Esri News
for Water Resources
Winter 2012/2013

ArcGIS Online Floats River Analysis

By Vladimir Moya Quiroga Gomez, Free Consultant

The rivers and wetlands on the Bolivian Amazon Basin are subject to flooding. Rivers meander across the level landscape and continuously change course. This dynamic basin morphology creates economic and environmental loss. Floodwater covers large areas and impacts cities, farmlands, and natural land. These floods are lethal, drowning people and livestock and spreading dengue virus. Visualizing this dynamic landscape with GIS helps people make decisions about where to live and work.

To demonstrate that hydrographic analysis can be done using a cloud computing service, the author performed a study that could be useful to local governments along Bolivia's Ichilo River for planning

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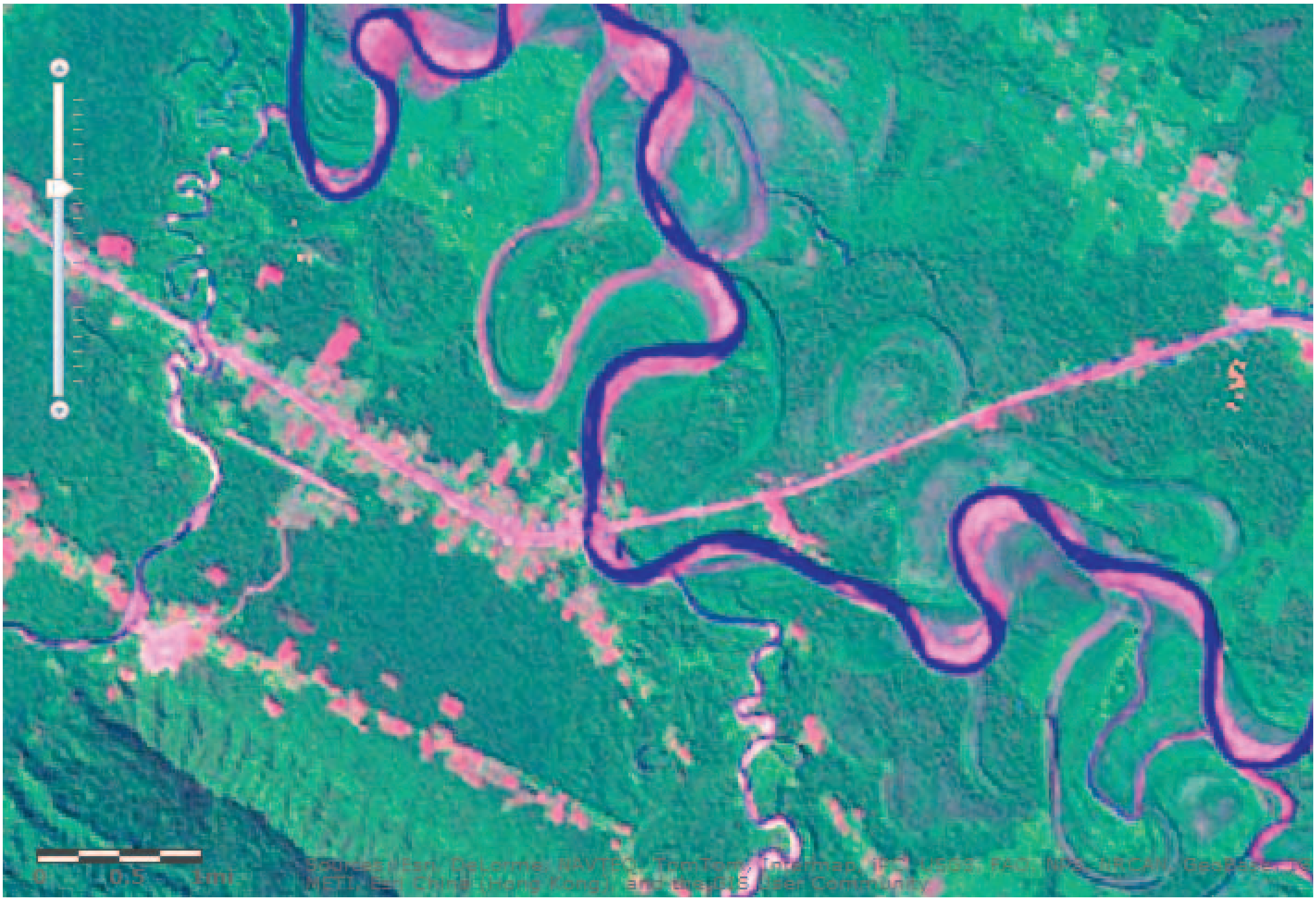

