The Effect of Land Use on Total Suspended Solids and Discharge

Champlain Valley Union High School, Sarah Clauss and Grace Hemmelgarn

Introduction

Land use is the management of the natural environment, classified as forested, agricultural, or urban. The management of the land affects runoff into nearby waterways. In forested areas, only 13% of rainfall runs off into rivers or streams, compared to 20% on grassland. The roofs and pavement of urban areas cause 98% of rainfall to become runoff.

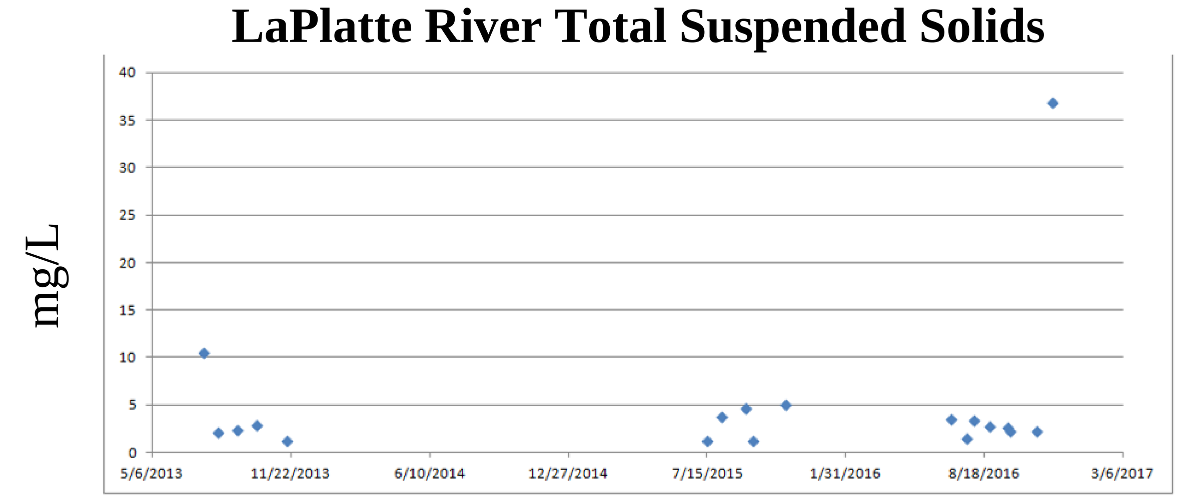
Runoff and erosion are the main sources of total suspended solids (TSS) in a stream. Total suspended solids are particles in the water column larger than 2 microns. Common solids found naturally in streams include: inorganic materials, bacteria, algae, and decomposing organic matter. Urban runoff can introduce soil, tire particles, and debris, while increasing flow, or discharge. As flow increases, larger particles can be suspended, resulting in higher TSS readings. At TSS levels below 20 mg/L, the water is considered clear; at 40 mg/L, the water begins to appear cloudy. Clear water and a relatively stable TSS level are indicators of a healthy stream. However, there are no state guidelines for acceptable TSS values.

By comparing land use, flow, and total suspended solids in the Allen Brook and the LaPlatte River, the effect of land use on water quality was analyzed.

Hypothesis: If the area surrounding a watershed is more urban, then the total suspended solids and flow will be greater than those of a mostly forested stream site.

