Caribbean-Florida Water Science Center Newsletter Volume 2, Spring 2015

U.S. Geological Survey Caribbean-Florida Water Science Center Newsletter

Message from the Director

Welcome to this issue of the USGS Caribbean-Florida Water Science Center (CFWSC) Newsletter. The Newsletter, published semi-annually, is designed to describe hydrologic events of interest, highlight recent projects, and list new publications from USGS offices in Florida and the Caribbean, including Puerto Rico and the U.S. Virgin Islands. Please share this Newsletter with friends and colleagues, and if there are specific topics you would like to see included in our Newsletters, let us know! The merger of the USGS Florida and Caribbean Water Science Centers was completed October 1, 2014, as part of a more widespread consolidation involving a number of water science center mergers in the Southeastern Region. The consolidation is designed to:

- facilitate resource and workforce sharing
- optimize employee strengths and distribute work load
- provide new opportunities for employee technical growth
- expand scientific expertise to address regional water-resource issues, and
- minimize overhead structures and costs in order to increase funds available for science activities.

The new CFWSC will continue to have an active presence in support of hydrologic research and monitoring across the Florida, Puerto Rico, and U.S. Virgin Islands region. We look forward to expanding our work with partner organizations throughout this region and identifying new projects of mutual interest relevant to our water-resources. Please feel free to contact me about any USGS programs or water-resource issues you may wish to discuss.

Rafael W. Rodríguez

Expansion of the USGS Streamgage Network in Florida and Puerto Rico

Recent increases in funding of the USGS National Streamflow Information Program (NSIP: *http://water.usgs.gov/nsip/*) have provided for expansion and structural upgrades of streamgages in Florida and Puerto Rico. The NSIP, focused on maintaining a long-term, unified National network to meet local- to National-level needs, addresses National goals for streamflow monitoring in five priority categories: (1) streamflow at interstate and National boundaries; (2) streamflow forecasting for floods and droughts; (3) river basin outflows; (4) streamflows in unregulated river basins of "sentinel" watersheds; and (5) streamflow information in support of three National water-quality networks (the largest rivers; intermediate-sized rivers; small pristine watersheds).

In 2014 the U.S. Congress provided a $6 million increase to NSIP primarily to ensure continuity and constancy of data collection at key streamgages in this National network. In Florida this resulted in a 22 percent increase in NSIP funding ($71,435). The newly expanded NSIP program in Florida fully funds 21 streamgages and partially funds 14 streamgages; the goal is full funding of 38 streamgages Statewide. The new funds were used to reactivate one discontinued streamgage and replace funding at 10 streamgages that had been withdrawn by local partners due to budget constraints. In Puerto Rico, the U.S. Congressional funding increase for NSIP in 2014 provided a 14 percent increase in funding ($21,170). The program funds were used to fully fund one streamgage, partially fund 15 streamgages, and replace old equipment. Some streamgages in Florida and Puerto Rico were rebuilt to increase flood resilience as part of the network expansion.

The USGS, through its Office of Surface Water (*http://water.usgs.gov/osw*), provides critical information needed by water resource managers, citizens, and others for flood protection, hydrologic surveillance, and water use. The reliable, timely, and impartial information provided by the USGS improves the understanding and management of water resources that contribute to the safety, health, and well-being of our citizens, and addresses important water issues at local, State, regional, and National levels.

The USGS streamgage network, which operates more than 7,000 streamgages Nationwide, provides streamflow information for a wide variety of uses including flood forecasting, hydrologic and water-quality surveillance, drought response, water management and supply, engineering design, research, support for economic development, and recreational safety. The streamgage network is funded primarily by the USGS Cooperative Water Program (*http://water.usgs.gov/coop/*), in partnership with local, State, and Tribal agencies, and the National Streamflow Information Program. Current real-time streamflow conditions, and historic records, for gages across the U.S. including Florida, Puerto Rico, and the Virgin Islands can be accessed on the USGS National Water Information System (NWIS) web site at: *http://waterdata.usgs.gov/nwis/rt*.