↑ This satellite image of the Ichilo River, shown in a spectral combination of bands 2, 4, and 7, reveals present and former flow paths and new vegetation cover (light color between purple and green). The user makes this land change information the basis for estimating future flow paths.

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ArcGIS Online Floats River Analysis

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road construction. He used ArcGIS Online GIS tools and its collection of global coverage maps and satellite imagery. He combined remotely sensed imagery and ArcGIS to see land topography that was otherwise hidden beneath vegetation and cloud cover. By combining different bands of satellite images, the author easily identified land use, land cover, and soil types to see how they were affected by meandering rivers and flooding.

Once the author had created the application, he published it as a service, making it available on the web and as a mobile application. Users can download the ArcGIS app for smartphones for free. Using the browser on the mobile device, the user accesses the map application and performs on-site analysis. For instance, with a measuring tool, a mobile user can determine the river's current cutting distances to estimate future meander cuts.

If you have questions, contact the author at vladyman@hotmail.co.uk.

↑ By comparing imagery of current channel flows with imagery from past years, the analyst can see how the landscape has changed over the last decade. The probable flow area is calculated to be about 15,134,085 square meters.

↑ The user accesses ArcGIS Online from a smartphone, opens the Bolivian Amazon Basin Ichilo River application, and chooses the satellite imagery for the project. Using tools to measure distances, the user has measured the probable cut of a meander neck at about 280 meters.

↑ With the distance measure tool, the user can determine the distance from a river to a roadway. This helps plan road construction and estimate maintenance.

GIS, GPS, and Lasers: Field Crews Accurately Assess the State of Northwestern Watersheds

"Integrating the laser with everything else creates streamlined workflows."

Mark Isley, AREMP Data Manager

↓ Field crews use a laser and prism setup from Laser Technology, Inc., to capture precise measurements of river and stream morphology, which are fed directly into a GIS.

Human activity such as logging and road building inevitably transform our environment, but federal agencies are collaborating to evaluate, protect, and restore some of the most vital and sensitive areas. Riparian zones—from the Latin word "ripa" meaning riverbank—refer to rivers, streams, and surrounding land. They serve as habitats for diverse flora and fauna and have far-reaching influence on soil and groundwater conditions. When outside influences turn a lush, shaded, slow-moving stream into a barren bedrock chute, the entire watershed can be impacted and invasive species can take over.

The Northwest Forest Plan helps ensure that such scenarios are avoided—and even reversed. The plan's policies and guidelines empower federal agencies to work together toward more sustainable management of federally owned lands that span from Northern California to the Canadian border and from the Cascade Mountains west to the Pacific Ocean. In the crucial area of watershed conservation, their efforts are informed by comprehensive reports prepared by the Aquatic and Riparian Effectiveness Monitoring Program (AREMP).

