

Watercourses in Flux: Climate Change and the Accelerating of Stream Erosion

David Van Vliet, Matrix Solutions
Inc.

November 20, 2024

Watercourses in Flux: Climate Change and the Accelerating of Stream Erosion

- Guelph case study
- Future climate and hydrologic modelling
- Streamflow impacts
- Mitigation alternatives



The hydrologic foundation of geomorphology and erosion processes is in flux due to climate change.

The potential impacts of climate change on streams and erosion can be evaluated using readily-accessible data and models

Thank you to my colleagues

- Geomorphology
 - Mariëtte Pushkar
 - Roger Phillips
 - John McDonald
- Modelling
 - Steve Murray



Why do we care about stream erosion?

- Asset damage (bridges, sewers, water mains, roads, trails, property)
- Human health
- Water quality and sediment load
- Ecosystem health
- Flood risk
- Costs for repairs and upgrades



What impacts stream erosion?

Physical Things

- Stream slope and channel shape
- Bed and bank composition

Dynamic Things

- Stream flow and velocity
- Riparian vegetation and land cover
- Sediment load
- Groundwater interactions

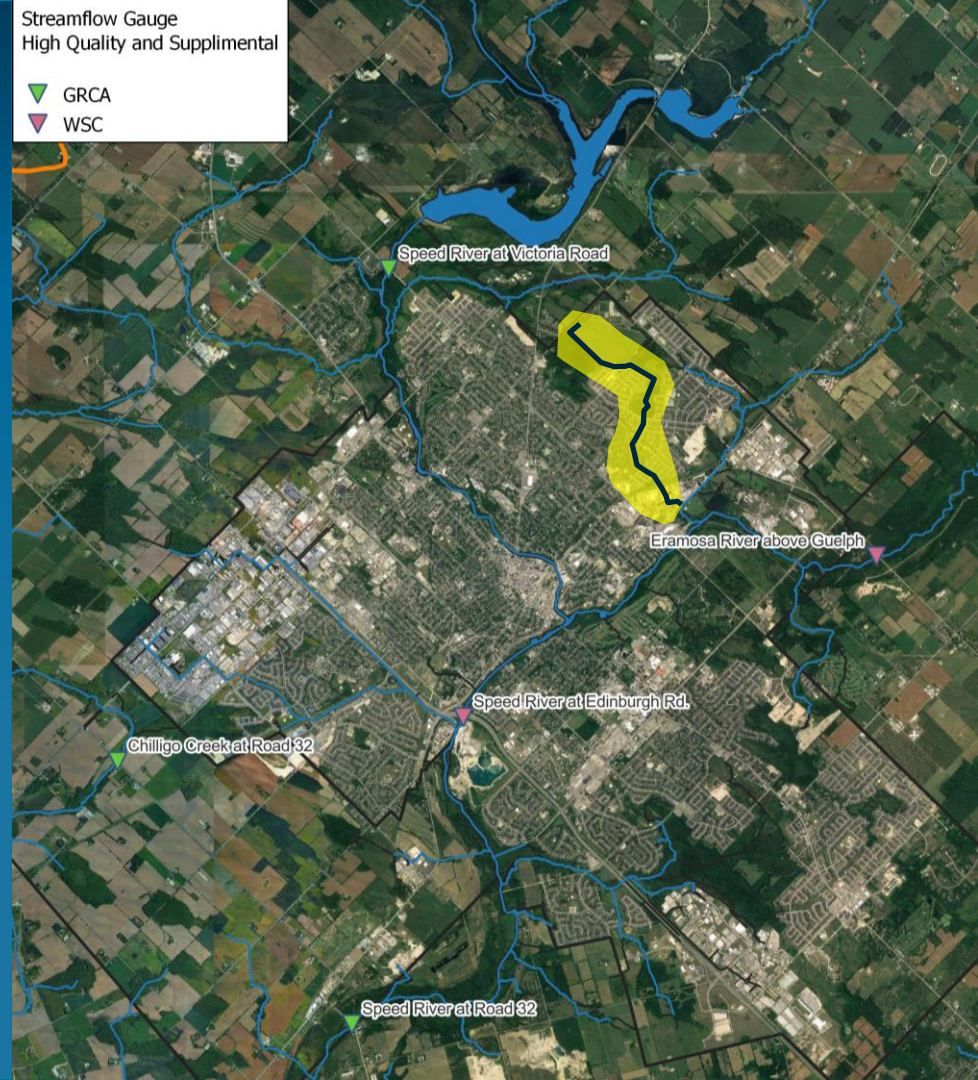


Hadati Creek, City of Guelph

- Tributary to Speed River
- Runs through natural and urban areas
- Degraded by urbanization (water quality, erosion, habitat degradation)
- Various stormwater, riparian restoration, habitat improvement projects

