2014-12-01

Latin American Data Drought: An Assessment of Available River Observation Data in Select Latin American Countries and Development of a Web-Based Application for a Hydrometerological Database System in Spanish

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Stephen Joseph Bolster

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

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December 2014

www.manaraa.com

ABSTRACT

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The demand and collection of hydrometeorological data is growing to support hydrologic and hydraulic analyses, and other studies. These data can amount to extensive information that requires sound data management to enable efficient storage, access, and use. While much of the globe is using technology to efficiently collect and store hydrometeorological data, other parts, such as developing countries, are unable to do so. This thesis presents an assessment of available river observations data in Latin American countries in Central America and the Caribbean. The assessment analyzes 1) access to available data, 2) spatial density of data, and 3) the temporal extents of data. This assessment determines that there are sections of the study area that constitute a drought of data or have limited data available.

Furthermore, the development of an internationalized HydroServer Lite, a lite-weight web-based application for database and data management, is undertaken. A pilot program of the translated system in Spanish is established with an agency in each of the following countries: Guatemala, Honduras, and Nicaragua. The internationalized version of HydroServer Lite promises to be a useful tool for these groups. While full implementation is currently underway, benefits include improved database management, access to data, and connectivity to global groups seeking to aid developing countries with hydrometeorological data.

ACKNOWLEDGEMENTS

For my wife Heidi and my family. I am grateful for their ever-loving support and smiles.

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1 INTRODUCTION

Collection of hydrometeorological data is necessary for hydrologic and hydraulic analyses, and is ever more important with increasing sophistication of models (Silberstein, 2006). These data are needed by agencies large and small across the globe. On the large scale, the United States Geological Survey (USGS) and the Environmental Protection Agency (EPA) together have over 350 million data points in 1.8 million stations across the United States (Beran and Piasecki, 2008). Smaller regional agencies that collect hydrometeorological data by automated sensors or even by hand can surpass millions of data points. This immense volume of data brings difficulties in maintaining it, including data storage, data organization, and data access. Agencies either manage data with in-house systems or pay for commercial software systems from third-parties. This problem leads agencies to devote thousands of dollars annually to maintain accessible and working data. Conversely, poor data management can spur other problems such as difficulty in locating data, costly preprocessing of data for use, inconsistent data, and/or inadequately documented data (Pokorny, 2006).

1.1 A Data Drought?

Is there a lack of available data in parts of the globe? In some developing countries, the lack of data management and thereby lack of available data prevents accurate studies from taking place. In Costa Rica, a study to determine groundwater vulnerability was greatly impeded because of the lack of data (Mende et al, 2006). This study to help protect groundwater resources yielded

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data with growing uncertainty because input variables needed to be estimated. Other studies in Africa required that variables be excluded from vulnerability assessments because input data could not be found (Alemaw et al, 2004). These examples are typical for many studies in developing countries where the lack of data and data management prevents or impedes studies. While developing countries struggle with data availability and management, the issue is not confined solely to those nations. A survey of New Zealand hydrologists found that reliable, accurate, and more plentiful data are necessary for complete studies, stating that a central location or national data repository could alleviate data contradictions and unreliability (Williams et al, 2008).

In general, lack of data impedes and reduces the accuracy of studies, but what effects does this have pertaining to river observations? River observations are any measurement taken on streams including stream stage or water level and/or streamflow or discharge. In regards to geographical extent, sufficient density of river observations is necessary to understand the "availability of surface water resources, their geographical distribution, and their variability in time." This information helps to determine the magnitude and frequency of floods and droughts (Guide to Hydrologic Practices, 2008). Temporal requirements for river observations include the extent of data, observation start and end date. A study on climatic changes in Canada by Burn (2002) determined that a minimum data extent of twenty-five years was necessary to ensure statistical validity of results. Similar extents are necessary when determining environment or human variations on rivers, such as dams and deforestation.

One solution to data unavailability is the encouragement of data publishing or data sharing. Data sharing can prevent the loss of data as occurs with any unpublished research (Heidorn, 2008). Similarly, the cost of saving and reusing shared published data is likely to be lower than recollecting the data again. In areas where multiple agencies may monitor data, such as the closely

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spaced countries of Europe or Central America, the exchange of hydrometeorological data can help the understanding and management of rare events such as flash floods (Viglione et al, 2010). The understanding of these localized events depends on a broader spatial context than one region alone to be fully analyzed, in which case data exchange is necessary (Borga et al., 2008). Data management inherently benefits from data sharing due to the processing required to publish data.

Data management occurs by one of three possibilities: in-house-setup, third-party proprietary software, or free and open source software. The choice between each of these data management systems is generally made by usability, operating costs, and organization needs. However, the three options can result in a variety of management systems, including data managed in paper files and cabinets, scattered files on computers and hard drives, to sophisticated servers that can remotely obtain real time situ data. To facilitate data sharing and publication some global organizations have provided standards in which data can be shared and read by any group requesting it.

1.2   GEOSS and the WMO

The Group on Earth Observations (GEO) coordinated efforts to create the Global Earth Observations Systems of Systems (GEOSS). This voluntary effort by ninety governments and seventy-seven organizations brings together data from each member and provides access to information and a connection of services for a global synergetic effort (GEO, 2005). The goals of GEOSS as explained by Butterfield, Pearlman, and Vickroy (2008) are:

1. achieve a comprehensive, coordinated, and sustained Earth observation system of systems;

2. assist developing countries in improving and sustaining their contributions;

3. achieve universal and effective utilization of observations, data and products, and the related technologies; and

4. full and open exchange of data with minimum time delay and minimum cost.

GEOSS fulfills these goals by bringing together global data systems into a comprehensive system of interoperable data systems spanning nine societal benefit areas including water, see Figure 1-1 (Christian, 2005). GEOSS is developing the GEO Discovery and Access Broker (DAB) to allow anyone to access the data connected to their system of systems. A major concern of GEOSS is enabling and connecting with developing countries; many of the same that are unable to efficiently manage their hydrometeorological data. Brigham Young University (BYU) is working in part with other American organizations to provide an infrastructure using HydroServer Lite that will enable non-English speaking organizations lacking advanced technical skill and funds to join GEOSS. These efforts fulfill each of the four stated goals of GEOSS and were part of the sixth GEOSS Architecture Implementation Pilot (API-6), which focused on benefits and usability for developing countries.

The World Meteorological Organization (WMO) has provided a framework for international cooperation for meteorology and hydrology. One of their many programs is the World Hydrological Cycle Observing System (WHYCOS, 2014). WHYCOS promotes the free exchange of hydrologic data. It follows a demand-driven approach by supporting eighteen regional-level and basin-level groups. The WMO is also a participating member of GEOSS.
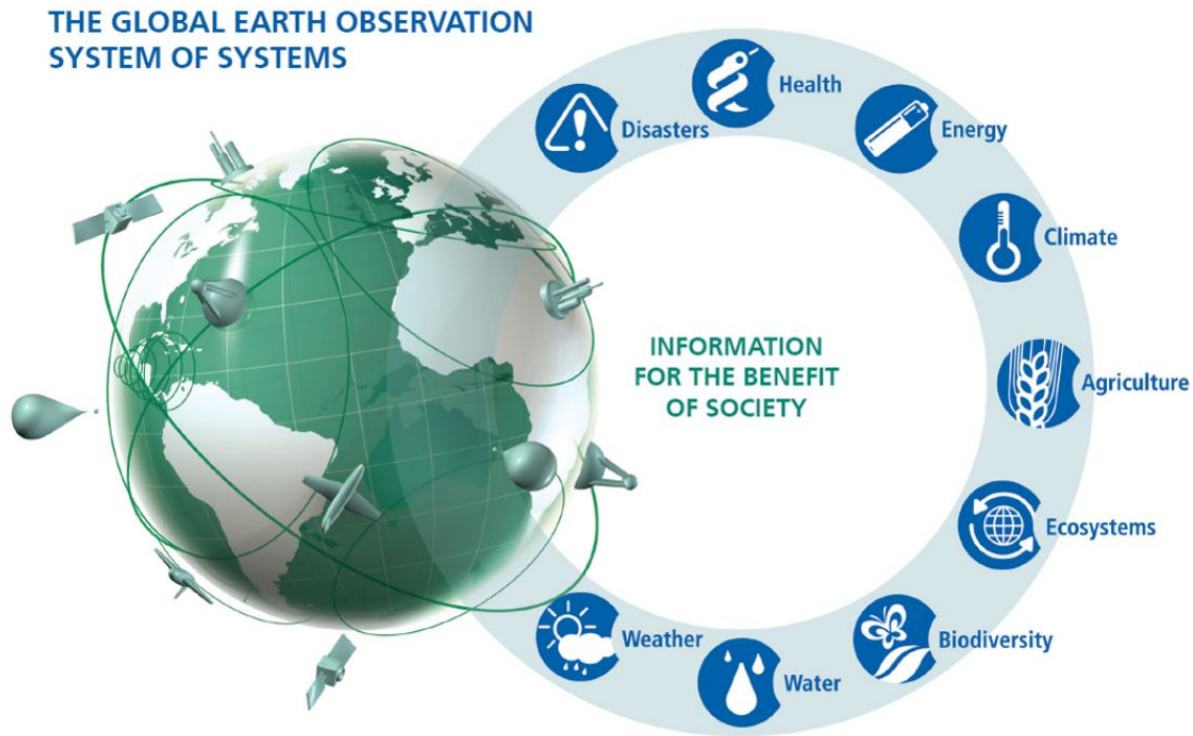
Figure 1-1: The Nine Societal Benefit Areas of GEOSS

1.3 Commercial Software Solutions for Water Data Sharing

While there are many companies that provide software for water data sharing, two third-party companies that produce widely used data management software systems are *Kisters* and *Aquatic Informatics*. Each produce a line of software tools that provide data management, automated data processing, system security, data processing tools, and more. Software is developed for versatile use and sold commercially. The USGS uses *Aquatic Informatics* software to efficiently manage water time series data nationally (aquaticinformatics.com). These commercial solutions for water data sharing include full technical support staff and regular updates for software improvements. They also require large monetary investments. Hydstra, WISKI, or

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AQUARIUS Servers can cost thousands of dollars per year per license (Kisters 2014, Aquatic Informatics 2014). Additional costs are needed to perform software training. In regards to Hydstra, *Kisters* states "Due to the comprehensive nature of Hydstra, it is essential that all users receive adequate training… it is important for an organization to make an ongoing commitment to training to cater for new staff and to keep up with the latest improvements to the system." These costs can be unsustainable for developing countries. For instance, one water resources management agency in Honduras used a version of Hydstra for many years; however, when they were unable to update to the newest version they in turn were unable to access the data stored and retrieved through this software. When water management agencies with low budgets, such as those in developing countries, use software that requires rigorous training and upkeep their ability to update it, manage it, and essentially use it is greatly impaired.

1.4   Free and Open Source Solutions for Water Data Sharing

The Consortium of Allied Universities for Hydrologic Science, Inc. (CUAHSI) is dedicated to the development of water science infrastructure and services in the United States. CUAHSI develops free and open source software. This model of software development provides significant benefits to all groups, including student, academics, consultants, agencies, and even software suppliers (Harvey and Han, 2002). The greatest benefits are provided in the form of harnessing new developments and rapid incorporation of changes in software or theory. The CUAHSI Hydrologic Information System (HIS) has developed many open source innovations to improve data management and access, including sharing (HydroServer), storing (the Observations Data Model [ODM]), cataloging (HydroCatalog), and discovery (HydroDesktop). The interconnectivity of these tools is shown in Figure 1-2.

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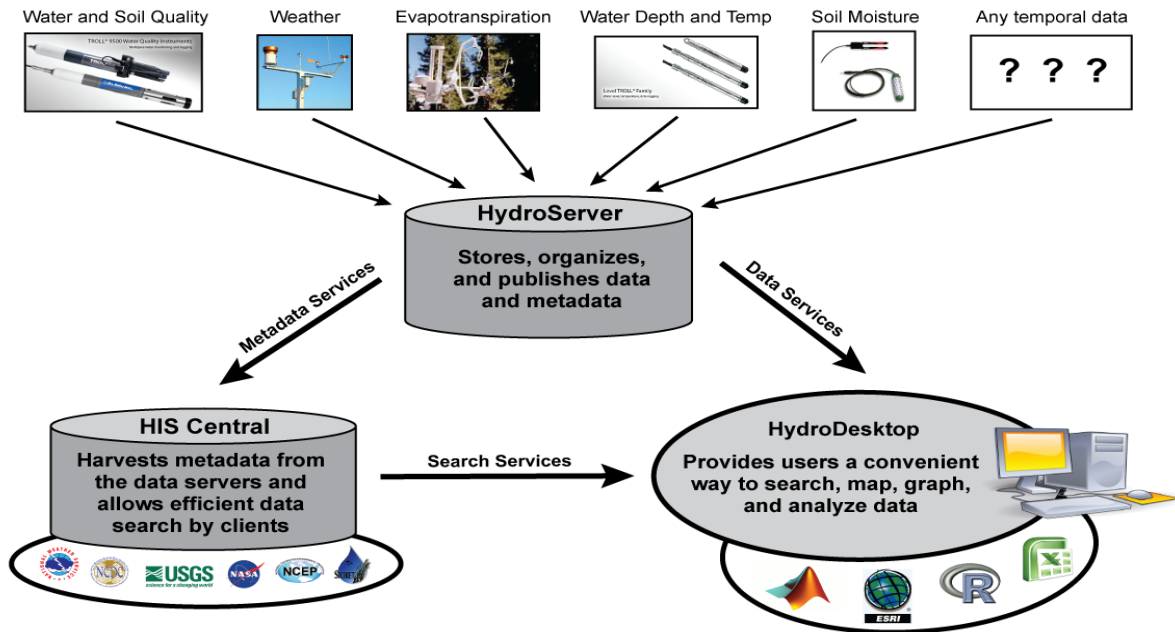
Figure 1-2: CUAHSI Data Triangle

HydroServer is any server that is connected to the internet that communicates through Service Orientated Application Protocol (SOAP) web services called WaterML and Water One Flow (Huang et al, 2011; Piasecki et al, 2010). These web services act as endpoints that permit the server's data to be read through other systems (Ames et al, 2009; Ames et al, 2012; Horsburgh et al, 2008). While the code of HydroServer is open source it requires the use of a Microsoft SQL Server database, a virtual private or dedicated server with the Windows Server operating system, and the Microsoft .NET framework. A HydroServer with enabled web mapping capabilities requires the additional Esri ArcGIS Server license. The ODM is an established database schema that collocates observational data with its metadata in one database (Horsburgh et al, 2008). The ODM was developed with community input from a range of water resource disciplines and is tailored to enable the documentation and annotation of data to allow for unambiguous presentation

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and interpretation. HydroCatalog, known as HIS Central, is a centralized catalog which compiles registered publically accessible HydroServers (Horsburgh et al, 2009). Registered HydroServers' web service endpoints are cataloged and exposed with web methods that allow searching for sites and time series across multiple servers. HydroDesktop is a geographical information system (GIS) that accesses HydroServer data through the catalog and permits discovery of all data with specified ontology parameters at HIS Central or from a specified Water One Flow Web Service (Ames et al 2009; Ames et al 2012). HydroDesktop provides the capabilities for data download, visualization, analysis, and manipulation. HydroDesktop, as is all of CUAHSI software and services, is free and open source. This permits the user-development of the software and allows the design of plugins such as additional map viewers, EPA watershed delineation, Hydro-R statistical analysis software, and more.

The utility of HydroServer and other resources from CUAHSI has moved beyond the United States and has been adopted by agencies in Italy (The Italian Institute for Environmental Protection and Research), New Zealand (The National Institute of Water and Atmospheric Research), and the Czech Republic (Kadlec, 2011). New Zealand has implemented a traditional HIS configuration, while Italy has deployed their HIS through a Linux based system. The Czech systems relies on the hydrodata.cz web server which harvests data from various government published sources. This daily data harvest then stores the data in a database on its server. The ability of these agencies to harness these developments from CUAHSI was dependent on the technical capabilities of their staff and the monetary funds necessary to purchase hardware and software to implement CUAHSI services. While the code and software for the CUAHSI HydroServer is free, it does require hardware and software that can total over $10,000, USD, which many small organizations across the globe cannot afford. These costs are incurred in obtaining

Microsoft SQL Server database, Windows Server operating system, the Microsoft .NET framework, and Esri ArcGIS Server license (hydroserver.codeplex.com, Microsoft.com, Esri.com). In addition to costs, once hardware is obtained, advanced information technology technical skills are required to setup and maintain this software and hardware. One setup of HydroServer took a person with little information technology experience two months of half-day work to install and configure (White, 2012). The monetary and technical capabilities required to implement HydroServer prevents organizations that lack these necessities from using HIS (Conner, 2013).

1.5 HydroServer Lite

In 2012, HydroServer Lite was developed by Idaho State University in conjunction with CUAHSI as a lite-weight system to maintain hydrologic data, catering to volunteer groups and research labs that typically use third-party web hosting services (Kadlec, 2010). HydroServer Lite is modified to operate on ASP.NET web hosting servers without the original HydroServer applications that must be run with full trust. It also uses the LAMP (Linux-Apache-MySQL-PHP) software stack, and as such is fully customizable to fit the specific needs of users (see source code at hydroserverlite.codeplex.com). HydroServer Lite employs the same data structure through the ODM, maintains the same global data standards of WaterML, and provides the same access through web services such as Water One Flow. This allows access to registered data through all CUAHI software. The required web server with a MySQL database to run HydroServer Lite is easily attainable through free or low-cost commercial webhosting services.

HydroServer Lite uses Hypertext Preprocessor (PHP) and SQL scripts to populate the necessary database tables during a simple installation sequence. Once setup and installed, HydroServer Lite employs a graphical user interface (GUI) to aid users in establishing metadata

and data values, including, a geographical display of site locations. This simplified system for hydrologic data management is all inclusive and provides an economical and minimal skill level solution to managing the ever growing amount of hydrologic data.

HydroServer Lite has proved beneficial to groups that wish to maintain data with standards based software. However, these benefits are currently limited to groups that understand and use English in a working environment, excluding many developing countries that require such a tool. Even if a non-English speaking group was able to use the current version of HydroServer Lite by translating specific words as needed, barriers to use would exist still. A study by Holmstrom (2006) on global software engineering found that "vocabulary itself is not the main problem but rather the interpretation of what is said". To most effectively use HydroServer Lite as a hydrologic data management tool in non-English speaking developing countries it would need to be translated into other languages along with similar instructional guides for its use. A version of HydroServer Lite for use in these developing countries would increase their ability to participate in global initiatives such as GEOSS, by mutually giving and receiving benefits from these global cooperatives.

1.6 Research Questions and Thesis Organization

This thesis undertakes two primary research questions. 1) In developing countries in Latin America a data drought exists for river observation data in terms of data availability, spatial density, and temporal extent. 2) The development of an internationalized HydroServer Lite translated to Spanish would be successful in improving data management and access.

The remainder of this thesis is organized as follows: Chapter Two includes an assessment of the river observation data drought in Latin America. Chapter Three includes the development of the internationalized HydroServer Lite, its translation to Spanish, and a pilot program with three

agencies in Central America. Chapter Four includes conclusions for the previous chapters and evaluates the research questions outlined herein.

