

ECWMMF Workshop

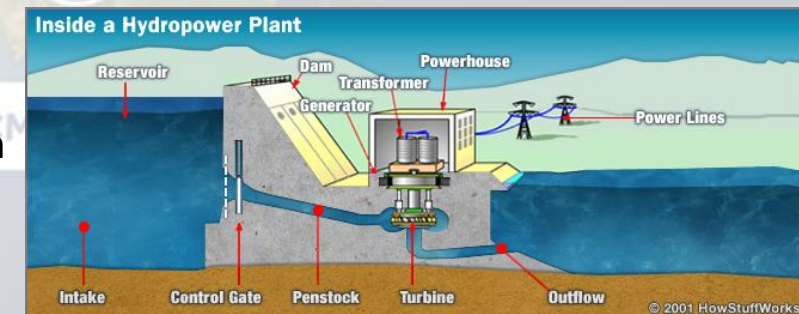
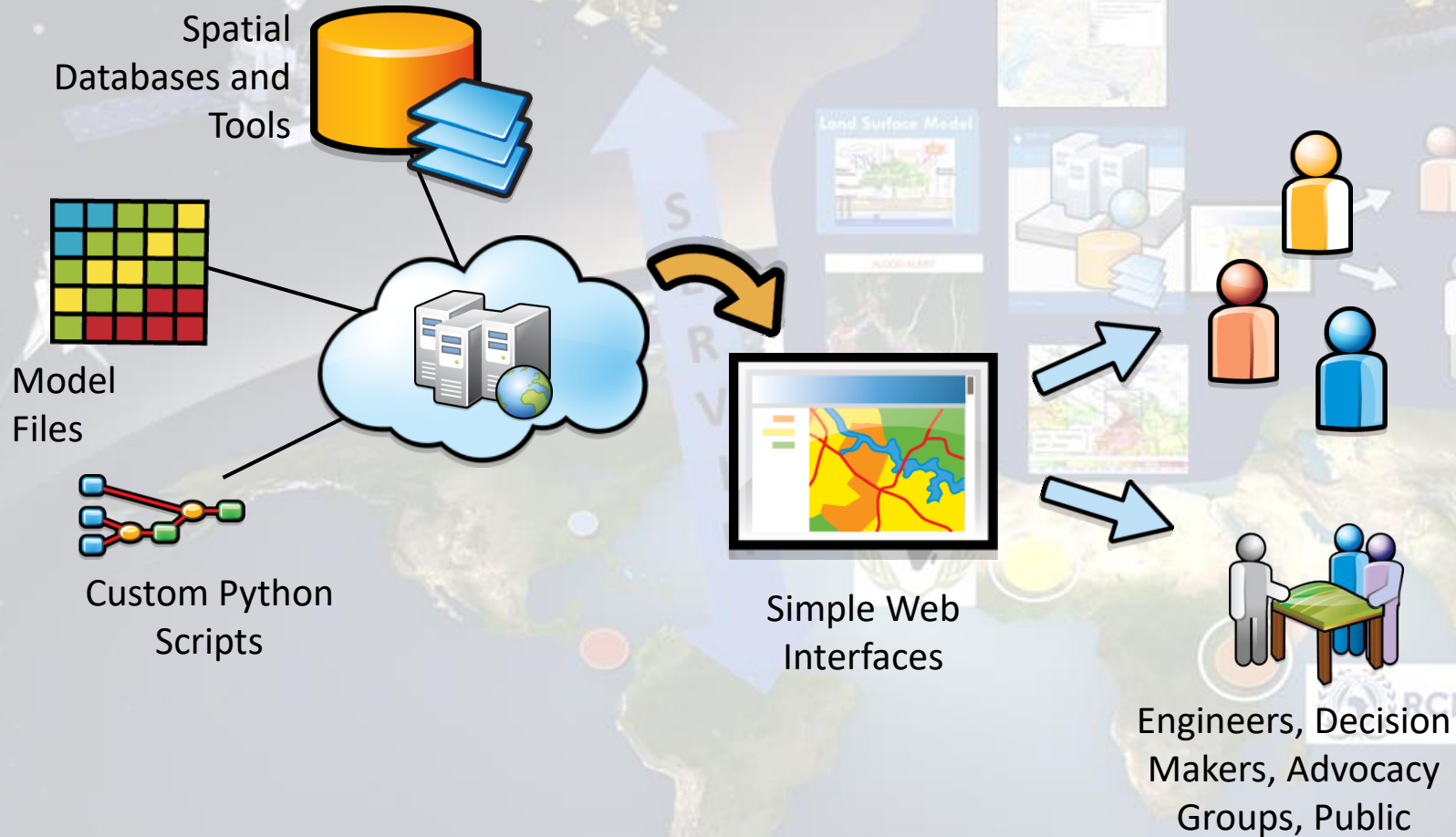
Providing Tailor-made Forecasts to the Community

Jim Nelson – BYU

Michael Souffront

Many Others – ECMWF, NASA, Esri, NOAA, and many more...

Stakeholders – They Make the Decisions



Global Modeling: Challenges



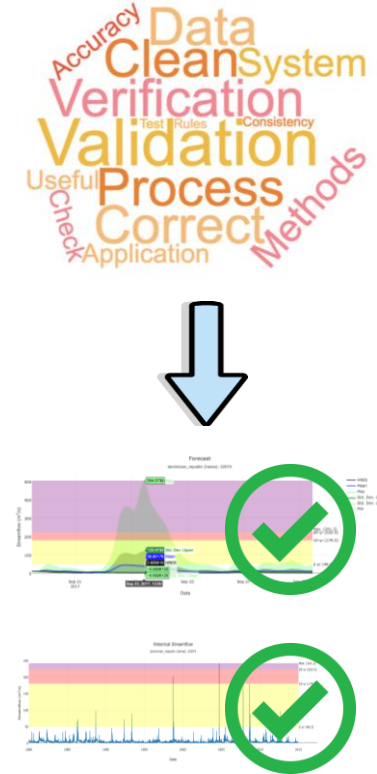
Cyberinfrastructure and Workflows



Web apps and web services



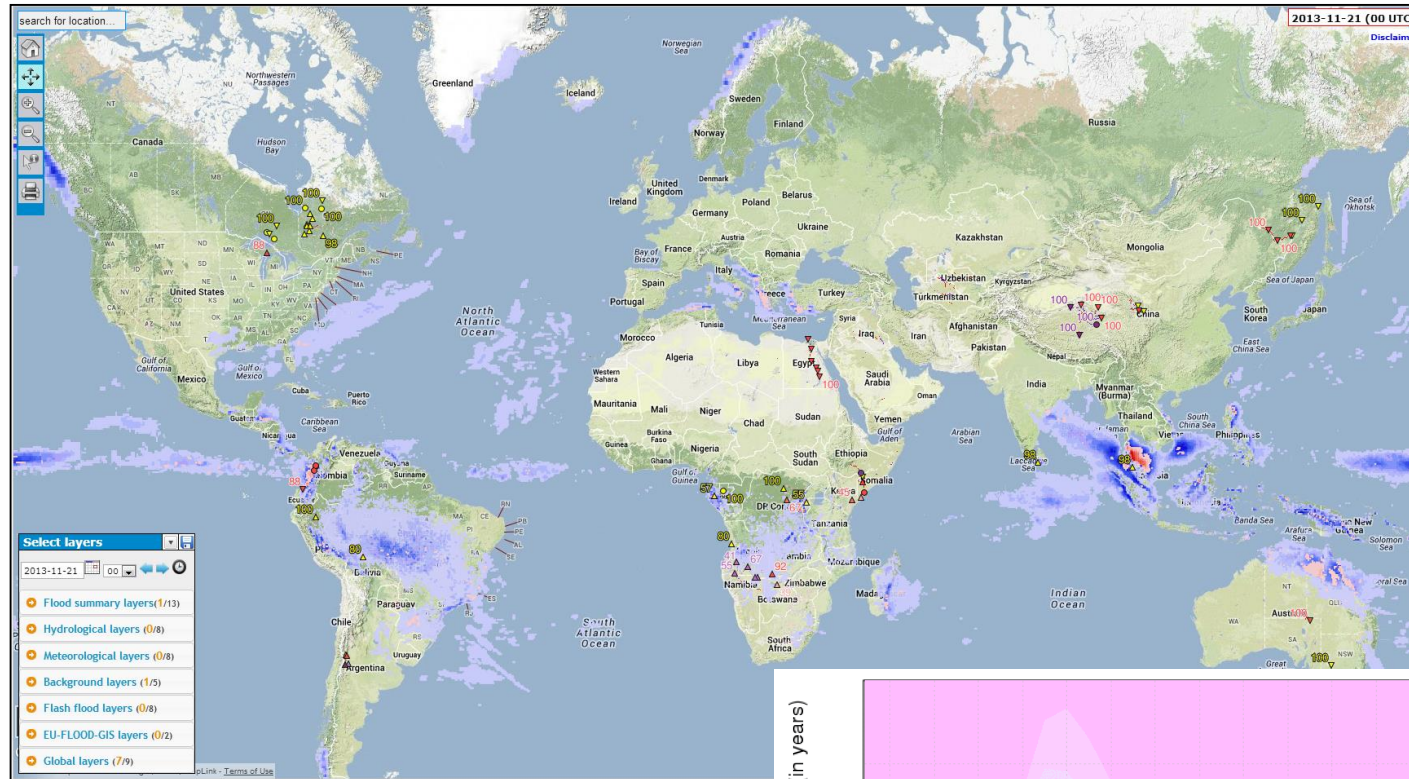
Partnerships, trainings, and collaboration



Accessibility tools and programmatic extraction

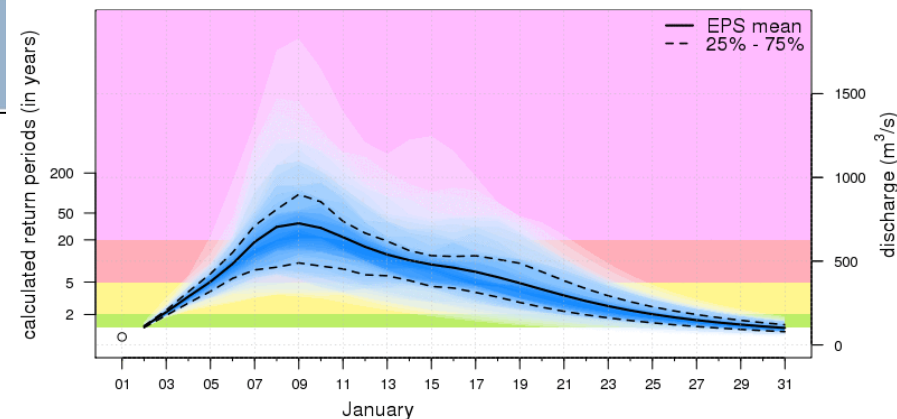
www.globalfloods.eu

Forecast Day	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
05/08/2017								2	2	4	4	4	6	4	4	4	4	4	4	4				
06/08/2017											2	2	2				4	6	8	12	12			
07/08/2017						2	20	41	65	80	86	88	86	80	69	63	51	49	51	49	41	39		
08/08/2017							100	100	100	100	100	100	100	100	100	100	100	100	100	100	96	82	73	63
09/08/2017							100	100	100	100	100	100	100	100	100	100	100	100	100	94	92	86	78	71



Return period exceeded:

- < 2 year (green)
- > 2 year (yellow)
- > 5 year (red)
- > 20 year (purple)



Forecast frequency:
Updated daily

Forecast lead time:
Up to 30 days

Forecast variable:
River Flow

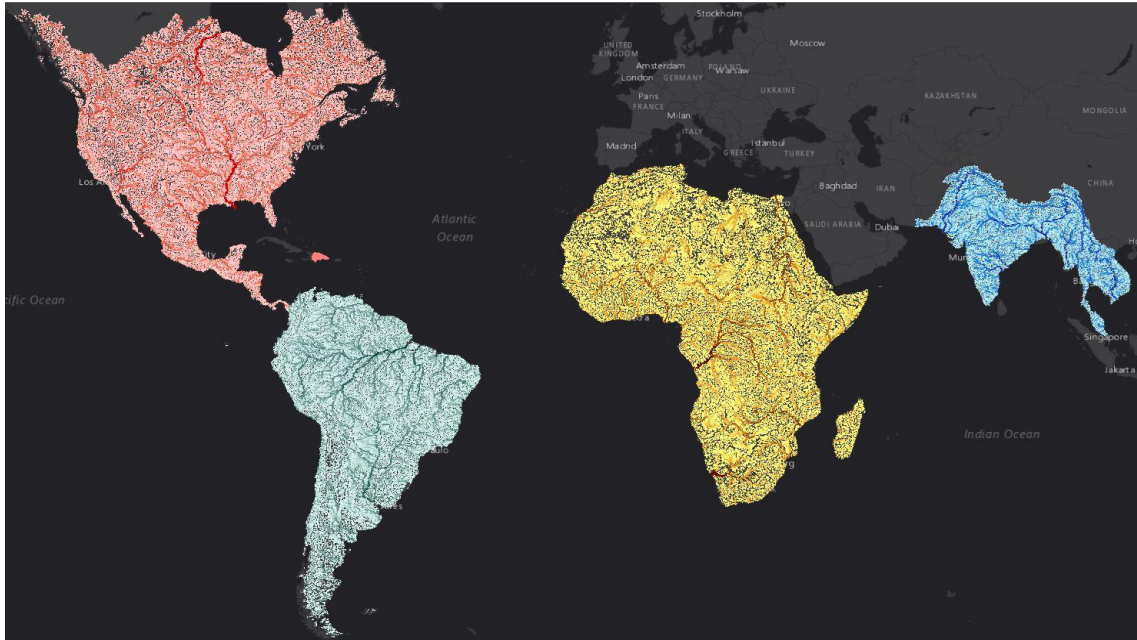
Forecast type:
Probabilistic

Forecast resolution:
Daily and 0.1 degree

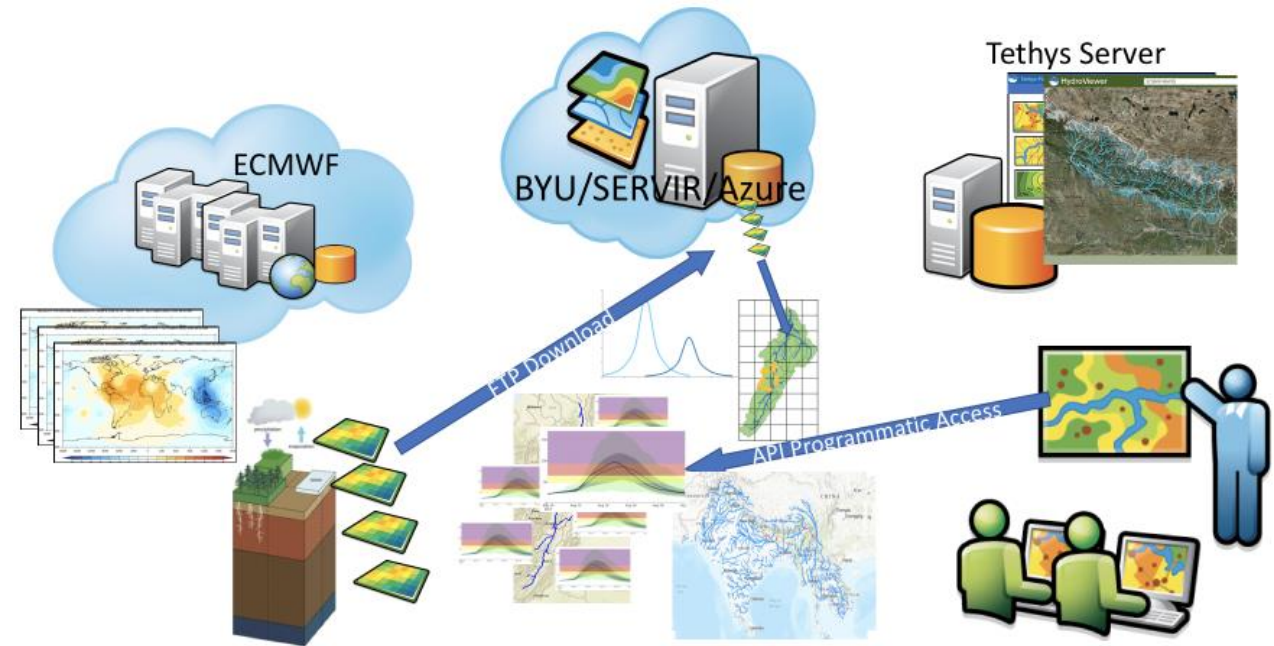
Modelling system:
ENS + HTESEL + Lisflood

Making it “tailor-made”

