GRAND FORKS

BRITISH COLUMBIA

Resilience to Riverine Flooding

Introduction to the Local Government

Grand Forks, British Columbia, is the regional hub of the Boundary area in the Regional District of Kootenay-Boundary, with an approximate population of 4,000 within the city and 10,000 rural residents. It is bounded by mountains with the Kettle and the Granby Rivers running through and bordering the municipality. Agriculture, forestry, and manufacturing are key industries in the area.

> *"For a small municipality, the City has made a lot of progress in terms of climate change adaptation, asset management and flood mitigation."* Graham Watt, Manager of Strategic Initiatives/ Flood Recovery, City of Grand Forks

The hydrology of the arid region is driven by the snowpack of the surrounding mountains and spring rains. The Kettle River is known as a river of extremes, prone to running almost dry or flooding. In addition, the municipality and the surrounding farmland rely on an aquifer which can be drawn low given the water use demand.

Significant climate-related events and impacts

In June 2018, Grand Forks experienced a record flood event, with historic snow accumulation, a widespread rain event, and significant spring heat resulting in record flows for the Kettle and Granby Rivers. Another major flood event occurred in 2017. In addition to flooding hazards, the municipality also experiences periodic extreme heat and drought events

Damage from the 2018 flood, which impacted about 240 hectares of the city and surrounding rural areas, was estimated at over $48M for the commercial, residential, and industrial core of the community. Thousands of hectares of land were impacted, disturbing agricultural areas, roads, and rural business sectors.

Record flood event of the Kettle and Granby Rivers in 2018 affecting many Grand Forks neighbourhoods

Municipal response to climate-related events

The 2018 flood occurred just days before the municipality had planned to update its floodplain hazard maps to better understand flood hazards and natural assets. Following the flood, an early-stage recovery plan was implemented, where community and municipal members investigated impacts on critical infrastructure and the surrounding ecosystem and initiated economic recovery.

> *"One of the biggest issues the flood recovery team faced was the social aspect, which the recovery partners in the community addressed through a case management model. Community recovery is complex and requires a local response."* Graham Watt

Just after the flood, an engineering study was conducted to provide a high-level overview of regional flood risks, impacts and disaster mitigation (adaptation) options for the municipality's rural and urban neighbourhoods. Four options were evaluated: (1) update floodplain bylaws and raise buildings, (2) enhance minimal flood and erosion protection, (3) develop flood protection infrastructure, and (4) initiate home buyout and restoration of the functional floodplain.

The four options were brought to stakeholders for their consideration and underwent a detailed cost analysis. Additional feedback was then sought by meeting with property owners and other community members. The engineering study and the consultations resulted in the city's flood mitigation plan, which was submitted to senior government funders in 2019. By the end of 2019, funding to support the mitigation plan was confirmed from Infrastructure Canada's Disaster Mitigation and Adaptation Fund and the Province of BC, totalling $51M.

"Council took the long view of flood mitigation by avoiding future damage - an estimated $100-150 million cost-- which amounted to more than three times the current investment." Graham Watt

Installation of revetment on the Kettle River to curb erosion after 2018 and 2020 freshets.

The proposed actions were well received by the community, as was the idea of managing the municipality's retreat to leave more room for the rivers. Some of the options, including bypass channel, such as that used in Winnipeg, were considered too costly, with over $100M in trucking expenses alone. Another option considered was a dam; however this type of intervention would have flooded the Granby River valley north of the city while only providing marginal flood protection.

Climate and other data used

Hydrological modelling, driven by projected future climate data, was used to inform the flood mitigation and community dike plan. The open source hydrological model RAVEN was used, as modelling efforts on the Kettle River had previously used this tool. The model was calibrated using observed streamflow data and then used to estimate potential future streamflows on the Kettle and Granby Rivers. Two key points of interest at the City boundary were identified to provide streamflow datasets for input to a separate hydraulic model.

A historical dataset from the Pacific Climate Impacts Consortium (PCIC) and downscaled and bias-corrected output from six different Global Climate Models (GCMs) for the period 1950-2100, were used to drive the hydrological model.

