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Use of GIS to Analyze Race and Income of Residents Distributed Along Stream Segments of the East Fork Trinity Watershed

Final Project for GEOG 5520 – Intermediate GIS
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I. Introduction

Every so often the debate over “environmental racism” surfaces in the local paper or on the radio. Environmental equity has long been a controversial topic in the Dallas metropolitan area. Once side of the argument states that minorities find themselves living in highly polluted areas with no way out and with no help for clean up from local and federal governments. Another side believes it is actually a circumstance of income. Wealthier people can afford to live away from highly industrialized areas in the county. The idea that one of these circumstances is acceptable while the other is not, however, is repugnant. If true, action should be taken against either of these two state of affairs. However, I have yet to come across a Dallas area geographical case study on the subject.

Additionally, since most demographic information is collected and analyzed within imaginary political boundaries (of little importance in the physical world), few have taken the approach of studying this phenomenon using real world boundaries like watersheds. I intend to establish whether there exists an association between pollution along the length of streams, frequently caused by contaminated surface runoff, and either race or income. This assignment will deal with the demographic characteristics of areas within the East Fork Trinity Watershed selected on the basis of whether local stream segments are listed as environmentally impaired by the Texas Natural Resources Conservation Commission (TNRCC) in the 2000 Surface Water Quality Standards.

II. Literature Review

Texas Political History

Disagreement over whether polluted areas tend to exist in areas with significant minority residents has been in the press [1] since at least the early 90s. The political climate in Texas has historically been pro big business. This means that economic success in Dallas has always superceded nonprofit and governmental environmental concerns. Now that George Bush is in the federal government, this attitude is unlikely to change. Take, for example, Bush's longstanding opposition [2] to stricter enforcement of the 1972 Clean Water Act guidelines. The rule Clinton issued in July of 200 would place a far greater importance on decreasing runoff of agricultural waste, fertilizer and sediment than any preceding rule. It would entail all states to acquire strategies and begin water quality dcleaning and restoration programs within the decade. As implementation of this rule would be expensive to business, the current administration is attempting to lengthen the effective date [3,4] of this important legislation. This means that pollution caused by storm water will not be diminishing any time soon.