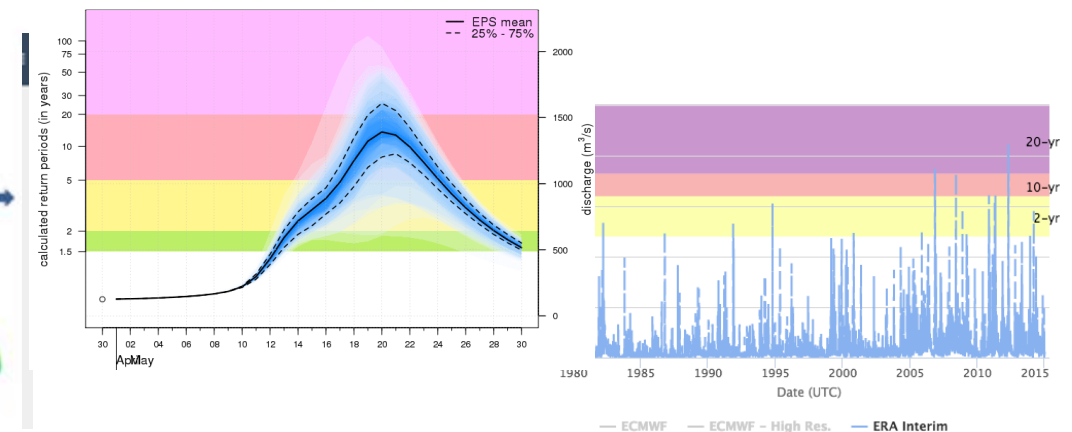
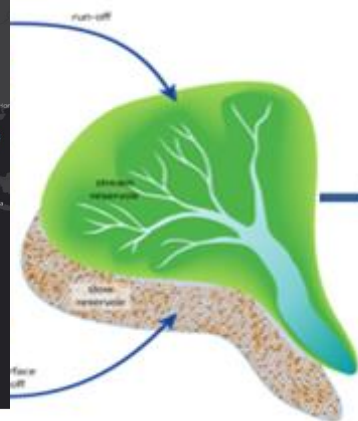
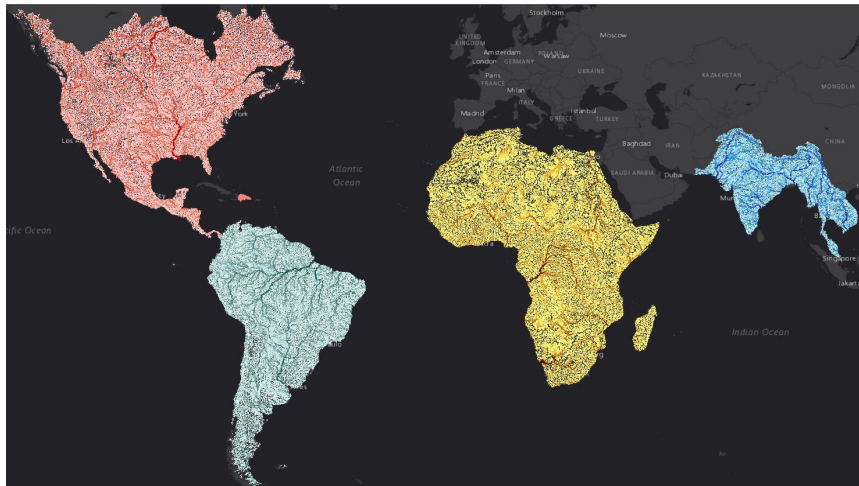
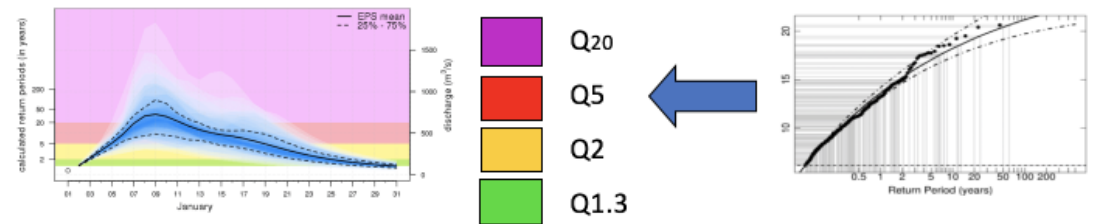
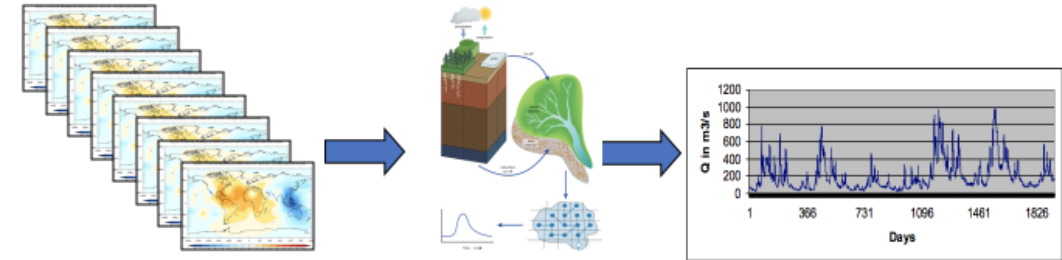
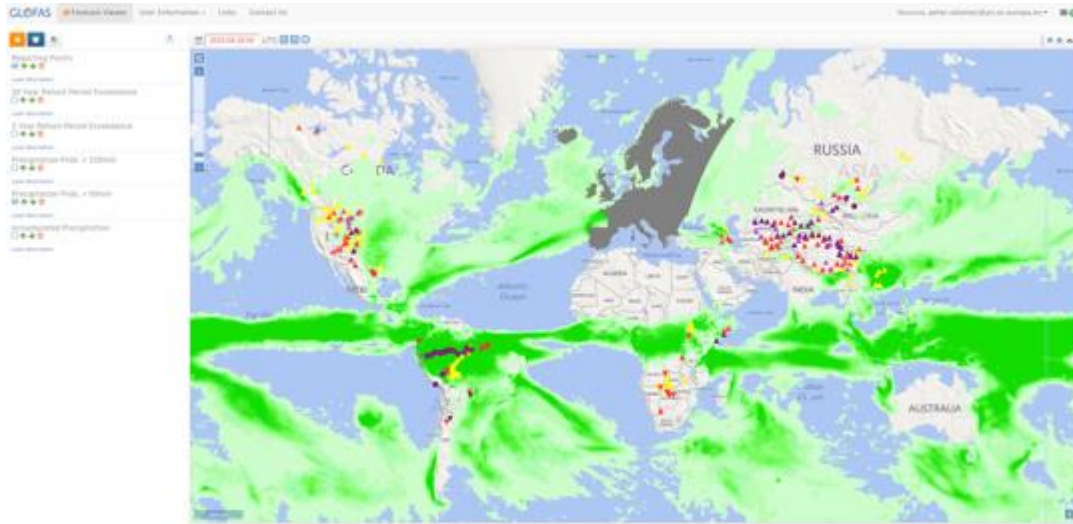
Higher density forecasts – Every River!



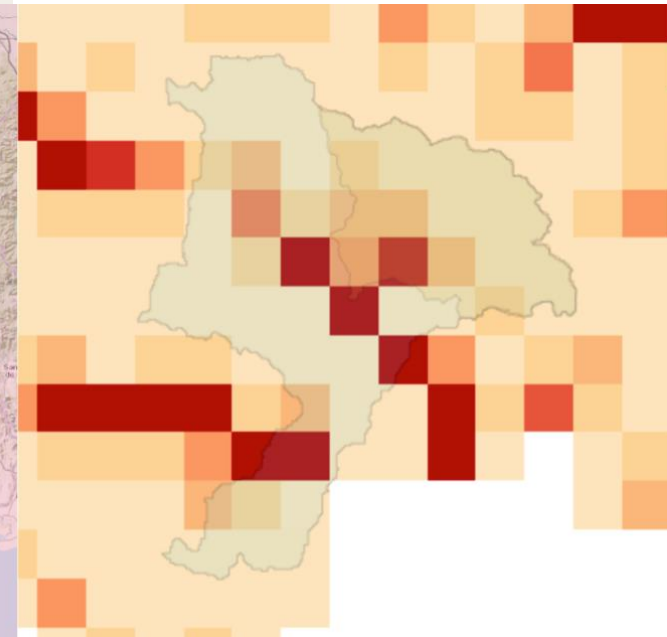
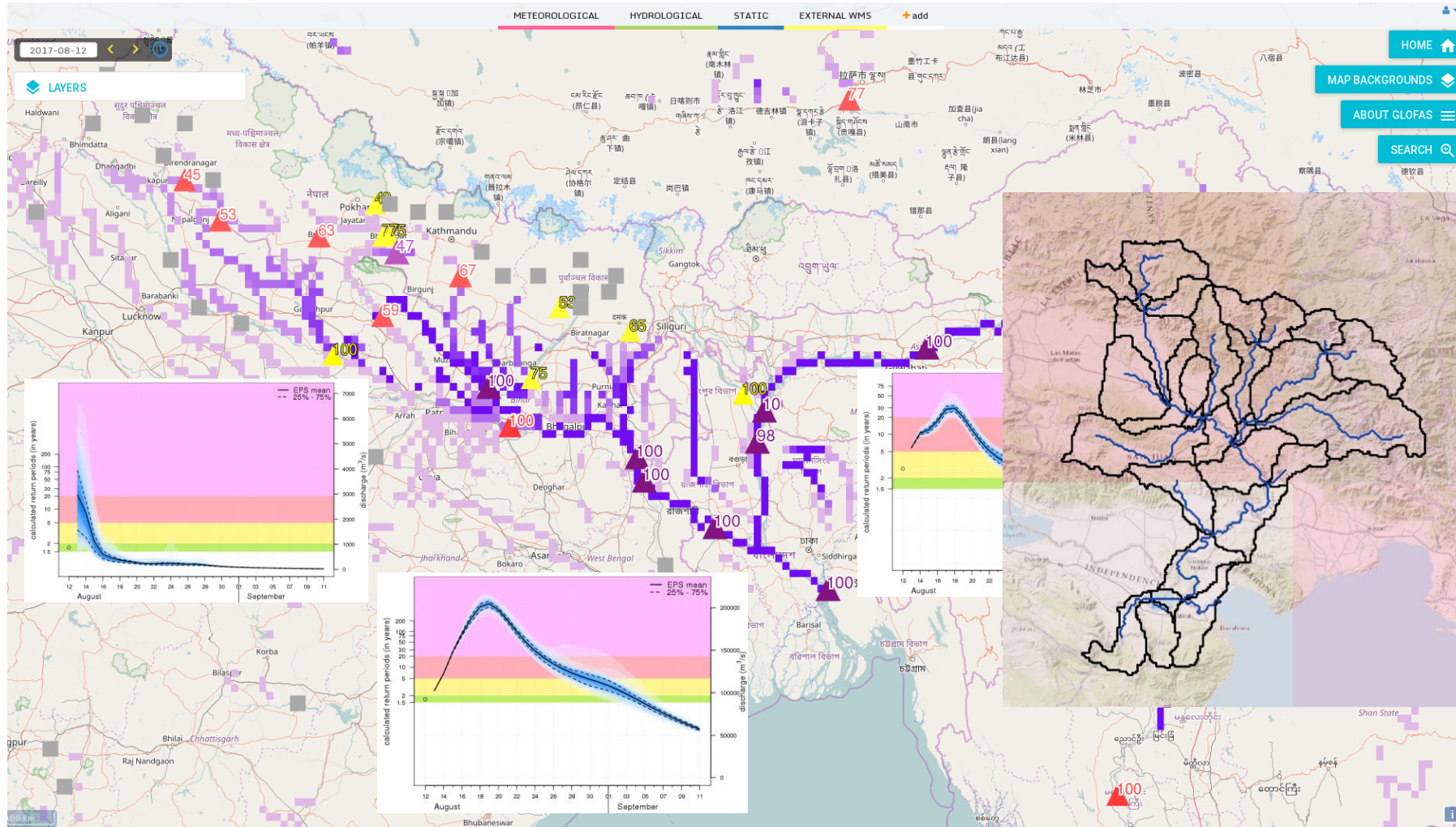
Services - Providing Local Access to Global Forecast Data



Streamflow Forecasting

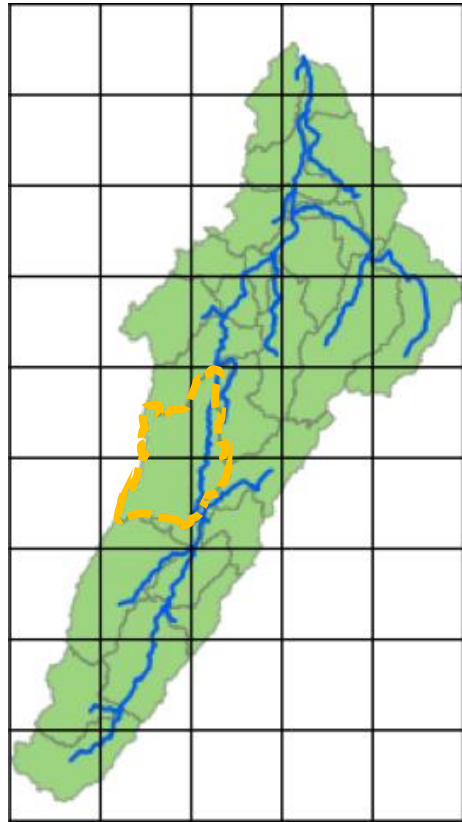


GloFAS - Limited to larger drainage areas

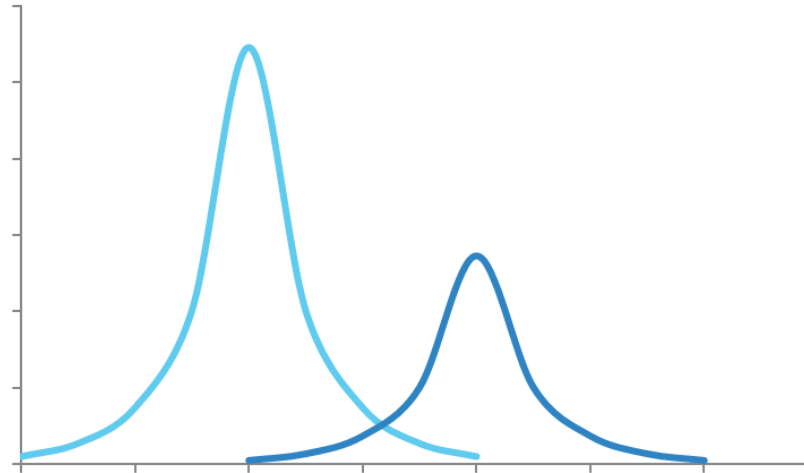


Downscaling process

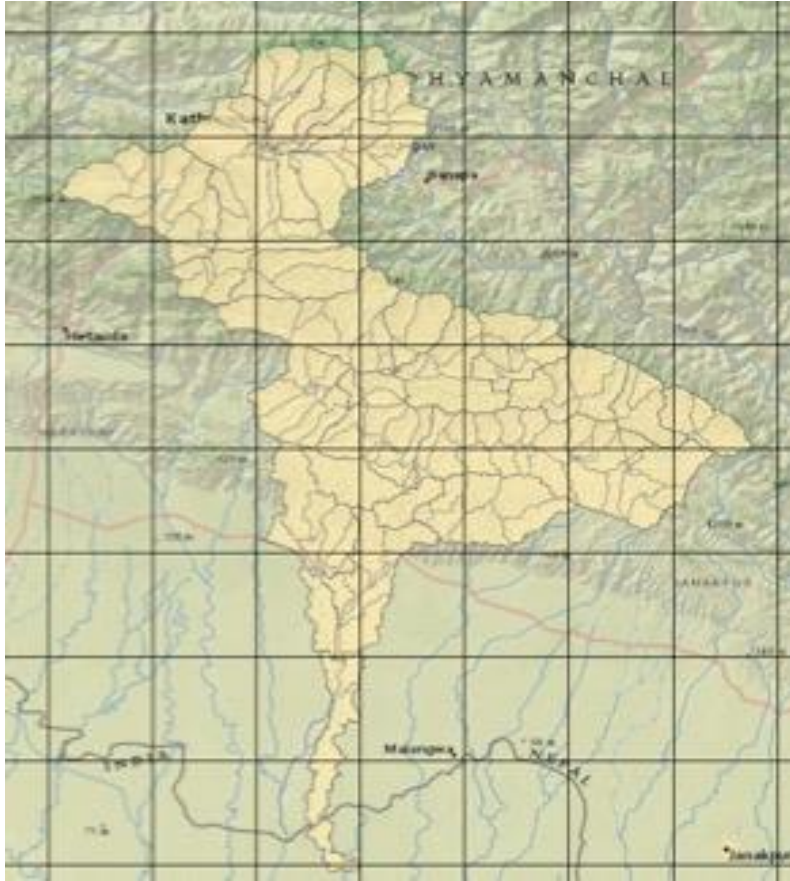
Mapping gridded runoff
to basins/stream network



