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Progress Report:
A GIS-based comparison of Pre- and Post-Lignite Strip Mining Waters in East Texas

My term project will use ArcGIS to investigate the spatial and temporal relations between the presence of the Reklaw Formation in the overburden/spoils of lignite strip-mining and acid water generation in east Texas. This project will test the hypothesis that the outcropping and subcropping of the Reklaw Formation in east Texas cause surface waters to acquire an anonymously low pH due to the dissolution of pyrite oxidation products (sulfate and hydronium ions).

At this stage in my research, I have located and compiled many of the shapefiles needed to display background information pertaining to physical location (using shapefiles of county lines and cities), geology (using a shapefile of the confined and unconfined portions of the Carrizo aquifer and one of the geology of Texas), ecology (using a shapefile depicting the major ecoregions in Texas), and hydrology (using shapefiles of existing reservoirs, HUCs, and flowlines). The resulting basemap will be a useful "launching pad" as I collect, import, and analyze data specific to my research question.

I also downloaded and explored the shapefile of major land resource areas (MLRAs) in east Texas produced by the USDA Natural Resources Conservation Service and described in the USDA Agricultural Handbook.[1] The corresponding database includes MLRA and LRR (land resource region) names for each vector polygon. However, this information largely duplicates the information already captured in a major ecological regions shapefile, and so it was ultimately discarded.

Low pH water in east Texas is more chemically aggressive than circumneutral pH waters. As a result, acidic waters dissolved silicate minerals faster and tend to carry a higher TDS (total dissolved solids) load. In the clay-rich east Texas region, these low pH waters tend to be enriched in $Al^{3+}_{(aq)}$, which is toxic to vegetation. Therefore, one method for identifying areas where low pH surface water may exist is to look for areas of distressed or dead vegetation. For this reason, I added a shapefile of land cover in east Texas from the 2006 National Land Cover Database, maintained by the Multi-Resolution Land Characteristics Consortium (MRLC).[2] This database includes a "Barren Land (Rock/Sand/Clay)" class (no. 31), which is defined as "areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for

[1] United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource Regions and Major Land Resource Areas (MLRA) of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. MLRA Geographic Database - digital maps and attributes.
[2] Available at http://www.mrlc.gov/nlcd2006.php.

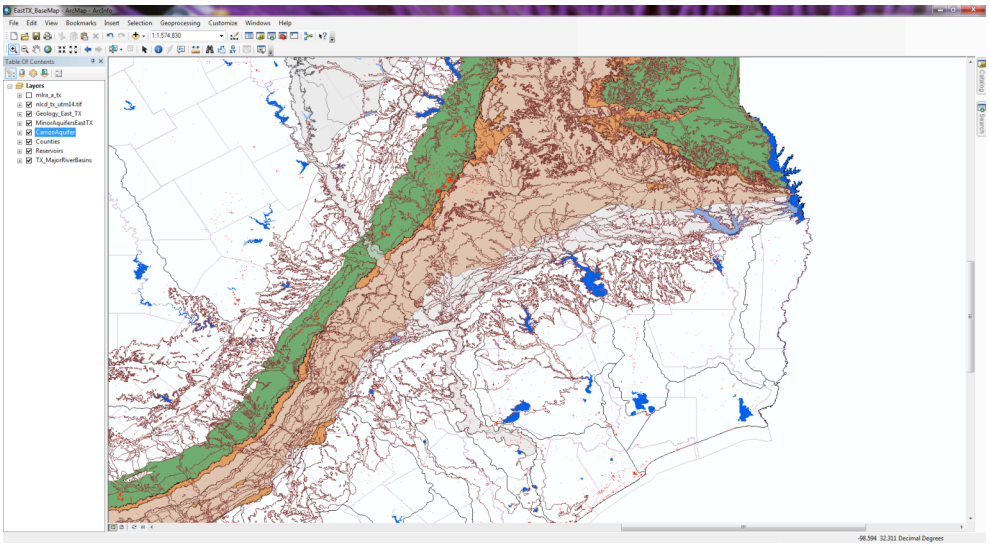
less than 15% of total cover" (MRLC website).[3] At this point, I plan to use only the "Barren Land" category, however, I may find some of the other land cover classes (e.g., developed land, scrub brush) useful at a future stage of my research.

