The GeoGLOWS Project: Essential Water Variables and Observations – Expected Value Chain, Products, Examples

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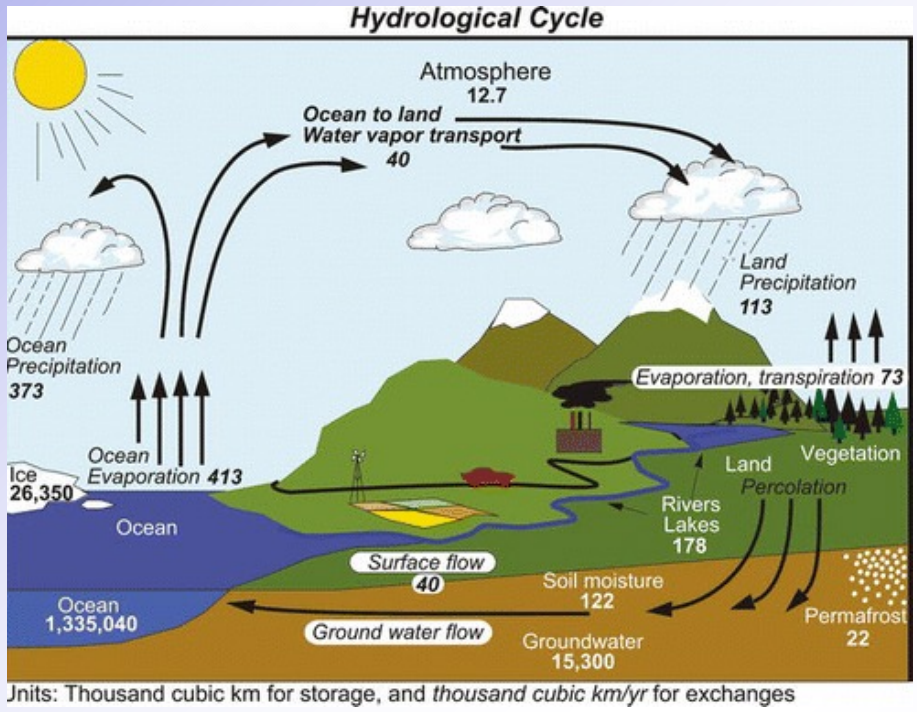
Developing the Essential Water Variables – 1



(Trenberth et al. 2006)

Initial research on closing the global water budget showed that

- certain variables were essential for describing the water storage and flux terms in the water cycle
- observations of the different variables had very different levels of maturity, resolution, coverage, and availability
- these variables came from / were needed by many different communities

Developing the Essential Water Variables – 2

A wide survey of water data needs for research and applications provided the background data for the initial EWV definitions:

- Water Needs Societal Benefits Areas Report, Unninayar and Friedl, 2010 (*http://sbageotask.larc.nasa.gov/Water_US0901a-FINAL.pdf*)

* every variable has needs that range from very short/local to climatological/global

The list of EWVs was formalized in a report on the status and prospects for water information:

- GEOSS Water Strategy Report, R. Lawford (ed.), 2014: (*https://ceos.org/document_management/Ad_Hoc_Teams/WSIST/WSIST_GEOSS-Water-Strategy-Full-Report_Jan2014.pdf*)
- as noted above, observations of the different variables had very different levels of maturity, resolution, coverage, and availability

Additional discussions have brought in water quality and surface water variables

R. Lawford is leading a status update report on the Water Strategy Report

Key international Concepts, Frameworks, and Conventions Require Water Information

GEO Societal Benefit Areas

UN Sustainable Development Goals

Sendai Framework for Disaster Risk Reduction

The Ramsar Convention on Wetlands

The Aichi Convention on Biological Diversity

The Framework Convention on Climate Change (UN-FCCC)

