Tethys Generated Decision Support Web Applications - Host, Share, and Visualize Earth Science Data

Nathan Swain, Katherine Moore Powell, Scott Christenson, Shawn Crawley

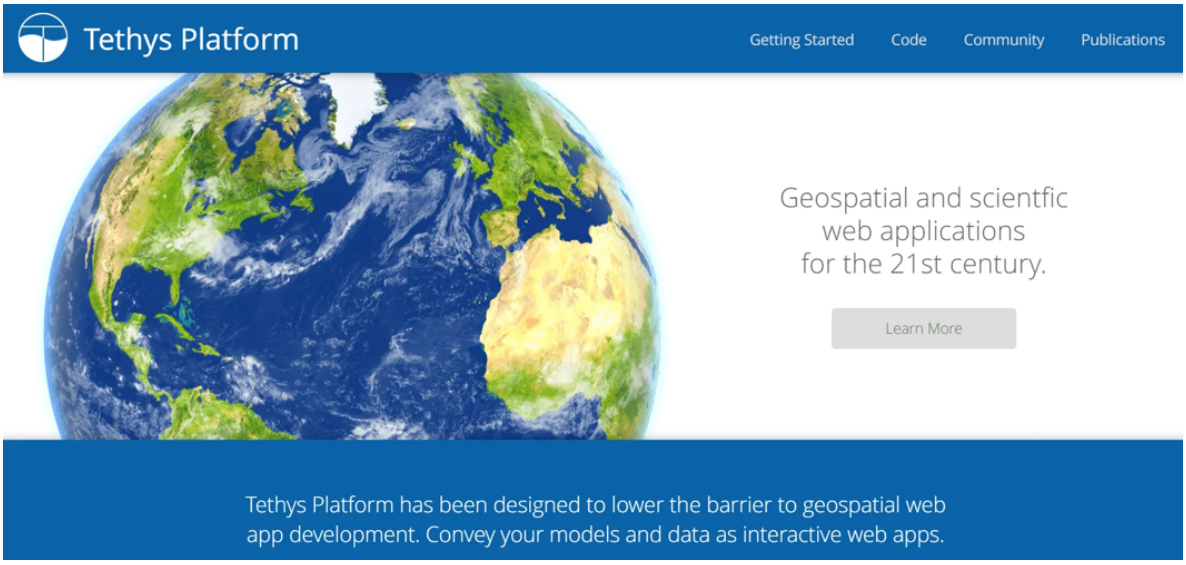
Aquaveo LLC, Lynker Corporation, U.S. Army Engineer Research and Development Center, Tethys Geospatial Foundation

PRESENTED AT:

Accelerating Informatics for Earth Science 2024

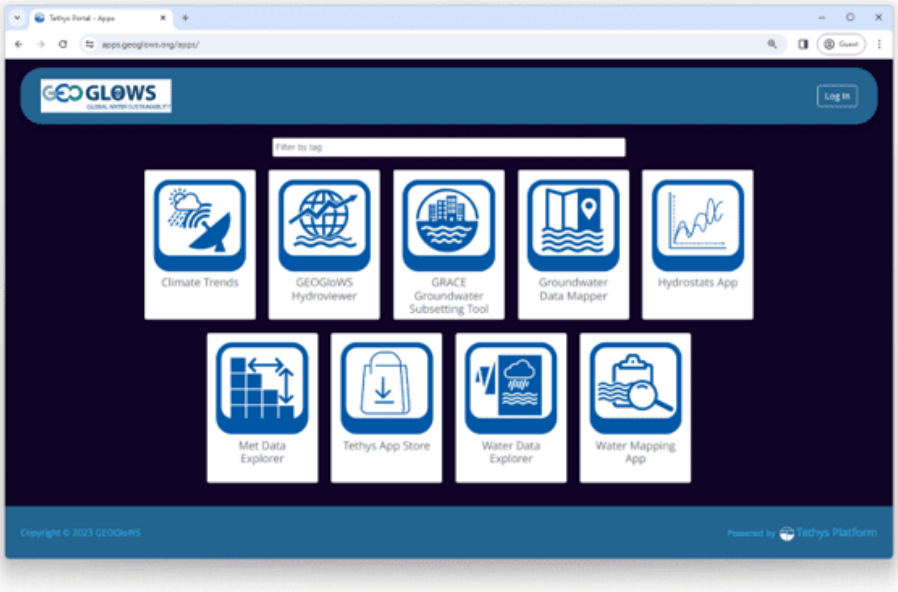
WHAT IS TETHYS PLATFORM?

An open-source web framework that enables new ways to use earth sciences models.



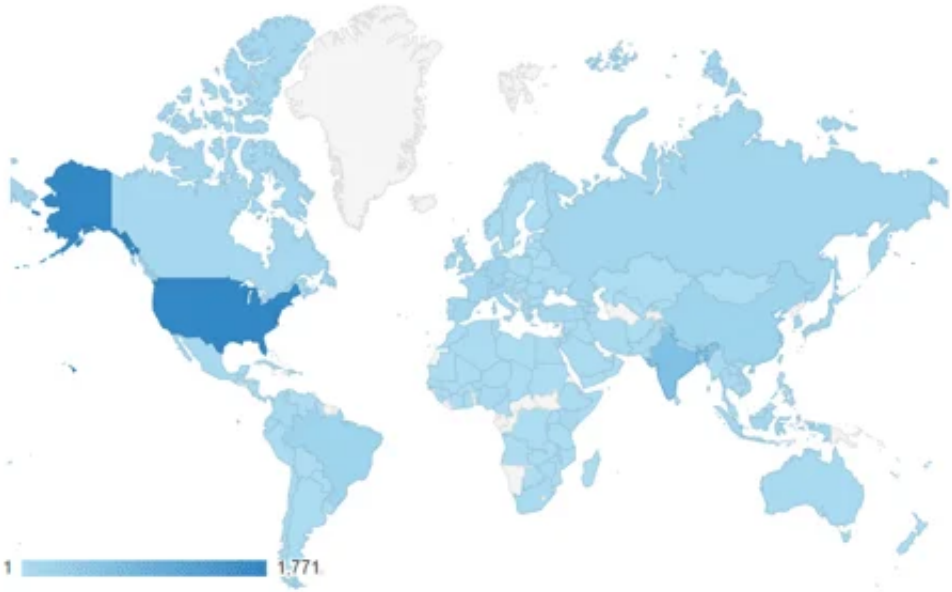
Earth science models can provide powerful insight during critical decision-making activities, but it often takes an expert to equip a model for a new scenario. Use Tethys Platform to distill the most common scenario exploration exercises into easy-to-use web applications.

Tethys Portal:



Tethys Portal is a batteries-included web portal for hosting Tethys applications and other external web tools. Use Tethys Portal to create a dashboard of all the web-based tools you use in your decision-making activities Powered by Django, the most popular Python web framework, Tethys Portal is secure and it supports user accounts with granular permission, enterprise authentication, and linking to external web tools and resources via Proxy Apps.