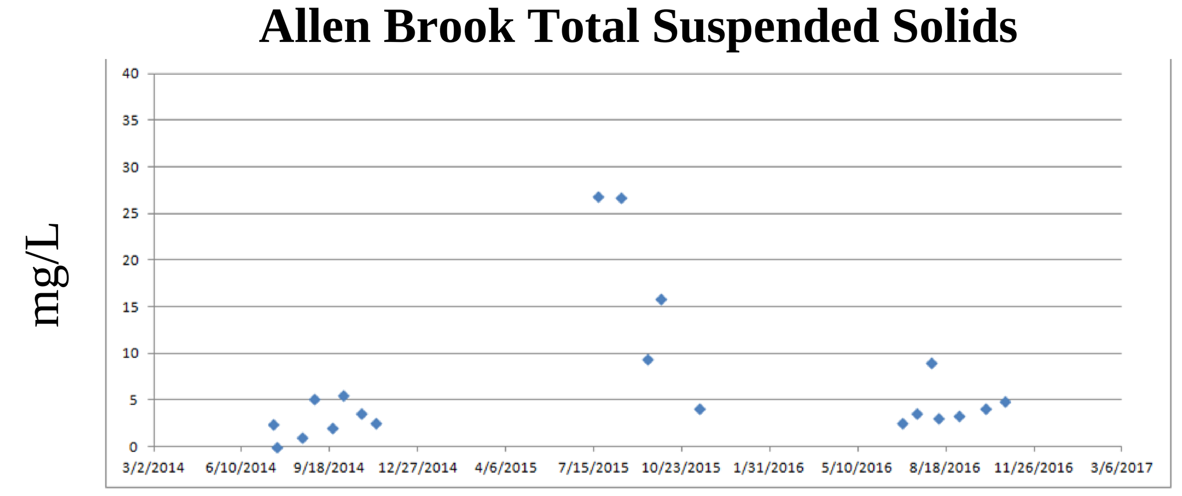
Total Suspended Solids

LaPlatte River Total Suspended Solids



LaPlatte River Average TSS: 5.06 mg/L

Allen Brook Total Suspended Solids



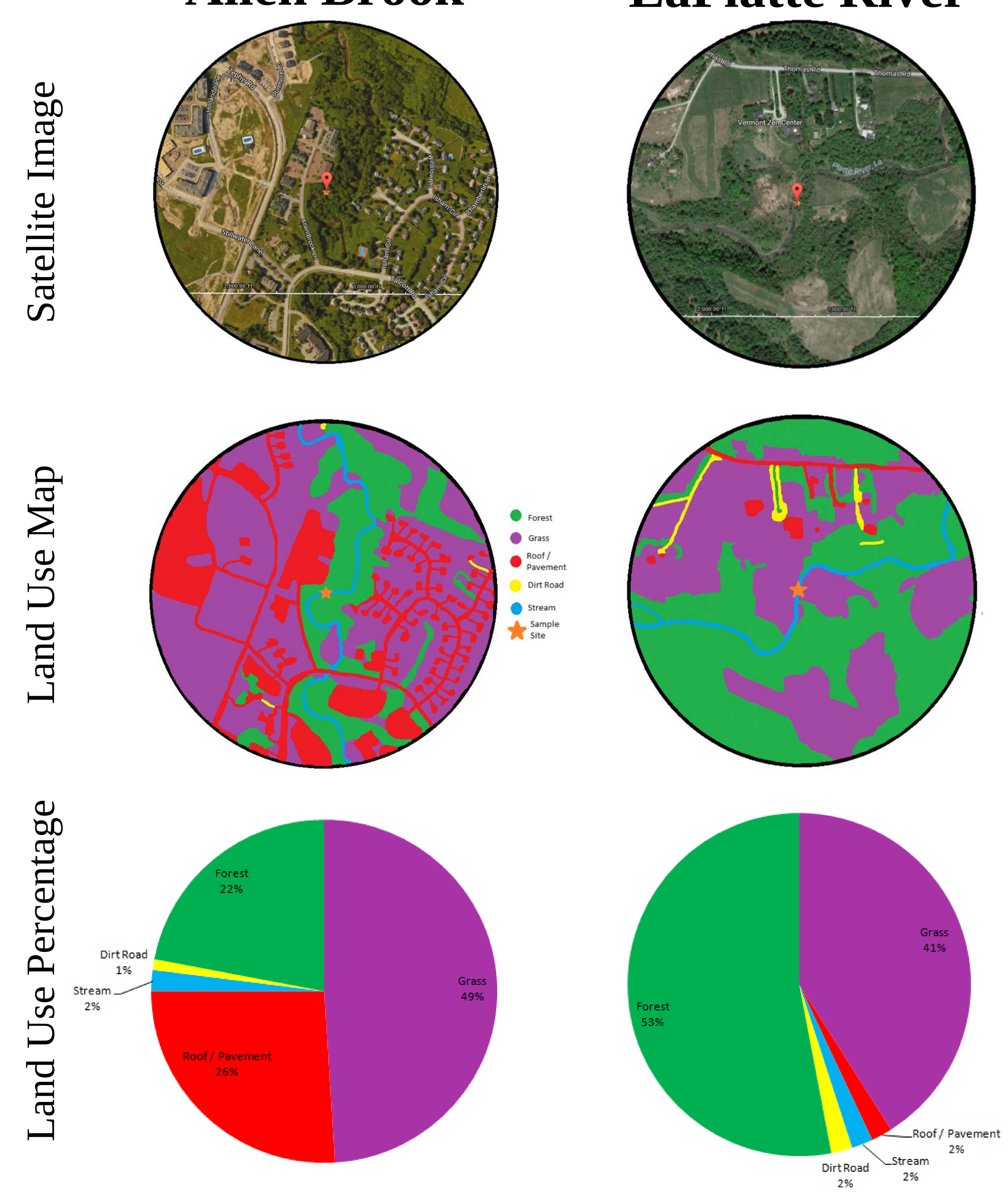
Allen Brook Average TSS: 6.78 mg/L

