Utah Groundwater Well level Use Case

Study Question

Watershed management requires an understanding of basic hydrologic processes and the concept of a water balance, as well as how they affect each other. Groundwater storage is one component of the water balance for a watershed and represents the amount of water that is stored in the subsurface. The purpose of this case study is to examine trends in groundwater levels measured in wells within the Weber River Basin of Northern Utah, USA, to see if they are related to trends in other landscape scale factors such as land cover, development, precipitation, temperature, runoff ratio, and streamflow. Ultimately, we want to learn how watershed management and land use impact groundwater levels (as a surrogate for the amount of water stored in the subsurface) and how that in turn affects streamflow. In this use case, we demonstrate the use of HydroExcel and HydroGet to download groundwater level data for approximately 1,400 USGS wells. We then illustrate examination of the data using R to look for trends in the groundwater levels.

Tools used

- ESRI ArcGIS 9.2
- HydroObjects
- HydroGET toolbar
- HydroExcel spreadsheet
- R Software

Procedure

The HydroExcel spreadsheet, which provides direct access to WaterOneFlow web services, is the starting point in identifying the well information needed to conduct the analysis. Using the USGS NWIS Ground Water Data WSDL in the HydroExcel spreadsheet, along with a bounding box based on latitude and longitude, we compiled a list of USGS groundwater well site codes, names, latitudes, and longitudes. Next, the groundwater level time series data were downloaded for each well using the batch processing mode found in the **Custom (Multiple Points)** interface in the HydroGET toolbar. HydroGet requires a feature class with the point locations of the sites to download the data. The feature class needs to have attributes that specify information required to download the data from web services. This information is in the form of a MySelect table. The following steps, which were adapted from the HydroGET toolbar manual pages 55-59, were taken to prepare the MySelect File and the MySelect Feature class for HydroGet:

1. Navigate to the folder where the HydroGet toolbar was installed. Find the file "MySelectSchema.xls". This is an empty MySelect file illustrated below (Figure 1).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	WSDL	Network	SiteCode	VarCode	StartDate	EndDate	AuthCode	HydroID	TSTypeID	Latitude	Longitude	SiteName	VarName	Units
2														
3														
4														
5														

Figure 1. Empty Myselect spreadsheet installed with HydroGET serves as a handy tool for batch processing.

2. Make a copy of the file so that you can keep the blank table for subsequent data requests.
3. Copy the information from the HydroExcel "Site" and "Variable" worksheets (i.e., WSDL, Network, SiteCode, SiteName, VarCode, VarName, StartDate, EndDate, Longitude, Latitudes, and units) to the **MySelect** spreadsheet and save it. You will have to assign a unique integer HydroID for each site. Also, you will need to fill in an integer TSTypeID to identify the groundwater level variable (it should be the same for each site). An example of MySelect is shown in Figure 2.

I1 | TSTypeID

A	B	C	D	E	F	G	H	I	J	K	L	M	N
WSDL	Network	SiteCode	VarCode	StartDate	EndDate	AuthCode	HydroID	TSTypeID	Latitude	Longitude	SiteName	VarName	Units
http://water.sdsc.ed	NWIS	400219111393701	72019	1/1/1900	12/31/2999		2000	1000	41.038556	-111.661043	(A- 4- 3)31cab- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403527111151401	72019	1/1/1900	12/31/2999		2001	1000	40.590786	-111.254622	(D- 3- 6) 3bdb- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403546111145901	72019	1/1/1900	12/31/2999		2002	1000	40.596063	-111.250456	(D- 2- 6)34dcc- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403558111153701	72019	1/1/1900	12/31/2999		2003	1000	40.599397	-111.261012	(D- 2- 6)34cbc- 2	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403600111154001	72019	1/1/1900	12/31/2999		2004	1000	40.599952	-111.261846	(D- 2- 6)33dad- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403608111164601	72019	1/1/1900	12/31/2999		2005	1000	40.602174	-111.280180	(D- 2- 6)33cbb- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403616111154001	72019	1/1/1900	12/31/2999		2006	1000	40.605508	-111.261846	(D- 2- 6)33ada- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403618111153701	72019	1/1/1900	12/31/2999		2007	1000	40.604952	-111.261013	(D- 2- 6)34bcc- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403638111160401	72019	1/1/1900	12/31/2999		2008	1000	40.610507	-111.268513	(D- 2- 6)33abb- 1	Depth to water lev	feet
http://water.sdsc.ed	NWIS	403639111155501	72019	1/1/1900	12/31/2999		2009	1000	40.610785	-111.266013	(D- 2- 6)28ddc- 2	Depth to water lev	feet

Figure 2. MySelect schema filled with information from HydroExcel spreadsheet related to Utah groundwater wells level case study.

4. Use the "AddXY Data" tool in ArcGIS to create a feature class that has the X-Y locations of each of the wells. Save the feature class to a shapefile called "Wells.shp."
5. Use the **Custom (Multiple Points)** interface of the HydroGet toolbar to download the data listed in the Wells.shp file into a designated ArcHydro geodatabase (Lower_Weber.mdb).