Suwannee River at Dowling Park, Florida, before (*left*) and after (*right*) site was rebuilt.

Record-Breaking Late Spring Rainfall Brings 2014 Flooding in the Florida Panhandle

On April 29, 2014, the Pensacola, Florida area experienced flash flooding as a result of an historic rainfall event that developed ahead of a slow moving cold front. The National Weather Service estimated that the total rainfall exceeded twenty inches during a 3-day period, and may have totaled as much as twenty-six inches in some areas. This heavy rainfall caused the failure of the earthen dam on Crescent Lake (see photo), a reservoir located on Bayou Marcus Creek about 1.5 miles upstream of US Highway 90. The failure of the dam released the contents of the lake into the creek, which was already flowing above flood stage, and it submerged the highway and the nearby USGS streamgage 02376100 Bayou Marcus Creek near Pensacola, Florida.

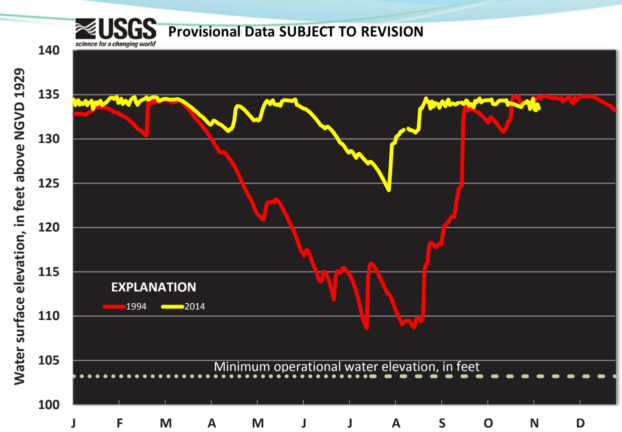
Crescent Lake Dam failure.

USGS personnel made 23 stream discharge measurements at 12 streamgage sites during this flood event and repaired one streamgage. USGS streamgage 02376100 recorded a water stage height of 11.27 feet, before the streamgage was submerged. An indirect streamflow calculation indicated that the peak water stage height was 11.90 feet, with an estimated discharge of 9,250 cubic feet per second.

Shelter at low flow.

Orange line shows high water mark on shelter during April flood.

USGS streamgage station 02376100



Reservoir water surface elevation at Lago Loiza at dam site (USGS Station Number 50059000) .

Widespread 2014 Drought in Puerto Rico Moderated by Tropical Storm Bertha

Summer rainfall deficits created abnormally dry to moderate drought conditions in the Commonwealth of Puerto Rico in 2014. June and July were drier than normal across most of Puerto Rico, with the exception of the western interior. Normal rainfall during the last 30 years in the Commonwealth of Puerto Rico has ranged from about 65–70 inches annually, but during the period from October 2013–July 2014, total rainfall amounts were as much as 20 inches below normal in some parts of the Commonwealth.

The USGS has more than 55 years of hydrologic monitoring data describing the Commonwealth's water resources, which are available to help the government and the public evaluate the drought situation (*http://pr.water.usgs.gov/drought/*). In Puerto Rico, rainfall deficits have led to regional droughts about every 15 to 18 years, on average. As of 2015, the USGS collects real-time precipitation data at 58 sites, stream-flow data at 116 sites, and measures surface-water elevations in 28 reservoirs. Groundwater level data are available from 87 active monitor wells (*http://pr.water.usgs.gov/*).

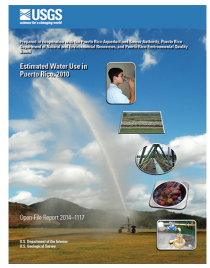
Drought has the potential to affect public water supply for the residents of Puerto Rico because reservoirs are the principal source of supply. The reservoir water levels are dependent on rainfall and stream flow. The total amount of available storage volume in reservoirs also limits water supply. Available reservoir storage volume can be reduced as a result of sedimentation, which has been documented in several reservoirs. Determining the sustainable water yield of reservoirs is a difficult challenge under prolonged below-normal rainfall; climate change amplifies this challenge.