2 A DATA DROUGHT IN LATIN AMERICA: DATA AVAILABILITY IN LATIN AMERICAN COUNTRIES IN THE CARIBBEAN AND CENTRAL AMERICA

2.1 Introduction

In developing countries, many studies' results demonstrate that there is a need for more data to complete full analyses. In 2006, Mende found that a lack of data impeded their results for a ground water assessment in Costa Rica. In 2004 Alemaw, determined that limited data for certain variables required that they be excluded from their assessment of ground water vulnerability to pollution. These studies in developing countries have found that limited data impeded their results.

While both of these studies determined that limited data affected studies involving groundwater, is there also a limit on available data for river observations? A study by Stehr et al (2008) in Chile was restricted to calibrating hydrologic models to four gauging stations for the 4,265 square kilometer Vergara basin. The researchers found that this was a low density relative to other basins in developed parts of the world, such as a similarly sized basin in Germany that has 46 gauging stations (Samaniego and Bárdissy, 2005).

Other studies determined that in Latin American countries many areas have sufficient meteorological data but insufficient hydrologic data. Therefore, to evaluate hydrologic parameters estimation is required by use of the meteorological data (Shiklomanov, 1993). This same study found that much of the data in developing countries, including those in Latin America, were unacceptable for use because their length of record was too short, five to ten years and/or the data was fragmented.

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These studies demonstrate that there are areas where only limited data is available; however, none provide a comprehensive assessment of the actual state of data limitations. Pringle et al. (2000) determined that in the developing tropical regions of Latin America, insufficient data is available to understand the biotic effects of manmade changes, such as dams and watershed development. However, these data are essential because as populations expand, regulation of the rivers will be necessary for flood control and water resources.

The WMO has presented guidelines for minimum station density. Having stations at this minimum density will help countries better manage water resources and observe the magnitude and frequency of floods and droughts. While this information is given in their handbook *Guide to Hydrologic Practices*, no assessments or reports are published on the extent that a country has met these standards. Similarly, no study has sought to determine the extent to which a data drought exists for developing countries, if at all.

This study seeks to determine the extent that a data drought, regarding river observations, exists in Latin American countries. The specific area of interest is Central America and the Caribbean. This region was selected because of the Spanish capability of the researcher and ties to regional hydrologic data managers. The area of interest includes: Belize, Cuba, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, and Puerto Rico.

2.2 Methodology

An extensive search of available river observations began with major catalogs that maintain government, academic research, and private data. Beginning a search through catalogs would obtain all available data that have free and unrestricted access. However, because many organization do not permit such access, the search for river observations also included contacting

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specific agencies that manage hydrometric data by phone and email. Personal acquaintances were also contacted by phone and email to obtain data.

2.2.1 Major Catalogs

The major catalogs used in the search for river observations included the DataONE, the Global River Discharge Centre (GRDC), and the CUAHSI HIS Central (SDSC, 2011). Each catalog was searched in the area of interest for datasets that contained the words: streamflow, stream discharge, stream gauge, and stream water level. Results from the searches were then reviewed individually to ensure that datasets were not duplicated and contained relevant information. For example, a search in HydroDesktop found 254 datasets in Puerto Rico while only 248 unique stations were found there. Ten datasets were found in Costa Rica; however, only two unique stations were found. Likewise, searching the DataONE catalog yielded eight datasets; however, four datasets were duplicates of those found from the GRDC, and the others found were not in the area of interest. **Table 2-1** summarizes the data available in the area of interest found through major catalogs.

2.2.2 Searching for Data from Government and Private Agencies

In many countries there is a key organization that manages hydrometeorological data. This private or government organization may collect data for the whole country or specific regions. Internet searches to find each organization took place by using keywords such as hidrología (hydrology), hidráulica (hydraulics), recursos hídricos (water resources), red hidrométrica (hydrometric network), and the country's name. Once organizations were found for that country the website was searched for any public information on river observations in the country. If the

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Table 2-1: Available Data Found through Major Catalogs

Country	CUAHSI Catalog (HydroDesktop)	GRDC Catalog	Unique to GRDC
Belize	0	0	0
Costa Rica	2	43	17
Cuba	0	10	10
Dominican Republic	0	5	0
El Salvador	0	5	2
Guatemala	0	7	3
Haiti	0	0	0
Honduras	0	5	3
Mexico	0	57	2
Nicaragua	0	16	14
Panama	0	15	0
Puerto Rico	248	24	0

necessary information was not found then a data request was sent to published contacts on the website that dealt with water resources, meteorology, and/or engineering. If no contact was made then phone calls were placed to the organization. Data for Puerto Rico, a United States territory, are maintained by the USGS in the National Water Information System (NWIS), and was thereby registered in the HIS Central Catalog. These data were accessed by both HydroDesktop and HydroExcel (Whiteaker, 2009); both were used to ensure a complete dataset.

2.2.3 Personal Contacts

If a personal contact was available for an organization in a country then they were sent data requests through email or phone calls. Many of these contacts were available through Fidel Perez, former director of the Department of Hydrology at the Instituto Nacional de Recursos Hidráulicos (National Institute of Water Resources) in the Dominican Republic, who is pursuing his doctorate degree at BYU. His personal contacts included people in the following countries: Cuba, Costa Rica, the Dominican Republic, El Salvador, and Haiti.

Other contacts have occurred through collaborative relationships between BYU, the Organization of American States (OAS), and agencies in the area of interest. Requests were made to obtain data from agencies in the Dominican Republic, Honduras, Guatemala, and Nicaragua.

While data for Mexico are available through their country's website, access to it was cumbersome and restrictive. The data stored in a Microsoft Access database had been previously converted to the CUAHSI framework by Gonzalo Espinoza (2012) at the University of Texas at Austin. Personal communication with Mr. Espinoza informed me of this dataset hosted at World Water Online (http://worldwateronline.org/).

2.2.4 Data Analysis

Stations that record river observations were compiled into excel tables that listed key attributes, including: station name, river name, X and Y locations or longitude and latitude, organization responsible for data, organization ID, method to obtain the data, start and end date of data record, station status of operation, and number of data points collected at each station. Excel files were used to create shapefiles for spatial visualization.

Station density for each country was analyzed based on the total number of stations, the number of active stations, the total square kilometers in the country, and river kilometers per station. River kilometers were determined by using the stream lines at fifteen arc-second resolution created by the USGS HydroSHEDS project (Lehner et al, 2008). The stream lines used a threshold of one hundred upstream cells for delineation.

Station density was compared to the WMO guidelines for recommended minimum densities of stations recording stream flow found in the *Guide to Hydrological Practices, Volume I, Hydrology – From Measurement to Hydrological Information* (2008). Station densities were also compared to the results found for Puerto Rico. Puerto Rico is used as a standard for

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comparison because its river observations are maintained by the USGS, while at the same time having similar tropical climate, physiographic regions, and socioeconomic conditions as the rest of the area of interest.

2.3   Results and Discussion

The availability of data will be discussed in terms of access to data, and temporal and spatial extent by which data covers each country. Figure 2-1 shows the location and operating status of each station for the entire area of interest.
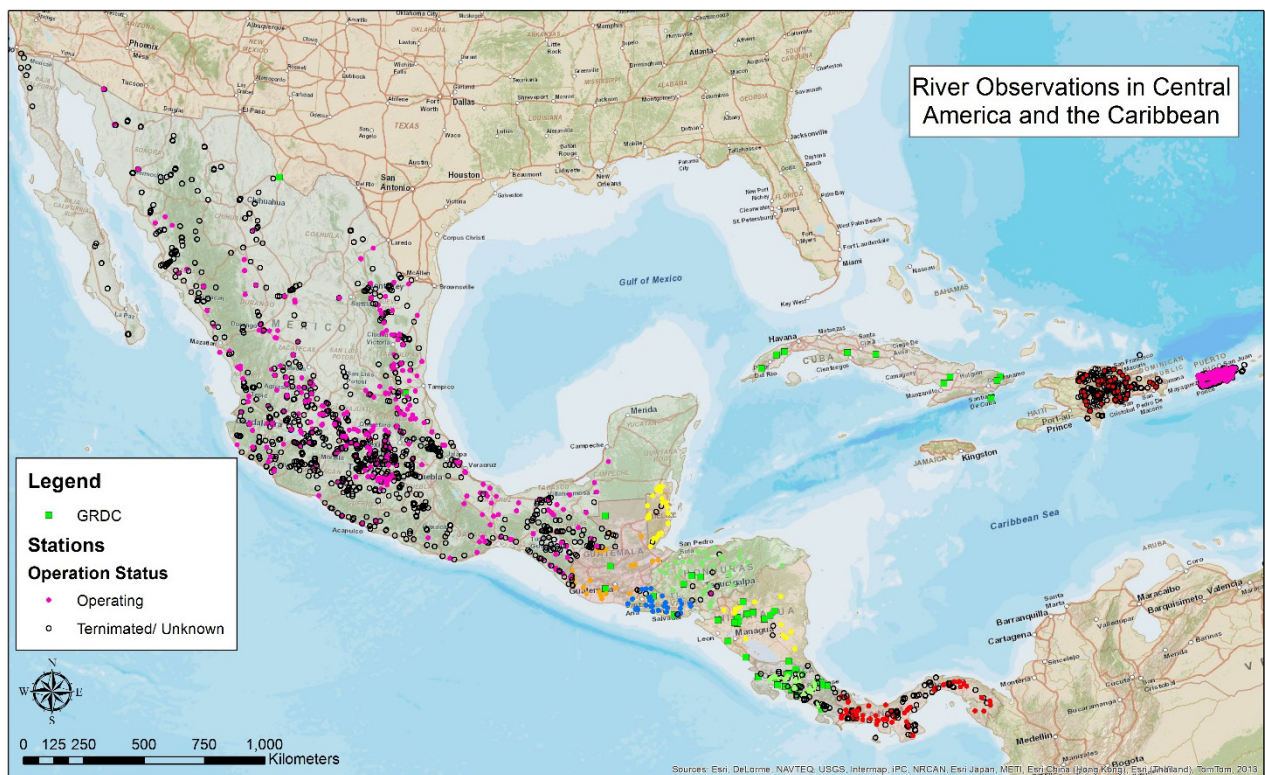

Figure 2-1: Locations of Stations Recording River Observations in Central America and the Caribbean

2.3.1 Access to Data Results

This search for available river observation data produced varying results for each country in the area of interest. Data from the GRDC are available in all the area of interest countries except Haiti and Belize. Duplicate stations by the GRDC dataset were not included in the final analysis nor are they accounted for in determining access to data for a country. The following paragraphs narrate the availability of data for each country.

2.3.1.1 Results for Belize

The webpage hydromet.gov.bz operated by the Belize National Meteorological Service was accessed to find data for Belize. The webpage includes a hydrology data request form, however, responses to inquiries from this form were never answered. Likewise, the page showing hydrology data statistics only provided data for one station and was unable to change to other stations. Contacting the Chief Meteorologist by email garnered a response, which culminated in obtaining PDFs of the data. Data are available by request at no charge. Figure 2-2 shows the locations of all stations recording river observations.
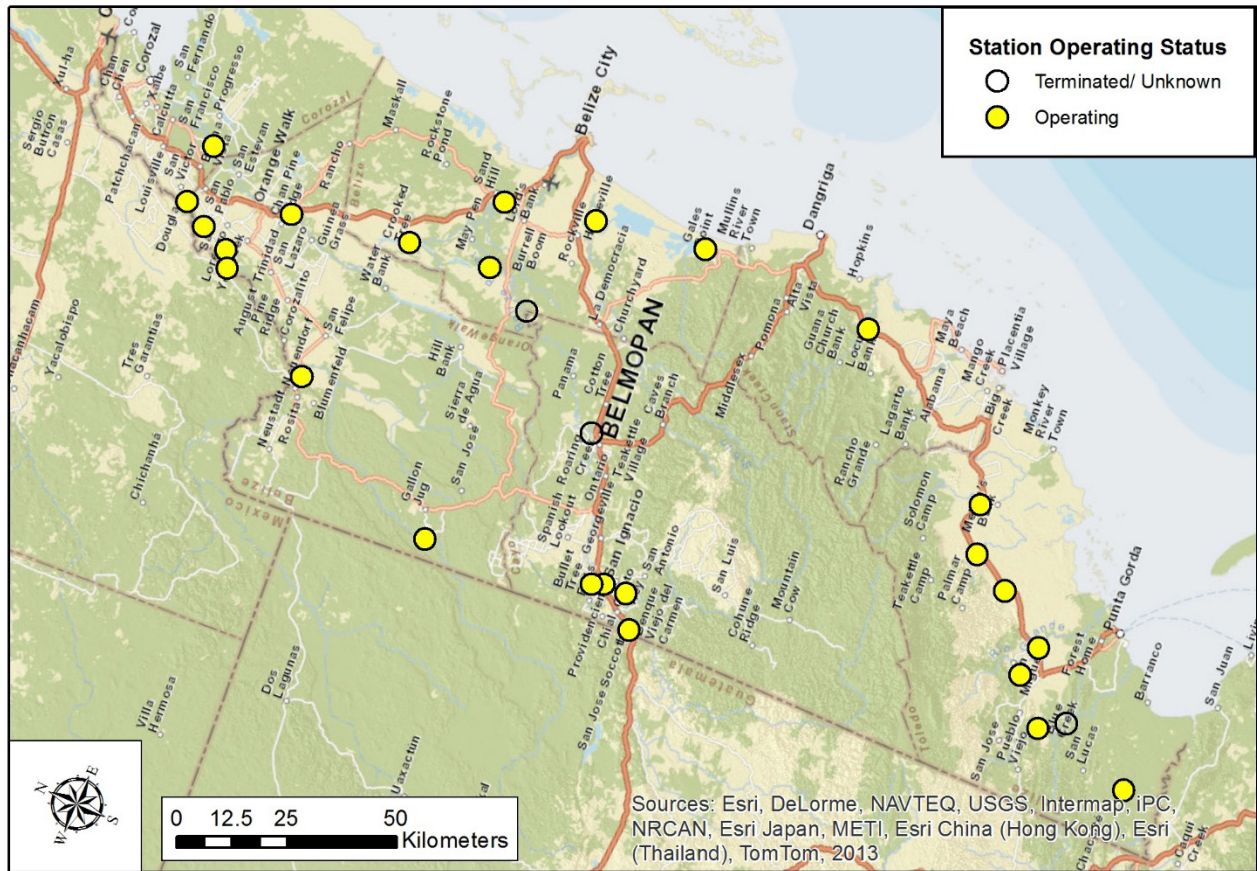
Figure 2-2: Station Locations and Operating Status in Belize

2.3.1.2   Results for Costa Rica

No website was found that contained direct access to hydrologic data; however, personal contacts provided the email of the Director of C. S. Estudios Básicos de Ingeniería (Basic Engineering Studies) within the Instituto Costarricense de Electricidad (Costa Rican Institute of Electricity) a state-owned holding company that controls assets in electric energy generation, transmission, and distribution. Data were transmitted through email by the Hydrology Area Coordinator. Data are available by request, but it is unknown if full datasets require a fee. Data

were also found through HydroDesktop for two stations. Figure 2-3 shows the locations of all stations recording river observations.
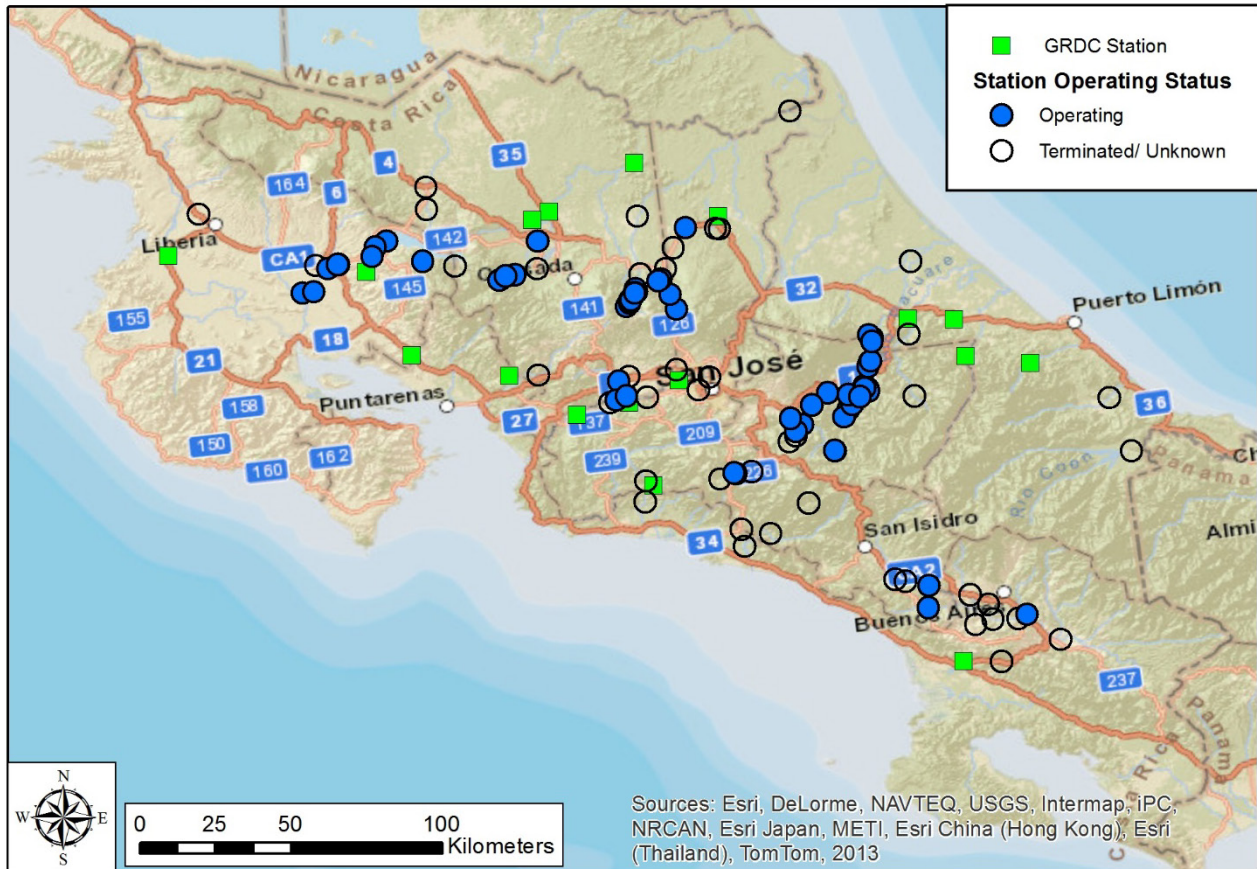
Figure 2-3: Station Locations and Operating Status in Costa Rica

2.3.1.3   Results for Cuba

The website for the Instituto Nacional de Recursos Hidráulicos (National Institute of Hydraulic Resources) www.hidro.cu has no information about a river observation monitoring network. Emails to website contacts and to personal contacts received no responses. No specific data were obtained for Cuba. Figure 2-4 shows the locations of GRDC stations.

