



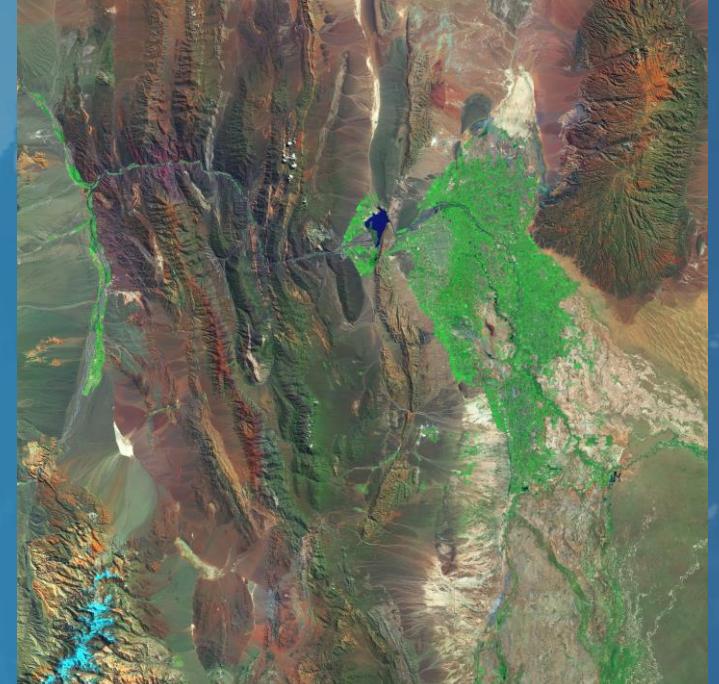
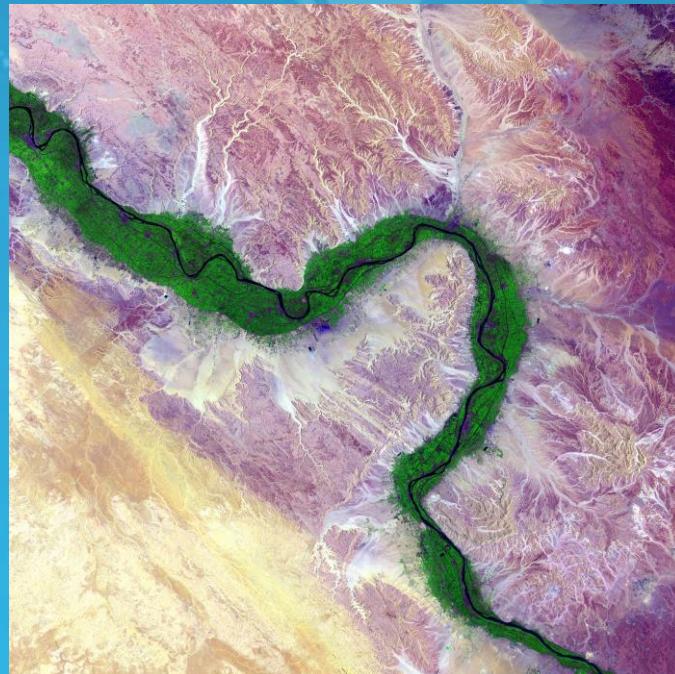
Providing a service to deliver global water information for local decision-making

On behalf of the GEOGLOWS Team

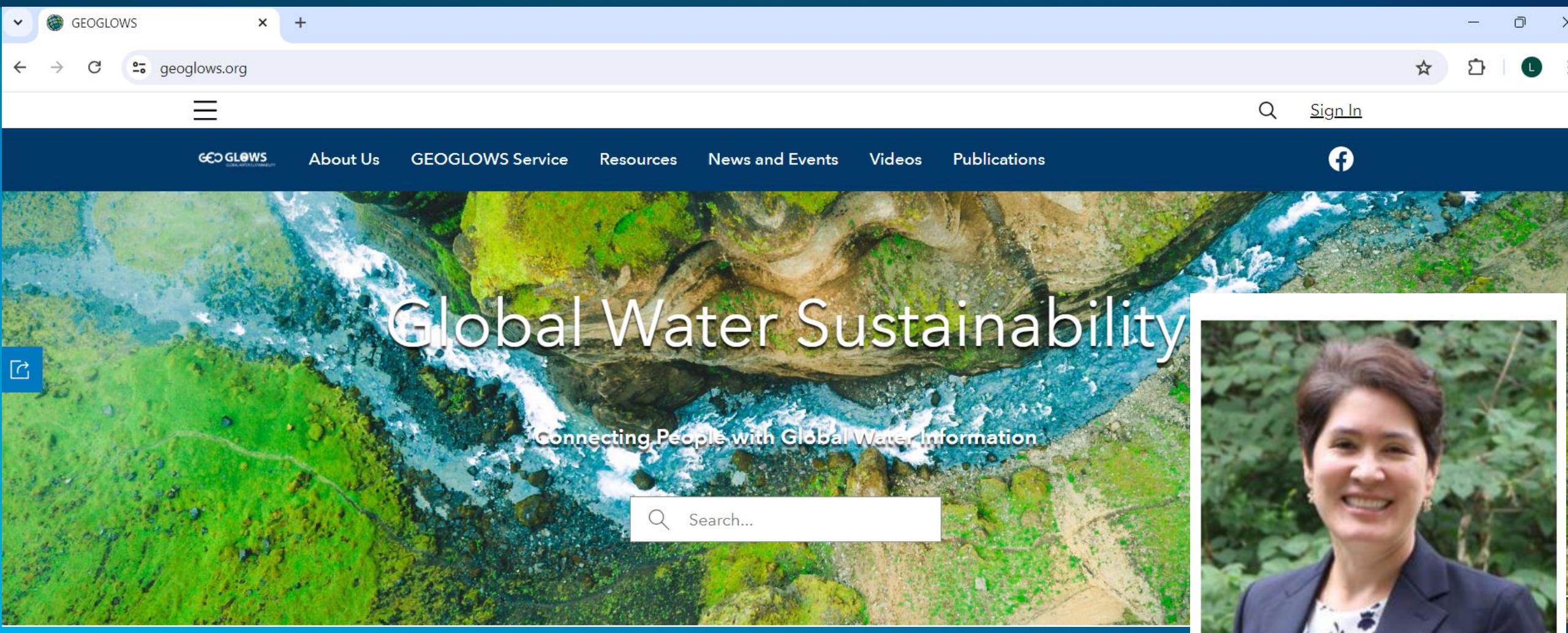


Group on Earth Observations

GEO is a partnership of more than 100 national governments and in excess of 100 Participating Organizations that **envision a future where *decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations.***



GEO Global Water Sustainability Initiative



The screenshot shows the GEOGLOWS website homepage. The header features the GEOGLOWS logo and a navigation menu with links to About Us, GEOGLOWS Service, Resources, News and Events, Videos, and Publications. A search bar and a 'Sign In' button are also present. The main banner image is a satellite view of a river flowing through a forested area. Overlaid on the banner is the text 'Global Water Sustainability' and 'Connecting People with Global Water Information'. A search bar with a magnifying glass icon and the placeholder 'Search...' is located in the center of the banner. Below the banner, a blue footer bar contains the text 'Dr. Angélica Gutiérrez | GEOGloWS Co-chair' and 'National Oceanic and Atmospheric Administration (NOAA) - USA Office of Water Prediction'. To the right of the banner, there is a portrait photo of Dr. Angélica Gutiérrez, a woman with short brown hair, smiling, wearing a dark blazer over a white top with blue floral patterns.

GEOGLOWS

geoglows.org

≡

Sign In

GEOGLOWS

About Us

GEOGLOWS Service

Resources

News and Events

Videos

Publications

Global Water Sustainability

Connecting People with Global Water Information

Search...

Dr. Angélica Gutiérrez | GEOGloWS Co-chair

National Oceanic and Atmospheric Administration (NOAA) - USA

Office of Water Prediction

GEOGLOWS - Overview

Objective Summary:

GEOGLOWS leverages partnerships, resources, and data, to deliver accurate, open, and accessible hydrological predictions on a global scale, playing a vital role in addressing complex water resource management challenges.

Organizations

- NASA
- NOAA
- ECMWF
- BYU
- Aquaveo
- Esri
- USAID
- WMO
- World Bank
- Amazon Web Services

Programs

- NASA - SERVIR
- NASA - Water Resources
- NOAA\NASA Satellites for flood mapping



GEOGLOWS Objectives

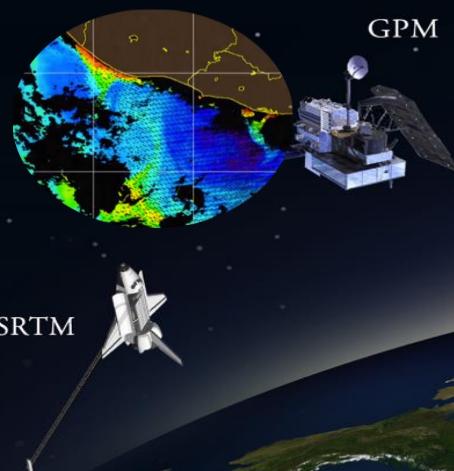


GEOGLOWS Partnerships





Weather and Climate



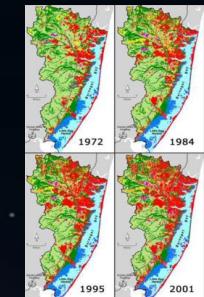
Food Security



Water and Disasters



Land Use Change



Resilience In...

ICIMOD

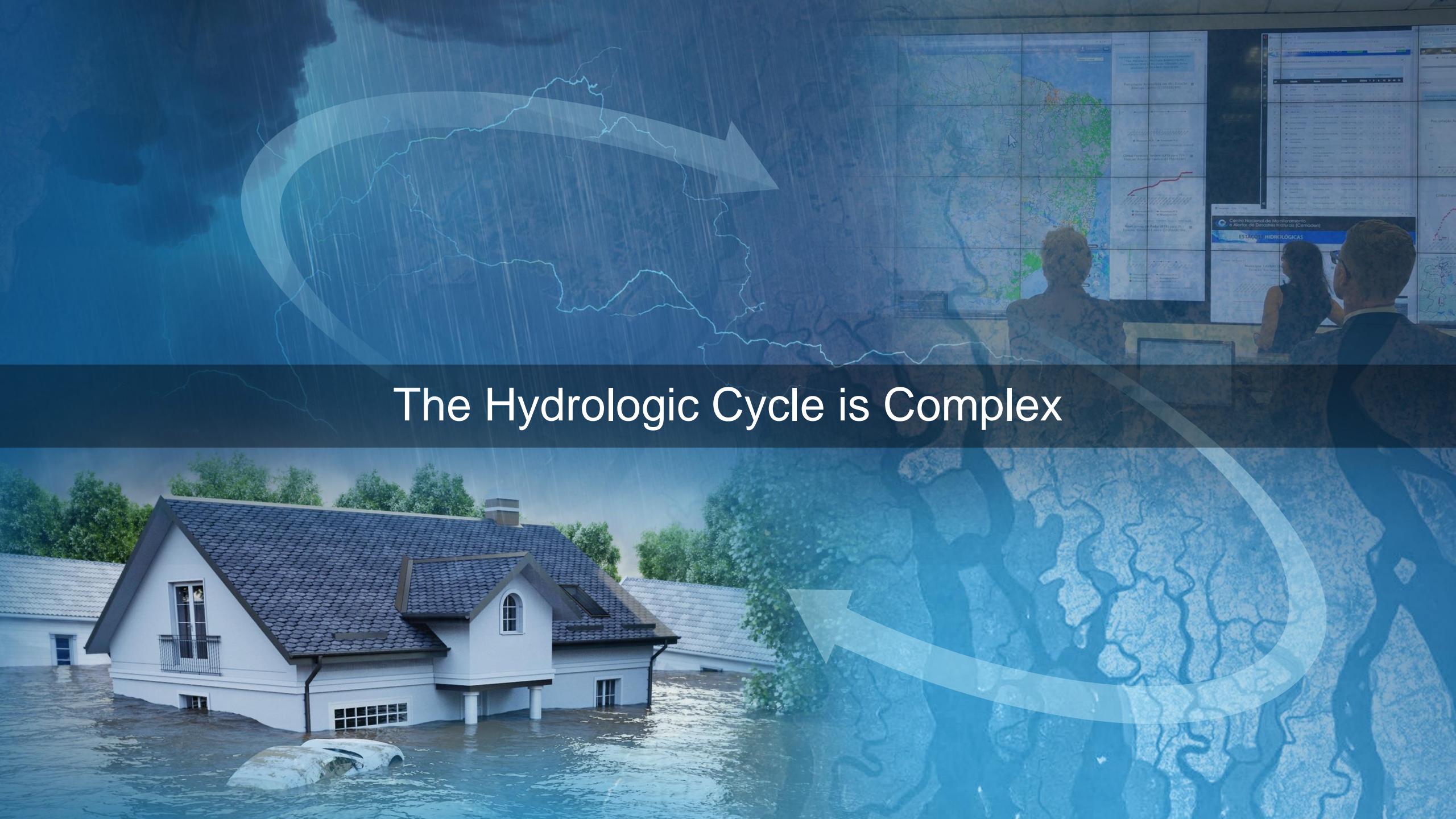


adpc



SERVIR Connecting Space To Village

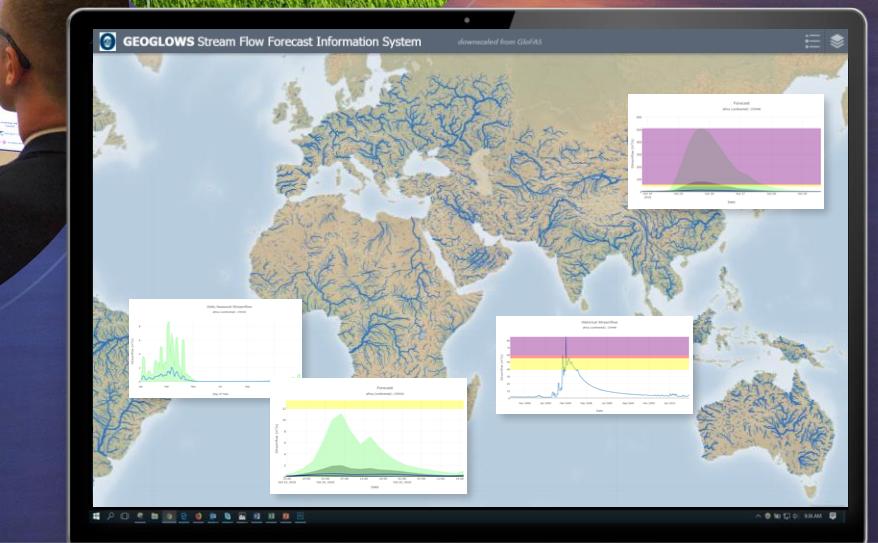




The Hydrologic Cycle is Complex

Improving Water Intelligence...

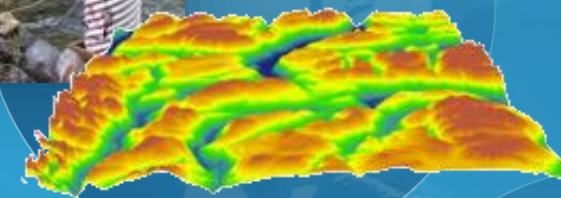
- Understanding of the hydrologic system is incomplete
- Lack of information = Uninformed decisions
- It is our responsibility to find better solutions



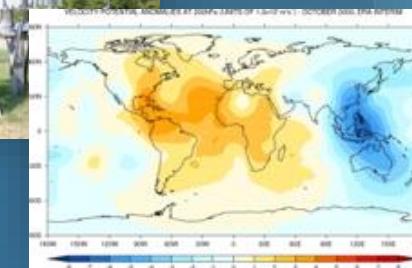
In Situ Streamflow Monitoring Systems



Water Quantity
and Quality



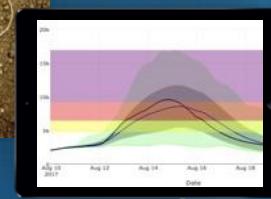
Rainfall & Snow



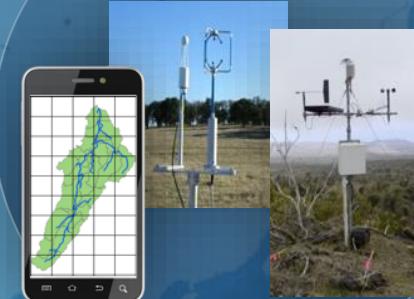
Remote
Sensing



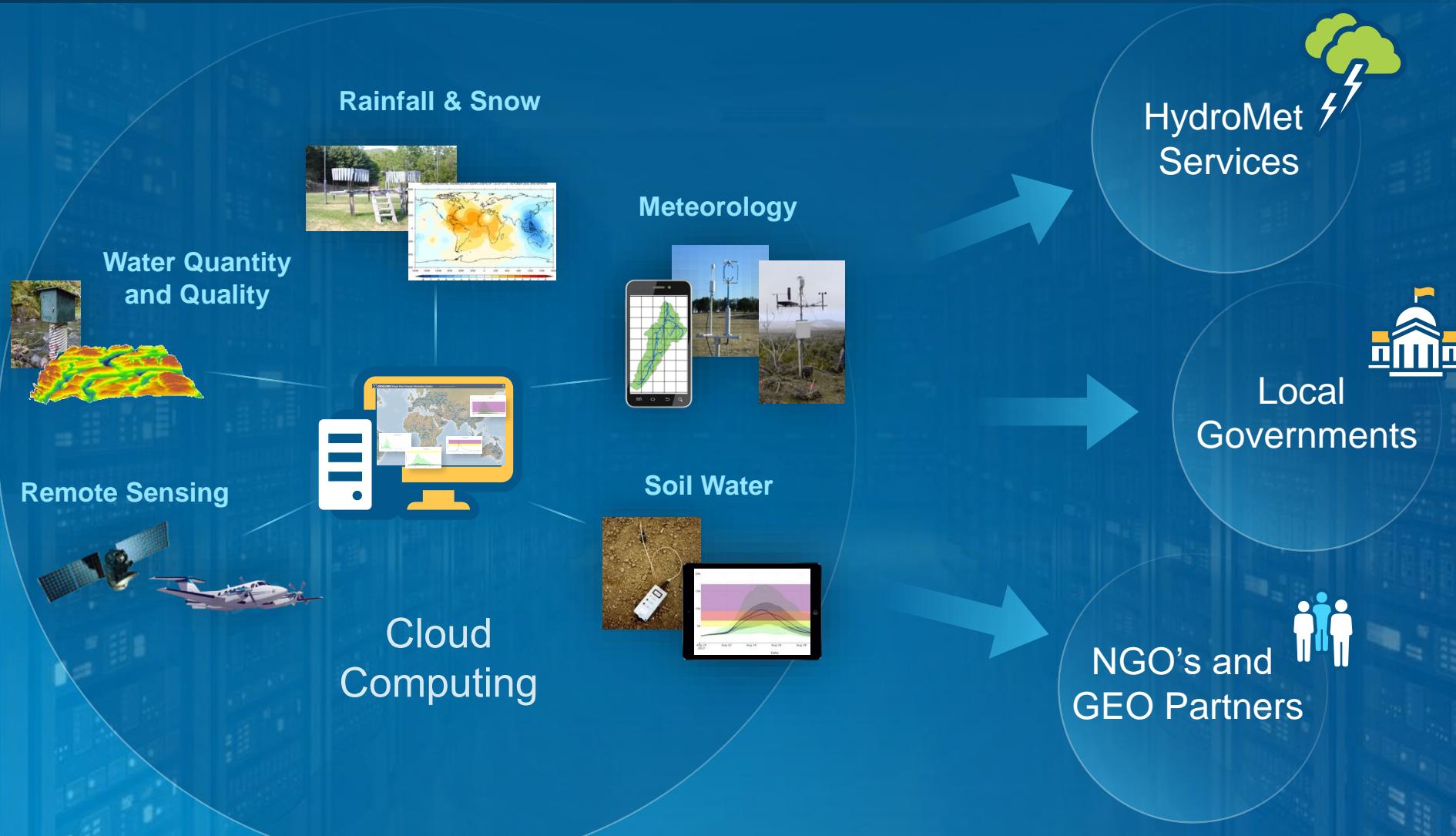
Soil Water



Meteorology



Leveraging Advances in Earth Observations



Actionable Intelligence: Hydrologic Modeling

Understand

Predict

Manage

- **Understand**
- **Predict**
- **Manage**

Units: Metric

Forecast Historical Flow-Duration Daily Season Monthly Season Download

ECMWF Available Dates

Select a Date

Streamflow (m^3/s)