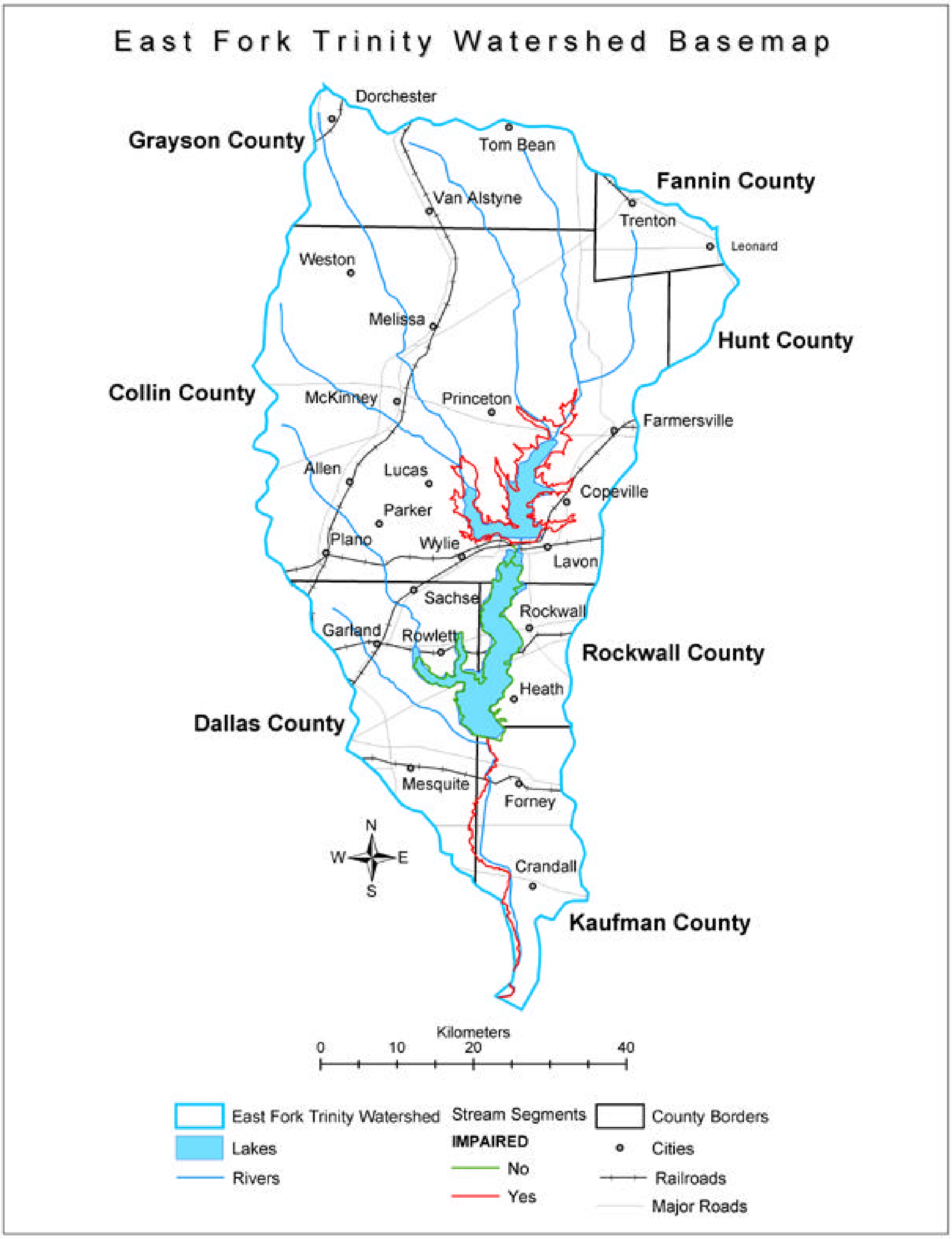
TNRCC Surface Water Quality Standards

The Texas Natural Resources Conservation Commission, acting in accordance with the Surface Water Quality Standards (Title 30, Chapter 307 of the Texas Administrative Code) Act [5], sets water quality standards for the State. TNRCC has catalogued a number of state watercourse segments that do not meet standards because they are impaired or threatened in the Texas 2000 Clean Water Act Section 303(d) List. Effective August 31, 2000, this list [6] designates which segments are impaired and which contaminants account for the failure of those sections to comply with the water quality standards. *An impaired segment is a water body which does not meet the standards set for its use, or is expected not to meet its use in the near future* [7]. *Intended to have relatively homogeneous chemical, physical, and hydrological characteristics, a stream segment provides a basic unit for assigning site-specific standards and for applying water quality management programs of the agency* [7].

