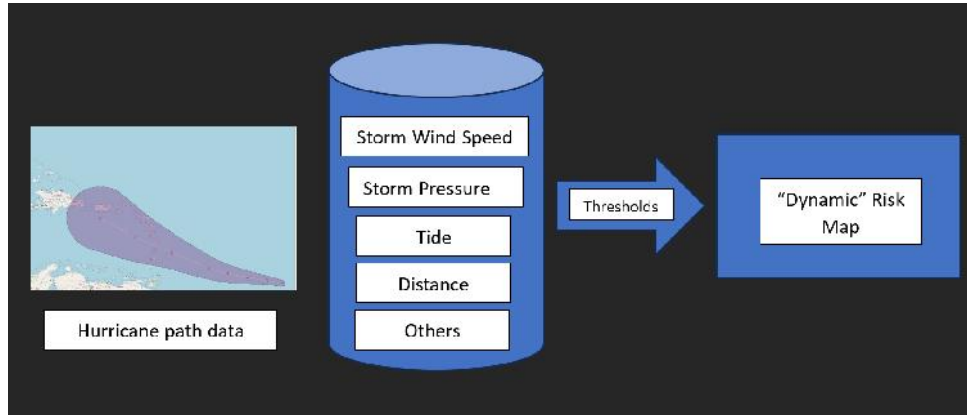
Integrated Storm Surge Risk Map

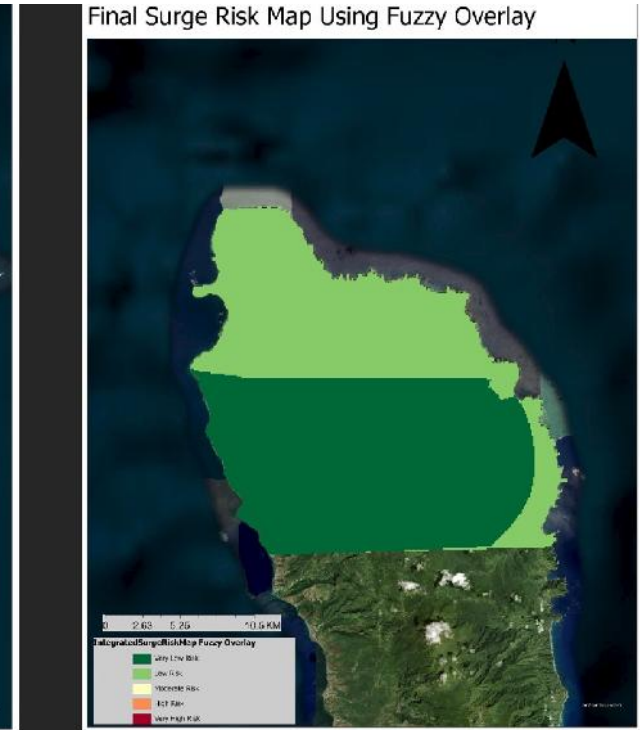*Accessible to open in any GIS software or view and share via our Foresight DRM platform using OGC standards*

