ADDRESSING GROUNDWATER-LEVEL CHANGES IN NEW MEXICO

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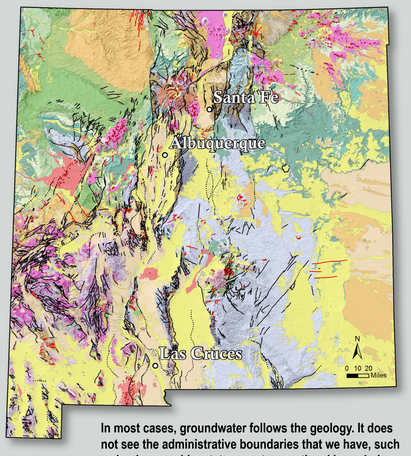
ABSTRACT

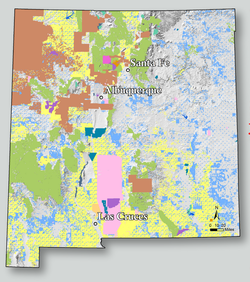
Changes in groundwater-levels can reflect very relevant water issues in the arid southwest, such as variations in nearby surface-water flows, fluctuations in aquifer recharge, and changes in groundwater storage. As collaborators from New Mexico Bureau of Geology and Mineral Resources (NMBGMR) at New Mexico Tech, U.S. Geological Survey (USGS), New Mexico Office of the State Engineer (NMOSE) and New Mexico State University (NMSU), we seek to address the groundwater storage change component of the Statewide Water Assessment initiated and funded by the New Mexico Water Resources Research Institute.

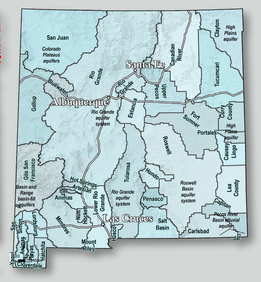
Our objective is to quantify changes in groundwater-levels and groundwater storage in regions of New Mexico. We are currently compiling high quality groundwater-level data into an ArcGIS-database. We will then use these data to develop regional groundwater-level change contour maps over selected time intervals. The intervals of assessment are based on the frequency of the measurements for the particular region, such as 5 to 10 year intervals. Finally, we will use the contour maps and estimates of aquifer properties to quantify regional changes in groundwater storage.

We are in the data compilation phase of this project. The interpretation of groundwater-level measurements is complicated by the irregular spatial and temporal distribution of the data and New Mexico's complex geology. In some regions, our study highlights data gaps where future work is needed. Documenting changes in groundwater-levels can identify areas where water-quality changes may be imminent, may help initiate additional water conservation efforts, and provides the State with a useful tool for groundwater quantity and quality management.



In most cases, groundwater follows the geology. It does not see the administrative boundaries that we have, such as land ownership, state, county or national boundaries.

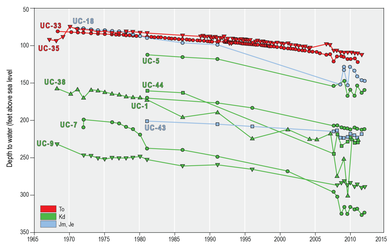




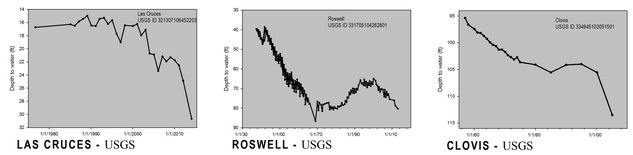
WHY ASSESS GROUNDWATER-LEVELS

Water in New Mexico is scarce. We currently rely on groundwater for approximately 50% of our water supply (Longworth et al., 2013). Models of surface-water flows in the Upper Rio Grande predict future decreases in water supply, along with seasonal changes and greater variability in flow (Llewellyn and Vaddey, 2013). The climate and surface-water effects predicted by this model presumably could affect the entire state, especially regions largely dependent on surface-water. As surface water resources change or decline, those regions now dependent on surface-water will likely turn to groundwater resources to meet their needs. However, the dynamic link between surface water and groundwater cannot be understated. Our proposed work will help prepare New Mexico for the impacts of these changes by providing some historical perspective of groundwater-level changes that have already occurred.