During the hurricane season, hydrologic conditions can change rapidly in response to tropical systems (*http://pr.water.usgs.gov/drought/hydro_conditions_selected_sites.html*). On August 2, 2014, Tropical Storm Bertha crossed the southern part of Puerto Rico. This storm provided sufficient rainfall to restore or partially restore water levels in some reservoirs. The water level in Lago Caonillas rose by 14 feet, and Lago Dos Bocas rose by 10 feet to fill completely. These two reservoirs are located in the north-central region of the Commonwealth. Water levels in Lago Toa Vaca and Lago Cerrillos, in the south-central region, rose by 3.3 and 3.5 feet, respectively. The water level in Lago Loíza rose by about 5.4 feet, and the water level in Lago de La Plata rose by 3.5 feet.

Water Use Updates for Florida and Puerto Rico: Two Recent Reports Released

Two new reports, “Water Withdrawals, Use and Trends in Florida, 2010” (*http://pubs.usgs.gov/sir/2014/5088/*) and “Estimated Water Use in Puerto Rico, 2010” (*http://pubs.usgs.gov/of/2014/1117/pdf/ofr2014-1117.pdf*) were released in 2014. These reports were published as part of the USGS National Water-Use Information Program, a cooperative program to compile, store, and disseminate water-use information locally and Nationwide. Since 1950, the USGS has compiled data at 5-year intervals on the amounts of water used in homes, businesses, and on farms throughout the U.S. and has detailed how use has changed with time. The nationally-consistent compilation requires extensive data aggregation and accounting of the amounts, locations, and rates of water use by multiple users and providers. This USGS-coordinated data-collection effort provides critical information needed by water-supply planners and managers to determine current and future water needs and to help plan for water-resources management throughout the Caribbean-Florida region.

In Florida, accurate estimates of current water use and projected trends are compiled by the USGS in cooperation with the Florida Department of Environmental Protection, and in collaboration with the five Water Management Districts. In 2010, the total amount of water withdrawn in Florida was estimated to be 14,988 million gallons per day (Mgal/d). Groundwater accounted for 65 percent of freshwater withdrawals, and surface water accounted for the remaining 35 percent. Freshwater from groundwater sources provided drinking water (public supplied and self-supplied) for about 92 percent of Florida’s population, and fresh surface water from lakes, reservoirs, and rivers provided drinking water for about 8 percent. Saline surface-water withdrawals in 2010 totaled about 8,582 Mgal/d, and nearly all saline withdrawals were used for once-through cooling water at power plants. Public water supply accounted for 35 percent of the 2010 total water withdrawals, and domestic self-supplied accounted for 3 percent. Agricultural irrigation accounted for 40 percent of the total freshwater withdrawals in the State, whereas commercial, industrial, and mining water use collectively accounted for 6 percent of freshwater withdrawals. Recreational landscape irrigation accounted for 6 percent of the 2010 withdrawals, and thermoelectric power generation accounted for 10 percent (Marella, 2014).