Results: Integrated Storm Surge Risk Maps
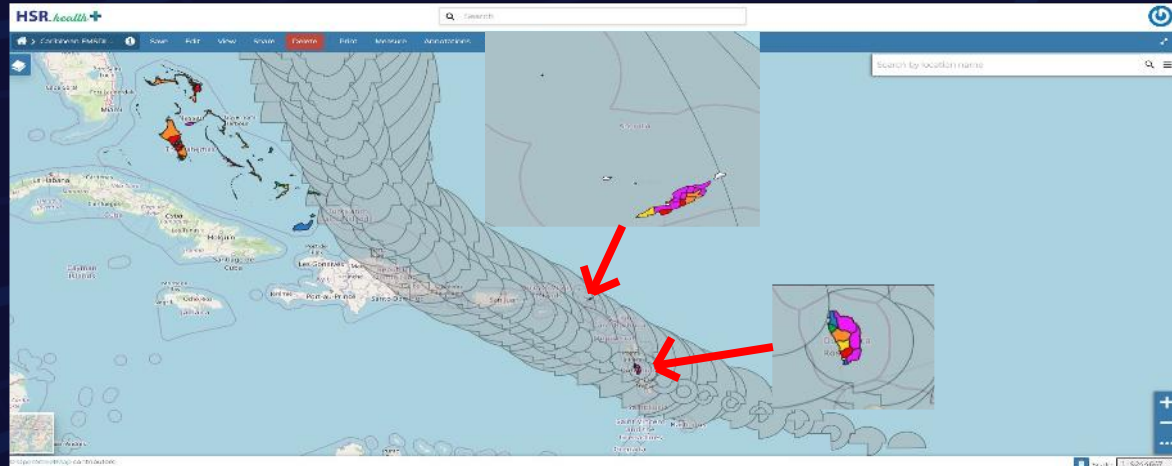