



Introduction

- River avulsions are the rapid transition from one flow path into another in the flood plain.
- Superelevation is the difference between the floodplain and the levee elevation and can be used to estimate the likelihood of avulsion.
- Avulsions pose a significant risk to human lives and infrastructure, reshaping the landscape and causing flooding.
- In this study we seek to quantify superelevation along the Assiniboine River using remote sensing, and assess it's risk of avulsion, creating a repeatable method for future use.

Study Area

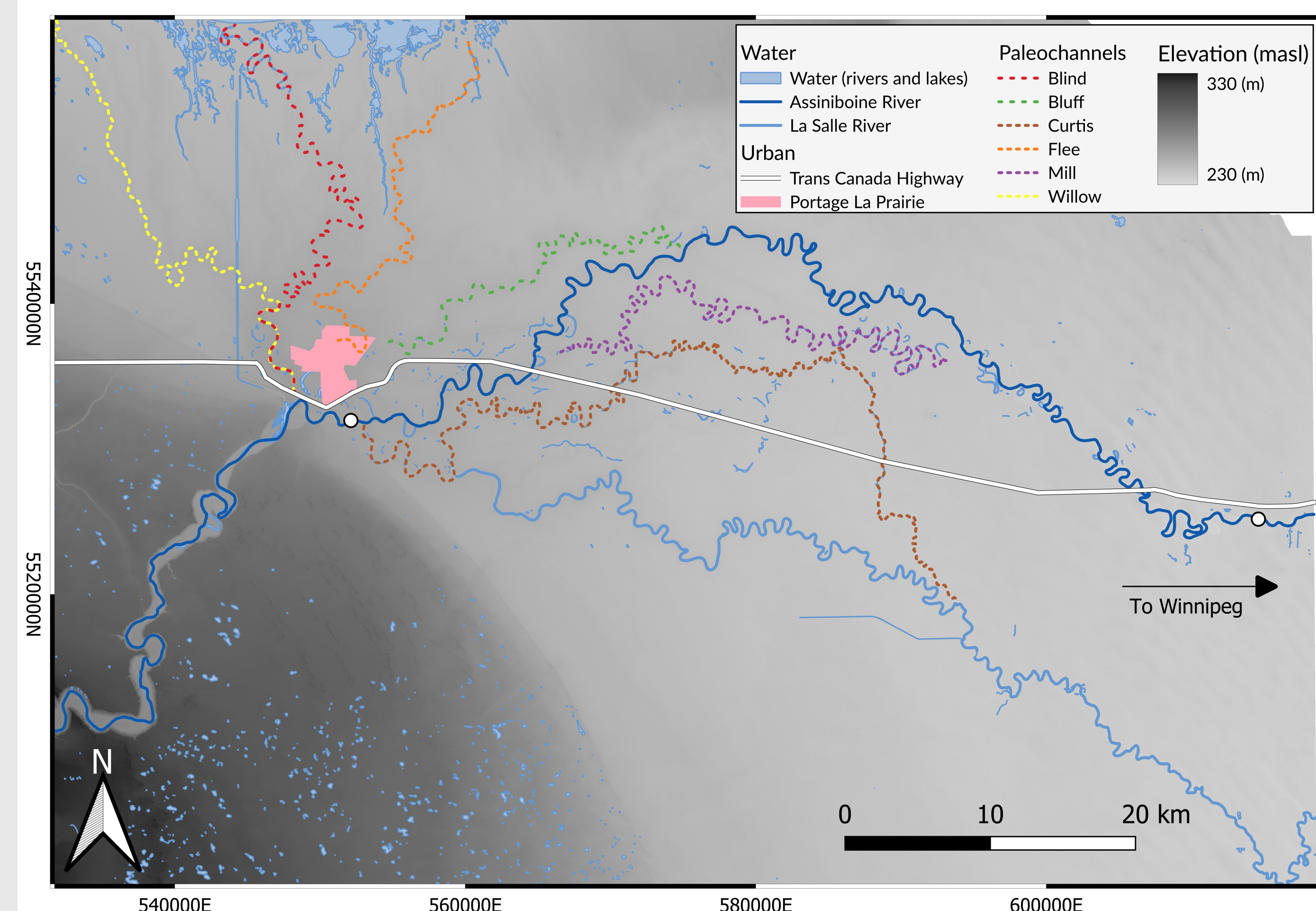


Figure 1. Map of Assiniboine River and paleochannels (modified from Rannie et al., 1989).

