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Publishing And Federating Global Water Data And Maps Via Web Services

David K. Arctur

David R. Maidment

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ARCTUR, DAVID K. (1,2), MAIDMENT, DAVID R. (1)
(1): Center for Integrated Earth System Science, University of Texas at Austin, USA
(2): Open Geospatial Consortium, USA

In most countries of the world, finding and accessing data about local, regional and national water resources (streamflow discharge, gauge depth, soil moisture, etc.) has been complicated by a number of issues, such as concerns of local and national security, and lack of suitable conventions and standards for data exchange that could be reasonably implemented and enforced at the national and international levels. These issues are now starting to be addressed, thanks to recently adopted standards for hydrologic data exchange, and growing acceptance of community standards for web services to perform such data exchange. This presentation reviews recent work in this area, in particular from an international initiative for the Global Earth Observation System of Systems (GEOSS) to federate regional water data into national catalogs for Italy, New Zealand, and a growing number of countries in Latin America. This builds on previous work by the Consortium of Universities for Advancement of Hydrologic Science (CUAHSI) with the U.S. Geological Survey and several other U.S. national agencies. The ability to discover and access such important data should improve the awareness and responsiveness of policy- and decision-makers in the event of natural disasters from storms, flooding and drought.

INTRODUCTION

Water is essential to all life on Earth, and the sharing of water data is essential if we are to make the best use of available water resources, and get better at understanding and preparing for extreme events such as floods and droughts. While the developed countries have made the most progress in this direction, the importance of building and nurturing earth observation and analysis skills and tools among developing countries cannot be overstated; this is a major "digital divide" and barrier to international cooperation on environmental sustainability issues. Formed in 2002, the Group on Earth Observation (GEO) has been working to overcome the institutional and interdisciplinary challenges to publishing, finding and accessing environmental data across many subject domains. In mid-January 2014, results of phase 6 of the Global Earth Observation System of Systems (GEOSS) Architecture Implementation Pilot (AIP-6) were presented at the 10th Summit of the Group on Earth Observation in Geneva. For more on GEO and GEOSS, see http://earthobservations.org and http://geoportal.org. This is a report of the results from AIP-6 in support of the GEO Work Plan 2012-2015 [1] and the Water Societal Benefit Area (SBA) strategic target [2]. This also outlines follow-on plans for the next annual cycle of development (AIP-7), now underway.

Goals
Our goals for the AIP-6 Water SBA were to improve: (1) means of discovery and access to water resources data around the world; (2) integration of gridded and time series data; and (3) the tools and processes for federating regional and national data sources into a global system (GEOSS).

Project Team
The science lead was Professor David Maidment at the University of Texas at Austin. Other participant organizations included: (1) CUAHSI; (2) the Department of Civil and Environmental Engineering at Brigham Young University in Utah; (3) the Global Institute for Water Security (GIWS) at the University of Saskatchewan in Canada; (4) European Commission's Joint Research Centre (JRC) in Italy, (5) the European Centre for Mid-range Weather Forecasting (ECMWF) in the United Kingdom, (6) the Italian National Institute for Environmental Protection and Research (ISPRA), (7) the Regional Environmental Protection Agency (ARPA-ER) of Emilia-Romagna region in northern Italy, one of Italy's 21 water regions; (8) New Zealand's National Institute for Water and Atmospheric Research (NIWA); (9) the Horizons Regional Council, one of New Zealand's 16 regional water-reporting agencies; (10) the Japanese Aerospace Exploration Agency (JAXA), (11-13) regional or national water agencies in Honduras, Guatemala, and Nicaragua; (14-16) commercial software and engineering companies Esri in the USA, Kisters in Germany, and PYXIS Innovation in Canada.