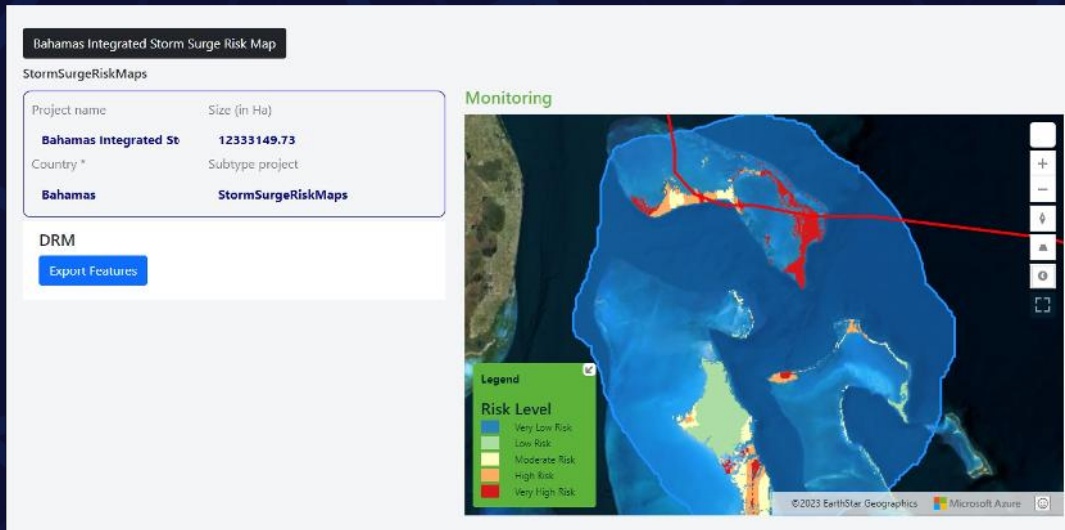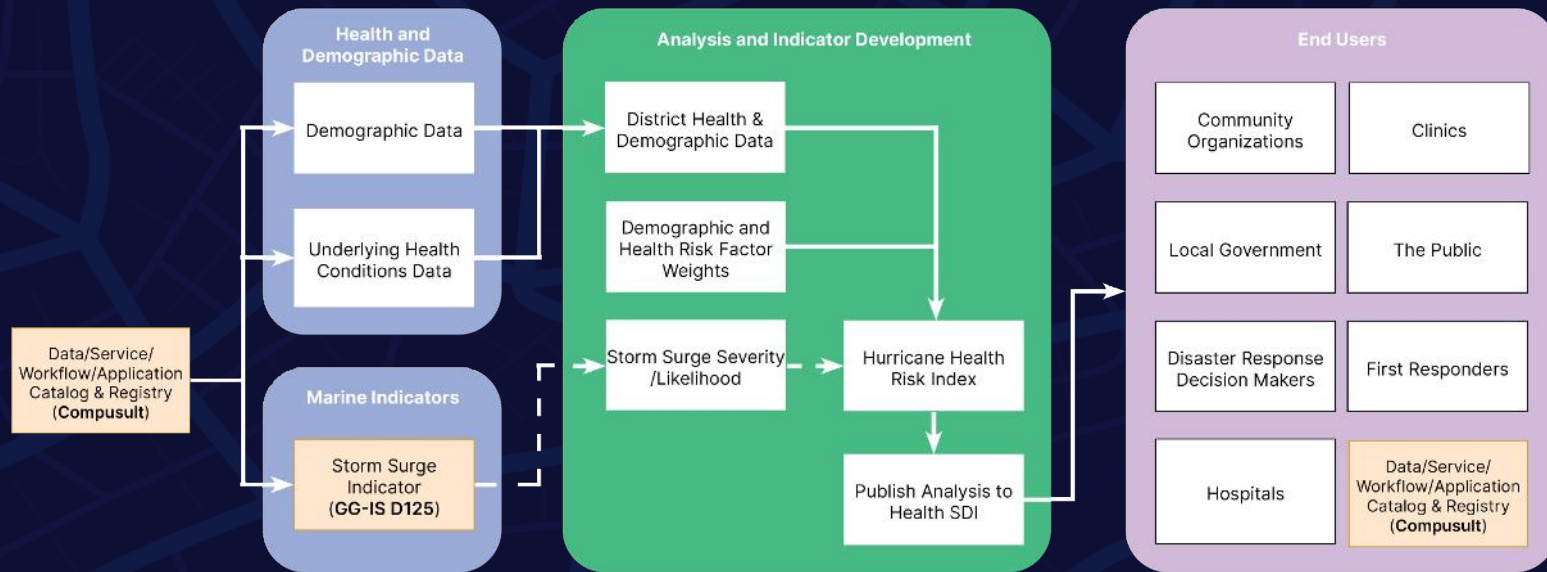