International User Base:



Tethys Platform has been adopted by users from around the world. It is used in government, academia, and the private sectors by organizations such as NASA SERVIR, NOAA OWP, NOAA CIROH, GEOGLOWS, US Army Corps of Engineers (ERDC), HydroShare, Aquaveo, Lynker, and Dynamic Engineers. The following stats from the analytics on Tethys Platform websites illustrate this fact (from 2022):

tethysplatform.org:

- 2000 visits
- 100 countries
- 53% - Americas
- 26% - Asia
- 14% - Europe
- 5% - Africa

docs.tethysplatform.org

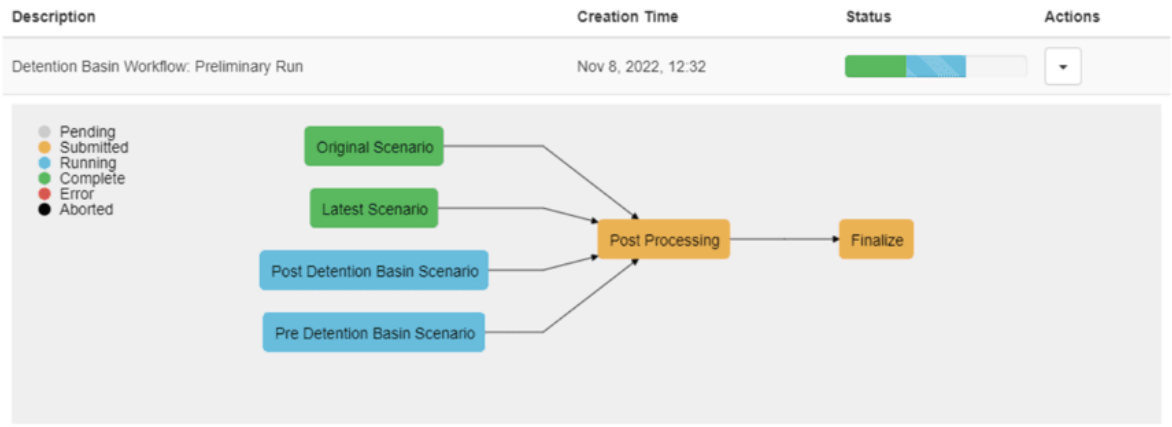
- 6400 visits
- 150 countries
- 38% - Americas
- 30% - Asia
- 21% - Europe
- 7% - Africa

OPEN-SOURCE GIS AND CLOUD COMPUTING

Web GIS:

Tethys applications are compatible with OGC web map services allowing them to display data from a variety of sources including open-source map servers like GeoServer and THREDDS and are also compatible with Esri ArcGIS services.

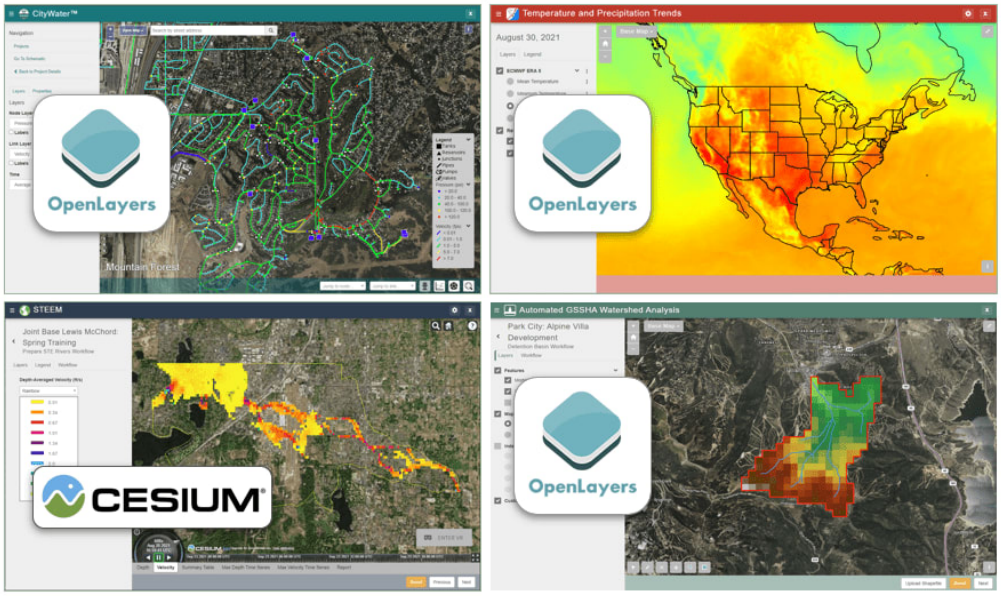
Cloud Computing:



Tethys Platform includes two open-source tools that can be used to build cloud computing scientific workflows: HTCondor and Dask. Since Tethys applications are coded using Python, the whole scipy ecosystem can be used in computing jobs. Tethys also includes a Jobs Table Gizmo for tracking job status (above).

OPEN-SOURCE WEB VISUALIZATION

OpenLayers:

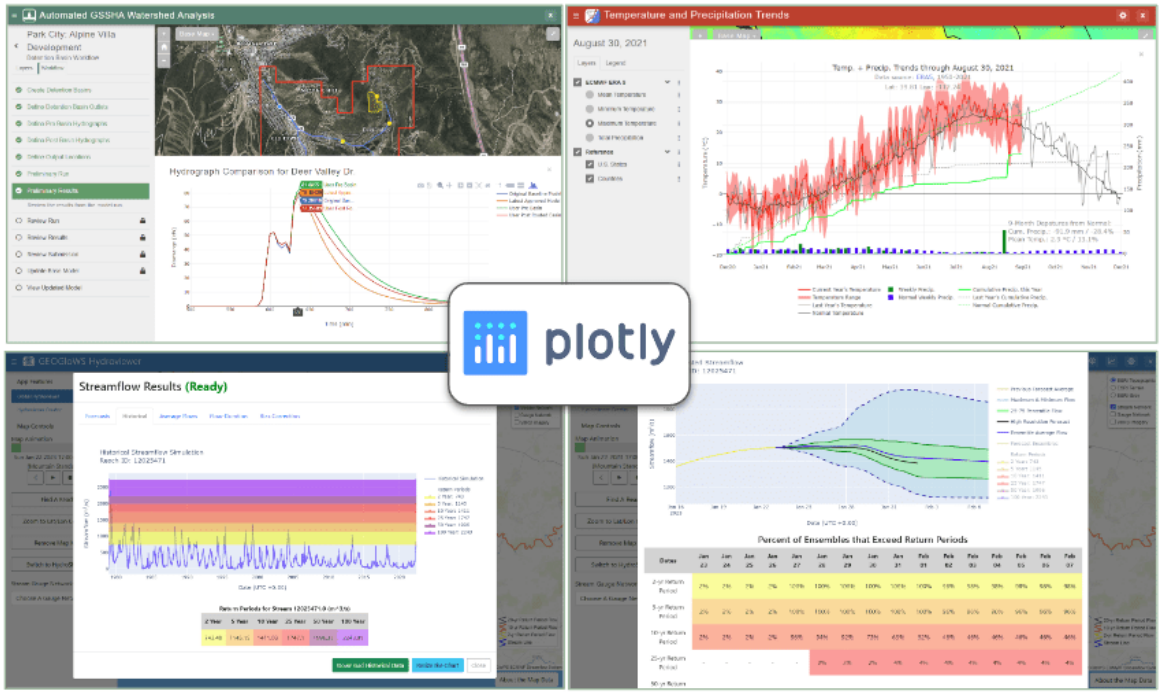


OpenLayers is an open-source 2D web mapping client. It can be used to visualize any OGC compatible or ArcGIS map service. It also supports vector data formats like GeoJSON, KML, and GML.