Muskingum Routing
with RAPID



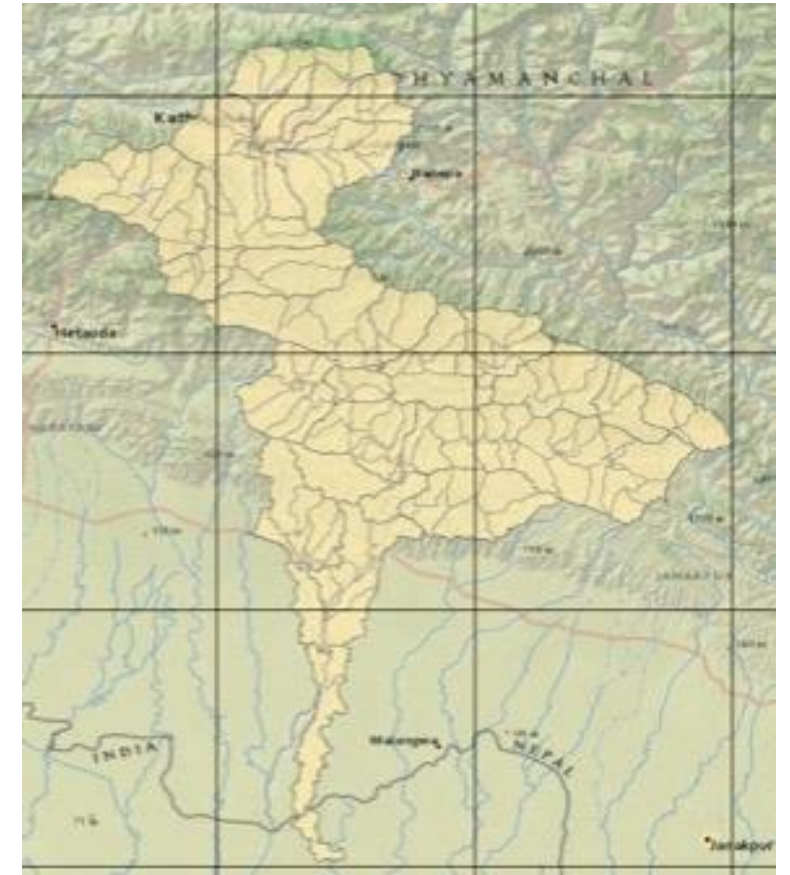
ECMWF Grid Resolutions



51 Ensemble Low - ~16 km



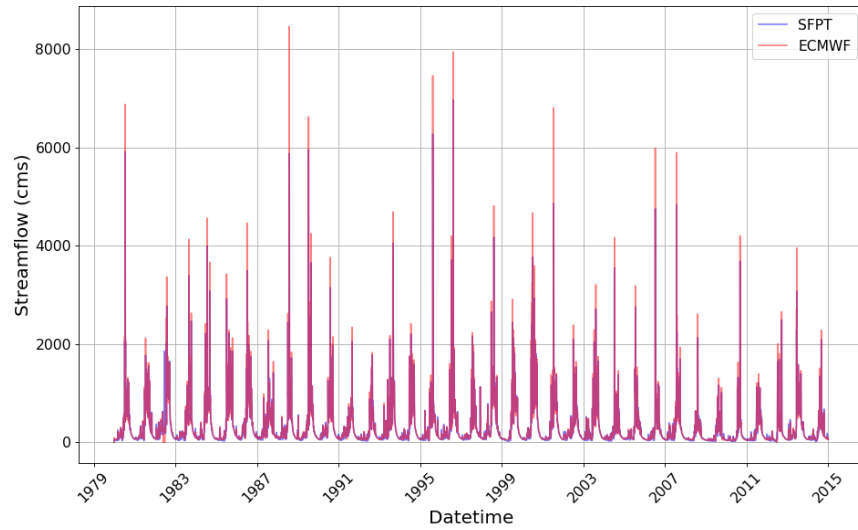
Single High - ~8 km



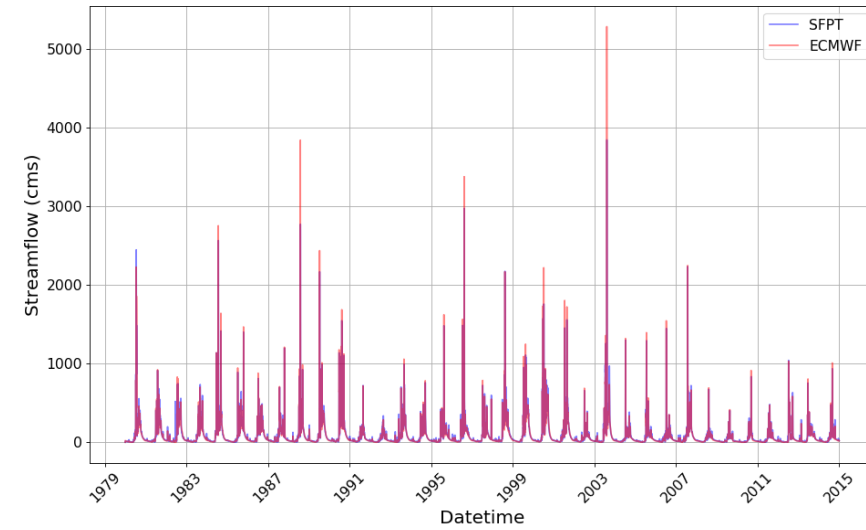
ERA-Interim - ~40 km

Same Forecasts as ECMW Validation

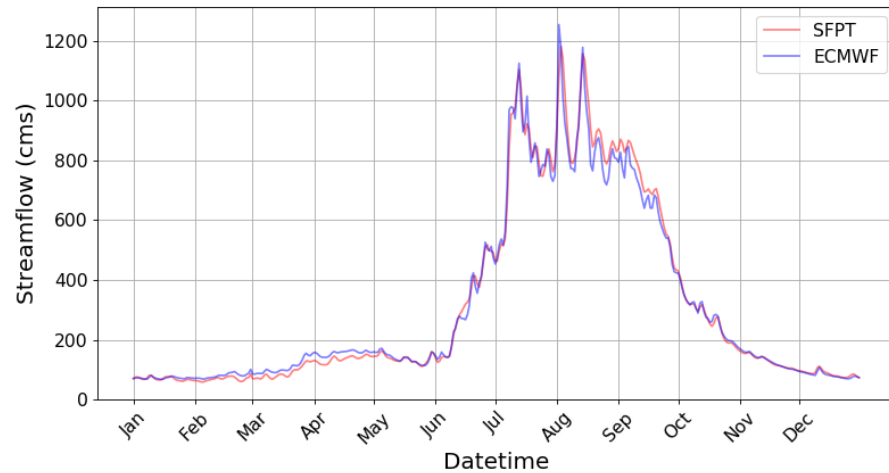
Hydrograph for Bheri



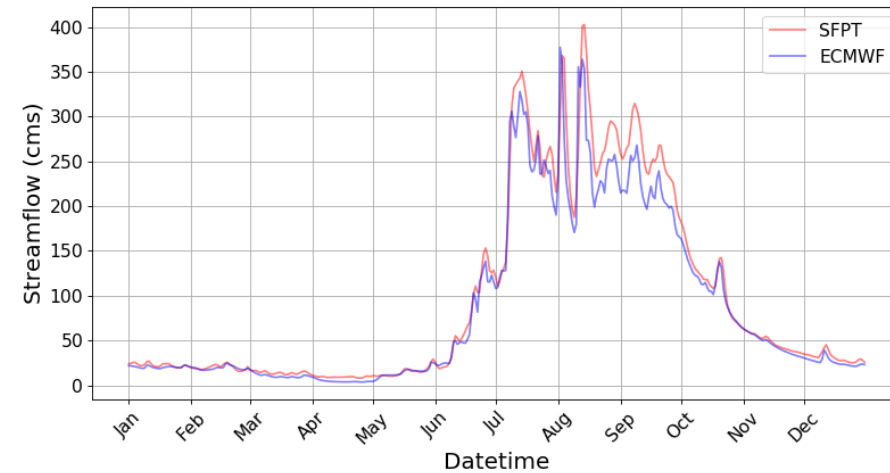
Hydrograph for Rapti



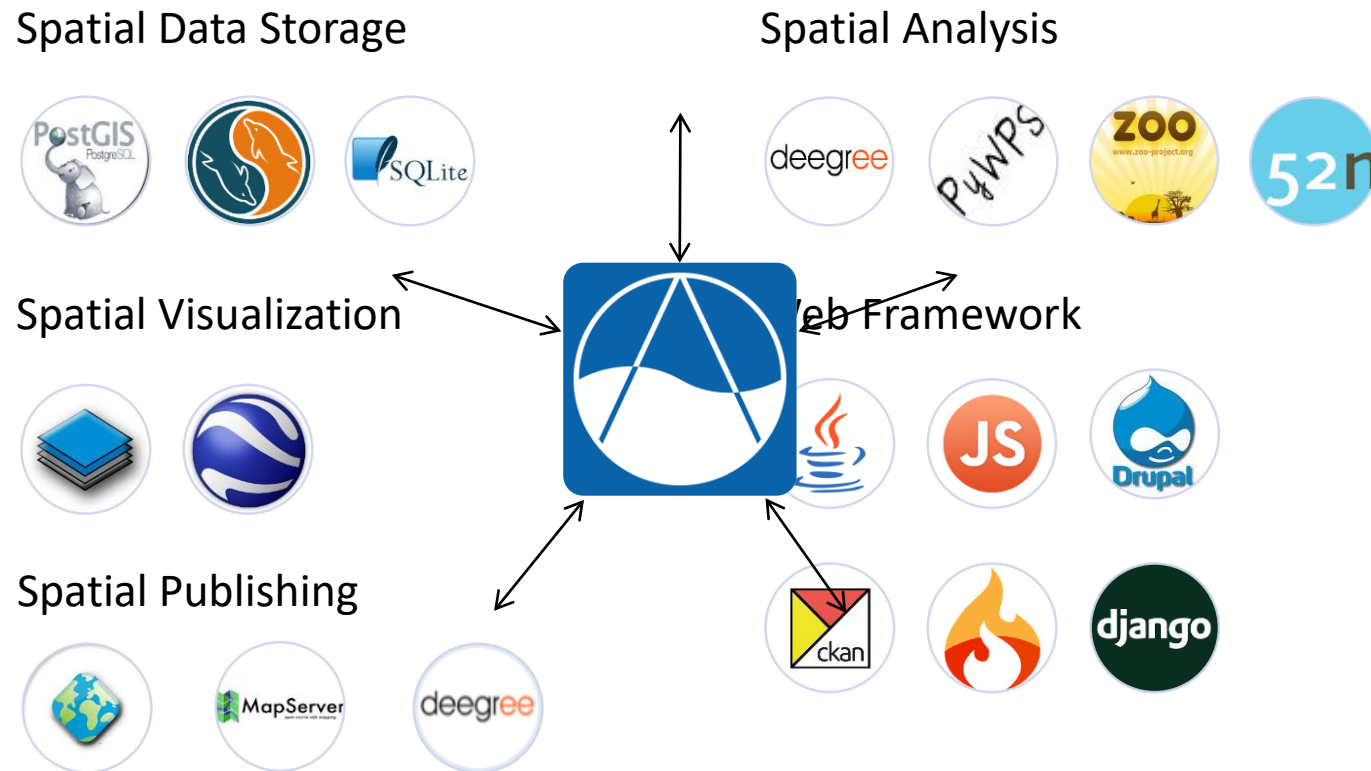
Daily Streamflow Averages for Bheri



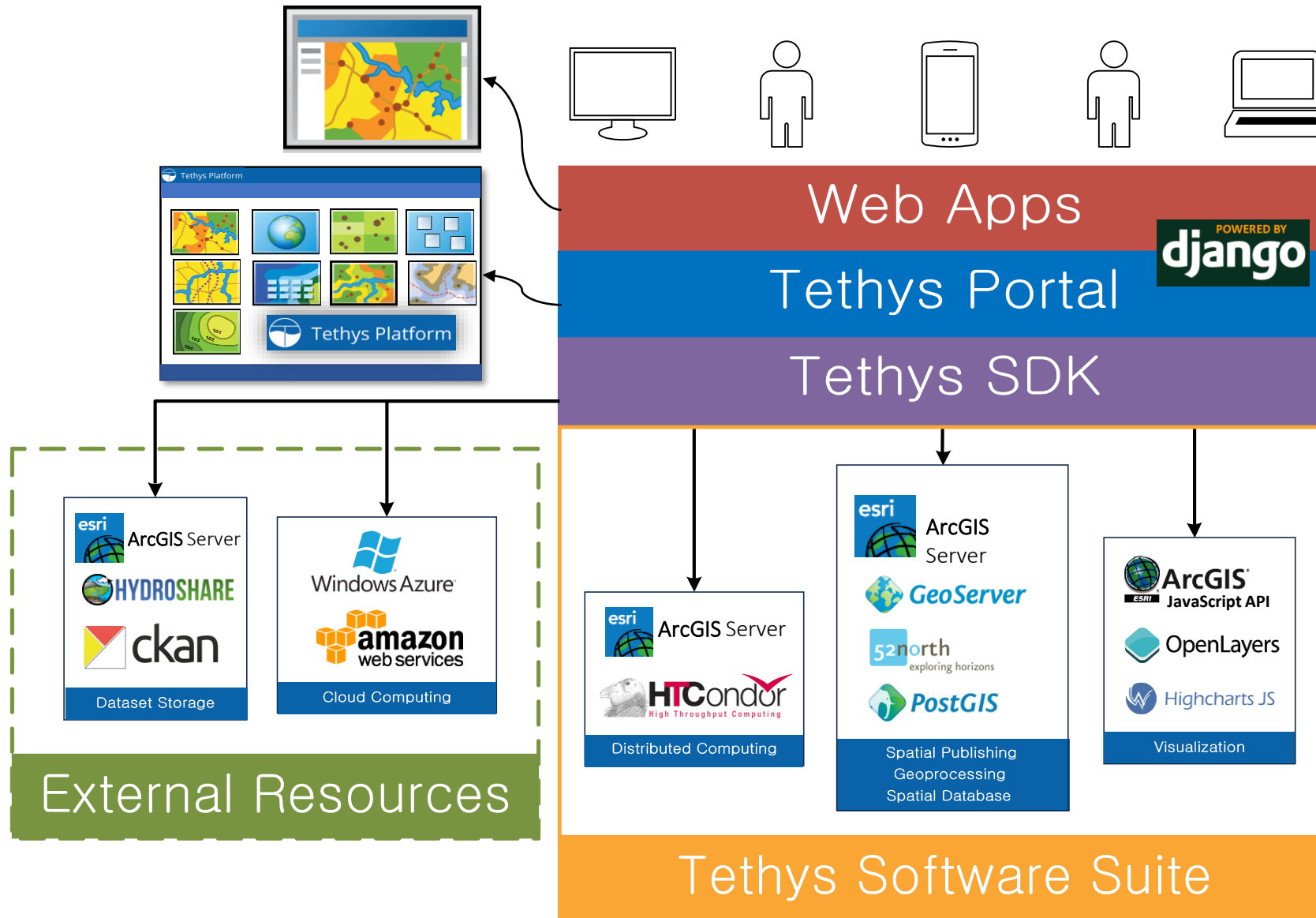
Daily Streamflow Averages for Rapti



Tethys - Software Selection

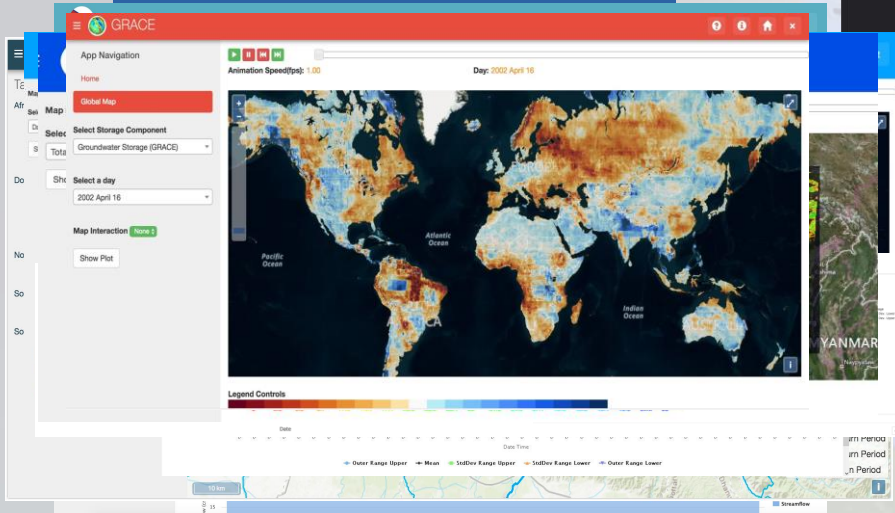


Tethys Platform - Portal/Apps



SERVIR Project - GEOGLOWS

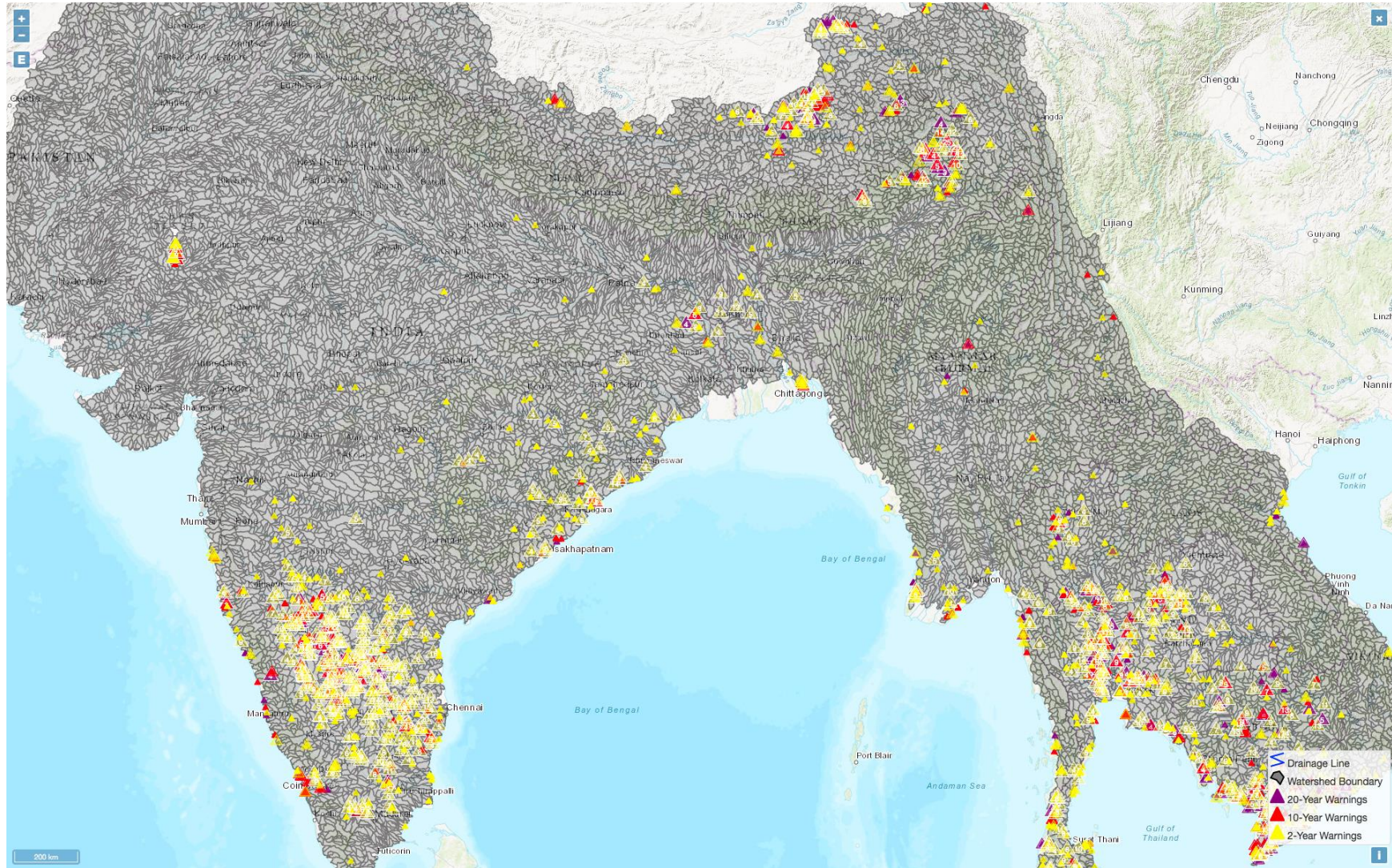
 Tethys Platform



Connecting Space To Village



Tethys Streamflow Forecasting Application



Tethys Streamflow Forecasting Application

☰ Streamflow Prediction Tool
🌐 📏 🔍 ⬅️

Table of Contents

- Africa (Continental)
 - Drainage Line ▾
 - Boundary ▾
 - 20-Year Return Period ▾
 - 10-Year Return Period ▾
 - 2-Year Return Period ▾
- Dominican Republic (National)
 - Drainage Line ▾
 - Boundary ▾
 - 20-Year Return Period ▾
 - 10-Year Return Period ▾
 - 2-Year Return Period ▾
- North America (Continental)
 - Drainage Line ▾
 - Boundary ▾
- South America (Continental)
 - Drainage Line ▾
 - Boundary ▾
- South Asia (Mainland)
 - Drainage Line ▾
 - Boundary ▾
 - 20-Year Return Period ▾
 - 10-Year Return Period ▾
 - 2-Year Return Period ▾

Units: Metric

Forecast Historical Flow-Duration Daily Season Monthly Season Download

ECMWF Available Dates
 2017-08-07 00:00:00

Forecast

south_asia (historical): 57756

Max. (8860.4)

20-yr (4587.3)

10-yr (2501.3)

2-yr (1153.8)