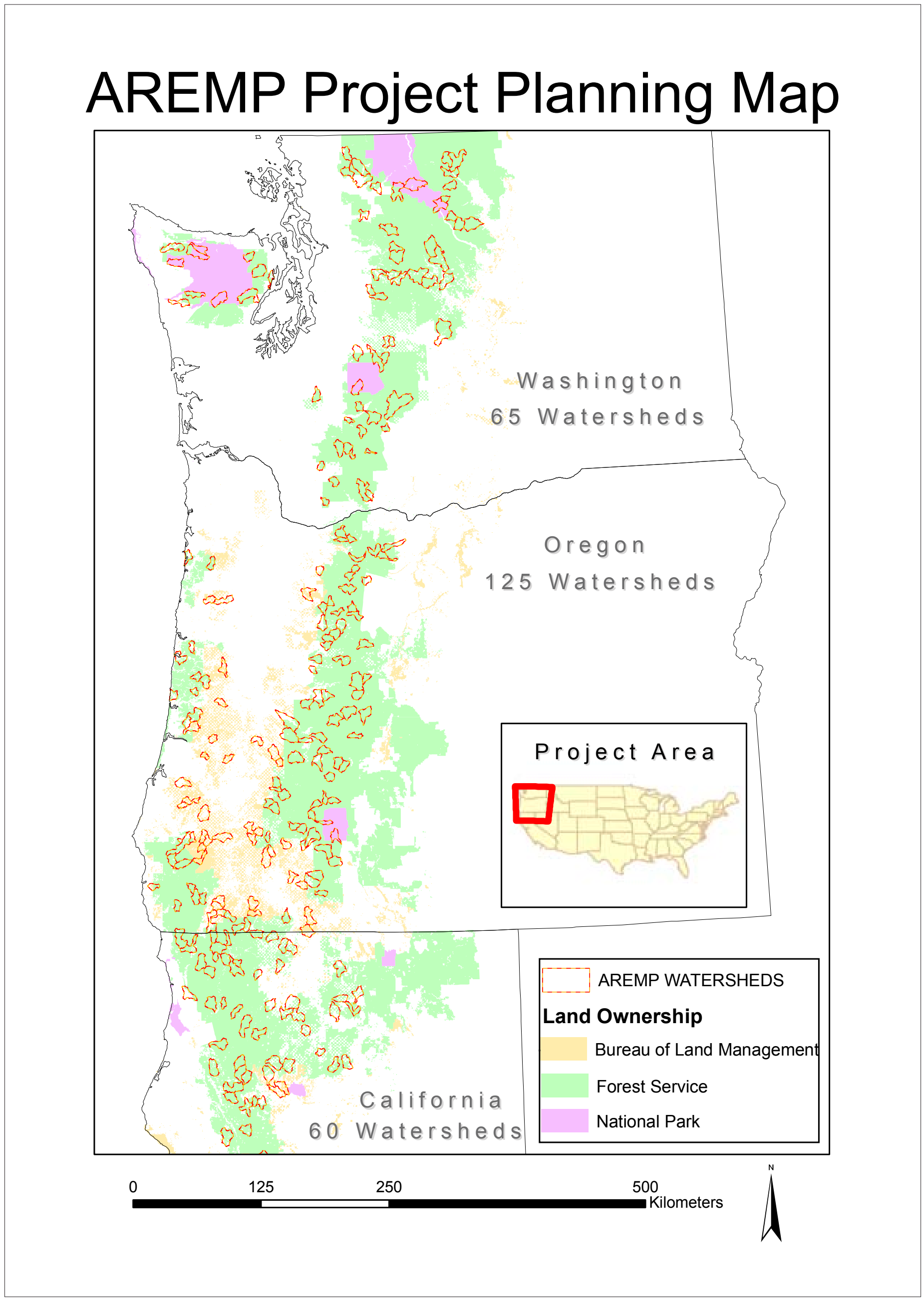
Each summer, adventurous AREMP field crews employed by the US Forest Service (USFS) and US Bureau of Land Management (BLM) set out to sample 28 watersheds, resulting in 250 watersheds sampled on a nine-year rotation. To determine monitoring site locations, the AREMP GIS team first identified watersheds with at least 25 percent of their stream channels lying within federal land. Of these watersheds, 250 were selected for stream sampling using a process that ensured a random, uniform distribution of watersheds throughout the Northwest Forest Plan area. Within each selected watershed, a similar process was used to select a random, uniform sample of stream survey sites. Because many other agencies and organizations also use this method to select study sites, AREMP findings contribute to richer overall knowledge about the sample areas and can help inform other environmental efforts.

AREMP crews measure a variety of attributes including the shapes and sizes of streams and rivers, the location and position of large woody debris in the stream channel, and biologic factors such as the types of aquatic insects and amphibians that are present. The result is an overall stream score for each watershed that reveals its health and enables comparisons with previous conditions.

