SEISMIC IMAGING TO HELP UNDERSTAND AND MANAGE WATER QUALITY IN COASTAL BENIN, WEST AFRICA

WHERE: Bénin, West Africa

WHAT: Using geophysical tools the team will map the groundwater system to help mitigate saltwater intrusion.

WHO: Boise State University; Gonzaga University; l’Université d’Abomey-Calavi, Bénin; l’Université de Nice Sophia-Antipolis, France

HOW MUCH: Total Project Cost: $194,162
SEG Foundation Grant: $89,664

WHEN: October 2012 – September 2014

PROJECT MANAGER: John Bradford, Boise State University
(208) 426-3898
johnb@cgiss.boisestate.edu
www.seg.org/gwb

OVERVIEW OF PROJECT

The coastal city of Cotonou in Bénin, West Africa, is a large population center that is facing a serious threat to the sustainability of its fresh water supply. Cotonou is Bénin’s largest city with approximately 1.5 – 2.0 million people. It relies on the Godomey aquifer for domestic water supply. The aquifer is undergoing saltwater intrusion and this problem is likely to worsen without significant steps to improve management of the pumping system. Lake Nokoué is a nearby water body that has high salinity levels throughout much of the year and is thought to be the primary source of salinity in the aquifer. Within Lake Nokoué is Ganvié (a city of greater than 30,000 inhabitants built entirely on stilts in the lake). The presence of this lake city and the fact that the lake is heavily relied upon for fishing has resulted in severe manipulation of the lake for waste disposal, navigation and fish farming. The continuity of the aquifer and saltwater flow paths are poorly understood but this information is critical to ensure sustainable access to fresh water in this growing urban center. We are using seismic reflection and electrical resistivity to map the primary aquifer system and identify flow pathways for saline water. Preliminary results from our first field season indicate that the aquifer system is significantly more complicated than previously thought. A key component of the project is providing integrated training and field experience for students from both the U.S. and Bénin.

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OBJECTIVE:

Shallow seismic reflection is a geophysical technique that is well suited to mapping the aquifer system, and when coupled with electrical resistivity measurements, can be a powerful tool in identifying flow pathways for saline water contamination. To map the hydrogeologic units of the Godomey aquifer system, we are acquiring seismic reflection and resistivity surveys over two field campaigns. During the first field season we focused on land seismic acquisition and coincident resistivity data in the area west of Lake Nokoué and into the Godomey well field. The second field season will be focused on marine seismic acquisition on Lake Nokoué and repeated electrical resistivity measurements. All seismic profiles are being tied to existing well logs with the primary objective of mapping the water bearing units and locating saltwater flow paths. The aquifer map produced through seismic reflection analysis will provide critical information to the local water management agency and measured geometry of geologic units will be used to improve hydrologic models of the aquifer.

Principal Outcomes:

- Development of a high-quality aquifer map for use by the water agencies of Bénin in the management of the domestic water supply for the city of Cotonou
- Opportunity for collaboration among colleagues from Gonzaga, Boise State, the Université d’Abomey-Calavi, the Université Nice Sophia Antipolis, and the Bénin government water agency
- Integrating undergraduate and graduate students directly into international field work, thus allowing U.S. and African students to work directly with their peers and faculty from the partnering countries
- Technology exchange among the four partner schools and the Bénin government agency
- Training on modern geophysical equipment and state-of-the-art data processing and analysis software for students from Bénin

Geophysical Equipment and Software:

- Geometrics 72-channel seismic system with cables and geophones
- IRIS SYSCAL Kid 24-electrode DC resistivity
- Trimble GeoXH GPS system
- Landmark ProMAX™ seismic reflection processing software
- Res2Dinv DC resistivity processing software

Methods:

Shallow seismic reflection will provide greater vertical and horizontal resolution at the target depth than other potential methods. We expect to acquire high quality data while minimizing our field costs through the use of a low cost seismic source and optimal seismic system (3 24 channel geodes). In addition to conducting land seismic surveys we will acquire a grid of marine seismic data in Lake Nokoué. We will use a single Geode with a 12 channel hydrophone streamer towed behind a small motorized boat. Finally, the land seismic data will be integrated with DC resistivity to provide direct information regarding the distribution of saline water. Once again, we will optimize field costs using an Iris Syscal Kid, 24 electrode system with potential for high-quality data and interpretation.

Status: Project began October 1, 2012, first field season completed February, 2013