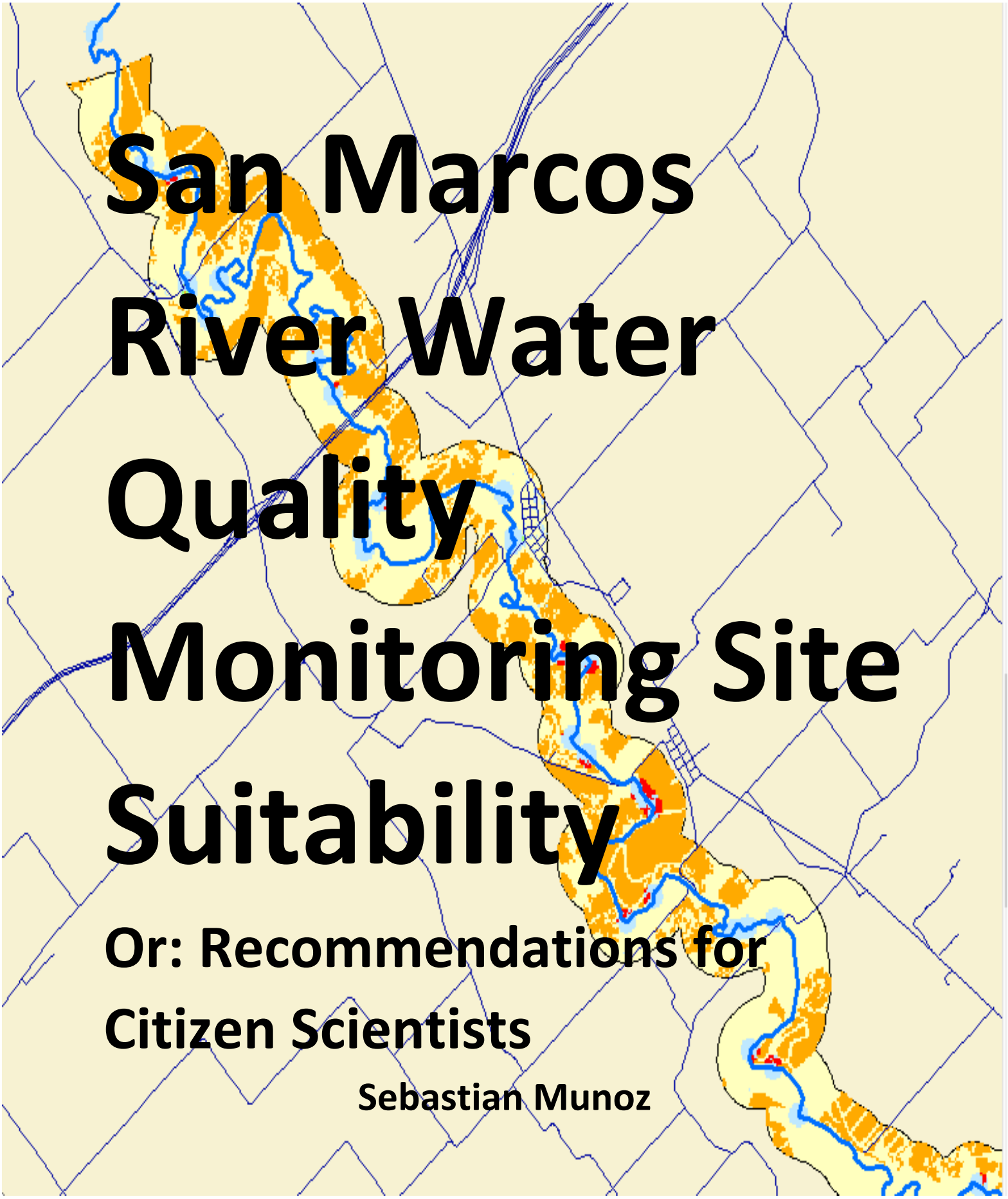

San Marcos River Water Quality Monitoring Site Suitability

Or: Recommendations for Citizen Scientists

Sebastian Munoz

Objective:

The TCEQ monitors surface water quality at sites around the state of Texas. A Citizen science offshoot of the TCEQ, Texas Stream Team, consists of paddling members that volunteer their time to monitor water quality and report it to the TCEQ. The objective of this report is to delineate locations accessible by boat on the San Marcos River, TX where additional water quality monitoring may be useful and viable. To achieve this, Land use and land cover, tributary input, and distance from existing monitoring sites are considered.