Methods

- Constructed a Digital Elevation Model (DEM) using a mosaic of light detection and ranging (LiDAR) scans of southwestern Manitoba, due to it's history of avulsion.
- Derived a Relative Elevation Model (REM) from the DEM by flattening the river water surface elevation.
- Created cross sections along the river based on the hop length of the river, normalizing the superelevation data by the bank-full channel depth.

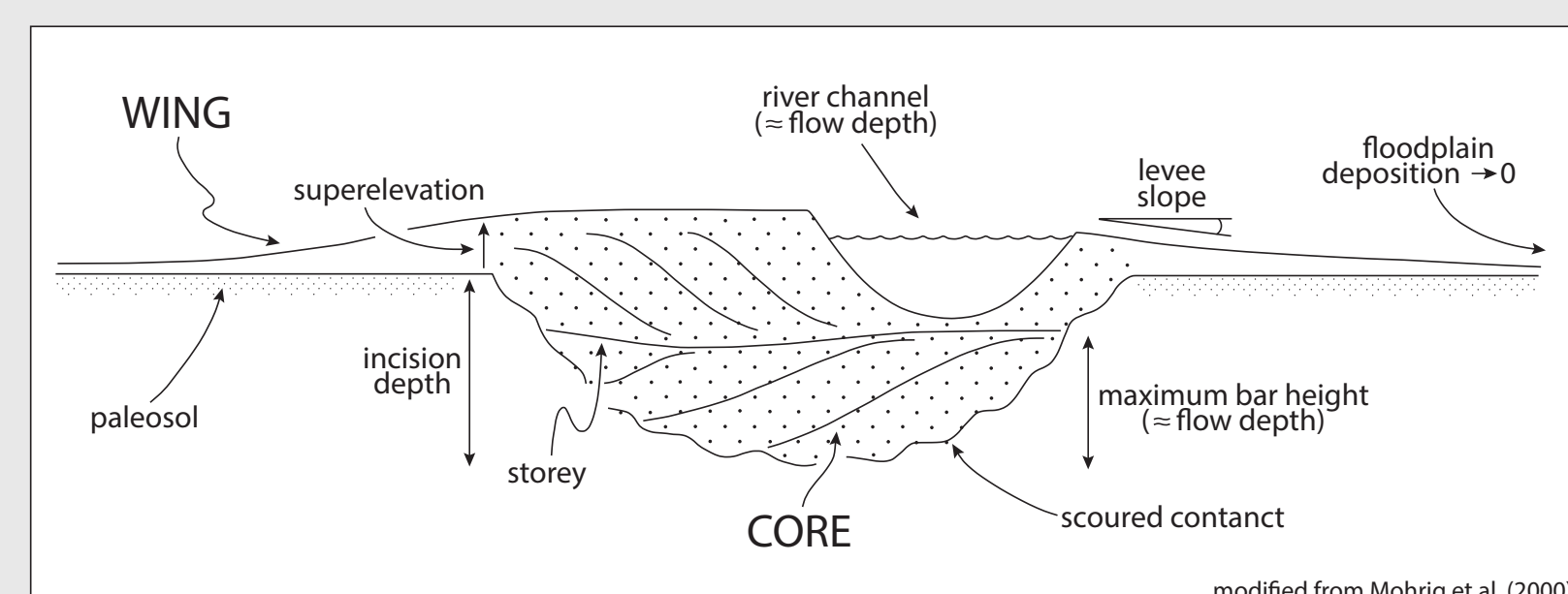


Figure 2: Study area and key avulsion parameters. B) A schematic diagram that highlights the key features of a channel belt with respect to avulsions. The river channel is elevation above the floodplain (i.e. superelevation), which creates a gradient advantage for the river to breach the levee and select a new path on the floodplain (Mohrig et al., 2000).