The AREMP team's findings help inform a variety of National Forest Plan efforts. Near Roseburg, Oregon, for example, before riparian zones were protected, logging activity resulted in decreased amounts of woody debris, altering the streams and making them less hospitable to the salmon that once thrived there. Federal and state governments and local nonprofit organizations placed trees and boulders in riparian zones to help build up substrate levels to create better fish habitats. Upon returning to sites like the ones in Roseburg, field crews found that the restoration work did in fact result in increased stream condition scores.

The AREMP team members also help look for the presence of invasive species. When they come across aquatic invasive species

→ Every nine years, 250 sites are surveyed between Northern California and the Canadian border. The collected data is combined with other spatial datasets and remotely sensed imagery and analyzed in a GIS to better understand the conditions of northwestern watersheds.



during their stream surveys, the appropriate government organizations are informed so they can take immediate action before the problem worsens.

After visiting 4 to 10 sites within a watershed, the crew moves on to the next watershed. To get to remote sites in places like Olympic National Park in Washington, which has some of the highest watershed scores due to limited human activity, crews must hike 10 or more miles. In some cases, horses are used to help transport survey gear to rugged sites. Crews work from May through September, with a few special monitoring projects extending into October.

A key piece of the field data collection that lays the groundwork for the surveys involves measuring river or stream morphology. This creates a map of the channel based on the width, depth, and path of the water and how it changes over time. To take accurate measurements, two crew members work together using a laser with an electronic compass and prism setup from Laser Technology, Inc., called the MapStar Impulse System, which is waterproof and can be mounted for extra stability on rough terrain. Measurements are immediately displayed on a backlit LCD display to ensure accurate readings in shady environments like riparian zones.

A built-in serial port brings the compass and laser data directly into surveying software running on Esri's ArcPad platform on rugged handheld devices. Customized data input forms specific to AREMP's work automatically appear when a laser measurement is taken, and the devices also record the location via a GPS sensor. These measurements are used to create a map using a toolbar extension for ArcPad called LaserGIS, providing context for each study site. Other crew members measure shade levels; sample for amphibians, invasive species, and small invertebrates like insects, snails, worms, and crayfish; and collect additional data. This data is input through custom ArcPad applets and forms and automatically related to the site map.

"Integrating the laser with everything else creates streamlined workflows," says AREMP data manager Mark Isley. "Sometimes we'll be measuring channel widths that are a meter or meter and a half wide with a depth of 10 to 15 centimeters, so highly accurate laser offsets are important to us."

Along with the data collected in the field, the GIS team brings in additional datasets, including vegetation from remotely sensed imagery and GIS road layers from the BLM and Forest Service. This data enables it to analyze key riparian factors across full watersheds, such as miles of road within riparian areas and the frequency of roads crossing streams. All this information together results in a comprehensive picture of the health of northwestern watersheds.

The AREMP team's hard work has not gone unnoticed. It has received a Riparian Challenge Award from the Western Division of the American Fisheries Society and a National Interagency Service First Award for its collaborative, multiagency monitoring program that supports the success of the Northwest Forest Plan.

Flood Map Service Makes Data Flow

By Stefan Fuest, Fernando Salas, David Maidment, Daniel Siegel, Steve Kopp, and Matt Ables

"See spatial and temporal flood data within a common geographic interface."