Data Collection: Several Data sources were used.

Texas Commission For Environmental Quality(TCEQ): TCEQ_SWQM_STATIONS.shp.

https://www.tceq.texas.gov/gis/download-tceq-gis-data

This dataset contains the locations of the surface water quality monitoring stations. From the metadata: Purpose: This dataset is intended for general purpose use, to determine locations of current and historical surface water quality monitoring stations as maintained by TCEQ. It is intended for use in planning future monitoring efforts and for reference when requesting surface water quality monitoring data from the TCEQ.

Texas Water Development Board (TWDB) : Hydrologic Unit Code Boundaries. This dataset was used to clip the NHD watershed dataset to the San Marcos River basin

http://www.twdb.texas.gov/mapping/gisdata.asp

Texas Natural Resource Information System(TNRIS) :

Rivers, Streams, and Waterbodies

This Dataset was utilized to Locate and symbolize the San Marcos river and its watershed. The HUC boundaries were used to clip this dataset to the watershed of interest.

https://tnris.org/data-catalog/entry/texas-nhd-river-streams-and-waterbodies/

Metadata description: The 1:24,000 National Hydrography Dataset (NHD), jointly developed by the USGS and the Environmental Protection Agency (EPA), is a hydrologic data network designed to show all surface water features including rivers and streams, ponds and lakes, springs, canals, wetlands, and shorelines.

Roads:

In Texas, Rivers access is legal via public roadways. A shapefile was acquired from TNRIS that contains the location of all public roads in the state of Texas.

https://tnris.org/data-catalog/entry/txdot-roadways/

Land Use Land Cover: Raster file showing land use and land cover for the entire state of Texas. Used in determining suitability/necessity of monitoring.

https://tnris.org/data-catalog/entry/national-land-cover-database-2011/

Personal Data: Longhorn Stream Team Water Quality monitoring locations.

Longhorn stream team water quality monitoring locations. A citizen science offshoot of the Texas commission for environmental quality. Data was in spreadsheet forms and converted into a geodatabase after properly being georeferenced.

Data Preprocessing:

The Longhorn Stream Team data had to be georeferenced. To accomplish this, known locations of monitoring sites were located on google earth, and then coordinates were imported. The

dataset was converted from an excel spreadsheet into a geodatabase, to do this a csv file was created and all of the cells were formatted. The water quality measurements were preserved this way and are now prepared/available for further analysis despite the focus of the project on geographic location only.

Preparation for ArcGIS processing:

To prepare the data for a suitability analysis, it had to all be converted to the same projection system so that analysis tools could be utilized. UTM zone 14 was chosen as all of the datasets of interest fell within the zone. The UTM scheme also provided for easy calculation of distances. Additionally, large coverage files had to be clipped to the area of interest to avoid doing non meaningful analysis.

The general workflow was used on all of the data files described above, and was as follows.