Key Organizations Working on EWVs

Integrated Global Water Cycle Observations (IGWCO) Community of Practice

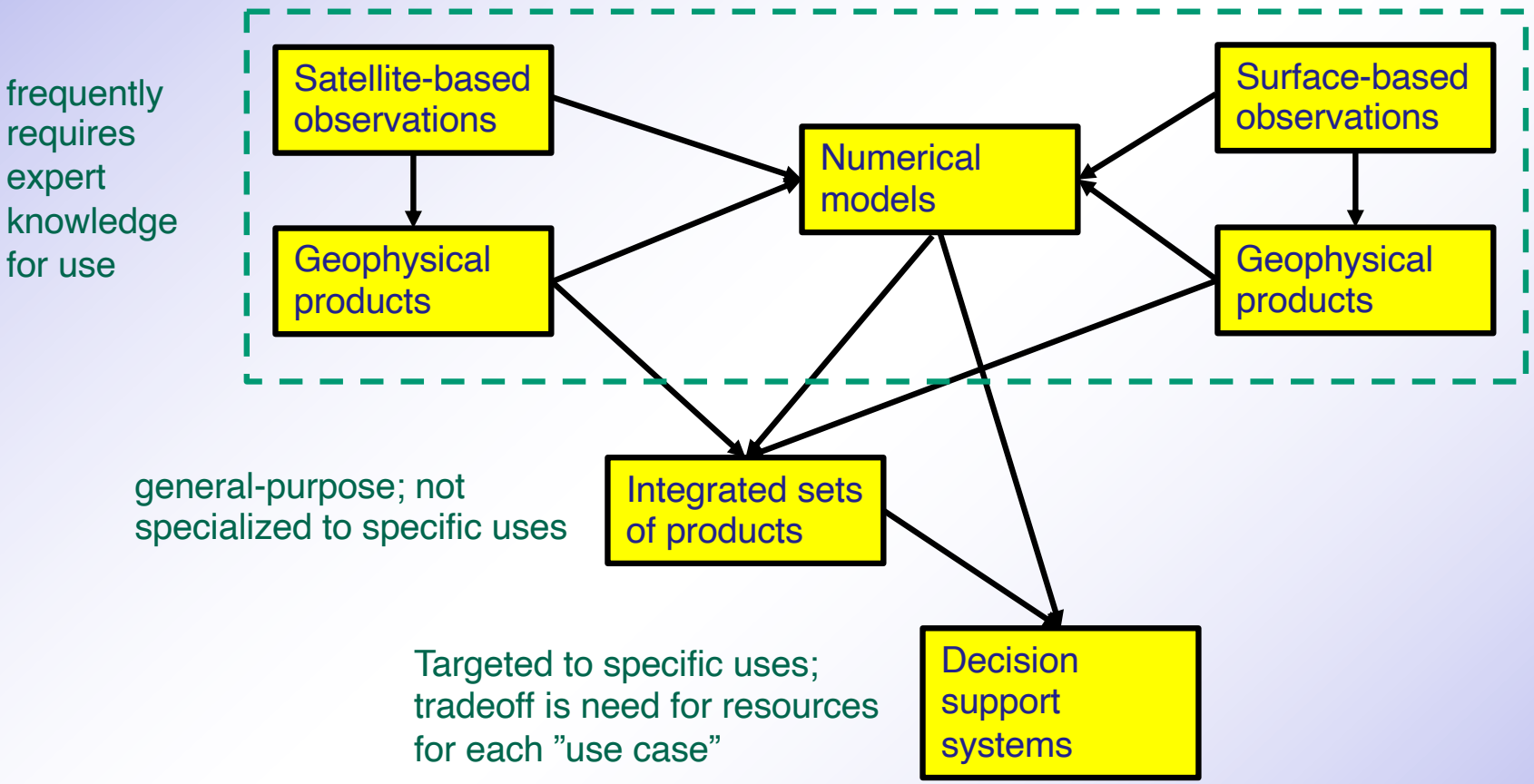
GEO Global Water Sustainabilty (GEOGloWS)

