The Hydrologic Drought of 2012 as Observed in Data from Wisconsin's Surface and Groundwater Networks

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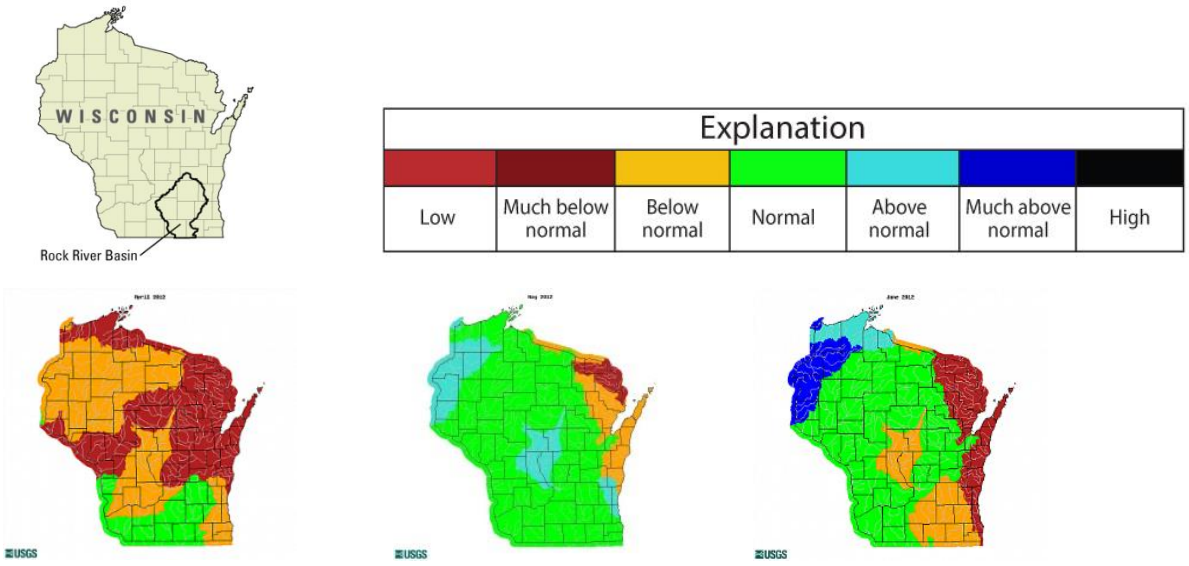
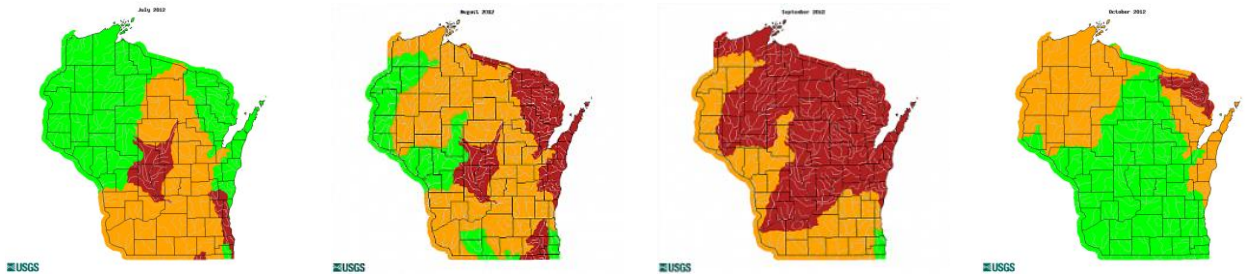
In 2012, nearly the entire State of Wisconsin experienced a hydrologic drought at some time during the year due to lower than normal levels of precipitation. Particularly wide-spread drought conditions were observed during the month of April, and again in the months of July, August and September. A hydrologic drought (http://nd.water.usgs.gov/drought/faqs/faq1.html) is one characterized by reduction of streamflow and lowering of groundwater levels (Subrahmanyam, 1967).

The hydrological drought conditions experienced in Wisconsin during 2012 are reflected in data collected by both the surface-water monitoring network of Wisconsin, operated by the U.S. Geological Survey (USGS), and the groundwater monitoring network of Wisconsin, operated by the USGS and the Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension (WGNHS). The operation of both these networks is made possible through the support of many local partners and volunteers.