Acknowledgements

Funding provided by NSF Grant EPS-1101317

Land Use

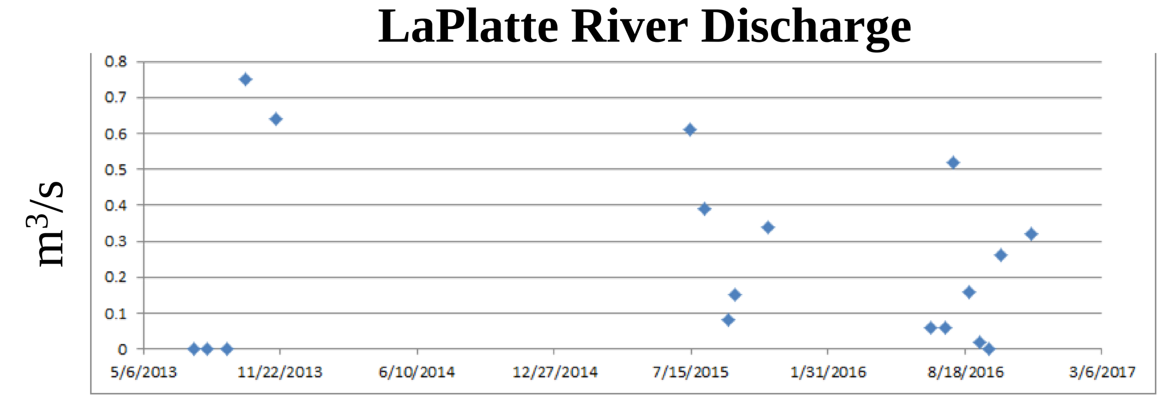
Allen Brook | LaPlatte River



The satellite and land use maps show a quarter mile radius around the Allen Brook and LaPlatte River stream sites.