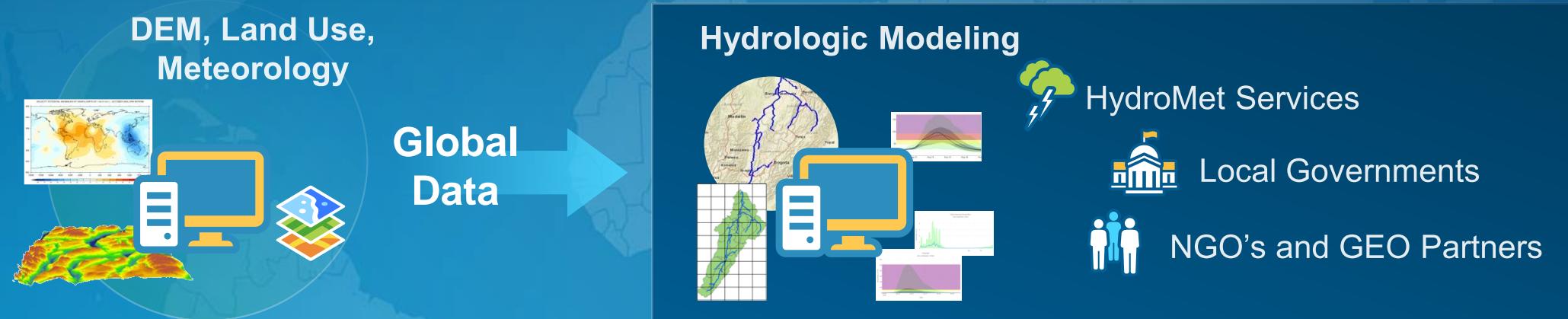
350
300
250
200
150
100
50
0

Upper
Lower

Close

Global Streamflow Services – A Paradigm Shift

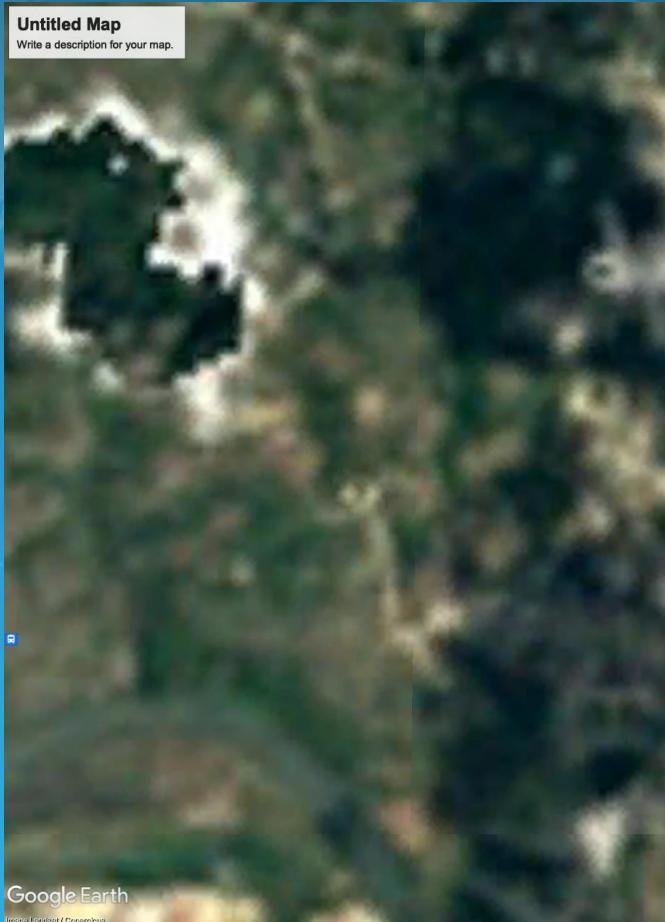
PAST – Individual Hydrologic Forecasting



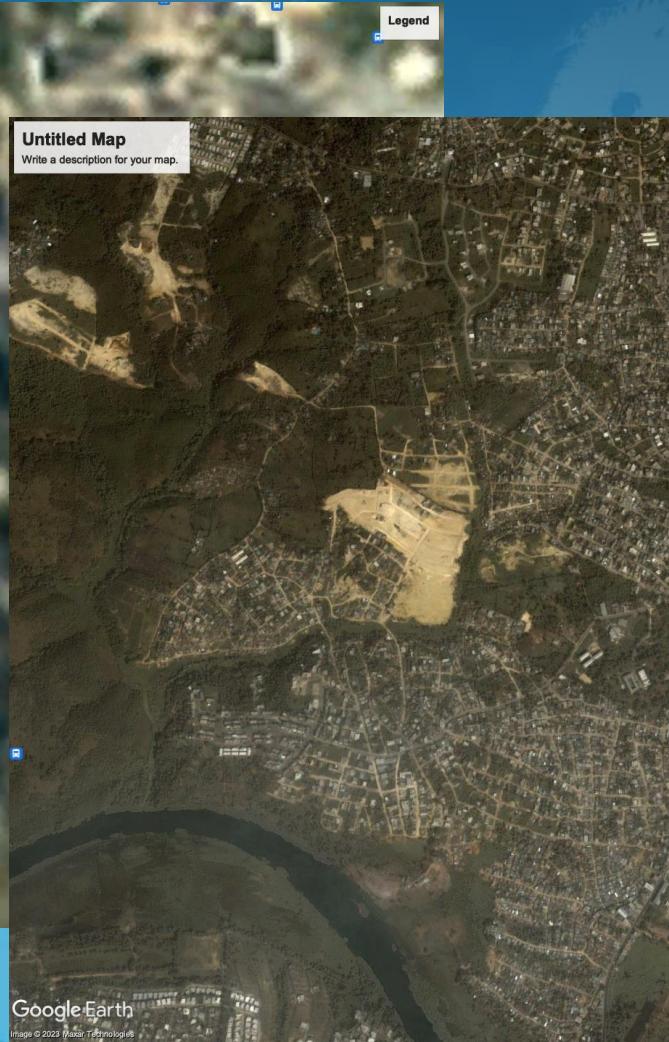
NOW – Global Hydrologic Forecasting



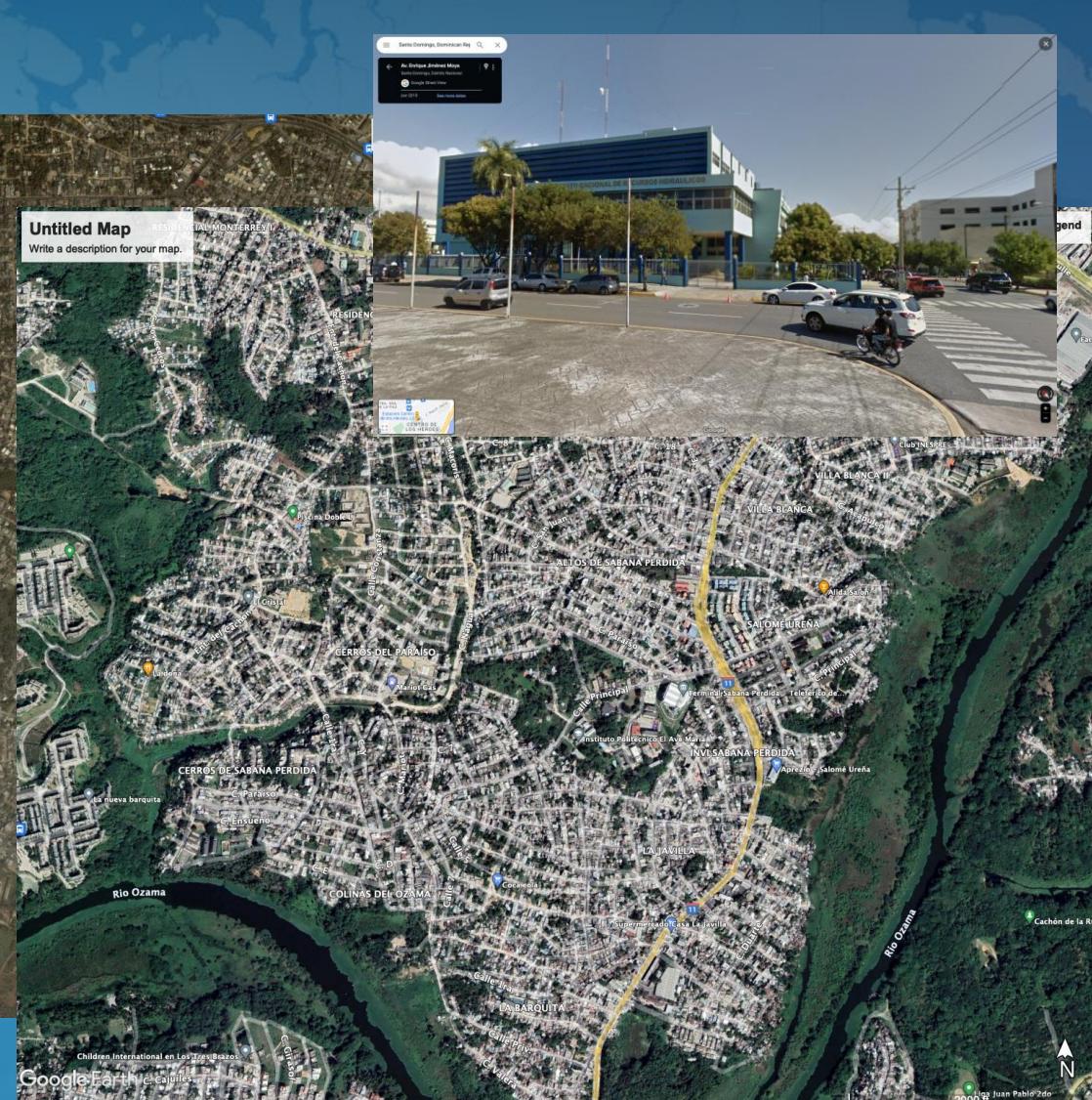
Like Google Earth Imagery – Benefits Over Time Help All



1985



2000

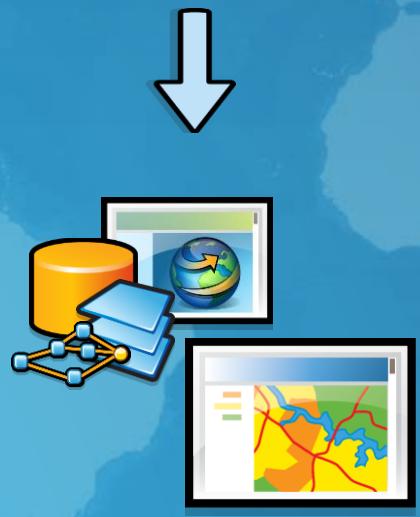


2022

Global Modeling Barriers to Overcome



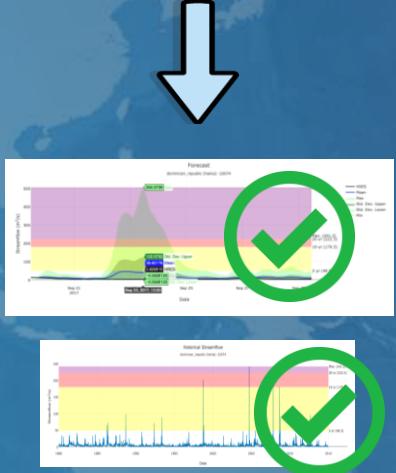
Cyberinfrastructure
and Workflows



Web apps and
web services



Partnerships, trainings,
and collaboration



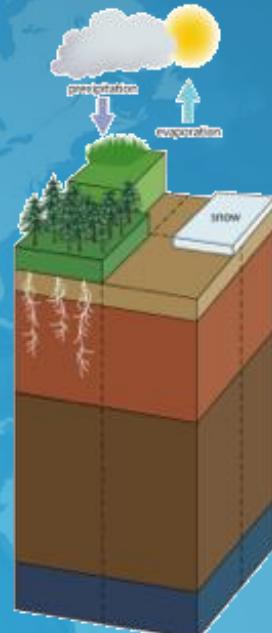
Accessibility tools and
programmatic extraction

GEOGLOWS Basic Model Formulation

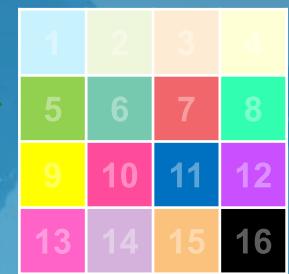
Meteorological Forecast



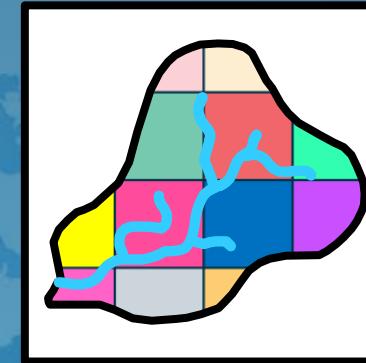
ECMWF land surface model
(GloFAS, ERA 5)



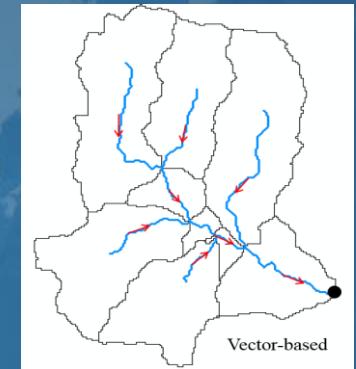
Runoff Grids



GIS Overlay
(grid runoff to basins)



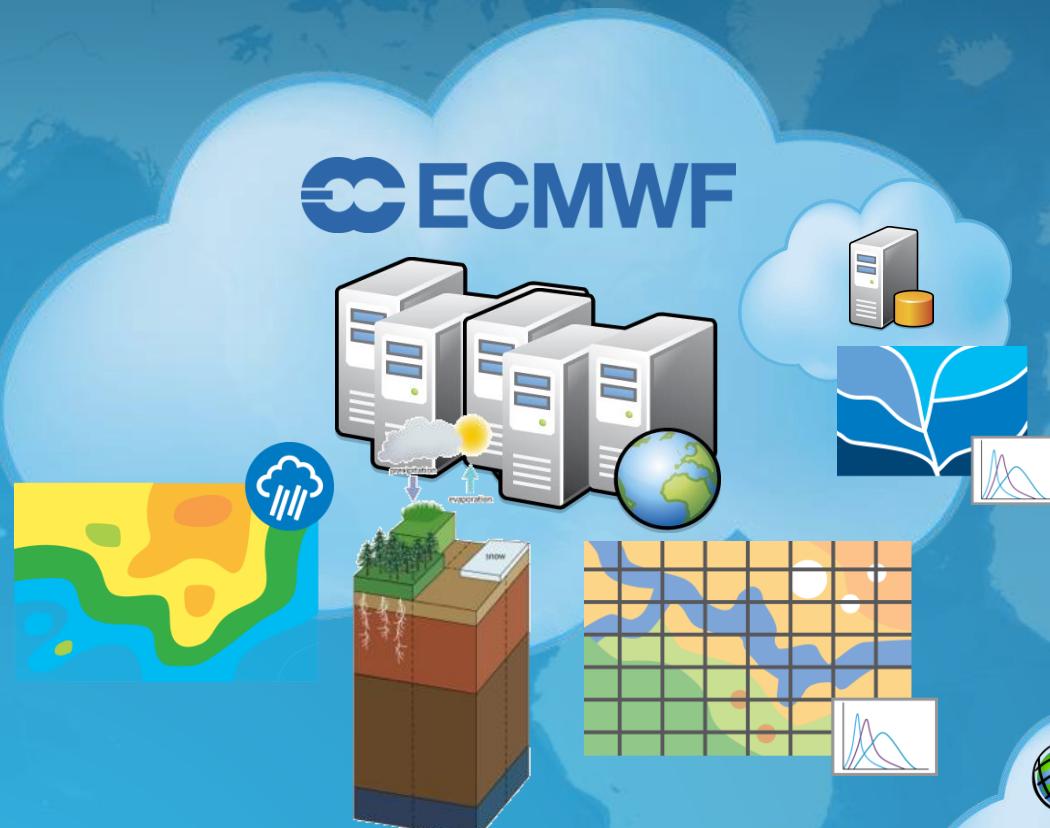
Muskingum Routing



Watersheds
(new data product)



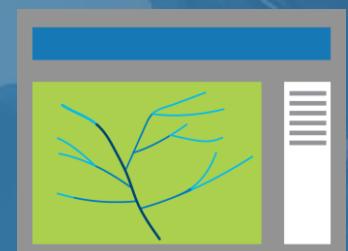
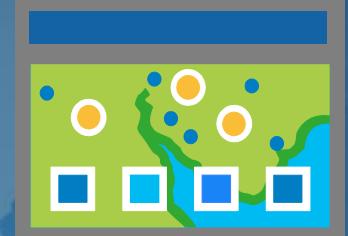
GEOGLOWS ECMWF Streamflow Services



Web Services

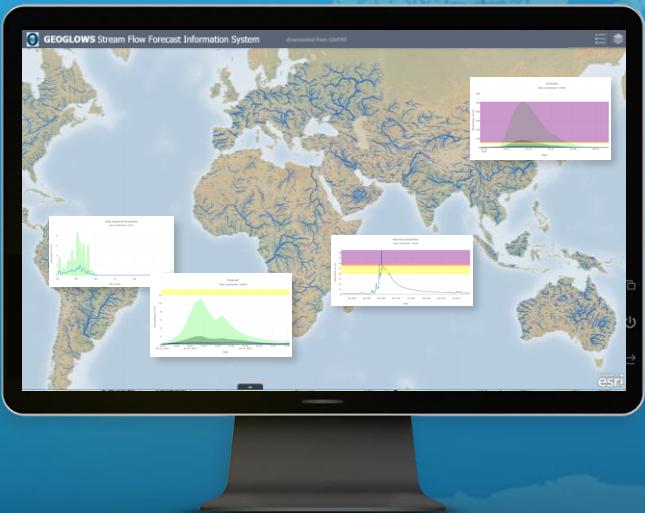


Streamflow API at ECMWF

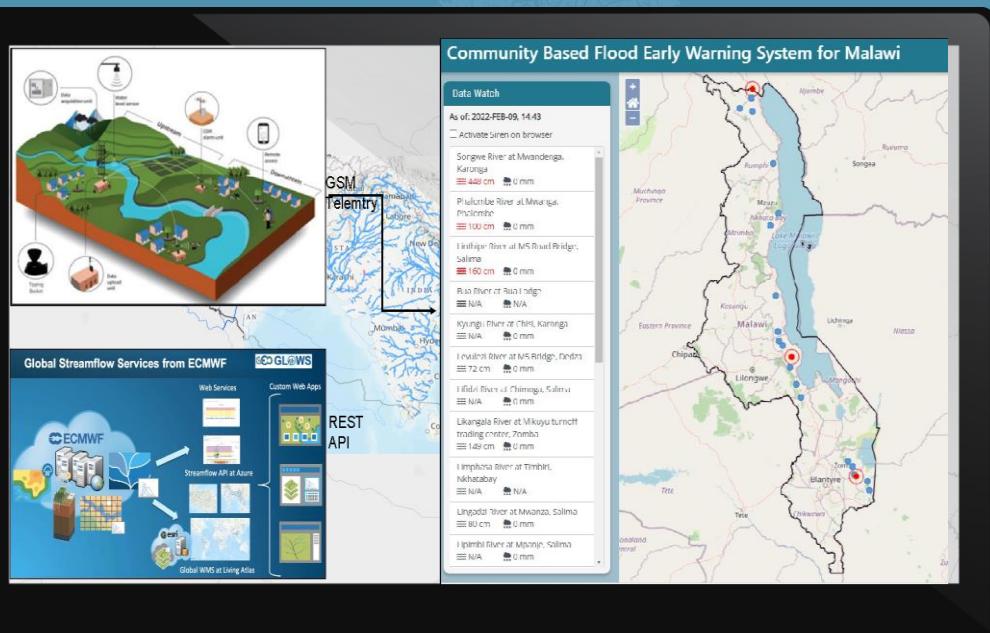


Global WMS at Living Atlas

Providing Actionable Information



Malawi



“... GEOGLOWS has extended warning lead time from hours to days”



