A Century of Change: Land Use and Land Cover Trends in the St. Croix River Basin

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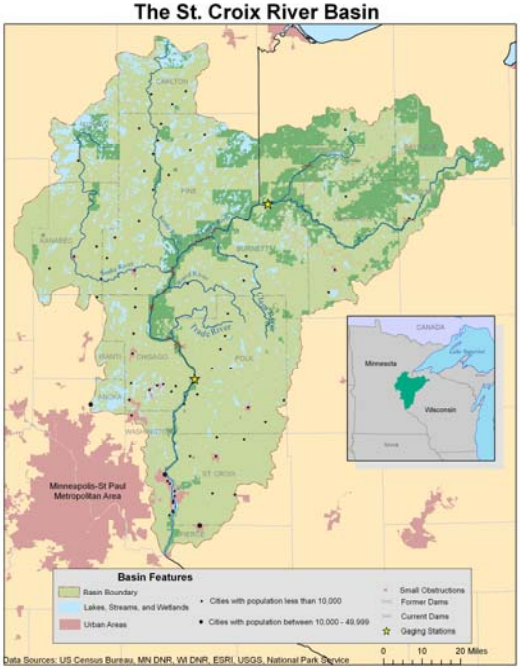
Research Impetus & Objectives

In 2004, the United States Geological Survey (USGS) issued a report analyzing streamflow data on the St. Croix River. These measurements of water discharge show a variation between the upper gaging station, which has seen little fluctuation since monitoring began in 1914, and the lower station at St. Croix Falls which has seen annual streamflow peaks, annual mean flows, and 7-day low flows increase by .45 to .55 percent per year since 1902.

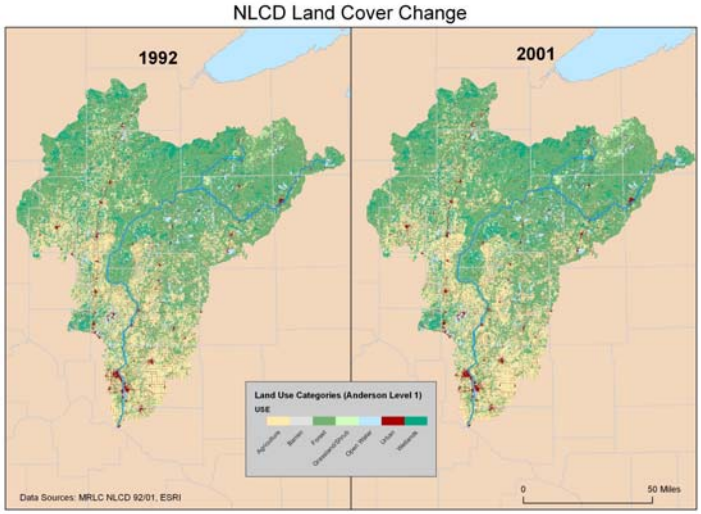
This project aims to examine data on land use in the basin that could explain what factors are influencing this variation. This primary method of data analysis was with Geographic Information Systems (GIS), with additional information provided by historical records.



Impervious Surfaces

The most relevant land features to the study are ones that would lead to increased water discharge, through the creation of surface runoff. Impervious surfaces prevent water from infiltrating the surface and re-entering the water cycle. Instead, it travels overland, often ending in rivers or drainage systems. The main contributors of impervious surface are roads, parking lots, and rooftops.