The Bahamas

Anguilla

Commonwealth of Dominica

Storm Surge Indicator & Hurricane Heath Risk Index Integration

Architecture & Workflow – Hurricane Heath Risk Index

Health and Social Factors Included in the Hurricane Health Risk Index

- Percent under 10 Years Old
- Percent over 65 Years Old
- COPD Prevalence
- Diabetes Prevalence
- Heart Disease Prevalence
- Cancer Prevalence

- Percent Disabled
- Percent non-Fluent
- Percent living in Multi-Unit Structures
- Percent living in Mobile Homes
- Percent High Housing Occupancy Density

Users and Benefits of the Hurricane Health Risk Index

End Users / Stakeholders

- Health Professionals and Researchers

- Marine Industry

- Governmental Organizations

- Economic Development

- Urban and Civil Planners

- Financial Institutions

- Energy, Utilities Sectors

- Tourists & Public

Benefits

- Identification of vulnerable populations across the hurricane impacted area

- Provide information that can be used for allocation of personnel and resources

- Allow a Federated Marine Spatial Data Infrastructure to be a source of health risk insights

HSR. health +

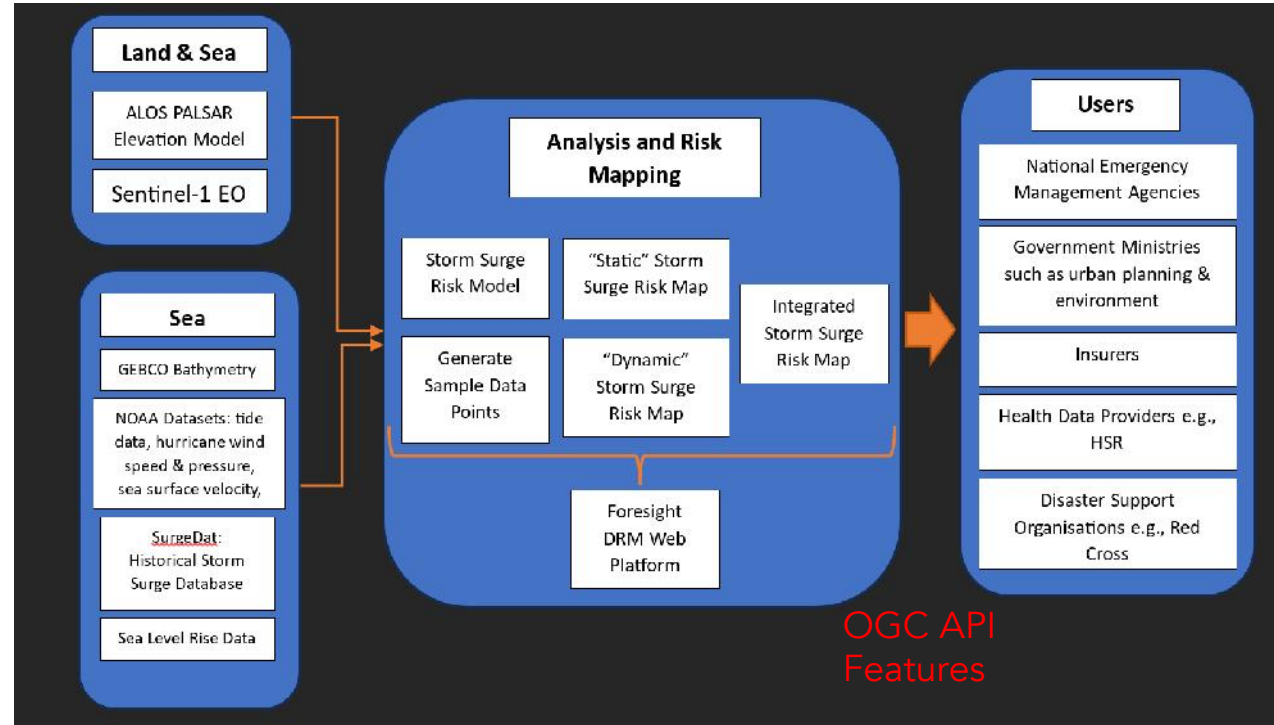# Architecture & Workflow – Storm Surge

Learn:
- Analysis of SurgeDat
- Collate Data
- Define Thresholds

Implement:
- Define Sampling Grid
- Define Storm Path
- Collate Data
- Apply Thresholds
- Produce Static & Dynamic Maps
- Integrated Risk Maps

Visualise & Share:
- Foresight DRM Platform
- OGC API – Features
- GeoMD Platform

GGIS

# Users & Benefits of the Storm Surge Risk Mapping

Users & Stakeholders:

- Government Agencies such as: The Bahamas National Emergency Management Agency (NEMA), Department of Disaster Management (Anguilla), Dominica's National Emergency Planning Organisation (NEPO)

- Ministry of Housing, Ministry of Environment.

- Support agencies such as the Red Cross (ICRC), Rescue Global, etc

- Caribbean Disaster Emergency Management Agency (CDEMA)

- Universities, Schools, Community Organisations

- Insurance Agencies: Local & Regional (e.g. CCRIF)

Benefits:

- Enables Disaster Pre-Planning

- Locating Relief Centres and Evacuation Sites

- Appropriate Allocation of Resources

- Informed Housing/Planning and Building Policies.

- Advanced Communications with Locals & Other Stakeholders.

- Identification of High Risk Areas with Respect to Storm surges.