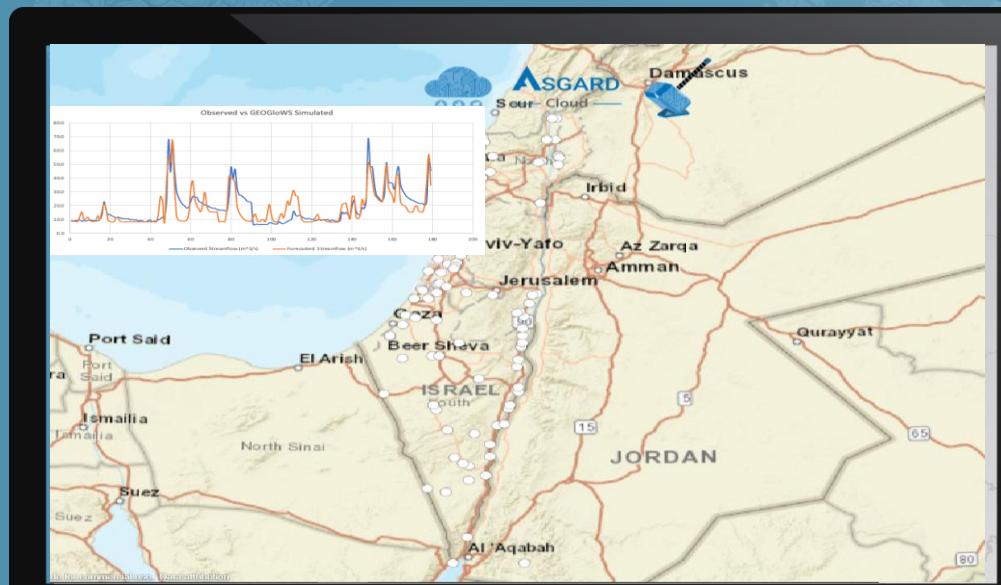
Samuel Gama

Israel

“... Separately calibrated GEOGLOWS to several stations in Israel and Gaza ”

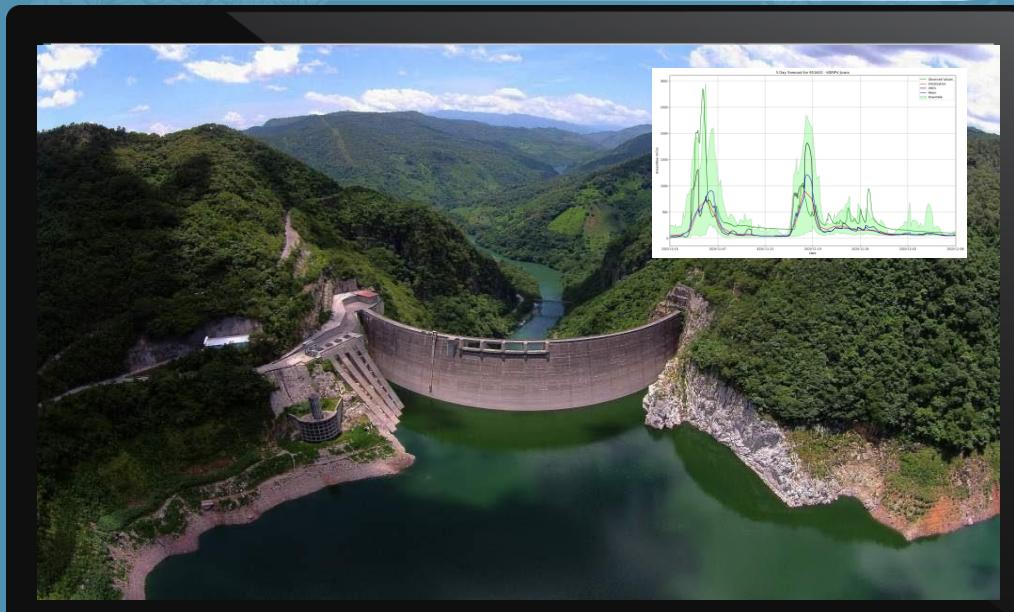


Amir Givati



Honduras

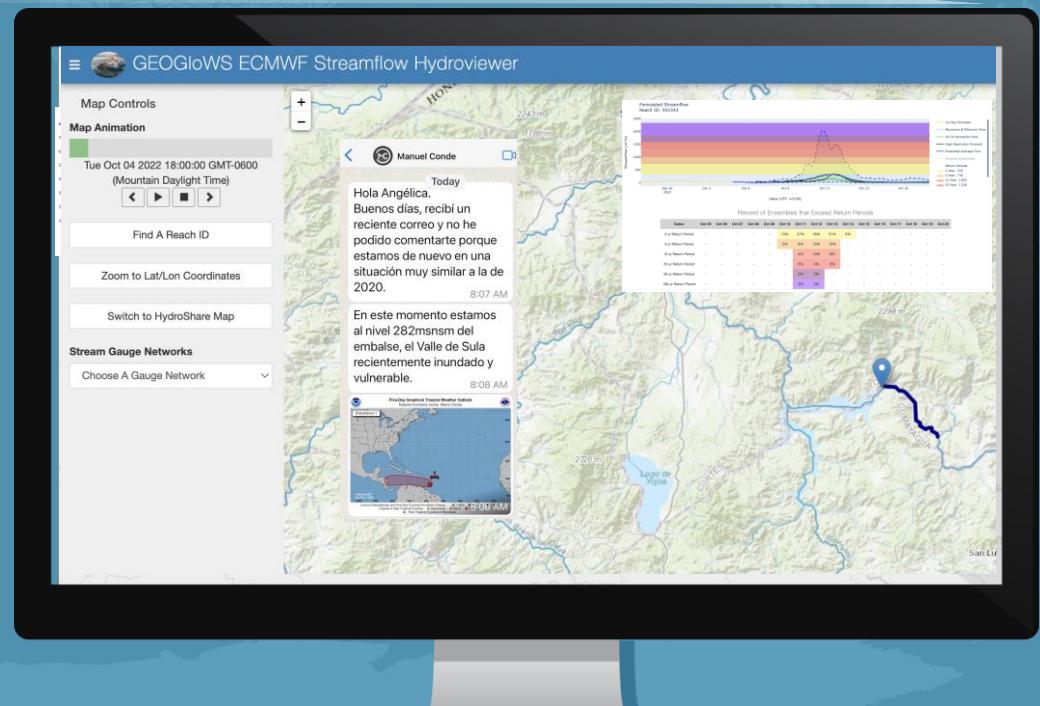
“... Helped manage reservoir releases during back-to-back hurricanes Eta and Iota”



Manuel Conde

Guatemala – Central America

“... GEOGLOWs is used by CEPREDENAC to provide hurricane early warnings”

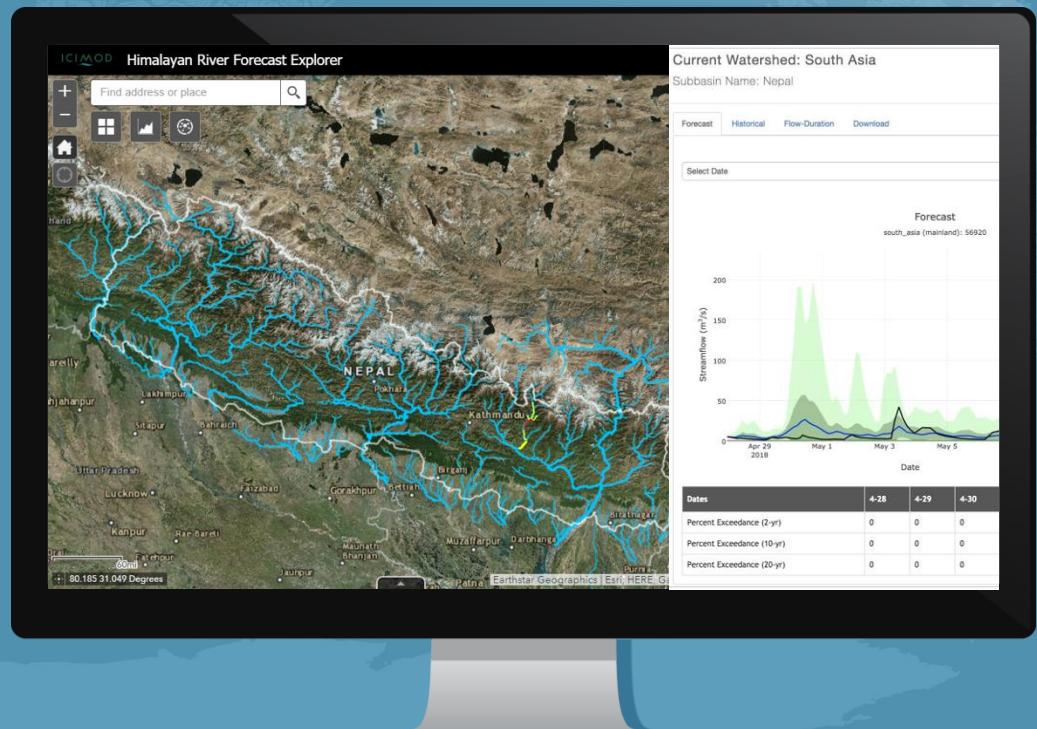


Nepal

“... important supplement to other data and models used by DHM, with the real possibility of saving lives and property”



Ram Gopal
Deputy Director DHM

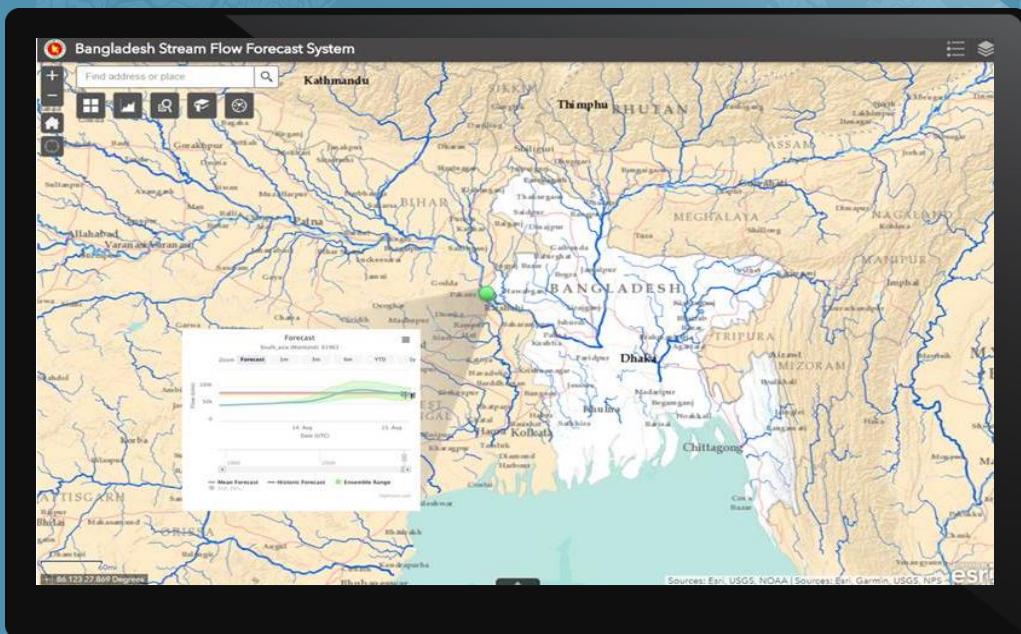


Bangladesh



Saiful Hossain
Superintendent Engineer
FFWC

*“...fills the critical
need of forecasting
transboundary
flows with greater
lead time”*

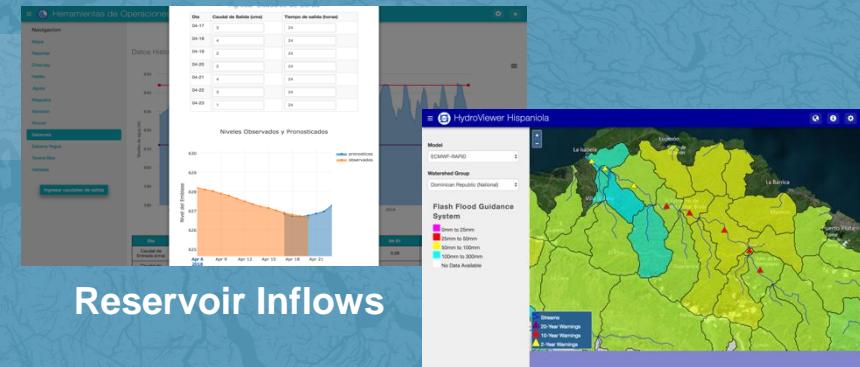


Dominican Republic

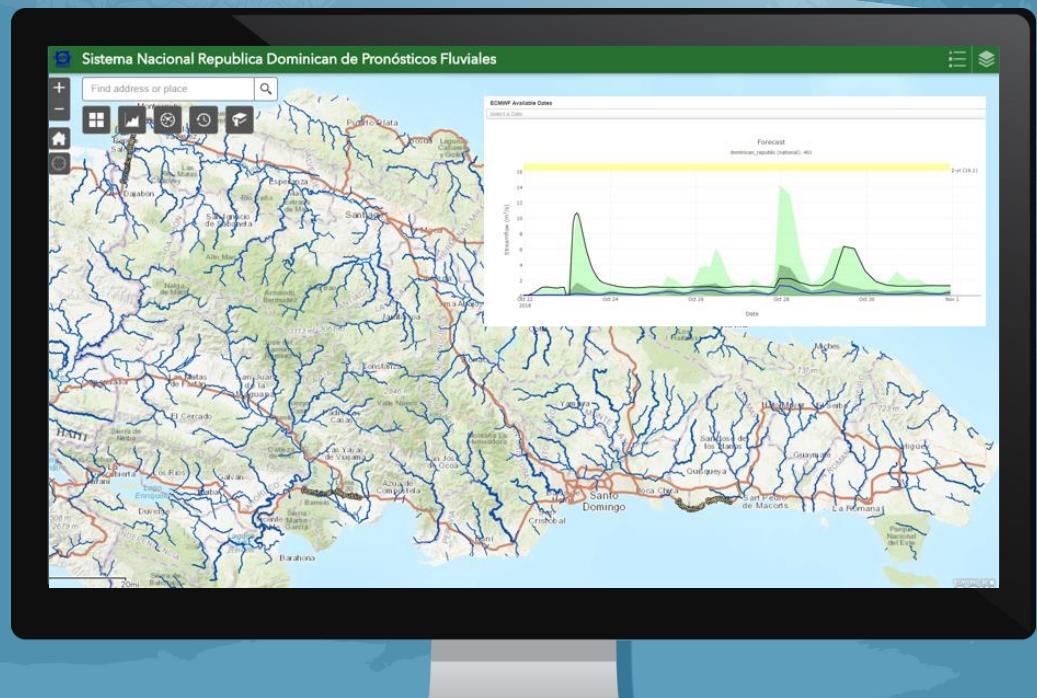


Israel Acosta
Director of Hydrology
INDRHI

“... providing a benefit where otherwise we do not have the internal capacity.”



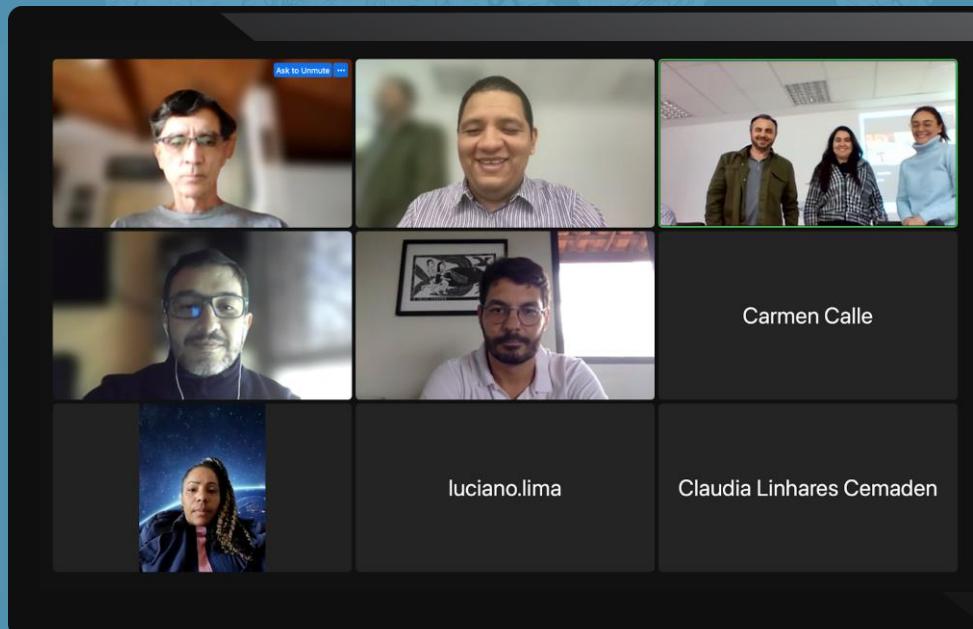
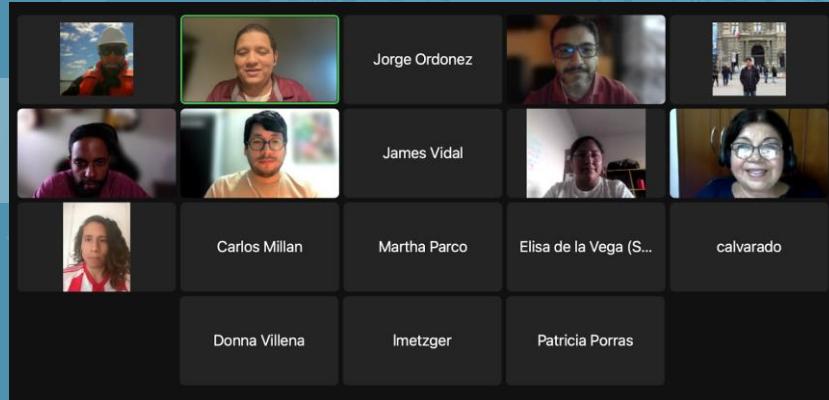
Combined with
WMO Flash Flood Guidance



SERVIR Amazonia



“... held 28 capacity building workshops training more than 300 in the last three years”

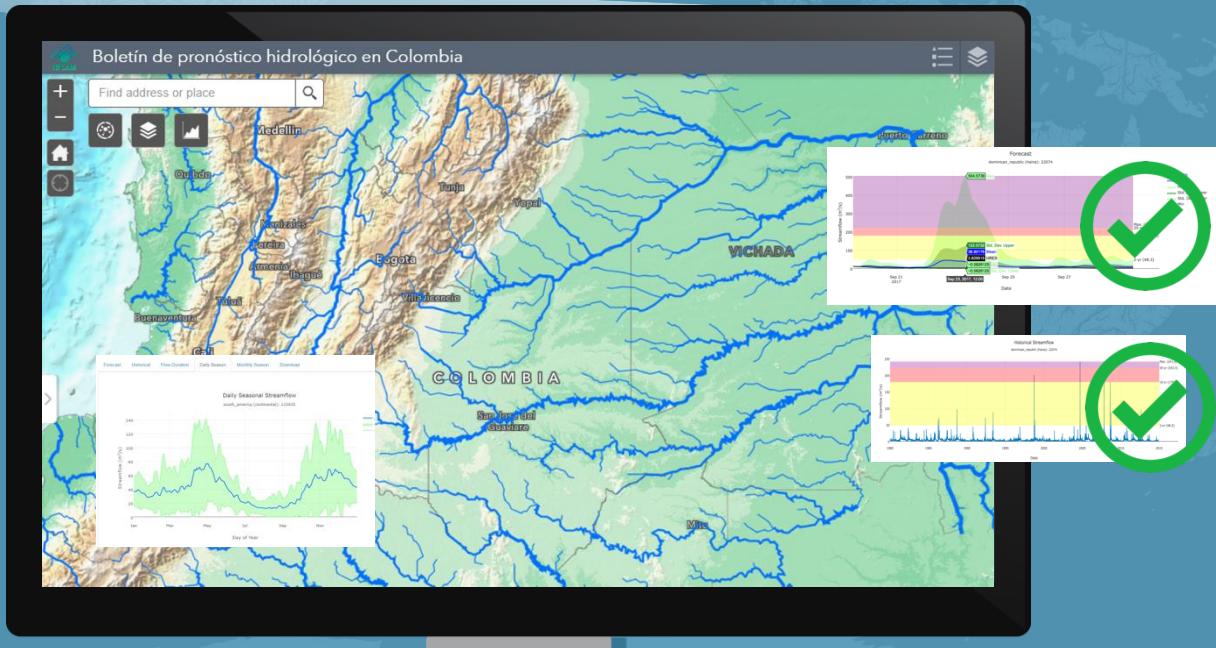


Colombia



Yolanda González
Hernández
Director IDEAM

“... better understand the climate in vast areas of our country where we are lacking information.”