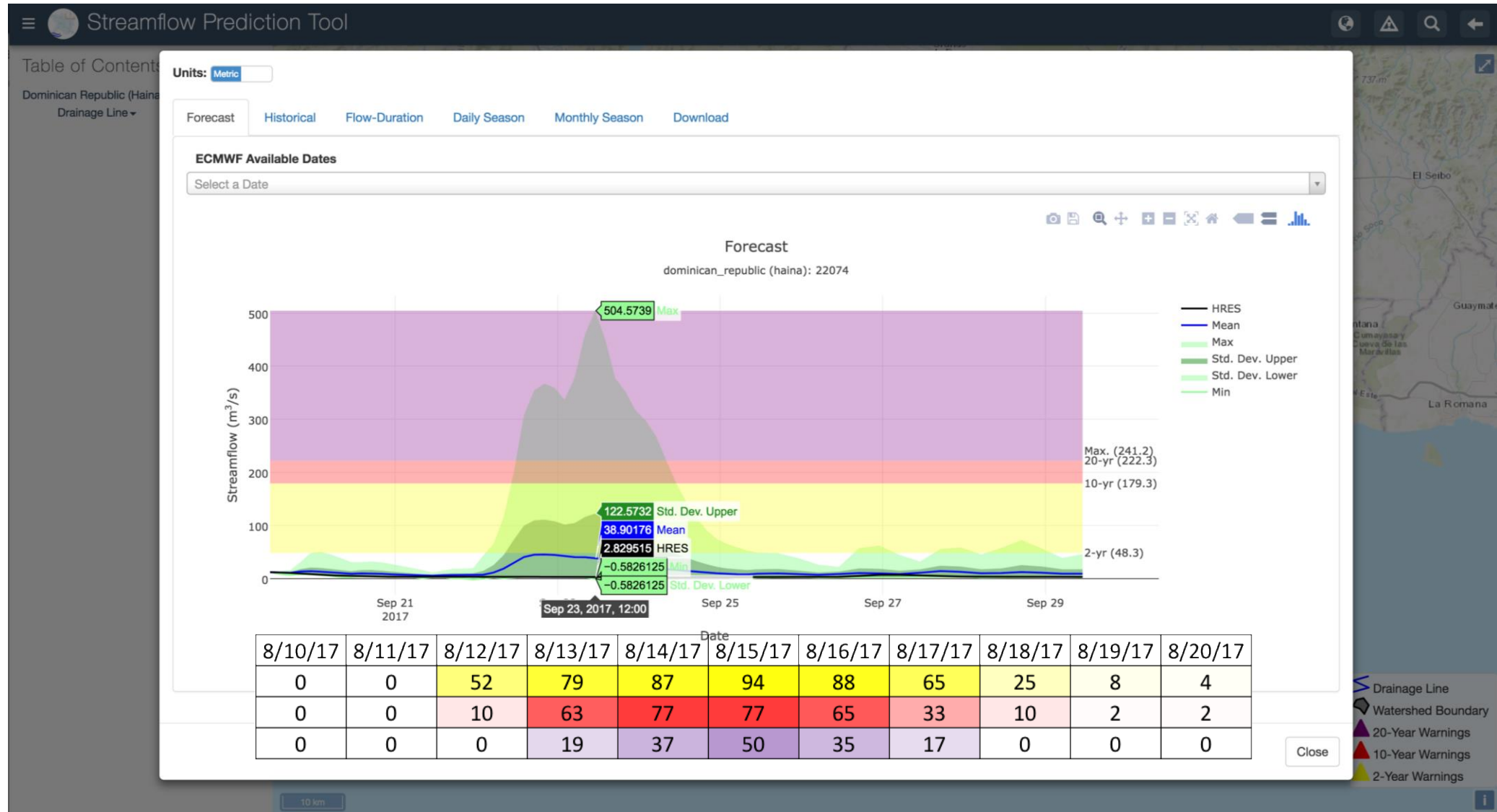
Date

8/10/17	8/11/17	8/12/17	8/13/17	8/14/17	8/15/17	8/16/17	8/17/17	8/18/17	8/19/17	8/20/17
0	0	52	79	87	94	88	65	25	8	4
0	0	10	63	77	77	65	33	10	2	2
0	0	0	19	37	50	35	17	0	0	0

Close

- Drainage Line
- Watershed Boundary
- ▲ 20-Year Return Period
- ▲ 10-Year Return Period
- ▲ 2-Year Return Period

Products - Forecasts



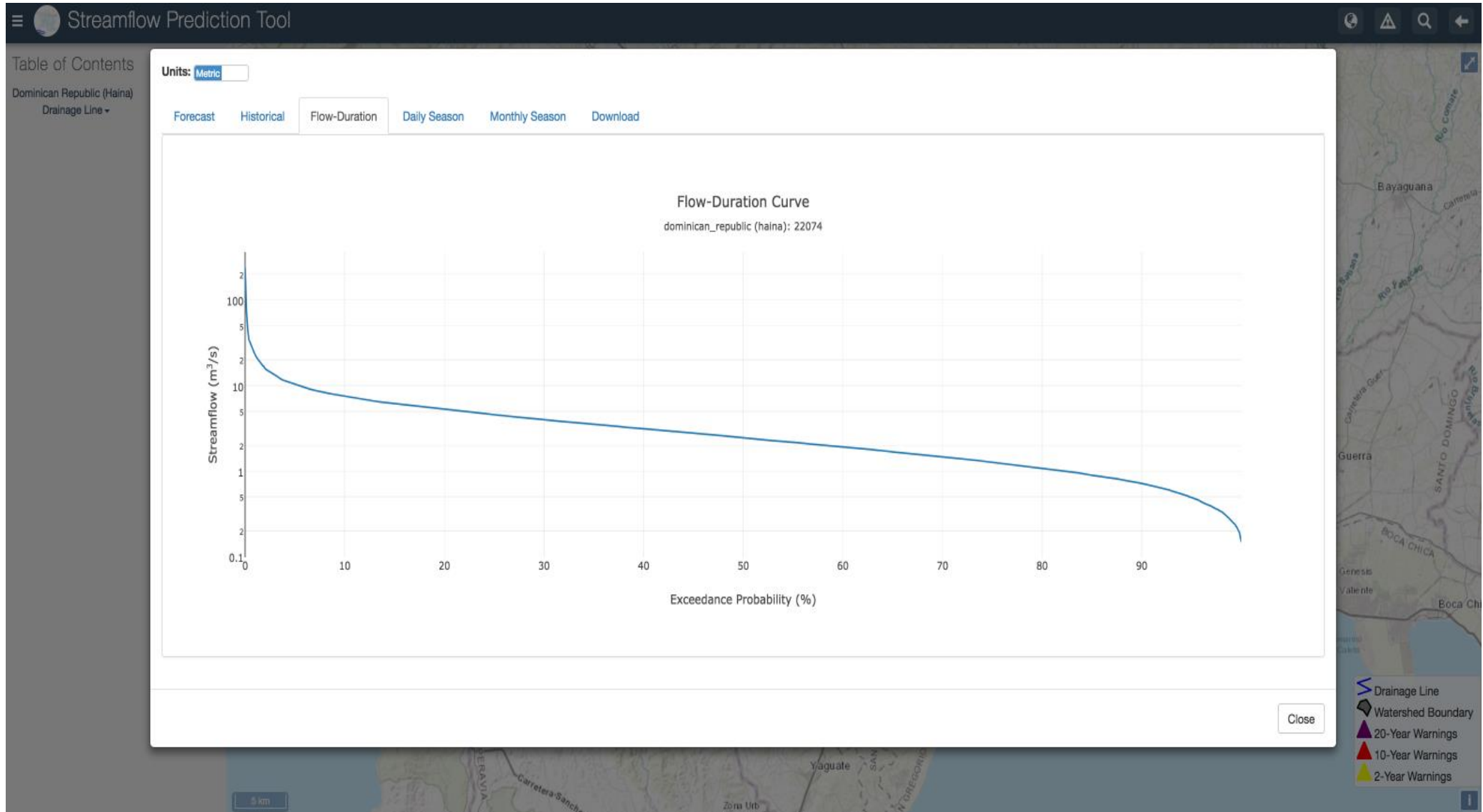
Products - Historical Perspective



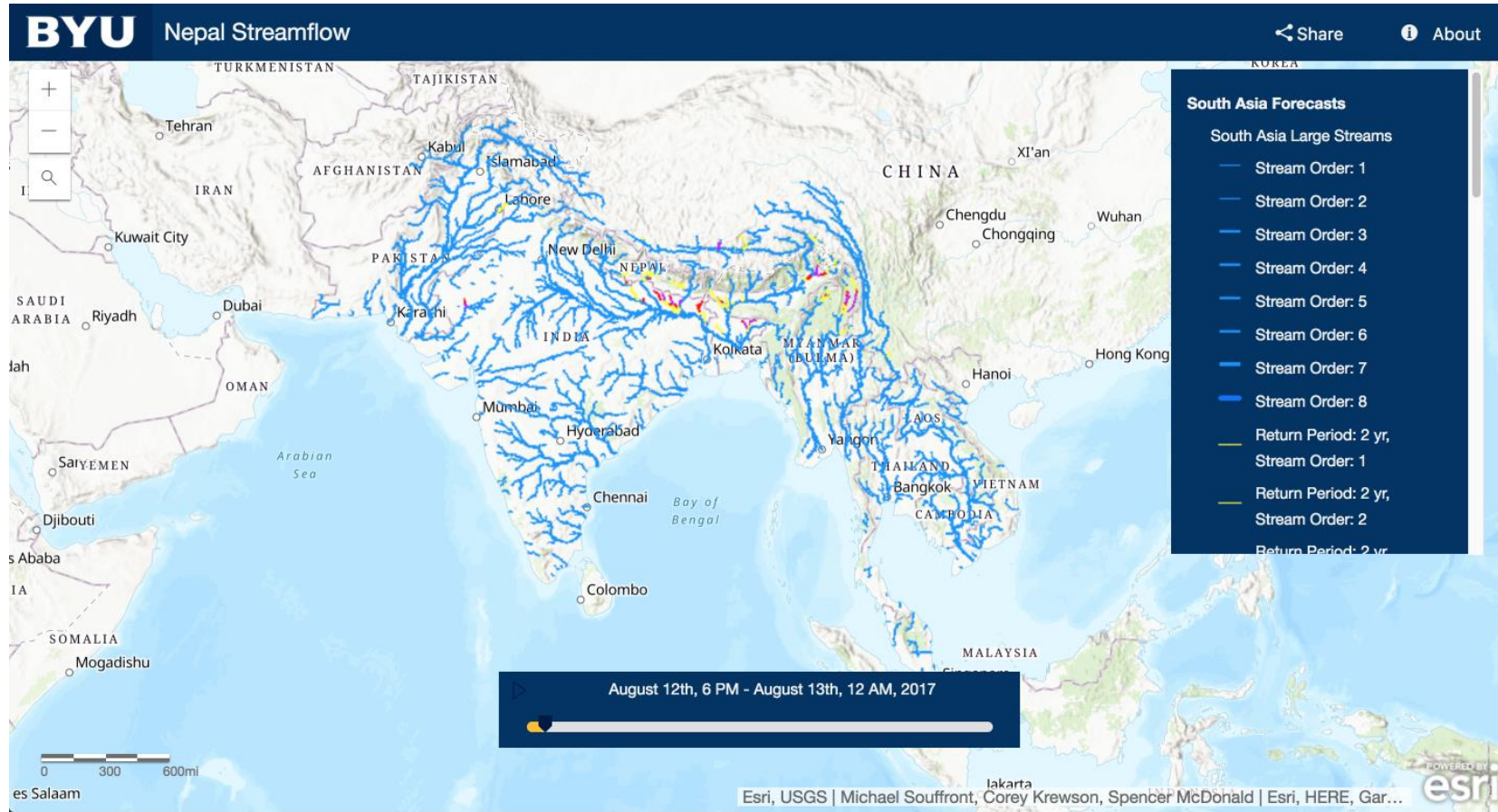
Products – Long term average flows



Products – Flow Duration Curves



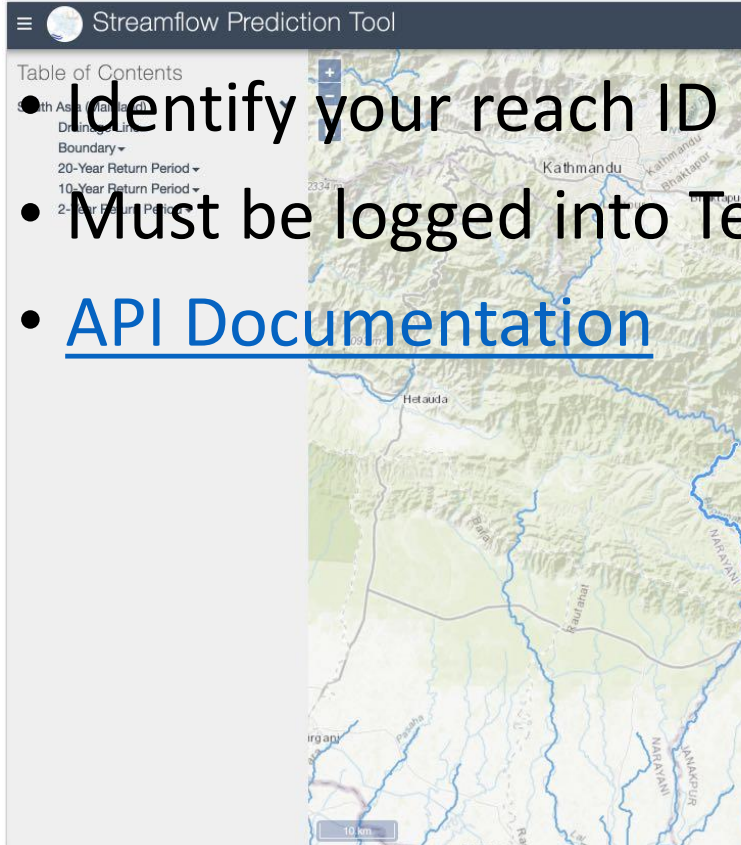
Products – Warning Visualization Services



Products – Warning Visualization Services



API Example



- Identify your reach ID

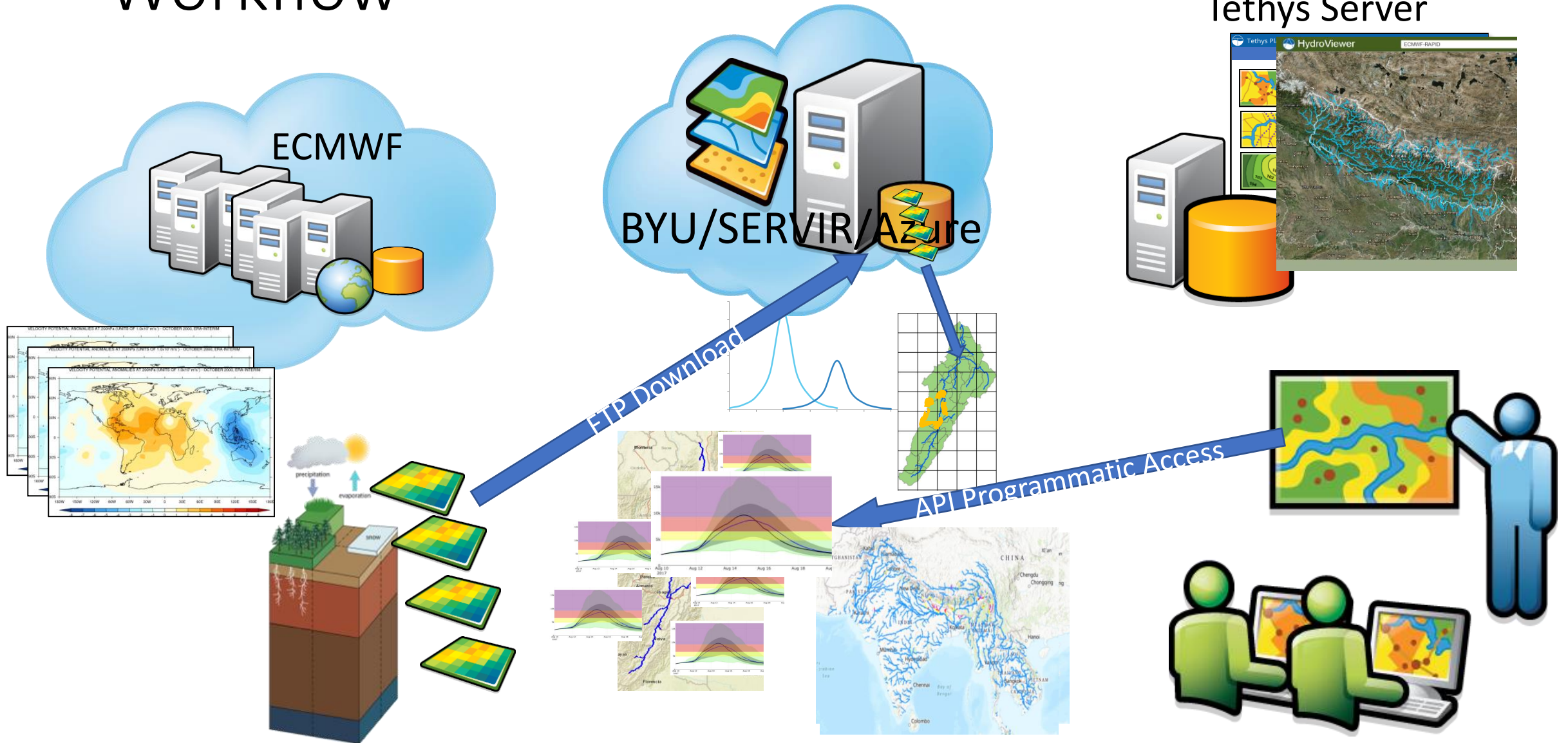
- Must be logged into Tethys.byu.edu for authentication

- [API Documentation](#)

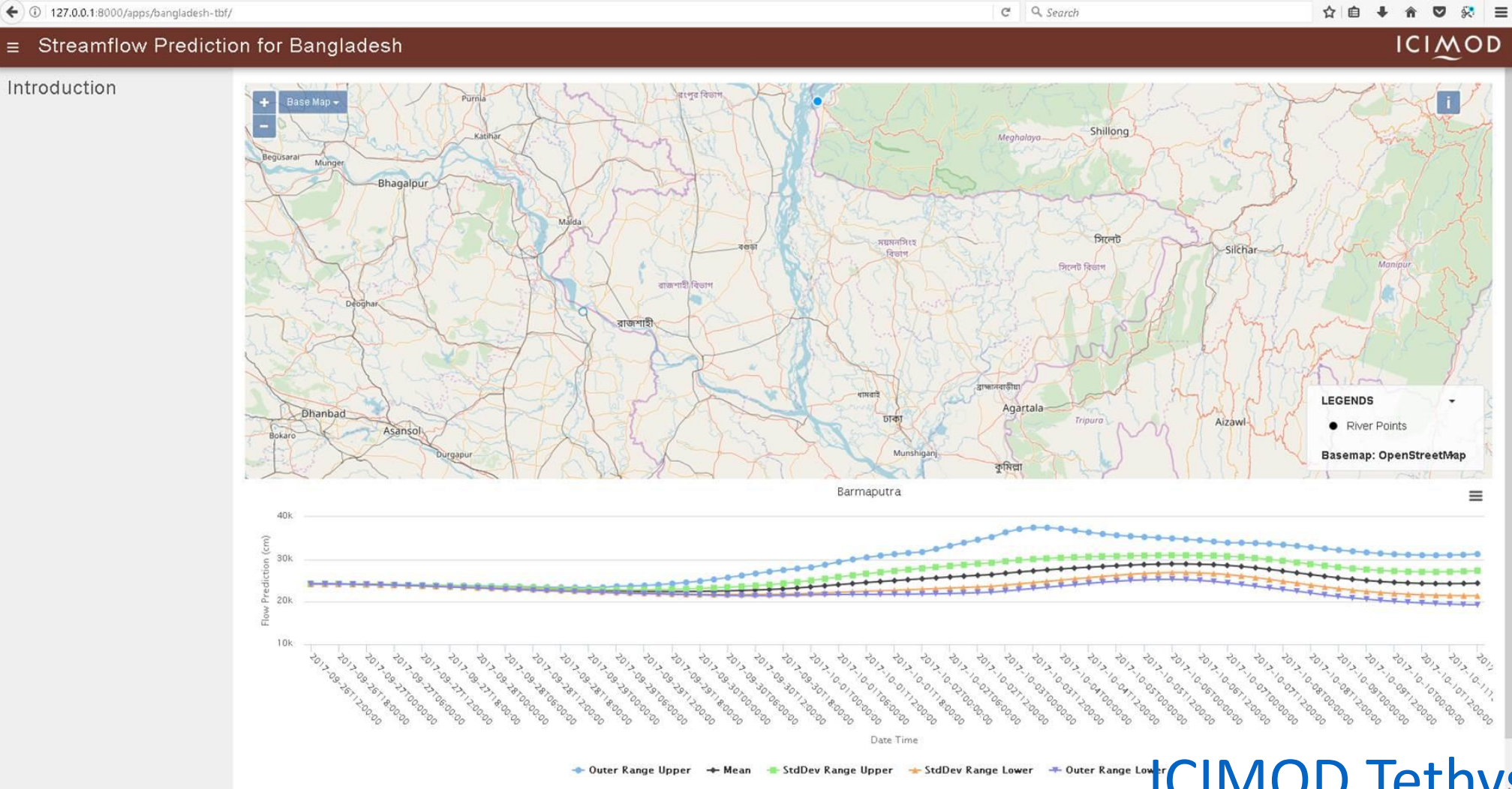


<https://tethys.byu.edu/apps/streamflow-prediction-tool/api/GetForecast/?watershed name=south asia&subbasin name=mainland&reach id=57340&forecast folder=most recent&stat type=mean>