GGIS

Microplastic Bioaccumulation Health Risk Index
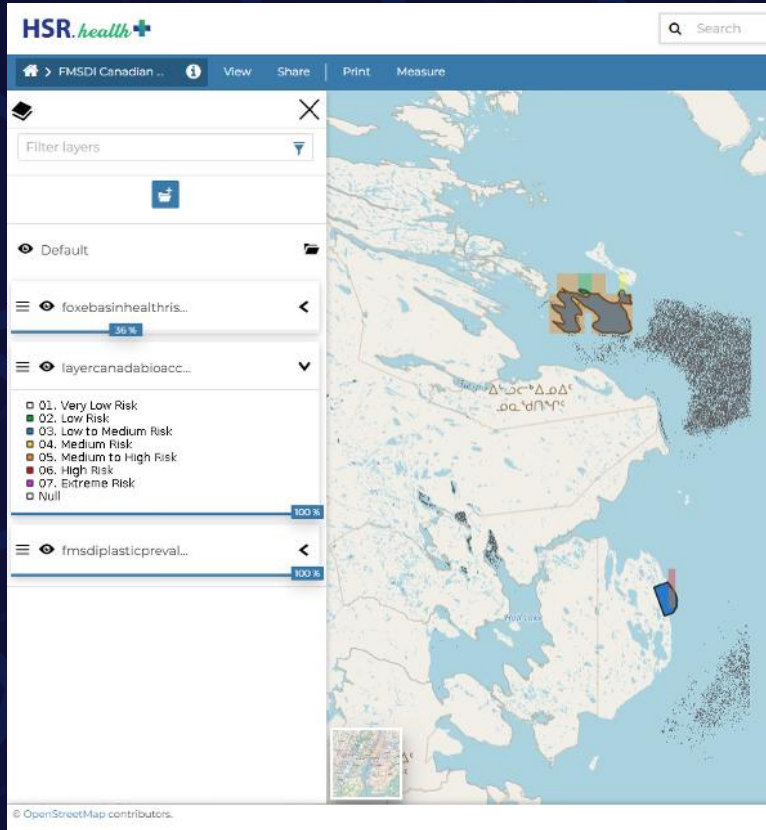
- Leverage satellite imagery, ML/AI to extract plastic prevalence & size in our oceans and waterways

- Identifies vulnerable populations to bioaccumulation based on population demographics and underlying health conditions

- Results available through Generative AI, geospatial applications, and direct access in multiple formats

- Demonstrated in the Foxe Basin, Canadian Arctic, funded by NRCan and NOAA.

Help End Users…

- Commercial and Marine Industries
- Fishing Industry
- Supply Chains
- Environmental Organizations
- Public Health Organizations
- Governments
- Health Researchers
- The Public

…With Use Cases

- Identify locations for environmental clean up
- Identify healthy/at-risk fish populations
- Manage supply chains
- Identify populations needs preventive clinical efforts, health education
- Land and sea plastic disposal policies and restrictions

HSR.health✚

The GeoMD Platform
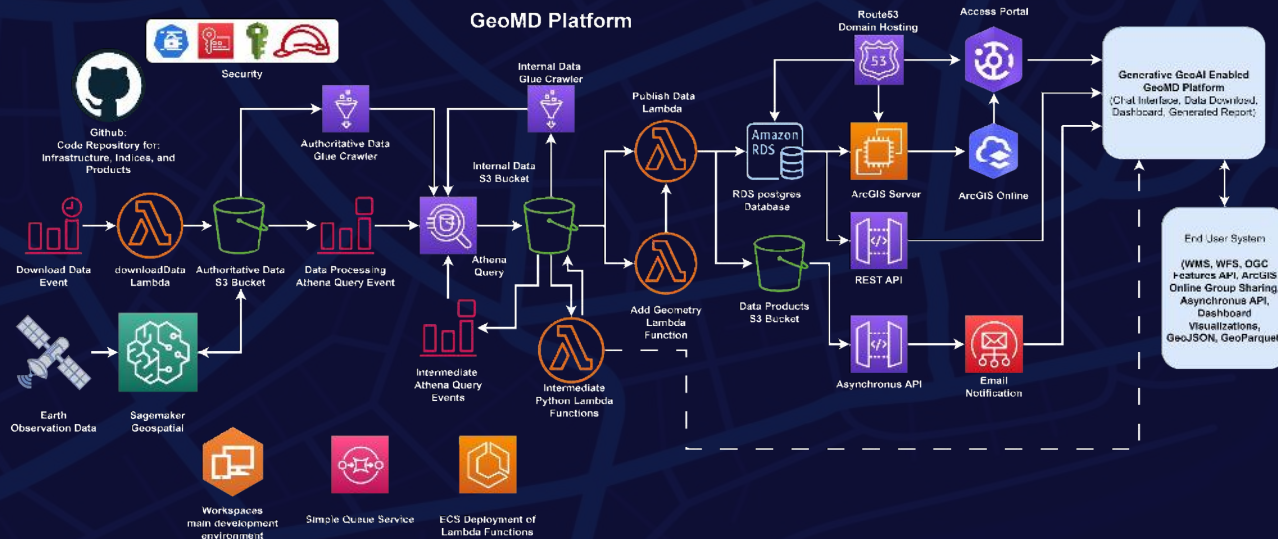
- Built in the AWS Cloud

