

Carp River Watershed Climate Change Impact Analysis

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Introduction

The Carp River watershed is located in the northwest of Ottawa and has an area of 295 km². The upper watershed is largely developed with urban land while the lower area remains rural in nature with high agricultural use.



The Ottawa area is expected to see up to a 6.5°C increase in average temperatures by the year 2100¹. As a result, the intensity and frequency of rain events is expected to increase⁴ putting the Carp River watershed at higher risk of increased flooding due to these events.

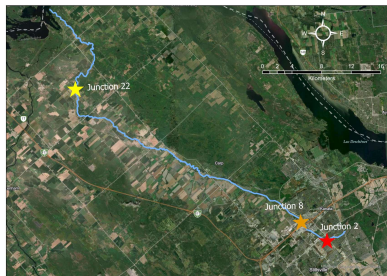
This study uses numerical hydrological modelling to investigate the impacts of climate change on the magnitude of flood events in the Carp River.

Emission Scenarios

- Four different emission scenarios were used to model different possible future outcomes for radiative forcings: SSP2-4.5, SSP5-8.5, RCP-4.5, and RCP-8.5.
- The 4.5 Wm⁻² forcings roughly follows historical patterns in socioeconomic development, while the 8.5 Wm⁻² provides the worst-case scenario.²
- Time horizons used for future projection were 2021-2050, 2041-2070, and 2071-2100.

Scaled IDF Curves

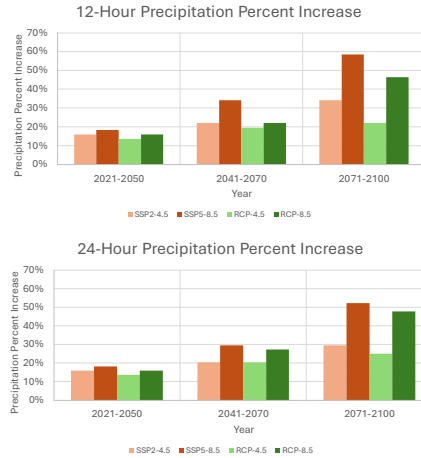
The saturation vapour pressure of water scales exponentially with temperatures and follows the theoretical Clausius-Clapeyron of a 7% increase per 1°C increase in air temperature.³ This relationship was used to scale historic IDF data based on projected temperature increases. The ECCC IDF curve from the Ottawa CDA RCS station was used as the baseline for all scaled precipitation data for the study.



Junction 22 provides the most accurate magnitudes and should be more heavily considered when looking at flood magnitudes and comparisons to known values since it is the location of the WSC gauge.

IDF Data Results

Precipitation amounts for the 12-hour and 24-hour duration storm events, derived from the scaled IDF curves, are projected to increase between 22% and 59% by the year 2100.



Hydrologic Model

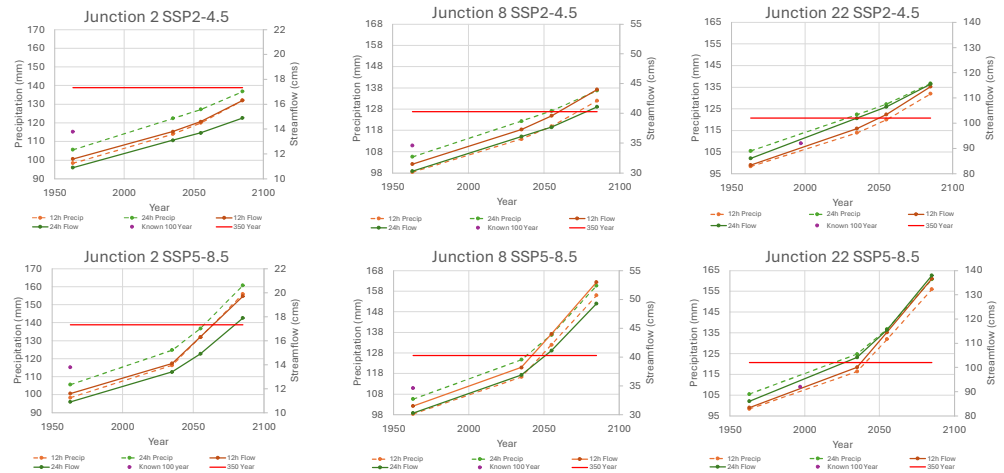
A physically based HEC-HMS model was used to estimate the future flood magnitude values in the Carp River.