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Figure 2-4: Station Locations in Cuba

2.3.1.4 Results for the Dominican Republic

BYU has a collaborative agreement with the Instituto Nacional de Recursos Hidráulicos (INDRHI). This relationship allowed for data requests to be sent directly to the agency. Data are available from both the INDRHI website indrhi.gob.do/ and an installation of HydroServer hosted at BYU, byuhydro.byu.edu/. Data are in various formats and are free. Figure 2-5 shows the locations of all stations recording river observations.
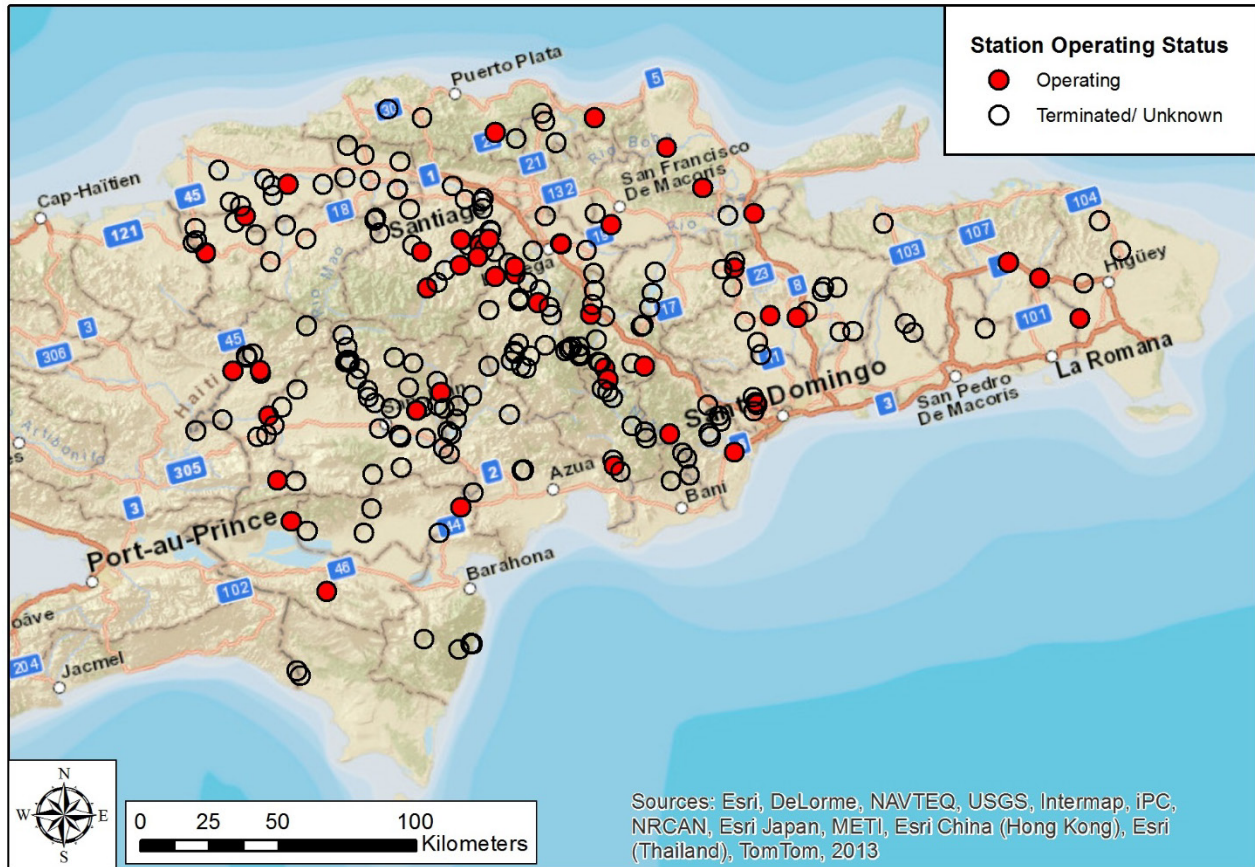
Figure 2-5: Station Locations and Operating Status in the Dominican Republic

2.3.1.5 Results for El Salvador

Links are available to obtain data for El Salvador on the website for the Ministerio de Medio Ambiente y Recursos Naturales (Ministry of Environment and Natural Resources). However, the links to access historical time series data do not work, snet.gob.sv/ver/hidrologia/archivo+historico/series+historicas/. Personal contacts by email to the agency yielded Excel files containing station information. Data are available by request in Excel format, no fee required. Figure 2-6 shows the locations of all stations recording river observations.

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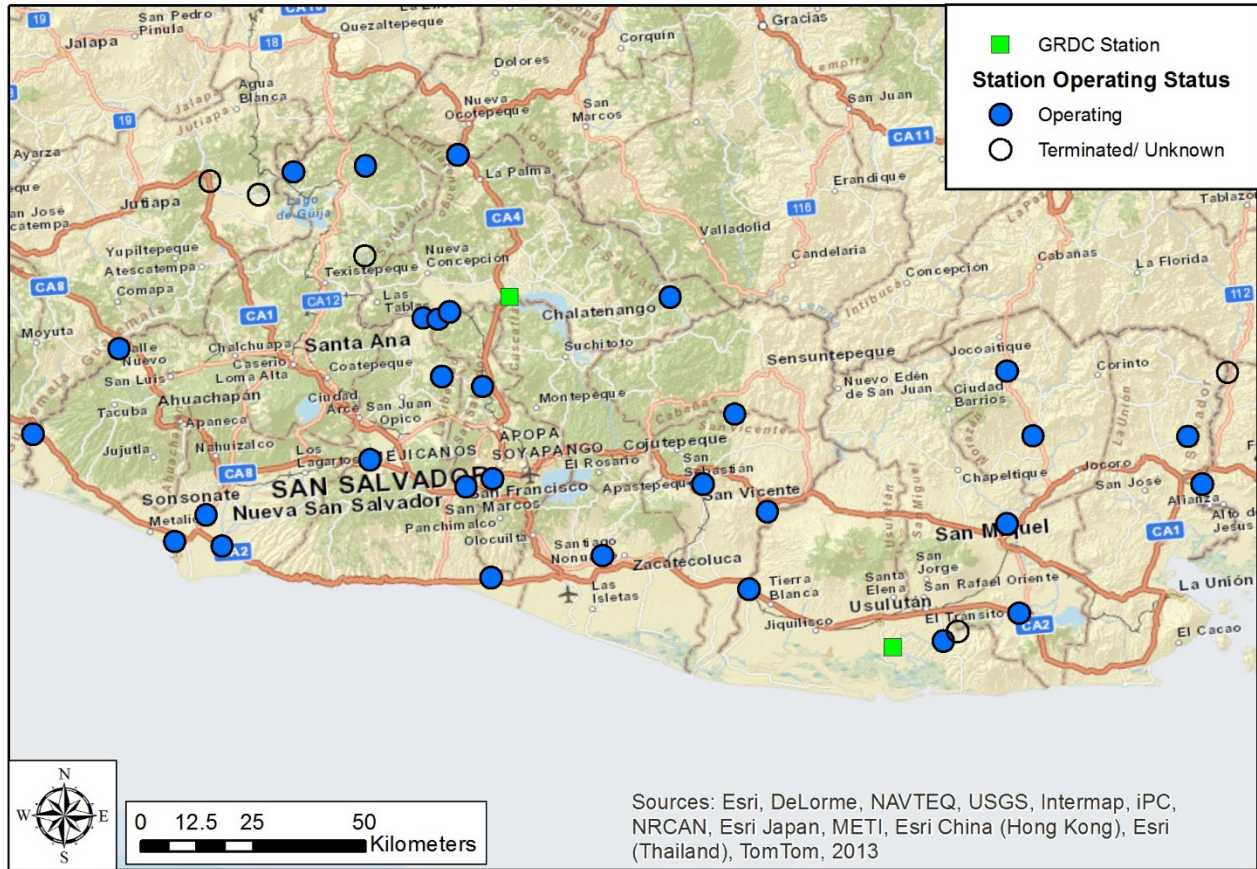
Figure 2-6: Station Locations and Operating Status in El Salvador

2.3.1.6 Results for Guatemala

The website for the Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología (INSIVUMEH) (National Institute for Seismology, Volcanology, Meteorology, and Hydrology) insivumeh.gob.gt, contains maps and station names for active stations. No datasets are available on the web nor did calling the organization result in further information. A second way to access limited data is through the National Oceanic and Atmospheric Administration (NOAA) at amazon.nws.noaa.gov/hads/charts/GT.html. Data from INSIVUMEH are available as maps and

from NOAA in tabular format; data from Guatemala is free of charge. Figure 2-7 shows the locations of all stations recording river observations.

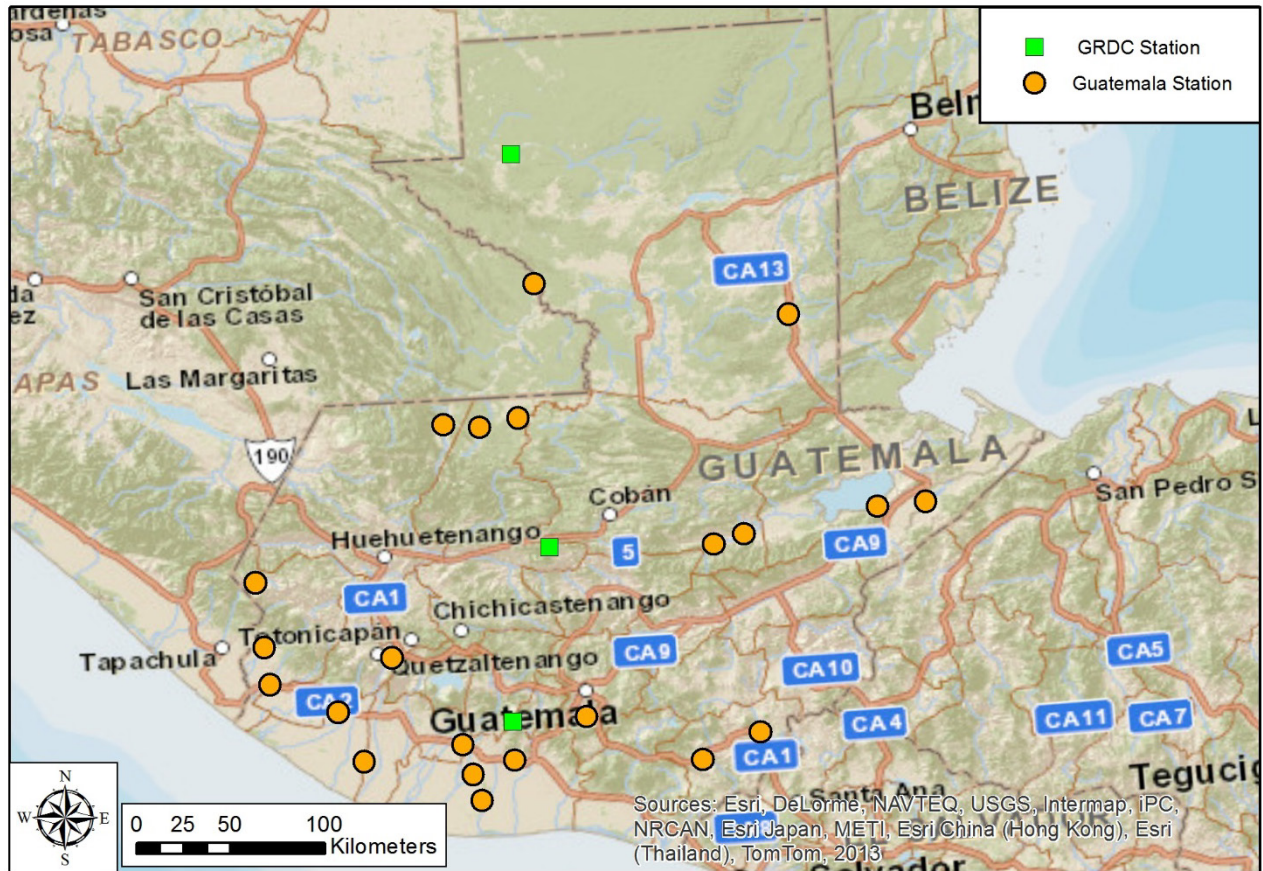**Figure 2-7: Locations of Operating Stations in Guatemala**

2.3.1.7   Results for Haiti

No website was found where hydrologic data could be obtained for Haiti. Personal contacts provided a phone and email for an engineer who works in water resources in Haiti, but after multiple requests for information none was received. Anecdotal information stated that the country

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has twenty-three stations that collect river observations, however, this information was never confirmed with any data. No specific data were obtained for Haiti.

2.3.1.8 Results for Honduras

While no information was available through the Secretaría de Energía, Recursos Naturales, Ambiente y Minas (Secretary of Energy, Natural Resources, Environment, and Mining) of Honduras, a collaborative agreement with BYU and an agency in Honduras known as the Comisión Contra Inundaciones en Valle de Sula (CCIV), which translates to the commission against flooding in the Sula Valley, provided access to river observation data. Limited amounts of data are also available at http://amazon.nws.noaa.gov/hads/charts/HN.html. Data are available in various formats at no charge. Figure 2-8 shows the locations of all stations recording river observations.

2.3.1.9 Results for Mexico

Access to data are available through the website of the Comisión Nacional del Agua (National Commission of Water) Banco Nacional de Datos de Aguas Superficiales (National Surface Water Data Bank) at conagua.gob.mx/CONAGUA07/Contenido/Documentos/ Portada%20BANDAS.htm. Access to files through the website is in Microsoft Access format. These data have been converted into the CUAHSI framework and are available at centraltexashub.org/kiwis.htm, and for this study were accessed through HydroExcel using Water One Flow web services. Data for Mexico are available in various data formats at no charge. Figure 2-9 shows the locations of all stations recording river observations.
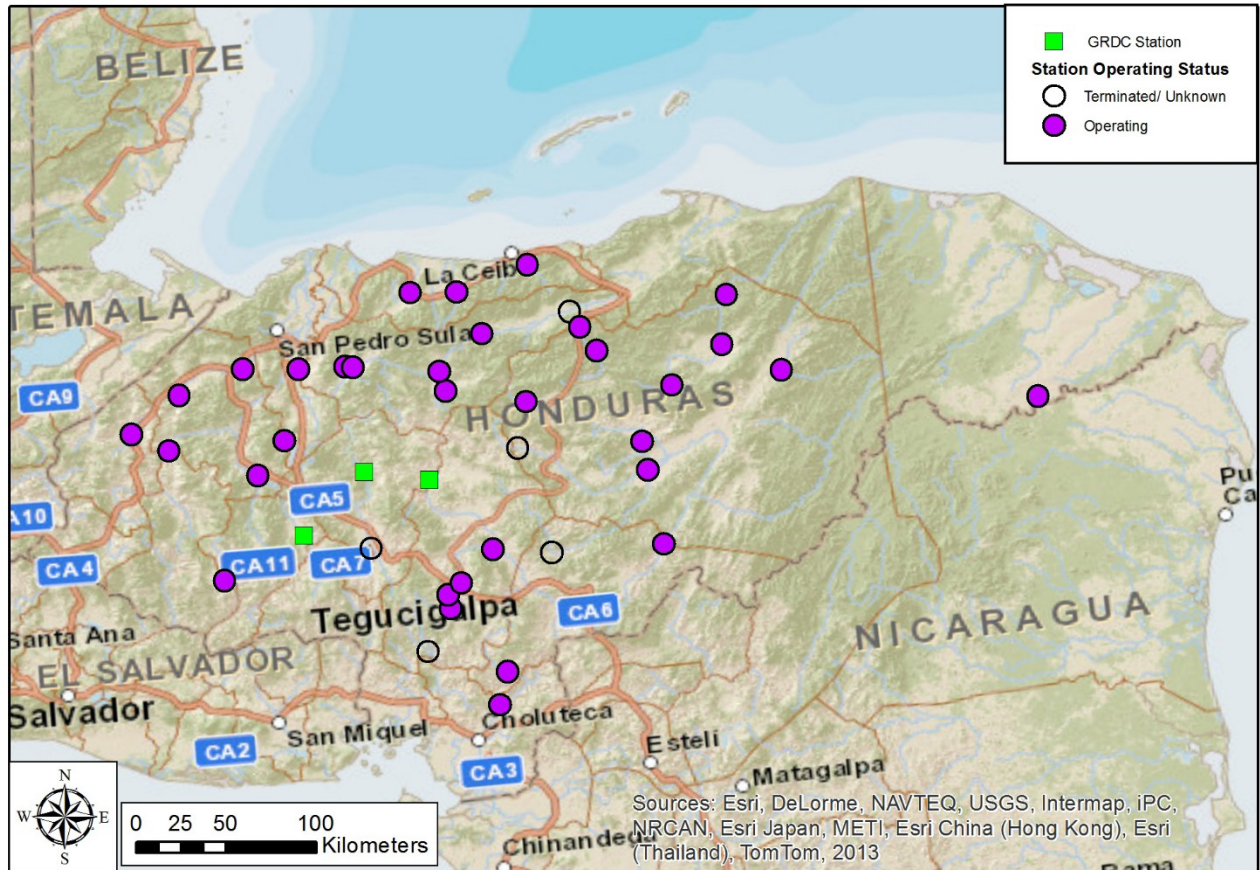
Figure 2-8: Station Locations and Operating Status in Honduras
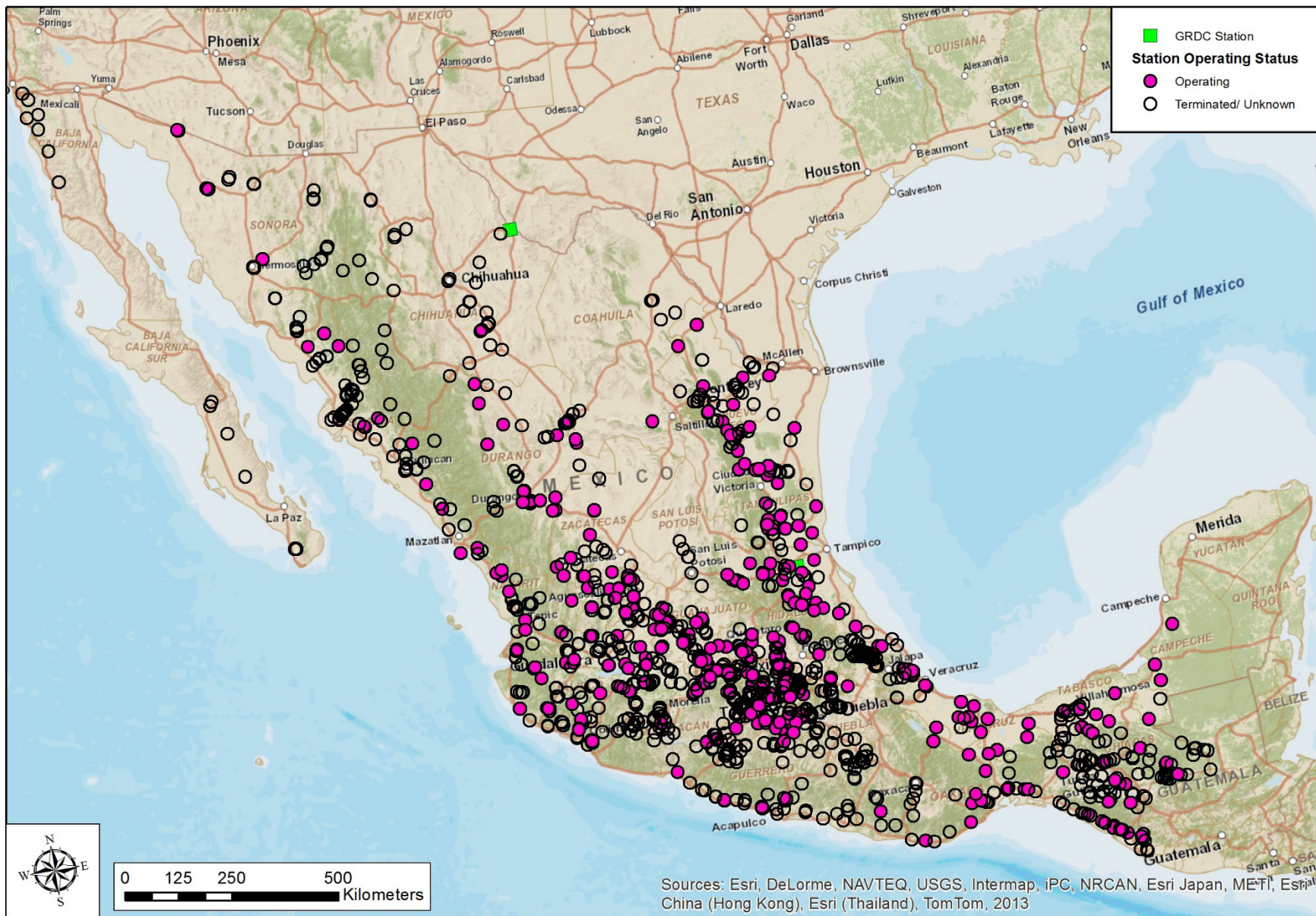
Figure 2-9: Station Locations and Operating Status in Mexico

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2.3.1.10 Results for Nicaragua

The Instituto Nicaragüense de Estudios Territoriales (INETER), translated to the Nicaraguan Institute for Terrestrial Studies, provides limited access to data on its website www.ineter.gob.ni/. This site restricts data retrieval to the past seven days. While BYU has a collaborative agreement with this agency, few data have been obtained. Some additional data were provided from this group by email. Data for Nicaragua in various digital formats are available upon request for a fee. Figure 2-10 shows the locations of all stations recording river observations.