DEVELOPMENT AND RESULTS

Improving Discovery and Access via GEOSS Portal
The GEOSS Portal provides metadata and access for millions of datasets, but it is not necessarily the best portal for interacting with these datasets, as it is intended mainly for identification and download of whole datasets and links to other relevant portals. With this project we wished to provide a means for users to discover and browse maps of water data, with the ability to see and download time series of streamflow and precipitation, site by site. For this we used the Esri ArcGIS Online web map viewer, the CUAHSI HydroDesktop map client, and Kisters' software tools for time series graphing and analysis. New web services for regional data access using CUAHSI HydroServer Lite (based on php and MySQL) were developed and installed in Italy, New Zealand, Canada, and USA. These served maps of locations and basic time series descriptions of stream gauges and precipitation monitors, using OGC Web Feature Service (WFS) [3], and provided links in certain data fields about each gauge to supply three main types of data: (1) a graph of current or historical streamflow and precipitation time-series values; (2) a data file in XML format using the OGC WaterML 2.0 [4] (or similar) schema corresponding to the same data as in the graph; and (3) a comma-separated-value (CSV) file with the same data values, that could be read by Microsoft Excel or another spreadsheet program. Bermudez and Arctur [5] first documented a web architecture for these services in 2011. With completion of this project, there are now several countries using WaterML for time series data, and web mapping for gauge locations.

Integrating gridded and time series data
The second objective was to improve integration of gridded and time series water data. The water variable we chose for this was soil moisture, specifically the top one-meter of soil

moisture, which is a model output from NASA's Global Land Data Assimilation Program (GLDAS), based on satellite data. This program generates grids of soil moisture and other water data over all the world's landmasses, at one-quarter-degree spacing, with 3-hour intervals. Working with Esri and Kisters, we have spurred development of a soil moisture map that can be tied to the time series at any grid point. This is visualized with a web application that allows the user to pick any point on a landmass, and then reveals the time series of values at the nearest grid point. In addition to mapping and graphing soil moisture through time, this application allows comparison of multiple locations, and multiple time ranges at a single location, by automatically overlaying and scaling multiple graphs. Given that the NASA GLDAS model outputs are not equally accurate over the entire globe, this capability will help in comparing the model outputs with *in situ* ground-based observation stations. This will also help us better understand soil moisture where it has not been measured.

Federation of Regional and National Water Data

The third objective of this project was to improve the tools and processes for federating regional and national water data. We found that many countries have several regional Hydrological Services, such as in Italy (21 regions) and New Zealand (16 regions). The national water agencies in these countries depend on all their regions to submit accurate, timely, and consistent reports of water resources information, in order to develop a national picture of their overall situation. In practice, this has been quite difficult and time consuming, with the result that such a national picture is never available "on demand" but only at predetermined reporting intervals.

As a result of this project, and thanks to the motivated efforts of participating regional water managers in Italy and New Zealand, these countries are now much closer to being able to generate on-demand national water status reports. In Italy, the example set by the ARPA-ER regional manager has led to publishing a consistent set of water maps for all 21 regions. In New Zealand, so far two regions and two national institutes have implemented the data mapping services developed there during the last year. To support the wider adoption of water data services in New Zealand, several agencies are currently working on a New Zealand environmental time series exchange standard based on OGC services.

In Latin America, previous outreach from Brigham Young University has already brought INDRHI, the national water agency of Dominican Republic to publish selected water data. Projects in Nicaragua, Honduras and Guatemala during the AIP-6 further demonstrated that these technologies can work well for them and that the only real barriers to implementation are overcoming political and national security concerns. We hope to see further progress with these and other Latin American countries in future projects.

Next Steps

The next cycle of GEOSS implementation started in April 2014. We are coordinating with WMO and IGWCO [6] so this development work will become institutionalized by the appropriate international authoritative agencies and data centers. We will also have coordination with the Global Flood Awareness System (GloFAS) based in Europe, and the Dartmouth Flood Observatory based in the USA. We hope to add more countries to the list of those supporting WaterML data services, and are expanding our outreach to developing countries, through access to CUAHSI resources in "The Cloud".

REFERENCES

[1] GEO Work Plan 2012-2015: http://www.earthobservations.org/geoss_imp.php

[2] GEO Water SBA Strategic Target: http://www.earthobservations.org/geoss_wa_tar.shtml

[3] OGC Web Feature Service (WFS) version 2.0, http://www.opengeospatial.org/standards/wfs

[4] OGC Water Markup Language (WaterML) version 2.0.1, http://www.opengeospatial.org/standards/waterml

[5] Bermudez L and Arctur D, Water Information Services Concept Development Study, OGC Public Engineering Report 11-013r6 (2011), URL http://portal.opengeospatial.org/files/?artifact_id=44834 .

[6] Integrated Global Water Cycle Observations (IGWCO) Theme, http://www.earthobservations.org/wa_igwco.shtml