Streamflow Gauge
High Quality and Supplemental

- ▼ GRCA
- ▼ WSC



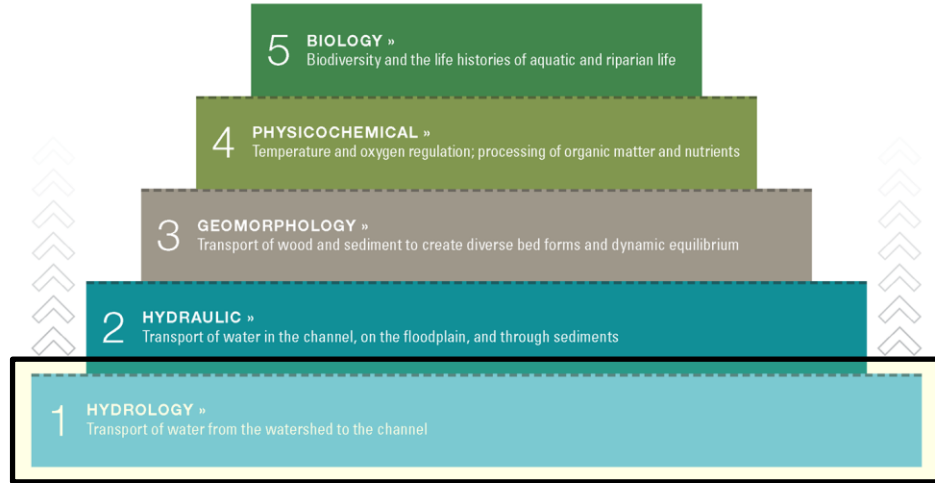


Natural Channel Assessment and Design

- Hydrology, and therefore climate, is foundational
- Multi-disciplinary science and engineering perspective

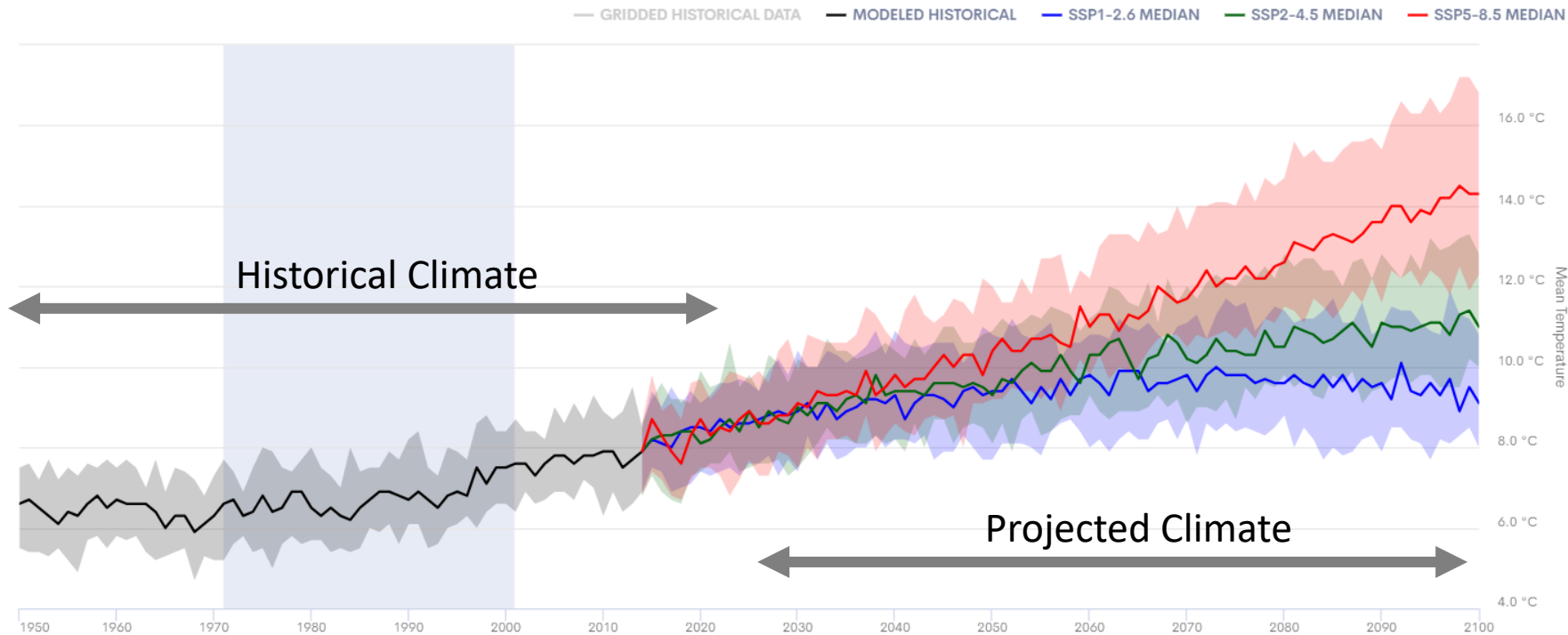
Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions



Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. *A Function-Based Framework for Stream Assessment and Restoration Projects*. US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006.

A Changing Climate – Temperature Is Increasing



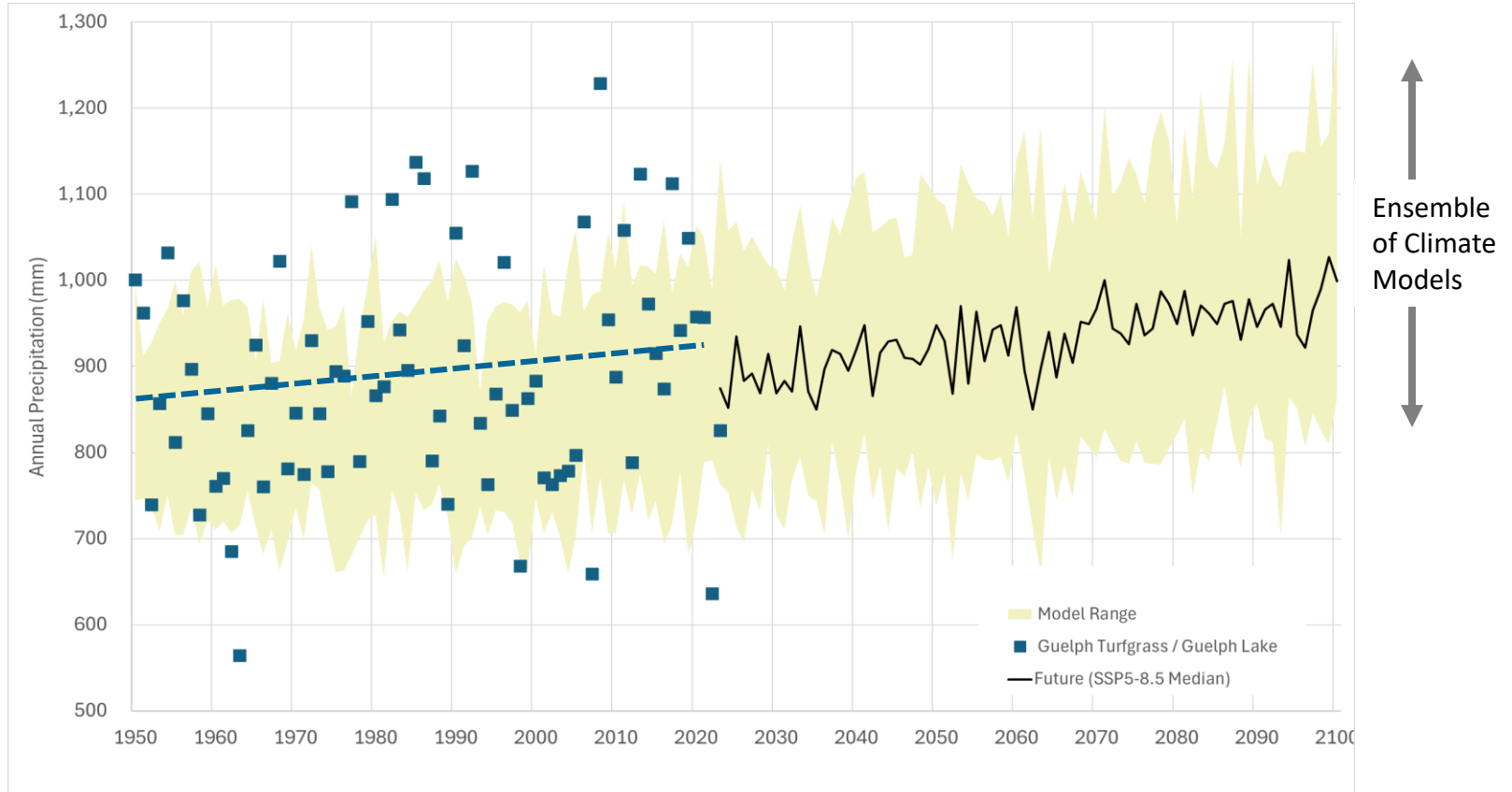
Warmer Air Holds More Moisture

Clausius-Clapeyron Relationship:

- Vapour pressure, or the maximum amount of moisture in the air, increases by 7% for every increase in 1 Celsius increase in temperature.
- More frequent, higher intense rainfall events