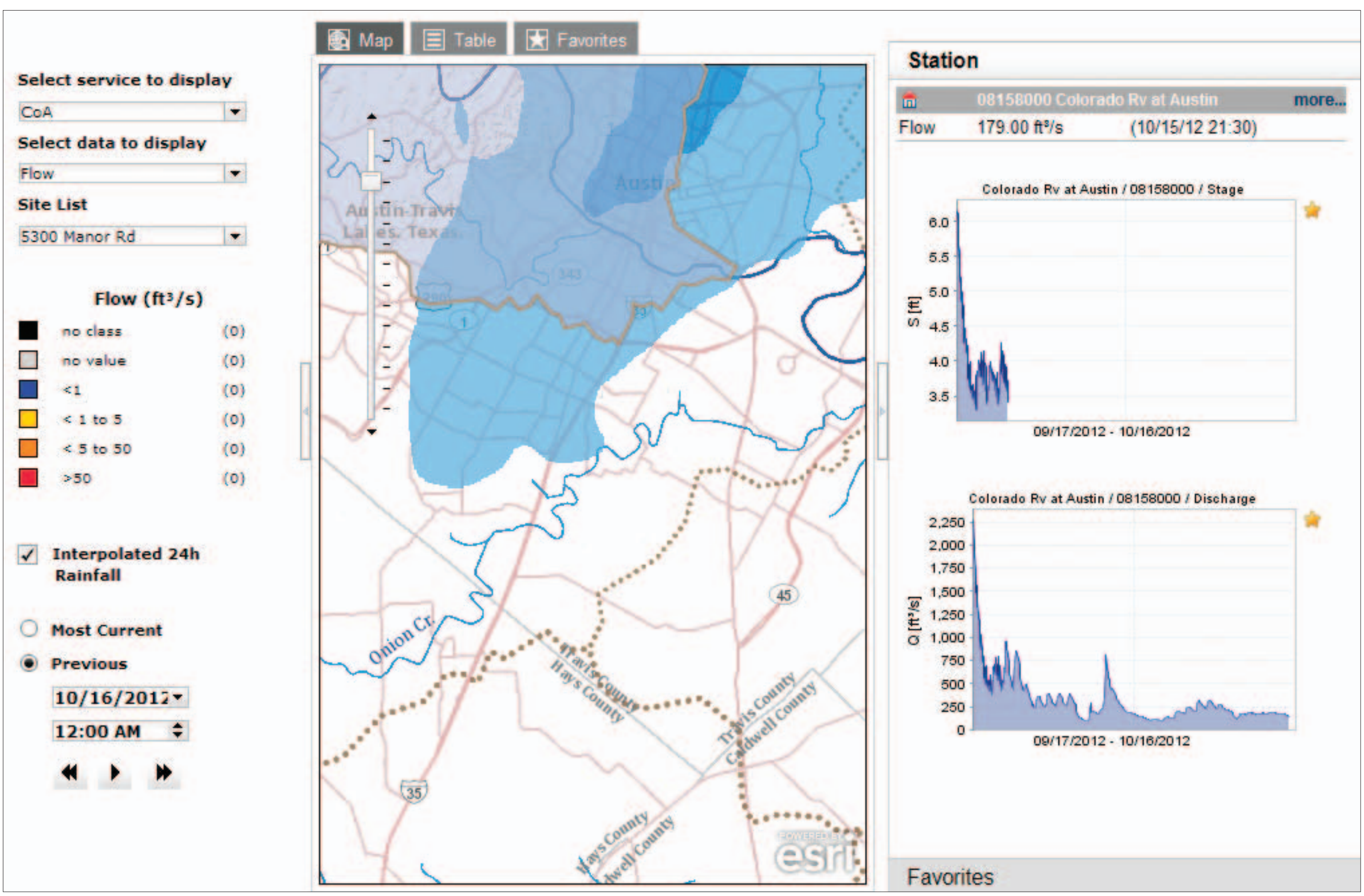
When floods occur in central Texas, precipitation, streamflow, and floodwater elevation data is captured by the US Geological Survey's (USGS) National Water Information System, the City of Austin's Flood Early Warning System, and the Lower Colorado River Authority's Hydromet system.