Step one: Projection into UTM zone 14

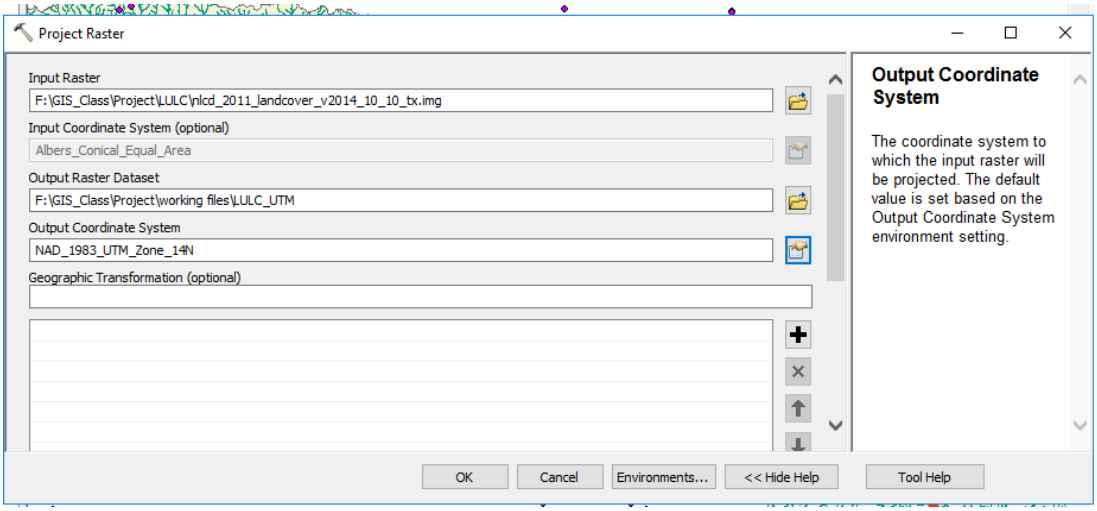

Figure 1. Example of projection into UTM zone 14 coordinates

This step allowed for datasets to be compared via analysis tools. Various projections were employed by each dataset, resulting files all had the same projection and datum NAD 1983 UTM Zone 14.

Step 2: Clipping to Hydrologic unit Code 12100203

The Hydrologic Unit 12100203 corresponds to the San Marcos River, and is the basin of interest therefore all datasets were clipped to the HUC outline to prevent unnecessary and messy calculations of larger areas.

ArcGis Processing

Preliminary processing: Watershed .shp files and organization

Using the NHD streams .shp file that was clipped to the HUC outline so that it contained only the San Marcos watershed projected in UTM, two separate files were made.

1) A .shp file containing the tributaries to the San Marcos River
2) The San Marcos River itself.

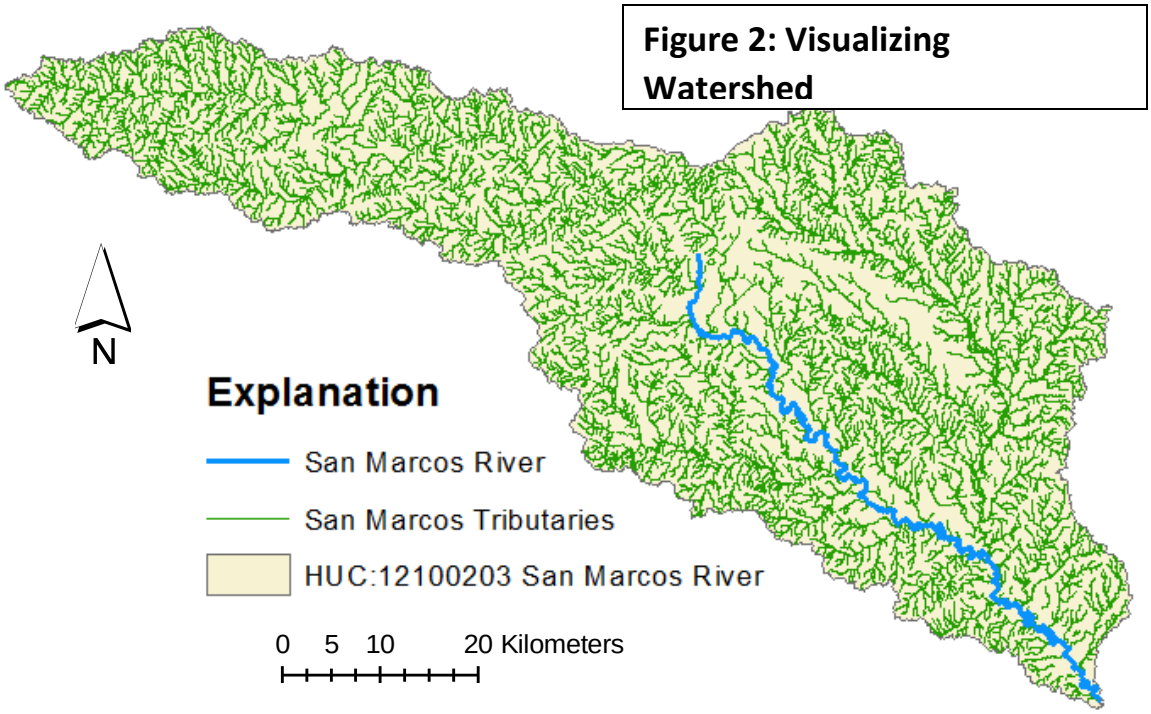

Figure 2. NHD data utilized to make two files, one containing the San Marcos River, and one containing its Tributaries. The files were exported from the original dataset by filtering by name in the Attribute Table

The tributary intersections were calculated by converting the San Marcos river into a path, and then using the locate along path tool to find where the tributaries connect with the main body of the river. New geometries for the river had to be calculated in the attribute table, and a new feature class was constructed to accommodate for the calculation in meters of the length.