CesiumJS:

CesiumJS is an open-source 3D-globe mapping client. It can be used to visualize 3D geospatial data from a variety of formats including KML, CZML, CAD/BIM, and glTF. Cesium also includes native support for the time dimension, making it ideal for animating temporally varying data. Cesium Ion adds curated data layers including Cesium World Terrain, Cesium World Bathymetry, and Cesium OSM Buildings to provide realistic context for data displayed in the globe.

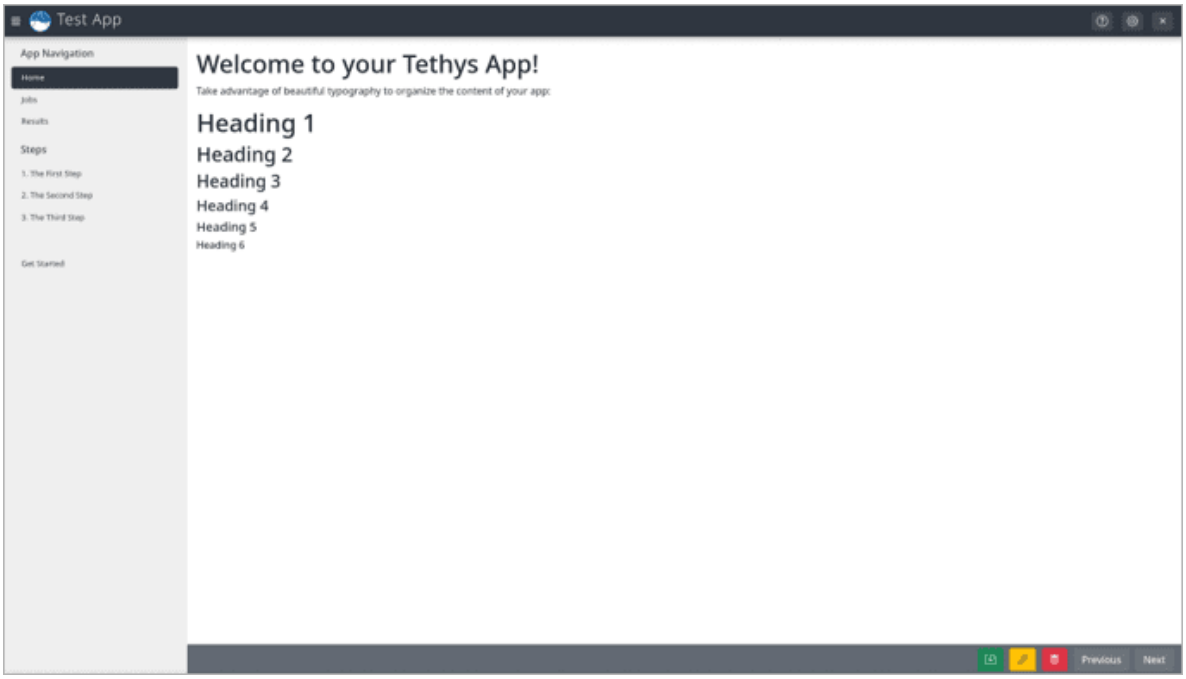
Plotting:


Automated GSSHA Watershed Analysis
Park City: Alpine Villa Development
Hydrograph Comparison for Deer Valley Dr
Temperature and Precipitation Trends
August 30, 2021
Temp. + Precip. Trends through August 30, 2021
plotly
GEOGLOWS Hydroviewer
Streamflow Results (Ready)
Historical Streamflow Simulation
Reach ID: 12025471
Percent of Ensembles that Exceed Return Periods

EASY TO GET STARTED

Getting Started:

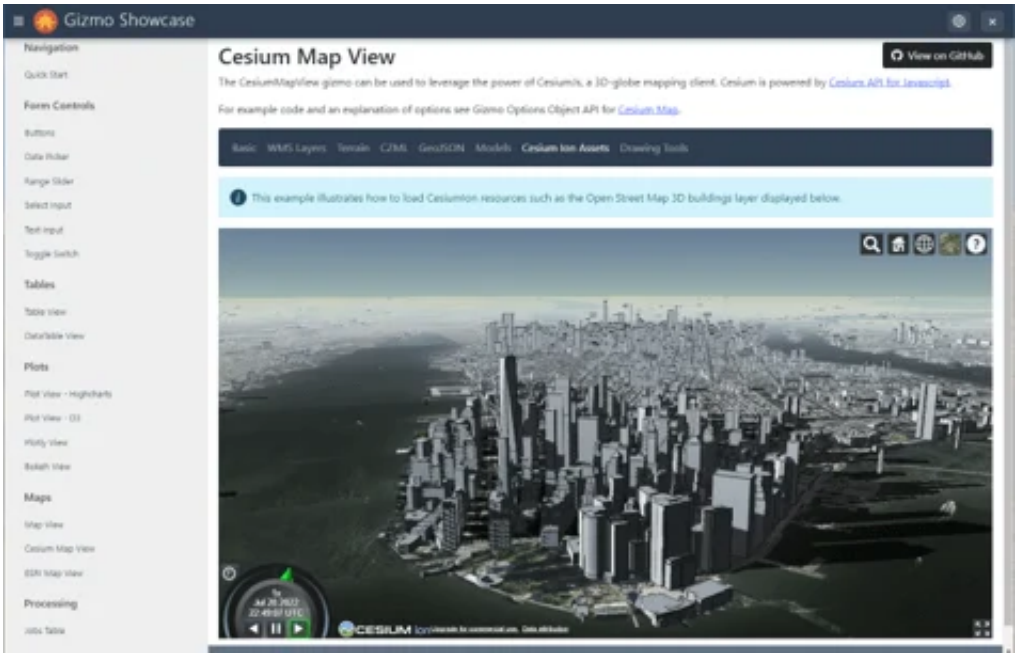
App Scaffold:



To generate a new app, use the Tethys scaffold, which generates the files needed for a new Tethys application with a default layout.

Tethys Gizmos:

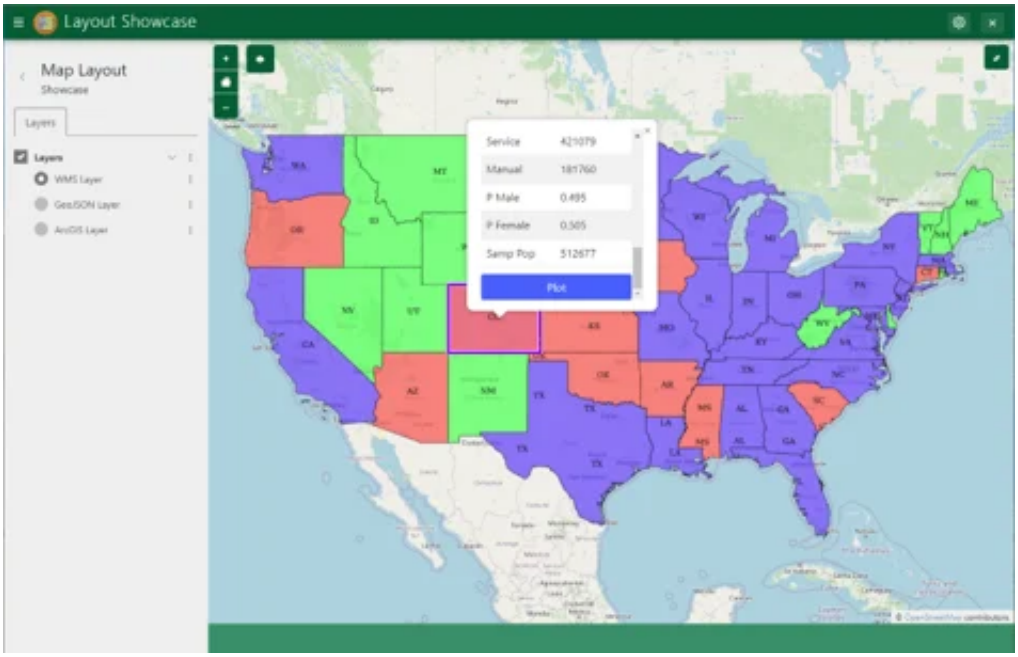
- Configurable components of an app
- Examples:
  - Date Picker Controls
  - Select Controls
  - Map View (OpenLayers)
  - Plotly View
  - Cesium Map View
- Gizmo Showcase App