Results

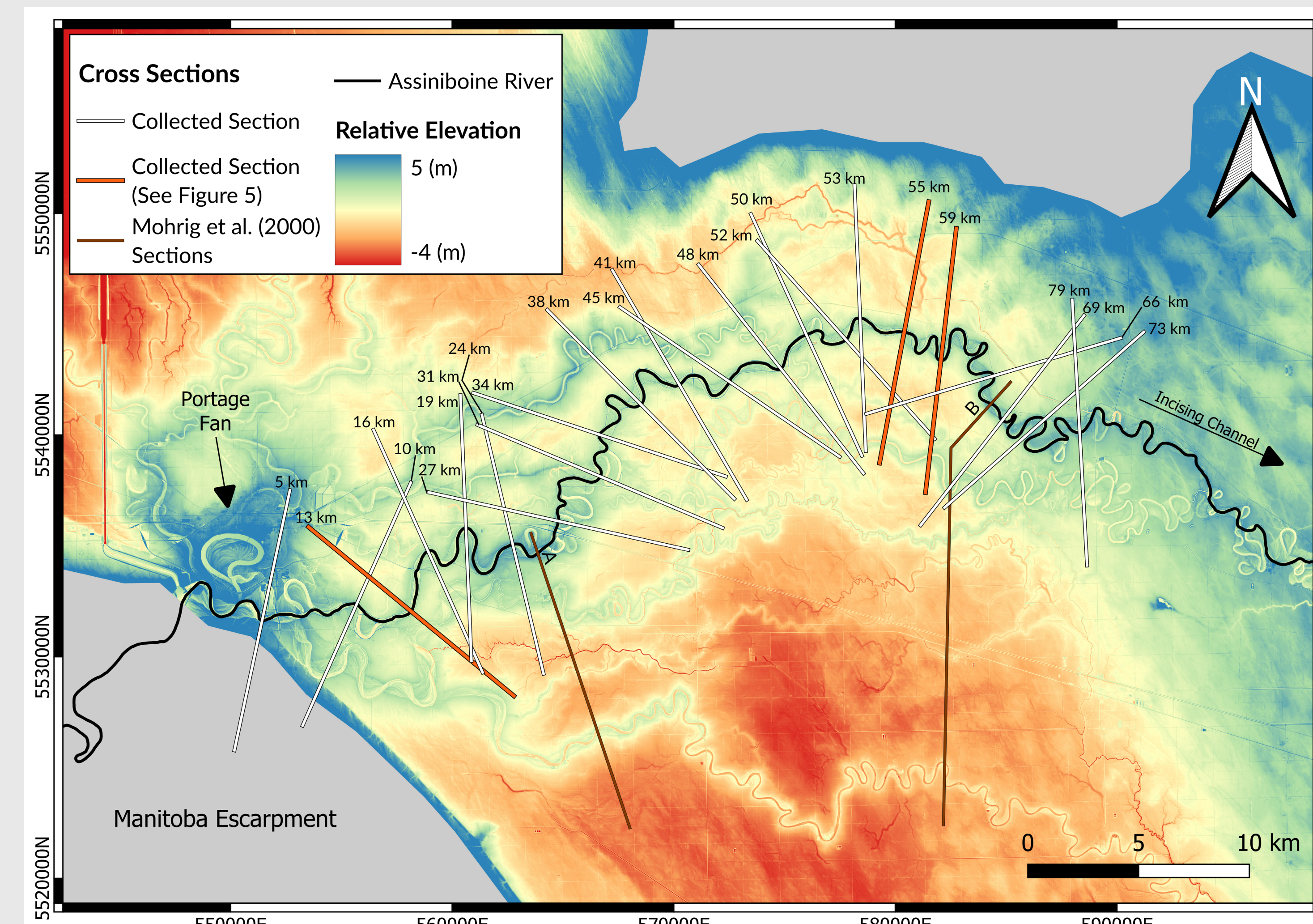


Figure 3. REM map and cross section locations.

- From the constructed REM (Figure 3.) we observe the floodplain is below the river surface and levees to the south of the Assiniboine River, before it incises approaching Winnipeg.
- We collected 22 cross sections along the Assiniboine River, 12 km across, after the Portage La Prairie Dam each is marked based on their distance along the river from the dam (see Figure 3).
- The collected cross sections river measured superelevation had a range of $3.6 (\pm 0.1)$ m - $6.5 (\pm 0.3)$ m, with a mean of $2.5 (\pm 0.7)$ m. The mean bankfull channel depth of $4.7 (\pm 0.7)$ m. Normalized superelevation ranges between $0.03 (\pm 0.002)$ to $0.80 (\pm 0.07)$, and a mean of $0.54 (\pm 0.01)$.