- ESRI ArcGIS Enterprise Stack

- Geonode / Geoserver Open Source Stack

- Event-Based data analysis pipelines

- Insights into Global Health Issues

Foresight DRM: GGIS Storm Surge Risk Mapping

- The analysis combines both land and sea datasets.

- Uses statistical algorithms and machine learning to extract patterns and rules from historical datasets.

- Is able to explore "what if" scenarios for defined potential hurricane paths or assessing the impact of sea level rise on future storm surges.

- Once the process is fully automated: Is able to provide near real time dynamic risk maps based on the environmental, land and sea data.

- Incorporation of data from local hydrographic agencies would help to improve the analysis.

- We will build on this prototype to provide a storm surge risk mapping service as part of our Foresight DRM product.

Generative AI Enabled GeoMD Platform

Combines:

- Geospatial Analysis
- AI/ML Data Science
- Health Risk Analysis
- Satellite Imagery Analysis
- Generative AI to simplify User Interaction
- Purpose-built LLMs to augment data curation & create training datasets

Resulting in a novel, powerful platform for health-focused insights

HSR.health +
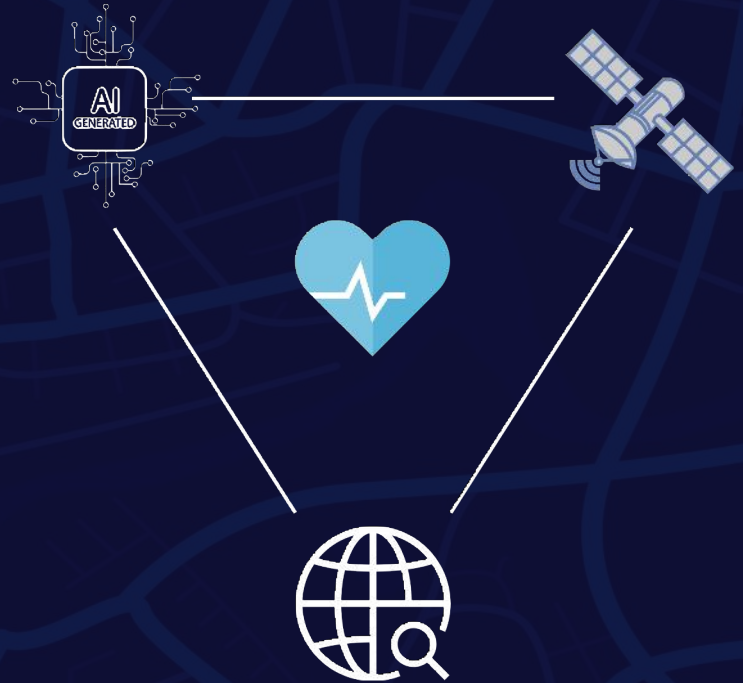
Generative AI Enabled GeoMD Platform

Eases and Expands Access to Dynamic Health Insights related to Impact of:

- Access to Care
- Social and Demographic Characteristics
- Environmental Factors
- The Built Environment
- Pre-existing Conditions
- And More

On adverse health outcomes, consumer behavior, and broad market impacts.

