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Urban Development and the Puget Sound

The goal of this project was to provide a geographic information system for the Puget Sound. This region is important to local vitality and to scientific research. The purpose was to create a relevant dataset within the spatial extent of this region that would be useful to students and faculty. This dataset would be contained in a single file geodatabase to provide accessibility and a dedicated coordinate system.

The planning process began with receiving shellfish poisoning data from a faculty member, Cheryl Greengrove. The original plan was to utilize this data with Puget Sound water quality data in a raster analysis and to create a base map to accomplish this analysis within. However, spatial coordinates for the dataset were not available. Upon further discussion, the focus of the project turned to developing a substantial base map for the Puget Sound. This base map would include layers from the built environment and natural environment. The built environment facet would include a population density raster and a development layer. The natural environment facet would include a combined topography and bathymetry layer and a land cover layer. Preliminary speculation pointed to government agencies as sources of relevant data. Universal Transverse Mercator was selected as the coordinate system because it was able to cover the entire extent of the Puget Sound. An additional element of analysis was added to the project through brainstorming with my small group. This analysis would include impervious surfaces, slope, and population density to determine potential pollution hazard zones to the Puget Sound.

The next step after the scope of the project was finalized was data collection. National Oceanic and Atmospheric Administration (NOAA) was an excellent source that provided the highest resolution shoreline that was available as well as the most recent land cover data. The shoreline data is in an average scale of one by seventy thousand with parts of the line file being higher and lower resolution. University of Washington's School of Oceanography provided elevation rasters that combined topography and bathymetry. These rasters were also in a high resolution at one by twenty four thousand. Much of the elevation rasters were formed from Light Detection and Ranging (LIDAR) data and are current up to 2005. Nine counties surround the Puget Sound and every block group shapefile was needed for each county. These shapefiles were obtained through ESRI's data resources page. The demographic data needed for these block groups were also downloaded through this site. These two sources were from the 2000 census. 2010 census data was not yet available.

Numerous methods and tools were used in the formation of this project. The first step was to create a file geodatabase that all data would be contained in. This would ensure that all data would be in the same coordinate system projection. A feature dataset was created and set to the UTM Zone 10N. The block group shapefiles were downloaded from the ESRI data resources page, but were not combined into one shapefile. These nine files were combined into one block groups shapefile using the *append* tool. The projection was not set so the *define* projection tool was used. The demographic data for summary file one (SF1) was also downloaded through this page. Block group data for SF1 was only available as an "all counties" selection. This data was imported to Microsoft Excel to remove all of the unnecessary counties from the file. This was accomplished by first finding the county codes for the necessary counties. The next step was to filter by county codes and copying and saving the block group data for the nine counties that were needed. The demographic table was then joined to the combined block groups shapefile. The field that was used in the join was the 'STFID' field that combines codes for the state, county, tract, and block group into one number. The block groups shapefile now contained the demographic data and was imported to the project geodatabase. The combined topography and bathymetry rasters were separated into eight pieces that covered the entire Puget Sound. These were connected using the *mosaic* tool. The projection was then defined for the combined elevation raster to *NAD 1983 Stateplane Washington North*. The *project raster* tool was used to set the projection of the raster to *UTM Zone 10N*. This raster was used to create a hillshade raster and a slope raster using the *hillshade* tool and *slope* tool respectively. These three rasters were then imported into the project geodatabase. The shoreline file was only available for the entire United States Pacific Ocean shore. The first step was to clip this file using the combined block groups shapefile. There were some lines left on the west side of Clallam County and Jefferson County that were not needed. These were deleted using the editor toolbar. The projection was defined for this shoreline file and then imported to the geodatabase. The final data added to the geodatabase was a 2006 land cover raster obtained through NOAA.

The first data implementation was to create a block groups shapefile that would include only land polygons and erase the area above water. This was needed to create an accurate population density raster. This process took several steps. The first step began by using the editor toolbar to connect the lines of the shoreline file that were open in the northwest corner and to connect any existing gaps by snapping the endpoints of all vertices. Next, all island lines contained in the Puget Sound were manually selected and exported as a file. Through trial and error, gaps in these island lines were found by converting the line file to a polygon file using the *feature to polygon* tool. After closing all shapes, an island polygon file was created. Another polygon file was created using only the exterior shoreline that did not include the islands. This exterior shoreline polygon was used as the input feature and the island polygons were used as the erase feature using the *erase* tool that created a “water” polygon. The water polygon was then used as the erase feature in the areas in the block groups file that were above water to make a land only block groups file. A new field was added to the attribute table of this file. This field was filled using the field calculator to calculate population per square mile for each blockgroup. *Feature to point* tool found the centroid point of each blockgroup. This point file was used to interpolate a population density raster using IDW (inverse distance weighting) interpolation. The land block groups file was set as a mask for the raster analysis.

The final analysis of the project was to locate theoretical shoreline pollution hazard zones. This was accomplished through the use of the raster calculator and slope, population density, and development rasters that had been reclassified. The land cover raster was converted to vector data and the developed polygons were exported. These polygons included high, medium and low intensity development, as well as developed open space. These were classified into two categories. High development combined high and medium intensity as class two to be effective with the raster calculator. This class had a range of fifty to one hundred percent impervious surfaces. Low intensity and developed open space were class one and had a range of less than twenty percent to forty-nine percent impervious surfaces. The slope raster was reclassified into zero to eight percent, eight percent to thirty percent, and greater than thirty percent slope. These classes were one, two, and three respectively. The population density was classified into four breaks by standard deviation. These three reclassified rasters were then added in the raster calculator. The calculation raster resulted in what was essentially a score from three as the minimum and nine as the maximum. The three highest scores or classes were converted to a vector layer. A fifty foot buffer was placed along the shoreline file. This buffer shapefile was then intersected with the high score layer to find shoreline pollution hazard zones. The zones that were found covered a large majority of the Seattle area and many parts of Tacoma. Another area that had a considerate zone was the naval base in Everett.

Based upon the analysis output of this project, there are numerous potential pollution hazard zones along the Puget Sound. There are several characteristics that are “significant in determining water quality impacts: land use intensity, land-cover composition, landscape configuration, and impervious area connectivity" (Chang 661). In this analysis land use intensity as well as impervious surfaces as characteristics to determine pollution hazard zones. Urban development has been shown to have a negative impact. "Values of total fecal coliform bacteria, Escherichia coli, total heterotrophic bacteria, chemical oxygen demand (COD), BOD, and phosphate were significantly higher in urban areas than at undeveloped sites" (Chang 660). Urban development is connected to higher population density compared to rural areas. Population density was chosen as another characteristic to determine pollution hazard zones. Slope was the last characteristic decided upon for the raster analysis. This would correlate with the landscape configuration characteristic that was found to be significant in effecting water quality. The combination of these characteristics affect "runoff and non-point source water pollution" that will eventually find its way to the Puget Sound (Chang 661). This method could be useful in setting up precautions in areas prone to water pollution.

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