Ecuador



Bolívar Erazo
Director Inamhi

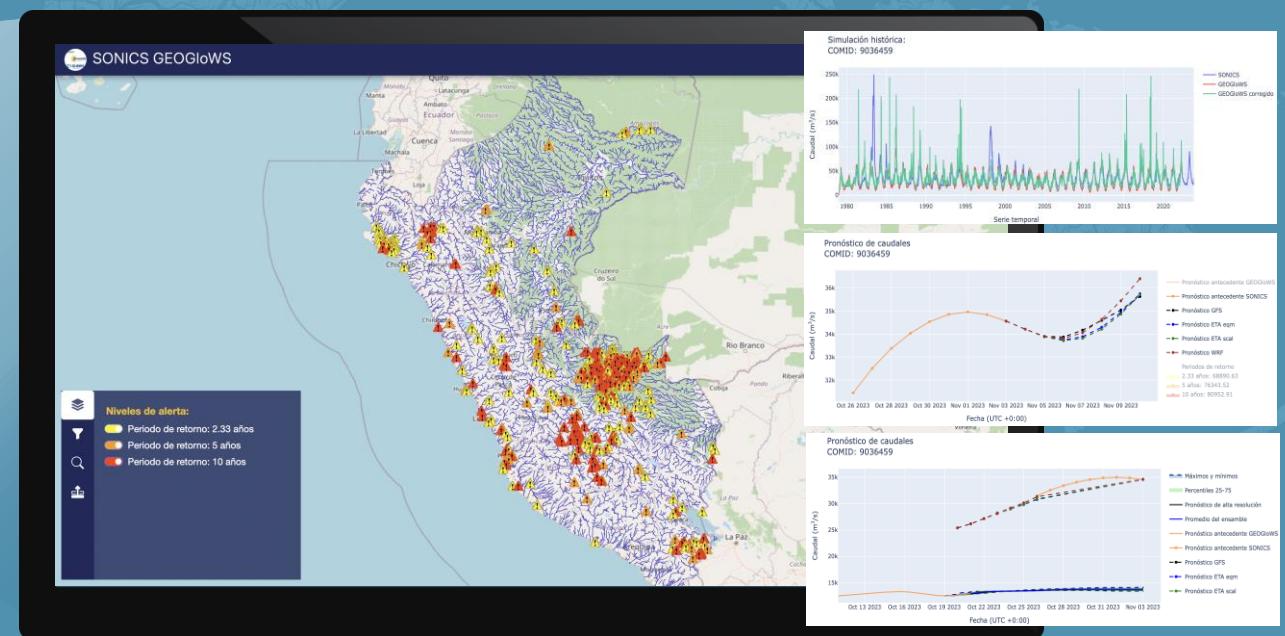
*“... Increased capacity
at Inamhi to provide
hydroinformatics to
stakeholders”*

The collage includes:

- Hydroviewer Ecuador:** A map showing flood alerts and historical data for Ecuador.
- INAMHI GEOGloWS Portal (Tethys):** A central hub for hydroinformatics, featuring a map of Ecuador with various data layers, and sections for "Plataforma Tethys", "Aplicaciones", and "Datos".
- Historical Validation Tool Ecuador:** A map showing historical validation data across the country.
- National Water Level Forecast Ecuador:** A map showing water level forecasts for Ecuador.

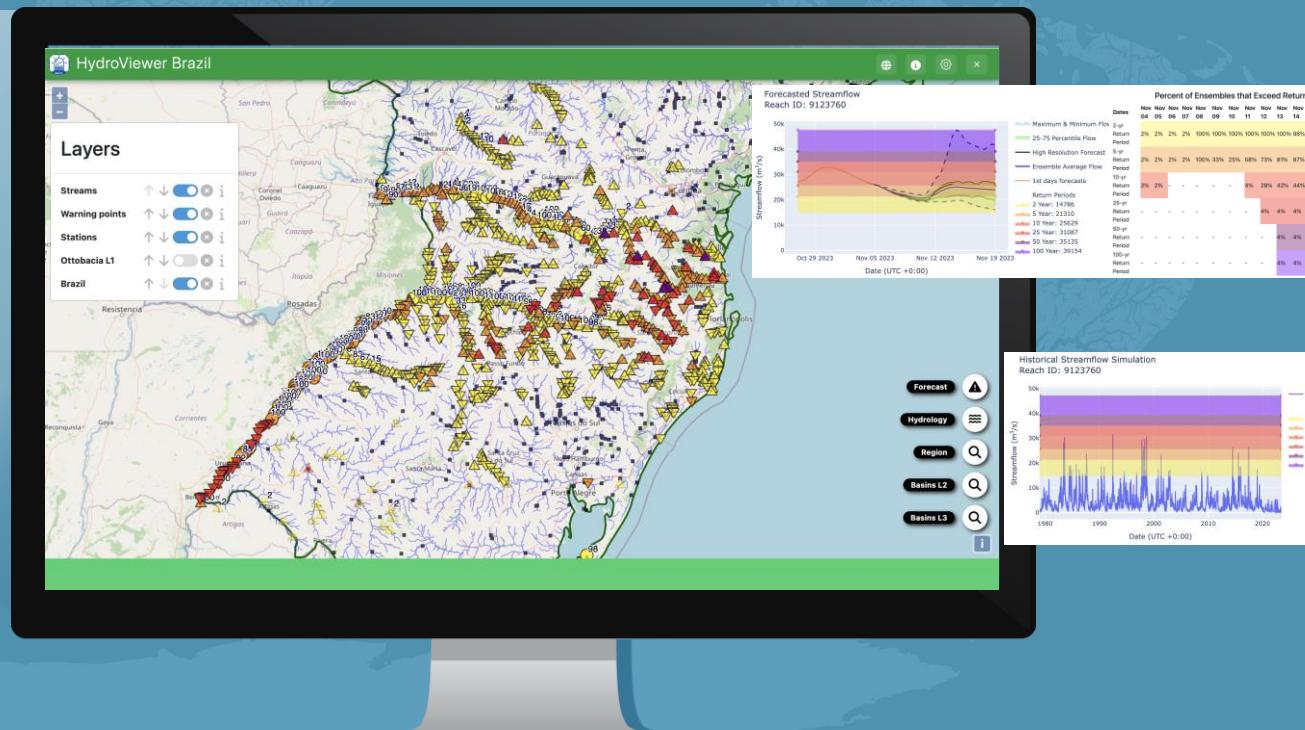
Peru

*“... combined with
local hydrological
model SONICS”*



Brazil

“... adding to the capability of CEMADEN to provide disaster warnings”



GEOGLOWS Toolbox Customization

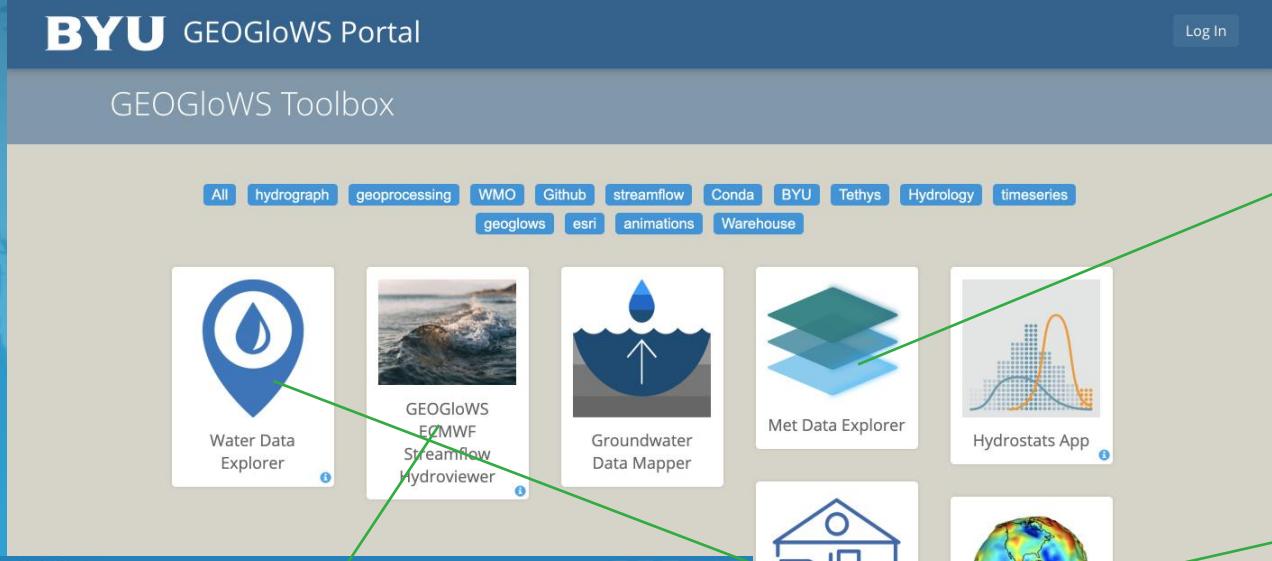
BYU GEOGLOWS Portal

GEOGLOWS Toolbox

Log In

All hydrograph geoprocessing WMO Github streamflow Conda BYU Tethys Hydrology timeseries

geoglows esri animations Warehouse



Water Data Explorer

GEOGLOWS ECMWF Streamflow Hydroviewer

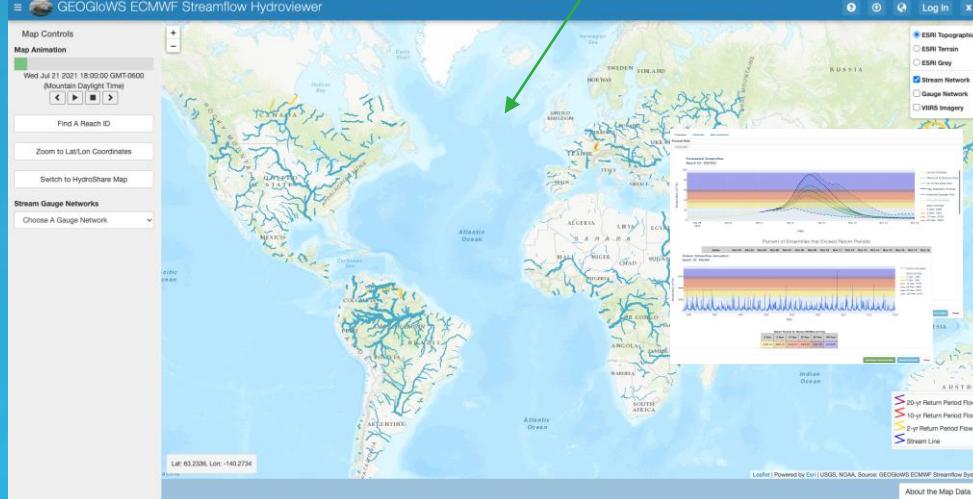
Groundwater Data Mapper

Met Data Explorer

Hydrostats App

Tethys App Warehouse

GRACE Groundwater Subsetting Tool



GEOGLOWS ECMWF Streamflow Hydroviewer

Map Controls

Map Animation

Wed Jul 21 2021 18:00:00 GMT-0600 (Mountain Daylight Time)

Find A Reach ID

Zoom to LatLon Coordinates

Switch to Hydroshare Map

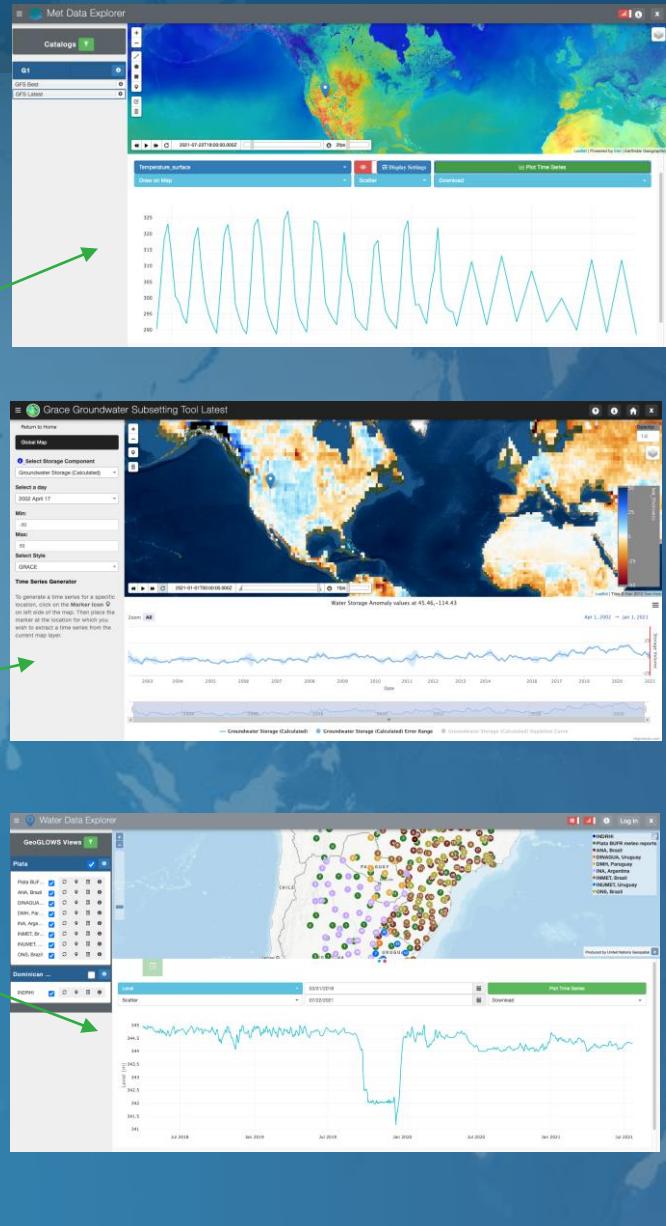
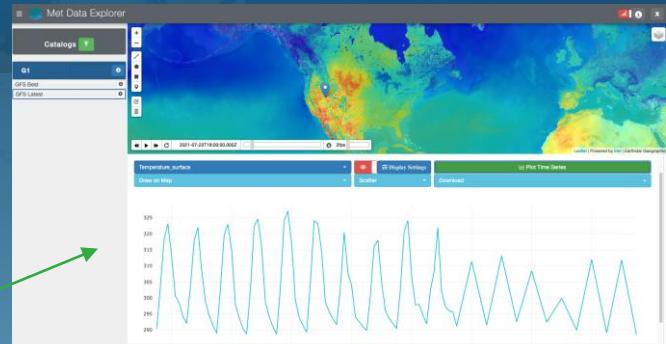
Stream Gauge Networks

Choose A Gauge Network

Lat: 63.2336, Lon: -140.2734

Leaflet | Powered by Esri | USGS, NOAA, Source: GEOGLOWS ECMWF Streamflow System

About the Map Data



The App Store – Sharing Resources



BYU GEOGloWS Portal

GEOGloWS Toolbox

Log In

All hydrograph geoprocessing WMO Github streamflow Conda BYU Tethys Hydrology timeseries

geogloWS esri animations Warehouse

Available TETHYS Applications

TETHYS App Name	Latest Version	Developer	Actions
data_rods_explorer	0.0.4	Gonzalo E. Espinoza	Install GitHub
embalses	1.0.0	Riley Hales	Install GitHub
epanet_model_repository	0.0.2	-	Install GitHub
epanet_model_viewer	0.0.2	-	Install GitHub
gfs	4	Riley Hales	Install GitHub
gpt	0.0.1	Sarva Pulta	Install GitHub
glads	4	Riley Hales	Install GitHub
gwdm	0.0.1	Sarva Pulta	Install GitHub
gwtn	0.0.1	Sarva Pulta	Install GitHub
historical_validation_tool_australia	1.0	Jorge Luis Sanchez-Lozano	Install GitHub

Showing 1 to 10 of 39 rows 10 rows per page 1 2 3 4

Installed TETHYS Applications

TETHYS App Name	Installed Version	Latest Version	Actions
app_store	1.0.9	1.0.9	Uninstall Update
earth_engine	1.1.1	1.1.1	Uninstall Update
food_impact_viewer	1.0.0	1.0.0	Uninstall Update
geogloWS_hydroviewer	1.7	1.7	Uninstall Update
historical_validation_tool_ecuador	1.1	1.1	Uninstall Update
hydroviewer_ecuador	1.2	1.2	Uninstall Update
metadatasearcher2	1.3.11	1.3.11	Uninstall Update
national_water_level_forecast_ecuador	1.0	1.0	Uninstall Update
statistics_calc	1.0.1	1.0.1	Uninstall Update
water_data_explorer	1.1.17	1.1.17	Uninstall Update