Data Sources

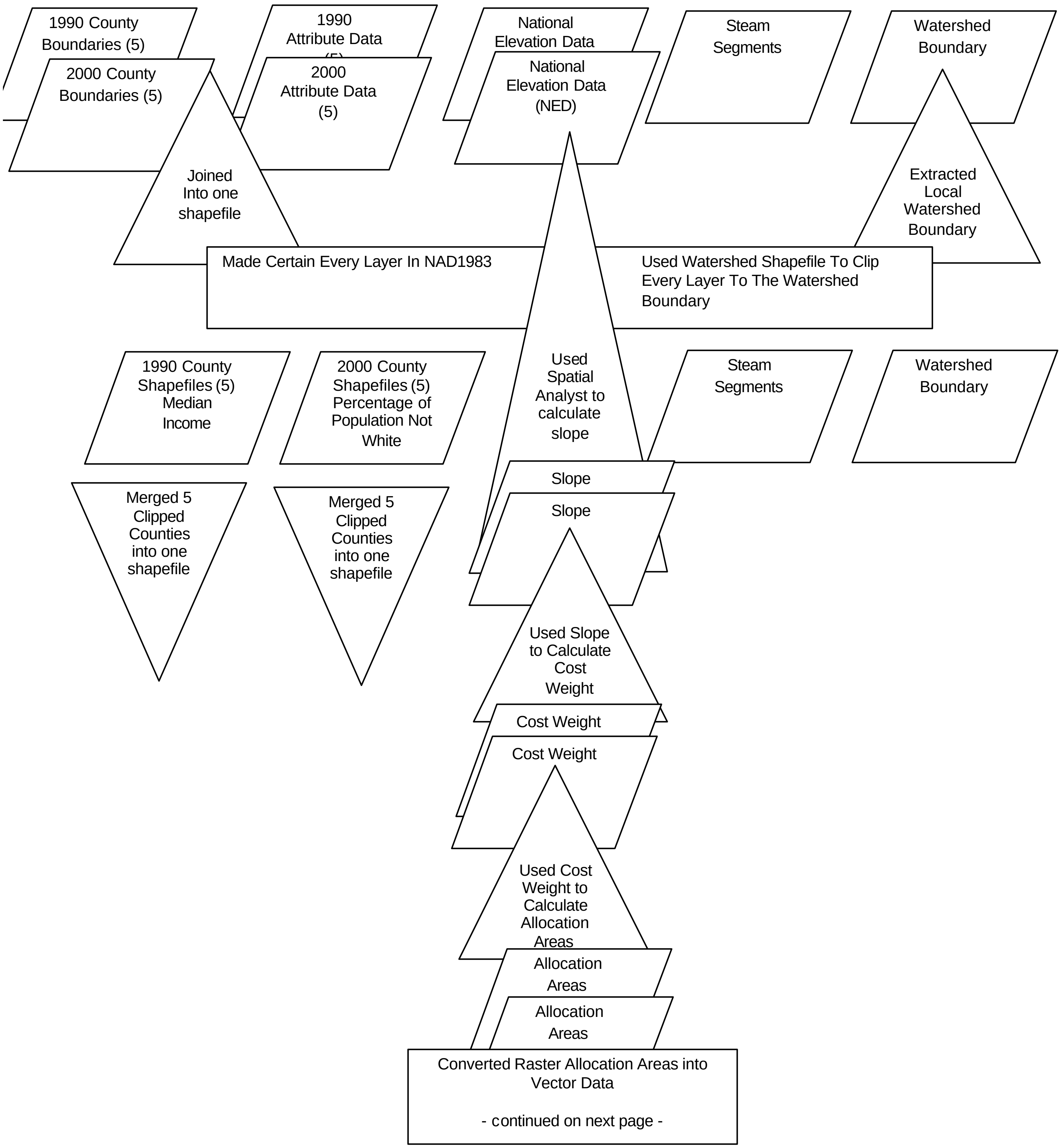
I found basemap data for the year 2000 from the United States Geological Survey (USGS). It includes the seven county boundaries that are pictured within the East Fork Trinity Watershed basemap on the next page. Major cites, railroads, roads, and hydrologic landmarks are also featured in the area. I downloaded this vector data from the National Atlas of the United States of America at their web site www-atlas.usgs.gov/atlasftp.html. These shapefiles were for the entire United States. After I unzipped and reprojected them into NAD 1983, I clipped each layer to the East Fork Trinity Watershed boundary. I created this watershed shapefile from the USGS national hydrologic unit boundary data file. I downloaded the stream segments from TNRCC's web site (www.tnrcc.state.tx.us/gis/base.html) and also clipped the Texas data to the watershed boundary. This gave me a group of stream segments for the southern end of the watershed. National Elevation Data (DEMs) used later to calculate slope is from the Texas Natural Resources Information System (TNIRS) web site at www.tnris.org/digital.htm. The county boundaries and demographic (1990 and 2000 Census) information used in this analysis is from the North Texas Council of Governments (NTCOG) website at census.dfwinfo.com/download.asp.