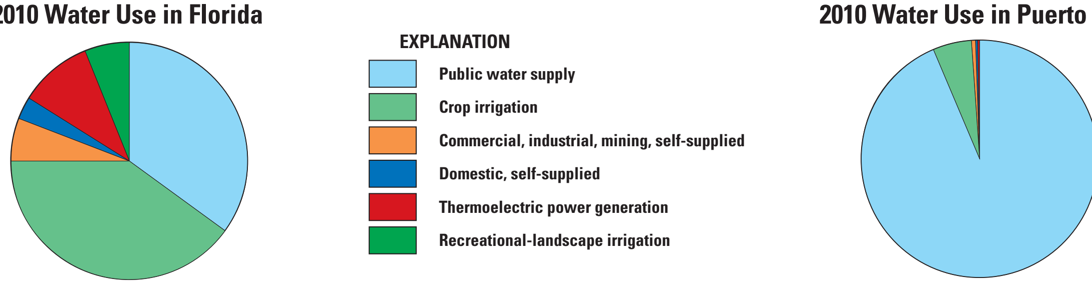


In Puerto Rico, the USGS National Water-Use Information program was implemented in 1980 to provide data for the management of the Commonwealth’s water resources. The USGS works in partnership with the Puerto Rico Aqueduct and Sewer Authority (PRASA), the Puerto Rico Department of Natural and Environmental Resources, and the Puerto Rico Environmental Quality Board to provide periodic compilation of water-use data for major use categories at 5-year intervals.

In Puerto Rico during 2010, public-supply water withdrawals by the PRASA from surface-water (587 Mgal/d) and groundwater (83 Mgal/d) sources constituted the major freshwater use category and were estimated at 670 Mgal/d. The population served by public-supply water facilities operated by the PRASA was estimated to be 96 percent of the total resident population (about 3,586,000 residents). Non-PRASA public-supply water withdrawals were estimated at 7.1 Mgal/d to serve a population of about 102,000 residents. Public-supply domestic water use in Puerto Rico was estimated at 206 Mgal/d, with about 30 percent of the total PRASA deliveries from surface-water and groundwater sources. Water withdrawals by domestic self-supplied users were estimated at 2.41 Mgal/d by a population of about 38,000 people. Groundwater withdrawals by industrial users were estimated at 4.30 Mgal/d.

Crop-irrigation withdrawals from surface-water and groundwater sources were estimated at 38.2 Mgal/d, of which 15.7 Mgal/d of surface water were in areas supplied by the public irrigation systems operated by the Puerto Rico Electric Power Authority. Groundwater withdrawals from Puerto Rico’s major aquifers for irrigation were about 22 Mgal/d. Micro-irrigation was the predominant irrigation method and was used to supply the water requirements for 80 percent of cultivated acreage. The nine active hydroelectric power plants located throughout Puerto Rico used about 556 Mgal/d of freshwater in 2010 (Molina-Rivera, 2014).

2010 Water Use in Florida **2010 Water Use in Puerto Rico**



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Urban Miami-Dade County: New USGS Model Simulates the Effects of Groundwater Pumpage and Sea-Level Rise on Canal Leakage and Regional Groundwater Flow

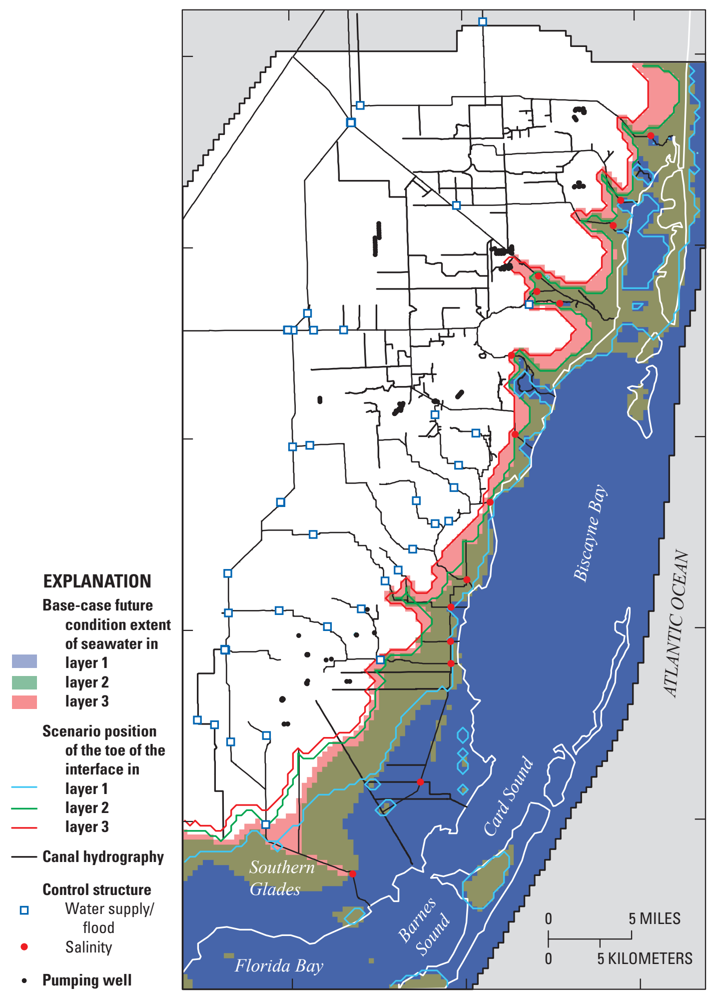
The USGS has developed and calibrated a dynamic coupled surface-water/groundwater model including urban areas of Miami-Dade County, Florida, and results are described in a recent report (Hughes and White, 2014) (*http://pubs.usgs.gov/sir/2014/5162/pdf/sir2014-5162.pdf*). The model simulates water levels in the canal system and surface-water/groundwater exchanges between the canal system and the Biscayne aquifer. The model shows how groundwater pumpage, sea-level increases, and other hydrologic stresses influence changes in canal leakage, regional groundwater flow, and the position of the freshwater-seawater interface.