The next stage of my project is to specifically identify the hypothetical source of acidity, the pyrite-rich Reklaw Formation. I will also identify the location of lignite mines in east Texas as these strip mines must dig past the Reklaw Formation (which is part of the overburden) to reach the lignite seams. Because the Reklaw Formation is disturbed and exposed to oxidizing (outcrop-type) conditions, lignite strip mines will be analyzed along with Relkaw outcrop locations for a correlation with low pH waters. I will also start gathering and incorporating surface water quality information from USGS and TWDB gauging sites in and downstream of target areas. A "wish list" of key water quality parameters to collect is:

(1) total discharge, Q
(2) $[SO_4^{2-}]$,
(3) $[H_2S]$ (if present),
(4) $[Al^{3+}]$,
(5) TDS,
(6) Cl^- (acts as a conservative natural tracer),
(7) pH,
(8) Ca^{2+} (sources include gypsum, calcite, and Ca-rich plagioclase dissolution),
(9) alkalinity (often treated as synonymous with bicarbonate), and
(10) Eh or DO.

Below are some screen shots illustrating my progress with the basemap:

Figure 1. Screen shot of map displaying NHDPlus flowlines, HUC10 watersheds, Carrizo aquifer unconfined and confined zones, existing reserveroirs, NLCD "Barren Land", and Texas county boundaries.



[3] Quotation from NLCD 2006 Legend and Classification Description: http://www.mrlc.gov/nlcd06_leg.php.

Figure 2. Screen shot of map displaying the major river basins of Texas, cities (as both point and polygon shapefiles), the Carrizo aquifer, various minor aquifers, and other information.

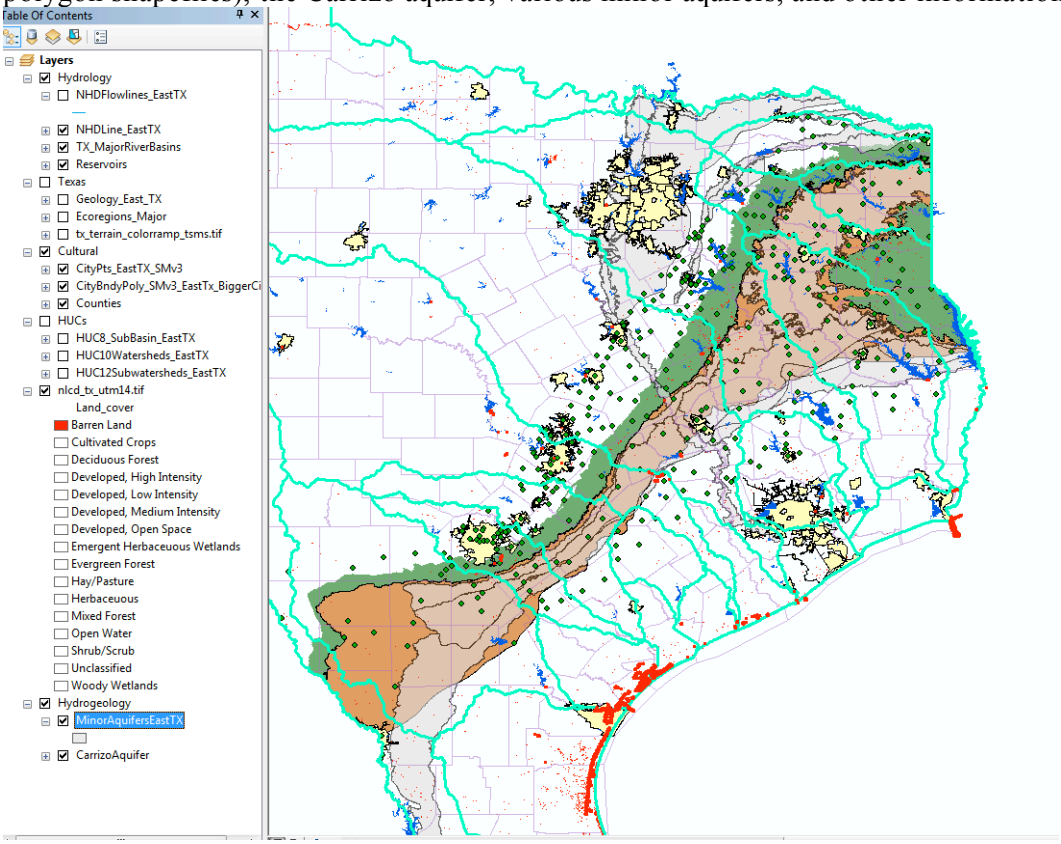


Figure 3. Screen shot of map displaying HUC10 watershed boundaries, NHDPlus flowlines, existing reservoirs, city/town locations (as points), "Barren Land," the Carrizo aquifer, and surface geology.