Showing 1 to 10 of 10 rows

Groundwater Data Mapper

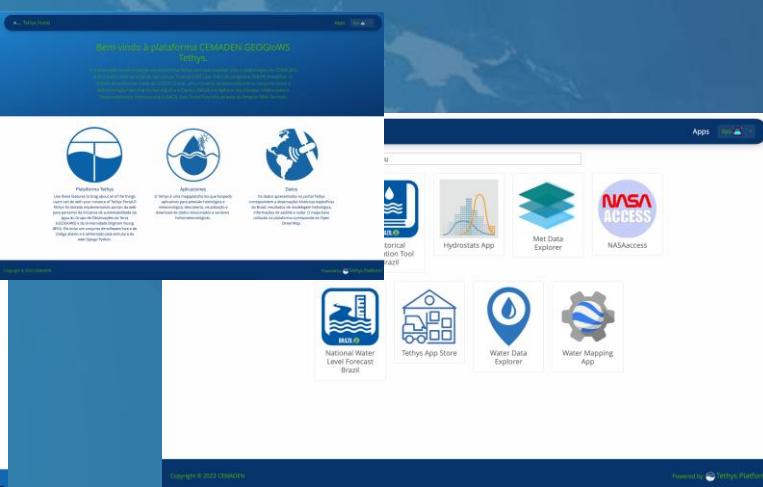
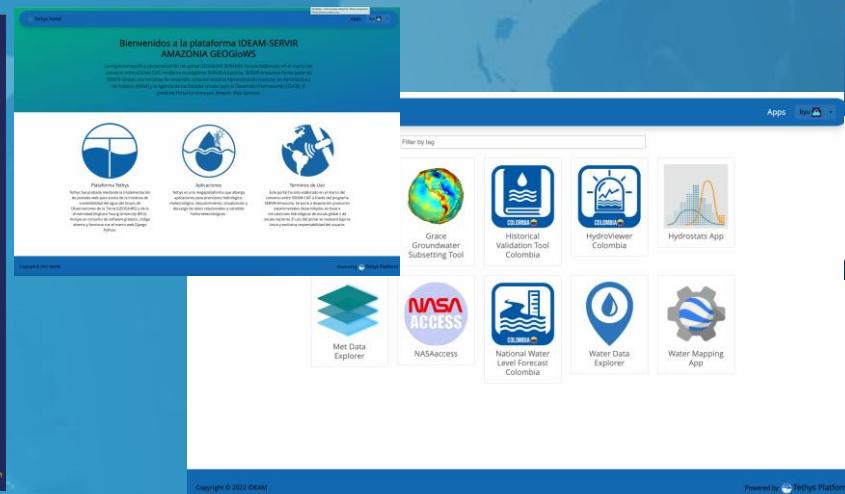
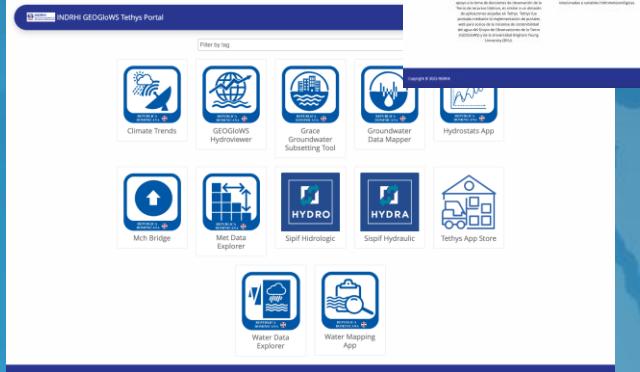
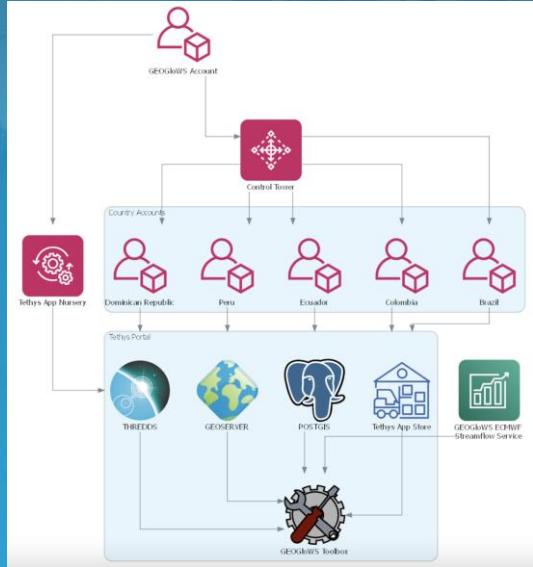
Met Data Explorer

Hydrostats App

Tethys App Warehouse

GRACE Groundwater Subsetting Tool

App Nursery – AWS Data Sustainability Initiative (ASDI)



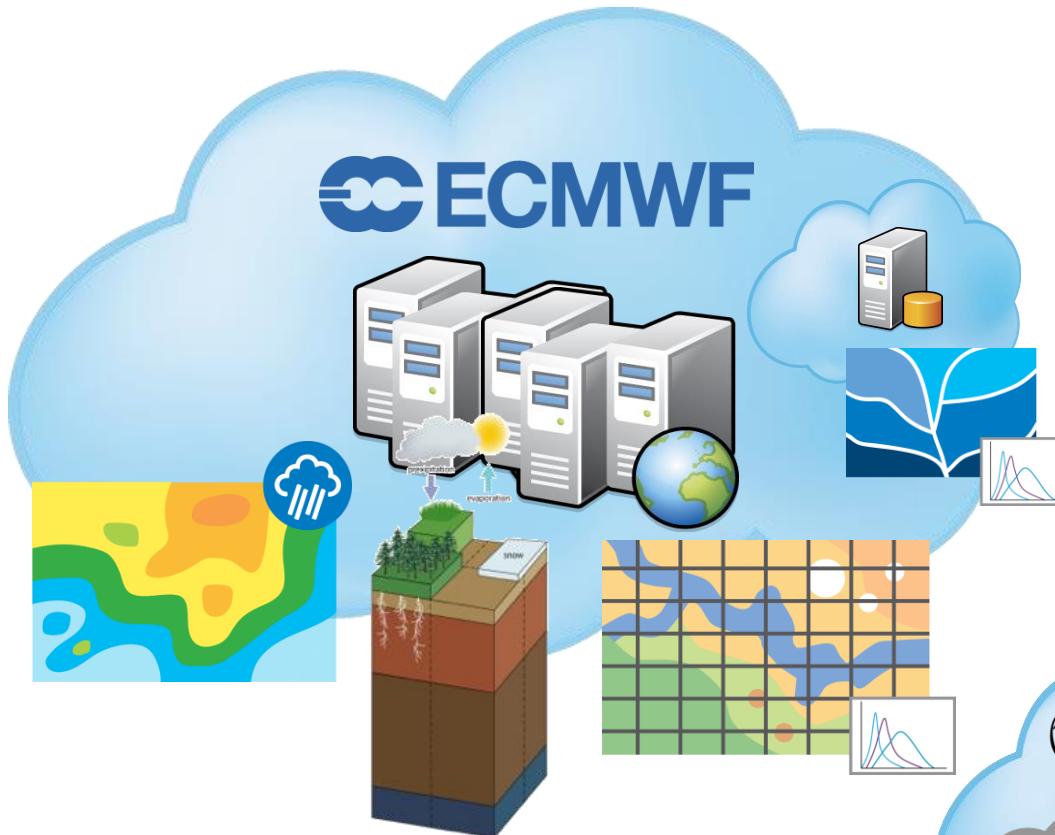


Understanding the GEOGLOWS Data



BYU Civil & Construction Engineering
IRA A. FULTON COLLEGE OF ENGINEERING

GEOGLOWS Data



Web Services

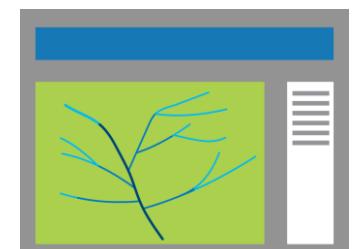
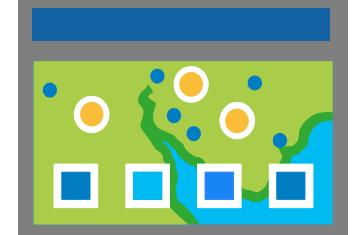


Streamflow API at ECMWF



Global WMS at Living Atlas

Custom Web Apps



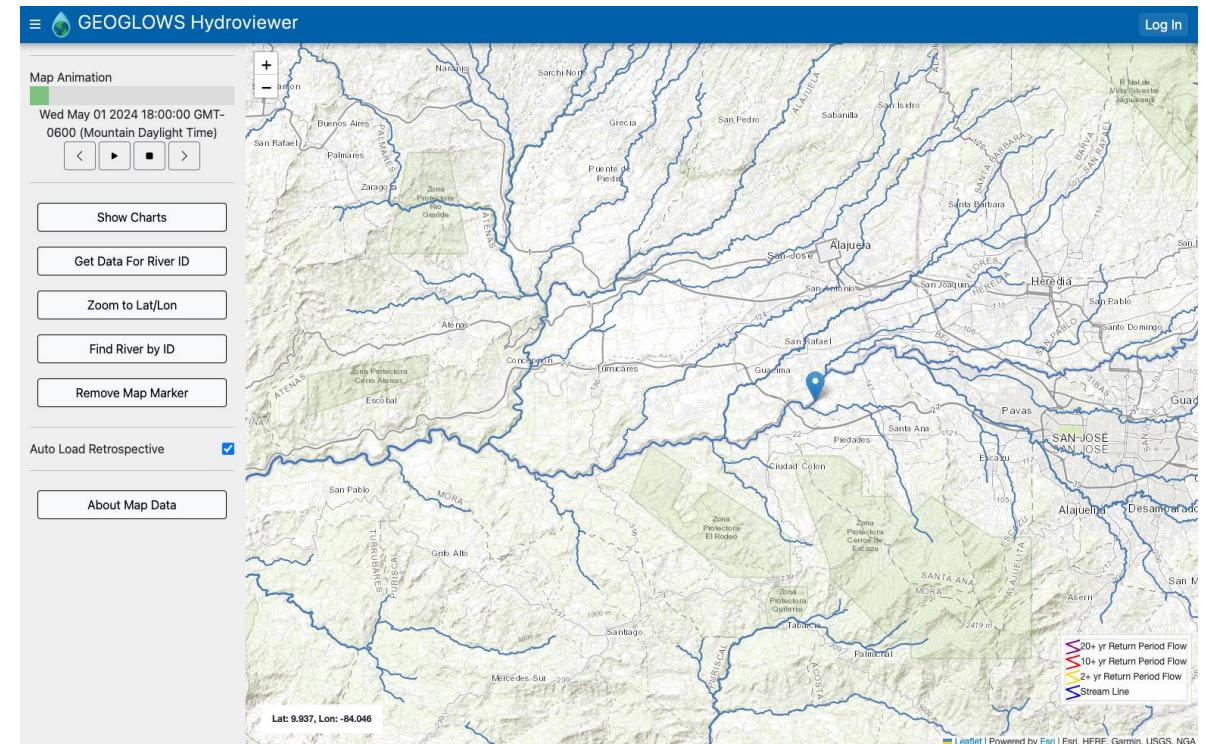
Version 1 and Version 2 Comparisons

	GEOGLOWS V1	GEOGLOWS V2
Stream Network	<ul style="list-style-type: none"> Streams are comparable to HydroSHEDS About 1 million streams 13 computational watershed groups Uniform method for estimating routing parameters applied to all river reaches 	<ul style="list-style-type: none"> Streams are a subset of TDX Hydro Version 1.0 About 7 million streams 125 computational watershed groups Data-driven regression to estimate routing parameters for each river individually
Retrospective Simulation	<ul style="list-style-type: none"> Daily average streamflow Begin date 1 January 1979 Updated every month Lag from real-time between 2 and 3 months Full dataset download only available on request Full time range available for a single river available via data service 	<ul style="list-style-type: none"> Daily average streamflows Begin date 1 January 1940 Updated every week Lag from real-time up to 1 week Full dataset freely available to download on Box and AWS S3 Data from 1990 to present for a single river available on data service Full-time period available on demand through AWS
Data Services	<ul style="list-style-type: none"> https://geoglows.ecmwf.int 	<ul style="list-style-type: none"> https://geoglows.ecmwf.int Implement endpoint versioning Planned future OGC API patterns implemented



V1 HydroViewer

<https://apps.geoglows.org/apps/geoglows-hydroviewer/>

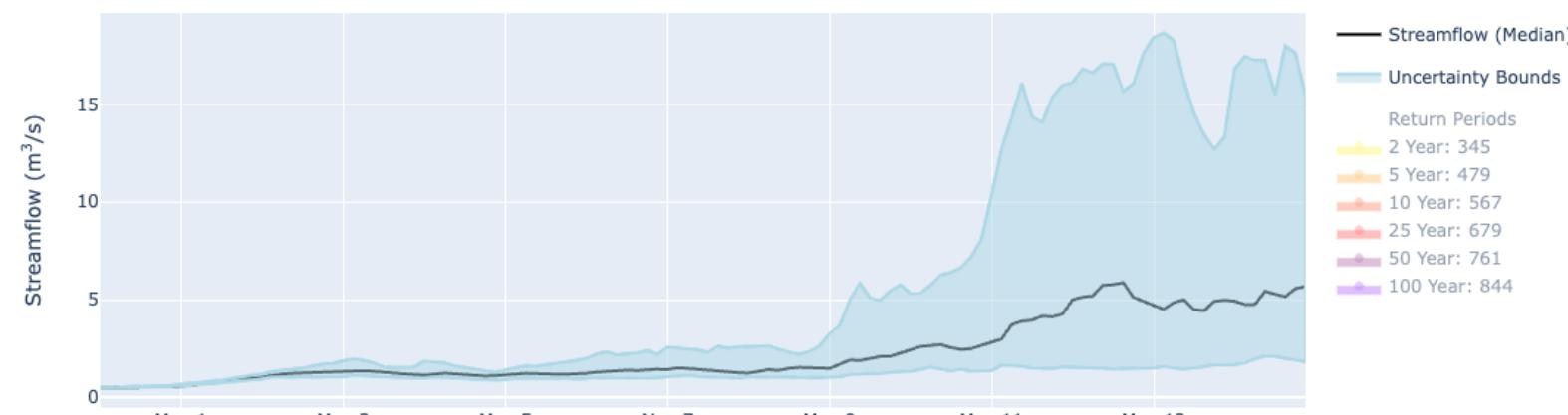


V2 HydroViewer

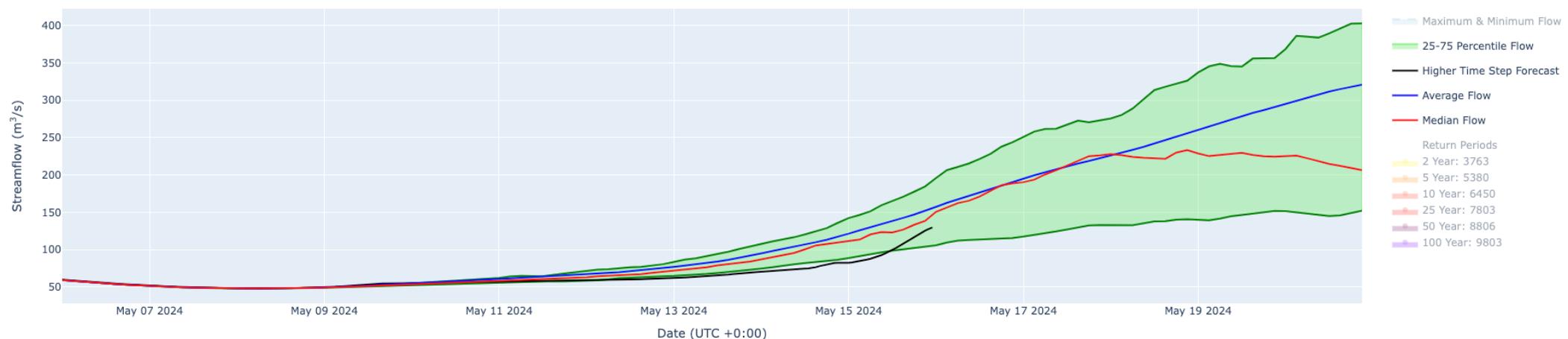
<https://beta.apps.geoglows.org/>

Forecast (stats)

Forecasted Streamflow

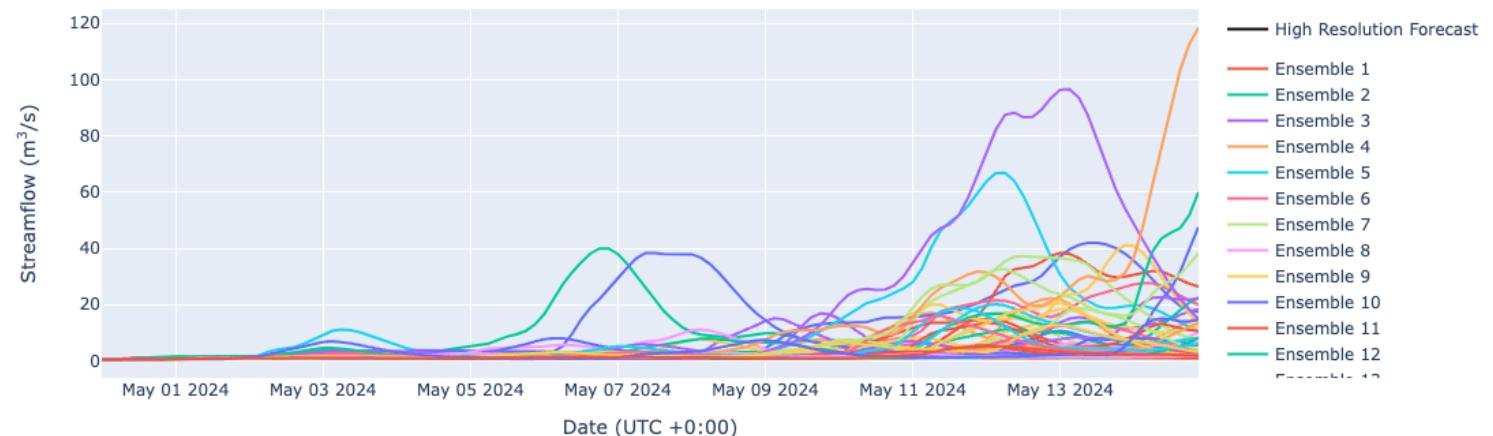


Forecasted Streamflow. Site: Rio San Juan en el Rancho La Trinidad
Reach ID: 770061283

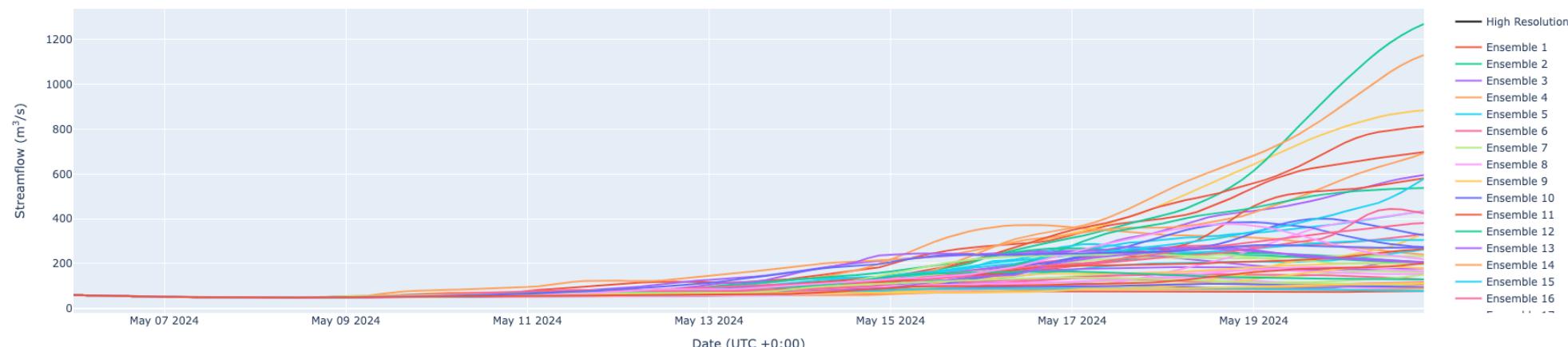


Forecast (ensembles)

Ensemble Predicted Streamflow



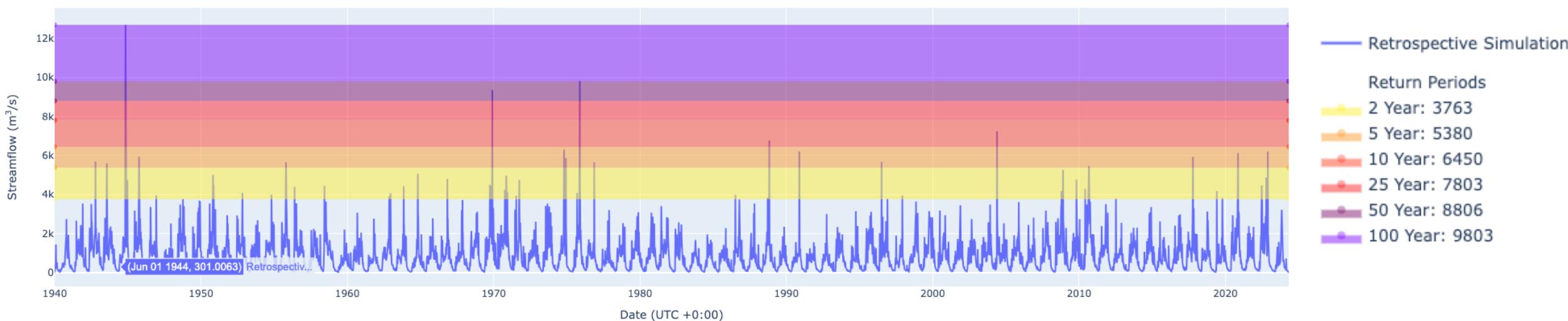
Ensemble Predicted Streamflow. Site: Rio San Juan en el Rancho La Trinidad
Reach ID: 770061283



Return Periods

Are used to classify extreme events. They require historical values to be calculated. A 100 year is expected to occur approximately once every 100 years. This does not mean multiple 100-year events can not occur sooner.