Streamflow - These state maps show the surface-water condition in watersheds for selected months based on measured total streamflow (USGS Water Watch, http://waterwatch.usgs.gov/index.php). The orange and red colors identify watersheds whose average total streamflows for that month were below normal and experiencing drought conditions. The average total streamflow of the Rock River Basin is based on about 30 long-term monitoring gages located around the basin (http://waterwatch.usgs.gov/?m=real&r=wi&w=map). The basin is shown to have normal streamflow conditions (green) for April while adjacent basins were experiencing some degree of drought (orange, brown, and red). The Rock River Basin did experience drought for the months of June through September, returning to flows in the normal range by October. In contrast, northwest Wisconsin which began April with streamflow below normal, rose above normal conditions in May and June (shades of blue) only to return below normal again later that summer.



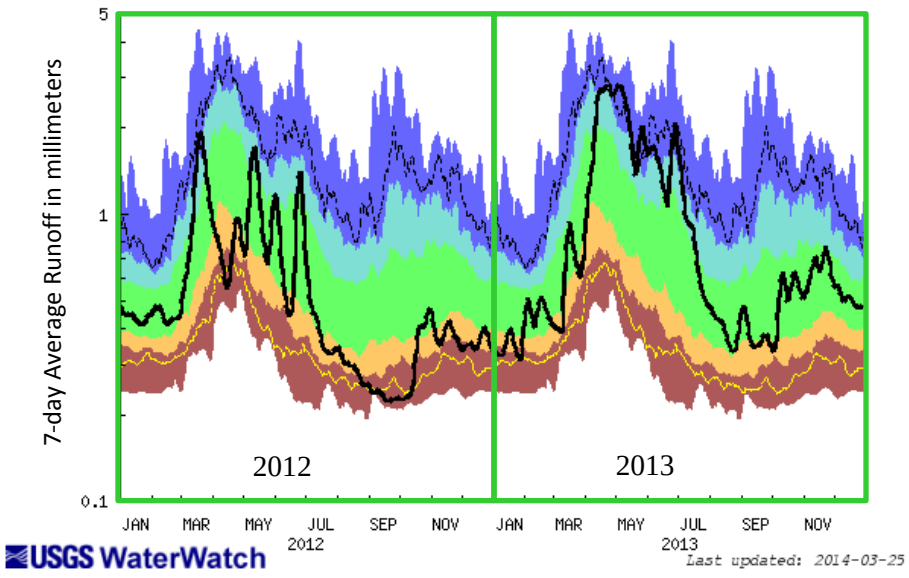
April 2012 May 2012 June 2012

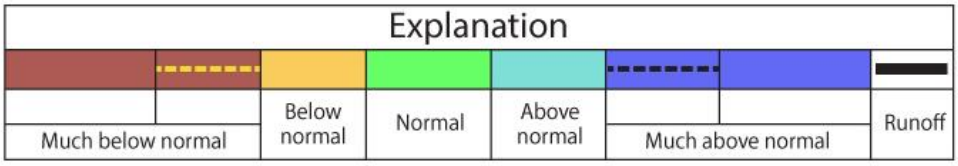


July 2012 August 2012 September 2012 October 2012