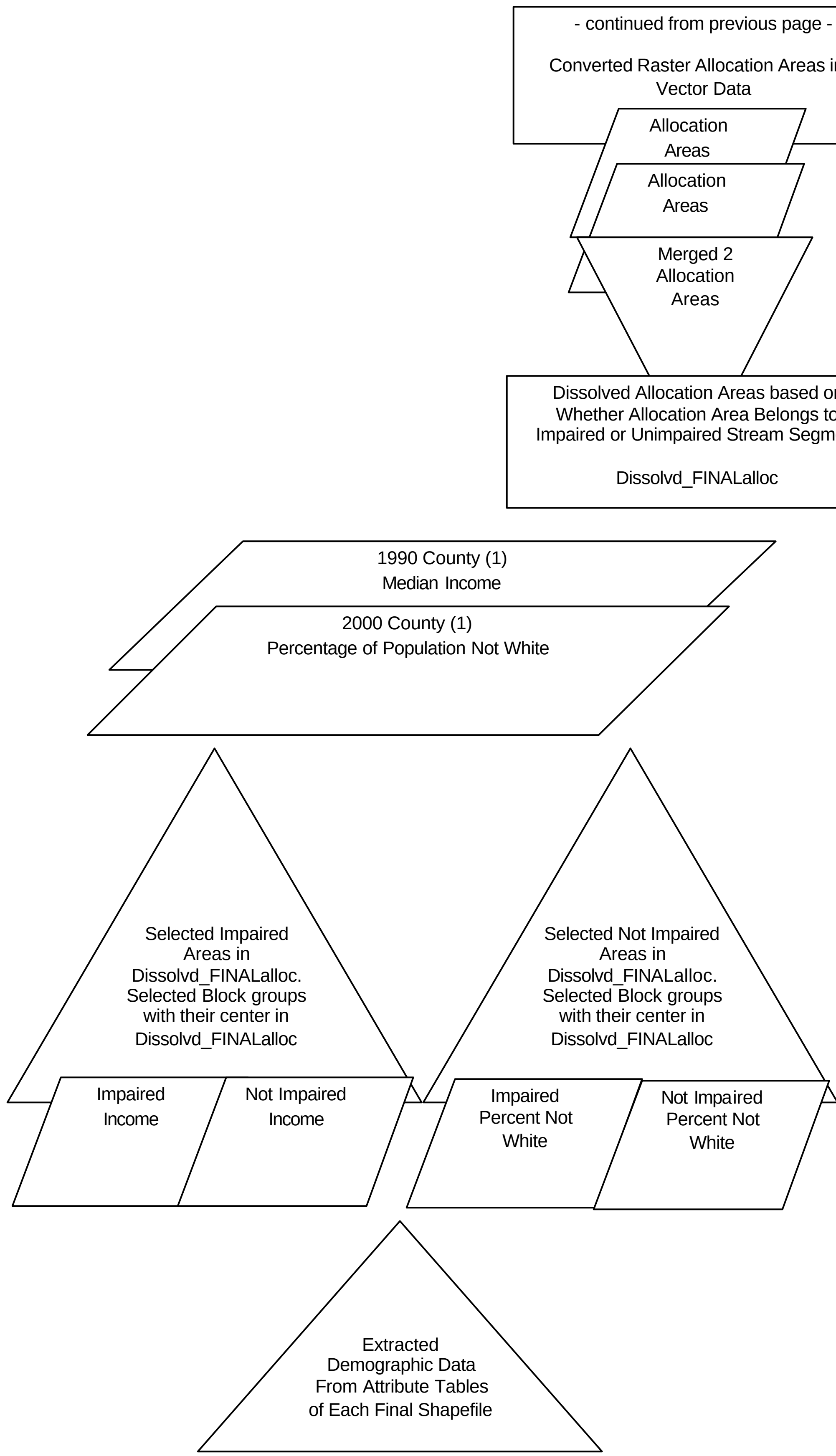
Map 1: Map of Study Area



III. Methodology

Flowchart




- continued from previous page -
Converted Raster Allocation Areas into Vector Data
Allocation Areas
Allocation Areas
Merged 2 Allocation Areas
Dissolved Allocation Areas based on Whether Allocation Area Belongs to Impaired or Unimpaired Stream Segment
Dissolvd_FINALalloc
1990 County (1) Median Income
2000 County (1) Percentage of Population Not White
Selected Impaired Areas in Dissolvd_FINALalloc. Selected Block groups with their center in Dissolvd_FINALalloc
Selected Not Impaired Areas in Dissolvd_FINALalloc. Selected Block groups with their center in Dissolvd_FINALalloc
Impaired Income
Not Impaired Income
Impaired Percent Not White
Not Impaired Percent Not White
Extracted Demographic Data From Attribute Tables of Each Final Shapefile

Flowchart Explanation

For this term project, I created a shapefile of the segments of streams within the East Fork Trinity watershed (see Figure 1) currently under study by TNRCC. TNRCC has denoted them as either impaired or not impaired by contamination. I will use ArcGIS 8.1 and the Spatial Analyst extension to allocate areas surrounding specific stream segments in the watershed to the stream segment that surface runoff will most easily move toward. This allocation should give me the areas that are most likely polluting stream segments and those that are not. It stands to reason that those areas that are causing pollution are themselves polluted while those that do not pollute are less likely to be polluted. Once I have the areas allocated, I will analyze the demographic information within these areas to learn whether environmental discrimination based on race or income is in evidence. As the Census 2000 median income estimates are unavailable until late summer of 2002, I will be using 1990 census data for median income information while using racial data from Census 2000.