Figure 2-10: Station Locations and Operating Status in Nicaragua

2.3.1.11 Results for Panama

Hydrologic data are managed by the Empresa de Transmisión Eléctrica S. A. (Company of Electricity Transmission). Their website, hidromet.com.pa/hidro_historicos.php, provides monthly summaries for each station. Contacting the organization through their general email provided access to full datasets. Data are available in various digital formats without a fee for academic work. Figure 2-11 shows the locations of all stations recording river observations.

Figure 2-11: Station Locations and Operating Status in Panama

2.3.1.12 Results for Puerto Rico

All data were obtained through HydroExcel from the NWIS. Data are available in various digital formats without a fee. Figure 2-12 shows the locations of all stations recording river observations. Table 2-2 provides a summary of data access for each country.
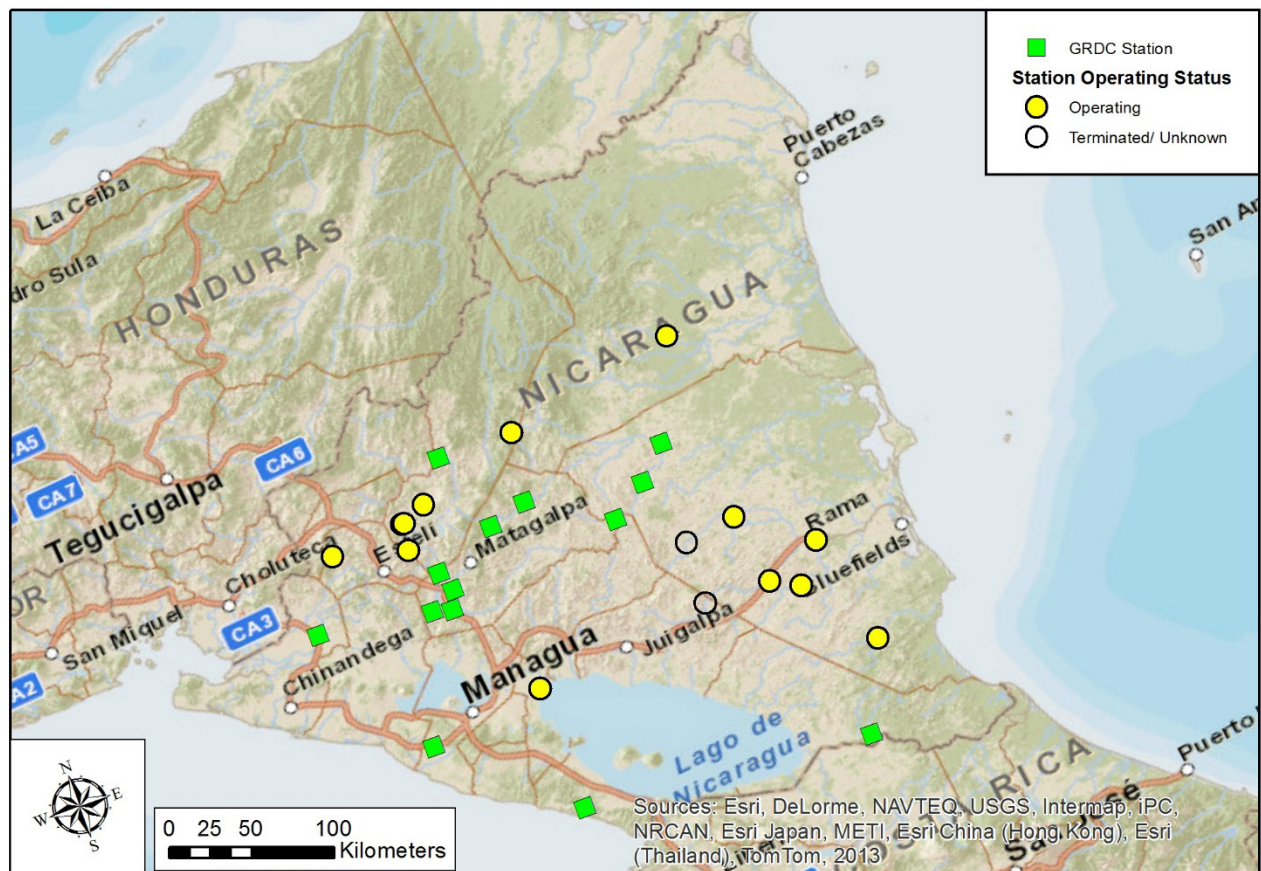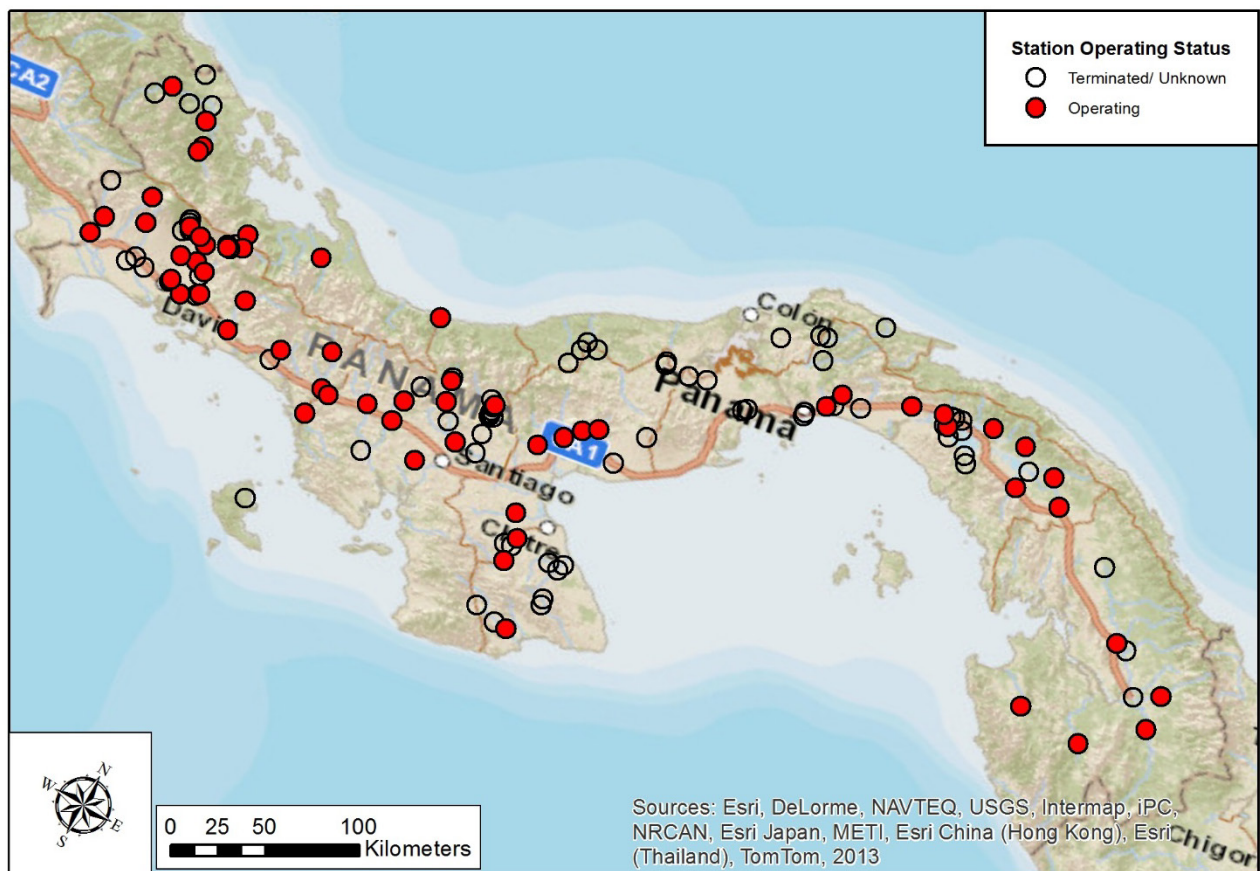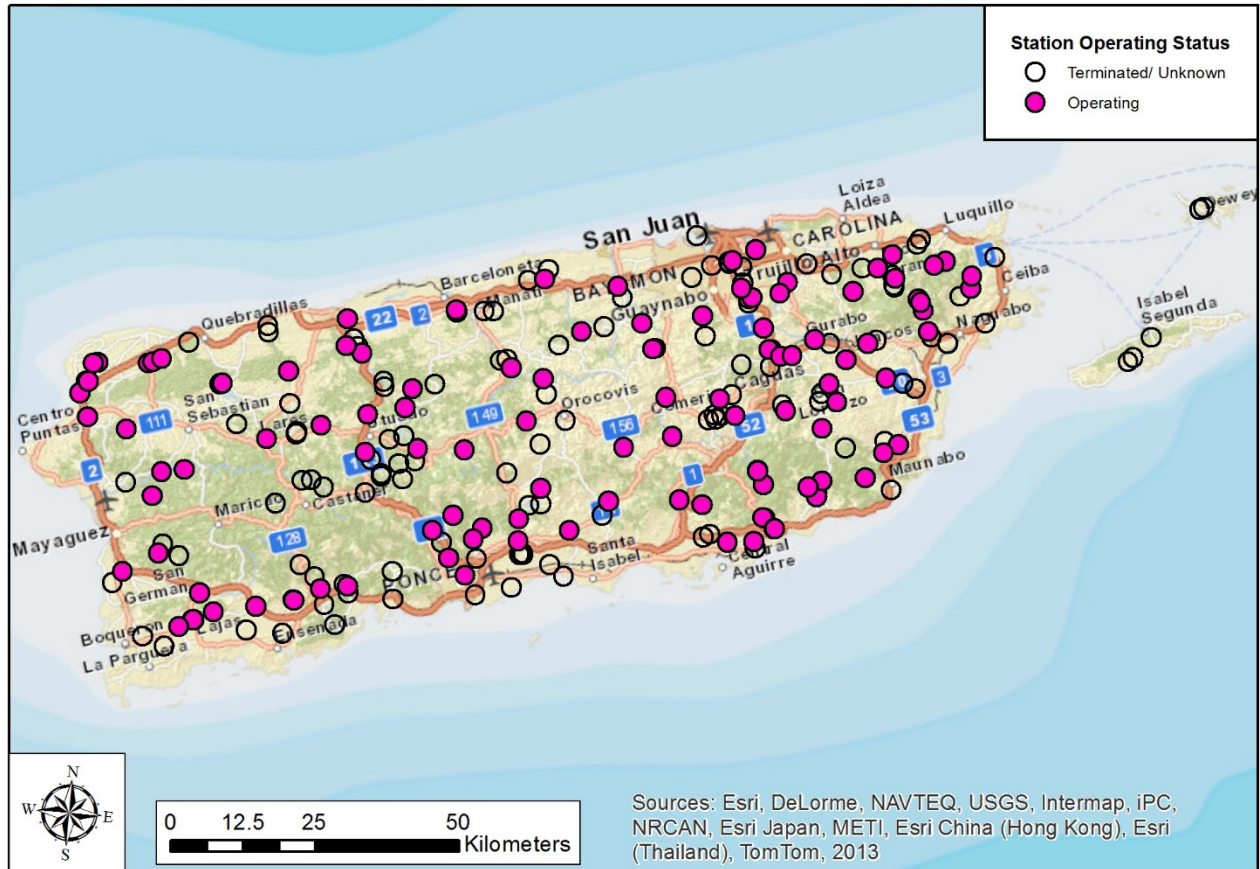

Figure 2-12: Station Locations and Operating Status in Puerto Rico

Table 2-2: Summary of Data Access for Each Country in Area of Interest

Country	Total Stations	Active Stations	Access Type	Access Means	Data Format	Charge	Access
Belize	50	26	Website	http://hydromet.gov.bz/hydrology-unit	PDF	None	Upon Request
			Website Email	rlopez@hydromet.gov.bz			
Costa Rica	121	56	Personal Email	JGranados@ice.go.cr	PDF	Unknown	Upon Request
				JZunigaM@ice.go.cr			
Cuba	9	0	N/A	N/A	N/A	N/A	Unavailable
Dominican Republic	241	44	Personal Email	Available Upon Request	Various Digital	None	Upon Request
			Website	byuhydro.byu.edu/			
El Salvador	37	30	Website	snet.gob.sv/ver/hidrologia/archivo+historico/series+historicas/	Excel	None	Upon Request
			Personal Email	mmartinez@marn.gob.sv			
Guatemala	25	22	Website	http://www.insivumeh.gob.gt:8080/redhidromet/frmMapa1.aspx#	Various Digital	None	Open
			Website	amazon.nws.noaa.gov/hads/charts/GT.html			
Haiti*	23	23	N/A	N/A	N/A	N/A	Unavailable
Honduras	41	33	Personal Email	Available Upon Request	Various Digital	None	Upon Request
			Website	http://amazon.nws.noaa.gov/hads/charts/HN.html			Open
Mexico	1549	371	Website	ftp://ftp.conagua.gob.mx/Bandas/Bases_Datos_Bandas	Various Digital	None	Open
			Website	http://crwr-wisk03.crwr.utexas.edu/cuahsiws/wsdl/WaterOneFlow.wsdl			
Nicaragua	29	13	Website	http://www.ineter.gob.ni/	Various Digital	Fee	Restricted
			Personal Email	Available Upon Request			
Panama	156	61	Website	http://www.hidromet.com.pa/hidro_historicos.php	Various Digital	None for Academic Use	Upon Request
			Website Email	hidromet@etesa.com.pa			
Puerto Rico	248	112	Website	http://waterdata.usgs.gov/nwis	Various Digital	None	Open
			CUAHSI Catalog	http://river.sdsc.edu/wateroneflow/NWIS/DailyValues.asmx?WSDL			

*Station information for Haiti is anecdotal and could not be confirmed

2.3.2   Access to Data Analysis

Of the twelve countries studied only two have open access to river observation data. While supplemental data can be found through the GRDC, this dataset represents only seven percent of the stations found through this study. Of the remaining ten countries, three have restricted or unavailable access to data. Comparing open access to restricted access datasets, the former has greater data organization and better data extents. These datasets benefit from using global data standards such as those found through the CUAHSI framework. Similarly, data access with open datasets is nearly instantaneous, while obtaining this same type of data from other organizations requires contacting various people to obtain the data over the course of days or weeks. It can be inferred that to some degree a similar lag in obtaining data is experienced by users within the organization that maintains the data. Eight countries have websites and provide access to the data or provide contact information from which data can be obtained. The remaining four countries either have no access to data or require personal associations and contacts with organizations to obtain data. This represents sixteen percent of the total land mass of the study area, which has data essentially unavailable. Excluding Mexico from the total land mass, it would represent sixty percent of the remaining area.

2.3.3   Density Results and Analysis

The density of stations in each country is analyzed for both the total number of stations and the number of active stations by the river kilometers and square kilometers per stations. Table 2-3 shows the results of this analysis and Table 2-4 shows the minimum recommended densities prescribed by the WMO by physiographic region.

Table 2-3: Station Density Analysis Results

Country	Total Stations	Active Stations	Km² per Station	Km² per Active Station	River Km per Station	River Km per Active Station
Belize	50	26	437	841	76	146
Costa Rica	121	56	433	936	78	168
Cuba	9	0	12243	-	1926	-
Dominican Republic	241	44	200	1097	34	184
El Salvador	37	30	559	690	102	126
Guatemala	25	22	4368	4964	822	934
Haiti	23	23	1176	-	175	-
Honduras	41	33	2727	3388	456	566
Mexico	1549	371	14	5267	229	958
Nicaragua	29	13	4410	9839	777	1734
Panama	141	61	475	1214	82	210
Puerto Rico	248	112	36	80	5	12

Table 2-4: Minimum Recommended Station

Densities by the WMO

Physiographic Region	Minimum Density (Km² per Station)
Coastal	2750
Mountainous	1000
Interior Plains	1875
Hilly/ Undulating	1875
Small Islands (Surface Areas Less than 500 km²)	300
Polar/Arid (Sparse Population)	20000

The results demonstrate that for active stations all countries would meet minimum density for arid or sparsely populated physiographic regions, however this is not the major physio geography of these countries. Mexico, Nicaragua, and Honduras do not meet minimum densities for coastal regions and only Puerto Rico, Belize, Costa Rica, and El Salvador meet station densities for mountainous regions. A comparison of the countries' spatial density to that of Puerto Rico

show that the river observations system in Puerto Rico is strikingly denser than those of the other countries. El Salvador is the next densest system; however, it is ten times less dense in terms of river kilometer per active station and approximately nine times less dense in terms of square kilometers per active station. In contrast, the active station density in square kilometer per station of Nicaragua is 123 times that of Puerto Rico.

2.3.4 Temporal Extent Results and Analysis

Table 2-5 shows the temporal extent of the station datasets where information is available. From these observations only Panama and Mexico would have stations that on average meet the criteria established by Burns for twenty-five plus years of records. However, Nicaragua, Costa Rica, and Belize have lengths of record greater than that of Puerto Rico, which has the advantage of being run by the USGS.