The extensive and highly managed surface-water system in southeastern Florida has allowed for the westward expansion of urban development and agricultural activities in Miami-Dade County. The network of canals derives water from many sources including the Everglades, the water conservation areas, and the Biscayne aquifer. Previous studies have determined that on a local scale, leakage from canals adjacent to well fields can supply a large percentage (46 to 78 percent) of the total groundwater pumpage from production well fields. Canals in the urban areas also receive seepage from the Biscayne aquifer that is derived from a combination of local rainfall and groundwater flow from Water Conservation Area 3 and Everglades National Park, which are west of urban areas of Miami-Dade County.

Simulation results of the impact of the increased groundwater pumping scenario indicate that seawater intrusion may occur at the Miami-Springs well field if the Miami Springs, Hialeah, and Preston well fields are operated using current permitted groundwater pumping rates. In general, however, results indicate that the canal system limits the adverse effects of proposed increases in groundwater pumpage on water-level declines and saltwater intrusion.

Model simulation results for increased sea level (0.5 feet during the 30-year simulation period) also indicate that water-table elevations increased and water-table gradients decreased across the system; with increased sea level, the largest increases in water-table elevations occurred seaward of the salinity control structures. Increased sea level caused flood-prone areas in onshore parts of the study area to increase by 10.32 square miles and increased the percentage of time water-table elevations in flood-prone areas were less than 0.5 foot below land surface by 4 percent. Increased sea level also resulted in landward migration of the freshwater-seawater interface; the largest changes in the position of the freshwater-seawater interface occurred seaward of the salinity control structures, except in parts of the model area that were inundated by increased sea level. Groundwater inflow, groundwater outflow, canal exchanges, surface-water inflow, and surface-water outflow were reduced as a result of decreased water-table gradients across the system.

Model limitations should be considered when interpreting simulation results. The model was designed specifically to evaluate the effect of groundwater pumpage on canal leakage and may not be appropriate for predictions based on data not used in model calibration, at different spatial and temporal scales, and (or) for hydrologic conditions substantially different from those during the calibration and verification periods. Despite these limitations, the model represents the complexities that affect how the hydrologic system responds to groundwater pumpage and other hydrologic stresses.



