Drought Notification System in Texas Monitors Groundwater Levels and Spring Flow to Trigger Action

Level TROLL® Instruments and TROLL® Link Telemetry Systems help conservation district manage water supplies and meet customer demands

Application

Conservation districts are looking for better ways to monitor and manage water resources, which are affected by naturally occurring cycles of drought, rising populations, and increasing demands from industrial sectors. Climate change associated with increased levels of greenhouse gases in the atmosphere may increase severity of future droughts (IPCC 2007). Potential effects of global climate change are also frequently factored into water management strategies.

The U.S. Drought Monitor suggests a risk management approach to drought management that emphasizes improved monitoring and planning. Water conservation districts are taking steps to reduce the impacts of drought through better preparedness, data collection, prediction, risk management, and improved response to drought emergencies (U.S. Drought Monitor; http://drought.unl.edu/dm/new.html; see Figure 1).

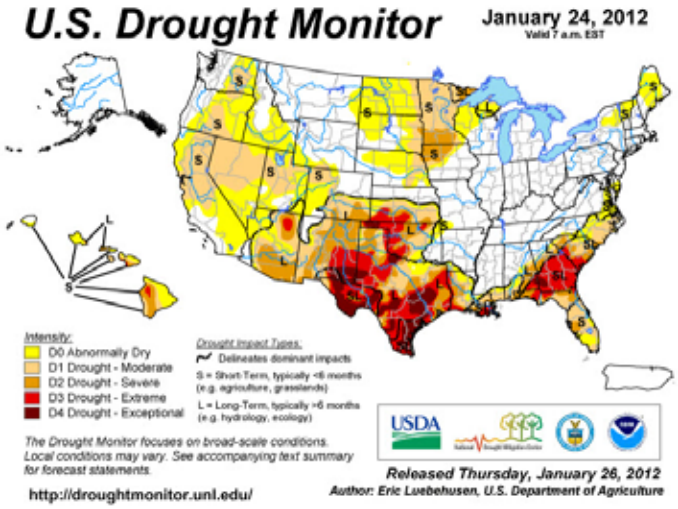

Figure 1: U.S. Drought Monitor summary and regional maps help the Barton Springs/Edwards Aquifer Conservation District plan for drought and manage resources. The U.S. Drought Monitor map is courtesy of and a joint effort of the National Drought Mitigation Center, the U.S. Department of Agriculture, and the National Oceanic and Atmospheric Administration.

Forward-thinking district manages drought

To manage water supplies and impacts from drought, conservation districts develop comprehensive management plans based on various hydrogeological studies. The Barton Springs/Edwards Aquifer Conservation District (BSEACD) in Central Texas has developed a management plan that considers environmental, economical, and social aspects of water use. The BSEACD is charged with conserving, preserving, protecting, recharging, and preventing waste of groundwater in the Barton Springs segment of the Edwards Aquifer (District Management Plan 2008).

The Barton Springs segment is a unique karst aquifer system that supports endangered species and supplies water to approximately 60,000 people – 80 percent public supply, 13 percent industrial use (quarry operations), and 7 percent irrigation (golf courses). The Barton Springs segment covers approximately 350 mi^2 (906 km^2) and has about 7,800 acre-feet/year (2.5 billion gallons) of authorized pumping from 94 permit holders under non-drought conditions. Hydrogeologists at the District are responsible for conducting drought assessments and managing water supplies to maintain the aquifer's water levels and water quality.

The State of Texas requires water planning based on drought of record (DOR) conditions and on groundwater modeling information and other studies or data about the aquifer (Smith, et al. 2007).

To characterize the Barton Springs segment and to manage resources, the District continuously monitors water levels in 28 wells with In-Situ® Level TROLL® Instruments (see Figure 2) and conducts hydrogeological studies, including geologic mapping, pumping tests, tracer tests, historical data evaluation, numerical groundwater modeling, well-impact analysis, and biological studies (Smith et al. 2007). Over the years, the District has added five Level TROLL® 500 Instruments (including three units with TROLL® Link Telemetry Systems), one Level TROLL® 300, and one Aqua TROLL® 200 to an existing fleet of In-Situ devices.

"A broad definition of sustainable yield considers that water can be extracted from an aquifer only to the extent that no undesired results take place," says Brian Smith, Ph.D., P.G. at the BSEACD. "The Barton Springs/ Edwards Aquifer Conservation District has determined that undesired results for the aquifer are drying up sole-source water-supply wells and jeopardizing the endangered salamander population at Barton Springs."