Tethys Layouts:

- Full-featured and customizable view
- Configured in Python
- Python and JavaScript APIs
  - Customizable and extendable

- Map Layout
  - Fullscreen map
  - Basemaps
  - Layer tree
  - Feature selection
  - Properties pop-ups
  - Click-and-plot
- Layout Showcase App



Development APIs:

Tethys applications are developed using a combination of Python and JavaScript. Tethys Platform includes development APIs that streamline common development activities. Easily add controls, plots, and maps to the pages of the application using the Template Gizmos API. Manage the files the application uses using the Paths API. Interact with external services using the Services API.

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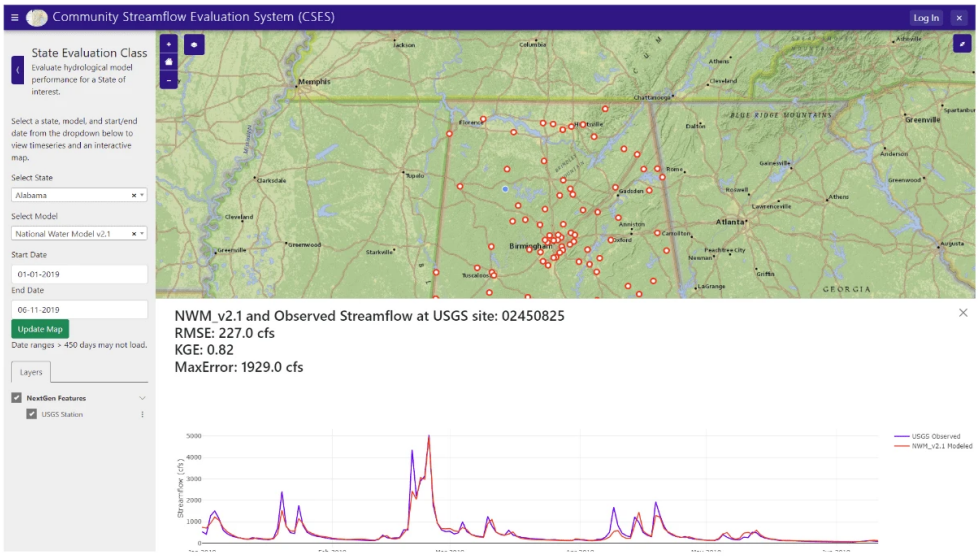
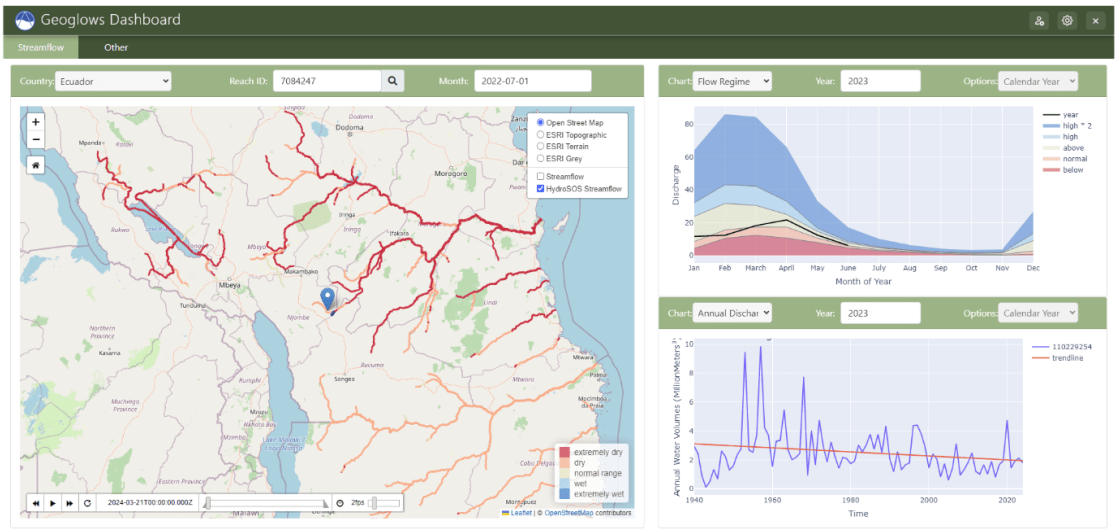
EXAMPLE APPLICATIONS

Community Streamflow Evaluation System (CSES)



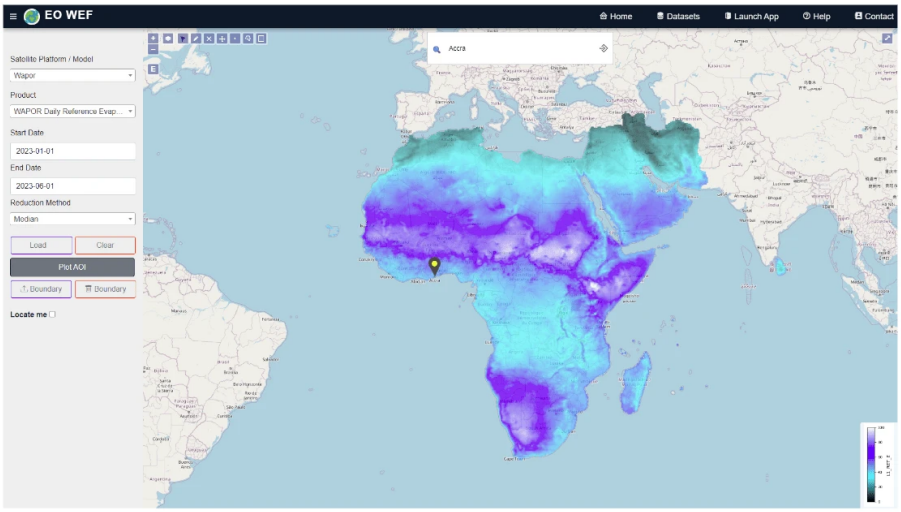
Author(s): Ryan Johnson, Shahab Alam, Gio Romero Link: http://portal.ciroh.org/t/apps/community-streamflow-evaluation-system/