Workflow



Bangladesh Transboundary Flow Forecast



Flood Mapping



Flood Map Visualizer

Back

Map Layers

- Points
- points_025
- pop_den_025
- land_cov_025
- point25

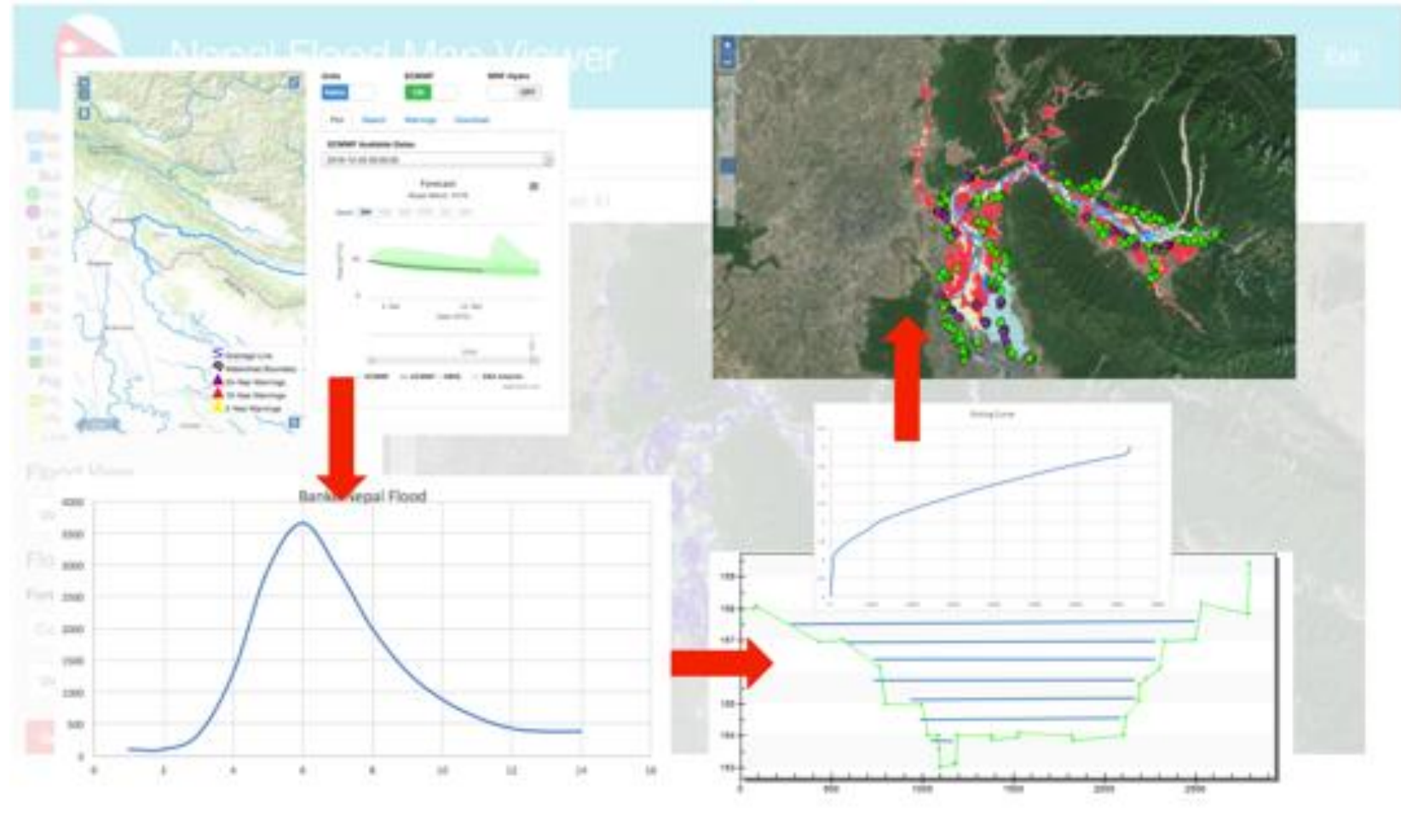
Forecast Date Start

31/08/2017 Noon

Forecast Stat Type

Mean

View Flood Forecast



Add to other web portals

hydrology.gov.np/#/?_k=zkpchj

Apps Bookmarks Citations Simplified... RecordSeek Rayapur - Google... 63

Government of Nepal
Ministry of Water Resources and Energy
Department of Hydrology and Meteorology
Hydrology Division | Flood Forecasting Section

HOME REAL TIME DATA RIVER WATCH RAINFALL WATCH CURRENT FORECAST PUBLICATIONS

!!! alert

ECMWF Available Dates
Select a Date

Forecast
demon_nepal (national): 1426

Surface (m/s)

Apr 7 2018 Apr 9 2018 Apr 11 2018 Apr 13 2018 Apr 15 2018

Map Satellite

Shey Phoksundo National Park
Annapurna Conservation Area

Nepal

24 hours

Below Warning Level and Steady
Below Warning Level and Rising
Below Warning Level and Falling

Above Warning Level and Steady
Above Warning Level and Rising
Above Warning Level and Falling

Above Danger Level and Steady
Above Danger Level and Rising
Above Danger Level and Falling

Government of Nepal started hydrological and meteorological activities in an organized way in 1962. The activities were initiated as a section under the Department of Electricity. The section was subsequently transferred to the Department of Irrigation and Department Irrigation, Hydrology and Meteorology was formed. Later on in 1988, a separate department of Hydrology and Meteorology was established. The Department of Hydrology and Meteorology (DHM) is an organization under the Ministry of Environment...

Notice

Flood Forecast Bulletin (13 Aug 2017, 6:00 AM)
बाढी पूर्वसूचना बुलेटिन (१७ असार २०७४, बिहान ६ बजे)
विशेष बाढी सूचना (मिती २६ असार २०७४ बेलुकी ६ बजे)
Notice Board
Flood Risk in Chure and Mahabharat Range

News and Events

Important Links

Weather Forecast

NWP Products

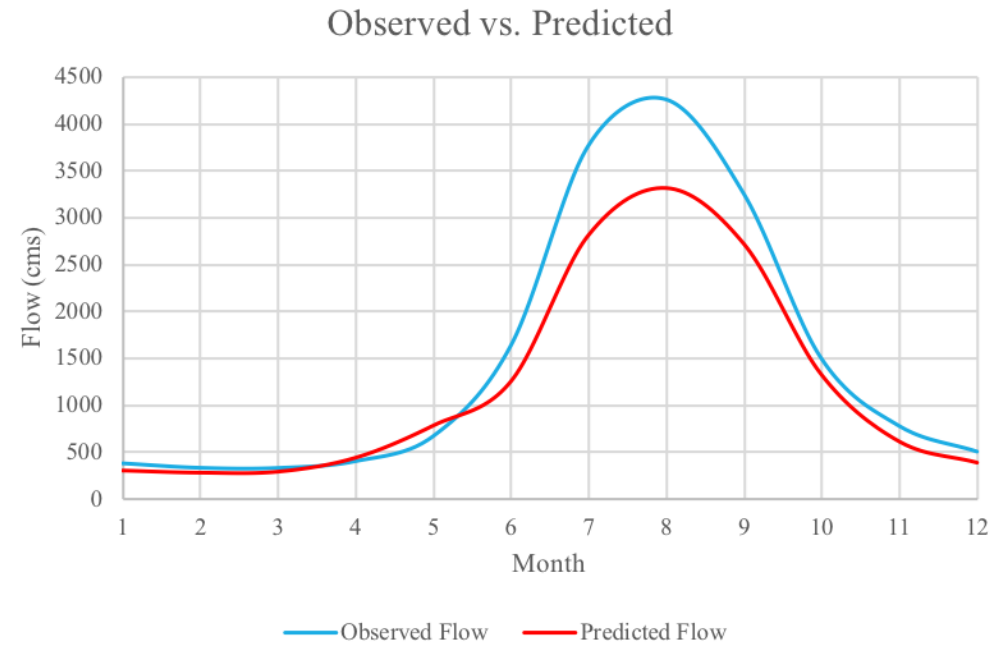
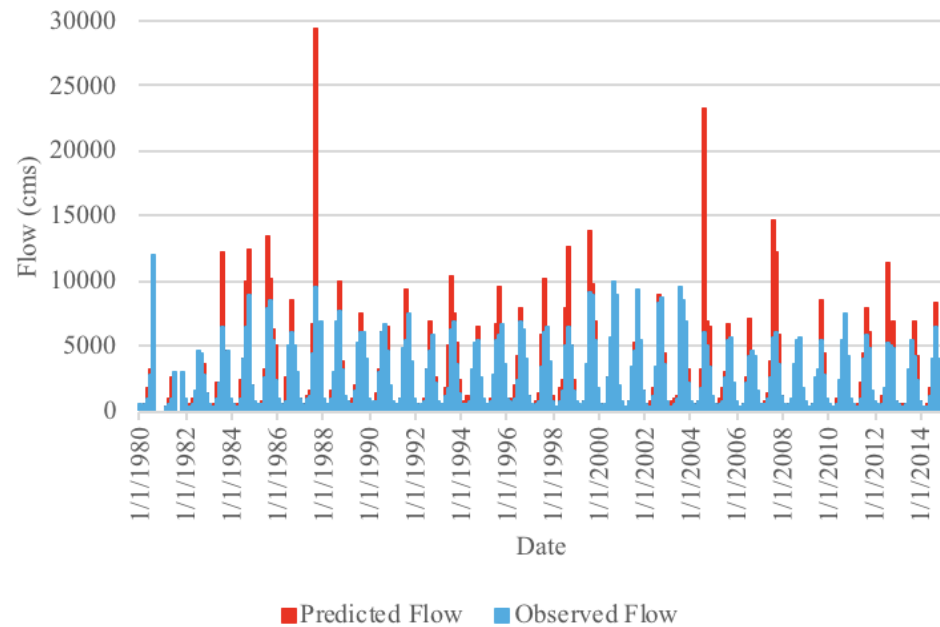
River Watch see all

Mahakali at Darchula (Dattu)	1.565 m
Surnaya Gad at Gajur Gaon	1.612 m
Mahakali at Parigaon	1.868 m
Humla Karnali at Lalighat	0.84 m
Sinja Khola at Diwara	1.167 m
Tila Nadi at Serighat	1.206 m
Lohare Khola at Dailekh	0.336 m
Seti River at Gopaghat	0.752 m

Rainfall Watch see all

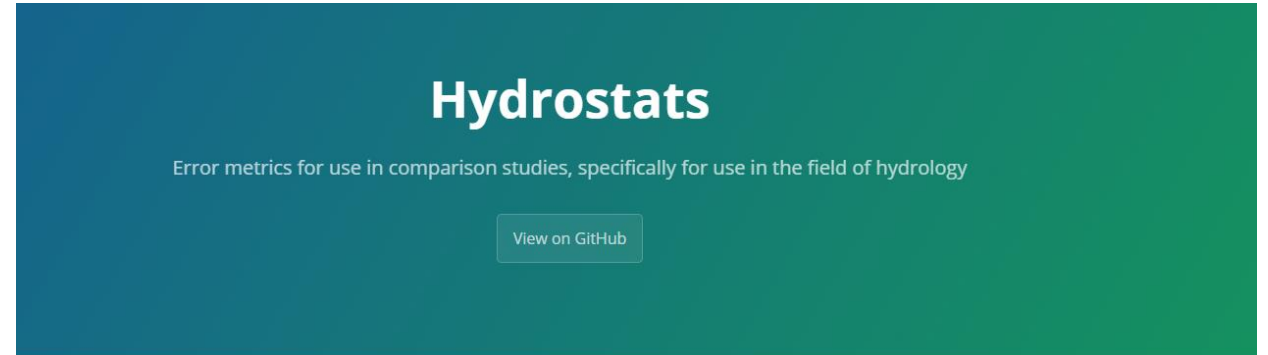
	1 HR	3 HR	6 HR	12 HR	24 HR
Safabagar					0 mm
Chisapani (Rainfall)					0 mm
Bagasoti					0 mm
Dailekh					0 mm
Gularia					0 mm
Ranijaruwa					0 mm
Nepalgunj					0 mm
Biiuwartar					0 mm

But... How accurate is the model?



Toolbox Objective

1. Provide Python and MATLAB tools to assist in validation
2. Allow flexibility for calculating different metrics for different time periods
3. Versatile enough for use with historical and forecasted data



[Documentation Editing Guide](#)

Contents

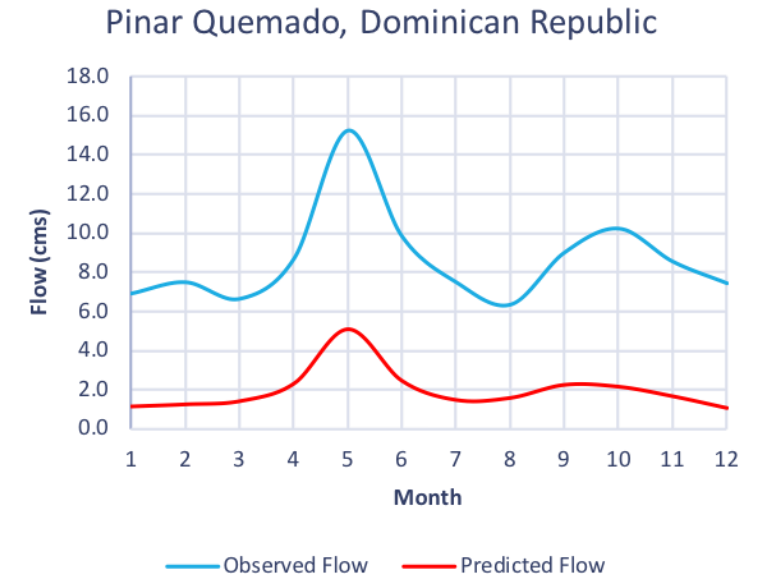
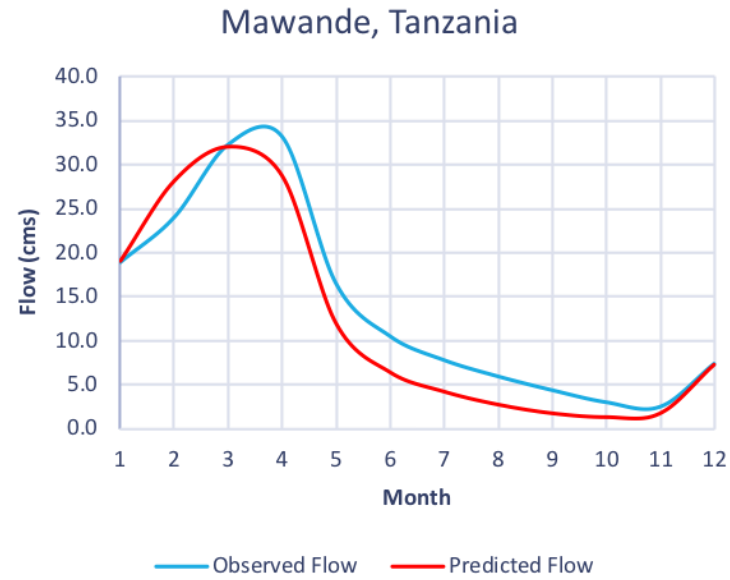
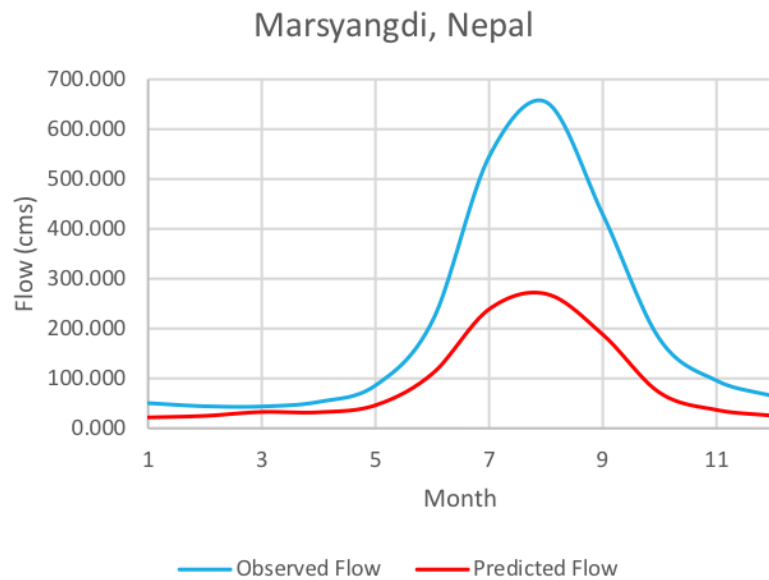
Metrics:

- Mean Error
- Root Mean Square Error
- Root Mean Square of Log Error
- Anomaly Correlation Coefficient
- R² Coefficient
- Spectral Angle
- Nash-Sutcliffe Efficiency