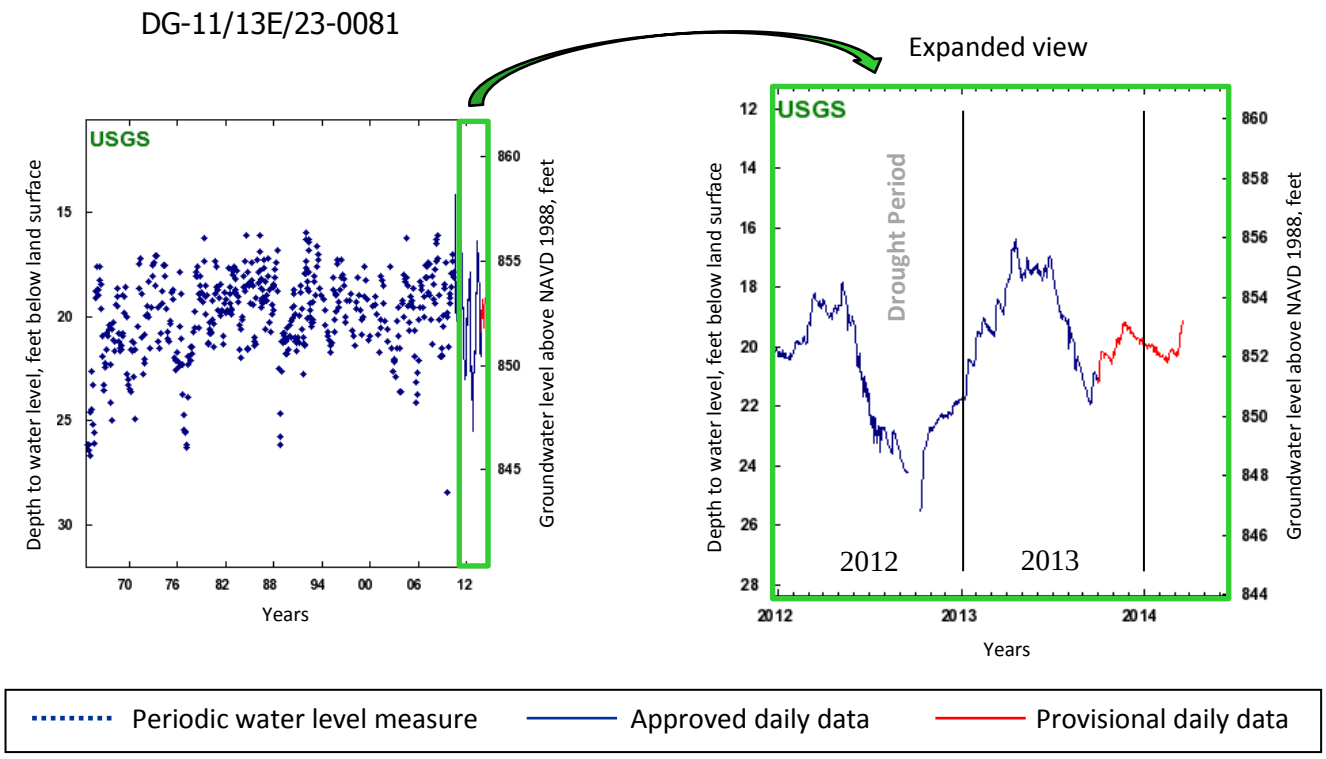
Total streamflow is made up of eventflow (short-term runoff from recent precipitation or snow melt) plus baseflow (longer-term contribution of groundwater from shallow aquifers). Over extended periods without precipitation or a melt event, the eventflow contribution approaches zero and the streamflow is composed almost entirely of baseflow. The relatively low amount of precipitation experienced during the hydrologic drought of 2012 is reflected in the 7-day average runoff for Wisconsin, expressed as the black line on the duration hydrograph shown below (http://waterwatch.usgs.gov/index.php). This figure shows the 7-day average runoff volume occurring through the year, computed from historical records of streamflow, and expressed as a depth across the entire area of the state. Normal 7-day runoff conditions are shown in green, with above normal conditions shown in shades of blue and below normal conditions shown in orange and brown. The solid black line indicates the actual value of 7-day average runoff through 2012 and 2013 and shows that the average runoff was below or much below normal for most of the second half of 2012.