Simulated change in the position of the freshwater/seawater interface from beginning to the end of the scenario simulation period for the increased sea-level and increased groundwater pumpage scenarios

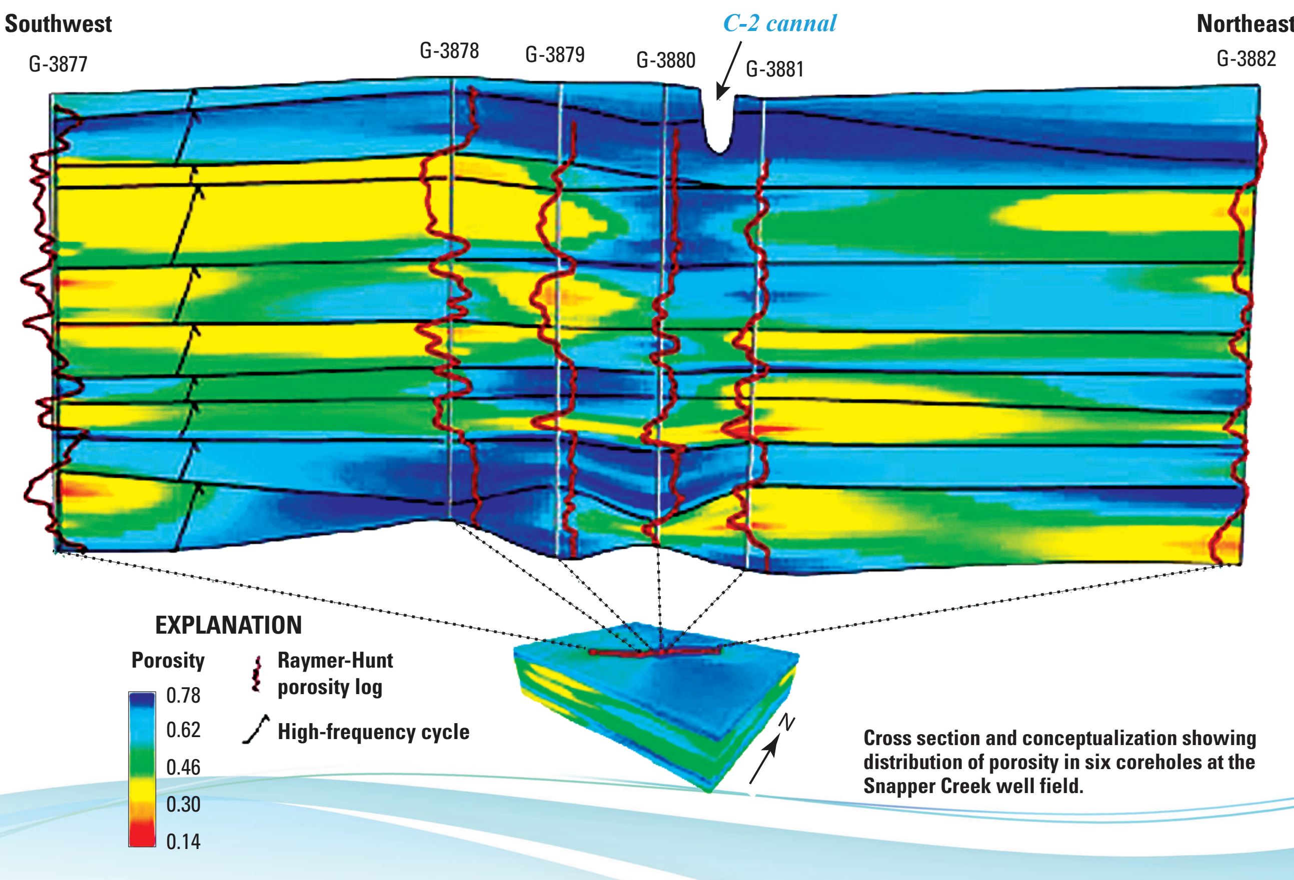
New Report Describes the Geologic and Hydrogeologic Framework of the Biscayne Aquifer in Central Miami-Dade County

The Biscayne aquifer serves as a sole source of drinking water for about 3 million residents in Miami-Dade, Broward, and southeastern Palm Beach Counties, Florida. Some of the production wells in the Biscayne aquifer are adjacent to water-management canals that are used for flood control, for recharge to the Biscayne aquifer, and to create hydraulic barriers to saltwater intrusion when used in conjunction with control structures near the coast. Groundwater withdrawals from production well fields may be inducing leakage from canals into the Biscayne aquifer. The Snapper Creek well field was chosen as a location in central Miami-Dade County for a detailed study of the potential for such leakage into the Biscayne aquifer from the C–2 (Snapper Creek) canal. The canal intersects the well field, roughly dividing it in half.