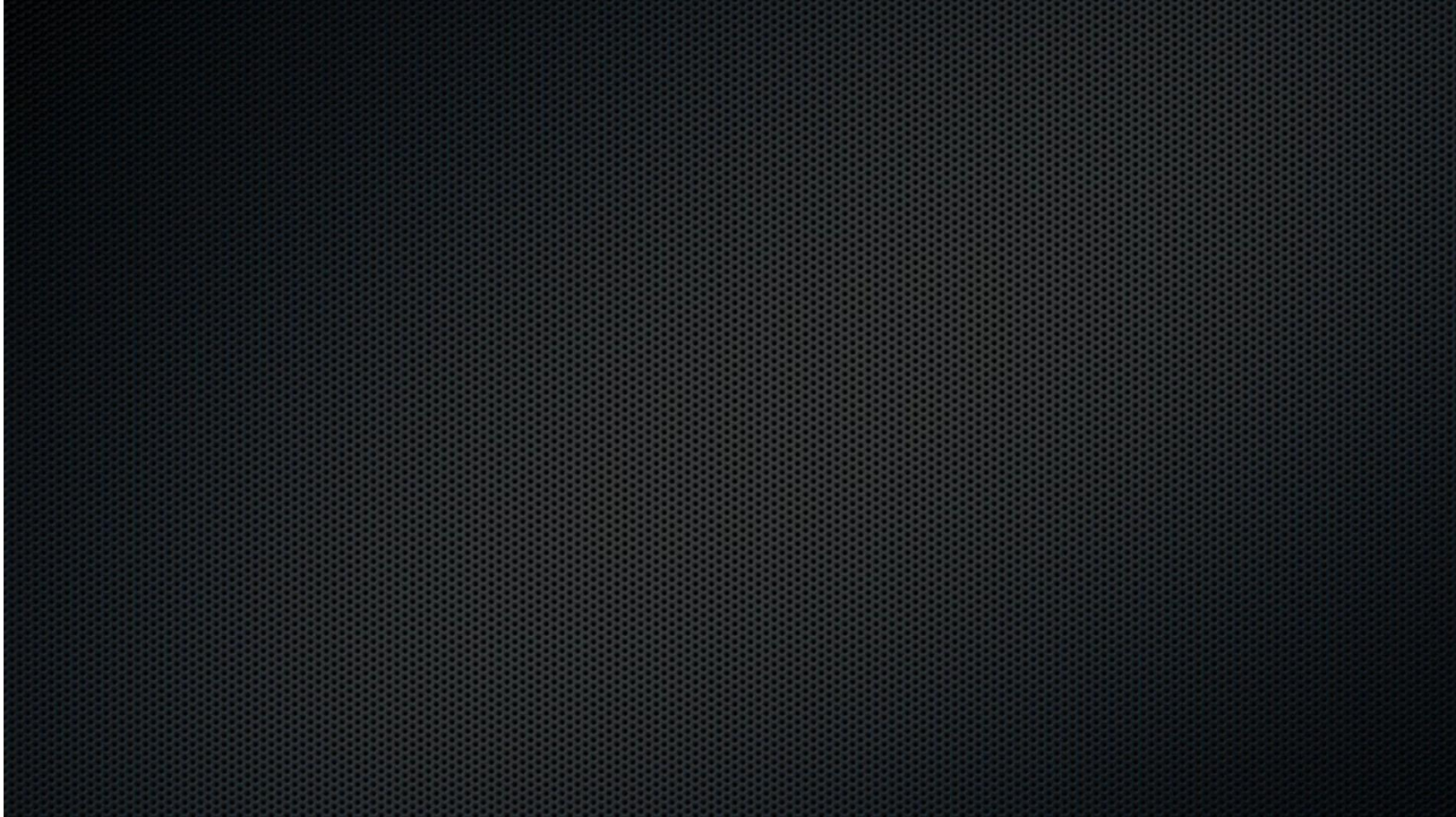
[Hydrostats Documentation](#)

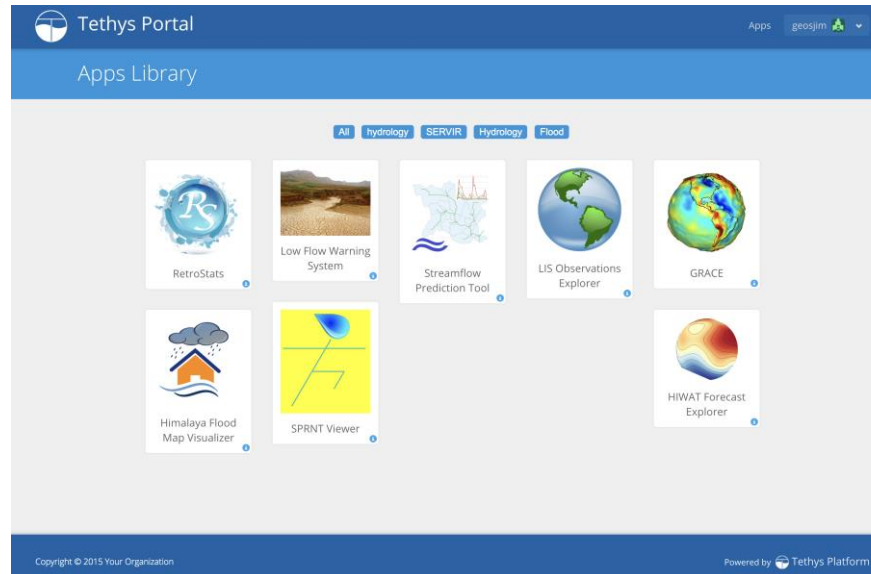
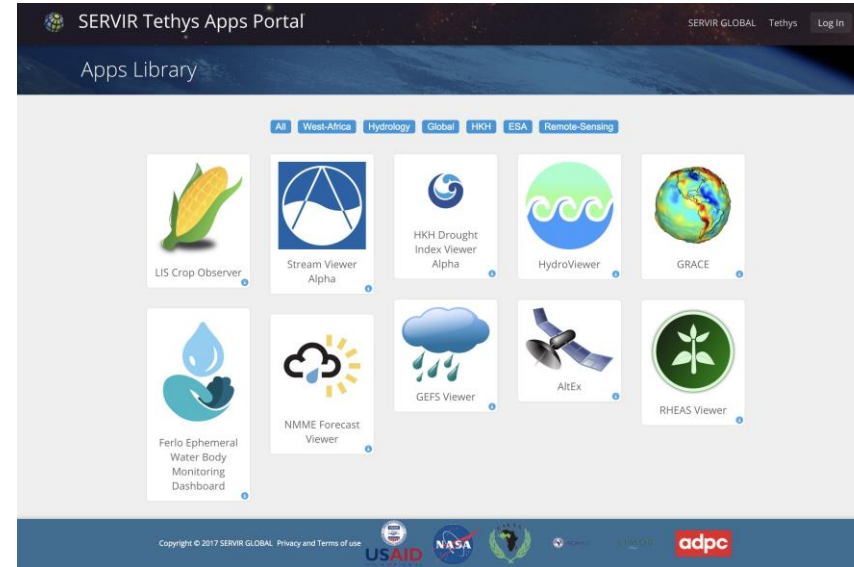
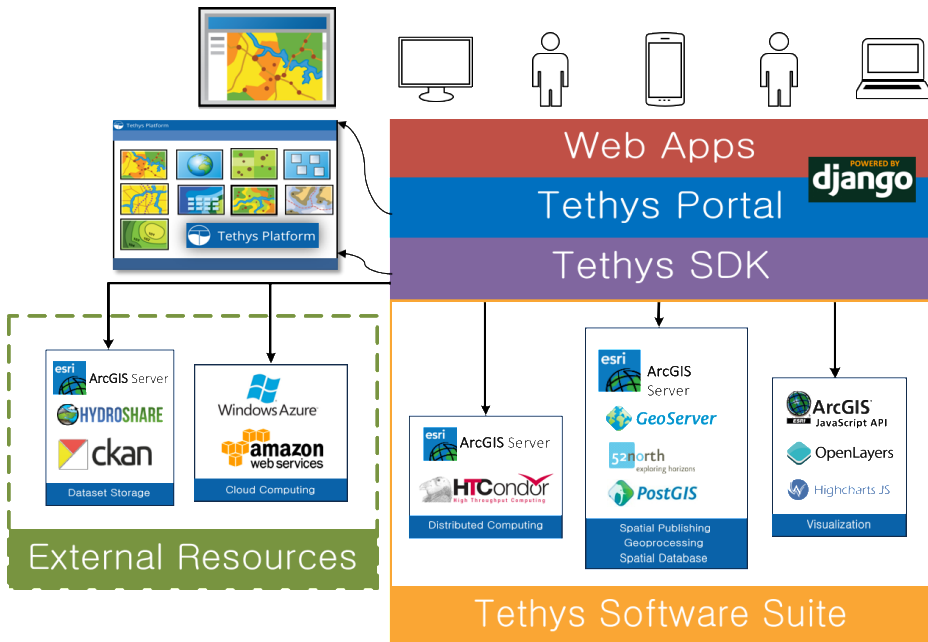
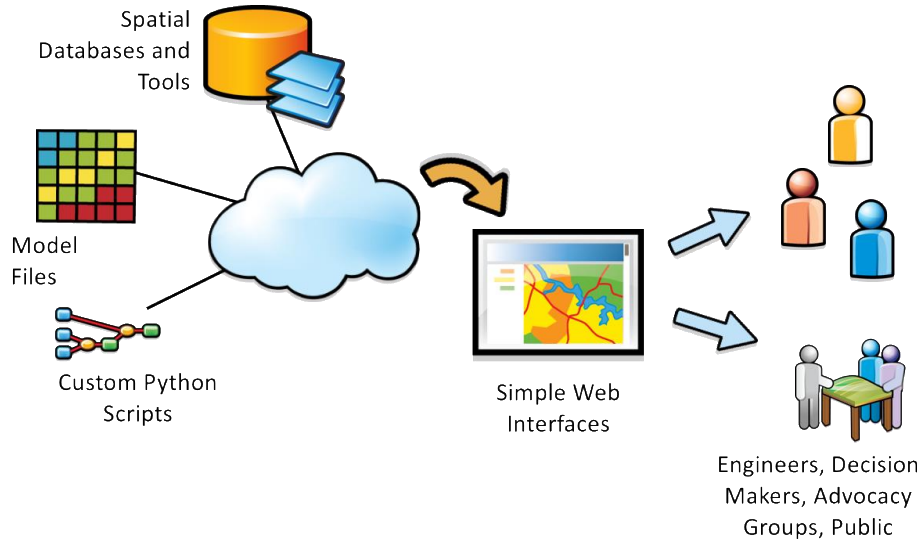
Metrics Results

Error Metric	Marsyangdi, Nepal	Mawande, Tanzania	Pinar Quemado, Dominican Republic
R²	0.3638	0.2579	0.4384
Correlation Coefficient	0.8122	0.7832	0.6334
Spectral Angle Coefficient	0.7308	0.6537	0.8274



Pilot Demo

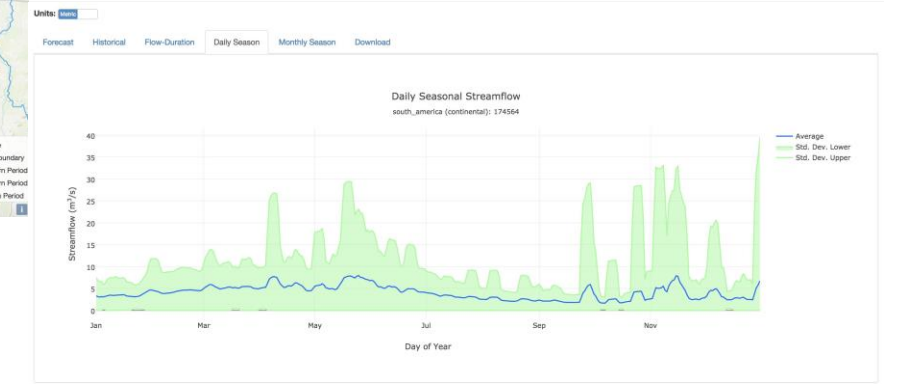
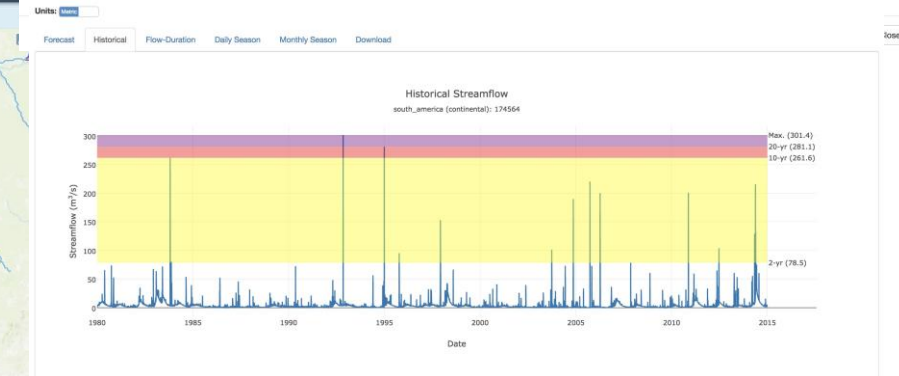
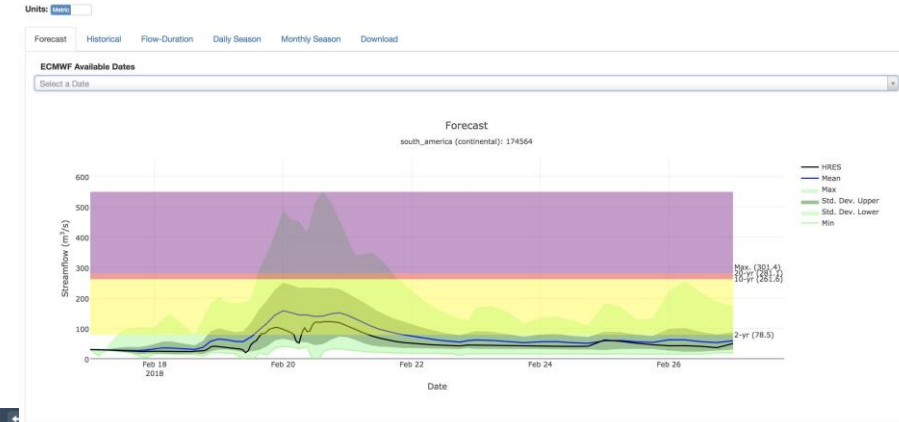
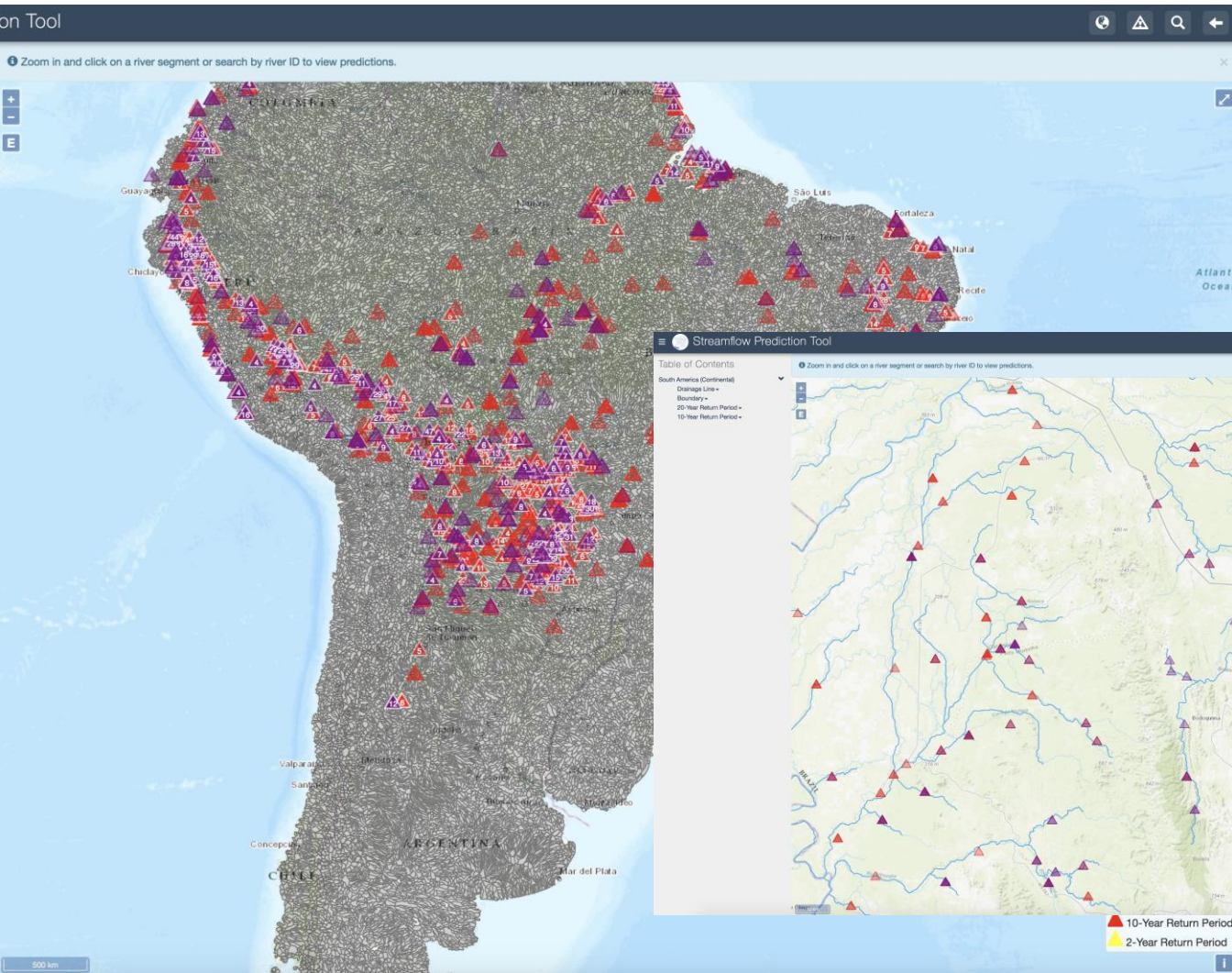




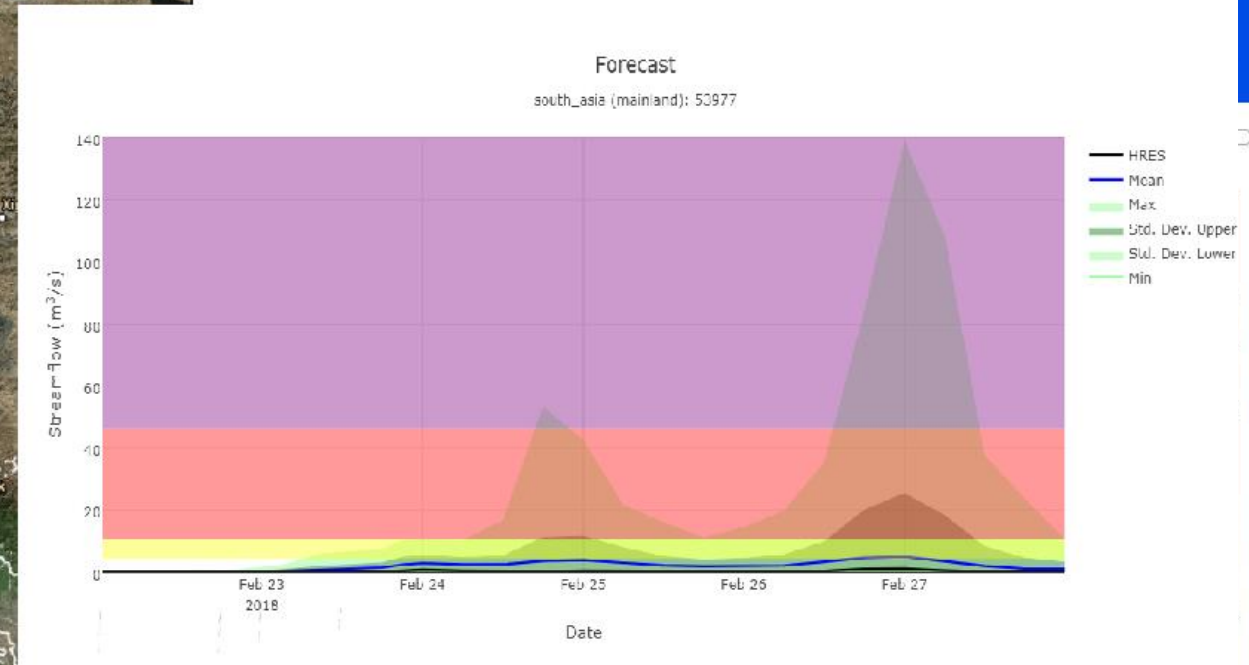
Tethys

- Open Source
- Collaborative
- Scalable, Replicable
- Developed at BYU for:
 - NSF
 - NASA-SERVIR
 - NASA-GEOGLOWS
 - National Water Model
 - US Army Corps
 - CUAHSI
- Many Applications (see next several slides)
 - Global Streamflow
 - Metrics
 - Flood Mapping
 - Grace
 - GLDAS