Duration hydrograph of 7-day average runoff for Wisconsin

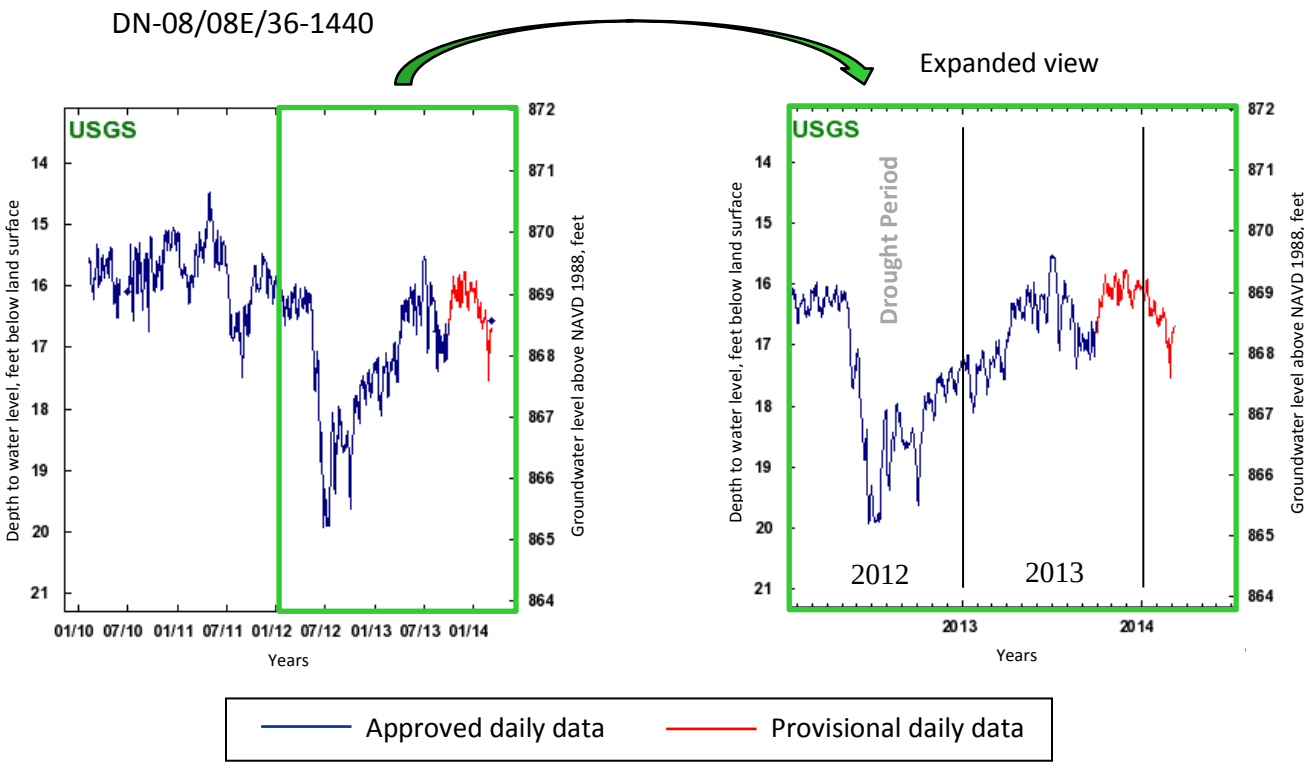




Groundwater levels –The extent to which a drought affects the groundwater levels in aquifers is the result of a complex interplay of many factors, including reduced recharge of precipitation to groundwater, local aquifer characteristics, the degree of interaction between surface water and groundwater, and increased pumping of groundwater in response to the drought. The 2012 hydrologic drought is reflected clearly in the measured level of groundwater in some Rock River Basin monitoring wells, while not reflected in others. One example of a well that does show a response is Dodge County Well DG-0081 between Beaver Dam and Columbus; this well is 125 feet deep and completed in the Cambrian-Ordovician aquifer system. The hydrologic drought of 2012 is seen as a drop in water level of around 8 feet from April to September, 2012 (http://groundwaterwatch.usgs.gov/AWLSites.asp?S=432415088552601&ncd=). Interestingly, even lower water levels have been measured at times during the 50-year period of record for this well.



Another example of a well that shows a response to the drought is Dane County well DN-1440; this well is 285 feet deep and completed in the Cambrian-Ordovician aquifer system, extending down to the deep Sandstone aquifer. The hydrologic drought of 2012 is seen as a drop of almost 4 feet from April to September (http://groundwaterwatch.usgs.gov/AWLSites.asp?S=430718089291501&ncd=). This well only has only about four years of data with lowest levels measured during 2012.



For the purposes of calibrating groundwater flow models, extended periods of drought provide scientists with data about the response of the groundwater system to hydrologic stress. As a drought begins, recharge to the groundwater system is slowed and flows in streams and water levels in aquifers often begin to decline. This hydrologic response to the drought can be incorporated into the testing and calibration of groundwater-flow models to ensure that the model is correctly simulating the natural hydrologic system. As an example, the hydrologic response to the 2012 drought was recently used by the WGNHS and USGS to calibrate an updated groundwater-flow model for Dane County, Wisconsin.

Data collected by hydrologic networks are critical to documenting average as well as extreme conditions and are regularly used to track the stage of rivers and lakes, forecast drought conditions, and predict the quality of recreational activities such as fishing or kayaking. Monitoring the response of streamflows and groundwater levels to prolonged periods of extreme weather, wet or dry, are particularly important for resource managers, conservationists, regulatory officials, and scientists who incorporate this information into the decisions and recommendations they make to protect life and property in the Rock River Basin.

For more information about the USGS Wisconsin Water Science Center and the Wisconsin Geological and Natural History Survey please visit:
http://wi.water.usgs.gov/
http://wisconsingeologicalsurvey.org/

Subrahmanyam, V.P., 1967, Incidence and spread of continental drought: World Meteorological Organization, International Hydrological Decade, Reports on WMO/IHD Projects, no. 2, Geneva, Switzerland.