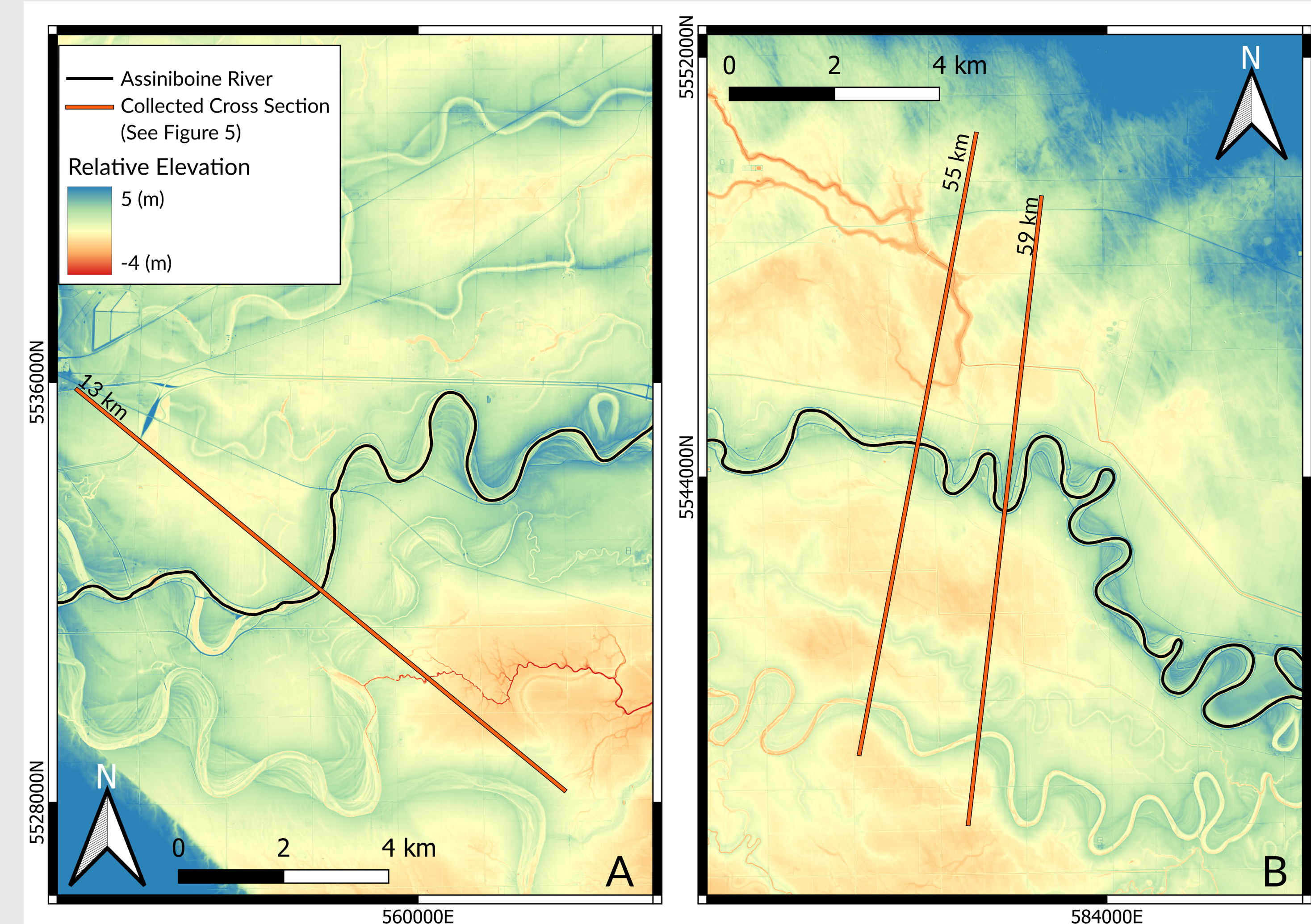


Figure 4. Areas of highest superelevation. See Figure 6 for cross section elevation profiles.