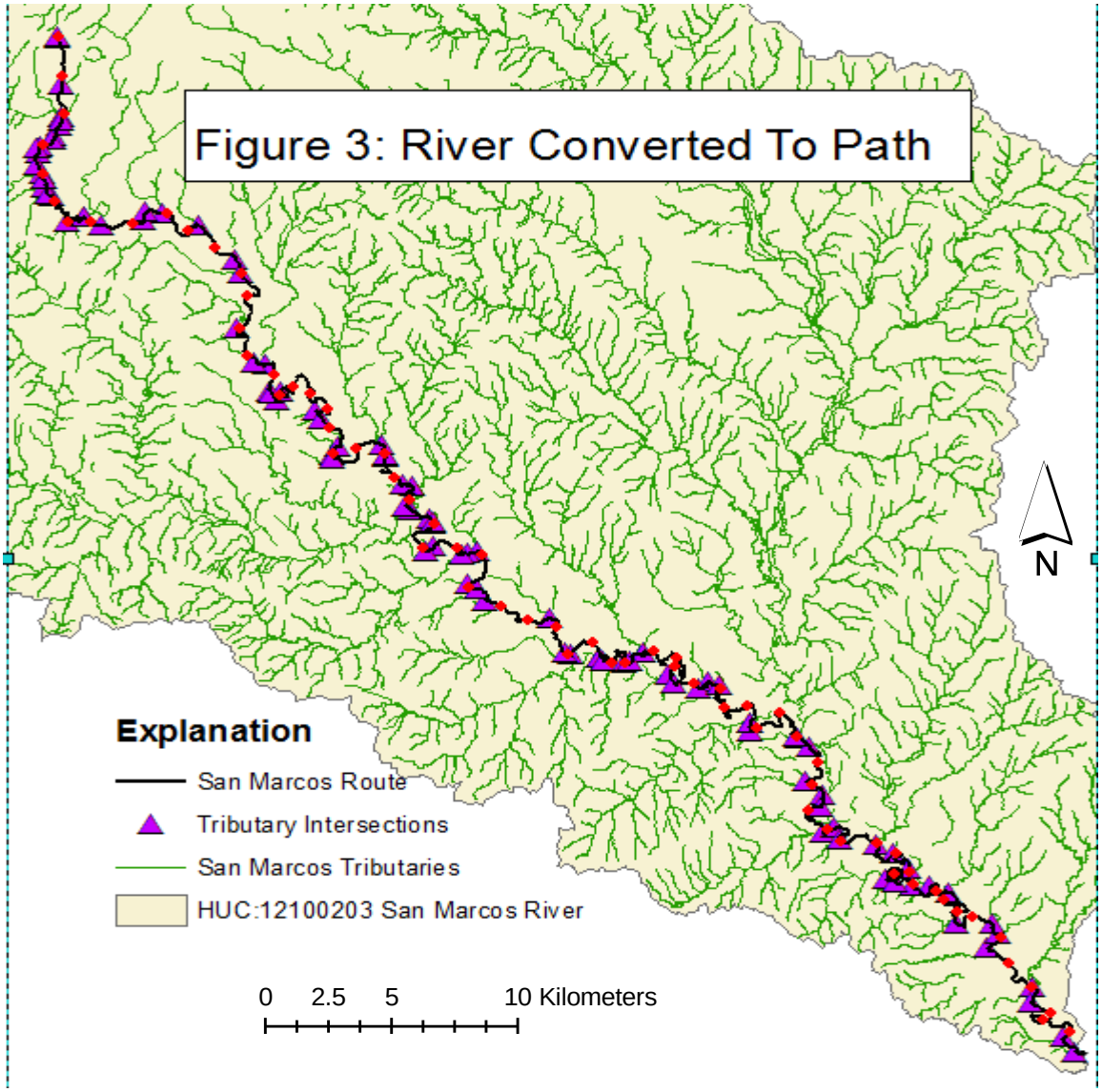

Figure 3. Updated watershed showing river converted to a route (red dots every 2 km). Tributary intersections were computed as a result of this analysis.