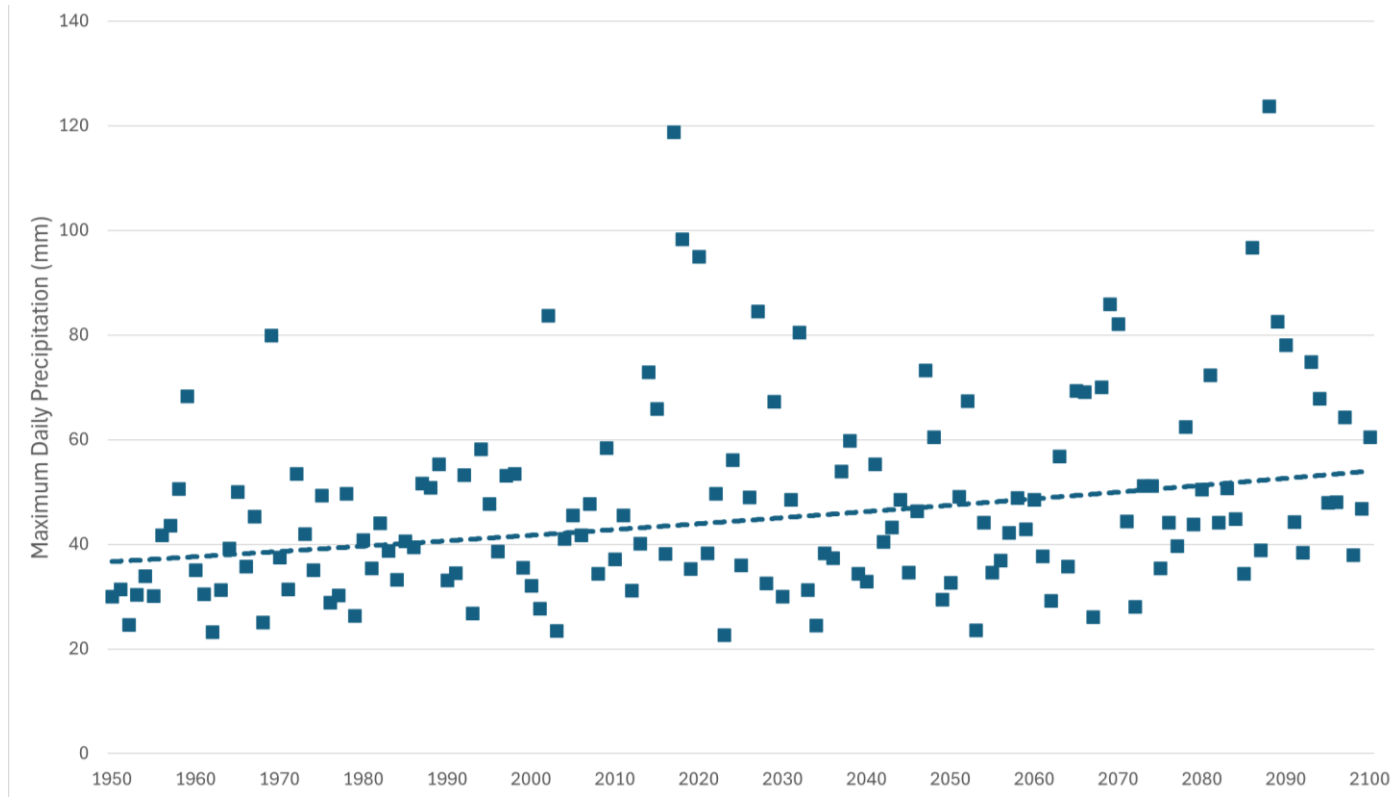


Guelph: Historical and Future Precipitation Trend