The sustainable yield assessment for the Barton Springs segment established the parameters of a (monthly average) water budget based on a recurrence of the

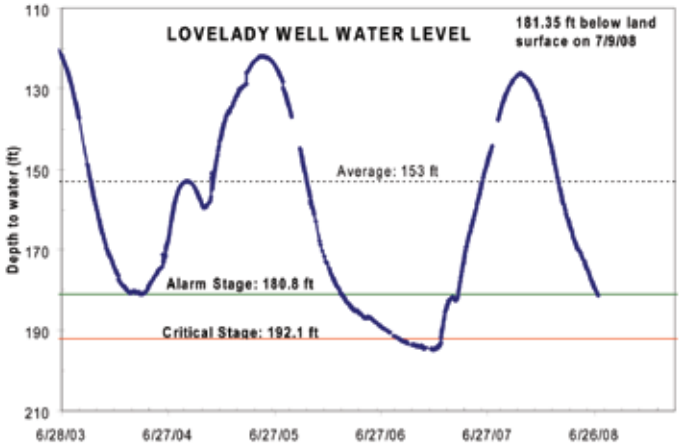

Figure 2: Level TROLL Instruments continuously collect data for the BSEACD. This hydrograph of Lovelady monitor well was developed using data collected with Level TROLL Instruments.

DOR. During the DOR in the 1950s, the lowest measured spring flow was approximately 10 cfs. Pumping 10 cfs during a recurrence of DOR conditions would therefore reduce spring flow to less than 1 cfs, or no-flow, for several weeks. Pumping of greater than 10 cfs would have negative impacts to many domestic wells, would increase the duration of no-flow conditions at Barton

Figure 3: Barton Springs flow rates are tracked at the U.S. Geological Survey gaging station at the site. This data, along with water level data from the Lovelady monitor well, help BSEACD determine the level of drought and actions needed to conserve water.

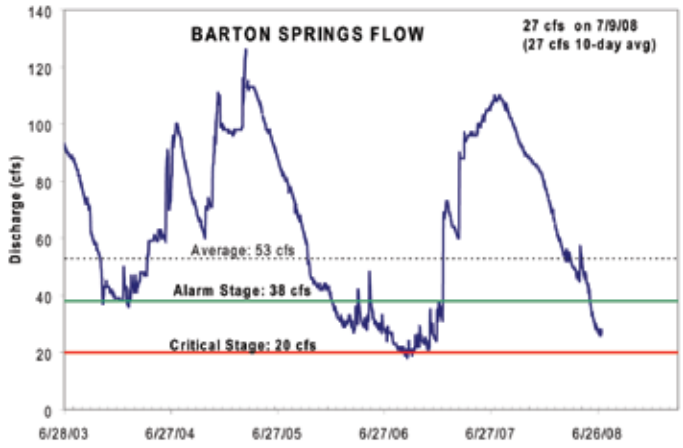

Figure 4: Discharge rates at Barton Springs.

Springs (see Figure 3), and would lead to unsustainable conditions (District Management Plan 2008).

To manage groundwater resources and to improve timing of drought declarations, the District has implemented a drought notification system or drought trigger policy. Many factors were considered when developing this policy, including prehistoric climatic data, the DOR, historic records of rainfall, groundwater levels, and spring flow data (Smith et al. 2007). Statistical analysis, numerical modeling, and input from various stakeholders helped mold the District's groundwater management regulatory program, which limits groundwater withdrawals from all sources when certain drought triggers are exceeded.

District declares drought

The District has defined drought triggers that enable them to declare different stages of drought: no drought, alarm stage, critical stage, and emergency response period (occurs if Barton Springs discharge is 14 cfs or less). To date, the emergency response category has not been used. Currently the drought triggers are based on flow rates at Barton Springs (see Figure 4) and water levels at the Lovelady monitor well. Either spring flow or water levels can trigger a drought stage (see Figure 5). However, both spring flow and water levels must be above their respective trigger levels to exit a drought stage (Smith et al, 2007).

From May to September and during drought-free periods, the District encourages permittees and the public to conserve water. The District reviews relevant aquifer data on a monthly basis during non-drought periods. The District informs the public and permittees about water conservation methods and drought status. In addition, the District assists permittees in developing drought planning strategies and complying with District drought rules.

If the Barton Springs discharge reaches 38 cfs or the Lovelady monitor well reaches 180.8 ft, then the alarm stage is triggered and notifications are sent to permittees. Permittees must reduce pumping by 20 percent. When the alarm stage is declared, District hydrogeologists report drought status on a biweekly basis.