HSR.health ✚

Demonstration Video and Persistent Demonstrators

Hurricane Health Risk Index

- HSR.*health*'s demonstration video:
  - https://www.youtube.com/ogcvideo

- Persistent Demonstrator for all island nations, and individually:
  - Anguilla: https://opengeomd.hsrhealthanalytics.org/catalogue/#/dataset/23

  - The Bahamas: https://opengeomd.hsrhealthanalytics.org/catalogue/#/dataset/24

  - Commonwealth of Dominica: https://opengeomd.hsrhealthanalytics.org/catalogue/#/dataset/40

Storm Surge Indicator

- GG-IS's demonstration video:
  - http://bit.ly/3MUUH33

- Persistent Demonstrator by island nations individually:
  - Anguilla: https://foresightcarbon.com/reports-drm/index.html#67-91

  - The Bahamas: https://foresightcarbon.com/reports-drm/index.html#68-89

  - Commonwealth of Dominica: https://foresightcarbon.com/reports-drm/index.html#69-100
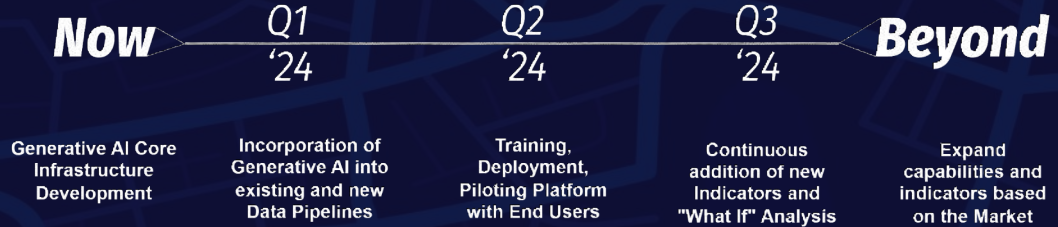
Future Work: Expand Use of Marine Datasets for Public Health Analytics

- Improve Guidance on Evacuations
  - A marine gazetteer can help predict which marine areas will be populated during a weather disaster such as bays, marines, and harbors. This data can aid in emergency preparedness by distinguishing which areas need to be evacuated, where shelters need to be established and plan for a fast response.

- Minimize Effects of Hurricanes, Storms
  - The Caribbean Science Atlas by the Nature Conservancy in the Caribbean has 100's of datasets regarding coral restoration, climate mitigation, marine protection, the locations of marine structures, such as mangroves, that can be used to mitigate the effects, including on human health, of hurricanes.

- Expand Use of Generative AI
  - Continue expanding the accessibility of marine data-informed health risks in a manner that are scientifically sound, and leverage generative AI front ends with LLMs to mine specific and relevant data, reducing bias and error.

HSR.*health* ✚

Tomorrow's Generative AI Enabled GeoMD Platform

- Natural Disasters
  - Wildfires
  - Drought
  - Heat

- Maternal & Child Health
- Medical Supply Needs
- Care Deserts
- Consumer Behavior
- Opioid Abuse Related Mortality
- Zoonotic Spillover
- Antimicrobial Resistance

Now — *Q1 '24* — *Q2 '24* — *Q3 '24* — **Beyond**

Now	Q1 '24	Q2 '24	Q3 '24	Beyond
Generative AI Core Infrastructure Development	Incorporation of Generative AI into existing and new Data Pipelines	Training, Deployment, Piloting Platform with End Users	Continuous addition of new Indicators and "What If" Analysis	Expand capabilities and indicators based on the Market

HSR. *health* +