GEO AquaWatch

Essential Water Cycle Variables (EWVs) for Water Cycle Research and Water Sustainability. Y: Yes (Available) P: Partial X: Used/Needed By (Adapted from Unninayar and Lawford, 2021)	Remote Sensing (Satellite and airborne)	In-Situ Observation Networks	Water Res. Mgmt. (UN-SDG-6.5.1)	Water Allocations (UN-SDG-6)	Adapt. To Climate Change (UN SDG-13) ; UN-FCCC	Water for Agriculture/ Forestry (UN-SDG-15)	Hydropower Production: (UN-SDG-7; UN-SDG-13)	Water Quality Monitoring (UN-SDG-6.3.2; UN-SDG-3))	Environment Flows/Ecosystems Services (UN-SDG-6, 13)	Health and Disease Warnings/Control (UN-SDG 3, 15	Floods/Natural Dis. Mitigate (UN-SDG-13)	Droughts/Heat Waves Warning (UN-SDSG-13)	Urban Water Management UN-SDG-6, 11)	Water Stress Reduction (UN-SDG-6.4.2)	Water Use Eff. Incr. (UN-SDG-6.4.1)	Transboundary Water Policy (UN-SDG-6.5.2)
Precipitation	Y	Y	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evaporation/ evapotranspiration	P	Y	X	X	X	X	X		X	X	X	X	X	X	X	
Snow/ice cover (including depth, SWE, freeze/ thaw margins)	Y	Y	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Soil moisture/temp	Y	Y	X	X	X	X			X	X	X	X	X	X	X	
Groundwater	P	Y	X		X	X		X			X	X	X	X	X	X
Runoff/streamflow/river discharge	P	Y	X	X	X	X	X	X	X		X	X	X	X	X	X
Lake/reservoir levels, water extent	Y	Y	X	X	X	X	X	X	X		X	X	X	X	X	X
Surface water extent; surface water elevation	Y	P	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Glacier/ice sheet balance	Y	P	X	X	X	X	X		X		X		X			X
Water quality	P	Y	X	X	X	X		X	X	X	X	X	X	X	X	X
Water use/demand	P	Y	X	X	X	X	X	X	X		X	X	X	X	X	X

Supplemental EWVs: Obs. required to support primary EWVs Y: Yes (Available) P: Partial X: Used/Needed By	Remote Sensing (Satellite and airborne)	In-Situ Observation Networks	Water Res. Mgmt. (UN-SDG-6.5.1)	Water Allocations (UN-SDG-6)	Adapt. To Climate Change (UN SDG-13) ; UN-FCCC	Water for Agriculture/ Forestry (UN-SDG-15)	Hydropower Production: (UN-SDG-7; UN-SDG-13)	Water Quality Monitoring (UN-SDG-6.3.2; UN-SDG-3))	Environment Flows/Ecosystems Services (UN-SDG-6, 13)	Health and Disease Warnings/Control (UN-SDG 3, 15	Floods/Natural Dis. Mitigate (UN-SDG-13)	Droughts/Heat Waves Warning (UN-SDSG-13)	Urban Water Management UN-SDG-6, 11)	Water Stress Reduction (UN-SDG-6.4.2)	Water Use Eff. Incr. (UN-SDG-6.4.1)	Transboundary Water Policy (UN-SDG-6.5.2)
Surface meteorology	Y	Y	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Surface radiation budget SW, LW	Y	Y	X		X	X				X		X		X	X	
Clouds & aerosols	Y	Y	X		X	X			X			X				
Soil moisture/temp	Y	Y	X		X	X			X	X	X	X	X	X	X	
Vegetation cover/type	Y	Y			X	X		X	X		X	X	X	X	X	X
Land cover, land use	Y	Y	X	X	X	X		X	X	X	X	X	X	X		X
Elevation/topography/ bathymetry, geology	Y	Y	X				X		X		X		X			X
Permafrost	P	Y			X	X		X	X		X					X