Preliminary processing: River Acessibility Via Road Crossing

In Texas, roads and rivers are both owned publicly, and river access is legal via public road right of ways (Texas Parks and Wildlife Department). For the purpose of this project, public road crossings were considered river access points. Using the properly clipped .shp files for the roads and the river path, the editor was used to clip the river into sections flanked by public road crossings. This allows the computation of the length of each segment, and is important to determine if the lengths of a proposed trip would be reasonable. Figure 4 documents this process.

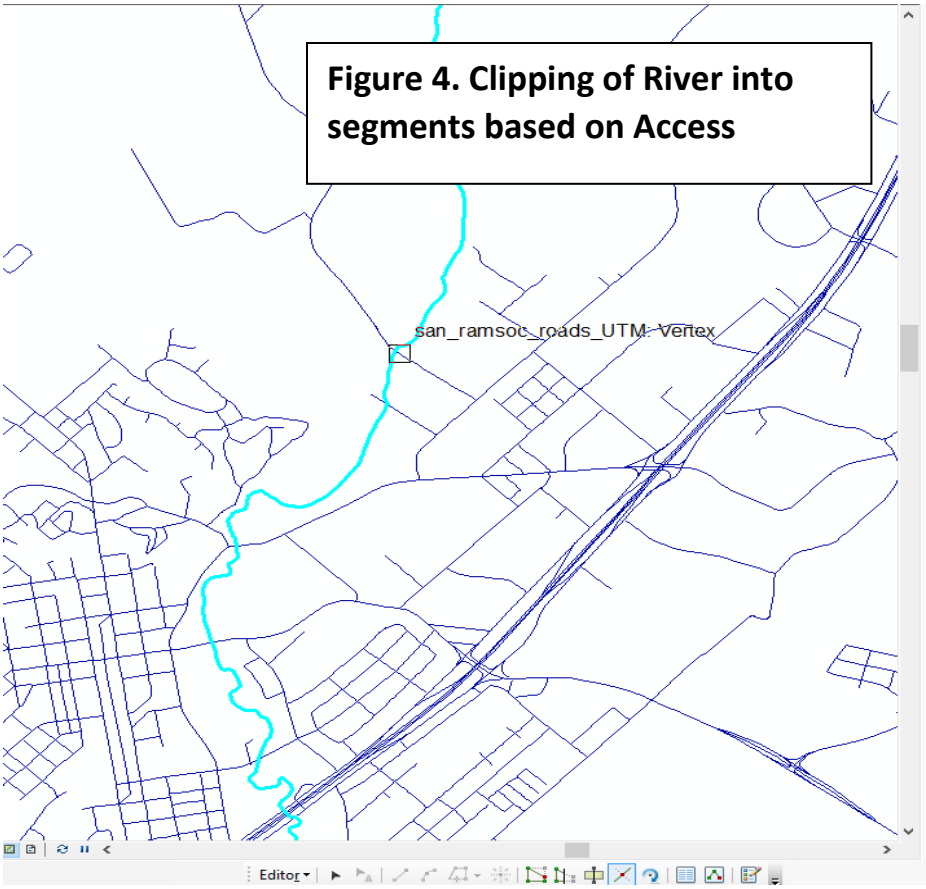

Figure 4. Splitting of river into segments by hand utilizing the editor. Each road crossing was chosen. In a systematic fashion working from upstream to downstream.

Suitability Analysis

With the preliminary processing and analysis being completed, the suitability analysis could be carried out.

Procedure: The analysis of the datasets for site suitability followed 2 steps **Elimination of areas not suitable for monitoring**, and **analysis of the remaining areas for the locations best suited for monitoring.**

Step 1: Elimination of Areas not Suitable for Monitoring

Paddling citizen scientists can extend water quality monitoring to reaches that are not accessible via private land access, and increase capability of water quality monitoring locations. Paddling however, does not have unlimited potential and a reasonable length of river must be considered. To this end, reaches of river longer than 11km (a reasonable distance for a casual days paddling) were excluded.