Table 2-5: Summary of Temporal Extent of Datasets

Country	Total Stations	Stations with Date Information	Average Length of Record (years)	Maximum Length of Record (years)	Minimum Length of Record (years)
Belize	50	37	19.0	46.0	1.3
Costa Rica	121	115	18.0	63.5	1.1
Cuba	10	10	9.4	16.0	2.0
Dominican Republic	241	237	14.7	46.0	1.0
El Salvador	37	32	5.8	13.4	1.0
Guatemala	25	0	-	-	-
Haiti	23	0	-	-	-
Honduras	41	0	-	-	-
Mexico	1549	1543	31.4	92.5	1.0
Nicaragua	29	16	16.6	38.8	0.7
Panama	141	141	29.9	69.5	2.7
Puerto Rico	248	248	16.0	69.1	0.03

2.4 **Future Work**

To better determine the extent which a data drought exists in the area of interest, in-depth analyses would be required to assess the data for each country. Station density analyses need to account for socio-economic and physio-climatic conditions in the country. Such analyses would divide countries into physiographic regions and assess them by each of the recommended densities from the WMO. Temporal extent of data could be better analyzed by grouping together observation's length of records for stations that are on the same river reach and may have replaced an old or destroyed station. In addition to temporal extent of data, further analyses would account for the spacing (frequency of measurement) and support (instantaneous or averaged observations) of data to better assess data gaps.

3 DEVELOPMENT AND DEPLOYMENT OF AN INTERNATIONALIZED STANDARDS-BASED HYDROLOGIC INFORMATION SYSTEM DATA SERVER

3.1 Introduction

CUAHSI has developed a framework to improve access, management, and storage of hydrometeorological data. This framework including HydroDesktop, HydroCatalog, and HydroServer provide open source solutions to managing, searching, and accessing data. The CUAHSI framework provides the advantages of storing data and metadata in standards based formats accessible by many global entities (Horsburgh et al, 2008). For users who would like to use HydroServer to store and manage their data, it requires two things: technical expertise to install and run the software and approximately $10,000 to buy the required proprietary licenses, software, and hardware to run HydroServer (hydroserver.codeplex.com, Microsoft.com, Esri.com). Similarly, proprietary software is costly, which precludes many organizations from using it.

HydroServer Lite is a lite-weight web-based version of HydroServer. HydroServer Lite has been successfully used as a low-cost alternative to HydroServer and requires little technical expertise for installation, setup, and regular use (Kadlec, 2010). The only cost for HydroServer Lite is that associated with obtaining and running a website, which many organizations already have. In such cases there should be no additional cost for using HydroServer Lite on the website.

HydroServer Lite has been used by Conner (2013) successfully to manage a database for a small ecological laboratory. Similarly, HydroServer Lite has been used as a hydrologic database system for many other entities as an open source web-based software (for a few examples see http://adventurelearningat.com/his/client/view_main.php,

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http://data.southwestcarbonpartnership.org/HydroServerLiteSWP/client/view_main.php, and
http://www.carolinacarrion.com/web/HIS22/client/view_main.php).

There is a need for hydrometeorological database systems for groups in developing countries. Experience in obtaining river observation data in developing countries has shown that the format and system in which data is maintained can greatly vary. For example, some groups maintain data in Excel files, while others have databases which are difficult for users to use. In general, developing countries face two obstacles in maintaining data: technical expertise and cost, both of which HydroServer Lite provides a solution. Studies have shown that while English systems can be used by foreign-language users who understand some English, many times they are unable to correctly interpret the context of the vocabulary (Holstrom et al, 2006). Therefore, a version of HydroServer Lite is required that is translated in the native language of those who need it in developing countries.

HydroServer Lite has fulfilled the need for custom, low-cost, database systems in the English speaking world. An international version would fulfill this same need and even more so in developing countries where the challenges with commercial highly technical software are the greatest. An internationalized HydroServer Lite would allow groups in developing countries to easily manage and publish data, and connect them with international groups, such as GEOSS, dedicated to connecting groups with necessary data and services. However, solely developing an international system will not begin to meet the full needs of developing countries, and a pilot program is needed to help implement said system. True success of internationalization will include the growth of regional leaders who will help others in the region to adopt and harness the benefits of HydroServer Lite. This partnership will allow others to benefit from relationships with

organizations like CUAHSI, WMO, and GEOSS who are actively trying to help developing countries.

3.2   Methods

This section details the methods involved in developing an internationalized version of HydroServer Lite and the steps taken to establish deployment with organizations in Central America.

3.2.1   International Code Development

The structure of HydroServer Lite is a package of PHP script, JavaScript, and SQL scripts. Each file in this package uses a combination of these codes to display the GUI, query the MySQL database, and post query results to the user's web page. The original HydroServer Lite has all the text displayed on the web page directly embedded in the code, which includes numerous lines to format the page, create alerts, and process data. To facilitate translation, the displayed text was removed from the original file and replaced with a PHP variable. For example, what would originally be found as `<h1>Enter a Single Data Value</h1>` is replaced with `<h1><?php echo $EnterSingleDataValue; ?></h1>`. Once a variable is created for each block of text, the actual text is stored in another file.

Text is stored in a combination of one or two files for each page, the *_common_text.php* and/or the *page_text.php*. The *_common_text* is a file that contains all blocks of text that are the same, either single words or paragraphs, allowing for these texts to be only translated once. For example, the term "Abstract" is displayed to the user in five different places in the software. The phrase "Required fields are marked with an asterisk (*)." Is repeated thirty-five times in the software. By having this text replaced once with one variable, translation

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time is reduced. Likewise, because HydroServer Lite is expected to be translated by multiple volunteers for one language, this also prevents different translations from occurring for the same text. If the common text was not used, the phrase `"Are you sure?"` could be translated with several variations. In Spanish it could be translated to "`¿Estás ceirto?`", "`¿Estás sin duda`", or "`¿Está usted seguro?`". By using the *_common_text* a consistent translation is maintained for any text displayed multiple times. Replacing text with variables also simplifies the translation process by removing text from its original file. By doing so the remaining code in the file cannot complicate and slow translation. For example, a translator with little or no experience with HTML does not need to decipher between formatting or text to translate as shown in the block below.

```
<td width="720" valign="top" bgcolor="#FFFFFF"><blockquote>
<p><br /><p class="em" align="right">Required fields are
marked with an asterisk </p> <div id="msg">
```

To facilitate translation and future updates, a new script and additional directories were added to HydroServer Lite. The additional directories include a language directory and subdirectories for each language translation that is complete. Subdirectories are named using codes from the International Organization for Standardization (ISO) 639-1. For example, the subdirectory containing the English text is named "en" and the parallel subdirectory for Spanish text is named "es." An example of the file structure is shown in Figure 3-1.
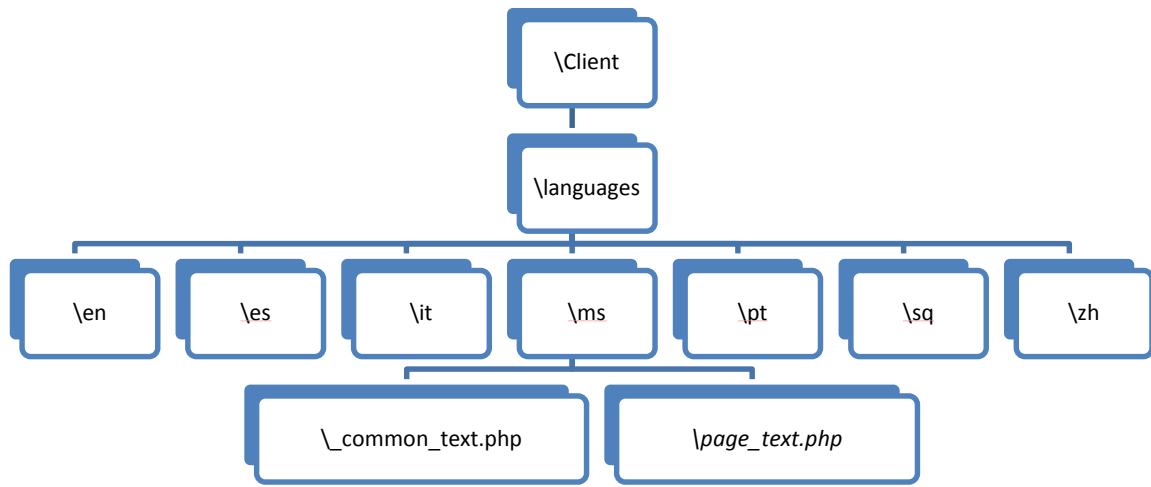
Figure 3-1: File Structure for Added Language Subdirectory with ISO 639-1 Codes

Within the language subdirectories reside the *_common_text* and *page_text*. The *page_text* represents each file in the main directory that has text stored within the language subdirectory. The name of the *page_text* is created by using the file name appended with _text. For instance, the text for *add_data_value.php* in the main directory is contained within the file named *add_data_value_text.php* in the language subdirectory. Nevertheless, if all the text from a file is already contained within the *_common_text* then the corresponding *page_text* file is not required and omitted.

Text displayed by both JavaScript and PHP were replaced with PHP variables and defined with the text in the language subdirectory. Each text is replaced with the corresponding variable called by the echo function in PHP. For instance, "Abstract:" is replaced with `<? php echo $Abstract; ?>` and stored in the *_common_text* as

$Abstract = "Abstract:";. To eliminate the need for multiple coding languages in the language directories, the JavaScript text was nested inside PHP variables. The JavaScript code alert("Error during processing! Please refresh the page and try again."); is replaced by alert(<?php echo "'".$ProcessingError."'";?>);. In total, 695 variables contain the entire displayed text of HydroServer Lite.

The script added to HydroServer Lite to read the language directories is the *internationalize.php* file. This file reads in both the *_common_text* and related *page_text* files bringing the variables stored there into memory. The *internationalize.php* file is included in every file of the main directory with the require once PHP function. The PHP code for *internationalize.php* is as follows:

```
$lang_code = "en";
$lang_file    =    str_replace(".php",    "_text.php",
basename($_SERVER["SCRIPT_NAME"]));
$page_text = "languages/" . $lang_code . "/" . $lang_file;
$common_text    =    "languages/"    .    $lang_code    .
"/_common_text.php";
include($page_text);
include_once($common_text);
```

The language code, which determines which language is displayed for users is set during initial installation; however, it can be manually changed if desired. To change the above instance to another language manually, a user would open *internationalize.php* and replace "en" from the first line with the appropriate ISO 639-1 language code that has been previously translated. Future development will allow users to instantaneously interchange between languages within the GUI of HydroServer Lite.

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Using the *internationalize* script to access text stored in the *page_text* and *_common_text* caused a problem when one file was called by another file and both were calling in the *_common_text*. For example, every page includes a universal *header.php* and *footer.php*. To remedy this an extra PHP parameter called $urlExtraName dictates that the path should be the path relative to *index.php* in the main directory. This issue was resolved by including `$urlExtraName="header.php";` in the *header.php* file.

Universal Character Set Transformation Format – 8 bit (UTF – 8) encoding was chosen to enable the character sets of the many languages into which HydroServer Lite is expected to be translated. Every file in HydroServer Lite was manually set to UTF – 8 encoding through a source code editor, Notepad++. For HydroServer Lite to correctly interpret the UTF – 8 encoding, which allows it to read foreign characters such as those with accents (ë, ñ, á, í, et cetra) from the MySQL database, `mysql_set_charset ("utf8");` was inserted into the *database_connection.php* file.

When a PHP script provided the text from the MySQL database to JavaScript components of HydroServer Lite, they were unable to correctly read the UTF – 8 encoding. One example of this occurs when site names are obtained from the database with *getsites.php*. In this file one line specifically was coded as `$sitename = $row2["SiteName"];` and was changed to `$sitename = utf8_encode($row2["SiteName"]);` to correctly read the UTF – 8 encoding.

3.2.2 Translation

Once the infrastructure of HydroServer Lite was completed, initial translation to Spanish commenced. To complete the translation rapidly, a group of six bilingual students and three native

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Spanish speakers volunteered to work together. The six bilingual students divided the *page_text* files and translated them. After translation they were submitted to one of the native speakers to review the accuracy of translation and maintain continuity between translations. The *_common_text.php* was delegated to the second native speaker for translation. The third native speaker translated the *create_database_tables.sql* file. Due to the nature of this file it was translated by itself and took five hours to accomplish. This is due to the large amount of controlled vocabulary entered into HydroServer Lite. However, a large portion of these controlled vocabularies are beyond the scope of many agencies who will primarily use HydroServer Lite to maintain streamflow, precipitation, and similar data. Therefore, future translation efforts will omit many of these controlled vocabulary lists, and users can use the ability to add new parameters to add the necessary information to their database. In total a complete translation to Spanish was completed in twenty-two hours.

To facilitate translation to other languages a Google application was created to provide access to a large number of volunteers for various languages, shown in Figure 3-2. The application allows the user to see the text they need to translate, and has a text box to enter translation. Translators are given a set of variables to translate that are stored in a Google spreadsheet. In some cases the translation is even reviewed by native speakers. Once the translation is complete a script will be used to transfer the translated text from the Google spreadsheet to PHP files inserted into the appropriate language subdirectory. There have been five translators for Portuguese, including one native Brazilian, two for Russian, two for Malay, one for Italian, a native for Albanian, and one native for Mandarin Chinese.

Figure 3-2: Example of Google Application to Facilitate Translation

3.2.3 Internationalization Development Needs

While the internationalized version of HydroServer Lite provides basic functionality in other languages, there are other aspects that need to be implemented that will improve its usability. Country specific terms, established as quality control for American users, need to be adjusted to complete the internationalization of HydroServer Lite. Postal Codes that only allow the American five-digit system need to be modified to allow alphabetical characters and increase the total number of characters. Entry of telephone numbers only permits American ten-digit numbers, and the data entry verification must be altered to accept other number combinations. Spatial reference controlled vocabulary needs to be expanded to include more than those solely used in the western hemisphere. Initially, spatial reference controlled vocabulary was limited to the controlled vocabulary registered with the Master Controlled Vocabulary Registry; however, with the change from ODM Version 1.0 to 1.1 CUAHSI has expanded the list from 225 to 339 entries including the World Geodetic System 1984/ Universal Transverse Mercator (WGS 84/ UTM) zones (http://his.cuahsi.org/mastercvreg). Adding the WGS 84/ UTM zones and other country specific zones to HydroServer Lite will allow users in other countries to better maintain their data.

Currently, HydroServer Lite provides a list of states for users to choose from to identify the location of sites or contacts. This list of states needs to be removed and replaced with a list of states or provinces based on a selected country, or a text box is needed to enter this information. If the county is not applicable for a specific region then a null value should be entered into the database if left blank. Finally, the ODM schema needs to be updated to accept country names in the sites table and the contact information in the data source table. It is anticipated that this update will occur with the release of ODM 2.0. The update of the ODM may contain other improvements to the controlled vocabulary, such as spatial references, that will be beneficial to HydroServer Lite. It is important that as these improvements occur from CUAHSI that HydroServer Lite developers update its functionality.

3.3   Results and Discussion

With an established Spanish version of the internationalized HydroServer Lite a pilot program needed to be implemented to ascertain its usefulness and, if successful, create regional leaders that will assist others to use it.

3.3.1   International Outreach

At a conference in Honduras, April 2013, hosted by the OAS, a presentation was given detailing the efforts of internationalizing HydroServer Lite and the benefits that it would bring to agencies dealing with hydrologic data. Three organizations from Honduras, Guatemala, and Nicaragua asked to be included in the implementation of the internationalized HydroServer Lite. In May of 2013 a webinar was hosted with these three agencies to discuss CUAHSI and GEOSS concepts and services (such as HIS, SOAP, and WaterML), and to demonstrate the capabilities of HydroServer Lite. The groups reconfirmed their interest and were given tasks to prepare to

establish a HydroServer Lite of their own. Unfortunately, many of these agencies were understaffed and still unsure how to proceed, stalling any progression made on their part. To better help them, various documents and presentations were prepared (see Appendix A) and sent to them. These documents included:

- How to prepare data to be entered into HydroServer Lite

- How to configure a HydroServer Lite on a web server

- The Why and How of HydroServer Lite

- Spreadsheets to enter data for HydroServer Lite

The purpose of The Why and How of HydroServer Lite presentation is to educate users of the system's capabilities and advantages, as well as to educate decision makers who could stall or hasten its implementation. Due to the lack of progress from the groups the spreadsheets were sent to each agency to gather data that could be used to establish an instance of HydroServer Lite.

Worldwater.byu.edu is a site that promotes and explains the purpose in development of an internationalized HydroServer Lite. To support groups in establishing HydroServer Lite a server with MySQL databases is currently maintained at worldwater.byu.edu. Information about the software, databases hosted on the server, and initiatives are presented therein. An example HydroServer Lite called the "Sandbox" was created that allows potential users to experience the user interface and capabilities of HydroServer Lite before installing their own. The sandbox has large time series data inputted that allows users to manipulate the data to any extent. Every night the sandbox database is restored to the original version permitting other users to experience the same setup of HydroServer Lite as well. As a result of the information gathered from the groups through the provided spreadsheet, instances of HydroServer Lite were established on

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worldwater.byu.edu for each group. It was anticipated that once an instance was established and agencies became familiar with it, they would have enough incentive to further pursue use. One group was able to provide the minimal data to setup a functional instance on the worldwater.byu.edu server, but the remaining organizations were unable or unwilling to provide data.

Ultimately, a trip to visit each agency to best grasp their needs was scheduled. In October 2013, a visit to each agency for one and a half days was completed with great success. Since the visits, continued and improved interactions have occurred with each agency to provide support and establish operational HydroServer Lite instances for each. The following details the status of these groups.

3.3.2 Guatemala

In Guatemala, the Coordinación Nacional para la Reducción de Desastres (CONRED), which translates to the national coordination for the reduction of disasters, is trying to establish HydroServer Lite. CONRED collects streamflow and precipitation data for flood prevention; however, their mandate extends to search and rescue, post disaster sheltering, and cleanup. They are using the HydroServer Lite established for them at worldwater.byu.edu intermediately until they can host it on their own server at conred.gob.gt. The principal contact at CONRED does not have much support and requested that the stations be setup for their HydroServer Lite. They hope to involve other agencies, those responsible for meteorological and hydraulic information, and to leverage the Guatemala laws that require information to be free and available to all in establishing additional HydroServer Lite instances. This may be a means to establish HydroServer Lite instances for many other groups in Guatemala and the region.

CONRED's HydroServer Lite has three sites, one of which has precipitation data. Currently, requests to receive data from CONRED are being made. This data will be used to further establish a functioning HydroServer Lite. Once established, CONRED staff will be instructed in how to use it. Figure 3-3 shows CONRED's HydroServer Lite displaying a data table of a site with an additional field to add a new data value to the table.

3.3.3 Nicaragua

In Nicaragua INETER, has worked to implement a HydroServer Lite. INETER is the national agency for cartography, meteorology, and water resources. Being in charge of these subjects at a national level has allowed them to maintain an Oracle database of hydrologic information. Regrettably, the Oracle database used by INETER is difficult to manage and one cannot easily access data. A conversion process is underway to migrate the data from this database into a MySQL database with the ODM. In Nicaragua, the data they collect and maintain has restricted access by law. Members of INETER feel this is wrong and believe they lose money in efforts to sell data. They plan to establish an instance of HydroServer Lite on their server and provide public access to plots of the data. Ability to download or view tables of the data will be restricted to users with established usernames and passwords. To complete restriction to the data, the directory containing web services will also be disabled on their instance. This will prevent other organizations from accessing their data, but will also prevent their own agency from connecting to their data from other resources such as HydroDesktop. The expectation is that law makers will soon allow free distribution of data understanding the benefits it will provide

Figure 3-3: HydroServer Lite for CONRED with Data Table and Data Value Editor Displayed

nationally with increased studies and other services available internationally from initiatives similar to GEOSS. Another incentive to law makers may come in the form of regional peer pressure. As other countries in the region provide free access to data and benefit from global efforts, law makers may worry they have been left behind with archaic views of data access.