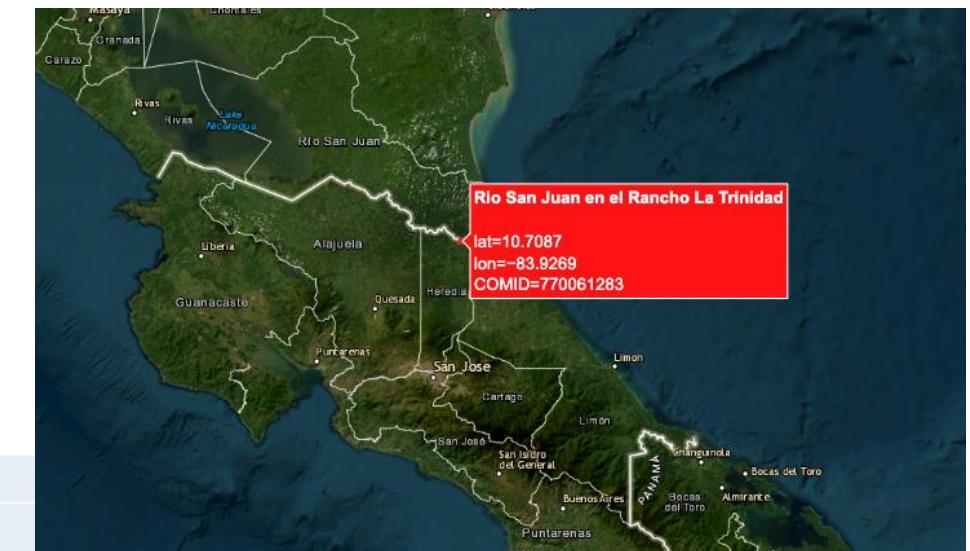
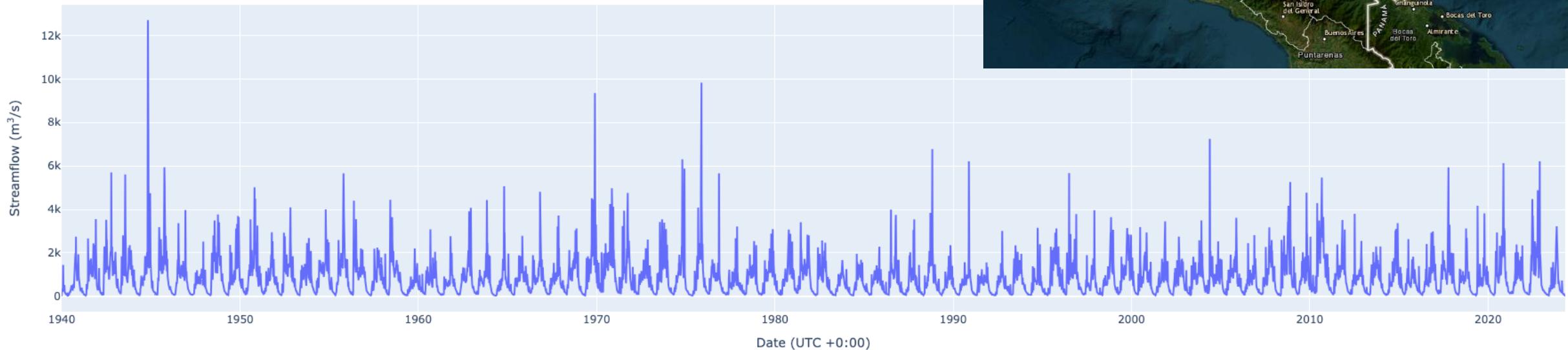
Retrospective Streamflow Simulation. Site: Rio San Juan en el Rancho La Trinidad
Reach ID: 770061283



Retrospective Simulation (80 years)

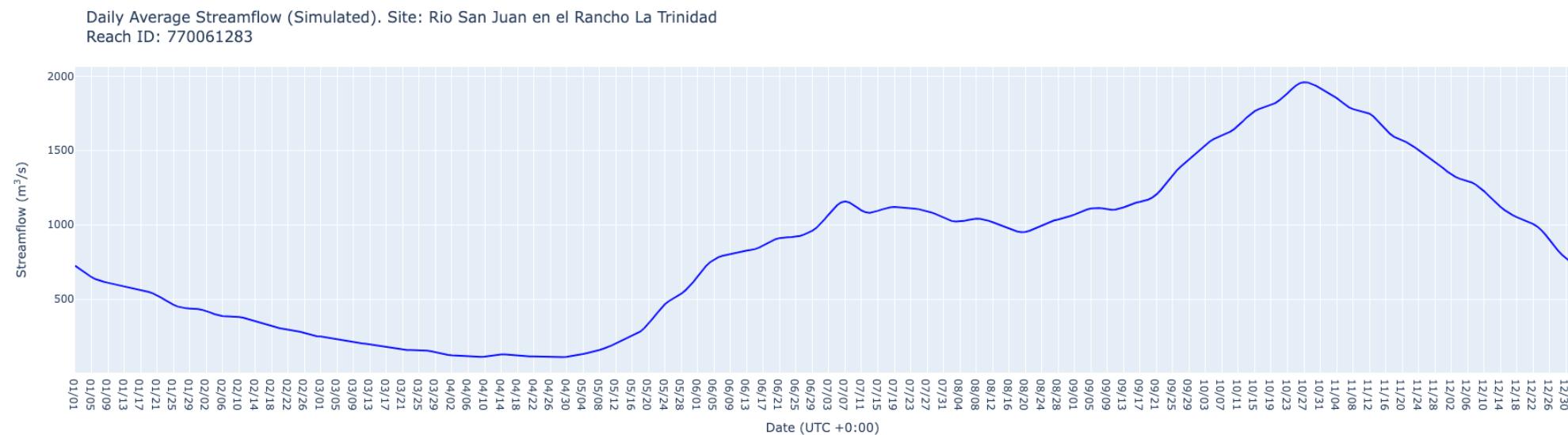
Simulated flow data, calculated from historical meteorologic data. Useful for understanding river behavior or comparing forecasts to previous events.

Retrospective Streamflow Simulation



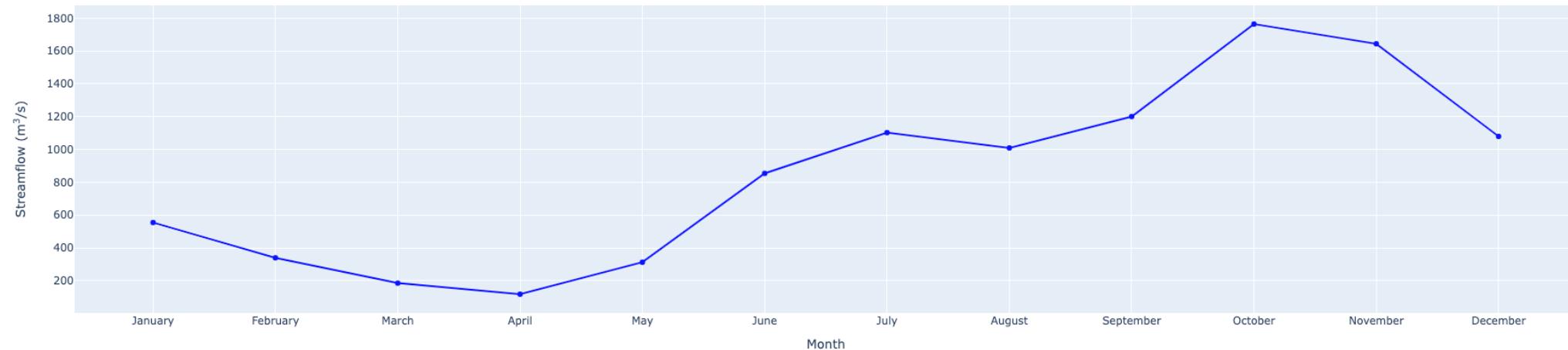
Daily Average Flow

Value of the average flow on every day of the year for a certain river segment. Is useful for understanding current flows based on season changes in normal.

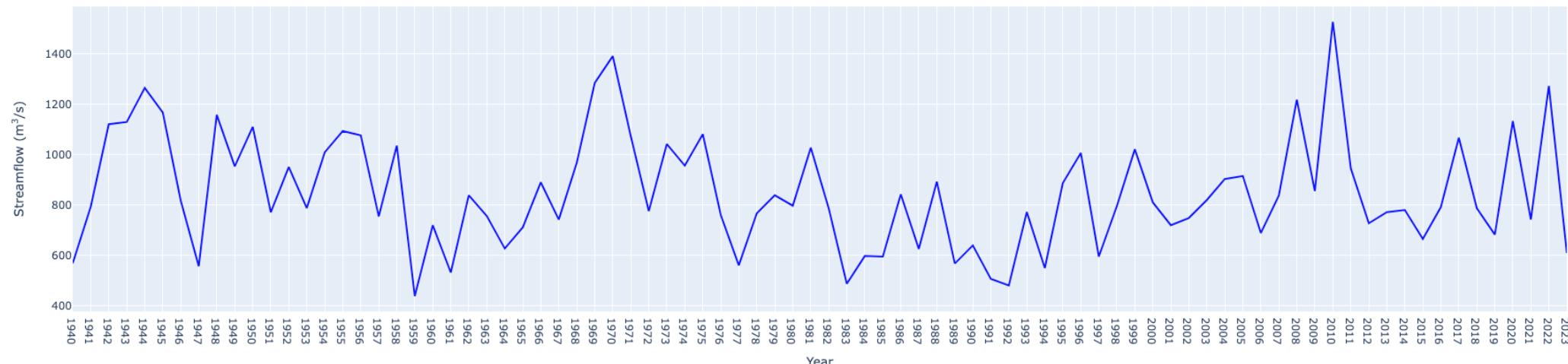


Monthly/Annual Average

Monthly Average Streamflow (Simulated). Site: Rio San Juan en el Rancho La Trinidad
Reach ID: 770061283

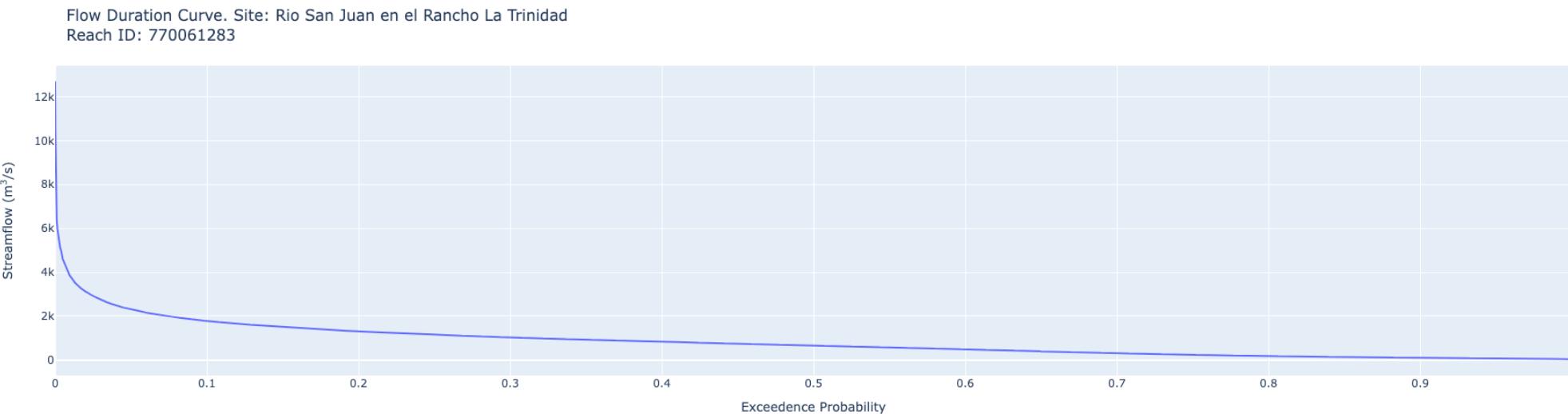


Annual Average Streamflow (Simulated). Site: Rio San Juan en el Rancho La Trinidad
Reach ID: 770061283



Flow Duration Curve

Is a measure of the probability that flow in a river exceeds a certain value.

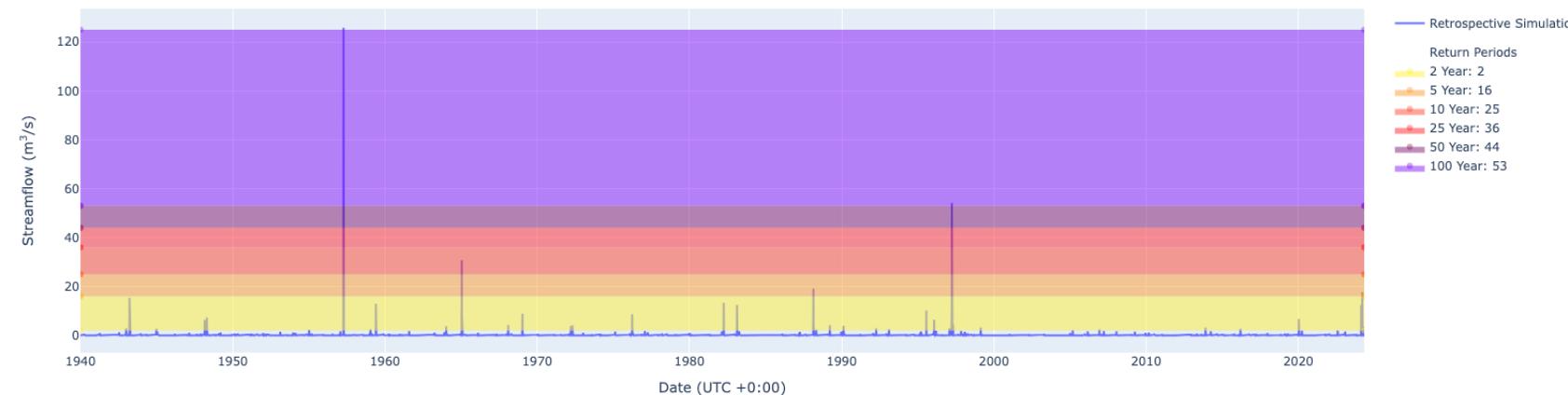


Discussion?

- Do you have access to this kind of information?
- What challenges exist if/when you do not?
- What problems could you solve with an 80-year historical simulation (record) on your rivers?
- What problems could you solve with a daily 15-day forecast

Forecast Application in Dubai

Retrospective Streamflow Simulation. Site: Near Dubai Airport
Reach ID: 290708005

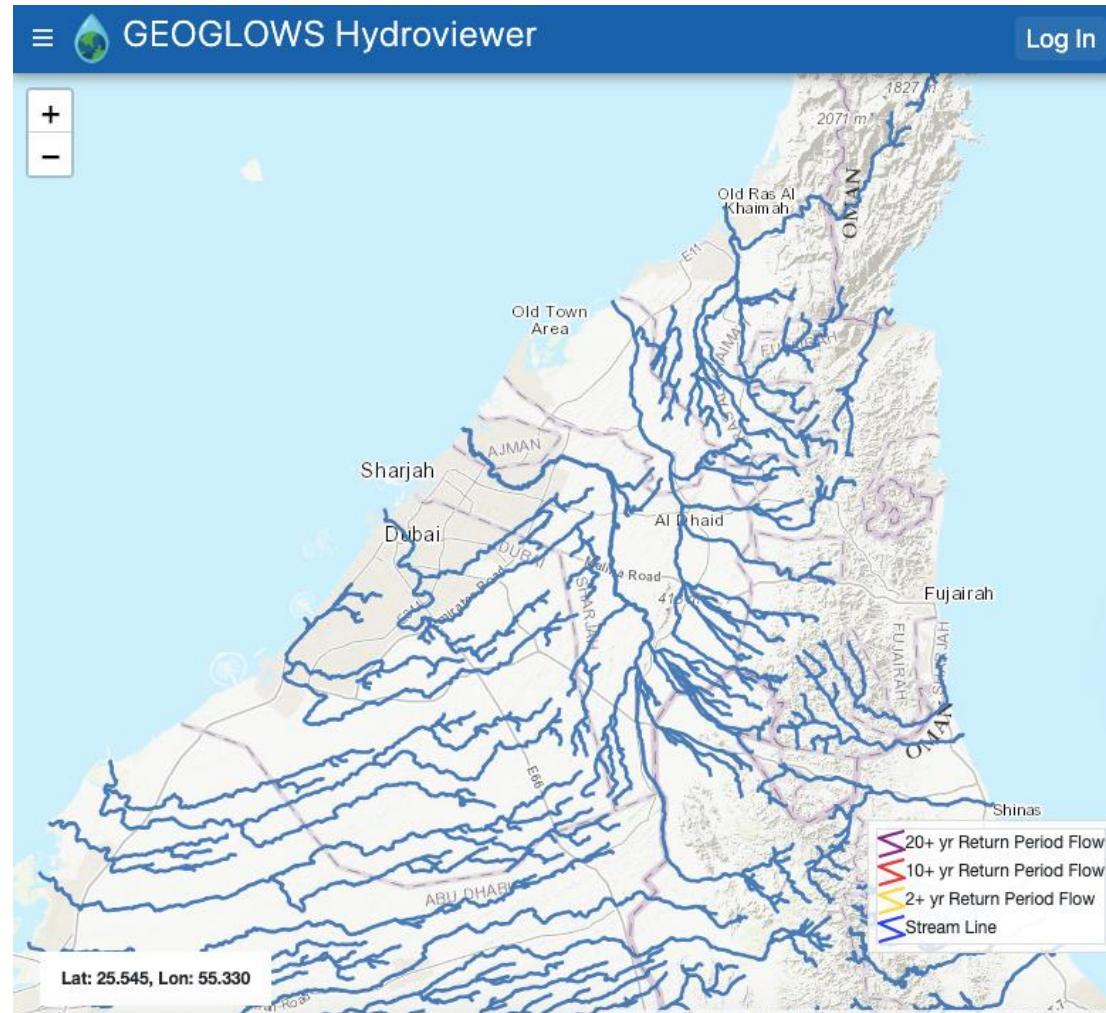


Flood forecasts based on output from the GEOGLOWS ECMWF Streamflow Services (GESS) global hydrological model, provide a global streamflow forecasting service, relevant for making informed predictions required for the emergency response decision-making process in the context of floods.

The following is a demonstration of how the NASA SERVIR GEOGLOWS forecasting services can help you make decisions in real-life scenarios.

The flood forecast response game will use flow forecast hydrograph and return periods as a basis.