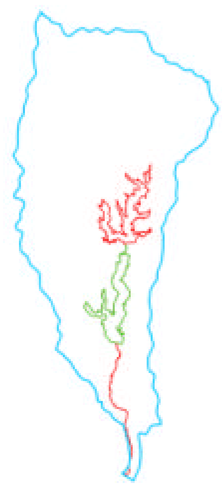


Figure 1: Stream Segments

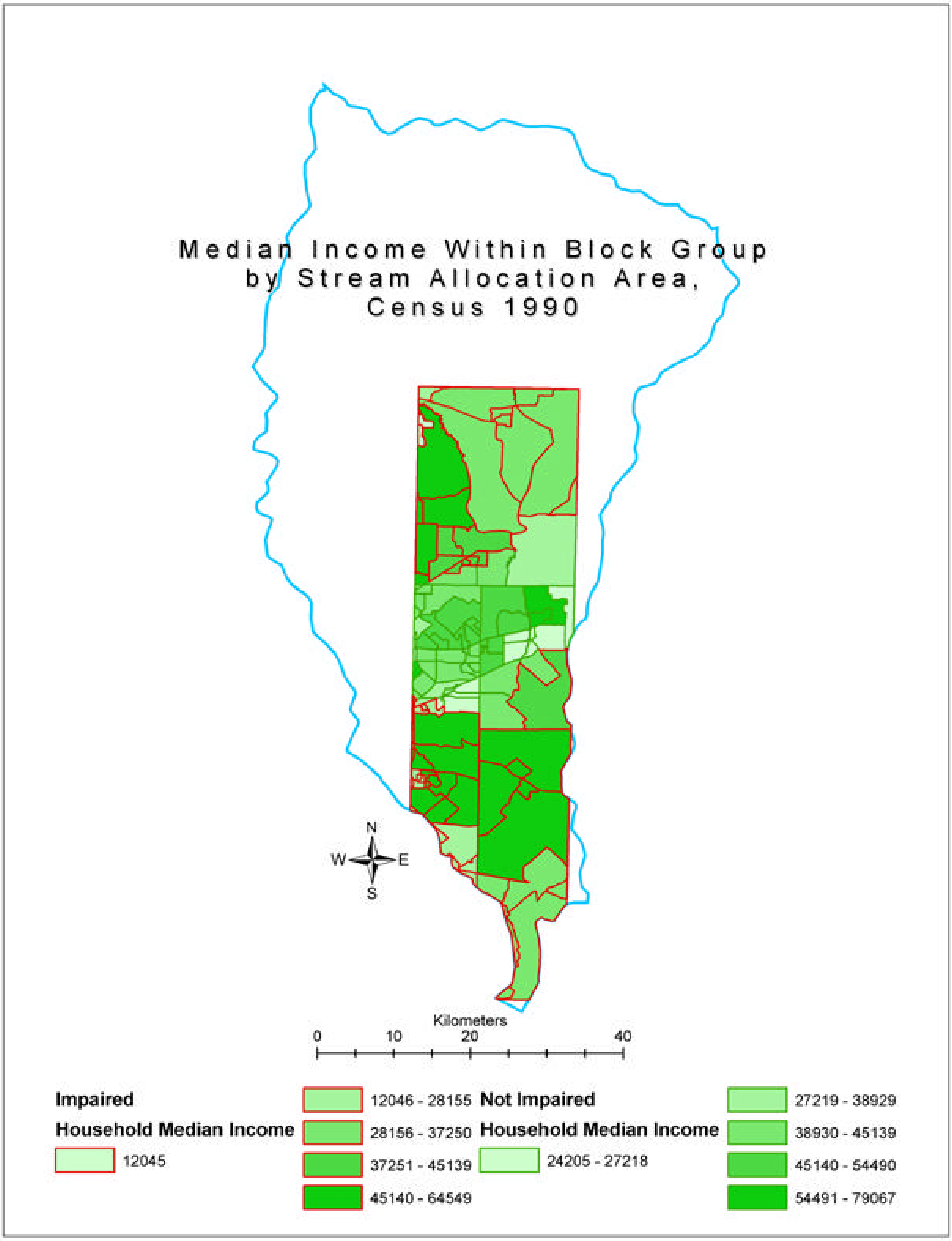
First I gathered all the necessary data layers: county boundaries and population attributes (1990 median income and 2000 non-whites as a percentage of the population), elevation data, impaired stream segments in the East Fork Trinity Watershed boundary. There are a total of seven counties involved in this watershed. These are Collin, Dallas, Hunt, Fannin, Grayson, Kaufman and Rockwall. Fannin and Grayson, however, are not part of the NTCOG. I spent two days attempting to find and compile the data for these counties to no avail. Ultimately, these counties do not even fall within the allocation areas discussed below. So, it is highly unlikely that including them would have changed the results of this study. I gathered the population attributes for each county by block group. Given the small area of a watershed, block data might have been more informative for this study but the Census does not provide income estimates by blocks. Since I also felt I should analyze both attributes at the same level, I decided on using block groups for calculating both race and median income.

I geoprocessed all the data layers used in this study. As I mentioned before, I got the watershed boundary by selecting it from the shapefile containing all watersheds in the country. I exported the selected data into another shapefile named 12030106, after the hydrologic unit number of the study area. For each county except Fannin and Grayson (once for 1990 and another for 2000) I joined the demographic attribute data to the county boundary shapefile. I then exported each into a new shapefile in order to make the join permanent. I also had to create a new attribute for the racial data. I calculated the percentage of non-whites in the population of each block group. Since I am analyzing such a small area, I decided to use the newly established National Elevation Data by the USGS. The USGS expects this elevation data to be more detailed and of better quality than Data Elevation Model (DEM) data. I downloaded the NED information for the area that falls within the East Fork Trinity Watershed at the Texas Natural Resources Information System (TNIRS) web site (www.tnris.org/digital.htm).