Eastern & Southern Africa: GEOGLOWS Dashboard



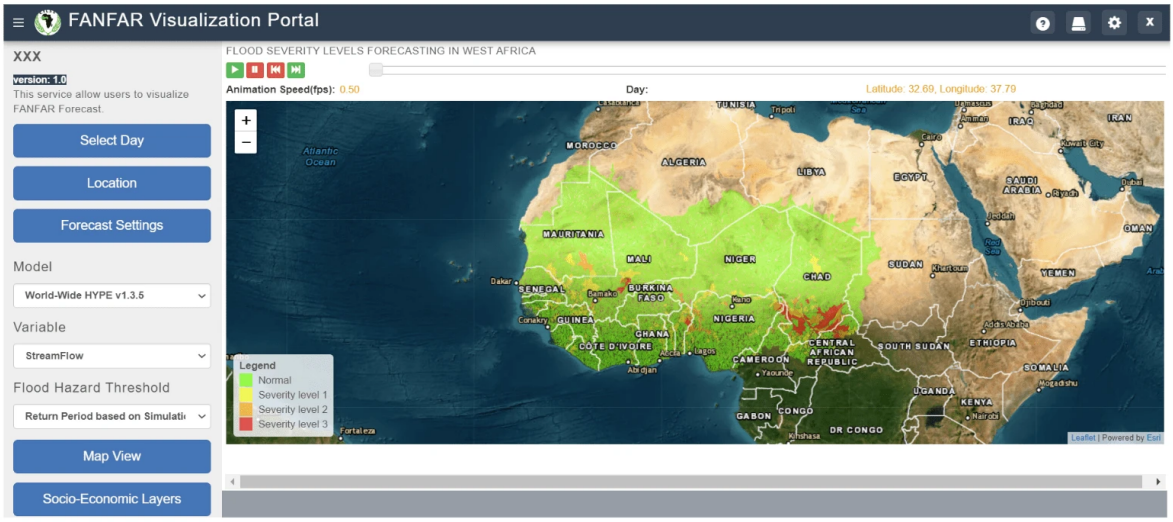
Author(s): Sonia Sun, Rachel Huber Link: <Development in Progress>

Earth Observation for Water, Energy, Food Nexus (EO-WEF)



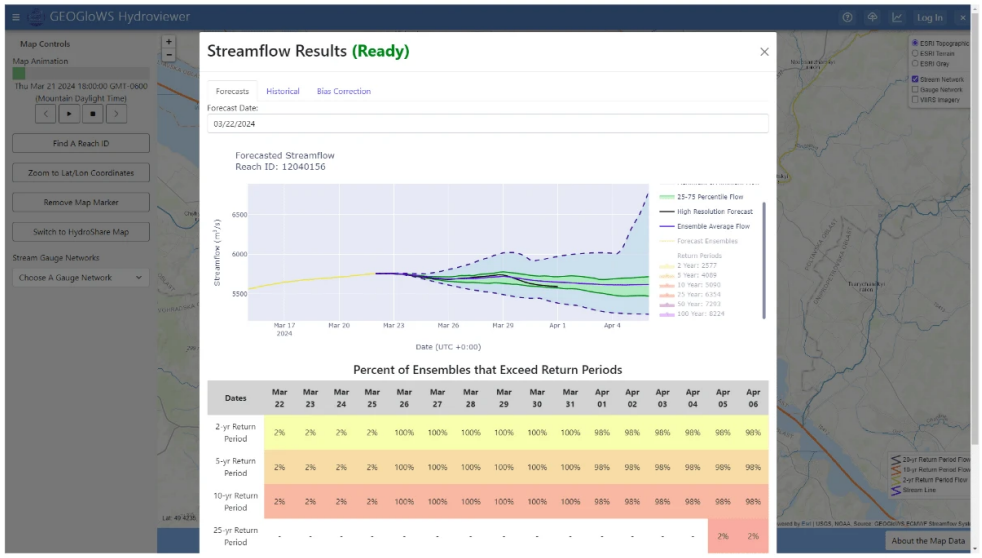
Author(s): Zolo Kiala Link: https://www.ctafs.org/apps/earth-engine/viewer/

FANFAR Portal



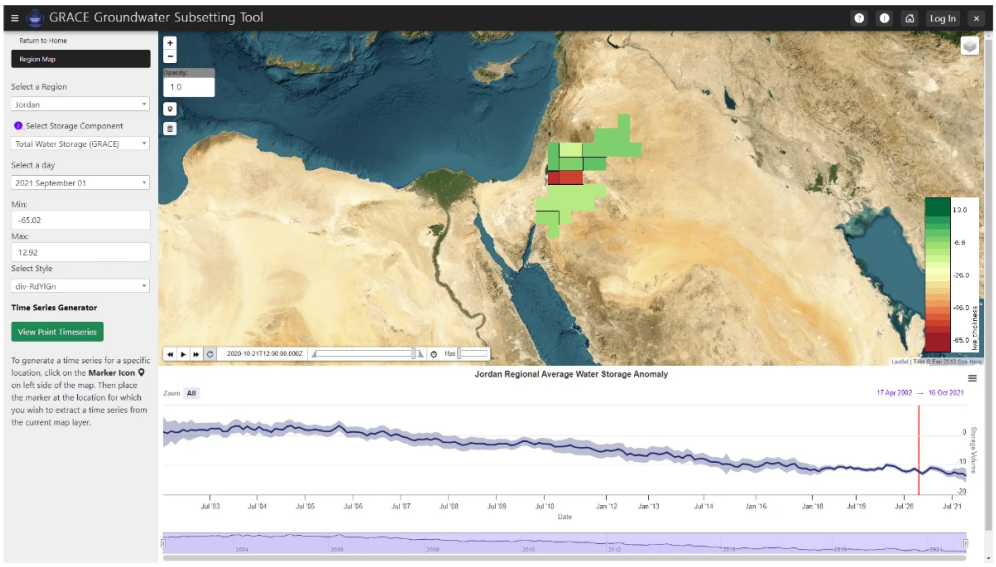
Author(s): Bernard Minoungou Link: http://154.127.90.200/apps/fanfar-portal/

GEOGLOWS Hydroviewer



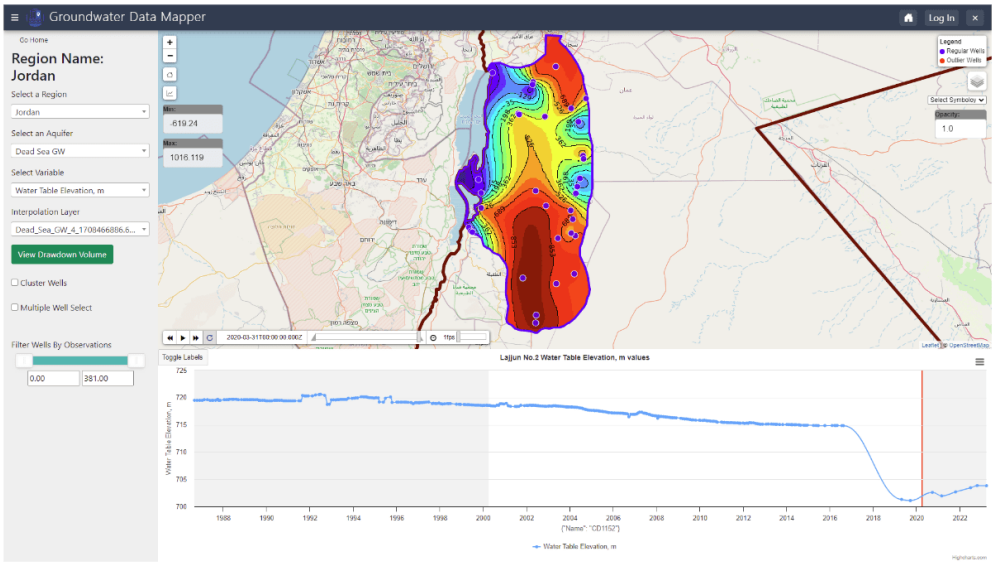
Author(s): Riley Hales, Jorge Luis Sanchez Link: https://apps.geoglows.org/apps/geoglows-hydroviewer/

