

Use of Remote Sensing for Investigating Impacts of Urbanization on Peak River Flows

Introduction:

Urbanization and its associated reduction in permeable surfaces can increase peak flood flows within a watershed. This increase in peak flows results from the lack of infiltration and the rapid routing of storm water into rivers. The purpose of this project was to investigate if remote sensing can be used to correlate the impact of urbanization on peak river flows. If this analysis is effective, the results can be used to better estimate flood risks under potential future urban development scenarios.



Figure 1: Location of Bellevue, WA

The river selected for this analysis was Mercer Creek near Bellevue Washington (USGS 12120000). Bellevue, is located just east of Seattle within the metropolitan area (as shown in Figure 1). In the last 100 years this area has undergone a dramatic change from mostly open land to a highly urbanized watershed. In particular, this project focused on the twenty year period from 1972 through 1992 because this period coincides with the available Landsat MSS data.

Methods:

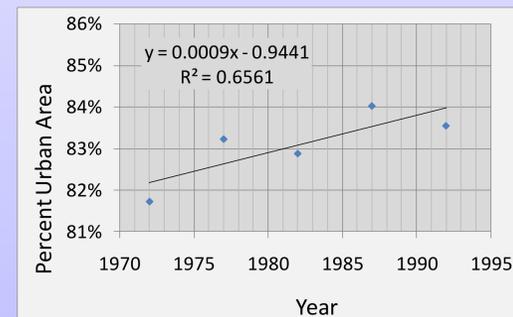


Figure 2: Change in Urban Area from 1972 to 1992

Two types of data were used in this project; remotely sensed data from Landsat and hydraulic data from the USGS.

The remotely sensed data included Landsat MSS data from the months of either July or August of 1972, 1977, 1982, 1988 and 1992. These data were analyzed using the Normalized Difference

Vegetation Index (NDVI) to highlight areas of vegetation. An unsupervised classification with 5 classes was used to classify the land cover. These 5 classes were combined to 2 classes (urban and open space) for use in the analysis. Suburban areas were combined with urban areas since suburban areas tend to have a substantial amount of imperious surfaces. The percent urban area for each of the years is shown on Figure 2. The land use classification used to determine the amount of urban area are shown on Figures 3 through Figure 7.