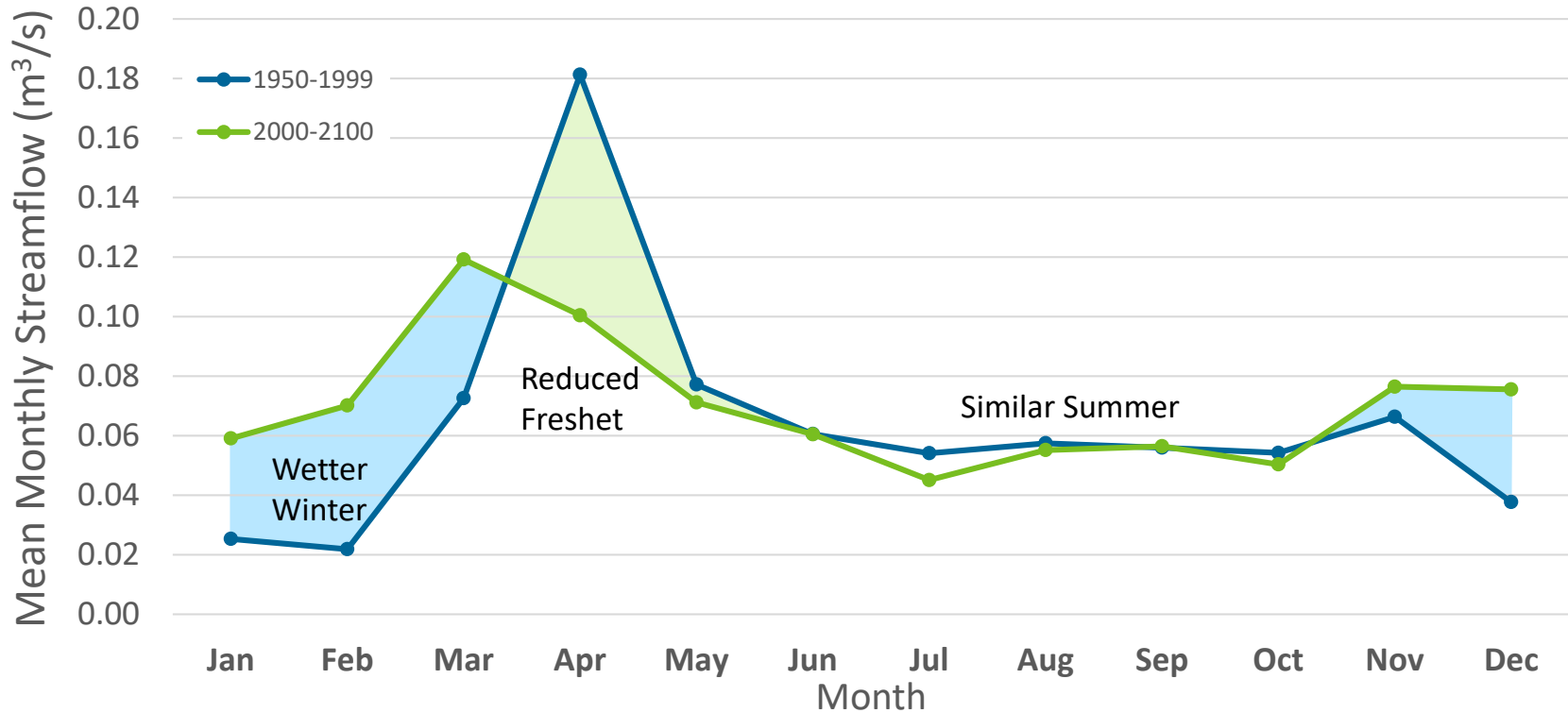
Projected Increase in Rainfall Intensity

(CanESM5 Regional Climate Model, SSP4-8.5)