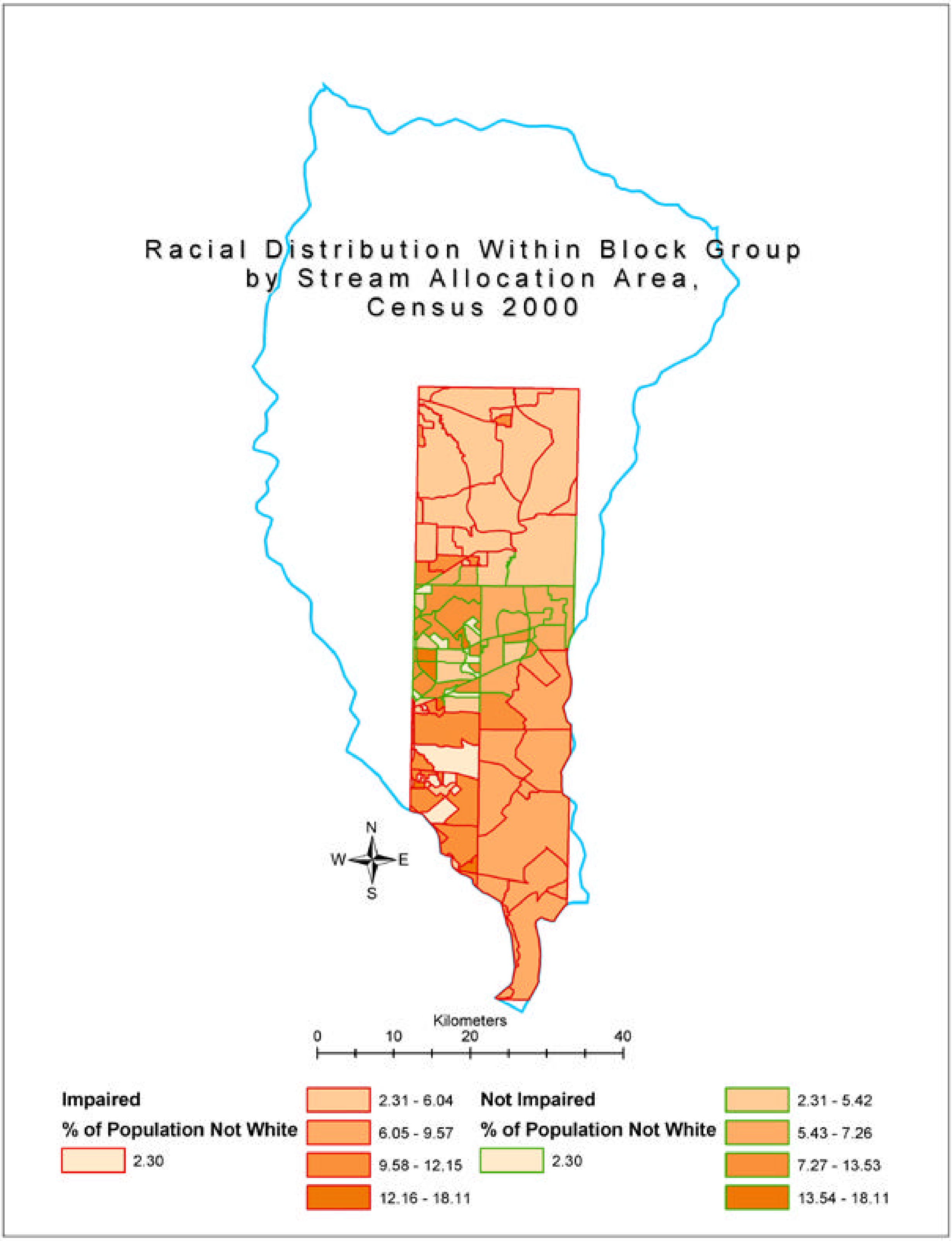
Second, I used the ArcGIS Spatial Analyst Extension to calculate the allocation areas based on the TNRCC stream segments. I calculated the slope for each grid of NED I had. Using the slope, I calculated the cost weight of each cell to get to a cell with a portion of the stream segments. I used the cost weight rasters to calculate the allocation areas for the stream segments. I converted the calculated allocation areas from raster to vector data. Then, I merged the layers in order to create one shapefile. I dissolved the allocation areas based on whether or not they were impaired. I then used this shapefile to clip the shapefiles containing the demographic data within the allocation areas. I selected those block groups from that had their centers in the clipped allocation areas. I did this four times, one for each attribute for each impaired and not impaired stream segment.