GRACE Groundwater Subsetting Tool



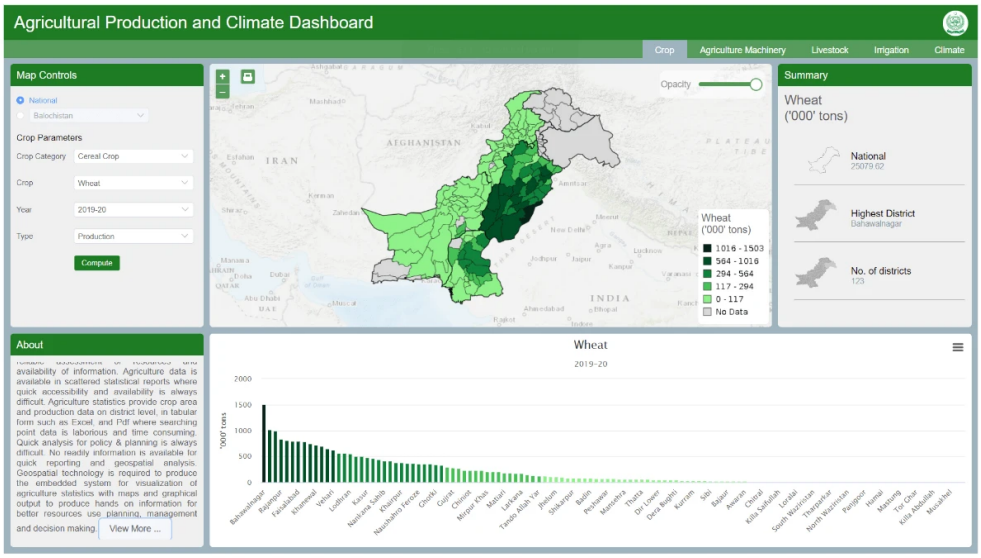
Author(s): Sarva Pulla, Travis McStraw Link: https://apps.geoglows.org/apps/ggst/

Groundwater Data Mapper



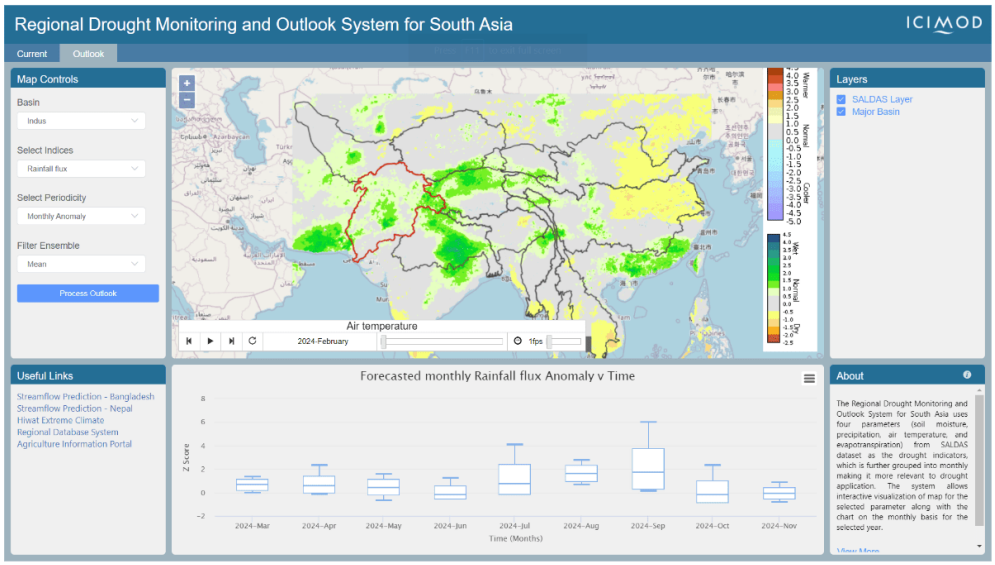
Author(s): Sarva Pulla, Steven Evans Link: https://apps.geoglows.org/apps/gwdm/

Himalaya: Agricultural Production and Climate Dashboard



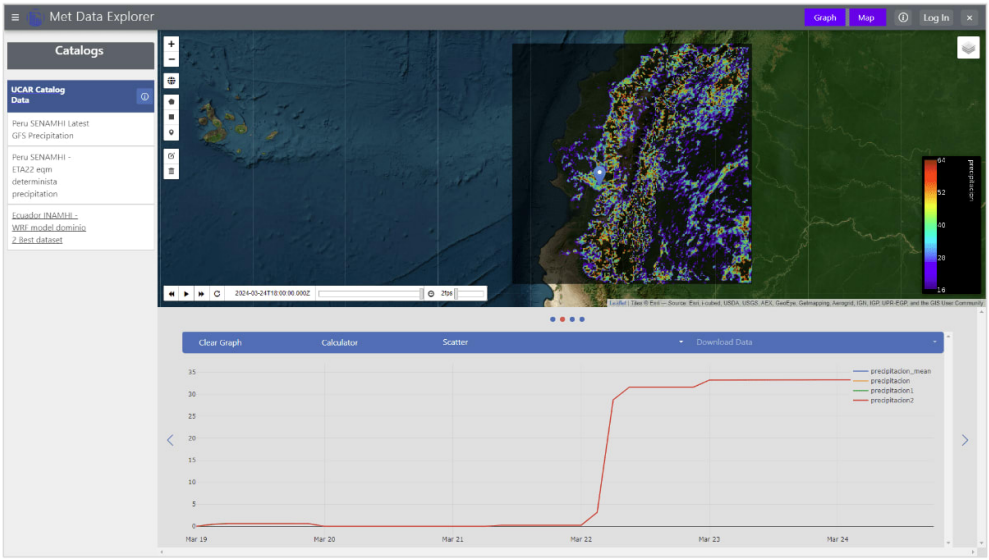
Author(s): ICIMOD Link: http://tethys.icimod.org/apps/agripk/