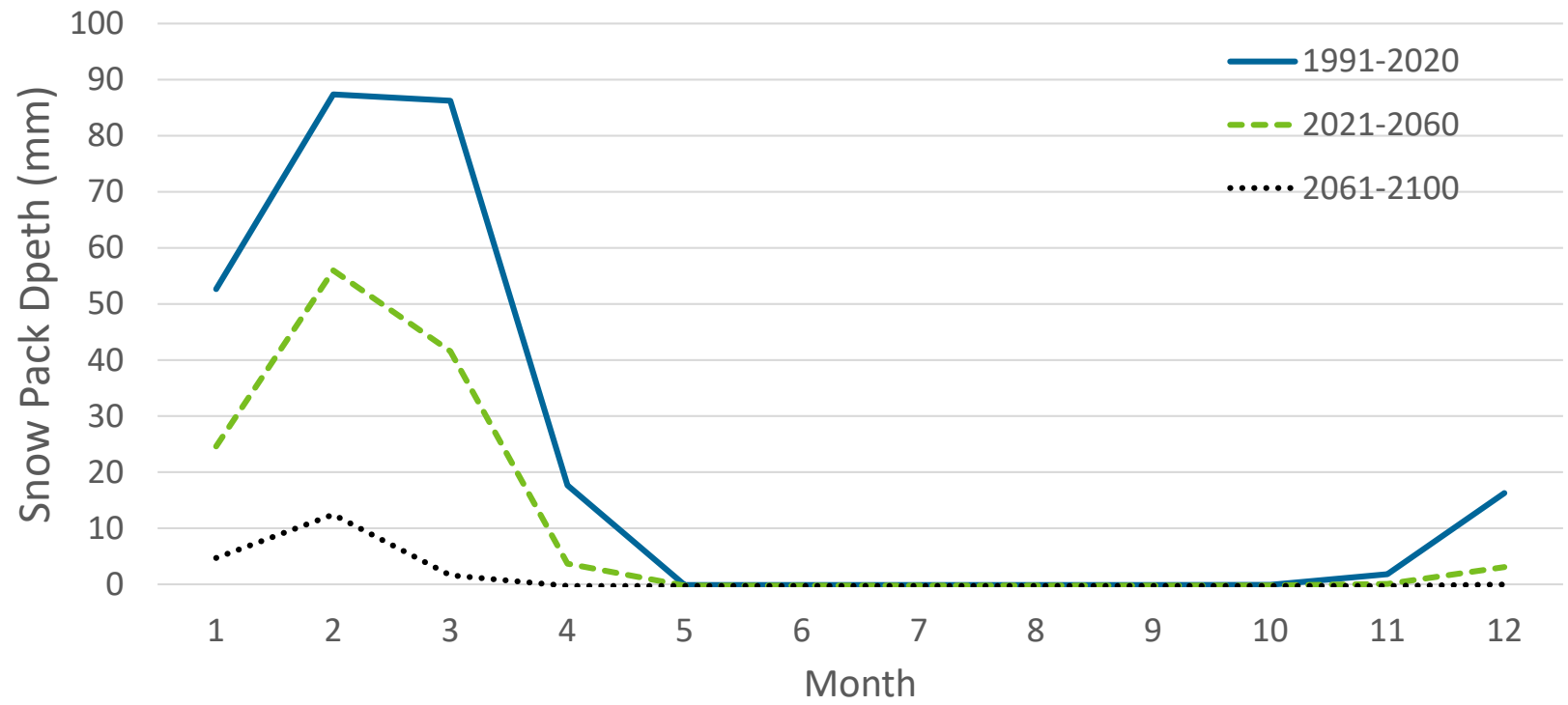
Hydrologic Modelling Results

Change in Seasonality



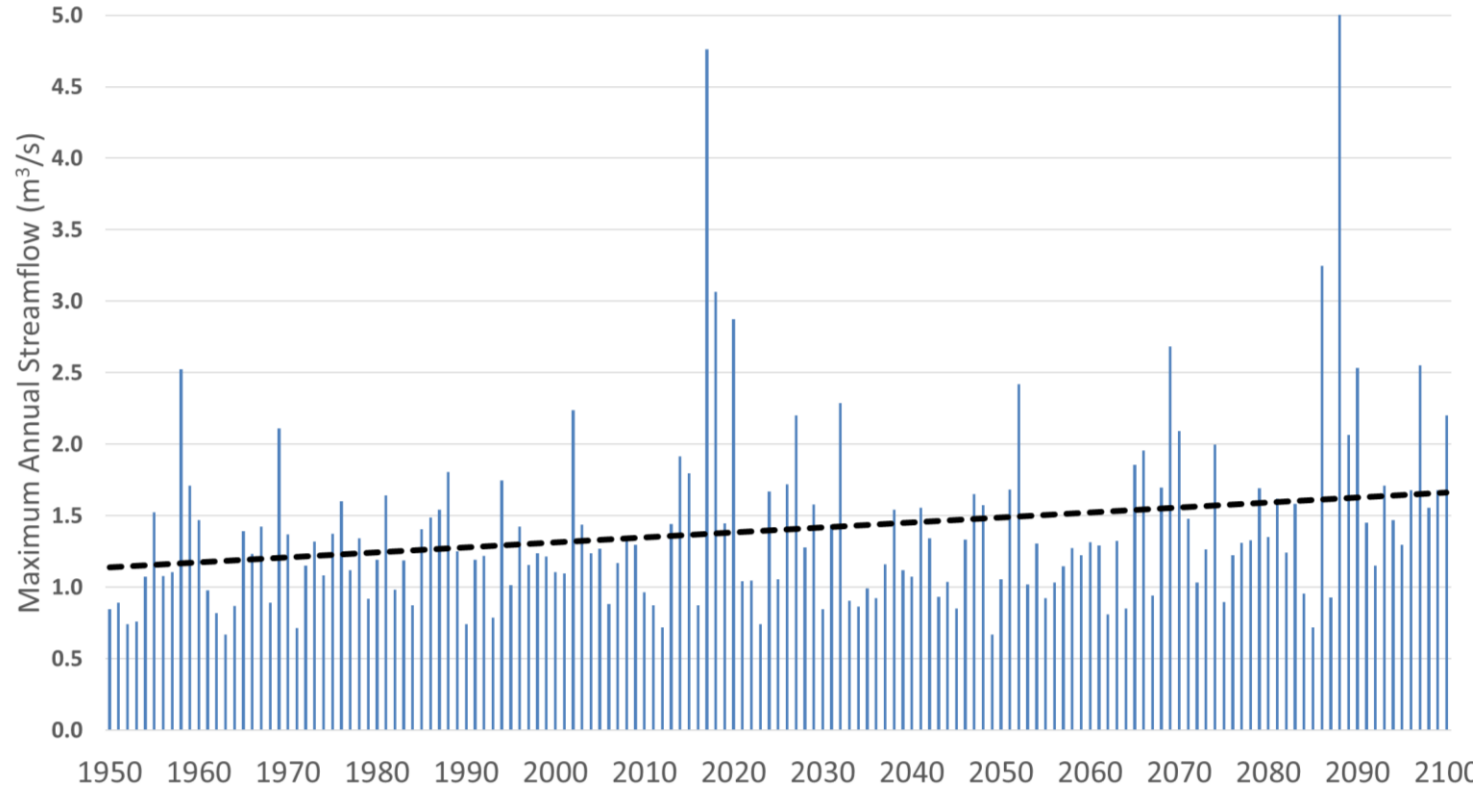
Hydrologic Modelling Results

Change in Snowpack



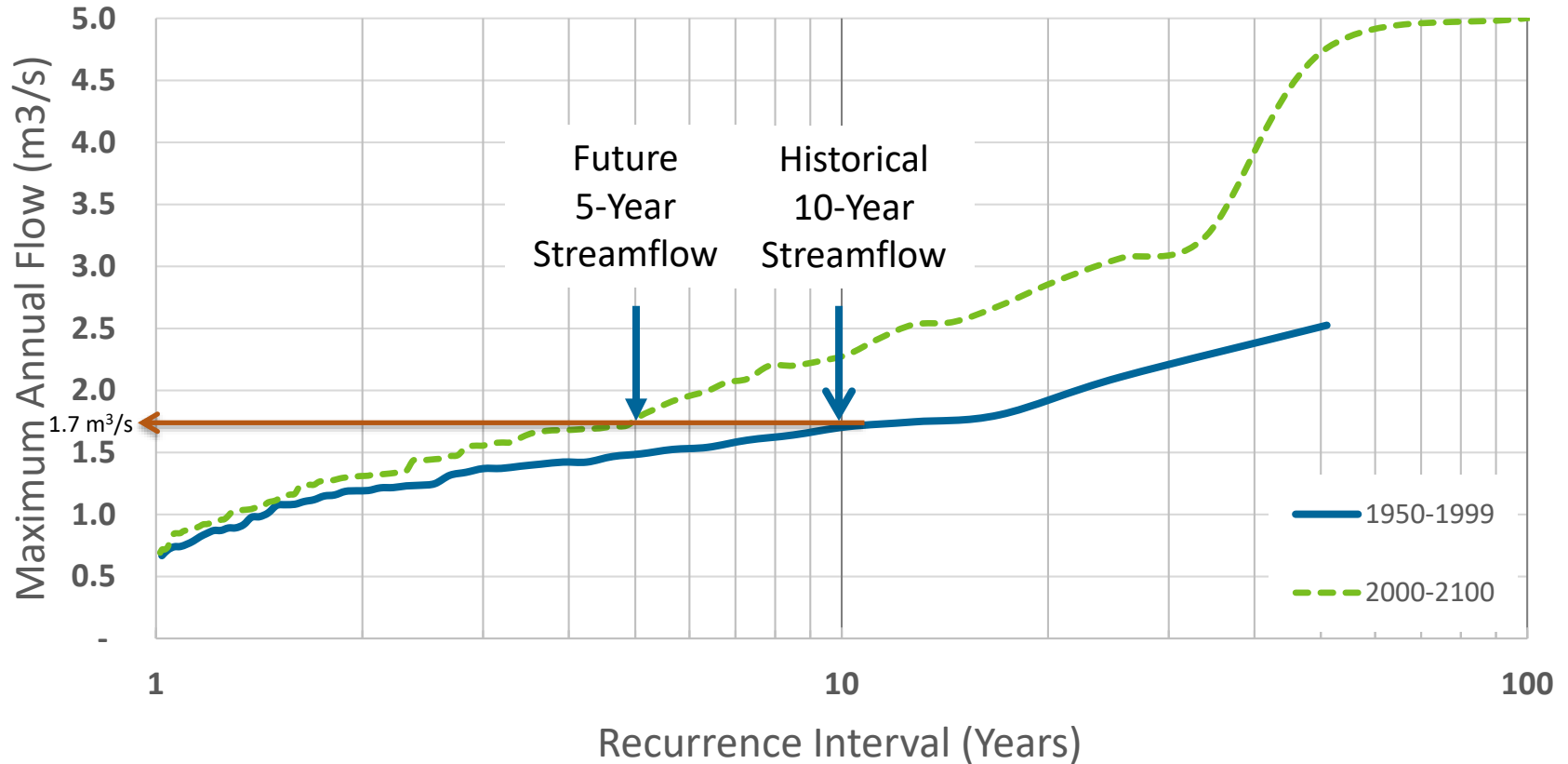
Hydrologic Modelling Results

Trend in Maximum Annual Streamflow (Hadati Creek)



Hydrologic Modelling Results

Trend in Recurrence Intervals



Climate Change Impacts on Stream Erosion

Stream flow and velocity	Notable increases in stream flow, and peak streamflow surges.
Riparian vegetation and land cover	Warmer wetter winters and hotter summer drought conditions may stress vegetation, increasing erosion susceptibility
Sediment load	Increased sediment from upstream high intensity rainfall
Groundwater interactions	Higher watertable and wetter fall/winter/spring conditions
Constructability	All above factors may influence construction strategy



How do we account for climate change?

- Design and build for the future, not the past
- Incorporate in our asset management programs
 - Monitoring and inspections
 - Cost of climate change
 - Repair, renew, replace
- Consider cumulative impacts of climate change and upstream urbanization
- Understand natural resilience and vulnerabilities



Matrix Solutions joined Montrose Environmental Group through acquisition in June 2023

Montrose At A Glance

Montrose provides strategic, integrated solutions that guide organizations through environmental challenges, ultimately delivering business value and positively impacting our planet and society.

We implement environmental solutions that scale.

- ~3,200 employees
- ~100 locations worldwide
- ~5,600 clients from the private and public sectors
- 6 patents issued in 2022, for a total of 18 patents



Questions?