Discussion

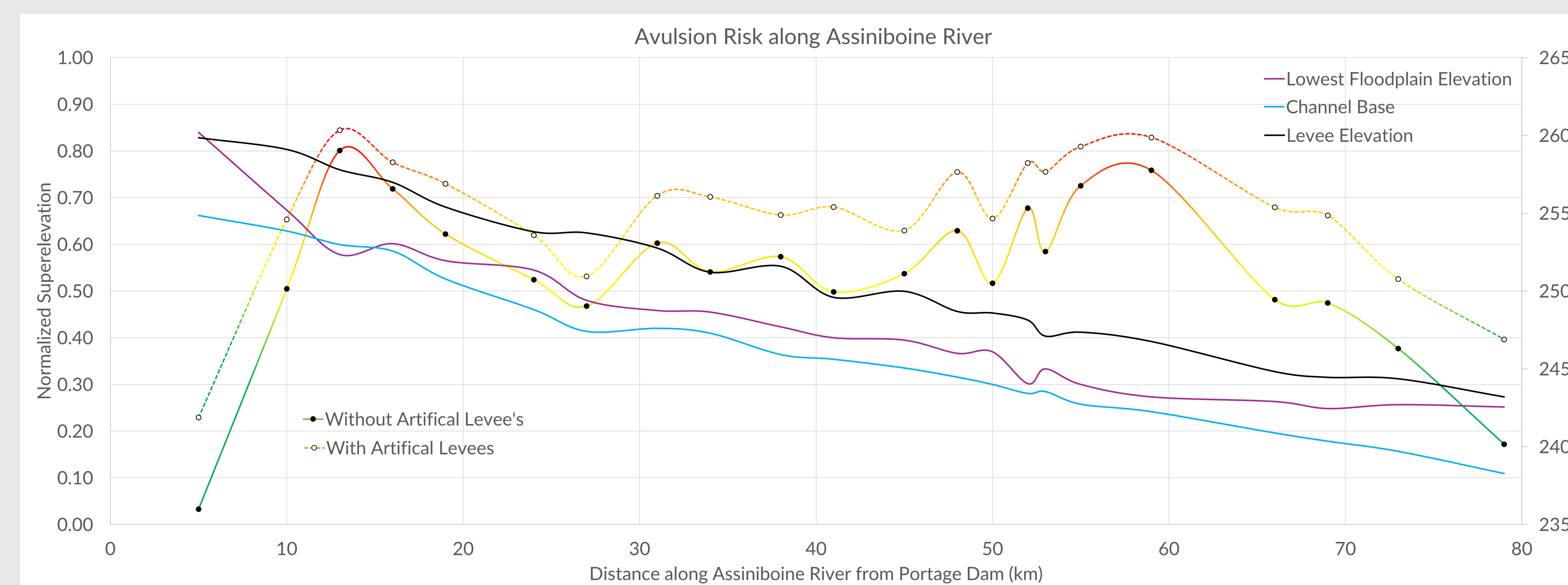


Figure 5. Avulsion risk along the Assiniboine River from cross section superelevation.

- The minimum threshold for an avulsion to occur is a normalized superelevation of 0.5, higher ratios increasing the likelihood of avulsion.
- The two areas with the highest observed normalized superelevation downstream of the Portage Dam were 13 km at $0.80 (\pm 0.07)$ (see Figure 4A and Figure 6A.) and at 59 km downstream reaching $0.76 (\pm 0.03)$ (see Figure 4B and Figure 6C.).

- Further research to collect the sedimentation rates of the Assiniboine River could be used to assess the timescale of when an avulsion may occur.
- Effort should be made to model the possible flow path of the predicted avulsion, to assess which areas of the floodplain have the highest exposure to the risk posed by an avulsion occurring on the Assiniboine River.
- Avulsions can happen suddenly and without warning and thus need to be addressed with different tactics than traditional flood monitoring.