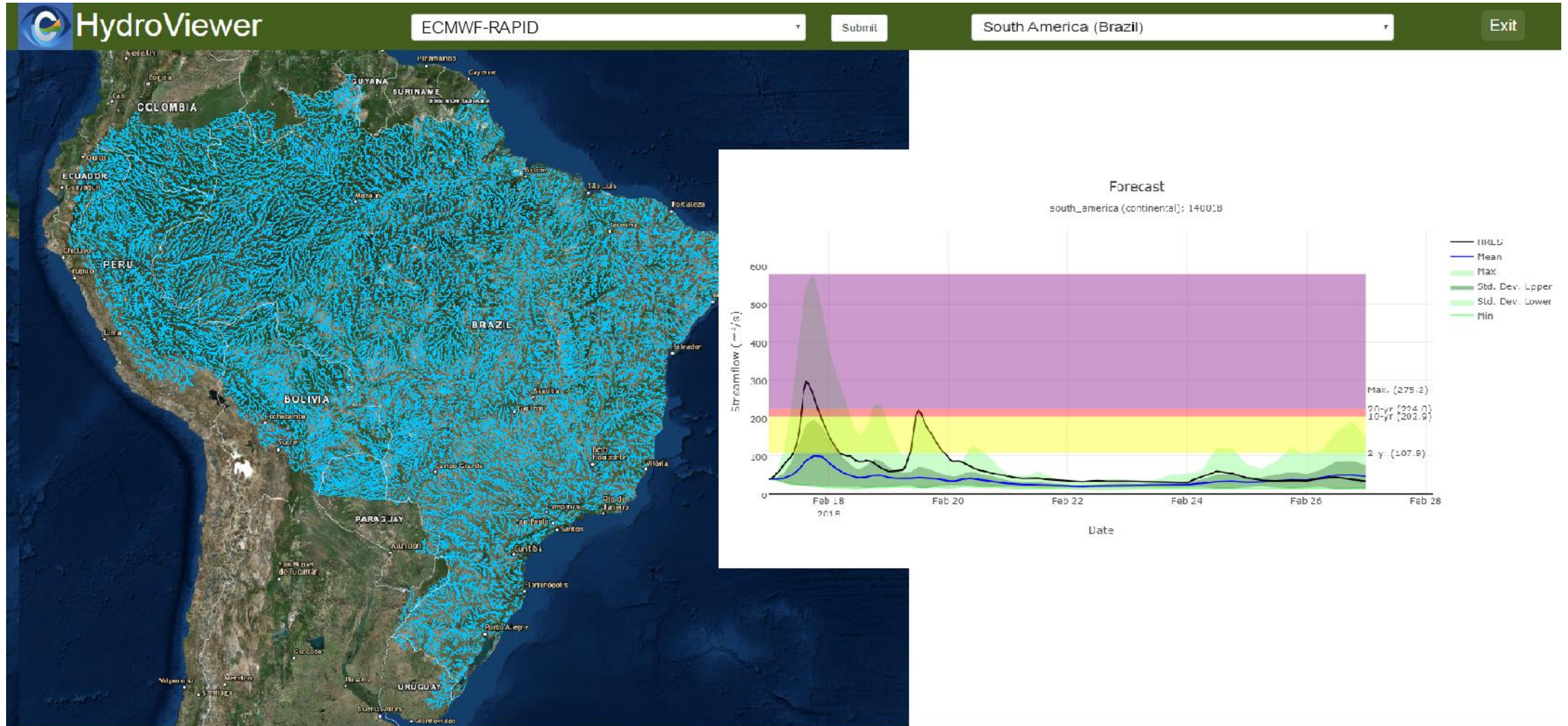
Streamflow Prediction App



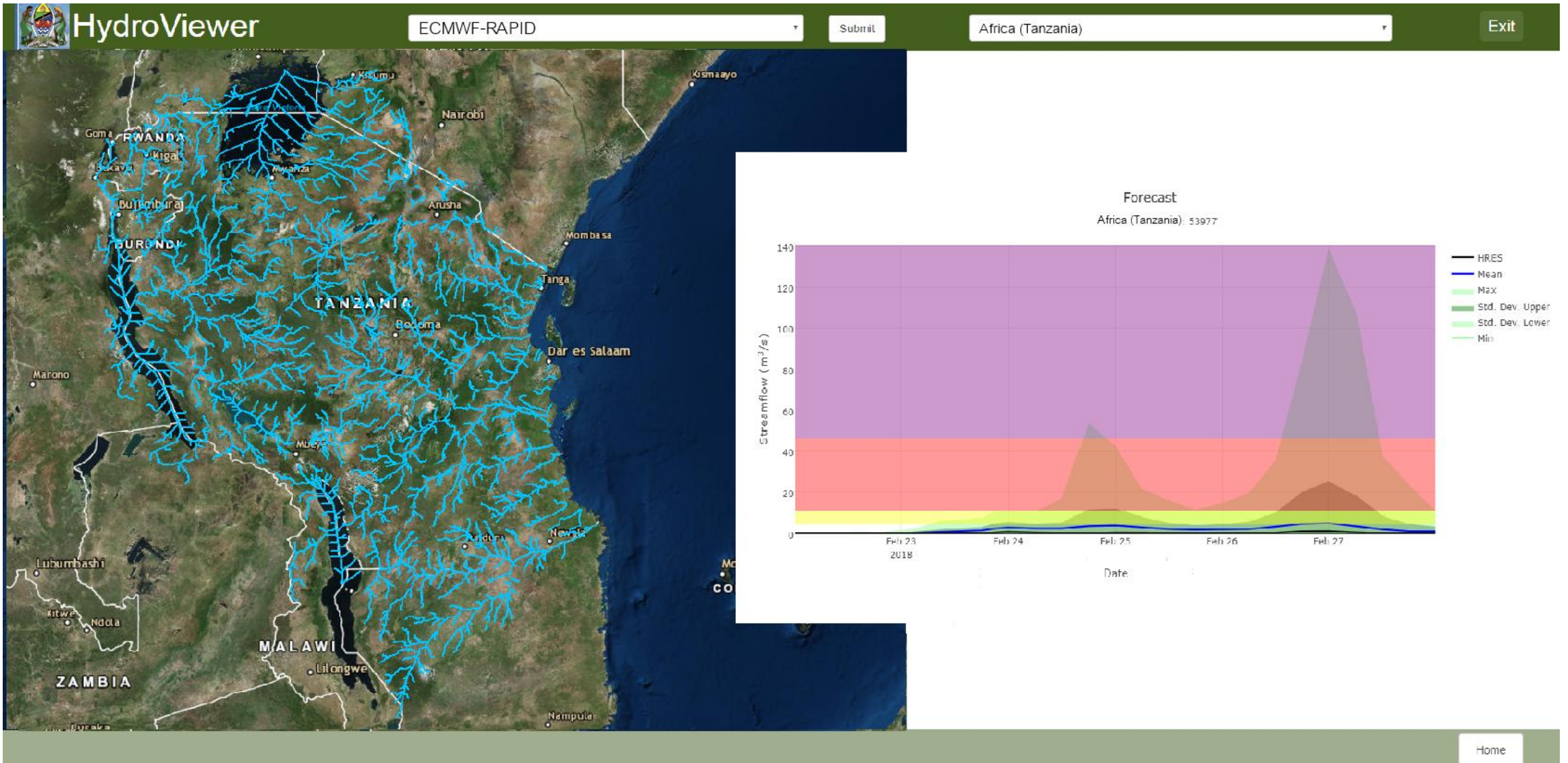
Short Term High Intensity Weather (HIWAT)