The processing to download 1356 wells took around 5 hours. Once we had the ArcHydro geodatabase, ArcMap/ArcCatalog selection functionality was used to extract well level data from the time series table in the ArcHydro geodatabase to dbf files for analysis using R. R is a software environment for statistical computing and graphics http://www.r-project.org.

Results

Figure 3 illustrates the groundwater level trends of wells in three different parts of the Weber basin and downstream Great Salt Lake shoreline area. All wells are shown in the map, but we constrained our analysis to wells that had 20 or more groundwater level observations. This figure illustrates how over the period of record groundwater level is declining in the Great Salt Lake shoreline area due presumably to pumping, but in the other parts of the watershed there is no general trend.

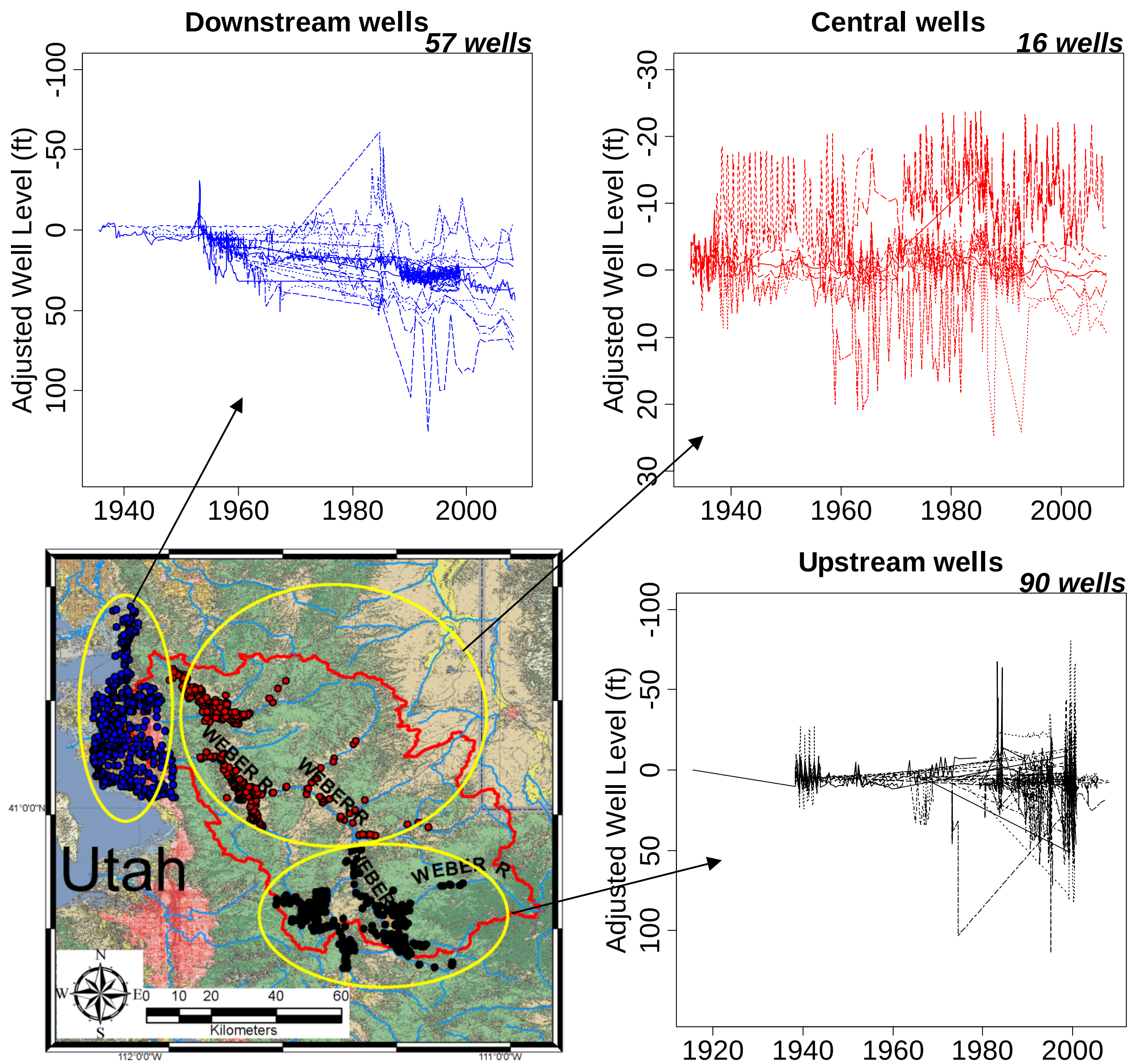

Figure 3. Adjusted groundwater levels for 90 wells in the upper stream, 16 wells in the central, and 57 wells in the downstream of the lower Weber River watershed. Each well level trace adjusted to start at the level of the mean on the current date of wells whose records started earlier.