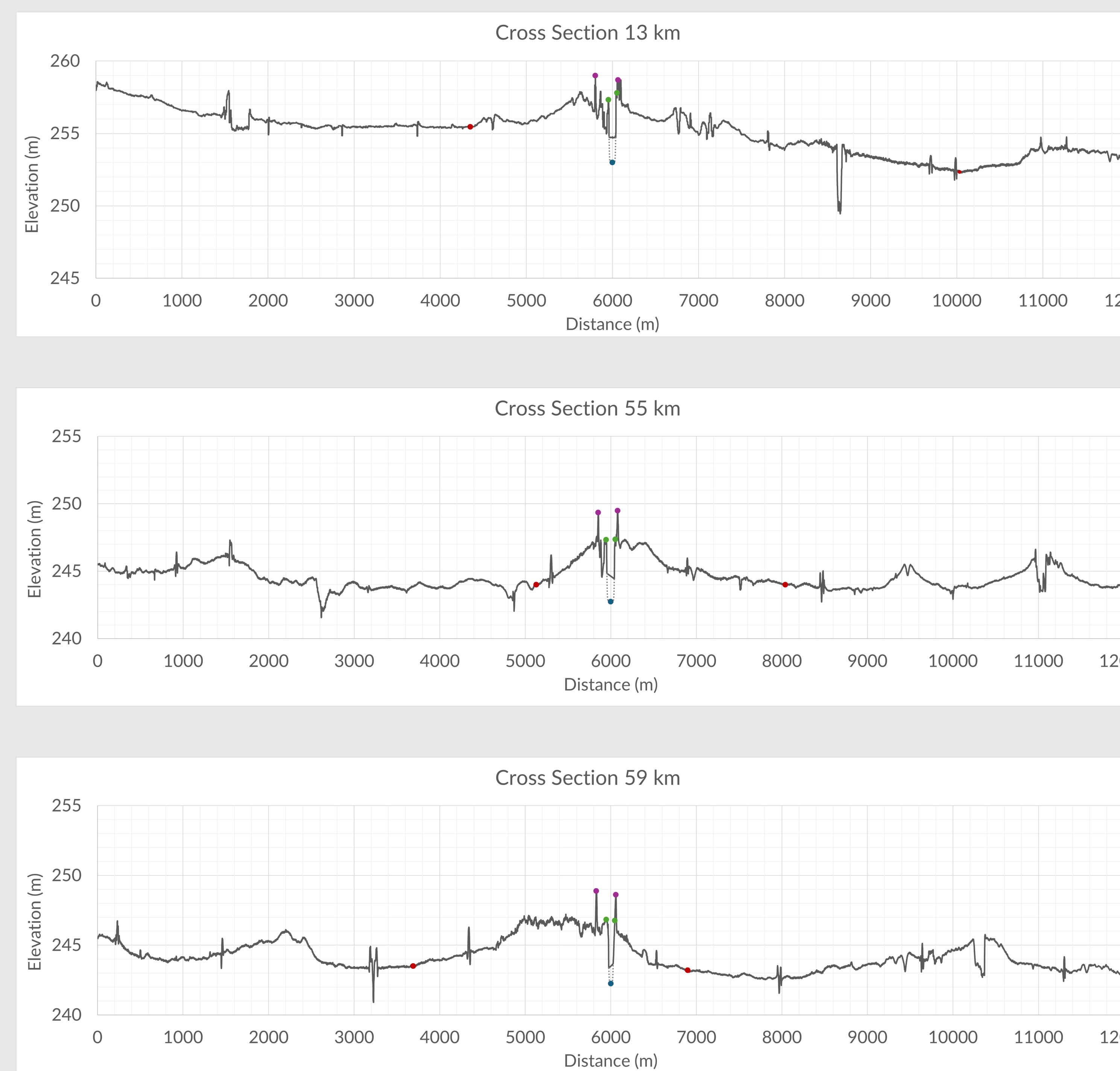


Figure 6. Highest normalized superelevation cross sections.

Flood plain elevation (red), estimated natural levee elevation (green), artificial levee elevation (purple), estimated channel base elevation (blue),

Conclusions

- The Assiniboine River is at a significant risk of an avulsion between Portage La Prairie and Winnipeg, posing a serious risk to individuals, infrastructure, and ecosystems. Steps should be taken to mitigate the risks posed by the superelevated sections of the river.
- The methods developed in this study provide a repeatable and accessible process of deriving avulsion risk of a river, through the use of LiDAR data.

References & Acknowledgements

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