Finally, I summarized the percent not white and the median income attributes in each of the four final shapefiles. I did this by opening the attribute table for each shapefile, selecting the attribute and clicking on summary. This gave me the average percentage of non-whites and median income for each block group in each allocation area (see Maps 2 and 3).

Map 2:


Median Income Within Block Group
by Stream Allocation Area,
Census 1990
N
W
E
S
Kilometers
0
10
20
40
Impaired
Household Median Income
12045
12046 - 28155
28156 - 37250
37251 - 45139
45140 - 64549
Not Impaired
Household Median Income
24205 - 27218
27219 - 38929
38930 - 45139
45140 - 54490
54491 - 79067

Map 3:


Racial Distribution Within Block Group
by Stream Allocation Area,
Census 2000
N
W
E
S
Kilometers
0
10
20
40
Impaired
% of Population Not White
2.30
2.31 - 6.04
6.05 - 9.57
9.58 - 12.15
12.16 - 18.11
Not Impaired
% of Population Not White
2.30
2.31 - 5.42
5.43 - 7.26
7.27 - 13.53
13.54 - 18.11

IV. Findings and Discussion

It appears that within the watershed there is no difference between the areas allocated to the impaired and not impaired streams as far as race and income levels go. According to some, the majority of the people living in the polygons outlined in red (impaired stream segment areas) should be non-white and have lower incomes than those living in the area that is not impaired. This does not bear out in this case study. It would be interesting to repeat this analysis for each watershed in North Texas. It happens that Garland and Mesquite are among one of the most integrated cites in Dallas County. So, these results might not bear out for other watersheds.

It may very well be because this analysis is at the watershed level that the results show no difference. Humans tend to segregate things in terms of political boundaries and not in terms of naturally occurring margins. Using smaller Census units might also make a difference. However, since the Census does not provide some of the data used here at the block level, other sources of demographic information should be explored. In addition, using superfund sites or other non-linear data to calculate allocation areas might make a large difference in the study's outcome. Finally, and I think most importantly, is my use of two separate rasters to calculate first slope, then cost weight and finally allocation areas. ArcGIS does not yet have the capability to merge raster data. I was unable to decipher how to do so in ArcInfo Workstation. Having a more accurate of the watershed elevation probably makes a difference in the areas allocated to each stream segment.

VI. References

1. Loftis, Randy Lee. Environmental Groups Meet Federal Officials: Action Sought On Pollution In Minority Areas. The Dallas Morning News 25 February 1992: 15A.

2. Pianin, Eric. Bush Seeks To Amend Water Rules: Environmentalists Oppose Policy Change. Washington Post 17 July 2001: 1A.

3. Sierra Club. Sierra Club Blames Bush For Legislature's Failure To Close The Loophole For Grandfathered Polluters: Environmental Group Commends Speaker Laney and House Members for Making Progress Toward the Goal. 30 May 1999 Press Release.

4. Sierra Club. Grandfathered Plants and Pollution in Texas. 19 October 1998 Press Release.

5. Texas, State of. Surface Water Quality Standards Act. Title 30, Chapter 307 of the Texas Administrative Code.

6. TNRCC. Texas 2000 Clean Water Act Section 303(d) List, Effective 31 August 2000.

7. TNRCC. Stream Segments 2000 Vector Digital Data Metadata. 6 December 2001.