While the migration of the INETER Oracle database is currently underway, a HydroServer Lite on worldwater.byu.edu does contain a limited dataset. The data on this HydroServer Lite includes eight sites across the country, each with a month's worth of data for stream water level or discharge. Figure 3-4 shows the HydroServer Lite for INETER displaying a map of stations with available data and Figure 3-5 shows multiple datasets displayed on a graph.

Figure 3-4: INETER Instance of HydroServer Lite with Map of Stations

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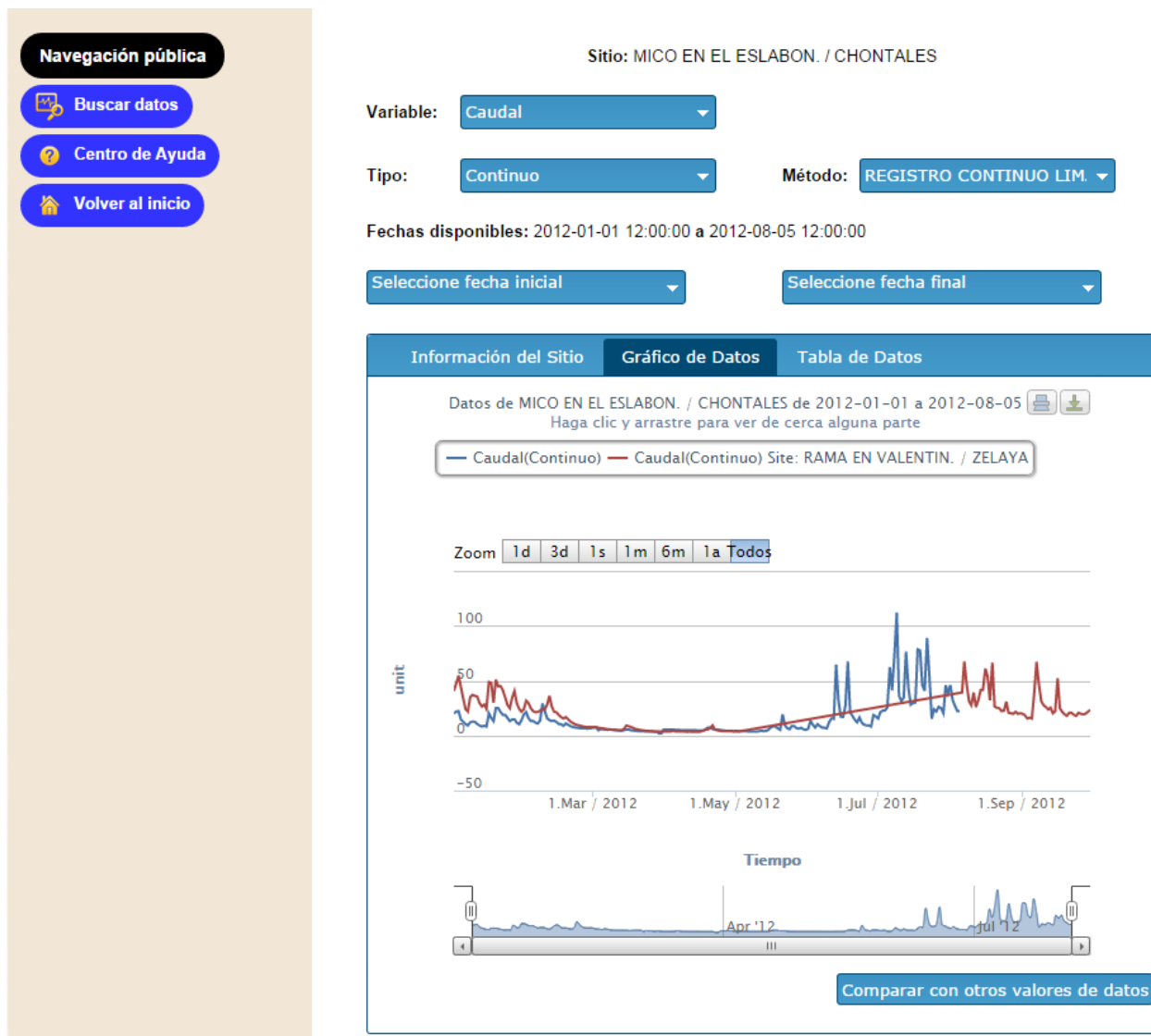
Figure 3-5: Multiple Stream Discharge Datasets in the HydroServer Lite for INETER

3.3.4 Honduras

In Honduras, CCIV has worked to use HydroServer Lite. This organization operates to prevent flooding in the main economic valley of the country. CCIV is not directly funded by the government, but at times benefits from funding from outside groups in response to large disasters, such as Hurricane Mitch in 1998. In particular, after this destructive hurricane they were given access to Kisters' HYDSTRA software. They used this to manage telemetry data until they were

unable to fund updates for the software and hardware required to maintain access. From that point on, they were unable to access the processed data, yet they continued to run a script to download a Kisters file containing the data. They have maintained approximately five years of data files without access to actual data. These files have now been recovered with a Visual Basic script and are being organized for entry to their instance of HydroServer Lite. Representatives of CCIV believed that without this data recovery the data may have been lost all together.

The data of CCIV is currently hosted on worldwater.byu.edu. CCIV does not currently have any servers to host data, nor to potentially migrate data to. They have a proposal to a Spanish agency that may help secure funding for a server to host data in the near future. The basic site information for their sixty-seven sites is available on HydroServer Lite with a map displaying the data in Figure 3-6. Once organization of precipitation and discharge times series is completed, these data will be added to their instance.

3.3.5   Steps Forward

The three above groups have large datasets collected over many years. They will need to allocate the necessary resources to obtain servers or commercial web servers to eventually migrate their data from worldwater.byu.edu. Once their databases are established, continued correspondence will help workout any complications that may arise within the internationalized HydroServer Lite. As they have more experience and success with the software they can recommend to and unite with other regional groups that can benefit from the system. As the internationalized HydroServer Lite is used and improved it can better support these organizations that need it.
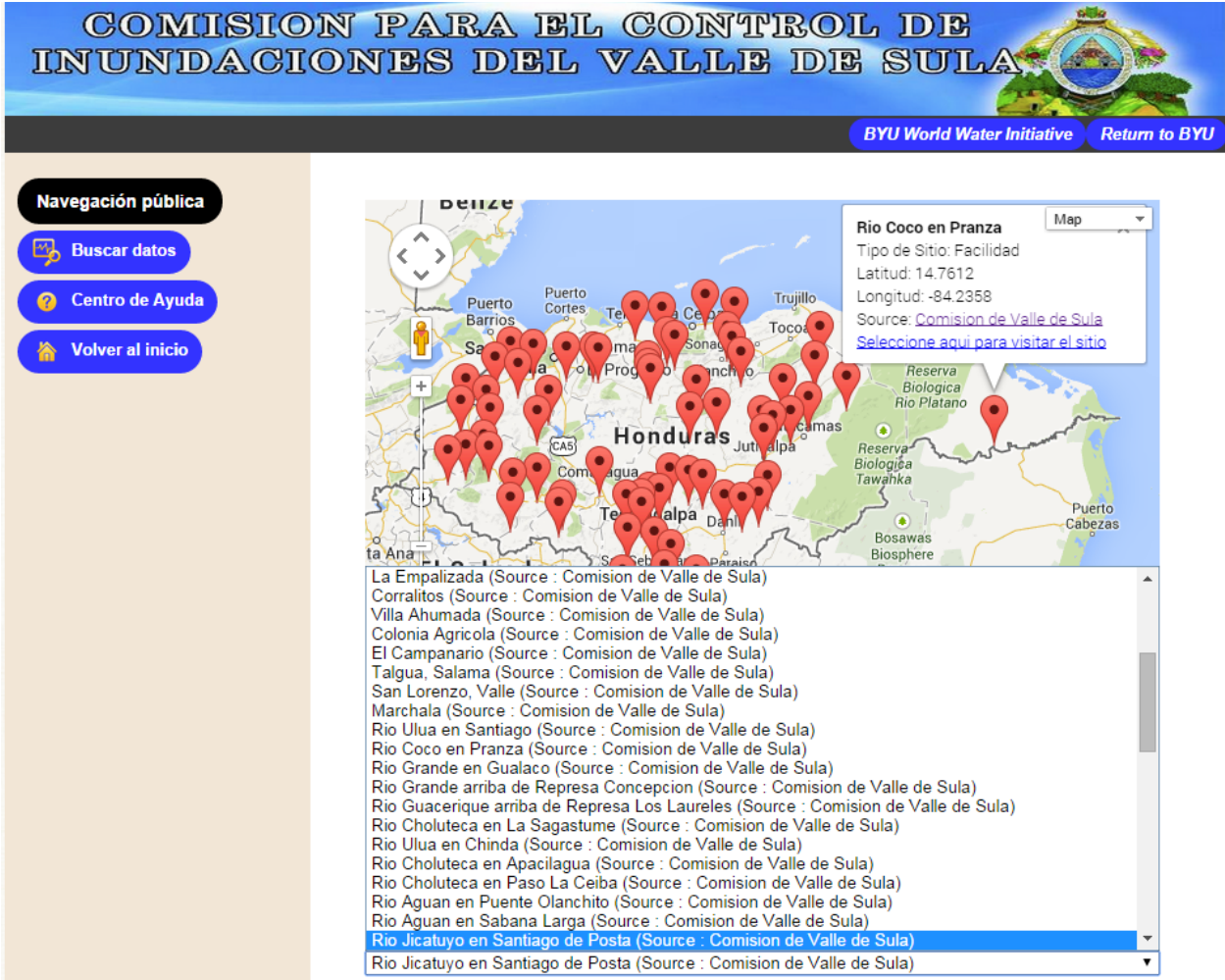
Figure 3-6: Honduras Stations on Map with Partial List of Stations Displayed

Once these instances of HydroServer Lite are fully operational and in use by these countries, they have the opportunity to connect to the GEO DAB, linking their in-situ data to the global exchange of data through GEOSS. Successful compatibility tests have been completed to ensure the web services in HydroServer Lite correctly function within the GEO DAB. Once their data are linked with GEOSS, each group can take advantage of the other services offered through GEOSS.

4   CONCLUSION

Chapter Two of this study sought to determine if a data drought exists in select countries in Latin America in terms of data access, spatial density, and temporal extent. An analysis of data access determined that one-third of the countries studied have limited or no access to hydrologic data. In terms of spatial density of active stations, only Belize, Costa Rica, El Salvador, and Puerto Rico meet the WMO's strictest physio geographic region minimum density of 1,000 kilometers per station. However, in comparison to Puerto Rico, whose hydrologic stations are run by a developed country, the densities of the other countries are approximately ten to one hundred times greater. Temporal extent of the stations show that Mexico and Panama are the only countries that have stations with an average of over twenty-five years of length of record, while Belize, Costa Rica, and Nicaragua have an average length of record over sixteen years.

Through these observations it is concluded that there is a data drought in the area of interest, though in this analysis, parts of this drought may be exaggerated by data access complications. All countries face at least one or more issues classifying them as having limited data. For example, while Mexico has an average length of record of over thirty years, and access to their datasets through online web services, the spatial density of the data is well above the coastal minimum densities recommended by the WMO. To better assess the extent of the data drought in Latin America, the steps outlined in the Future Work section should be followed. In countries where limited data access is encountered, they may benefit from the standards based hydrologic database management software provided by the internationalized version of HydroServer Lite.

The internationalized version of HydroServer Lite fulfills a need of many agencies to provide low-cost, easy-to-use hydrologic data management software. Now available in Spanish, future translation will allow HydroServer Lite to be used in many countries around the world. In conjunction with GEOSS, the BYU World Water Group has aided three developing countries to implement HydroServer Lite to varying degrees. While these countries have ongoing implementation, a final assessment of the research goal is unavailable at this time; however, a summary of the ongoing process is given below.

For Guatemala, a site has been established that will migrate to a server that CONRED maintains, and they are working to gather regional partners. In Nicaragua, HydroServer Lite will be used as a new means to maintain and access data for the national water resources agency with hopes to change national laws on data sharing. Isaìas Montoya from INETER described the benefits of working with HydroServer Lite and GEOSS by stating, "This data will help us make studies. Without data, we have no studies. And without studies, we do not have knowledge, and without knowledge we cannot improve the conditions of our watersheds". In Honduras, CCIV is starting to maintain their newly restored data with HydroServer Lite, giving access to data that will help protect the economy and livelihoods of the people in the Valle Sula.

These new partners are pioneering the way for other groups to adopt HydroServer Lite and join global projects such as GEOSS. While HydroServer Lite has yet to improve data management and access with these groups they are trying to implement the system to obtain said goal. The challenges that face them in using HydroServer Lite include limited manpower to work on the project and government approval for using a system that allows free access to data. However, these agencies have a vision that the improved data management and access will provide immense

benefits and affect the lives of millions of people. In the words of Luis Da Costa from CCIV, this work is "for the benefit of society and of the countries that desperately need this support."

REFERENCES

Alemaw, B. F., Shemang, E. M., & Chaoka, T. R. (2004). "Assessment of Groundwater Pollution Vulnerability and Modelling of the Kanye Wellfield in SE Botswana—a GIS Approach." *Physics and Chemistry of the Earth, Parts A/B/C*,29(15), 1125-1128.

Ames, D. P., Horsburgh, J., Goodall, J., Whiteaker, T., Tarboton, D., & Maidment, D. (2009, July). "Introducing the Open Source CUAHSI Hydrologic Information System Desktop Application (HIS Desktop)." In *18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation, Modelling and Simulation Society of Australia and New Zealand and International Association for Mathematics and Computers in Simulation* (pp. 4353-4359).

Ames, D. P., Horsburgh, J. S., Cao, Y., Kadlec, J., Whiteaker, T., & Valentine, D. (2012). "HydroDesktop: Web Services-Based Software for Hydrologic Data Discovery, Download, Visualization, and Analysis." *Environmental Modelling & Software*, 37, 146-156.

Beran, B., & Piasecki, M. (2008). "Availability and Coverage of Hydrologic Data in the US Geological Survey National Water Information System (NWIS) and US Environmental Protection Agency Storage and Retrieval System (STORET)." *Earth Science Informatics*, 1(3-4), 119-129.

Borga, M., Gaume, E., Creutin, J. D., & Marchi, L. (2008). "Surveying Flash Floods: Gauging the Ungauged Extremes." *Hydrological Processes*, 22(18), 3883.

Burn, D. H., M. A. (2002). "Detection of Hydrologic Trends and Variability." *Journal of Hydrology*, 107–122.

Butterfield, M. L., Pearlman, J. S., & Vickroy, S. C. (2008). "A System-of-Systems Engineering GEOSS: Architectural Approach." *Systems Journal*, IEEE,2(3), 321-332.

Christian, E. (2005). "Planning for the Global Earth Observation System of Systems (GEOSS)." *Space Policy*, 21(2), 105-109.

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Conner, L. G., Ames, D. P., & Gill, R. A. (2013). "HydroServer Lite as an Open Source Solution for Archiving and Sharing Environmental Data for Independent University Labs." *Ecological Informatics*, 18, 171-177.

CUAHSI, 2012. CUAHSI Hydrologic Information System http://his.cuahsi.org *Accessed* November 2013

Espinoza Dávalos, G. E. (2012). *A Mexican Case Study for World Water Online.* M. S. thesis University of Texas, Austin, Texas.

GEO, Geneva, Switzerland, "10-Year Implementation Plan Reference Document," (2005) [Online]. Available: http://www.earthobservations.org/about_geo.shtml

The Global Runoff Data Centre, D -56002 Koblenz, Germany. 2014.

Guide to Hydrological Practices, Volume I, Hydrology, From Measurement to Hydrological Information (6th edition). (2008). Geneva: World Meteorological Organization. Retrieved from http://www.whycos.org/hwrp/guide/index.php

Harvey, H., & Han, D. (2002). "The Relevance of Open Source to Hydroinformatics." *Journal of Hydroinformatics*, 4, 219-234.

Heidorn, P. B. (2008). "Shedding Light on the Dark Data in the Long Tail of Science." *Library Trends*, 57(2), 280-299.

Holmstrom, H., Conchuir, E., Agerfalk, P., & Fitzgerald, B. (2006). "Global Software Development Challenges: A Case Study on Temporal, Geographical and Socio-Cultural Distance." 2006. *ICGSE '06. International Conference on, Global Software Engineering* (pp. 3 - 11). Florianopolis, Brazil.

Horsburgh, J. S., Tarboton, D. G., Maidment, D. R., & Zaslavsky, I. (2008). "A Relational Model for Environmental and Water Resources Data." *Water Resources Research*, 44(5).

Horsburg, J. et al., 2009. "An Integrated System for Publishing Environmental Observations Data." *Environmental Modelling and Software,* pp. 879-888.

Huang, M., Maidment, D. & Tian, Y., 2011. "Using SOA and RIAs for Water Data Discovery and Retrieval." *Environmental Modelling & Software,* Volume 26, pp. 1309-1324.

Kadlec, J., & Ames, D. P. (2010). "Development of a Lightweight HydroServer and Hydrologic Data Hosting Website." In *Proceedings of the AWRA Spring Specialty Conference on GIS and Water Resources*, New Orleans, LA.

Kadlec, J., & Ames, D. P. (2011). "Design and Development of Web Services for Accessing Free Hydrological Data from the Czech Republic." In *Environmental Software Systems. Frameworks of eEnvironment* (pp. 581-588). Springer Berlin Heidelberg.

Lehner, B., Verdin, K., Jarvis, A. (2008): "New Global Hydrography Derived from Spaceborne Elevation Aata." *EOS*, *Transactions*, AGU, 89(10): 93-94.

Mende, A., Astorga, A., & Neumann, D. (2007). "Strategy for Groundwater Management in Developing Countries: A Case Study in Northern Costa Rica." *Journal of Hydrology*, 334(1), 109-124.

Piasecki, M., Ames, D., Goodall, J., Hooper, R., Horsburgh, J., Maidment, D., Tarboton D., & Zaslavsky, I. (2010). "Development of an Information System for the Hydrologic Community." In *9th International Conference on Hydroinformatics*, HIC., Tianjin, China.

Pokorny´, J. (2006), "Database Architectures: Current Trends and Their Relationships to Environmental Data Management." *Environmental Modeling Software*, 21, 1579– 1586, doi:10.1016/j.envsoft.2006.05.004.

Pringle, C. M., Freeman, M. C., & Freeman, B. J. (2000). "Regional Effects of Hydrologic Alterations on Riverine Macrobiota in the New World: Tropical-Temperate Comparisons." *BioScience*, 50(9), 807-823.

Samaniego, L., & Bárdossy, A. (2005). "Robust Parametric Models of Runoff Characteristics at the Mesoscale." *Journal of Hydrology*, 303(1), 136-151.