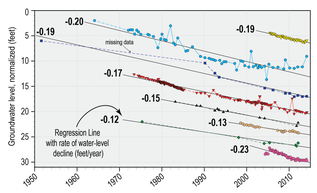
Short-term and long-term water-level changes can reflect very relevant (or can be harbingers of soon-to-be relevant) water issues and the hydrologic stresses on an aquifer or region (Taylor and Alley, 2001). In the arid southwest, water-level change may indicate depletion of the aquifer, variations in nearby surface-water flows, fluctuations in aquifer recharge amounts, and changes in the total water remaining in storage for future use.



UNION COUNTY - Geoffrey C. Rawling, October 2013



LAS CRUCES - USGS **ROSWELL** - USGS **CLOVIS** - USGS



LA CIENEGA - Johnson et al., in press

Groundwater is being depleted in regions across New Mexico. As surface-water resources become less dependable, groundwater depletions will increase.

Long-term monitoring of changes in water-levels and water-quality are essential in New Mexico. Future projects will hopefully address water-quality changes.

New Mexico Bureau of Geology and Mineral Resources

AQUIFER MAPPING PROGRAM

WHAT WE DO

Characterize the quantity, quality and distribution of groundwater in aquifers using information from geology, geophysics, hydrology and chemistry. This program addresses state needs for groundwater information useful in planning, permitting, conservation and protection of our most vital resource: **WATER**

Project part of Statewide Water Assessment funded by NM WRRI.

ArcGIS, illustrations and design by Brigitte Felix

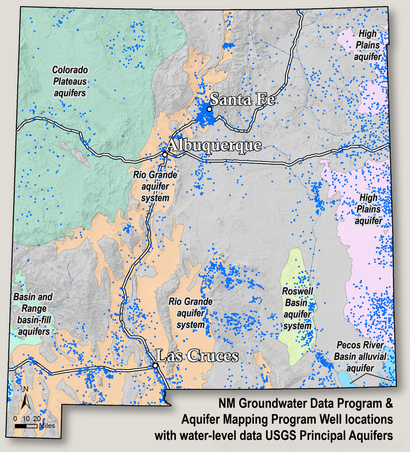
STEP 1:
Compile and filter water-level data

The first objective is to compile available groundwater-level data for New Mexico through collaboration with USGS, NMOSE, NMSU and other entities collecting water-level measurements. These data are compiled in NMBGMR's Aquifer Mapping database (see image on right). Data are filtered to remove duplicate locations or sites with insufficient location information.

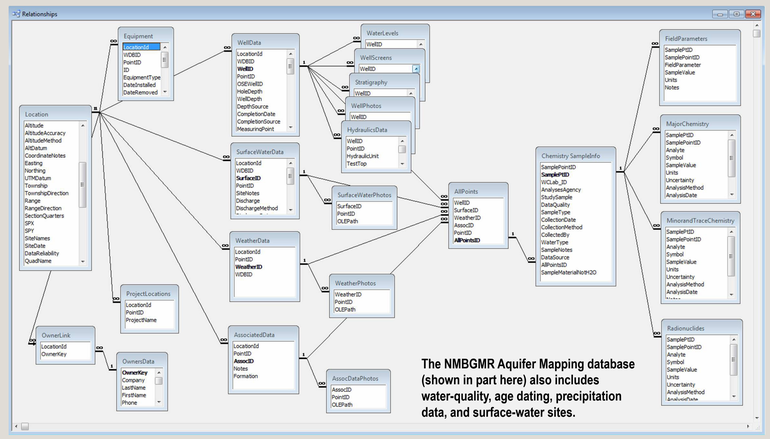
Data sources
- Groundwater Data Program network (USGS, NMOSE, others)
- NMBGMR Aquifer Mapping Studies
- Bernalillo County and others soon
- Currently ~5400 wells