Figure 5. Elimination of segments of River Greater than 11 km

FID	Shape *	GNIS_Name	length_
0	Polyline ZM	San Marcos River	14575
1	Polyline ZM	San Marcos River	4735
2	Polyline ZM	San Marcos River	346
3	Polyline ZM	San Marcos River	1418
4	Polyline ZM	San Marcos River	688
5	Polyline ZM	San Marcos River	1569
6	Polyline ZM	San Marcos River	774
7	Polyline ZM	San Marcos River	6014
8	Polyline ZM	San Marcos River	5998
9	Polyline ZM	San Marcos River	2870
10	Polyline ZM	San Marcos River	8523
11	Polyline ZM	San Marcos River	9013
12	Polyline ZM	San Marcos River	6452
13	Polyline ZM	San Marcos River	5067
14	Polyline ZM	San Marcos River	6363
15	Polyline ZM	San Marcos River	10031
16	Polyline ZM	San Marcos River	10105
17	Polyline ZM	San Marcos River	6659
18	Polyline ZM	San Marcos River	16537
19	Polyline ZM	San Marcos River	13289
20	Polyline ZM	San Marcos River	6923

Another consideration is the existence of historic water quality monitoring sites—it does not make sense to include in analysis reaches of river that are already being monitored. To do this, a 5 km radius buffer was placed around a .shp file that combined existing Longhorn Stream Team and TCEQ Water Quality monitoring stations. Figure 6 documents the elimination of segments unsuitable for analysis.