Meeting User Needs for Water Data Is Still a Work in Progress



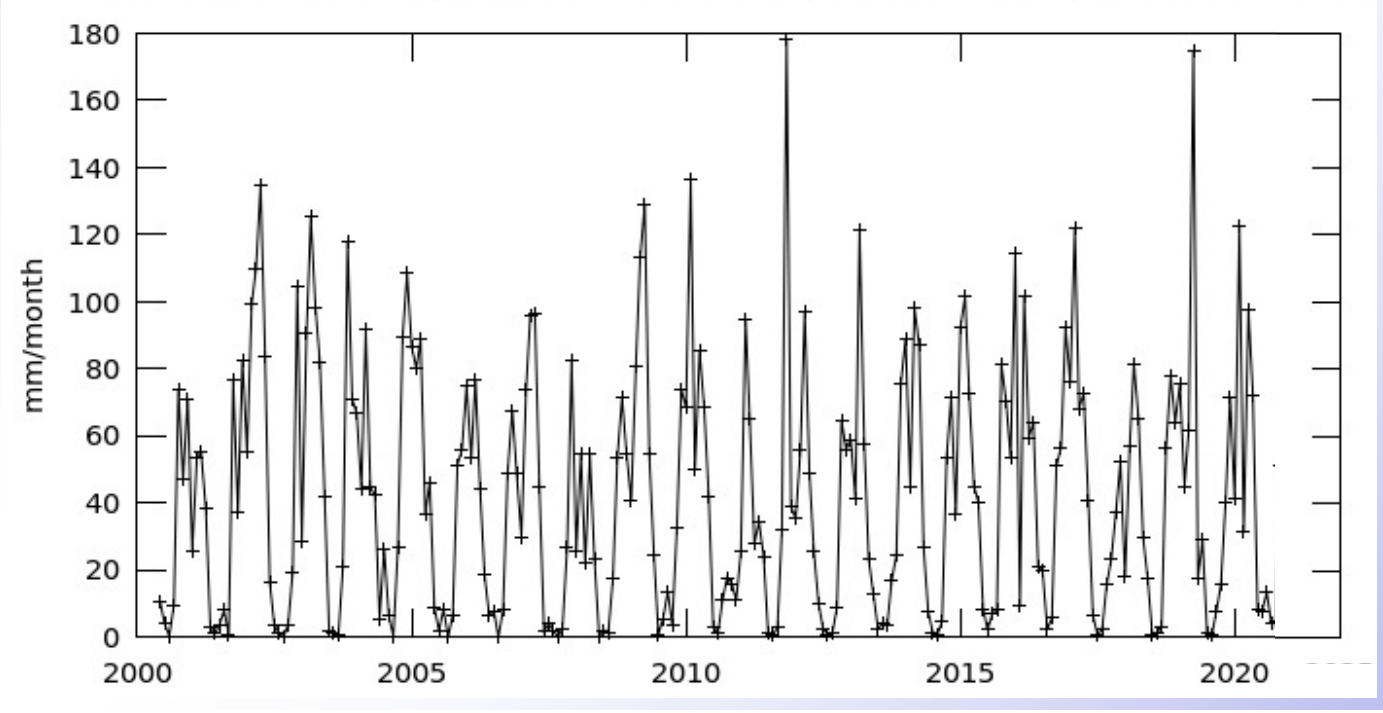
Example: Gionvanni

https://giovanni.gsfc.nasa.gov/giovanni/

Web-based access to NASA Earth Science datasets

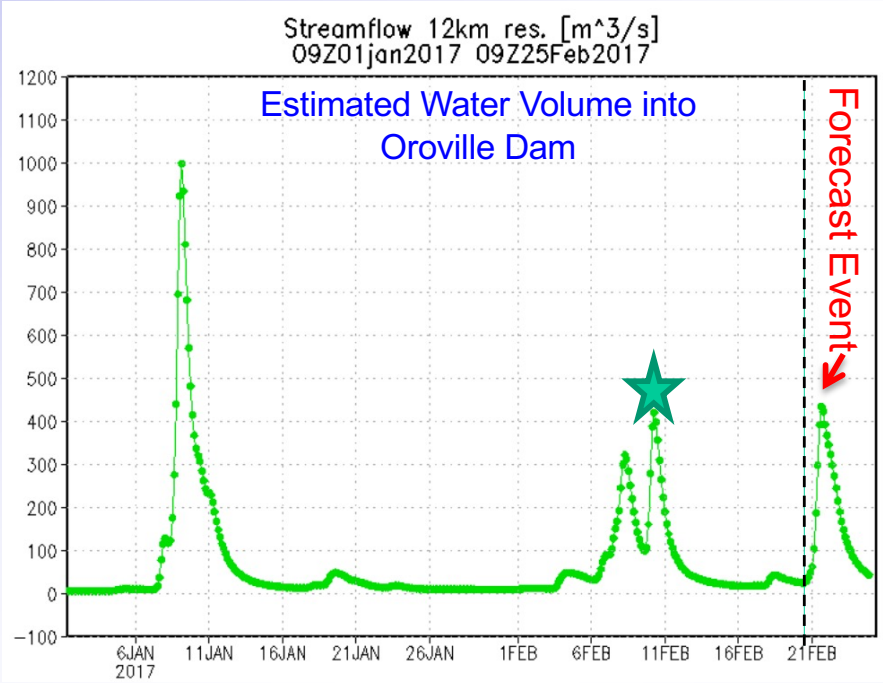
- basic display and selected analysis functions
- download of analyzed data, output graphics, and analysis setups
- only applies to datasets within the Giovanni database