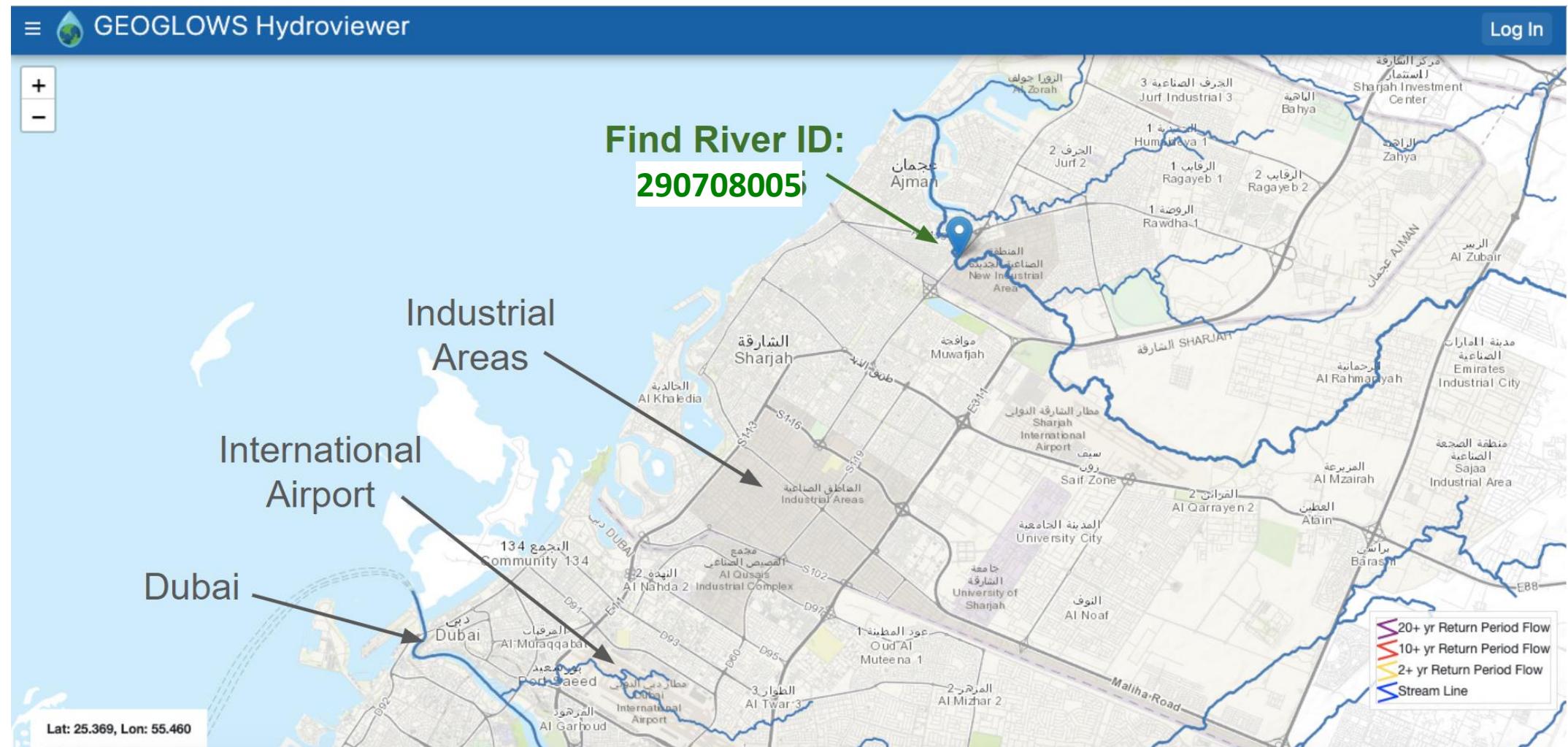
Forecast Application in Dubai



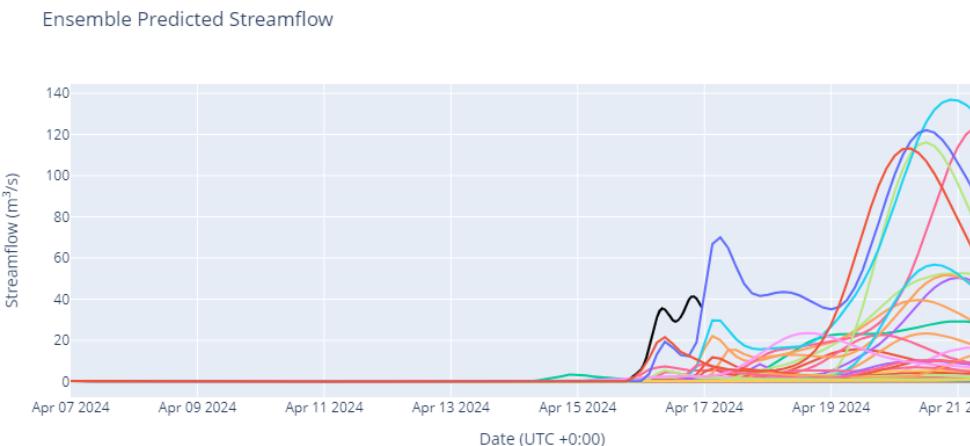
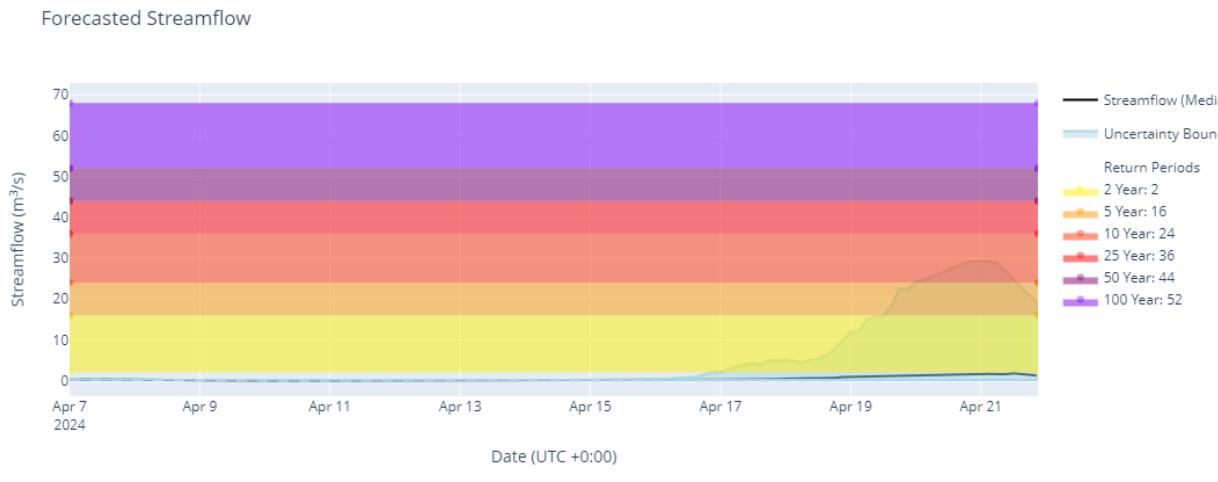
Imagine that you are engaged in the emergency response decision-making process in Dubai.

A flow forecast graph will be provided indicating a flood probability. Each day the current streamflow and the predicted flow over the subsequent 15 days will be shown. Based on the given information, how would you choose to respond considering both economic implications/limitations as well as preparation/safety?

Forecast Application in Dubai



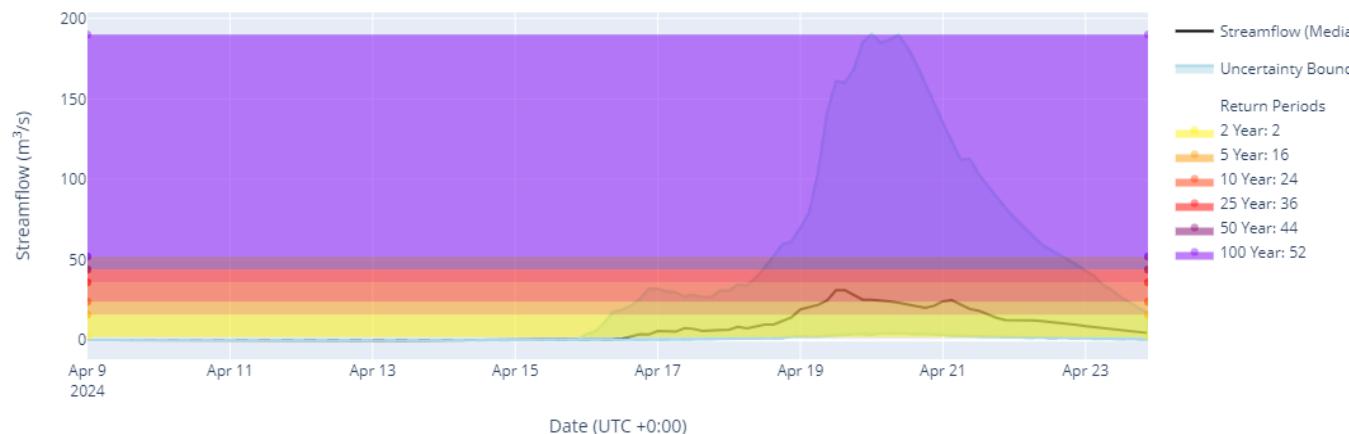
April 7, 2024



The displayed flow forecast graphs show the current streamflow and the predicted flow over the subsequent 15 days and the associated ensemble hydrograph. What would you choose to do at this point, if anything?

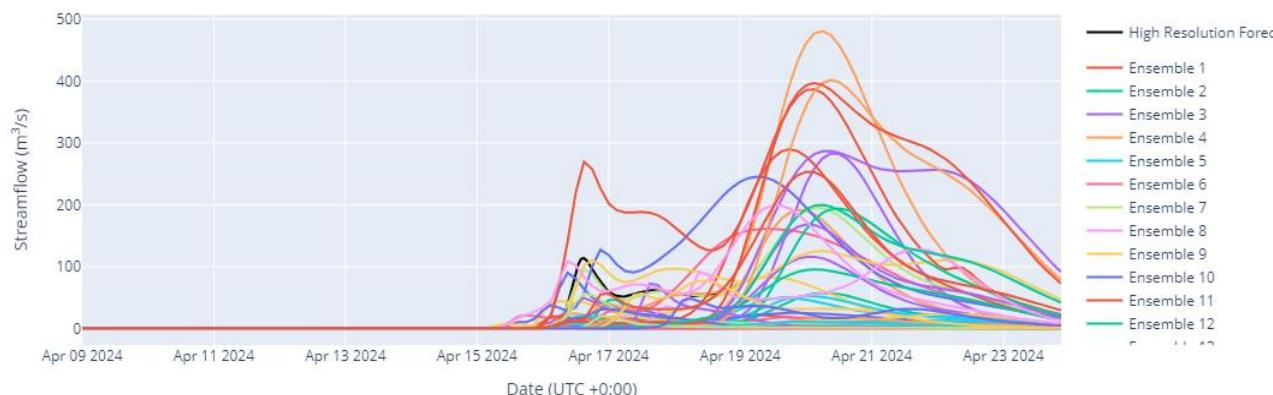
April 9, 2024

Forecasted Streamflow



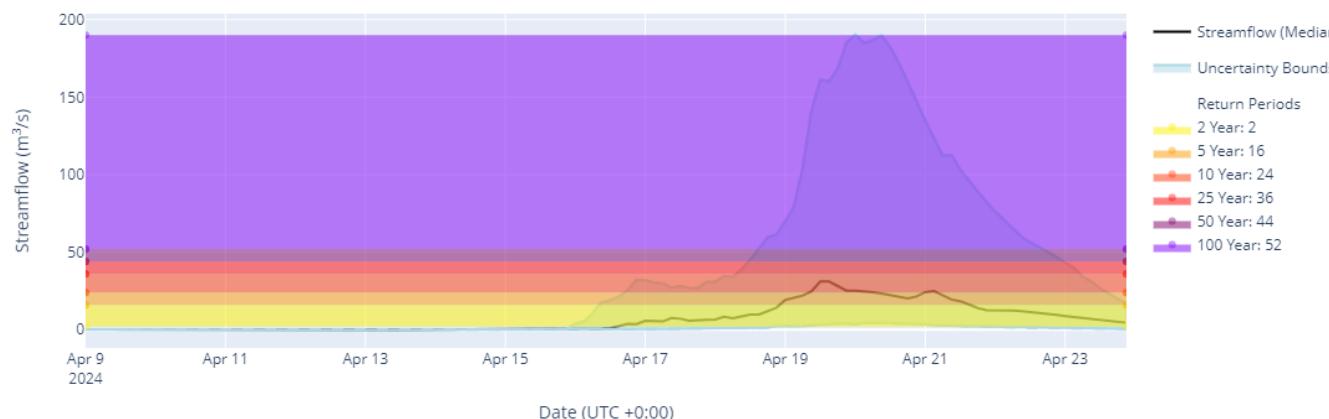
What would you do?

Ensemble Predicted Streamflow



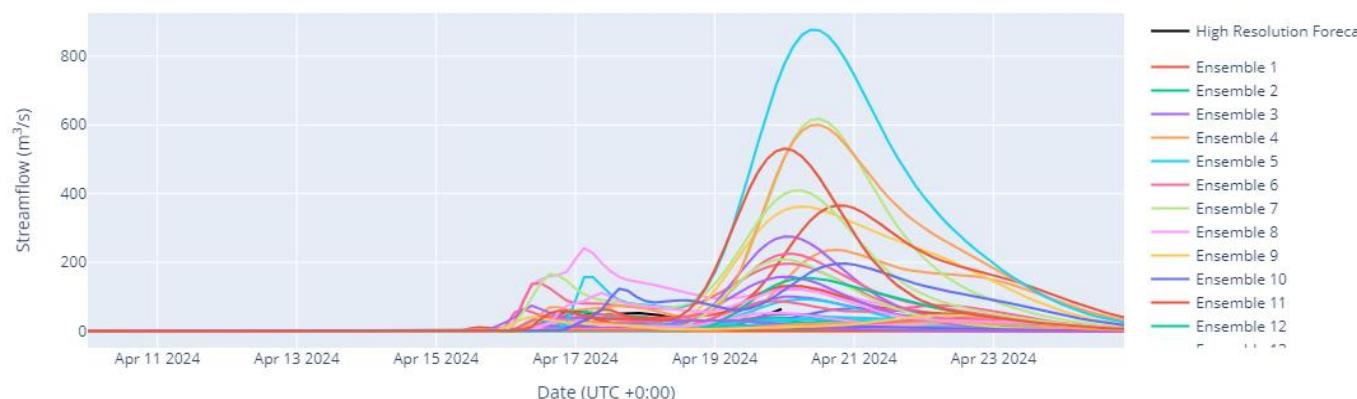
April 10, 2024

Forecasted Streamflow



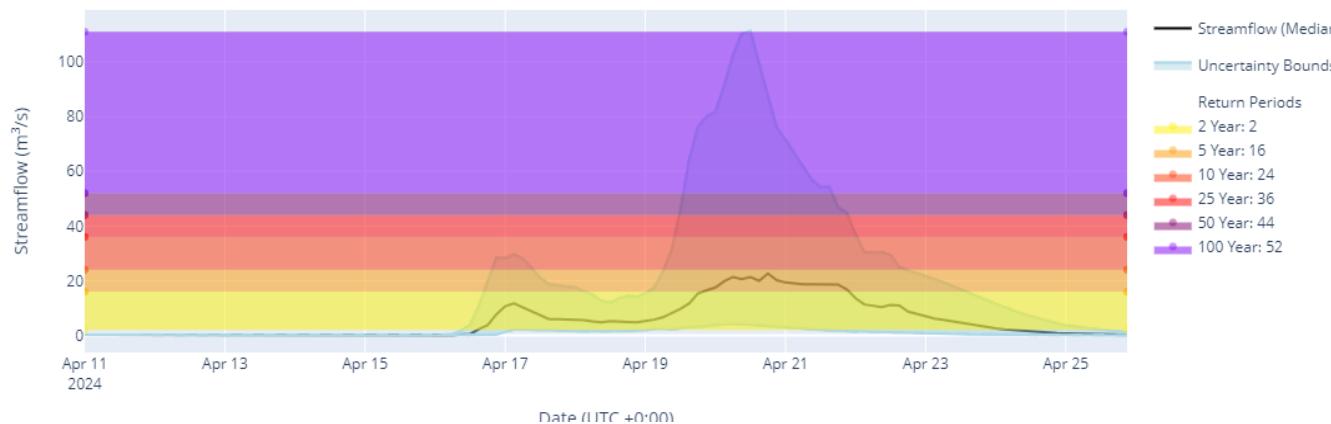
What would you do?

Ensemble Predicted Streamflow



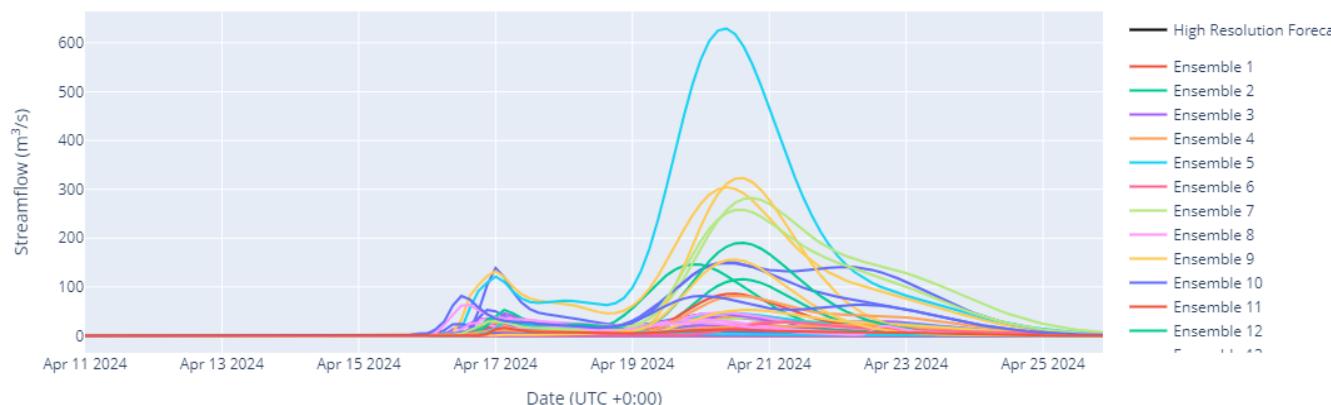
April 11, 2024

Forecasted Streamflow



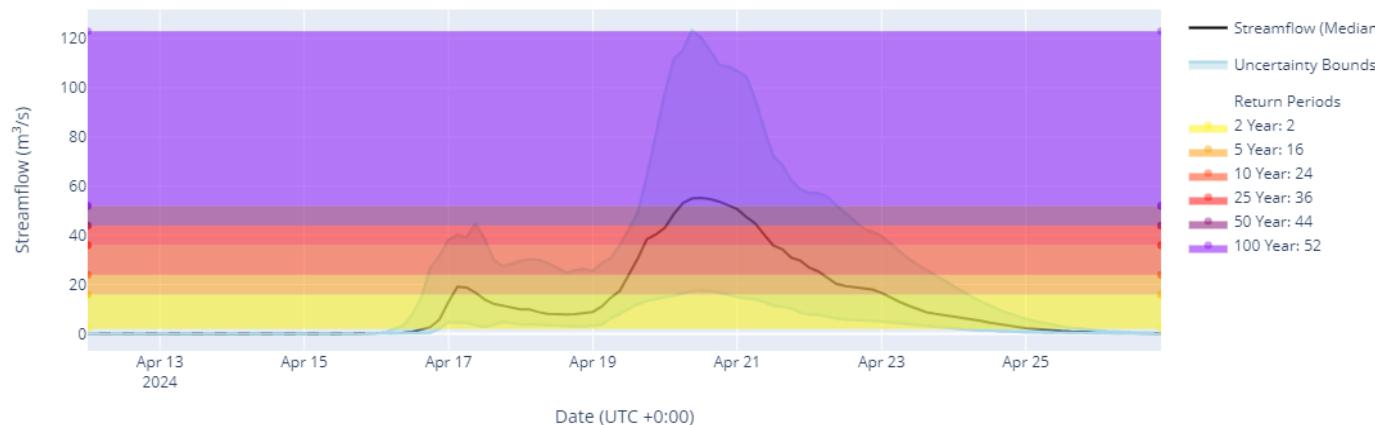
What would you do?