Lithostratigraphy, lithofacies, paleontology, ichnology, depositional environments, and cyclostratigraphy of the rocks and sediments penetrated by 11 coreholes were linked to geophysical interpretations to construct geologic and hydrogeologic frameworks for the study area. They were also linked to the results of slug tests of the hydraulic properties of the aquifer in the six test coreholes at Snapper Creek well field. Coupling of the data produced a new and more highly detailed resolution of the geologic and hydrogeologic framework for the study area, and provided insight on the scale of processes and properties important to understanding the Biscayne aquifer.

The hydrogeologic framework shows that the Biscayne aquifer within the study area can be divided into two major flow units, one near the surface (upper Biscayne aquifer flow unit) and the other at the base of the Biscayne aquifer (lower Biscayne aquifer flow unit). Both major flow units are continuous across the study area and are separated by a semi-confining unit that has relatively lower permeability compared to the major flow units. This "middle semiconfining unit" contains several thin interbedded minor flow zones that are not continuous across the study area.

Geologic, hydrogeologic, and hydraulic information acquired from the Biscayne aquifer during construction of monitoring wells within the Snapper Creek well field can be used as input into numerical models that can be used to quantify leakage from the canal to the production wells, and could be used to evaluate the groundwater flow budget at the well-field scale (Wacker and others, 2014, *http://pubs.usgs.gov/sir/2014/5138/pdf/sir2014-5138.pdf*).



Cross section and conceptualization showing distribution of porosity in six coreholes at the Snapper Creek well field.

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Recent Publications from the Caribbean-Florida Water Science Center

Belaineh, G., Sumner, D., Carter, E., and Clapp, D. 2014, Harmonizing Multiple Methods for Reconstructing Historical Potential and Reference Evapotranspiration: Journal of Hydrologic Engineering, 10.1061/(ASCE)HE.1943-5584.0000935 , 05014006.

Booth, A.C., Soderqvist, L.E., and Berry, M.C., 2014, Flow monitoring along the western Tamiami Trail between County Road 92 and State Road 29 in support of the comprehensive everglades Restoration Plan, 2007–2010: U.S. Geological Survey Data Series 831, 24 p. *http://pubs.er.usgs.gov/publication/ds831*

Choquette, A.F., 2014, Pesticides and nitrate in groundwater underlying citrus croplands, Lake Wales Ridge, central Florida, 1999–2005: U.S. Geological Survey Open–File Report 2013–1271, 28 p. *http://dx.doi.org/10.3133/ofr20131271*

Cunningham, K.J., 2014, Integration of seismic-reflection and well data to assess the potential impact of stratigraphic and structural features on sustainable water supply from the Floridan aquifer system, Broward County: U.S. Geological Survey Open–File Report 2014–1136, 5 p., *http://dx.doi.org/10.3133/ofr20141136*

Gomez-Gomez, Fernando, Rodriguez-Martinez, Jesus, and Santiago, Marilyn, 2014, Hydrogeology of Puerto Rico and the outlying islands of Vieques, Culebra, and Mona: U.S. Geological Survey Scientific Investigations Map 3296, 40 p. plus 2 pls. *http://dx.doi.org/10.3133/sim3296*.