IMERG Final Run monthly precipitation for Tashkent



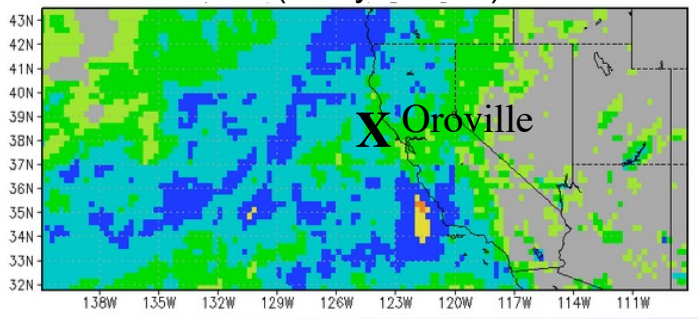
Example: Flood Estimation for Oroville Dam (California, USA), February 2017

The Global Flood Monitoring System (GFMS) uses IMERG and model output to detect potential flooding conditions and estimate intensity

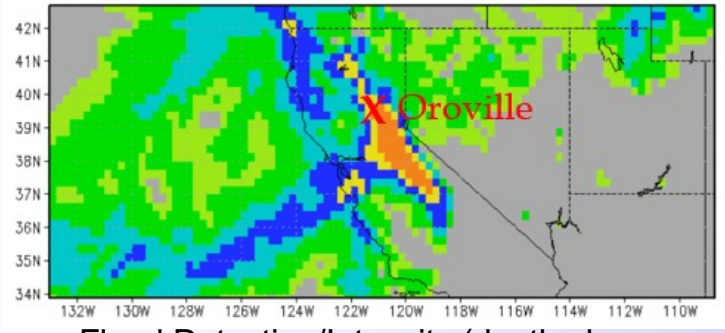


Adler (Univ. of Maryland) *http://flood.umd.edu*

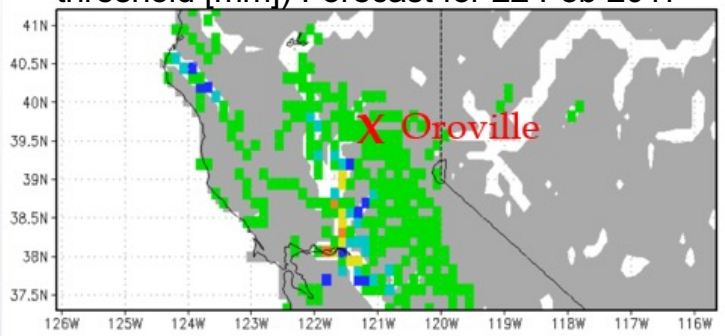
IMERG Rainfall (7-day accum.) 21 Feb 2017