SDSC, 2011. *CUAHSI HIS Central Catalog and Search Web Service.* http://hiscentral.cuahsi.org. *Accessed* 1 12 2013.

Shiklomanov, I. A. (1993). "World Water Resources: A New Appraisal and Assessment for the 21st Century." *Water in Crisis*. New York, Oxford

Silberstein, R. P. (2006). "Hydrological Models are So Good, Do We Still Need Data?." *Environmental Modelling & Software*, 21(9), 1340-1352.

Stehr, A., Debels, P., Romero, F., & Alcayaga, H. (2008). "Hydrological Modelling with SWAT under Conditions of Limited Data Availability: Evaluation of Results from a Chilean Case Study." *Hydrological Sciences Journal*, 53(3), 588-601.

Viglione, A., Borga, M., Balabanis, P., & Blöschl, G. (2010). "Barriers to the Exchange of Hydrometeorological Data in Europe: Results from a Survey and Implications for Data Policy." *Journal of Hydrology*, 394(1), 63-77.

White, T., 2012. "Design, Development and Assessment of a Citizen Scientist Interface to the Consortium of Universities for the Advancement of Hydrologic Sciences, Inc. Hydrologic Information System." M.S. thesis Idaho State Univ, Pocatello, Idaho 105 pp.

Whiteaker, T., Boddupalli, A., & Siler, C. (2009). HYDROEXCEL 1.1. 1 SOFTWARE MANUAL.

WHYCOS. (2014) Switzerland, "About WHYCOS," Retrieved
http://www.whycos.org/whycos/about-whycos

William, G., Milke, M. W., & Raffensperger, J. F. (2009). "Survey of New Zealand Hydrologists
on Information Needs."

World Water Online, The University of Texas at Austin, Center for Research in Water
Resources. 2014. http://worldwateronline.org/

APPENDIX A. ELECTRONIC SOFTWARE TRAINING RESOURCES

A.1   How to Prepare Data to be Entered into HydroServer Lite

Preparando Su Base de Datos y Sus Datos

Por Stephen Bolster 2012-05-28

Su Base de Datos

Para implementar *HydroServer Interactivo Cliente Web* necesita un servidor de web o sea una página de web. Por ejemplo, nuestra página es *http://wwol.groups.et.byu.net*. Esta página es habilitada con PHP y tenemos conectado una base de datos MySQL. Si ya tienen una página de web, hay que averiguar que pueden usar PHP y conectar a una base de datos de MySQL. Normalmente puede chequearlo con su alojamiento web (web host) y/o pedirle acceso para una base de datos de MySQL.

Cuando ya tiene su página de web lista, verifique que tiene la información necesaria para conectar a su base de datos, como se ve a continuación.

Por favor introduzca los ajustes predeterminados siguientes...

Opciones de configuración de base de datos MySql

Host de la base de datos:

Nombre de usuario de la base de datos:

Contraseñas de la base de datos:

Nombre de la base de datos:

Configuración

A continuación puede ver otra información necesaria para hacer la configuración.

Opciones de configuración de apariencia y funcionalidad del sitio web

Nombre de la Organización:		(Ej: McCall Escuela de Ciencias al Aire Libre)
Nombre del Página principal:		(Ej: MOSS blog)
Página principal:		(Ej: adventurelearningat.com)
Versión del programa:	Versión 2.0	(Ex: Versión 2.0)

Ajustes de configuración por motivos de seguridad

Dominio del sitio web:		(Ex: adventurelearningat.com)

www.manaraa.com

Ajustes de configuración para agregar una nueva fuente

Versión del Perfil:

Ajustes de configuración para agregar sitios

Fuente de Datos: _(Ej: McCall Escuela de Ciencias al Aire Libre)_

X local:

Y local:

ID de la proyección local:

PosAccuracy_m:

Dátum Vertical:

Referencia espacial:

Ajustes de configuración para agregar una nueva variable

Código de la Variable:

Tiempo de soporte:

Ajustes de configuración para agregar valores de datos

UTCOffset:

UTCOffset 2:

Código de censor : nc

Nivel de control de calidad: 0

Precisión del valor: NULL

ID del tipo de desplazamiento: NULL

ID del calificador: 1

ID de la muestra: NULL

Derivado de ID: NULL

Si hay duda en que requieren estos, no se preocupe los ❓ puede darle más información.

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Preparar Sus Datos

Hay diferente información que necesitan entrar al sistema. Estos pueden ser preparados y organizados antes de recibir el paquete de *HydroServer Interactivo Cliente Web* mismo. Sugiero que provechen de esta semana para preparar y organizar esta información.

Fuentes

Fuentes es la organización o persona de quien recibieron la información. Puede ser su organización proprio u otros. Esta información necesita ser entrada una por una, la información requerida está a continuación.

Añadir una nueva fuente

Organización:		* *(Ej: McCall Outdoor Science School)*
Descripción:		* *(Ej.: La misió del MOSS es...)*
Enlazar con el Orig:		*(Opcional, Ej: http://www.mossidaho.org)*
Nombre de Contacto:		* *(Nombre completo)*
Teléfono:		* *(Ej: XXX-XXX-XXXX)*
Correo Electrónico:		* *(Ej.: info@moss.org)*
Dirección:		*
Ciudad:		*
Estado:	Seleccione...	*
Código Postal:		*
Cita:		*(Opcional, Ejemplo: Datos acquiridos por científicos del MOSS y científico afici...)*
MetadataID:		*(Esto se generará automáticamente al momento del envío.)*
Categoría de temas:	Seleccione...	*
Titulo:		* *(Ej: Twin Falls High School)*
Resumen:		* *(Ej.: Estudiantes de secundaria/científicos aficionados colectando...)*
Metadato Enlace:		*(Opcional)*

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Sitios o Estaciones

Para entrar la información para los sitios los siguientes datos son necesarios, aparte del código del sitio que es creada automáticamente; a menos que lo ajusten. También pueden usar el mapa para obtener la latitud, longitud, y elevación. Estado y condado son específicamente para los Estado Unido, entonces entre *Internacional* por estado y condado no es necesario.

Los campos requeridos están marcados con un asterisco(*).

Añadir un nuevo sitio

Fuente de Datos: Seleccione...

Nombre del Sitio: _____ * (Ej: Boulder Creek en Jug Mountain Ranch)

Código del Sitio: S- _____ * ⓘ (Usted pude ajustar esto si es necesario)

Tipo de Sitio: Seleccione... *

Fotografía del Sitio: Choose File No file chosen
(La fotografía debe ser en formato .JPG; El archivo será cargado en el botón enviar abajo.)

Puede introducir la latitud / longitud / altura manualmente o simplemente hacer doble clic en la ubicación en el mapa. Una vez que el marcador está puesto en el mapa, es posible hacerle clic y arrastrlo hasta la ubicación exacta que usted desea para ajustar los resultados y que sean más precisos.

Latitud: _____
Longitud: _____ *
*
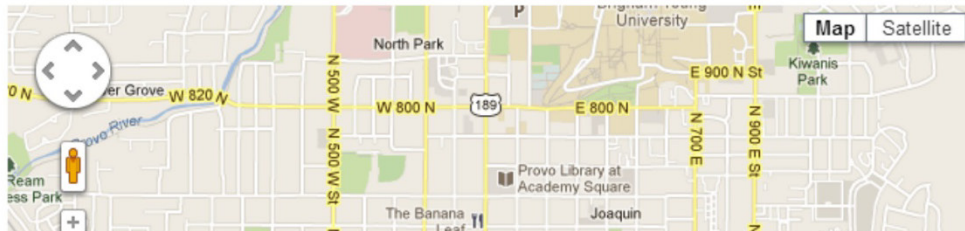
Elevación: _____ * Metros ⓘ

Estado: Seleccione... * ⓘ

Condado: 🔄 Seleccione el estado primero...

Dátum Vertical: Seleccione... * ⓘ

Referencia Espacial: Seleccione... * ⓘ

Comentarios: _____ (Opcional)

www.manaraa.com

Variables

Todo los variables que necesitan son añadidos por esta página. Los cuadros azul tienen listas para escoger la información, al escoger algo los cuadros blancos so llanados.

Agregar una nueva variable

Código de la Variable:	BYU * ⑨ (Ej: IDCS-22 o IDCS-22-Avg)
Nombre de la Variable:	Seleccione... *
Definición de la Variable:	* ⑨
Especiación:	Seleccione... * ⑨
Definición de la Especiación :	*
Unidad del Tipo de Variable:	Seleccione... * ⑨
Medio del Muestra:	Seleccione... * ⑨
Definición del Medio de Muestra:	*
Tipo de Valor:	Seleccione... * ⑨
Definición del Tipo de Valor:	*
Regularidad del Valor:	Seleccione... * ⑨
Tiempo de soporte:	* ⑨
Unidad de Tiempo :	Seleccione... *
Tipo de Dato:	Seleccione... *
Definición del Tipo de Dato:	Por favor seleccione un tipo de dato para ver su definición *
Categoria:	Seleccione... * ⑨
Definición de la Categoría:	Por favor seleccione una categoría para ver su información *

Método

Los métodos son añadidos por esta página. Los métodos describen el equipo para obtener los datos.

Añadir un nuevo método

Nombre del Método : [   ] * (Ej: YSI DO 250<1 Meter)

Método de Enlace: [   ] (Opcional; Ex: http://www.ysi.com/productsdetail.php?
DO200-35)

Por favor, seleccione a continuación la(s) variable(s) utilizada(s) por este método:
Seleccionar todo funciona manteniendo la tecla Ctrl flecha abajo y seleccionando multiple
opciones):

```
Select....
Discharge (Continuous)
E-coli (Sporadic)
Precipitation (Average)
Snow Water Equivalent (Continuous)
Water depth (Continuous)
```

Datos

Para entrar datos, pueden hacerlo de tres maneras. Solo un único valor, varios valores, e importar un archivo de CSV. La base de datos es muy particular en el formato del archivo que es importado. Unos ejemplos son los siguientes.

```
LocalDateTime,DataValue
2012-04-01 0:00:00,10.99
2012-04-01 0:10:00,11.01
2012-04-01 0:20:00,11.02
2012-04-01 0:30:00,11.04
2012-04-01 0:40:00,11.04
2012-04-01 0:50:00,11.05
2012-04-01 1:00:00,11.07
2012-04-01 1:10:00,11.08
```

```
1   LocalDateTime,DataValue
2   2012-03-05 06:15:00,0.01
3   2012-03-05 06:30:00,0
4   2012-03-05 06:45:00,0
5   2012-03-05 07:00:00,0.01
6   2012-03-05 07:15:00,0.01
7   2012-03-05 07:30:00,0.02
8   2012-03-05 07:45:00,0.01
9   2012-03-05 08:00:00,0
10  2012-03-05 08:15:00,0
11  2012-03-05 08:30:00,0
12  2012-03-05 08:45:00,0
13  2012-03-05 09:00:00,0
14  2012-03-05 09:15:00,0
15  2012-03-05 09:30:00,0
16  2012-03-05 09:45:00,0.01
17  2012-03-05 10:00:00,0
18  2012-03-05 10:15:00,0
19  2012-03-05 10:30:00,0
20  2012-03-05 10:45:00,0
21  2012-03-05 11:00:00,0.05
22  2012-03-05 11:05:00,0.03
23  2012-03-05 11:15:00,0.03
24  2012-03-05 11:30:00,0.02
25  2012-03-05 11:45:00,0.02
26  2012-03-05 12:00:00,0.02
27  2012-03-05 12:15:00,0.03
28  2012-03-05 12:30:00,0
```

	A	B
1	LocalDateTime	DataValue
2	12-02-25 00:25:00	18
3	12-02-26 00:26:00	20
4	12-02-27 00:27:00	30
5	12-02-28 00:28:00	12
6	12-02-29 00:29:00	15
7	12-03-01 00:01:00	30
8	12-03-02 00:02:00	25
9	12-03-03 00:03:00	32
10	12-03-04 00:04:00	31
11	12-03-05 00:05:00	22
12	12-03-06 00:06:00	20
13	12-03-07 00:07:00	15

Si necesita cambiar la fecha y tiempo en Excel puede hacerlo de "Format Cells" y ponerlo asi:

yyyy-mm-dd hh:mm:ss

Es posible que en español necesiten "aaaa" para **año** en vez de "yyyy" por **year.**
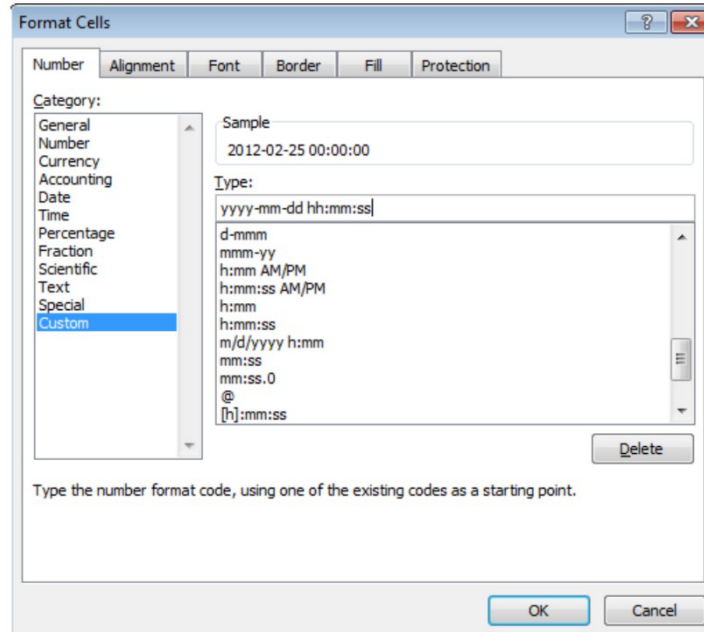
Anuqué su sistema e datos son en español primera fila requiere *LocalDateTime, DataValue*. Si no lo tiene exactamente así, no servirá. Si pueden preparar sus datos a archivos de CSV así será más fácil a entrar sus datos a su nuevo sistema.

HYDROSERVER INTERACTIVO CLIENTE WEB GUÍA DE INSTALACIÓN

JIRI KADLEC, DAN AMES, y STEPHEN BOLSTER; UPDATED 5/23/2013

PROPÓSITO

El propósito de este documento es mostrar cómo configurar el HydroServer Interactivo Cliente Web en cualquier servidor web.

HydroServer Interactivo Cliente Web es una aplicación de CUAHSI HIS WaterOneFlow servicios de web (véase http://his.cuahsi.org/), y una independiente herramienta de publicación de datos para los datos hidrológicos.

Para obtener más información sobre HydroServer Interactivo Cliente Web, o para participar en el esfuerzo de desarrollo de software para HydroServer Interactivo Cliente Web, por favor visite: http://hydroserverlite.codeplex.com.

PASOS PARA CONFIGURAR HYDROSERVER INTERACTIVO CLIENTE WEB

Hay muchas opciones para la creación de sitios web. En muchos casos tal vez ya tenga un sitio web para su organización. Utilice una de las dos secciones siguientes que sea más aplicable a su organización: el uso de un sitio web existente u obtención de un sitio de pago.

EL USO DE UN SITIO WEB EXISTENTE

Si su organización ya tiene un sitio de web hay que averiguar que tiene acceso a una base de datos MySQL. Si la tiene hay que obtener la siguiente información.

1. Host de Base de Datos
2. Nombre de Usuario de Base de Datos
3. Contraseña de Base de Datos
4. Nombre de Base de Datos

Con esta información podrá conectar su base de datos al sistema de HydroServer Interactivo Cliente Web. Si no tiene acceso a una base de datos MySQL, hay que contactar su administrador de servidor de web para crearla o buscar la información de conexión.

CREAR UNA PÁGINA WEB DE PAGO

En caso necesitan un servidor de web hay muchas opciones a donde comprarlo. Un ejemplo es Godaddy.com, no avalamos sus servicios y usted puede otras opciones en el web. Antes de seleccionar un servicio de web host, verifique que su sitio de web tendrá capacidad de usar MySQL y PHP. Después de obtener su servidor de web anote la información de la sección anterior sobre la base de datos MySQL.

COPY HYDROSERVER INTERACTIVO CLIENTE WEB FILES TO THE SERVER

Descargue los archivos de HydroServer Interactivo Cliente Web de http://wwol.groups.et.byu.net/descargar/. Los archivos se descargan como un archivo comprimido llamado HydroServerInteractivioClienteWeb.zip. Utilice de manera apropiada para su servidor web para subir los archivos a su sitio.

Es todo. HydroServer Interactivo Cliente Web ahora está disponible en el servidor listo para ser configurado!

Una vez que los archivos de HydroServer Interactivo Cliente Web files se cargan, ejecutar la instalación. Para ello, abra un nuevo navegador web, y vaya a http://www.suservidordeweb.com/client/setup/ (Si los archivos fueron subidos a la carpeta public_html root, entonces los archivos de instalación estarán bajo "cliente / setup ").

[NOTA IMPORTANTE: LOS PASOS RESTANTES DEBEN LLEVARSE A CABO EN CUALQUIERA DE LOS GOOGLE CHROME O MOZILLA FIREFOX NAVEGADOR. INTERNET EXPLORER Y SAFARI NO ESTÁN ACTUALMENTE ADMITIDOS, AUNQUE ESTE SOPORTE SE ESPERA EN EL FUTURO MUY CERCA.]

Haga clic en "Comenzar Instalación". Esto iniciará una breve secuencia de instalación para ayudar a configurar las tablas de base de datos MySQL y un archivo de configuración utilizado por el software.

En el formulario correspondiente, introduzca una nueva contraseña de administrador. Tenga en cuenta que ahora está manejando tres nombres de usuario y contraseñas: una para el servicio de alojamiento web, una para la base de datos, y esta nueva para el HydroServer Interactivo Cliente Web interfaz de web. El nombre de usuario "his_admin" no se puede cambiar, pero es necesario especificar una contraseña para acompañar este nombre de usuario.

También debe introducir su nombre del Host de la base de datos, Nombre de la base de datos, Nombre de usuario de la base de datos, y Contraseña de la base de datos. Especifique también el resto de los valores de configuración predeterminados (los iconos de ayuda para obtener instrucciones). Haga clic en el botón "Guardar configuración " en la parte inferior para confirmar la nueva configuración. Debe recibir una confirmación de que la base de datos ha sido creada.

PRUEBE SU INSTALACIÓN

Para probar la instalación, vaya a la página principal o la primera página de web para su HydroServer. La URL para acceder a su HydroServer es www.suservidorweb.com/client/. Puedes acceder a su instalación de HydroServer través de la página web con el nombre de usuario his_admin y su nueva contraseña. ¡Si usted es capaz de iniciar la sesión, su HydroServer Interactivo Cliente Web instalación fue con éxito y el sistema ahora está listo para usar!