Data was extracted from three junctions near areas of interest: Junction 2, Junction 8, and Junction 22.

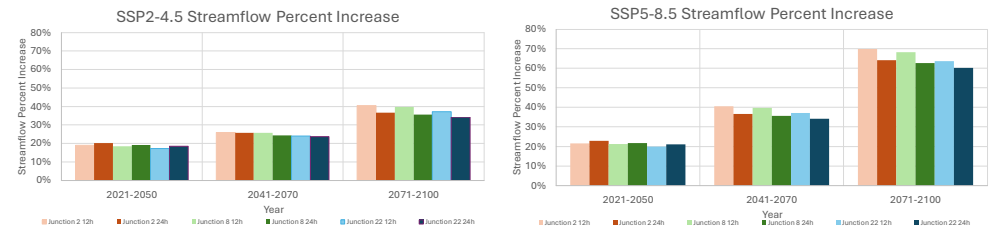
- Junction 22 is the location of the Carp River Near Kinburn WSC (02KF011) gauge.
- Junction 8 is within the Carp River Restoration Area.
- Junction 2 is in the headwaters of the river within the urbanized section.

Modelling Results

350-year flood event magnitudes are currently used in place of scaled 100-year floods to account for the increase due to climate change. The projected flows from the hydrologic model are compared against previously determined 350-year flood magnitudes for the Carp River. The scaled 100-year event floods intersect the 350-year event around 2050 or earlier for Junctions 8 and 22, showing that use of this 350-year value for predicting increases in flooding due to climate change is only suitable for short-term climate change projections.



A higher increase in flood magnitudes is predicted in the Junctions higher upstream in the Carp River, with an estimated maximum projected increase of 70% at Junction 2. The higher coverage of impermeable areas and the absence of a floodplain in the urbanized upper watershed contribute to higher peak runoff and flows which are further increased by more intense rainfall events due to climate change.



Next Steps

This study provides a good basis for understanding the effects of climate change in the Carp River. Next steps include:

- A low flow climate change study should be completed for the Carp River.
- The effects of snowmelt on the flood regime should be modelled with a continuous HEC-HMS model.
- Projections for Ottawa's urban development should be accounted for along with climate change.

Contact Information

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References

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2. Li, C., Zwiers, F., Zhang, X., Li, G., Sun, Y., & Wehner, M. (2021). Changes in Annual Extremes of Daily Temperature and Precipitation in CMIP6 Models. *Journal of Climate*, 34(9), 3441-3460. <https://doi.org/10.1175/JCLI-D-19-1013.1>
3. Martel, J.-L., Brisette, F. P., Lucas-Picher, P., Troin, M., & Arsenault, R. (2021, August 3). *Climate change and rainfall intensity-duration-frequency curves: Overview of science and guidelines for adaptation* [Journal of Hydrologic Engineering]. Vol 26, no 10. ASCE Library. [https://ascelibrary.org/doi/10.1061/\(ASCE\)1084-0699\(2021\)26:10\(1043-5584.0002122](https://ascelibrary.org/doi/10.1061/(ASCE)1084-0699(2021)26:10(1043-5584.0002122)
4. NCC, City of Ottawa, Ville de Gatineau, Conservation Authorities, Environment and Climate Change Canada. (2020, June 1). *Climate projections for the National Capital Region Report*. Open Government Portal. <https://open.canada.ca/data/info/ceffe357-d8bc-4712-b8d9-11b7c6affa71>