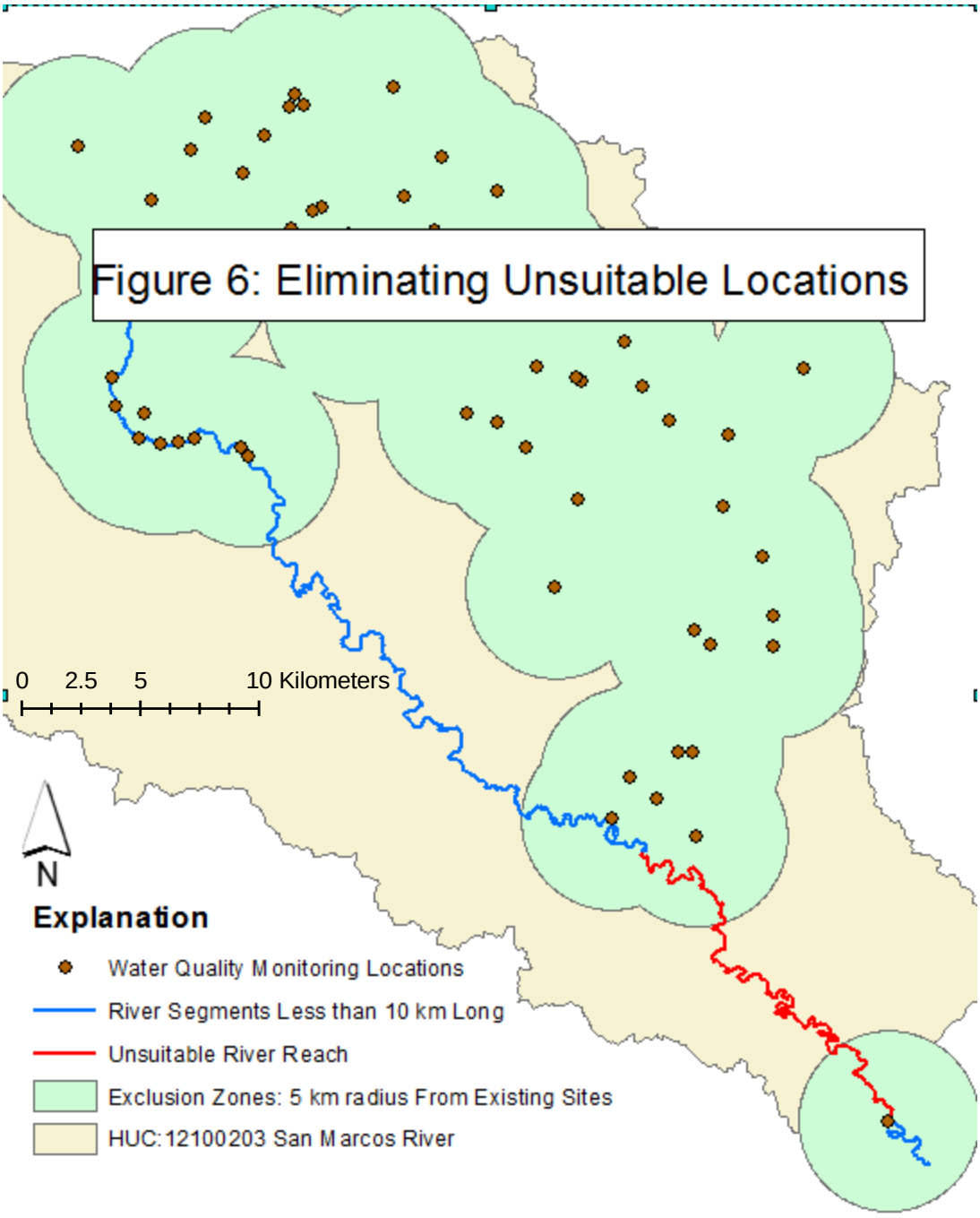

Figure 6. Elimination Criteria for Water Quality monitoring locations.

Step 2: Suitability Analysis of Non-eliminated sections

Nonpoint source pollution is derived from surface runoff, and Agricultural and urban development are major sources of contamination (USGS).

The factors utilized in analysis were land use and land cover because according to the TCEQ development can lead to impaired water quality. To account for this Low intensity development was given a risk value of 1, medium intensity development was given a risk value of 2, and high intensity was given a risk value of 3. According to (USGS) agriculture is one of the primary sources for pollution, and so Hay pastures and cultivated crops were both given risk indicators of 3. Tributaries can bring water from different sources into the river, and can cause parameters to change. Because of this, a risk value of 1 was given to tributary intersections. Although tributaries might not contribute to contamination, the introduction of new water with a potentially different chemistry was considered reason to monitor for changing parameters. The following table shows the contamination risk classification scheme for raster analysis.

Category	**Abbreviation**	**Risk Value**
Low intensity Development (LULC)	LID	1
Tributary intersection	TI	1
Medium intensity development (LULC)	MID	2
High Intensity Development(LULC)	HID	3
Hay/ Pasture (LULC)	HP	3
Cultivated Crops (LULC)	CC	3

Once the risk values had been determined, the LULC raster had to be reclassified according to risk value. The clipped TNRIS raster was utilized, and the corresponding values for each land cover of interest were reclassified to match the table above. The tributary intersection raster had to be created, as the current form of data was in a vector .shp file. This was done by creating a 50m buffer around the stream intersection point, and rasterizing the buffers and then reclassifying the output to have a value of 1.

The rasters were analyzed by creating a 1 km buffer around the stretch of river that was determined in step 1, and utilizing as a map algebra environmental mask. The map algebra operation is defined by the equation below by eq 1.

Eq 1. 'LID' + 'TI' + 'MID' + 'HID' +'HP'+'CC'