Once the hydrological model was calibrated to match historical conditions, it was fed temperature and precipitation data from the six different GCMs for two different Representative Concentration Pathways (4.5 and 8.5). The model was then able to estimate future 1-in-100 year and 1-in-200 year peak flow return periods

Following the hydrological modelling, it was recommended that the city enhance its flood protection to withstand peak flows 10% higher than the 2018 flood event. Ultimately, a design hydrograph was developed for both the Kettle and Granby Rivers, and this provided input for hydraulic modelling to determine the required dike design.

The hydrological model provides a good tool for estimating changes to flood magnitudes in the future. In addition, we can start to understand potential changes to the overall hydrologic regime of these river systems and other impacts this may have on the City." Lawrence Bird, Hydrologist & Environmental Scientist, Associated Environmental Consultants Inc.

Flood mitigation actions implemented to date

The City of Grand Forks is moving swiftly to implement the proposed flood mitigation actions, which aim to reduce the impacts of climate change. The following actions are either already completed or underway:

- Nearly complete acquisition of 73 single family dwellings, 20 vacant properties and mobile park to enable floodplain restoration and flood mitigation structures
- Conceptual designs for related capital projects, specifically the dike ongoing since 2020
- Construction of an earth berm dike to start in early 2022 with concrete and sheet pile floodwalls to be used in areas where the dike is not large enough
- Drainage enhancement in the downtown area, including major improvements to the stormwater main, pump stations and settling ponds
- Restoration of more than eight hectares of open space and wetland and removal of a 1971 dike
- Use of non-structural approaches in rural parts of the community, such as development restrictions, prevention of further floodplain removal and other bylaws to protect development from hazards and maintain the natural functions of the floodplain

Acquired properties by the Flood Mitigation Program; this land will serve as a natural floodplain.

"The role of natural assets can't be stressed enough; they add considerably to our municipality's resilience to flooding". Graham Watt

Opportunities and challenges in implementing the actions

The City of Grand Forks encountered several opportunities but also a number of challenges in implementing the flood mitigation actions.

The Grand Forks flood attracted a lot of provincial and federal attention, which increased the awareness and understanding of climate change in the area. Fortunately, the flood event coincided with funding offers that could both facilitate recovery and future resilience. Funding availability and the impact of extreme flooding on the lives of Grand Forks citizens resulted in faster decision-making at the municipal level and quicker funding approval.

Furthermore, opportunity lay in the use of hydrological models, such as the one used by Grand Forks. Such models are a tool that municipalities can use to understand other hydrological hazards, such as drought. Specifically, the models can be used to support water management decisions during drought and low river flow into the future.

Grand Forks also experienced challenges in implementing the recommended actions, including funding constraints and uncertainties. As an example, the home buyout program was financially challenging since funders only considered current, post-flood fair market values, as opposed to pre-flood values. This resulted in substantial financial losses for homeowners. Another significant barrier was achieving equity and social justice in the post-disaster period. Specifically, there was limited local capacity to provide medium- to long-term housing options for flood-affected households.

Moreover, inherent limitations with hydrological and future climate models had to be understood and contended with, including:

- modelling uncertainties;
- difficulty in modeling cumulative effects of climate change and future landscape changes (e.g., forest harvesting and wildfire impacts); and
- resolving complex physical processes, such as rain-on-snow events, which are generally not well parameterized by these models.

Next steps for Grand Forks in climate-related flood mitigation

- Complete the implementation of the Flood Mitigation Program, including dikes, drainage improvements, and floodplain restoration.
- Seek funding to enhance flood protection and wetland restoration options, including future property acquisition.
- Complete the development of proactive planning tools to regulate development and land use in the floodplain, reducing the exposure to hazards in the community over time.

Looking for more great resources?

Check out ChangingClimate.ca, your one-stop-shop for examples of climate change impacts and examples of adaptation actions from across Canada.

Need climate data to support your adaptation actions?

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