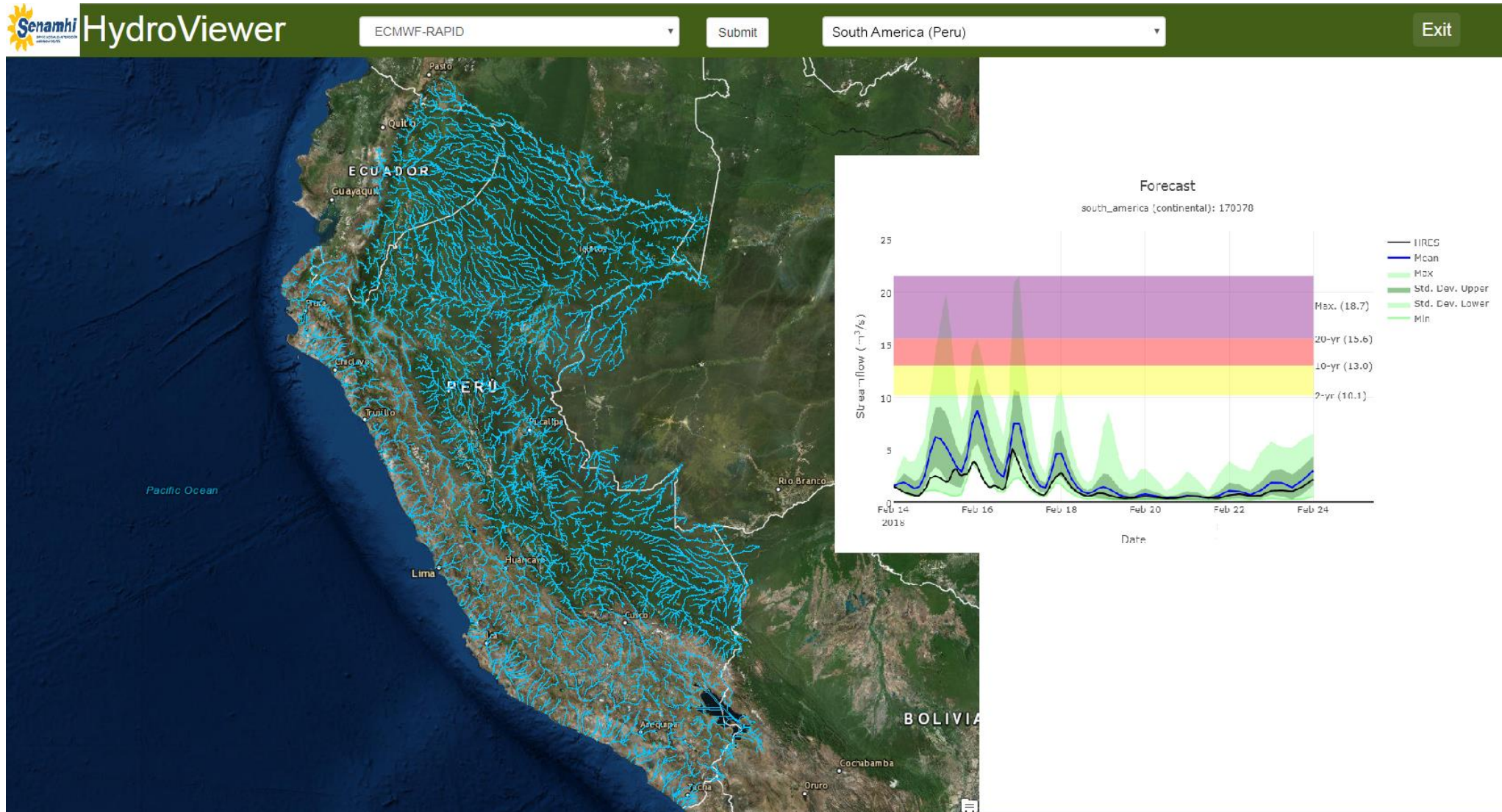
Brazil - CEMADEN



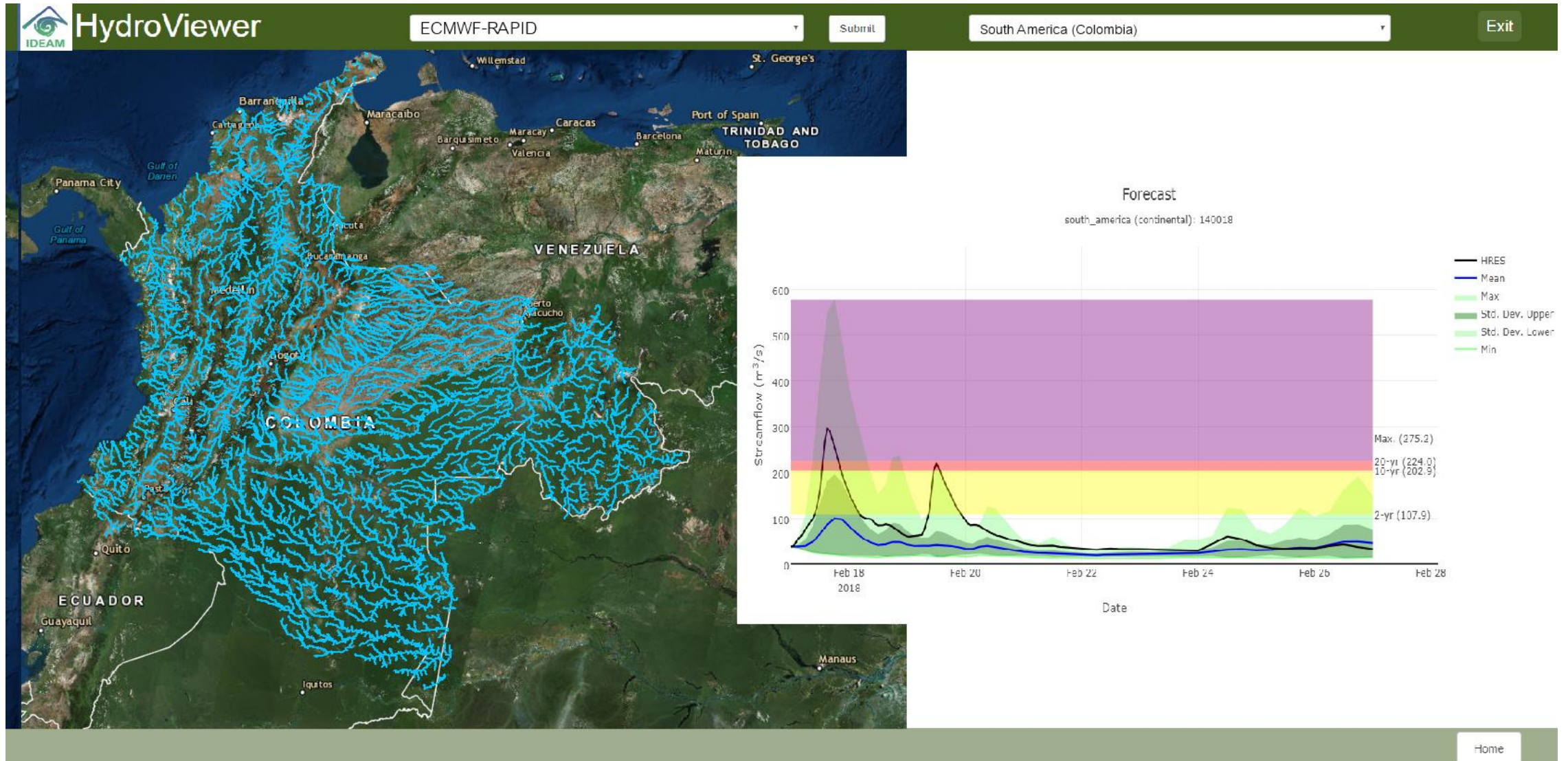
Tanzania – NHM



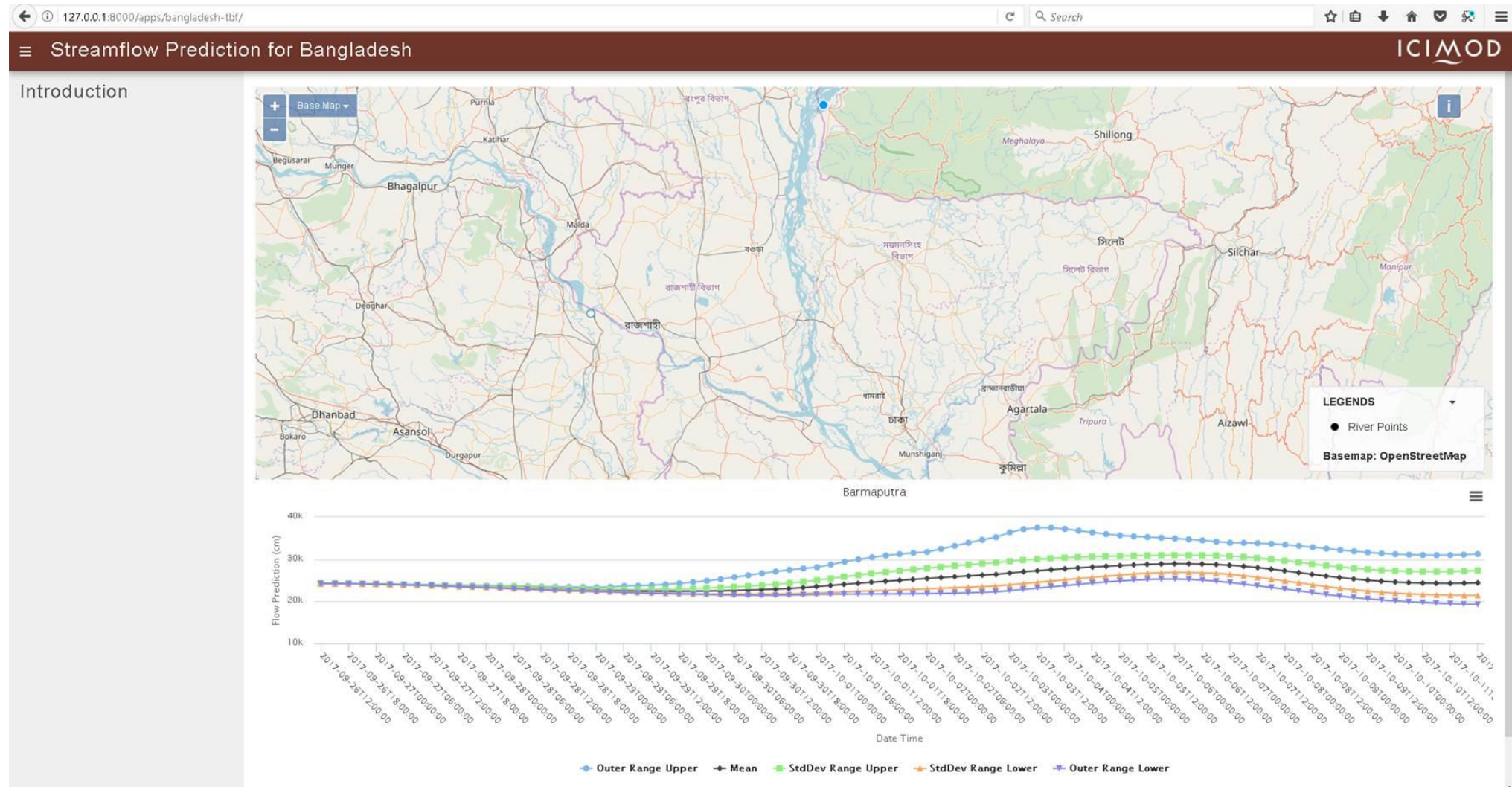
Peru - SENAMHI



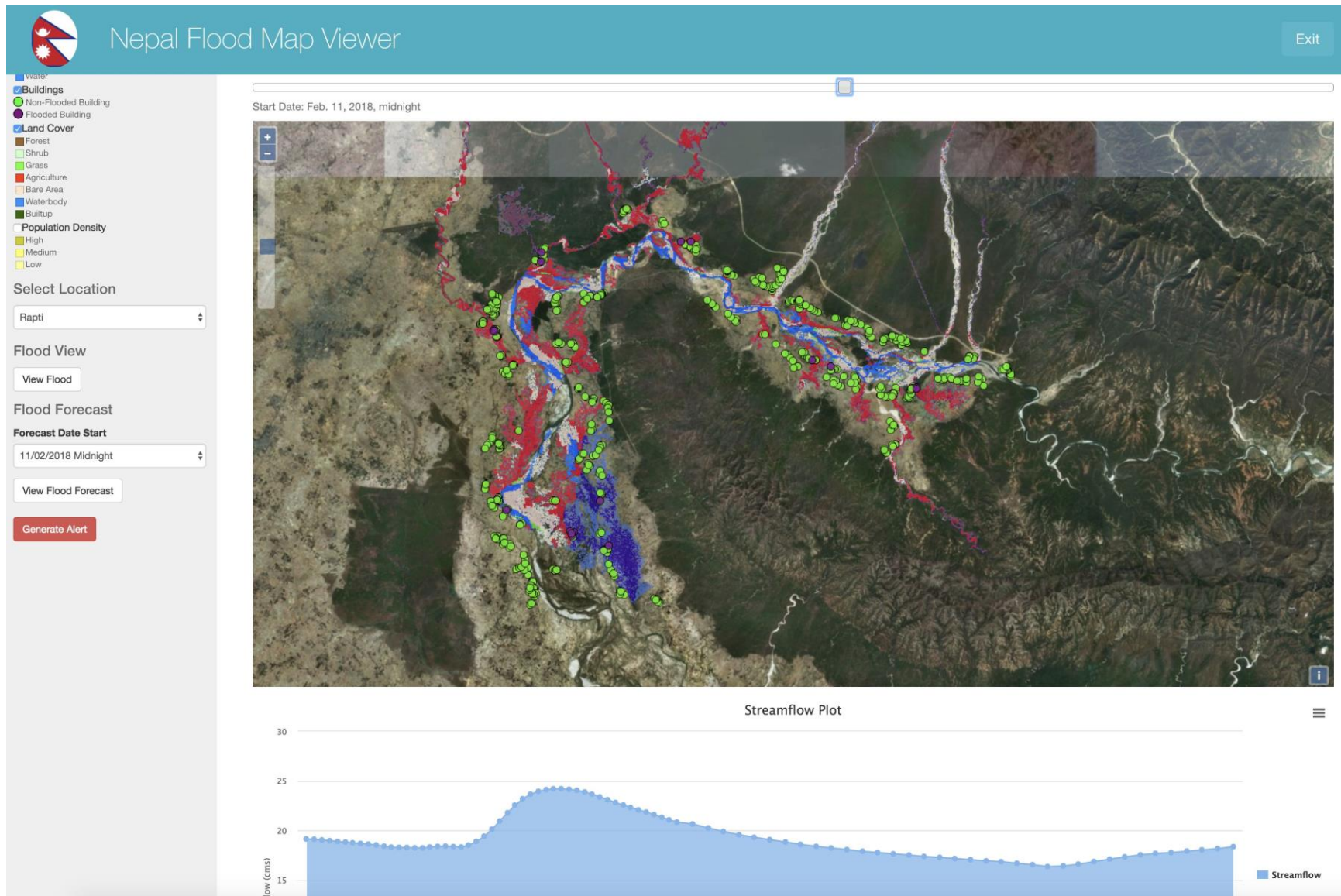
Colombia - IDEAM



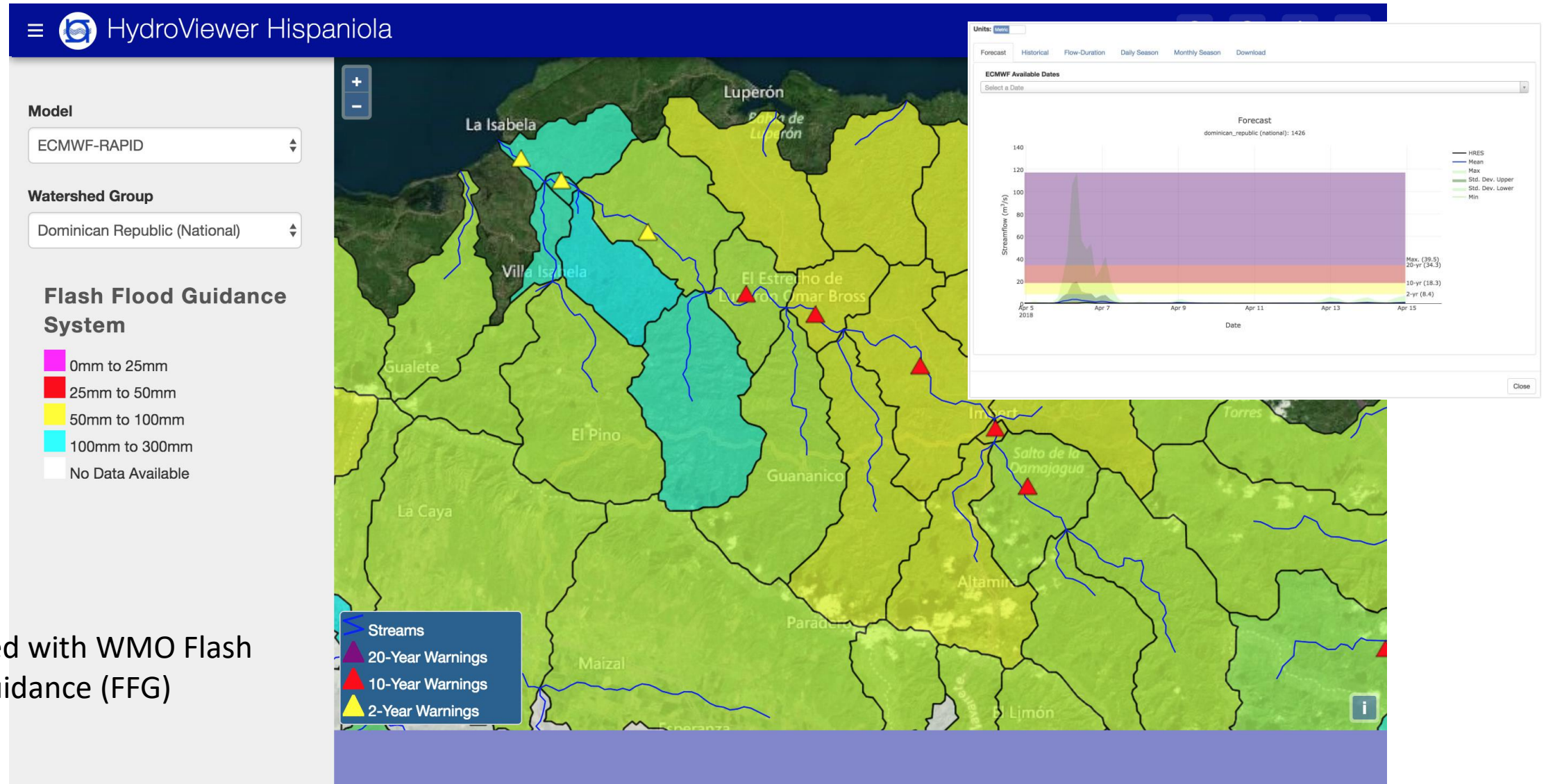
Bangladesh Transboundary Flow Forecast



Nepal Flood Inundation/Impact



Dominican Republic (Haiti) - INDRHI



Combined with WMO Flash Flood Guidance (FFG)

Reservoir Management

Herramientas de Operaciones

Navegacion

- Mapa
- Reportar
- Chacuey
- Hatillo
- Jigüey
- Maguaca
- Moncion
- Rincon
- Sabaneta**
- Sabana Yegua
- Tavera-Bao
- Valdesia

Datos Historicos

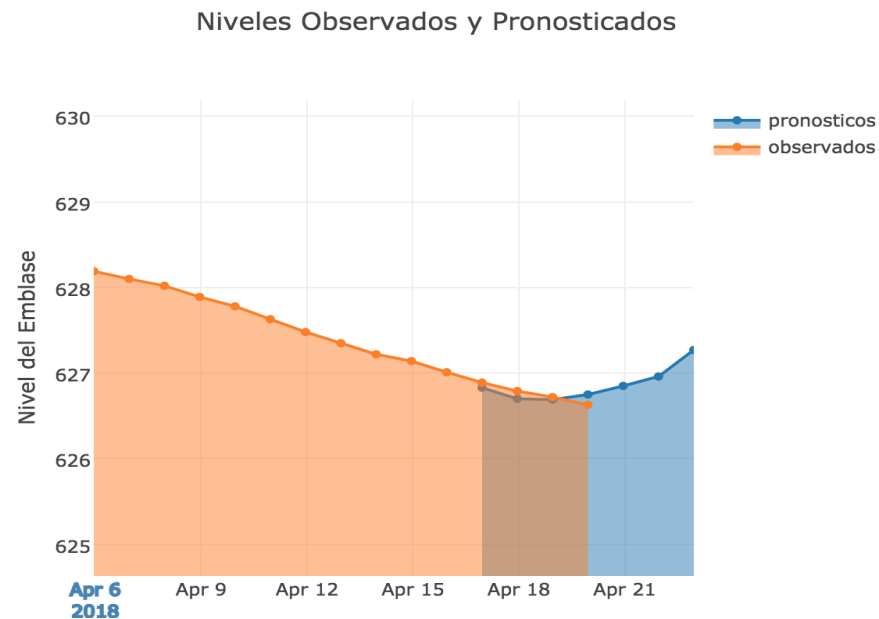
Niveles de agua (m)

Ingresar caudales de salida

Dia	Caudal de Entrada (cms)

Ingresa caudales de salida

Dia	Caudal de Salida (cms)	Tiempo de salida (horas)
04-17	<input type="text" value="3"/>	<input type="text" value="24"/>
04-18	<input type="text" value="4"/>	<input type="text" value="24"/>
04-19	<input type="text" value="2"/>	<input type="text" value="24"/>
04-20	<input type="text" value="2"/>	<input type="text" value="24"/>
04-21	<input type="text" value="4"/>	<input type="text" value="24"/>
04-22	<input type="text" value="3"/>	<input type="text" value="24"/>
04-23	<input type="text" value="1"/>	<input type="text" value="24"/>



Historico
— Nivel Minimo
— Nivel Maximo

Fecha	Caudal de Salida (cms)
04-21	3.28
04-22	2.66
04-23	5.77

Collaborative Development of many Apps

APP WAREHOUSE

The APP WAREHOUSE displays a grid of 20 application icons, each representing a different tool or model. The icons are arranged in a 4x5 grid. The applications shown are:

- Raster
- Table
- Watershed
- GSSHA Model
- Climate Change Impact
- Vector
- Collections
- Stream Flow
- EPANet Model
- HydroServer Catalog
- Time Series
- Data Rods
- NASA Explorer
- Canned Models
- NFIE Data Viewer
- Hydro Prospector
- Funes
- Storage Capacity
- Reservoir Management
- IRODS Explorer

Surrounding the central grid are several smaller images showing various data visualizations and maps, including a map of South America, a 3D terrain model, a satellite image, a map with a red dot, a map with a blue line, and a map with a green area.




Top Free iPhone Apps

Paid Free Top Grossing


All Categories

- | | | | | | | | | | | |
|--|---|---|--|---|---|--|--|---|---|--|
|
1. Candy Crush Soda Saga
Games
Get |
2. Facebook Messenger
Social Networking
Get |
3. Facebook
Social Networking
Get |
4. Instagram
Photo & Video
Get |
5. iTunes U
Education
Get |
6. YouTube
Photo & Video
Get |
7. New Words With Friends
Games
Get |
8. Snapchat
Photo & Video
Get |
9. Stick Hero
Games
Get |
10. Pandora Radio
Music
Get |
11. WhatsApp Messenger
Social Networking
Get |
|
12. Musfy - Free Music Downloa...
Music
Get |
13. Google Utilities
Utilities
Get |
14. Trivia Crack
Games
Get |
15. Twitter
Social Networking
Get |
16. Pinterest
Social Networking
Get |
17. Sniper 3D Assassin: Shoo...
Games
Get |
18. Google Maps
Navigation
Get |
19. True or False: Quiz Battle
Games
Get |
20. Kik
Social Networking
Get |
21. Monster Dash
Games
Get |
22. Find My iPhone
Utilities
Get |
|
23. Gmail - email from Google
Productivity
Get |
24. Spotify Music
Music
Get |
25. Netflix
Entertainment
Get |
26. Wish - Shopping Mad...
Lifestyle
Get |
27. Amazon App
Lifestyle
Get |
28. Microsoft Word
Productivity
Get |
29. Skype for iPhone
Social Networking
Get |
30. Walmart - Savings Catch...
Lifestyle
Get |
31. Beats Music
Music
Get |
32. Yik Yak
Social Networking
Get |
33. Uber
Travel
Get |



 NASA SERVIR PORTAL

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 ICIMOD NEPAL PORTAL

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 WMO LA PLATA PORTAL

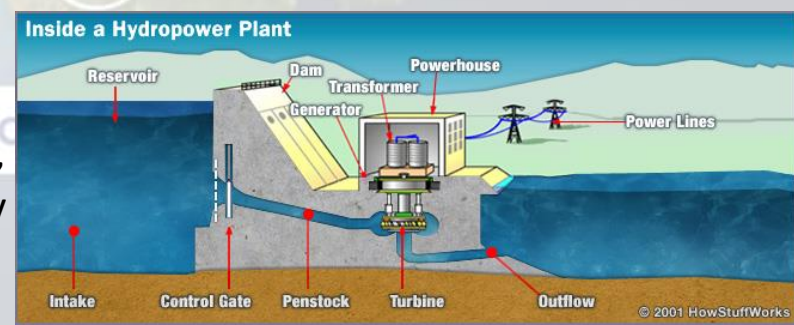
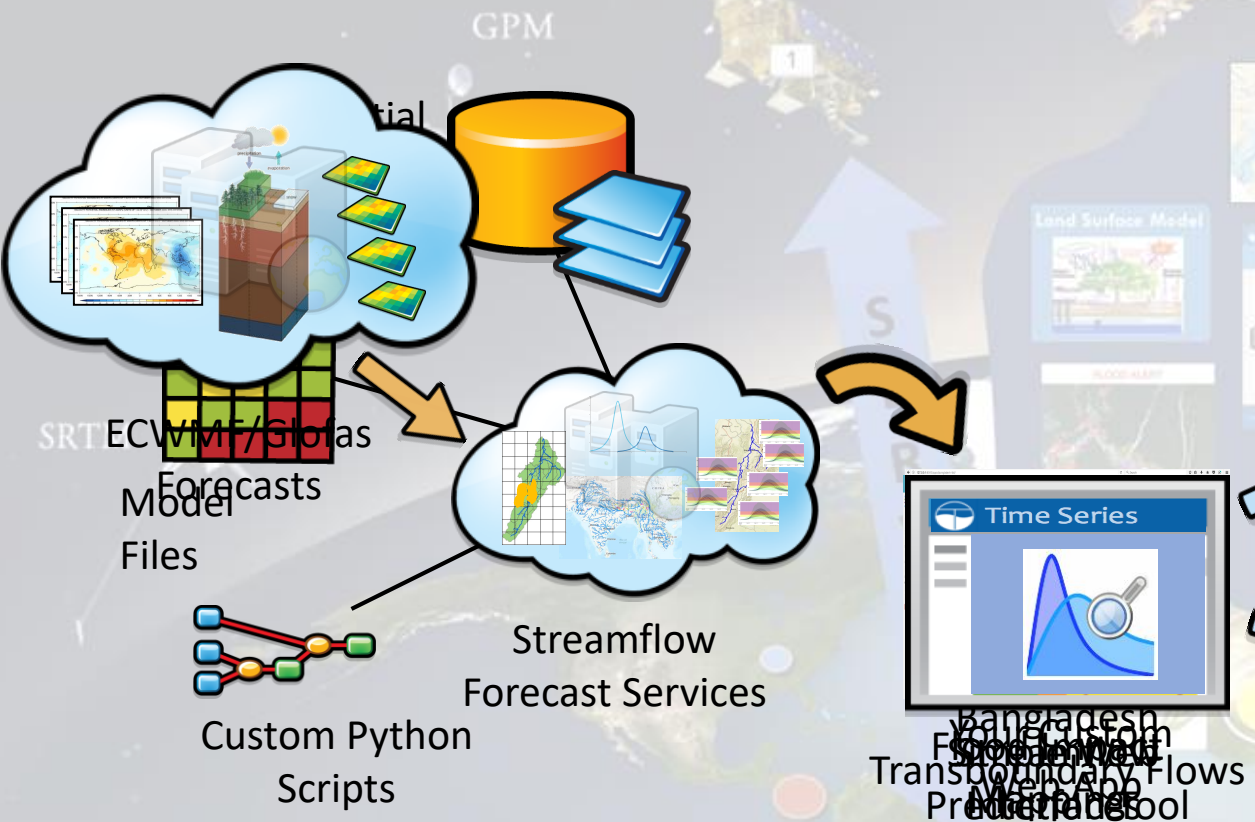
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APP WAREHOUSE



A grid of 18 application icons for the App Warehouse. The icons include: a 3D topographic map; a grid with numbers 1-5; a network diagram; GSSHA Model; Climate Change Impact; a map with a location pin; Collections; a map with a location pin; EPANet Model; Hydrologer Catalog; a line graph; a map with a location pin; a globe; GSSHA; a globe; Punes; Storage Capacity; a network diagram; and NFIE IRODS Explorer.

Stakeholders – YOU Make the Decisions



Engineers, Decision Makers, Advocacy Grps, Public Action, Others