Es una buena idea para personalizar aún más su HydroServer Interactivo Cliente Web instalación por sustituir el WebClientBanner.png (960 píxeles de ancho por 200 píxeles), por lo que su encabezado en cada página tiene su logotipo o nombre de la organización. Este archivo se encuentra en su "/ client / imágenes" subcarpeta. La imagen predeterminada es la siguiente:

Un buen número de imágenes de sustitución que se pueden editar o personalizar con su propio texto usando un programa de gráficos de su elección se encuentran disponibles en la HydroServer Interactivo Cliente Web página de documentación aquí:

http://download-codeplex.sec.s-msft.com/Download?ProjectName=hydroserverlite&DownloadId=524126

Ejemplos de estas banderas incluyen la siguiente:

También debe personalizar su homepage_shot.jpg (300 píxeles de ancho por 301 píxeles) archivo de imagen. Esta es la imagen que se encuentra en la ventana principal de la página principal. Personalizar a su propia imagen le dará a su sistema una apariencia única que coincide con su organización.

La imagen por defecto homepage_shot.jpg parece así:

Una imagen revisada podría incluir el logotipo de su equipo de investigación, una foto de su área de estudio, investigación o cualquier otra imagen que ayuda a las personas a reconocer su sitio. Por ejemplo:

Después de instalar HydroServer Interactivo Cliente Web, Usted debe probar su funcionalidad básica por

- Crear un nuevo usuario o nuevos usuarios con diferentes niveles de permisos y ver cómo cada nivel de usuario (administrador, gerente, técnico) tiene una visión diferente de la barra de menú de la izquierda.
- Crear una nueva fuente de datos, sitio, variable.
- Agregar nuevos datos a la HydroServer con el único valor, múltiples y la carga de archivos métodos de entrada de datos.
- Ver los datos con el gráfico y vistas de datos tabulares.
- Descargar los datos utilizando el archivo de CSV opción de exportación.

NOTAS FINALES

PRUEBA EN HYDRODESKTOP

Además de las ideas de las pruebas mencionadas anteriormente, también se debe considerar tratando de conectar a la base de datos a través HydroDesktop. Esto le permitirá buscar y recuperar datos de la instancia HydroServer y valida que el servidor está hablando correctamente el WaterML y servicios lingüísticos WaterOneFlow. Un tutorial que explica cómo acceder a esos "servicios web no publicados" se publica en el http://hydrodesktop.codeplex.com página de documentación aquí: http://download.codeplex.com/Download?ProjectName=hydrodesktop&DownloadId=340161.

REGISTRARSE EN HIS CENTRAL

Si usted llena su servidor con datos útiles, entonces usted debe también considerar el registro en el Sistema de Información Hidrológica CUAHSI más amplia para que otros puedan conocer sus datos. Usted puede hacer esto siguiendo las instrucciones publicadas en el http://hydroserverlite.codeplex.com página de documentación aquí: http://download-codeplex.sec.s-msft.com/Download?ProjectName=hydroserverlite&DownloadId=504294

INFORMAR SU EXPERIENCIA

Si tiene algún problema con su configuración, puede comunicarse con el equipo de desarrollo para más información mediante la presentación de un billete en cuestión a http://hydroserverlite.codeplex.com.

HydroServer Interactivo Cliente Web

Cómo y Para Qué Usarlo

Por Stephen Bolster
Universidad de Brigham Young
Departamento de Ingeniería Civil

Cómo Usar HydroServer Interactivo

Cómo Usar HydroServer Interactivo

- Servidor de Web
- Instalación
- Preparación de Datos
- Ayuda

Servidor de Web

- HydroServer Interactivo Cliente Web (HSI) es una aplicación de código abierto (*open source*) para la gestión de datos. Fue creado por el *Consortium of Universities for the Advancement of Hydrologic Science, Inc.* (CUAHSI), específicamente para los datos hidrológicos.

- HSI funciona vía internet, utilizando Hypertext Preprocessor (PHP) y una base de datos MySQL

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Servidor de Web

Cualquier persona u organización puede usar HSI los únicos requisitos son los siguientes:

- Tener un servidor de web
- Usar base de datos MySQL y trabajar con PHP
  - Generalmente todos los servidores de web cumplen estos requisitos

Servidor de Web

- HSI usa este sistema por que todo es *open source* y no cuesta mucho
- Otra opciones para sistemas de gestión de datos cuestan miles de dólares
- Por ejemplo, HydroServer, también hecho por CUAHSI, puede costar mas de $10.000

El Costo Para un HydroServer

Microsoft SQL Server = $3.899
Microsoft Web Server = $1.055
ESRI ArcGIS Server = $5.000
Costo Total = $9.954

¡Adicione el costo de un administrador de servidores y el costo es muy grande!

HSI a lo sumo llega a ser aproximadamente $25 por mes (y a veces mucho menos) pagando por un servidor de web, pero tal vez ya lo tenga.

Servidor de Web

- Si ya tiene un sitio de web , tendrá un servidor de web. Solo hay que averiguar si tiene acceso para una base de datos MySQL.
- Si necesita comprar un sitio de web es muy fácil obtenerlo por un alojamiento web (web hosting).
- Ejemplos de donde comprar un sitio de web son:

  - godaddy.com
  - webcom.com.mx/
  - guatemalanetworks.com/

  - hostmundial.com/honduras
  - hostingnicaragua.com/
  - yahoo.com/webhosting

Instalación

La instalación de HSI es muy simple:

1. Cargar los archivos de HSI al sitio de web
2. Entrar "su sitio de web"/client/setup
3. Seguir la secuencia de comandos para configurar el nuevo HSI

BYU
BRIGHAM YOUNG
UNIVERSITY
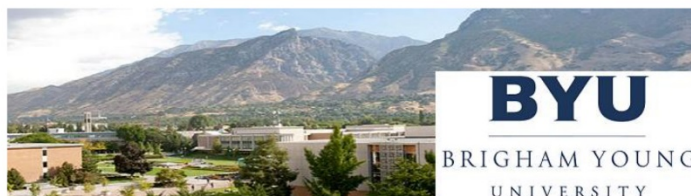
Bienvenido a la Instalación

Esta secuencia de comandos de configuración lo guiará para instalar HydroServer Interactivo en su servidor de web. Por favor, asegúrese de que tiene los datos listos de la base de datos antes de continuar.

Comenzar Instalación

Instalación

Para Configurar Necesitará

- Crear Contraseña para el administrador principal (his_admin)
- Información de la base de datos
  - El Host
  - El Nombre de usuario
  - Contraseña
  - Nombre de la base de datos
- Datos de su organización
  - Información de referencia espacial
  - Otros metadatos...

Eso es todo. Ahora hay que preparar los datos para cargar a HSI

Preparación de Datos

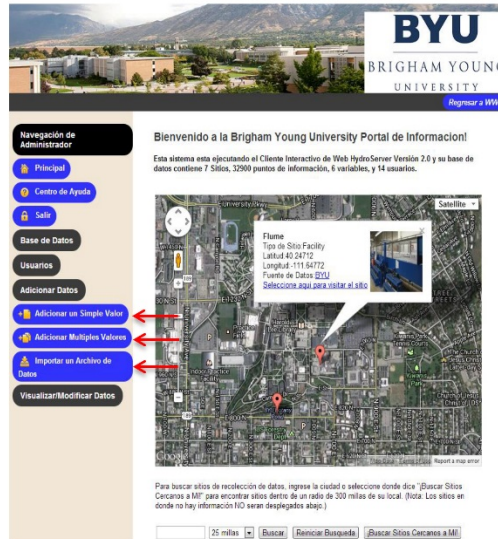Para la mejor gestión de datos y de metadatos tendrá que obtener la siguiente información:

- La Fuente de datos
- El Sitio (estación) donde recoge los datos
- Las Variables involucradas con los datos
- El Método para obtener los datos

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www.manaraa.com

Preparación de Datos

Hay 3 modos de entrar los datos

- Adicionar un único valor
  - Permite adicionar solo un valor
- Adicionar múltiples valores
  - Permite adicionar varios valores a cualquier variable o/y sitio
- Importar un archivo de datos
  - Permite cargar un archivo CSV para un sitio y una variable
  - La mejor manera de cargar muchos datos

Preparación de Datos

Adicionar un Simple Valor

Adicionar Múltiples Valores

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Preparación de Datos
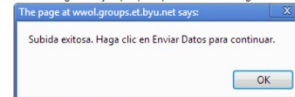
Importar un archivo de datos
- Es la mejor manera para adicionar datos al sistema
- Hay que ser muy exacto con el formato
  - Utilice dos columnas
  - La primera fila primera columna dice "LocalDateTime"
  - La primera fila segunda columna dice "DataValue"
  - Y la fecha es en formato de "aaaa-mm-dd hh:mm:ss"
    - Para el 20 de diciembre 2011 a las 9:30 p.m. será "2011-12-20 21:30:00"

Ayuda

En el caso de que necesitan mas tiempo para preparar, escoger un alojamiento web, o preparar el servidor de web podemos ayudar

Tenemos espacio en un servido aquí donde podemos poner sus datos hasta que estén listos para usar su sistema

Será solo temporal y es fácil cambiarlo cuando estén listos con su propio servidor

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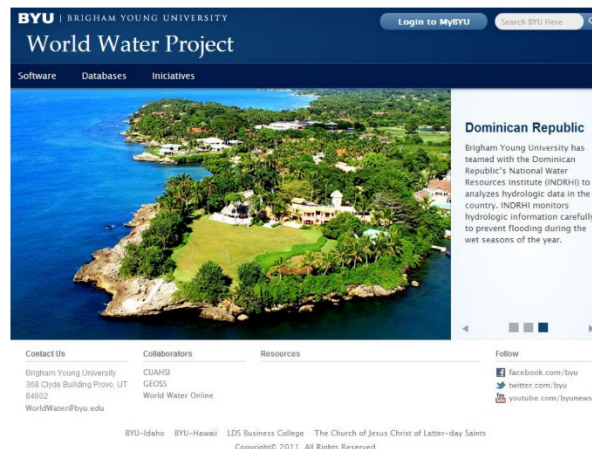
Para Qué Usar HydroServer Interactivo

Para Qué Usar HydroServer Interactivo

Aparte del costo de HSI, hay otras razones para implementar HSI en su organización

- Acceso Administrativo
- Gestión de Datos
- Acceso a los Datos
- Ejemplo

Acceso Administrativo

HSI proporciona la capacidad de
proveer diferentes niveles de
acceso a su sistema

- Administrador
  - Tiene acceso a todas partes
    del sistema
- Gerente
  - Tiene acceso para adicionar
    sitios y datos, ver datos, y
    gestionar usuarios
- Técnico
  - Tiene acceso solo para cargar
    y ver datos

Gestión de Datos

HSI le ofrece la gestión de la base de datos
- Añadir y editar a la base da datos incluyendo
  - Fuentes de los datos
  - Sitios (estaciones)
  - Variables
  - Métodos
- Manejo de Usuarios
  - Adicionar nuevos usuarios
  - Cambiar contraseñas
  - Cambiar el nivel de autoridad
  - Eliminar usuarios

Gestión de Datos

Parte de la gestión de los datos se incluye la habilidad de editar los datos entrados. Puede editar

- La fecha
- La hora
- El valor

Gestión de Datos

Estructura de las Tablas de la Base de Datos (El ODM) que facilita HSI

Acceso a los Datos

HSI brinda fácil acceso a los datos por medio de una conexión web. Uno puede
- Ver gráficos de datos
  - Ver diferentes fechas en el gráfico
  - Comparar con otros valores de datos en el gráfico
- Ver una tabla de datos
  - Cambiar la ordenación
  - Descargar los datos
    - Seleccionar las fechas inicial y final para descargar

Acceso a los Datos

- Tener sus datos en este sistema facilita y acelera el acceso a los datos dentro su organización
- Tendrá una locación central para todos sus datos
- Cuando quiera compartir los datos fuera de su organización puede hacerlo fácilmente

Acceso a los Datos

Nota sobre acceso a los datos fuera de su organización

A veces los gobiernos tienen leyes que regalan como se comparten los datos hidrológicos. Aún cuando HSI es creado para facilitar el intercambio de datos, puede ser alterado para limitarlo. Algunas páginas pueden ser eliminadas que permiten acceso a los datos sin ingresar con el nombre de usuario. Por HSI ser *open source* el código puede ser alterado en cualquier forma que sea mas útil a su organización.

Ejemplo

El departamento de Ingeniería Civil de la Universidad de Brigham Young ha decidido usar HSI para las investigaciones hechas aquí. Aunque tenemos otros sistemas disponibles, usamos HSI porque es más fácil para enseñar a los diferentes estudiantes que manejan datos, comparándolo con otros sistemas que requieren una comprensión avanzada de base de datos y servidores. HSI tiene la misma funcionalidad que tienen estos sistemas. Los datos del departamento estarán disponibles en el sitio web worldwater.byu.edu.

Conclusión

<u>HydroServer Interactivo Cliente Web es</u>
- Gratis y solo necesita servidor de web que tal ves ya tenga
- Simple para instalar

<u>HSI ofrece</u>
- Acceso administrativo
- Gestión de datos avanzado
- Acceso a los datos

¡Todo esto está a su alcance y estamos listos para ayudarles!
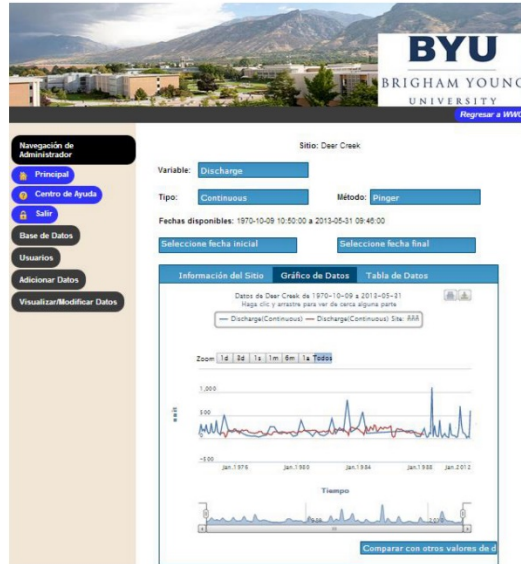
El Fin

Si tenga cuestiones o comentarios contacte

Stephen Bolster
sjbolster@gmail.com

-Gracias-

A.4 Spreadsheets to Enter Data for HydroServer Lite

Ingreso	Ejemplo	Información de Ayuda	Sus Datos
Nombre de la Organización	Universidad de Brigham Young		
Nombre del Página principal	World Water Online - BYU	Nombre de su sitio de web si lo tiene	
Página principal	worldwater.byu.edu	Dirección de su sitio web	

Ingreso	Ejemplo	Información de Ayuda				
			Fuente 1	Fuente 2	Fuente 3	...
Organización	McCall Outdoor Science School	Nombre de la organización				
Descripción	El misión de MOSS es...	Descripción de la organización				
Nombre de Contacto	José Fulano	Nombre de contacto en la organización responsable de la información de la fuente				
Teléfono	XXX-XXX-XXXX	Número de teléfono de contacto de la organización				
Correo Electrónico:	info@moss.org	Correo electrónico de contacto en la organización				
Dirección Ciudad	363 Clyde Building Provo	dirección de envío				
Categoría de Temas	Clima	Tema que cubre esta fuente				
Titulo	Twin Falls High School	Título de los datos				
Resumen	Científicos aficionados colectando...	Breve descripción de los datos				

Ingreso	Ejemplo	Información de Ayuda
Fuente de Datos	U.S. Geological Survey	Esta será una fuente previamente definido en la lista de fuentes
Nombre del Sitio	Provo BYU	
Tipo de Sitio	Facilidad	El tipo de sitio en el que se recogen los datos
Latitud	40.23548	
Longitud	-111.6701	
Dátum Vertical	NAVD 88	El datum vertical de la elevación. Vocabulario Controlado de VerticalDatumCV. Por ejemplo, MSL, que representa el nivel medio del mar.
Referencia Espacial	NAD 83	La referencia espacial es con el propósito de registrar el nombre y EPSG código de cada sistema de referencia espacial utilizado. Por ejemplo, NAD83 / Idaho Central.

cada sitio puede tener múltiples variables asociadas a ella

Sitio 1	Sitio 2	Sitio 3	...

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Ingreso	Ejemplo	Información de Ayuda	Variable 1	Variable 2	Variable 3	...
					Puede sólo tener dos variables (caudal y precipitación)	
Nombre de la Variable	Caudal	Una lista desplegable de variables que ya existen en la base de datos se y proporcionan las definiciones..				
Especiación	No aplicable	Un código usado para identificar cómo el valor del dato es expresado. Por ejemplo, El fósforo es expresado como P.				
Unidad del Tipo de Variable	pies cubico por segundo	La categoría general para el tipo de unidad que su variable tiene.				
Medio de Muestra	Agua Superficial	El medio de la muestra u observación fue tomada ó creada.				
Tipo de Valor	Observación de Campo	El valor del tipo de dato a ser registrado. Por ejemplo, Esta variable fue medida en el campo ó es parte de una simulación, etc.				
Regularidad del Valor	Regular	Si el valor de los datos son de un serie de tiempo regularmente muestreada.				
Tiempo de soporte	1	El valor numérico que indica la huella temporal de valores de los datos. 0 muestras instantaneas (muestras tomadas en aleatorio ó irregular intervalos). Otros valores indican el tiempo sobre el cual los valores de los datos son agrupados. Por ejemplo, el valor fué colectado cada 10 minutos.				
Unidad de Tiempo	segundo	Unidad de tiempo utilizado para medir puntos de datos				
Tipo de dato	Continuo	La manera en que se registran los datos en cuanto a tiempo				
Categoria	Hidrología	La categoría científica general de esta variable se mide ajustada.				
Método(s) Usado(s)	pluviometer	Será(n) método(s) criados en la proxima hoja. Puede poner "No método específico"				

Ingreso	Nombre del Método	Método de Enlace	Método 1	Método 2	Método 3	...
Ejemplo	*YSI DO 250<1 Meter*	*http://www.ysi.com/productsdetail.php?DO2 00-35*				
Información de Ayuda		Enlace a la página web que describe el método				
La(s) Variable(s) Utilizada(s) por este Método	Caudal	Será(n) variable(s) criada(s) en la hoja anterior.				

Para entrar los datos nesecitamos los siguientes valores
Con cada conjunto de valores de datos, indique la fuente, sitio, variable, y el método utilizado por favor

	Por Ejemplo		Sus Datos 1			Sus Datos 2			Sus Datos 3			
Fuente -	BYU		Fuente -			Fuente -			Fuente -			…
Sitio -	Rio Provo		Sitio -			Sitio -			Sitio -			
Variable -	Caudal		Variable -			Variable -			Variable -			
Método -	Sensor de Corriente		Método -			Método -			Método -			
Fecha	Hora	Valores	Fecha	Hora	Valores	Fecha	Hora	Valores	Fecha	Hora	Valores	
2002-03-31	13:00	51.00										
2002-03-31	14:00	53.00										
2002-03-31	15:00	54.00										
2002-03-31	16:00	52.00										
2002-03-31	17:00	50.00										
2002-03-31	18:00	50.00										
2002-03-31	19:00	50.00										
2002-03-31	20:00	49.00										
2002-03-31	21:00	48.00										
2002-03-31	22:00	51.00										
2002-03-31	23:00	53.00										
2002-04-01	0:00	55.00										
2002-04-02	1:00	66.50										
2002-04-03	2:00	67.00										
2002-04-04	3:00	66.75										
2002-04-05	4:00	66.00										
2002-04-06	5:00	63.00										
2002-04-07	6:00	62.00										
2002-04-08	7:00	61.00										
2002-04-09	8:00	57.00										
2002-04-10	9:00	53.00										