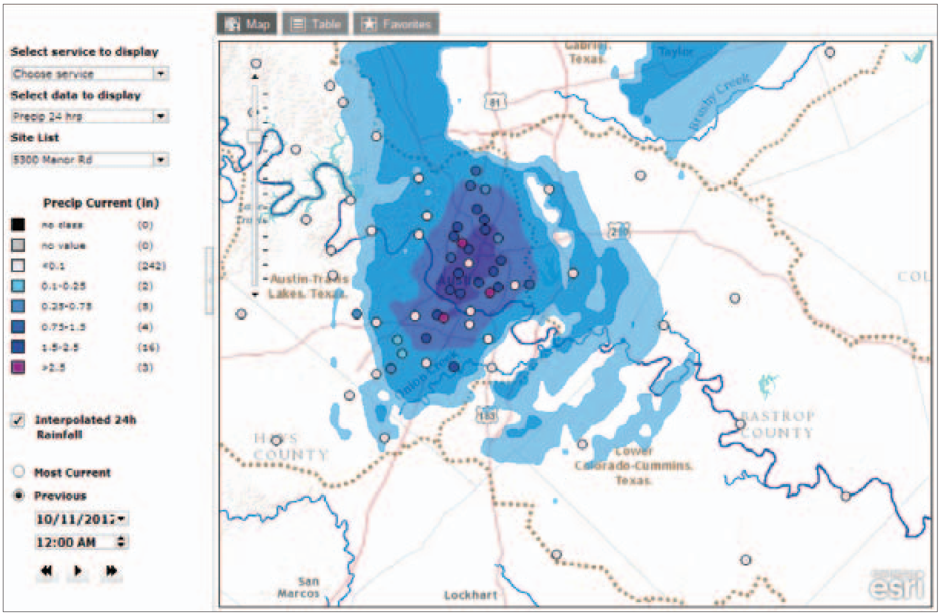
The problem is that all these vital water datasets and maps are stored in disparate systems and disseminated via individual websites and data streams without a common interface to synthesize information; each system has its own web page where data is accessible one gauge at a time.

The solution for this problem is the Central Texas HUB, an information system developed by the Center for Research in Water Resources (CRWR) of the University of Texas, Austin; KISTERS; and Esri. The system continuously ingests water observation data from various data providers into a central database maintained by CRWR. Water Information KISTERS, primary engine for the database, stores this data, performs calculations, and outputs value-added information products on the fly, such as three-hour moving precipitation totals.

The HUB provides users with near real-time water data and historical statistics, such as mean, maximum, and minimum values, which provide context and a basis for comparison at each individual observation point. Users can see data over time for a period of a week, a month, or a year. The HUB also thematically maps all the data within the system by organizing streamflow, precipitation, and water level data on individual GIS layers. Moreover, users can choose to combine or separate data

↓ Water discharge data is shown as a table, a chart, and a map.





↑ Precipitation values are shown by region and station for the geospatial analysis of flood conditions.

by specifying an individual data provider or theme.

CRWR uses Esri's ArcGIS Online World Hydro basemap as the foundation for displaying hydrologic features and drainage areas for each streamflow and water level observation point. Users can generate watersheds and interpolated precipitation maps using geoprocessing services on the Central Texas HUB's ArcGIS for Server. By performing this function, the user can quantify the amount of precipitation that falls over a given watershed and the streamflow and water level that result from that event.

CRWR also uses WaterML, a special language designed to communicate water data through the Internet and disseminate information via water web services. All the data within the Central Texas HUB is available through a suite of proven industry and open standard web services and encodings such as the Open Geospatial Consortium, Inc. (OGC), web services; Esri ArcGIS Online; KISTERS time series services; JSON; and WaterML. These services are all made available through the KISTERS Web Interoperability Solution (KiWIS). Because data within the HUB is accessible via web services, users can build customized map applications that fit their needs more closely.

Water data within the HUB is accessible by means of a web browser or a water web services interface. Using ArcGIS API for JavaScript, the Central Texas HUB designers created browser-based mapping applications to efficiently communicate information on the web pages.

Through a common geographic interface, the HUB seamlessly integrates multiple web services so that users can see flood data within spatial and temporal contexts. For instance, users can visualize the location and time of an observation and the watershed in which that particular observation occurred.

The Central Texas HUB designers are continually enhancing the system's capability. Currently, they are building an application that links water observation data with models that simulate and forecast water movement through a river network.

Access the Central Texas HUB at centraltexashub.org/wiskiweb.htm.

For more information, visit centraltexashub.org or contact Fernando Salas at fernando.r.salas@utexas.edu.

Learn about ArcGIS Online at arcgis.com.

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December 3–7, 2012
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fallmeeting.agu.org

Association of California Water Agencies (ACWA)
December 4–6, 2012
San Diego, California, USA
www.acwa.com

American Meteorological Society (AMS) Annual Meeting
January 6–10, 2013
Austin, Texas, USA
annual.ametsoc.org

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