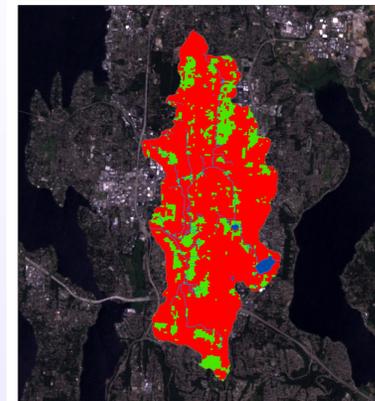


Figure 3: Land Use in 1972

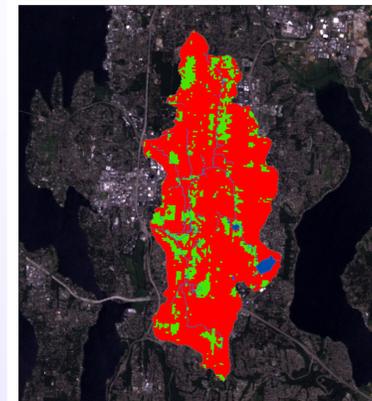


Figure 4: Land Use in 1977

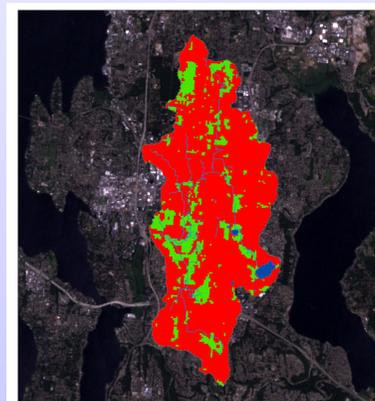


Figure 5: Land Use in 1982

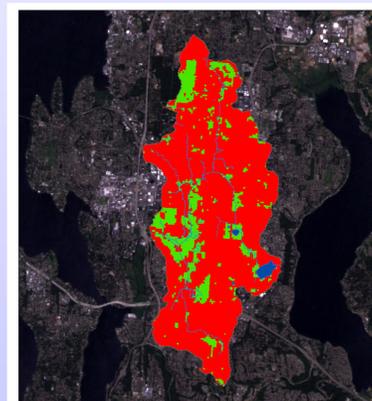


Figure 6: Land Use in 1988

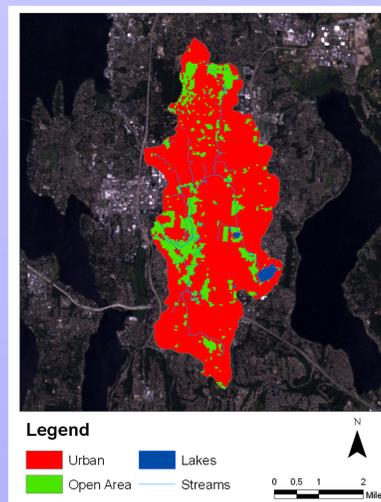


Figure 7: Land Use in 1992

Methods Continued:

A time series plot of the peak flow data for Mercer Creek near Bellevue Washington (USGS 12120000) for the period of interest (1972 to 1992) is shown on Figure 8. From the slope of the linear regression, it can be seen that peak flows in Mercer Creek have been increasing over time.

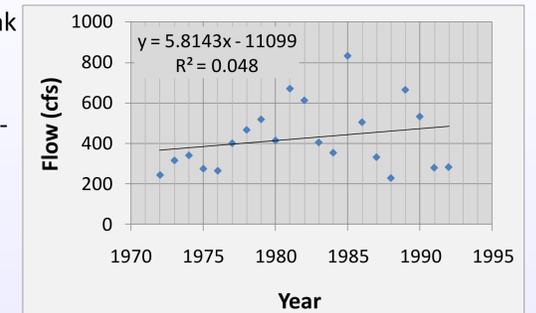


Figure 8: Trend in Peak River Flow from 1972 to 1992

Results:

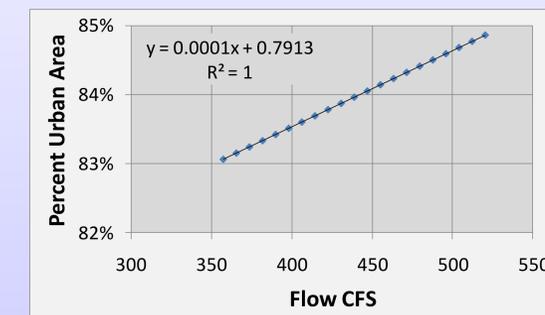


Figure 9: Correlation Between Percent Urban Area and Peak River Flows

Comparing the increase in urban area to the peak flows from 1972 to 1992, shown in Figures 2 and Figure 8 indicates that both the percent open area and peak flows have increased over time. By combining the linear regressions for both sets of data increases in urban

area can be directly correlated to increases in peak flow. This correlation is provided on Figure 9.

Discussion:

Based on the results of this analysis combining remote sensing with hydrological data can be used to quantify the impact of urbanization on peak river flows within the Mercer Creek watershed. The level of detail used in this project was sufficient for a proof of concept investigation but the results are not sufficient for use in land and community planning.

For practical application a more in-depth analysis is needed. To increase the precision of this analysis a data source with a higher spatial resolution should be used (LandsatTM, Aster, etc.). Classification of the images using a supervised classification based on local knowledge of the basin would increase the accuracy of the classification. These data should then be compared to, and used with other forms of data including historical maps and census data to verify the land use classifications. Historical data can also be used to explore the impacts of urbanization occurring prior to the availability of remotely sensed data.