Issues
- Spatial gaps in data
- Temporal variations (5-year intervals staggered across the state)

At present, we are in this phase

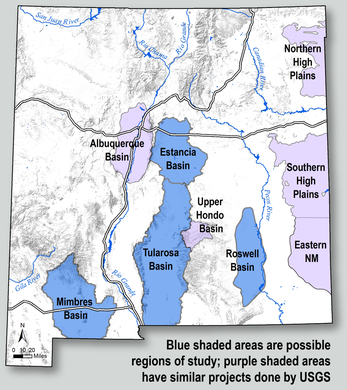


NM Groundwater Data Program & Aquifer Mapping Program Well locations with water-level data USGS Principal Aquifers

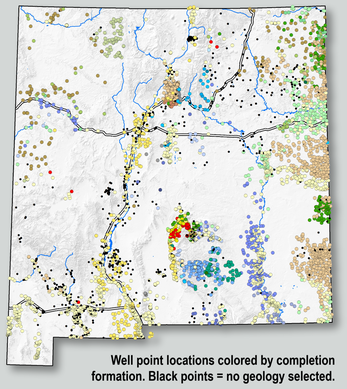


The NMBGMR Aquifer Mapping database (shown in part here) also includes water-quality, age dating, precipitation data, and surface-water sites.

STEP 2:
Selection of basins/regions and data



Blue shaded areas are possible regions of study; purple shaded areas have similar projects done by USGS

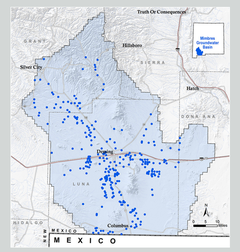


Well point locations colored by completion formation. Black points = no geology selected.

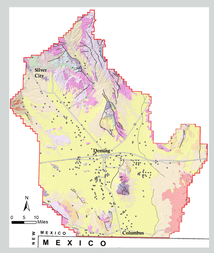
Possibilities: Mimbres, Estancia, Tularosa, Roswell

Work of this nature has been done in some regions of New Mexico, but not across the entire state, in part because of the localized data coverage (see Step 1). Based on the data available in New Mexico, with large regions lacking data, a statewide contour map would have serious limitations. Work by the USGS, such as in the Albuquerque Basin (Falk et al., 2011), the upper Hondo Basin (Donohoe, 2004; Darr et al., 2014), and in eastern New Mexico (Tillery, 2008), has shown water-level changes from pre-development to recent conditions. USGS also produced water-level and groundwater storage change maps for the entire High Plains Aquifer (McGuire, 2013), and maintains a High Plains web site (ne.water.usgs.gov/ogw/hpwlms). Efforts at the NMBGMR on regional hydrogeologic studies have produced a variety of water-level change maps (i.e. Rawling, 2013; Timmons, 2013; Newton et al., 2012). Taken together, these studies cover only small portions of the State and may represent different time periods and so are not always directly comparable.

Regions for contouring will be selected based on density of well locations, frequency of measurements and geology. Across New Mexico, wells are completed in different geologic formations. All formations do not have the same hydrologic properties. Contoured data need to be from wells within the same formation.



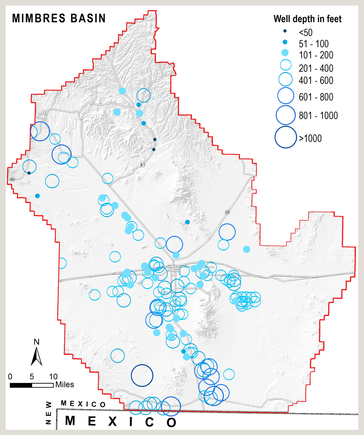
Mimbres Basin example. Selection of 286 well locations, with 7859 water-level measurements.

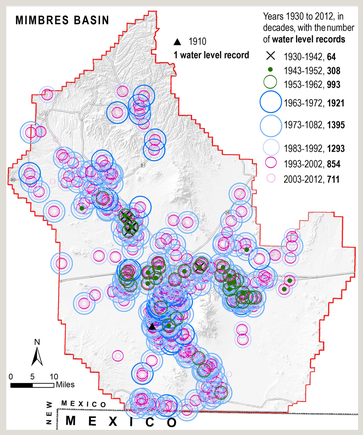


Mimbres Basin has a relatively uncomplicated geology. Most wells are completed in alluvial materials (yellow unit).