Lee, T.M., Sacks, L.A., and Swancar, Amy, 2014, Long-term balance between net groundwater exchange and new precipitation in Florida seepage lakes: Journal of Hydrology: *http://dx.doi.org/10.1016/j.jhydrol.2014.04.009*

Marella, R., 2014, Water withdrawals, use, and trends in Florida, 2010: U. S. Geological Survey Scientific Investigations Report 2014–5088, 59 p. *http://dx.doi.org/10.3133/sir20145088*

Molina-Rivera, Wanda, 2014, Estimated water use in Puerto Rico, 2010: U.S. Geological Survey Open–File Report 2014–1117, 35 p. *http://pubs.er.usgs.gov/publication/ofr20141117*

Mount, G.J., Comas, Xavier, and Cunningham, K.J., 2014. Characterization of the porosity distribution in the upper part of the karst Biscayne aquifer using common offset ground penetrating radar, Everglades National Park, Florida: Journal of Hydrology, vol. 515, p. 223–236. *http://dx.doi.org/10.1016/j.jhydrol.2014.04.048*

Prinos, S.T., 2014, Using state-of-the-art technology to evaluate saltwater intrusion in the Biscayne aquifer of Miami-Dade County, Florida: U.S. Geological Survey Fact Sheet 2014–3050, 6 p. *http://dx.doi.org/10.3133/fs20143050*

Prinos, S.T., Wacker, M.A., Cunningham, K.J., and Fitterman, D.V., 2014, Origins and delineation of saltwater intrusion in the Biscayne aquifer and changes in the distribution of saltwater in Miami-Dade County, Florida: U.S. Geological Survey Scientific Investigations Report 2014–5025, 101 p. *http://dx.doi.org/10.3133/sir20145025*

Reese, R.S., 2014, Hydrogeologic framework and geologic structure of the Floridan aquifer system and intermediate confining unit in the Lake Okeechobee area, Florida: U.S. Geological Survey Scientific Investigations Map 3288, 8 sheets, plus 12 plates. *http://dx.doi.org/10.3133/sim3288*

Sepúlveda, N. and Doherty, J., 2014, Uncertainty analysis of a groundwater flow model in East-Central Florida: Groundwater, *http://onlinelibrary.wiley.com/doi/10.1111/gwat.12232/full*

Swain, E.D., Decker, J.D., and Hughes, J.D., 2014, Utilizing dimensional analysis with observed data to determine significance of hydrodynamic solutions in coastal hydrology: Computational Water, Energy, and Environmental Engineering vol. 3, no. 2: p. 57–77. *http://dx.doi.org/10.4236/cweee.2014.32008*

Swain, E.D., Smith, T.J., and Stefanova, Lydia, 2014, Applying downscaled global climate model data to a hydrodynamic surface-water and groundwater model: American Journal of Climate Change vol. 3, p. 33–49. *http://dx.doi.org/10.4236/ajcc.2014.31004*

Wacker, M.A., Cunningham, K.J., Williams, J.H., 2014, Geologic and hydrogeologic frameworks of the Biscayne aquifer in central Miami-Dade County, Florida: U.S. Geological Survey Scientific Investigations Report: 2014–5138, 66 p. *http://dx/doi.org/10.3133/sir20145138*

The USGS Water Mission Area (WMA) has the principal responsibility within the Federal Government to provide the hydrologic information and interpre-tation needed by others to achieve the best use and management of the Nation's water resources. The WMA actively promotes the use of its information products by decision makers to:

- Minimize loss of life and property as a result of water-related natural hazards, such as floods, droughts, and land movement.
- Effectively manage groundwater and surface-water resources for domestic, agricultural, commercial, industrial, recreational, and ecological uses.
- Protect and enhance water resources for human health, aquatic health, and environmental quality.
- Contribute to wise physical and economic development of the Nation's resources for the benefit of present and future generations.

If you have an environmental or resource-management issue that you would like to investigate in partnership with the USGS, please contact any of our senior management staff (listed below). Projects are supported primarily through the USGS Cooperative Water Program (*http://water.usgs.gov/coop/*). This is a program through which any State, County, local, or regional agency may work with the USGS to fund and conduct a monitoring or investigation project.

USGS Caribbean-Florida Water Science Center

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