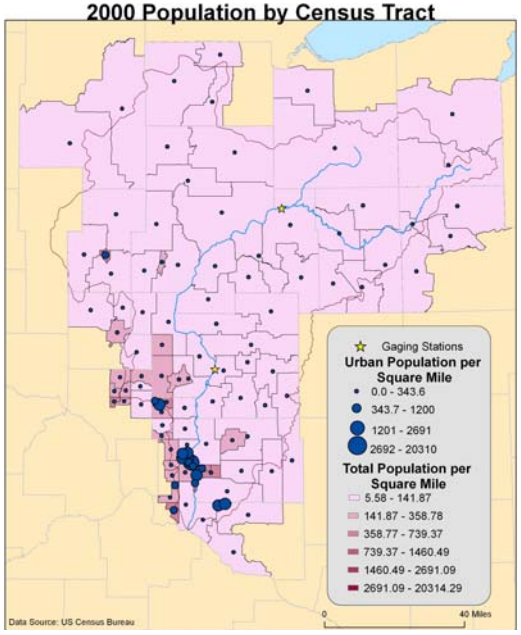
Impervious surface coverage can be derived directly from satellite images, but the EPA has developed a more accurate method. This system combines population and housing data, paved road areas, and commercial, industrial, and mining land uses, and then factors in known values of impervious for different uses. Using this 'Multiple Data Sources' method, the percent total impervious area in the St. Croix Basin above the upper gaging station is estimated at1.93%, while the area below this station has 2.77% impervious area.



Data & Methodology

Each type of variable was acquired from a different data source and required a slightly different methodology. Some data, such as population, was downloaded in numerical format and analyzed in that format, as well as being mapped. Other data, such as land cover, is downloaded in a categorized raster format, and spatially analyzed based on the categories and areas.

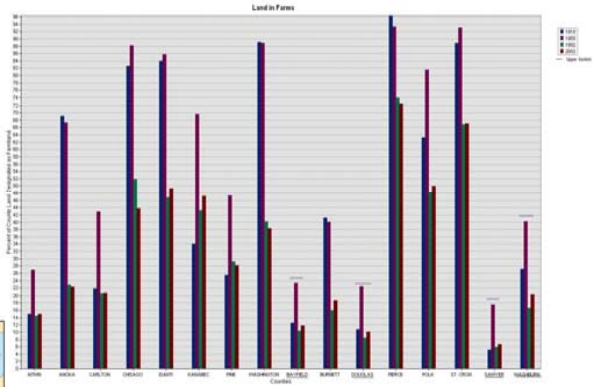
Because some data is not able to be limited to just the Basin area (which is based on USGS delineations), 16 counties were identified as falling all or mostly within the basin, and data for these counties was mapped and analyzed. All maps are in the UTM Zone 15N projection.



Agriculture & Land Use

The USDA conducts a Census of Agriculture which records information on land in farms and its use. The graph below shows the distribution of land in farms among counties over the century, and it is clear that the four counties above the upper gaging station have a much smaller proportion of land devoted to farms.

The map to the left shows change in land cover between 1992 and 2001. This dataset was created by the Multi-Resolution Land Characteristics Consortium and utilizes 7 categories of land cover. The map shows that the largest land cover in the basin is forest, and the dominance of agriculture in the lower section of the basin is also reflected. Urban areas cover only a small percentage of the basin, mainly in the southern Twin Cities area and following the road networks northward.



Conclusions & Future Research

Preliminary analysis reveals several points of change over the years that differ within the basin. Population growth has been on the whole greater in the lower section, and in the upper section the majority of growth has been in rural rather than urban areas. Since 1900, the overall rate of growth of the population below the Danbury gauge was 322%, while the area above this gauge had an overall rate of 16%. These population numbers impact land use, water use, and impervious surface coverage.

Farming has also been more extensive in the lower section, in terms of total land in farms as well as ratio of improved farmland to woodland or pasture. In 1992, the Census of Agriculture shows that the percent of land in farms in the lower section of the basin was around 3.6 times that of the upper section.

Different aquifers underlie the upper and lower regions of the basin, and the uses of water also vary. All this data gives an overall picture of processes at work in the basin, and show that the upper basin has experienced much less change over the century, although it may be beginning to enter a period of greater flux. The detailed examination will be conducted by a computer model based on the data gathered in this project. Other areas of research that could be useful are specific spatial distribution of irrigation practices, and soil types which influences infiltration, runoff, and erosion.