GEOS-5 Rainfall Forecast (3-day accum.) 22 Feb 2017



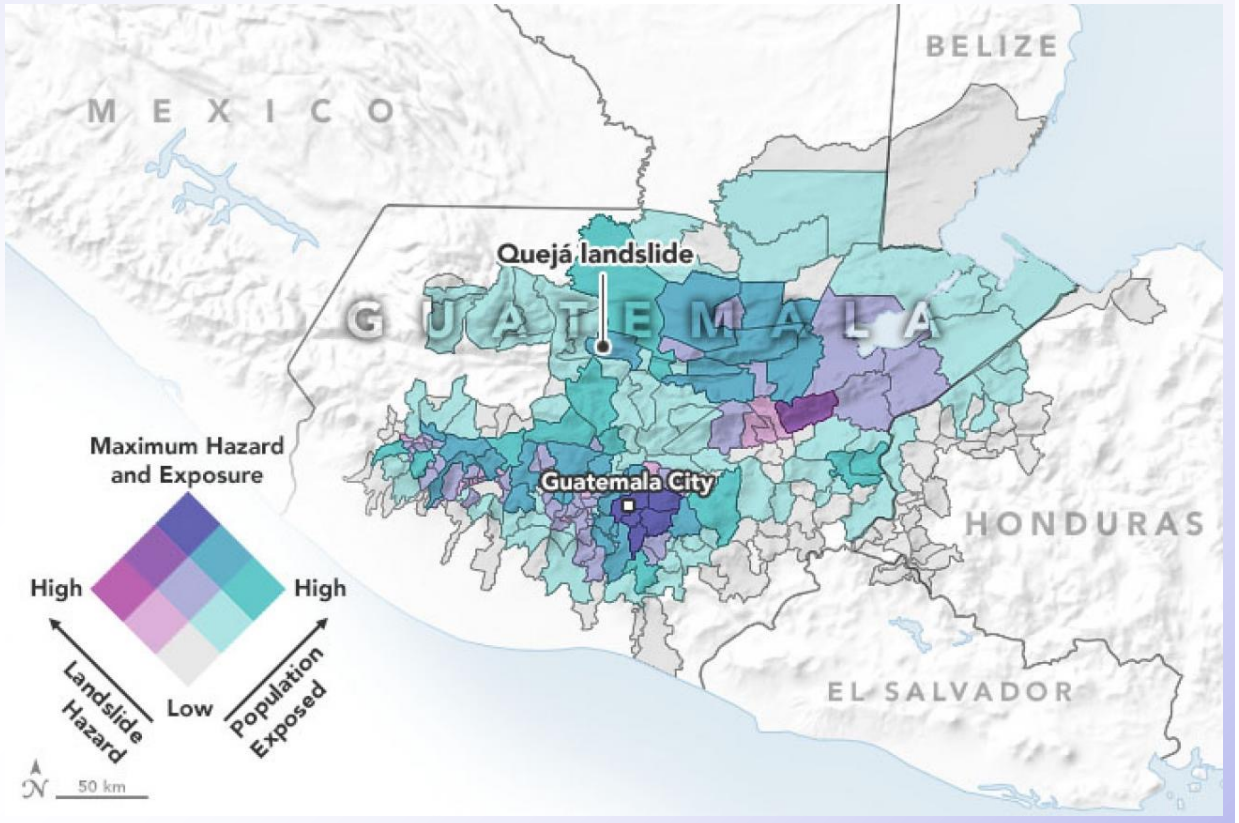
Flood Detection/Intensity (depth above threshold [mm]) Forecast for 22 Feb 2017



Example: Landslide Hazard in Guatamala Due to Hurricane Eta, 3 November 2020

https://earthobservatory.nasa.gov/images/147542/mapping-landslide-hazards-in-central-america

- NASA Landslide Hazard Assessment for Situational Awareness (LHASA) model
- predicted landslide hazard on November 5, overlaid with district-level population data
- NASA Earth Science Disasters program shared the information with national and international emergency response agencies



Global Streamflow Forecasting Project

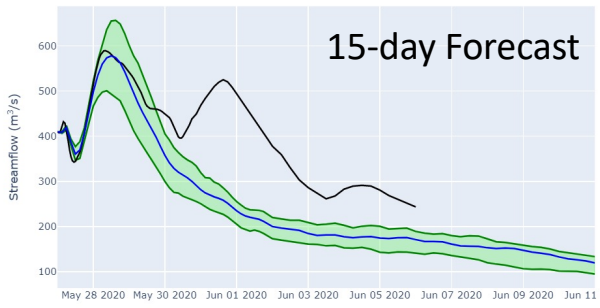
Jim Nelson (Brigham Young Univ.)

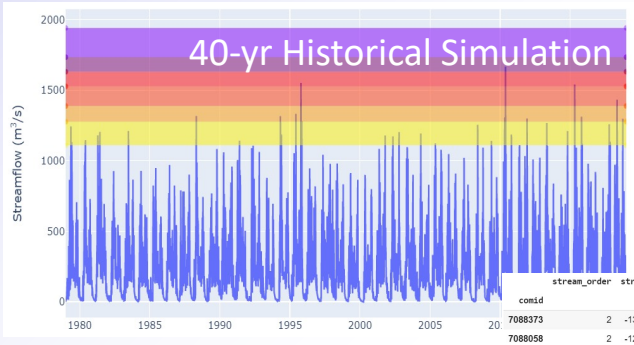
https://hydroinformatics.byu.edu/global-streamflow-forecasts ; worldwater@byu.edu

- open global hydrologic information system to address national, regional, and local water management efforts
- streamflow forecasting, with all its accompanying modeling resources, are created and run on proven global systems, and then made accessible locally through web services
- the goal is to provide data dissemination, portals, and capacity building
- partners include ECMWF, NASA-SERVIR, ESRI, NOAA, Microsoft Azure, World Bank, BYU and more
- GEOGloWS Global Streamflow forecasting pilots
  - Dominican Republic, Colombia, Bangladesh, Nepal
  - analysis of past floods, forecasting of future floods and damage, and other water resources, based on local needs