Ensemble Predicted Streamflow



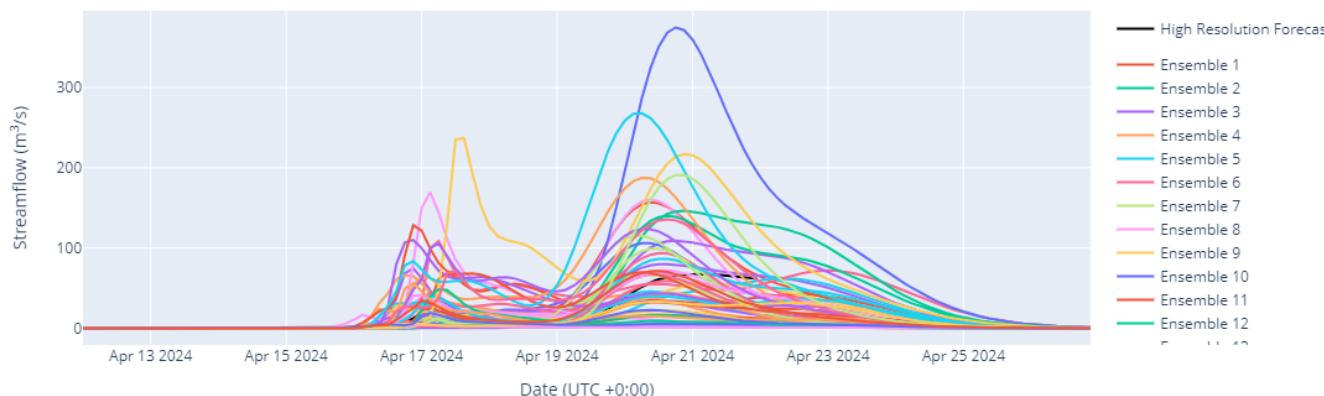
April 12, 2024

Forecasted Streamflow



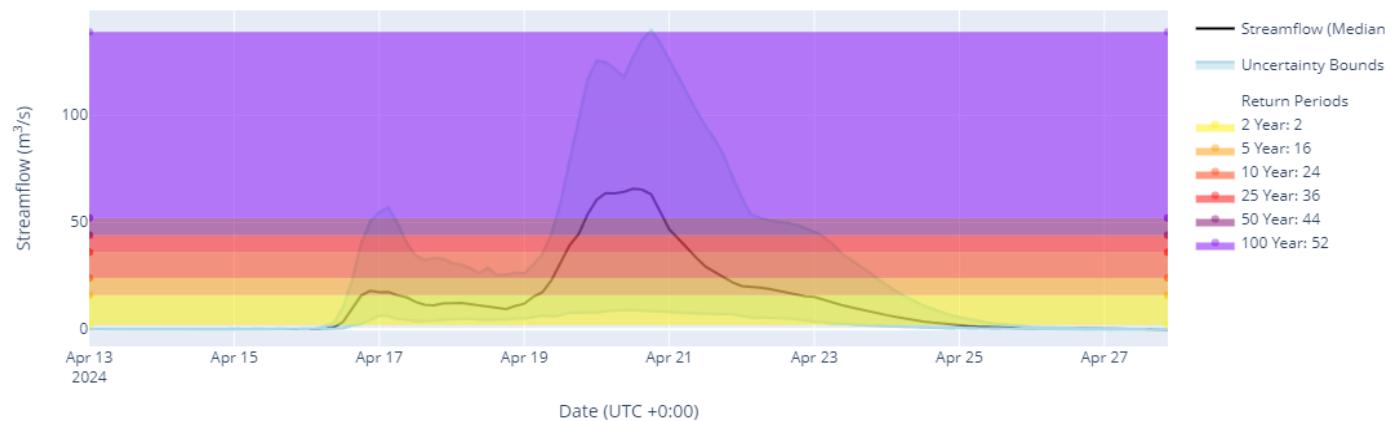
What would you do?

Ensemble Predicted Streamflow

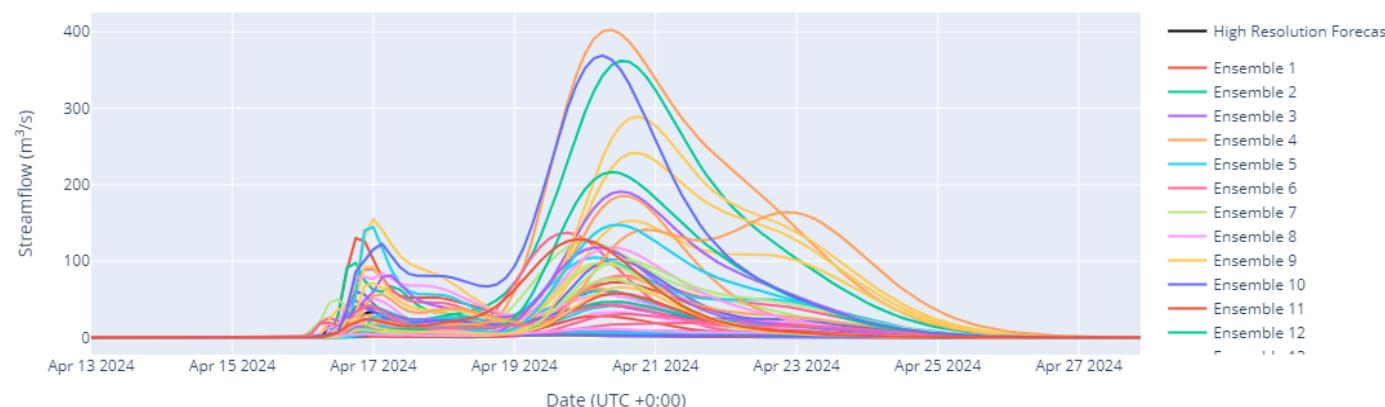


April 13, 2024

Forecasted Streamflow



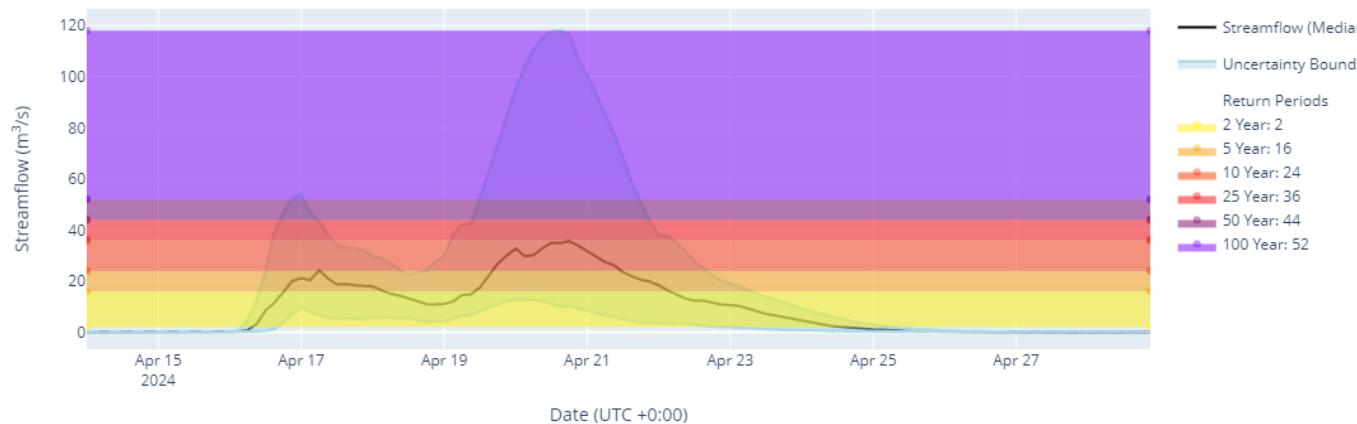
Ensemble Predicted Streamflow



What would you do?

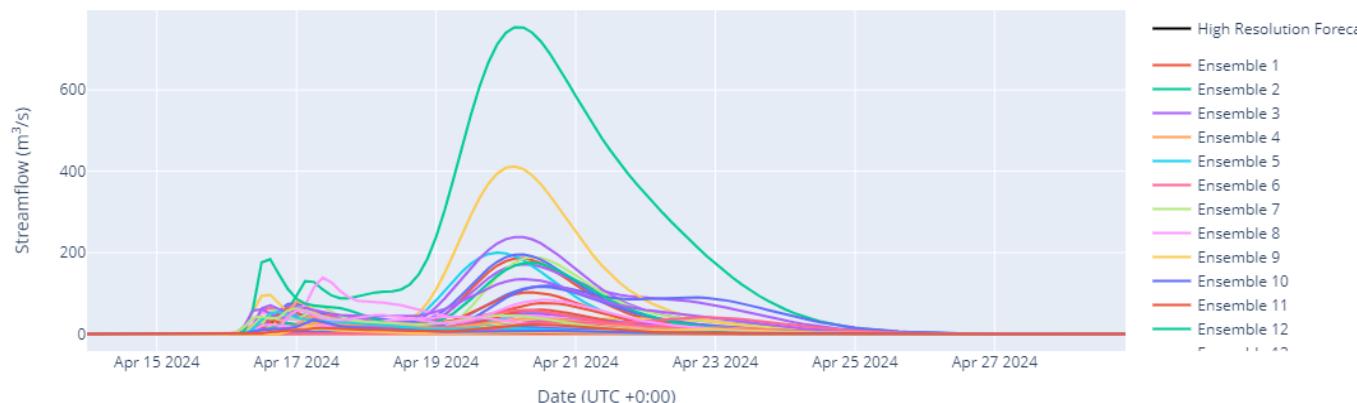
April 14, 2024

Forecasted Streamflow



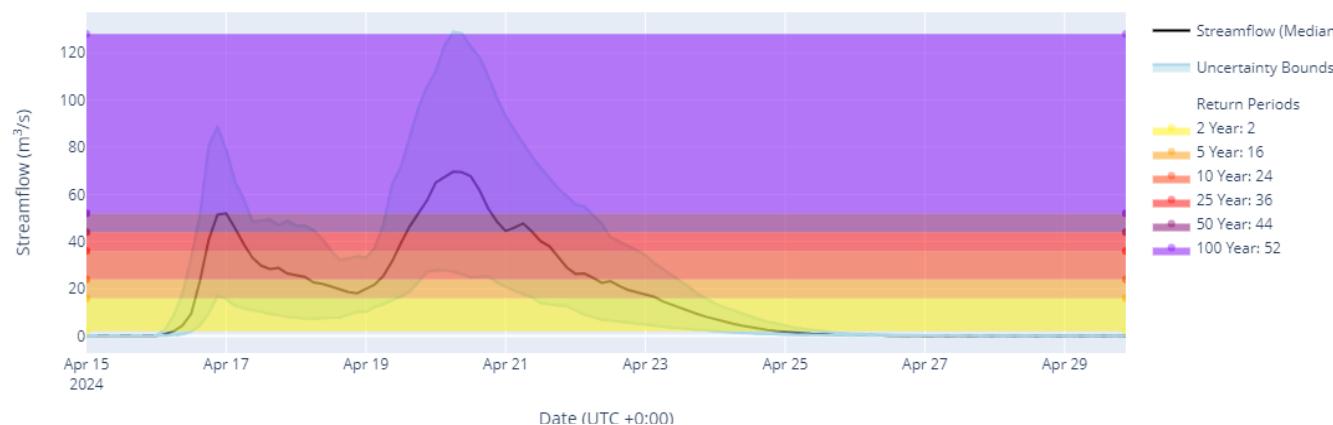
What would you do?

Ensemble Predicted Streamflow



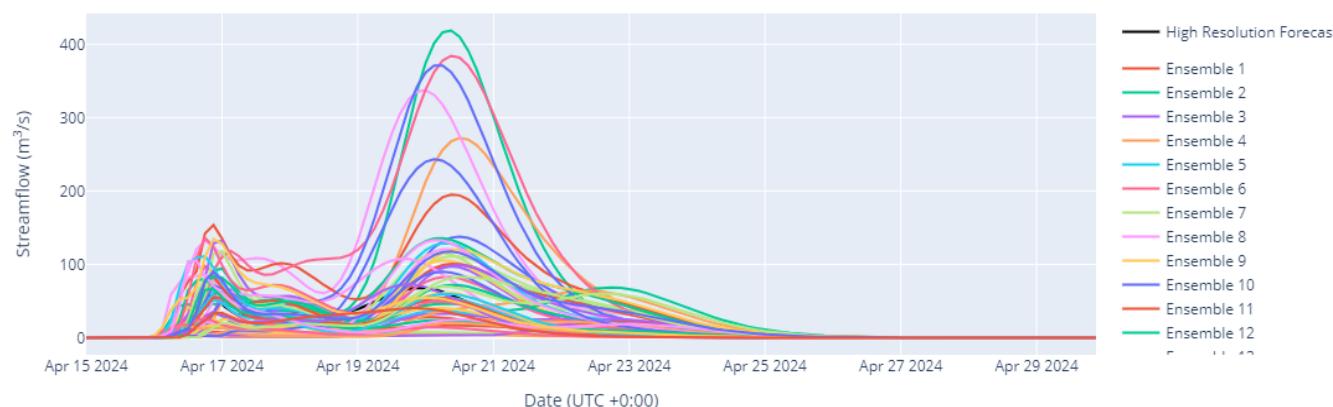
April 15, 2024

Forecasted Streamflow



What would you do?

Ensemble Predicted Streamflow



Dubai Flooding April 2024



<https://www.news24.com/citypress/trending/watch-dubai-gets-a-years-worth-of-rain-in-a-day-20240418>

In April 2024, the United Arab Emirates experienced unprecedented and devastating floods due to heavy rains, described as the country's heaviest rainfall in 75 years. The slow-moving storm began on April 14 and intensified on April 16, breaking records for the most rainfall in a 24-hour period since meteorological records began in 1949. Cities such as Dubai and Sharjah were severely affected, with Dubai recording a year's worth of rain in just 12 hours, and areas farther east receiving nearly 2 years' worth of rain within 24 hours.

Floodwaters rose rapidly, disrupting transportation and inundating roads. Some areas remained flooded even after the rain stopped, with up to 10 inches of rain measured in less than 24 hours, far exceeding the typical annual rainfall of 5.5 to 8 inches. The situation was so severe that even days after the rains ceased, satellites were still able to detect the extent of the flooding from space.

Dubai Flooding April 2024

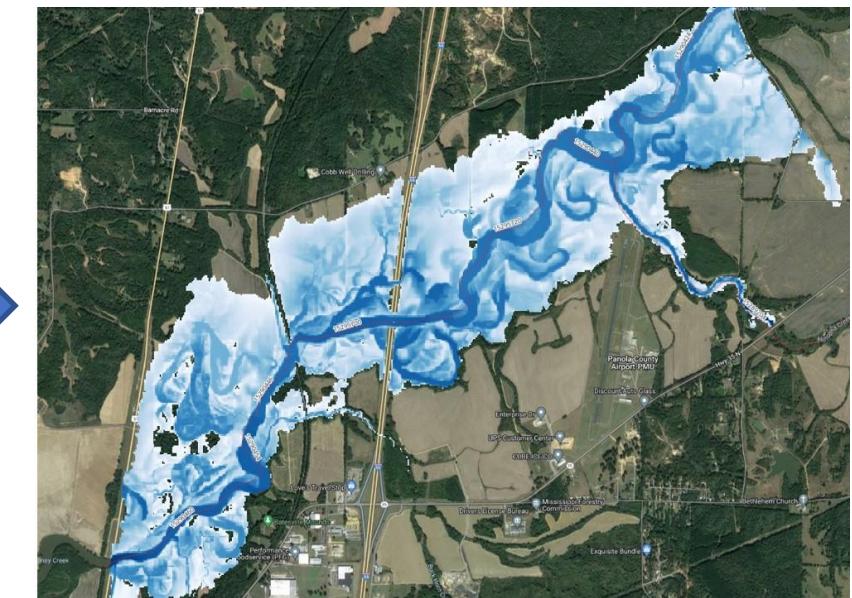
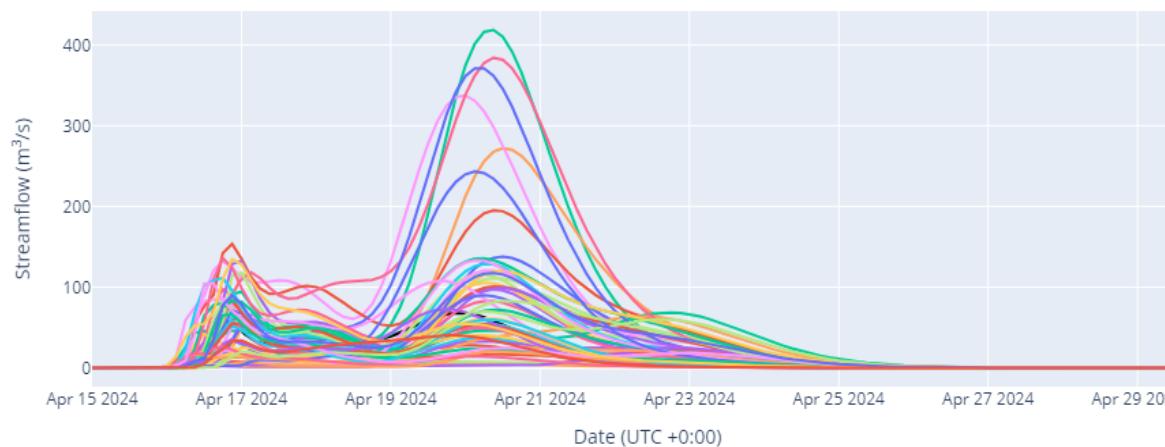
Dubai International Airport experienced significant disruption, with flights temporarily halted due to the deluge. As of April 18, the UAE was still in the process of recovery from the catastrophic flooding, with Dubai's international airport facing ongoing delays.



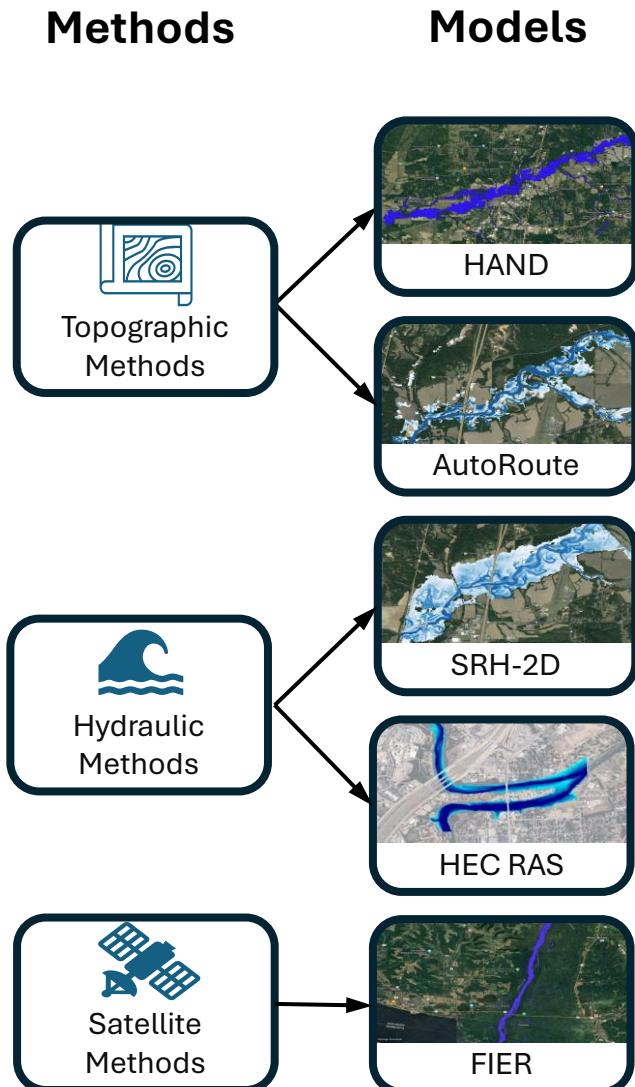
Dubai International Airport, the world's busiest for international travel, experienced a surge in passenger numbers in 2023, reaching a total of 86.9 million passengers. The airport is a vital hub, connecting to 262 destinations in 104 countries worldwide through over 100 international carriers. Additionally, Dubai reported its best-ever tourism numbers, hosting 17.15 million international overnight visitors in 2023, contributing significantly to the city's economy. With projections estimating an increase to 88.8 million passengers this year, the airport faces mounting pressure, especially considering the recent flooding events that disrupted operations. This underscores the airport's significance to the country's economy and the challenges posed by the need to accommodate increasing passenger volumes amidst such impactful natural occurrences.

Understanding Impacts

Ensemble Predicted Streamflow



Flood Inundation Mapping



- Topographic Models fill up based on the geography of an area. They are relatively computationally light, and give a rough estimate of flooded areas.
- Hydraulic modeling methods, solve equations representing the mass and momentum of fluid flow. They are more computationally expensive, but when created and calibrated correctly can be more accurate.
- Satellite methods, like FIER, seek to leverage the power of observed satellite images. They create flood inundation maps through statistical methods.

Questions?

Thank You!!