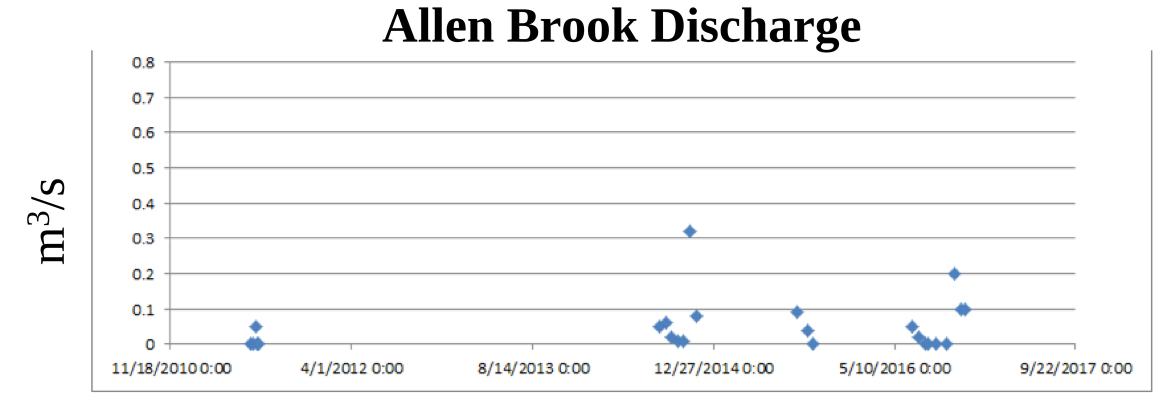
Discharge

LaPlatte River Discharge



LaPlatte River Average Discharge: 0.242 m^3/s

Allen Brook Discharge



Allen Brook Average Discharge: 0.078 m^3/s

Discussion and Analysis

In a comparison of land use around each stream site, it was found that both had a similar percentage of grass in the immediate surrounding area, with 49% at the Allen Brook and 41% at the LaPlatte River. However, the LaPlatte had significantly more forest (53%) than the Allen Brook (22%). The area around the Allen Brook was 26% roofed or paved, compared to only 2% of the LaPlatte. In forested areas, about 13% of rainfall enters local waterways, while 98% of rainfall on roofs and pavement becomes runoff. As a result, the Allen Brook experienced more runoff than the LaPlatte River.

The average discharge of the Allen Brook (0.078 m^3/s) was less than that of the LaPlatte River (0.242 m^3/s). The Allen Brook, despite having more surrounding urban land, had a slower discharge rate than the LaPlatte.

The LaPlatte River had an average total suspended solid level of 5.06 mg/L, while the Allen Brook had an average of 6.78 mg/L. Clear water usually has a TSS level of 20 mg/L or less, so both streams have a water quality able to support healthy ecosystems. Rivers with a faster discharge rate tend to hold more, larger suspended solids; however, the TSS data does not show a considerable difference between the sites. The LaPlatte, with a slightly faster flow, has a TSS level comparable to the Allen Brook. Even though the majority of total suspended solids come from runoff and erosion, the urban land use at the Allen Brook does not appear to increase TSS levels.

Conclusion

The hypothesis was: the total suspended solids and flow will be greater for a stream in an urban area than one in a forested area. The data did not support the hypothesis because the difference in urban land use at each site did not have an effect on the TSS or discharge of the streams. There was not a notable difference in total suspended solids or flow between the LaPlatte River and the Allen Brook sites.

Further Research

Total suspended solids usually decrease with increased salinity due to aggregation, which occurs when the suspended particles are bound together by the salts. This creates heavier particles which settle to the bottom. Since the Allen Brook has more surrounding urban land, it is possible that runoff from salted winter roads increases salinity and reduces TSS. A future study could compare the salinity levels in each stream, while continuing to monitor land use, flow, and total suspended solids.

Resources

Frankenberger, Jane, Dr. "Land Use and Water Quality." *Safe Water for the Future*, Purdue University, engineering.purdue.edu/SafeWater/watershed/landuse.html#intro. Accessed 16 Mar. 2017.

Map of LCD_UprLPltt_181. *Google Maps*, Google, 2017, https://www.google.com/maps/place/44%C2%B021'44.2%22N+73%C2%B012'36.1%22W/@44.362715,-73.2097268,1149m/data=!3m1!1e3!4m5!3m4!1s0x0:0x0!8m2!3d44.362284!4d-73.21004. Accessed 14 Mar. 2017. Map.

Map of WR_AllnBrk_361. *Google Maps*, Google, 2017, https://www.google.com/maps/place/44%C2%B027'04.4%22N+73%C2%B006'09.4%22W/@44.4505796,-73.1049096,1144m/data=!3m1!1e3!4m5!3m4!1s0x0:0x0!8m2!3d44.451226!4d-73.102616. Accessed 14 Mar. 2017. Map.

"Turbidity, Total Suspended Solids and Water Clarity." *Fundamentals of Environmental Measurements*, Fondriest Environmental, 13 June 2014, www.fondriest.com/environmental-measurements/parameters/water-quality/turbidity-total-suspended-solids-water- clarity/. Accessed 16 Mar. 2017.