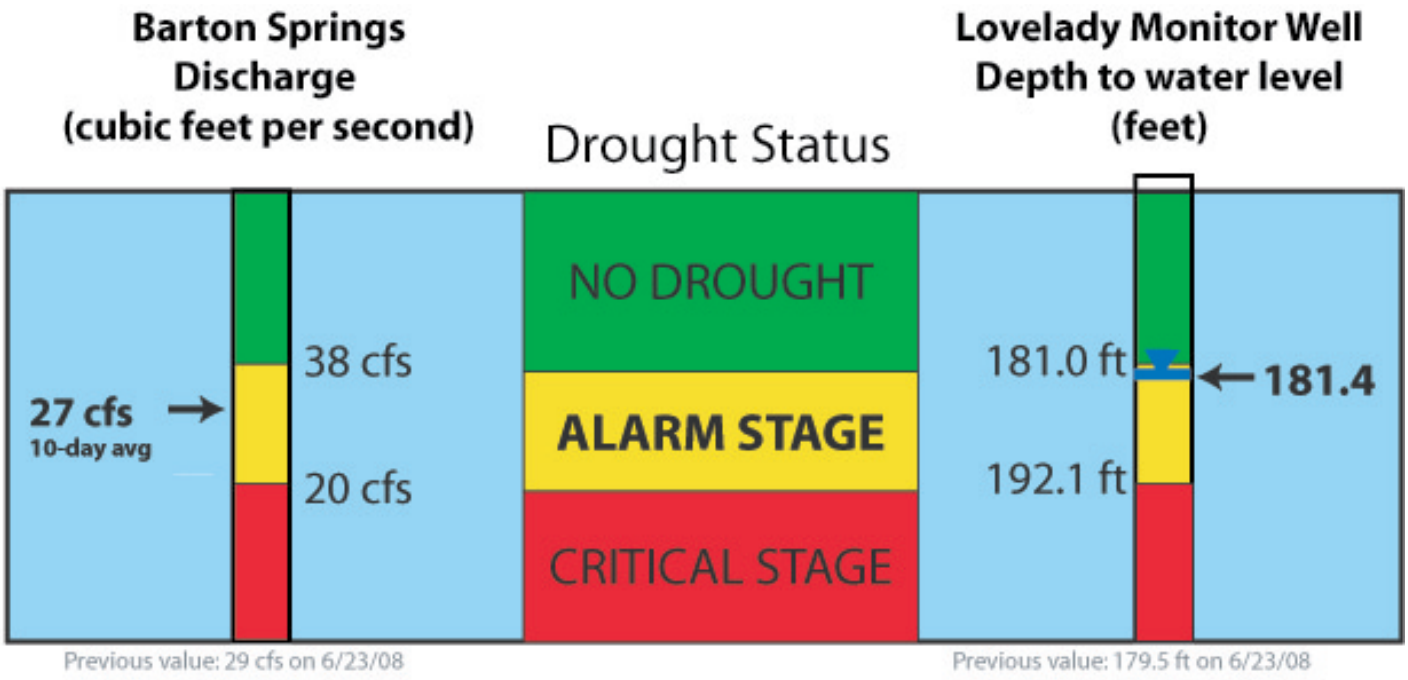

Figure 5: The drought status chart quickly communicates the level of drought to District board members, permittees, and the public.

If spring flows fall to 20 cfs or if water levels reach 192.1 ft, the District declares critical drought status. The District provides weekly updates and notifies permittees that they must reduce pumping by 30 percent. The District monitors spring flow and water levels on a biweekly basis.

"The drought trigger policy has improved the timing of entering into drought status," says Brian Smith, Ph.D., P.G. "This helps minimize impacts on water supply wells and maintains flow at Barton Springs, which helps protect endangered species."

District fine-tunes resource management

In an on-going effort to fully characterize the aquifer system, to support District policy development, and to adapt to changing conditions, District scientists use the latest data collection tools.

"During the past two droughts, we've collected a lot of water level data using Level TROLL® 500 Instruments placed throughout the District," says Brian B. Hunt, P.G. "Due to the accuracy and precision of the Level TROLL® Instruments, we have been able to more closely correlate data from Barton Springs to water levels in the Lovelady monitor well.

"We are now considering a change in one of the drought trigger levels," Hunt continues. "We may increase the water level metric from the Lovelady monitor well so that its trigger is more closely aligned to when Barton Springs reaches its threshold of 38 cfs. By raising the drought trigger level, alarm drought status notification will have less uncertainty and will increase conservation efforts that can stave off the possibility of moving into the critical stage."

To support increased frequency of data collection during a drought, the Lovelady monitor well is outfitted with a TROLL® Link Telemetry System (Figure 6). The telemetry system sends data from the Level TROLL 500 instrument to District headquarters, which saves time and decreases fuel and labor costs.

"With continuous monitoring of water levels throughout the District and implementation of a drought trigger policy, the District minimizes the undesired results of groundwater exploitation," says Smith. "The enactment of conservation measures and reduction of pumping under conditional permits will minimize adverse impacts to water supply wells and to the endangered salamanders."

Figure 6: Level TROLL 500 Instruments log Lovelady monitor well every hour. A TROLL® Link Telemetry System transmits data to a cell phone atthe main office.

More robust data sets help District hydrogeologists fine-tune management strategies and meet goals and policies set forth by the District's Board of Directors, the Texas Water Development Board, and the State of Texas.

References

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