How does urbanization affect streamflow in three different basins with differing degrees of urban development in the Puget Sound region?

**Abstract**

This study is about the effect of urbanization on streamflow, specifically in the Pacific Northwest, and how different degrees of urbanization produces different flow rates. This was a synthesis project, finding gauge data about the basins and analyzing it. Two basins were chosen from King County and one from Snohomish County based on their percent impervious surface and other characteristics such as size, shape, etc. Streamflow data from the past ten years was gathered for each basin and used to produce graphs. The data show that overall, the second most urban basin has higher flow rates but the most urban basin has the lowest flow rates. This is explained by the restoration work that the most urban basin has undergone to prevent further flooding. As urbanization continues to increase, the discharge rates in streams will also increase unless restoration work similar to what the most urban basin has had done is applied to other basins.

**Introduction**

As the human population continues to increase around the globe, so does the expansion of urban areas. This “expansion of urban areas” can simply be defined as urbanization or more specifically, “the conversion from rural land uses to residential and commercial uses” (Couch and Hamilton, 2002). As expansion increases, the amount of impervious surfaces also increases which leads to an excessive amount of water runoff during storms. The runoff from the streams then causes flooding. It’s important to know that there are consequences involved with urban development and that these consequences are likely to increase as we change our approach to development. “Urbanization” is not a single condition; instead, it is a collection of actions that lead to recognizable landscape forms and, in turn, to changes in stream conditions (Konrad and Booth, 2005).

Some of the hydrological consequences of urban development include increased flooding and bank erosion, the redistribution of landscape patterns and successions, and changes in water quality from increased urbanization to stormflow and physical disturbance of and changes to aquatic habitat (Walsh et al., 2005). Humans aren’t the only ones affected, stream ecosystems are as well. To investigate these hydrological effects more closely, three basins with different degrees of urbanization were selected and analyzed. This study took place on the western side of Washington state, around the Puget Sound area. This region, west of the Cascades but east of the Olympics, is the coastal area of the Pacific Northwest and is commonly known for its wet climate. The three different drainage basins being analyzed are Tulalip Creek, May Creek, and Thornton creek, each having a different degree of urbanization. By exploring how the hydrology of these basins differ, there will be a clear picture of how the increase of urban development affects overall streamflow.

**Methods**

**Data Selection**
- Daily streamflow data was chosen from the last 10 years (2010-2019)
- Data was downloaded from the USGS and King County databases
- Data for Tulalip Creek was from USGS
- Data for Thornton Creek and May Creek was gathered from the King County database

**Table 1:** Characteristics for each basin
- **Tulalip Creek:**
  - Area: 15.64 sq miles
  - Perimeter: 15.64 miles
  - Impervious surface: 3.88%
  - Channel Shape: 7.42
- **May Creek:**
  - Area: 3.86 sq miles
  - Perimeter: 26.66 miles
  - Impervious surface: 12.43%
  - Channel Shape: 24.06
- **Thornton Creek:**
  - Area: 5.66 sq miles
  - Perimeter: 25.35 miles
  - Impervious surface: 44.51%
  - Channel Shape: 7.1

**Results**

- **Tulalip Creek:**
  - Average daily discharge: 12128000 ft³/s
  - Baseflow: 200 ft³/s
  - Peak discharge: 12128000 ft³/s
  - Total discharge: 12128000 ft³/s
- **May Creek:**
  - Average daily discharge: 12128000 ft³/s
  - Baseflow: 200 ft³/s
  - Peak discharge: 12128000 ft³/s
  - Total discharge: 12128000 ft³/s
- **Thornton Creek:**
  - Average daily discharge: 12128000 ft³/s
  - Baseflow: 200 ft³/s
  - Peak discharge: 12128000 ft³/s
  - Total discharge: 12128000 ft³/s

**Discussion**

- The data presented both show and don’t show the impact of urbanization
  - Tulalip creek shows higher and more frequent peaks in its hydrograph which means it has a higher overall discharge rate than the other basins (figure 6)
  - Comparing the seasonal patterns for May and Tulalip Creeks, May creek has higher average flows for both rainy and dry seasons
  - Although Thornton creek is the most urban, it has the lowest average flows through both seasons
  - The urban basins have lower baseflows because they have reduced infiltration which means they have less groundwater being discharged as baseflow (Walsh et al., 2005)
  - Thornton Creek’s decade hydrograph has a lower discharge rate than both May and Tulalip Creeks even though it is the most urban
    - Shown by low peaks and low baseflow (figure 7)
    - Comparing the 2016-2019 hydrographs, May creek is displaying more flashiness due to the steep rising peaks and lower baseflows (figure 8)
    - Thornton Creek wasn’t used in the comparison because of the restoration work done to it
    - Projects were designed to control flooding and erosion
    - Projects included funds to reduce combined sewer overflows and flooding: construct major stormwater detention facilities, new sewers, and storm drains (Hara, 2007)

**Conclusion**

To conclude, streamflow is drastically affected by the amount of urbanization. Basins that are in more populated areas, will have higher discharge rates with high peaks and low baseflows which is displayed by the May creek data and hydrographs. Thornton creek is more urban than May and Tulalip Creeks but it doesn’t display those attributes. Although it is the most urban, it has had work done to it to manage stormwater and runoff. If this type of work could be applied to other basins, it would prevent flooding in many areas and improve the overall health and flow of streams.

**Acknowledgments**

Thank you to the PLU geoscience faculty for an amazing past four years. Thank you to my mentor Rose Mckenney for all of the help and guidance and thank you to my friends and family for the constant support.

**References**