Himalaya: Regional Drought Monitoring and Outlook System for South Asia



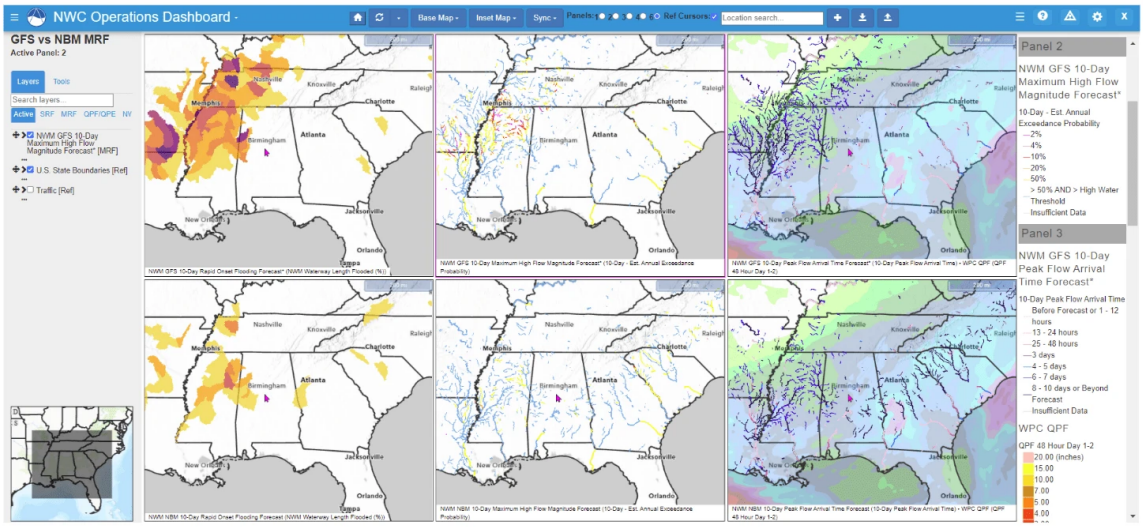
Author(s): ICIMOD Link: http://tethys.icimod.org/apps/regionaldrought/outlook/

Met Data Explorer



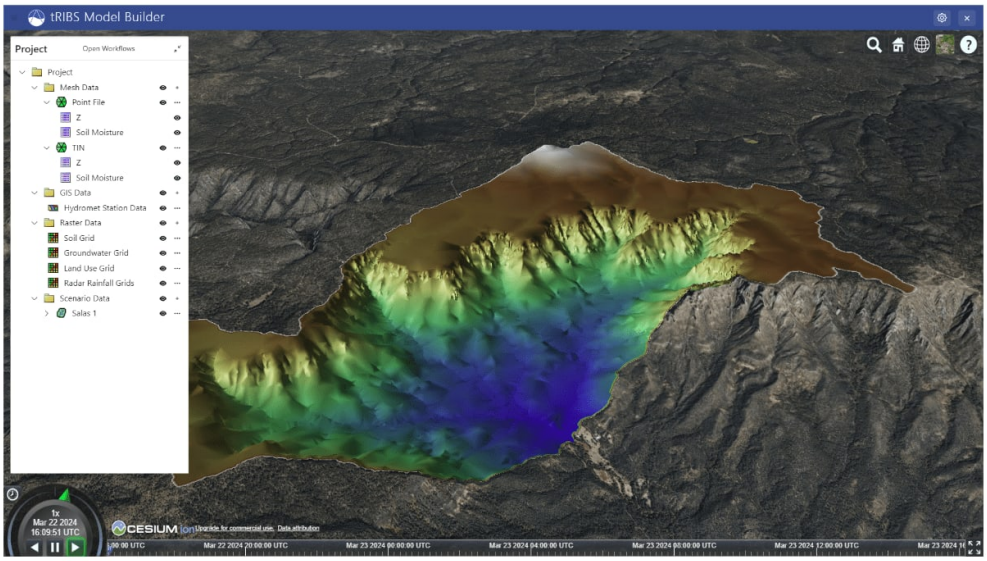
Author(s): Enoch Jones Link: https://apps.geoglows.org/apps/metdataexplorer/

NOAA OWP



Author(s): Shawn Crawley Link: <Internal Use Only>

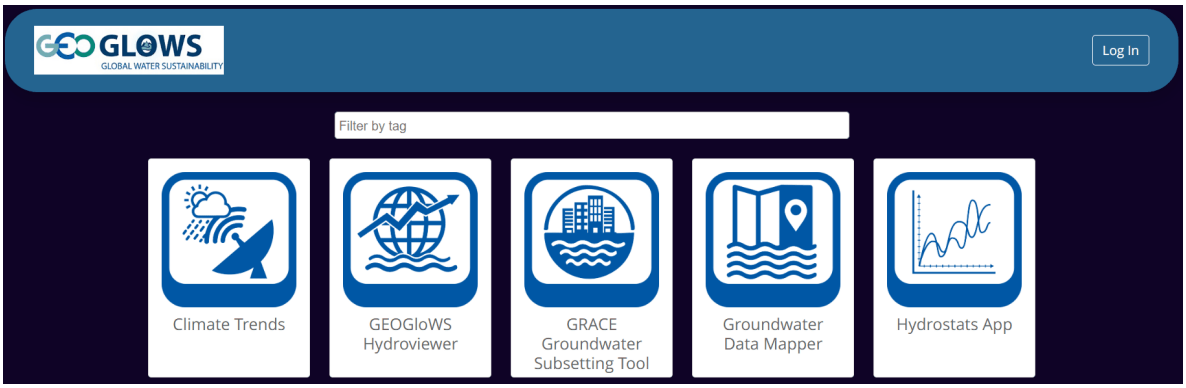
tRIBS Model Builder



Author(s): Salt River Project, Arizona State University, Aquaveo Link: <Development in Progress>

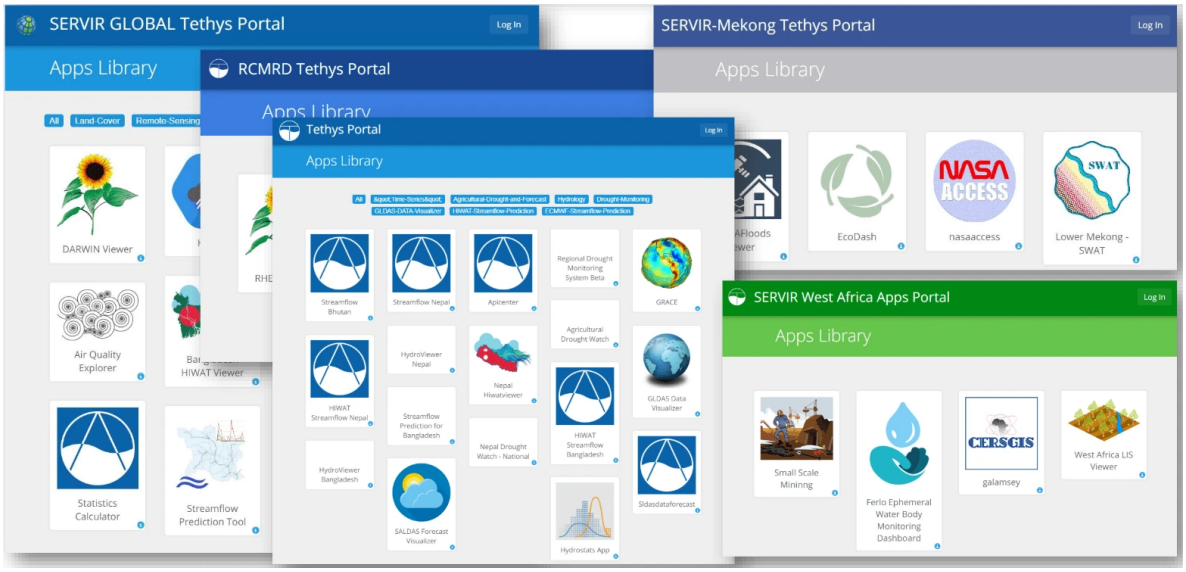
TETHYS PORTALS: NASA SERVIR & GEOGLOWS

GEOGLOWS: (https://apps.geoglows.org/apps/)



The Group on Earth Observations (GEO) Global Water Sustainability (GEOGLOWS) working group has created the Global Streamflow and Flood Forecasting System, a global streamflow forecasting service that allows local stakeholders to focus on solving water management problems such as flooding, drought, and water/food security issues by providing the water intelligence they need to make decisions. In addition, GEOGLOWS has sponsored the development of a suite of global water resource web applications, which have been deployed at https://apps.geoglows.org (https://apps.geoglows.org).