***mask**: 1 km buffer of selected river segment.

Figure 7 visualizes these results

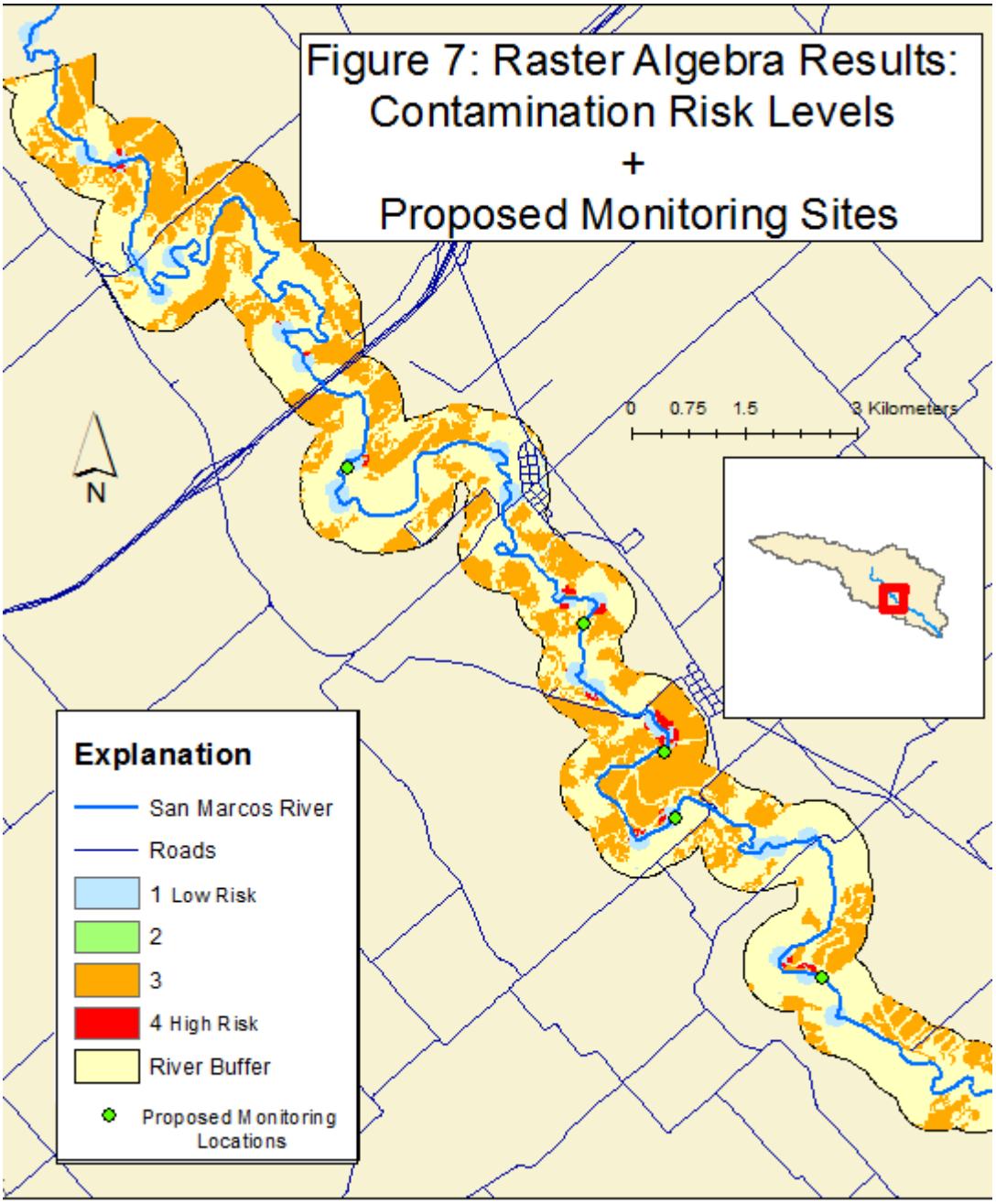

Figure 7 Shows the final product, A risk analysis of Contamination and potential water quality monitoring locations. Note: only 2 of the 4 locations could be utilized due to proximity.

Next Steps: As a result of this project, the following recommendations are made: for any desiring paddling citizen scientist organization to boat the river and take water quality measurements at the locations indicated. A geodatabase has been organized, with fields created for the water quality monitoring parameters recommended by the Texas Commission for environmental quality so that data can be easily input and georeferenced for use in a Geographic Information System. If you desire this or any further information, contact Sebastian Munoz (smunoz1212@gmail.com).

References

TCEQ Nonpoint Source Pollution: Public Education https://www.tceq.texas.gov/p2/Education/nps.html (accessed December 2017).

TWPD : If A River Runs Through It, What Law Applies? (Frequently asked Questions: River Navigation):, https://tpwd.texas.gov/publications/nonpwdpubs/water_issues/rivers/navigation/kennedy/_kennedy_faq.phtml (accessed December 2017).

USGS NAWQA Water quality and nonpoint sources in agricultural watersheds:, https://water.usgs.gov/nawqa/informing/agriculture.html(accessed December2017).

Additional resources

https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg415/rg-415_chapter2.pdf
Description of TCEW water quality monitoring