Advancing Flood Detection and Preparedness through GEOSS Water Services

David K. Arctur
University of Texas at Austin
Open Geospatial Consortium (OGC)

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Context

Multiple agencies are developing models & approaches that can be used in detection and prediction of flooding

- NASA GRACE
- NASA GLDAS/NLDAS
- NWS Precipitation
- USGS National Water Information System
- ECMWF/JRC Global Flood Awareness System
- Numerous local, regional & national flood early warning systems

Essential model results and observational data need to be shared with key emergency response staff as quickly & clearly as possible
For timely, accurate situational awareness...

Austin’s Flood Early Warning System

Canada’s Multi-Agency Situational Awareness System (MASAS)
More context

• An essential aspect of sharing this kind of information is that it needs to work consistently across institutional and political boundaries
  – Local, state, national, continental, global, and fields of science

• This does not make the development of tools easier, but complicates it: more & different stakeholders need to come to the table, share ideas & agree on decisions

• Regardless, we really have to do it… so we start somewhere:
  – by making basic water data (streamflow, stage, soil moisture, precipitation, runoff) consistently available in as many countries as we can reach
How do we do that?

We bridge socially across:
- communities of data providers
- communities of domain scientists
- communities of emergency response professionals & policy makers

And technologically across:
- disparate, agency-dependent data collection regimes
- different data formats, data quality, spatial & temporal resolution, IT architectures

This type of work cannot be done simply, quickly, or unilaterally… but it is happening!
One key development group...

- OGC/WMO Hydro DWG started in 2008
  - Conducted 2 interoperability experiments, leading to...
  - Water Markup Language (WaterML Part 1), adopted as international standard in 2012 for exchange of water data time series
  - Now working on exchange of rating curves, gagings and cross-sections (WaterML Part 2, 95% complete)
  - And water quality (WaterML Part 3, just starting)
    - One variable per time series
  - WaterML is based on the OGC Observations & Measurement (O&M) Standard, also an ISO standard…
An Observation is an action whose result is an estimate of the value of some property of the feature-of-interest, obtained using a specified procedure.
So where are we?

- We have a core information model for observations (OGC O&M)
- Extended & profiled to represent water data (WaterML)
  - A means of requesting & receiving it over the web (Sensor Observation Service, SOS)
- A means of mapping station point locations for easy discovery (Web Feature Service, WFS)
- A set of interfaces for cataloguing these data services (Catalog Service for the Web, CSW)

And these are all international standards
Gauge description and data links...

http://geoss.maps.arcgis.com/home/webmap/viewer.html?webmap=5efcdfb2d744e3ea65eaf58c06f9d0c

For quick overview

WaterML for full details

For easy analysis
WaterML 2.0

Document metadata

Observation description

Phenomena time

Result time

Procedure

Observed property

Feature of interest

Time series data

Result

Time series metadata

Time series data, cont'd
GEOSS: An approach to socializing the technology

• **GEOSS: Global Earth Observation System of Systems**
  – Hosted by GEO (Group on Earth Observations) to publish Earth observation datasets from 92 member countries
  – Enables distributed search among dozens of catalogs, accessing millions of data services, **following international data exchange standards (ISO, WMO, OGC, …)**
  – Data is organized around **9 Societal Benefit Areas (SBAs): Water, Weather, Climate, Biodiversity, Ecosystems, Energy, Agriculture, Health, Disasters**

• **GEOSS AIP (Architecture Implementation Pilot)**
  – Series of 1-year project cycles to implement GEOSS, started in 2007; AIP-6 complete in 2013; AIP-7 in progress.
GEOSS was started with millions of datasets from remote sensing…
Now working to add water time series data.
GEOSS Water Services Team (*) new members

Academic
• University of Texas at Austin, USA
• Brigham Young University, USA
• University of Saskatchewan, Canada
• Feng Chia University, Taiwan *