NASA SERVIR:



Dr. Jim Nelson (BYU) introduced the Tethys Platform to SERVIR as a component of his AST project in the Hindu Kush-Himalaya region. ICIMOD and the PIs for the other 3 projects in HKH saw the value in using Tethys as a way to deliver their services:

• Managing the Changing Water Resources South of the Himalayas (David, C.)

• Monitoring Intense Thunderstorms in the Hindu-Kush Himalayan Region (Gatlin, P.)

• Comprehensive Stream Flow Prediction and Visualization to Support Integrated Water Management (Nelson, J.)

• Seasonal Prediction of HKH Hydrological Extremes wit the South Asia Land Data Assimilation System (Zaitchik, B.) Other SERVIR hubs became interested in learning and adopting the platform for different services.

NSF POSE (OPEN-SOURCE)

- POSE is Pathways to enable Open-Source Ecosystems
- New National Science Foundation Program
- First solicited in 2022
- Awarded in September 2023
- NSF Award #: 2303756

Scenic

National Science Foundation

Primary Activities:

- Form Managing Organization
  - Tethys Geospatial Foundation
- Build the User Community
- Build the Contributor Base
- Improve the Tethys Platform Distribution

AUTHOR INFORMATION

Nathan Swain

Dr. Nathan Swain is a Project Engineer for Aquaveo. He specializes in developing web solutions for scientific modeling and informatics applications. He completed a Ph.D. at Brigham Young University, Provo, Utah, USA with an emphasis on Civil and Environmental Engineering. His research culminated in the development of Tethys Platform. He has led the resulting Tethys Platform open-source project as chair of the Project Steering Committee for 7 years. At Aquaveo, Dr. Swain has led the development of an in-house commercial application, CityWater, and several custom apps for clients using Tethys Platform. He has given numerous Tethys Platform training sessions to groups ranging from students to professional developers and engineers. Dr. Swain is currently developing and delivering a series of 5-day training sessions on Tethys Platform to developers in Kenya, Nepal, and Alabama for NASA SERVIR.

Katherine Moore Powell

Katherine has a strong background in technology, environmental sciences, and user engagement . Earning a PhD in Environmental Studies from the University of Colorado Boulder, she has experience in various roles for a variety of projects for Lynker - Senior Water Resource Scientist, Technical Director, Associate Scientist, Project Manager, Climate Ecologist, and Ecohydrologist. Katherine has extensive experience connecting research to applied solutions, developing decision support tools, as well as providing expert advice on sustainability, climate change adaptation, and water resource management. Prior to her science career, Katherine earned a business degree, was a business owner, and consulted in software analysis and development. Working as an associate scientist for the Field Museum, she has chaired several environmental committees, served on regional environmental boards, and led the development of adaptation plans in the Chicago region. She is currently a Director on the board for the American Water Resource Association (AWRA).

Scott Christensen

Dr. Scott Christensen is a Research Civil Engineer at the US Army Engineer Research and Development Center (ERDC) where he leverages and enhances the capabilities of Tethys Platform and other Python libraries to support rapid development of web-based interfaces to high-performance computing modeling workflows. He received his Ph.D. in Civil and Environmental Engineering from Brigham Young University, Provo, Utah, USA where his research focused on high throughput computing of hydrologic models and adding computational support to Tethys Platform. Dr. Christensen has served on the Tethys Platform steering committee since it was created 7 years ago and continues to be a core contributor to the project. He has helped teach Tethys Platform training sessions to both students and colleagues. He serves as a mentor to many developers who are new to Python and/or Tethys Platform.

Shawn Crawley

Shawn Crawley completed his undergraduate (2015) and graduate (2017) degrees in Civil and Environmental Engineering at Brigham Young University with a focus on water resources, geographic information systems (GIS) and both data and computer science. A significant portion of his graduate project work was done developing water resource related web applications using Tethys Platform. Since entering the professional world, he has worked as a software engineer for Aquaveo (2016-2018), NOAA (2018-2022), and Lynker (2022-present). In all of these roles he has helped build infrastructure and develop applications to support all aspects of water resource data systems, including modeling, processing, storage, retrieval, and visualization. In 2021, he was elected to the Tethys Platform Steering Committee and currently maintains that involvement. Though his professional experience with training, teaching and speaking has mostly been limited to internal interactions, he recently presented his work done for NOAA using Tethys Platform in the AWRA 2022 Geospatial Water Technology Conference. Ultimately, he hopes for many future opportunities to both perform and present the exciting work that is on the horizon of his career path.

TRANSCRIPT

ABSTRACT

Tethys Platform is an open-source web framework for developing and hosting geospatial earth sciences web applications. The source code for Tethys Platform is published and maintained on GitHub and is released through the BSD-2-Clause open source license. Links to the source code, documentation, community forums, and other resources can be found on the Tethys Platform website (tethysplatform.org).

Tethys Platform was originally developed by Brigham Young University as part of the the CI-Water project, an NSF EPSCoR Research Cyberinfrastructure grant (EPS 1135482 (tel:1135482)). Former participants in the CI-Water project are now leaders in the Water Resources and Hydroinformatics science community including Dr. Fred Ogden, Chief Scientist for the National Water Center, Dr. Steve Burian, Director of the NOAA Cooperative Institute for Research to Operations in Hydrology (CIROH), Dr. David Tarbon, PI of the successful sister project, HydroShare, and Dr. Jim Nelson, thought leader behind the Group on Earth Observations (GEO) Global Water Sustainability (GEOGloWS) ECMWF Streamflow Service.

Tethys Platform enables better, more intuitive, and interactive communication between earth science/geoscience scientists and decision-makers, first responders, and the general public through the medium of web applications. It does so by lowering the technical barriers that prevent many scientists from creating these types of web applications. The evidence that Tethys Platform is addressing a problem of import is found in the broad international interest in the project and in the types of web applications that have been developed by our users, some of which are described in the Vision and Broader Impacts section below.

Tethys Platform has successfully lowered some of the technical barriers by providing a curated suite of free and open-source software (FOSS) that is made accessible through a unified, well-documented, Python and JavaScript Software Development Kit (SDK) called Tethys SDK. Some of the FOSS that is included out-of-the-box are OpenLayers, CesiumJS, Bokeh, and Plotly for visualization; GeoServer, THREDDS, and PostGIS for hosting geospatial and gridded datasets; and Dask and HTCondor for distributed computing. Furthermore, the backend of Tethys web applications is developed using Python allowing app developers to leverage the scientific Python ecosystem for efficient data analysis. Finally, Tethys Platform is built on the Django Python web framework giving it a solid web foundation with excellent security and performance.