Global Streamflow Services

Products

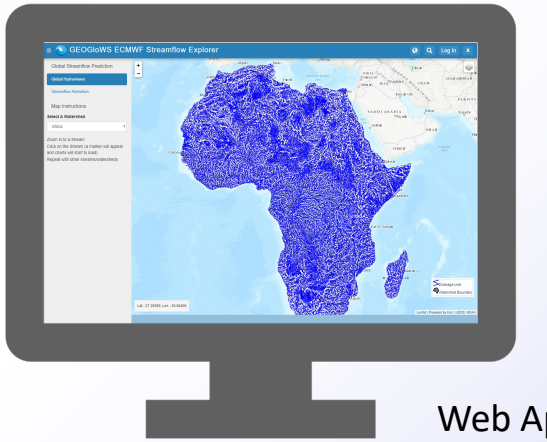




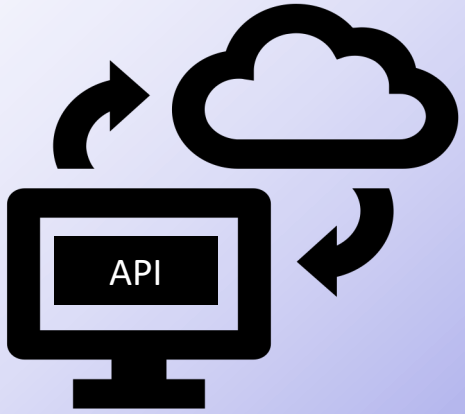
Forecast Warning Points

comid	stream_order	stream_lat	stream_lon	max_flow	date_r2	date_r10	date_r20
7088373	2	-13.175418	34.734576	1.583960	2020-05-27 00:00:00	2020-05-27 00:00:00	2020-05-27 00:00:00
7088058	2	-12.914583	34.637917	0.783468	2020-05-27 00:00:00	2020-05-27 00:00:00	2020-05-27 00:00:00
7087329	2	-12.159113	34.319213	5.707321	2020-05-27 00:00:00	NaN	NaN
7082034	2	-7.471365	30.330647	6.314908	2020-05-27 00:00:00	2020-05-27 00:00:00	NaN
7080390	2	-6.034400	29.374605	38.883274	2020-05-27 00:00:00	NaN	NaN
7080111	2	-5.785656	37.792871	26.787642	2020-05-27 00:00:00	NaN	NaN
7080307	2	-6.021502	29.255398	80.980751	2020-05-27 00:00:00	NaN	NaN
7079969	2	-5.707459	38.573907	71.166985	2020-05-27 00:00:00	NaN	NaN
7079855	2	-5.544495	38.322260	54.125420	2020-05-27 00:00:00	NaN	NaN
7079990	3	-5.755827	38.681257	94.953659	2020-05-27 00:00:00	NaN	NaN
7079904	3	-5.681796	38.817762	124.044678	2020-05-27 00:00:00	NaN	NaN
7079814	4	-5.500474	29.555745	2732.678467	2020-05-27 00:00:00	2020-05-27 00:00:00	2020-05-27 00:00:00
7080136	5	-5.788296	27.000914	8944.719727	2020-05-27 00:00:00	NaN	NaN
7079570	2	-5.269085	29.404018	13.499873	2020-05-27 00:00:00	NaN	NaN
7079568	4	-5.333432	29.509887	2581.337646	2020-05-27 00:00:00	2020-05-27 00:00:00	2020-05-27 00:00:00

Accessibility



Web Applications



Concluding Remarks

Essential Water Variables (EWVs) focus attention on the most critical water information

- user requirements analysis shows a wide range of time/space scales
- different EWVs have different degrees of completeness and maturity

Satellites, surface observations, and numerical models all have a role

- support for providing local observations is key to having the best analyses

The "middleware" that creates merged products and decision support systems requires specific development and specialization

- understand the strengths/weaknesses of the available input data
- address the site-specific needs of users
- account for a range of expertise among users
- has sustained financial/administrative support

Classic end-to-end systems do one thing well

Modern systems seek to provide toolkits and APIs that allow customized, user-defined interfaces

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