STEP 3:
Contour changes in groundwater-levels over a regionally-appropriate time interval

We will develop regional maps for selected basins that show changes in water levels over time intervals that reflect the frequency of measurements performed in a particular region. Due to the nature of the data collection intervals, statewide comparison from one region to another may not be within the same years. Areas where additional data are needed will be identified in this process.





STEP 4:
Calculate changes in groundwater storage over relevant time intervals (where possible)

With these regional maps of water-level change, using ArcGIS, these surfaces can be paired with an average specific storage raster map to estimate changes in groundwater storage (McGuire, 2013).

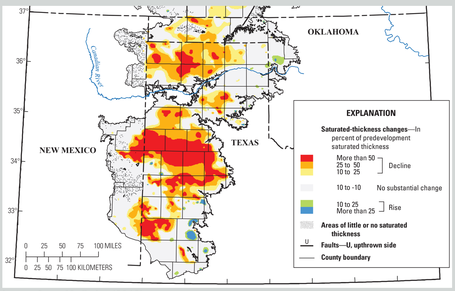
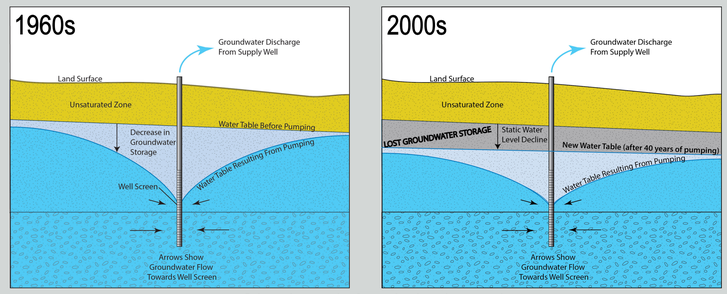


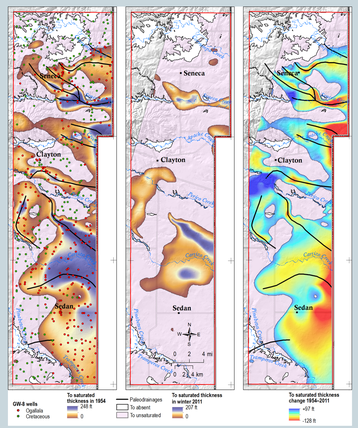
Image from McGuire (2013).



Schematic example of water-levels and storage change

PRODUCTS

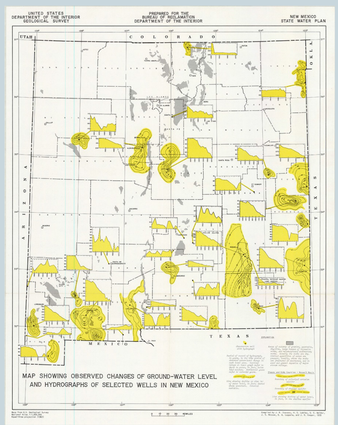
- Compiled water-level database (ArcGIS friendly)
- Mapped regions of water-level changes (ArcGIS)
- Estimate of change in groundwater storage
- Technical report describing methodology
- June 2015 completion of 2-3 regions



UNION COUNTY - Rawling, 2013

APPLICATION OF RESULTS

- Methodology can be applied to other regions
- Provide basis to assess other methods of addressing groundwater storage change, such as NASA's GRACE satellite data
- Identify critical areas of groundwater depletion, where water-quality changes could be imminent
- Compiled, publicly accessible data



Map compiled in 1974 with a similar idea

CONSIDERATIONS

- To enhance statewide data coverage, additional local cooperators are needed
- Data collection continues - but needs support for continued compilation
- Beyond the quantity of water, groundwater-quality issues must also be considered

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