Community Labs, Portals
• CUAHSI Water Data Center, USA
• Dartmouth Flood Observatory, USA *
• NASA Goddard Hydrological Science Lab, USA
• NASA Goddard Earth Sciences DISC, USA
• Federal Institute of Hydrology, Germany * (supporting GRDC, GEMS/Water)
• EC Joint Research Centre (JRC), Italy
• European Centre for Midrange Weather Forecasting (ECMWF), UK
• Centre for Ecology and Hydrology, UK *
• CEOS Water Portal (JAXA), Japan
GEOSS Water Services Team, cont’d

National and regional agencies
- Italian National Institute for Environmental Protection and Research (ISPRA)
- Regional Agency for Environmental Protection in Emilia-Romagna (ARPA-ER), Italy
- New Zealand National Institute of Water and Atmospheric Research (NIWA)
- Horizons Regional Council (HRC), New Zealand

Commercial Engineering & Software
- Esri, USA
- Kisters AG, Germany
- Microsoft Research, USA
GEOSS Portal: connecting to community portals and other resources

GEOSS Discovery and Access Broker
Viewing & comparing time series values

World Soil Moisture Explorer
Monthly mean soil moisture 2003 – 2013, upper 1000m, from NASA GLDAS NOAH model

http://dtc-sci01.esri.com/kisters/index.html?appid=eaaa17b657584efca519a7243d52624d

Gridded map at timestamp

Time series & stats at grid point

Generated at 2016-02-05 23:32:42 GMT
Flood Monitoring

The Dartmouth Flood Observatory maps flood extents globally, based on pre- and post-event imagery from NASA MODIS.
Flood Monitoring
The Dartmouth Flood Observatory preserves the record of each major flood event, for posterity and for use in global flood hazard modeling, to help identify severity of current flooding.
Flood Prediction

Global Flood Awareness System (GloFAS) from the European Centre for Medium-Range Weather Forecasting (ECMWF) and the Joint Research Centre (JRC)

Inputs: global spatial data

- Digital elevation
- Land use
- ECMWF ERA-INTERIM Re-ANALYSIS for discharge climatology (1979-2010)
- ECMWF VAREPS for forecasts since June 2011

Hydro-Meteo model with grid-based routing (LisFlood)

Output: global daily discharge

Spatial resolution 0.1 degree
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ECMWF ERA-INTERIM Re-ANALYSIS for discharge climatology (1979-2010)
ECMWF VAREPS for forecasts since June 2011

Downscaling the river routing through integration with RAPID
**Target: 2-week advance forecasting of major floods**

GloFAS provides probabilistic forecasts of flooding events for large basins.
One more application for soil moisture

• Working with NASA NLDAS model output for soil moisture, Gonzalo Espinoza (UT Austin) has developed a statistical analysis tool
  – Displays soil moisture grid cells colored by percentile, relative to historical averages from 1979 to present
• This can provide useful context to emergency response managers, preparing for new rain events in a given area
• Current work is to add runoff (useful in flood analysis) & evapo-transpiration (useful for drought analysis); and extend to all USA
Soil Moisture Statistics

Texas Soil Moisture map
Last update: Tuesday, August 19, 2014
Contact: Gonzalo E. Espinoza (gespinoza@utexas.edu)

Values for August, 19 2014
Quad code: 30100-F6
Soil moisture: 333.99mm
Anomaly: 65.24mm
Percentile: 95%

Statistics of the day
Mean: 268.75mm
StdDev: 36.57mm
Range: 168.01mm
Summary

- **WMO Information System (WIS)**
  - Global network of authoritative national agencies’ data
  - WIS is being integrated with GEOSS for distributed search
- **OGC/WMO Hydrology Domain Working Group** develops core standards through OGC Interoperability Experiments & Pilots
- **GEO/GEOSS** provides an organizing principle for implementing data and map catalogs and services that works across boundaries between nations, institutions, and scientific / societal domains.
- **Crowdsourcing** is coming into use, taking advantage of citizen event monitoring.

A federated web of portals, data and tools for consistent data services is emerging – now we need to make this accessible and useful for emergency response in extreme events!
Thanks!

David Arctur
david.arctur@utexas.edu