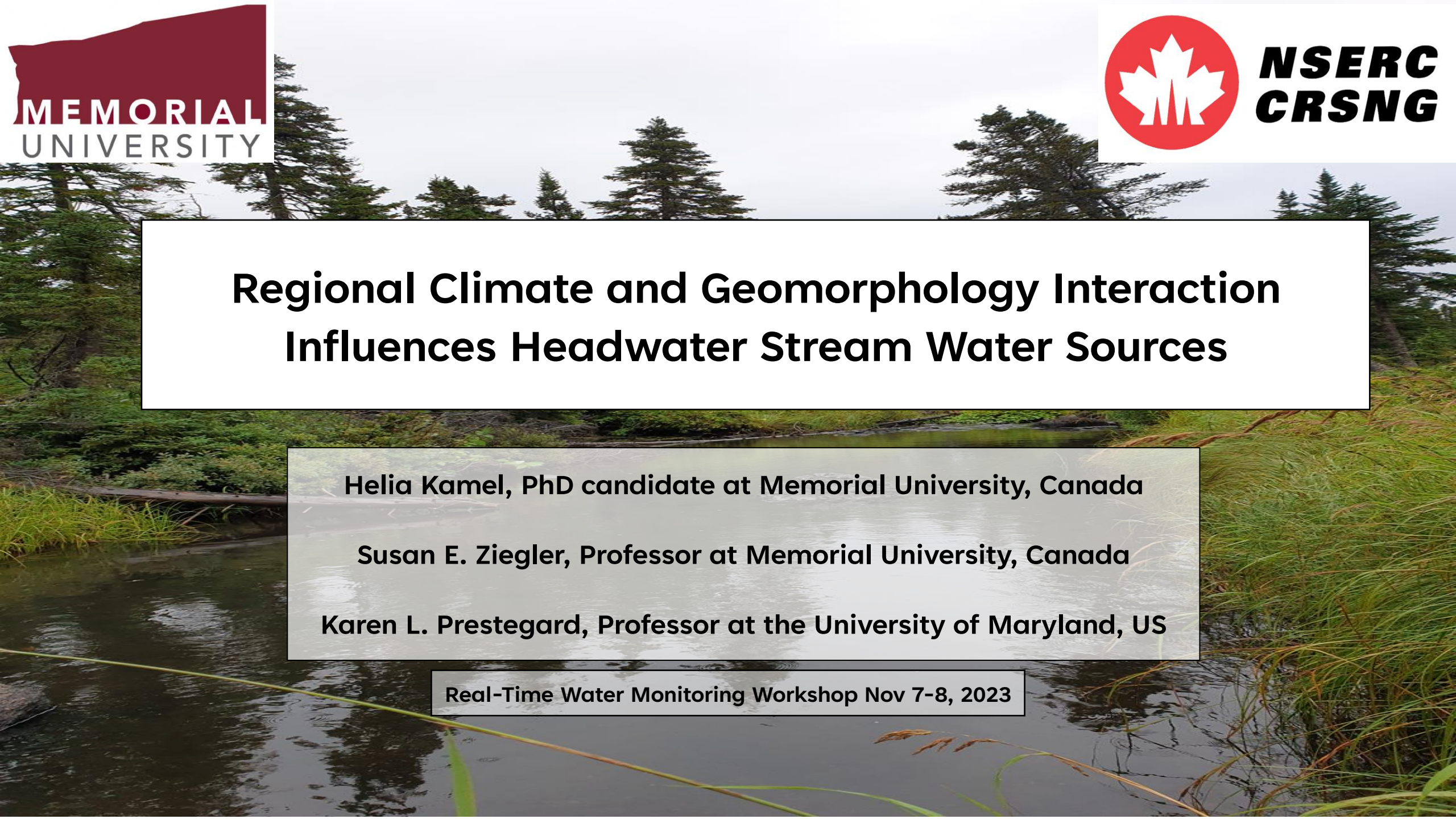


Regional Climate and Geomorphology Interaction Influences Headwater Stream Water Sources

Helia Kamel, PhD candidate at Memorial University, Canada

Susan E. Ziegler, Professor at Memorial University, Canada

Karen L. Prestegard, Professor at the University of Maryland, US

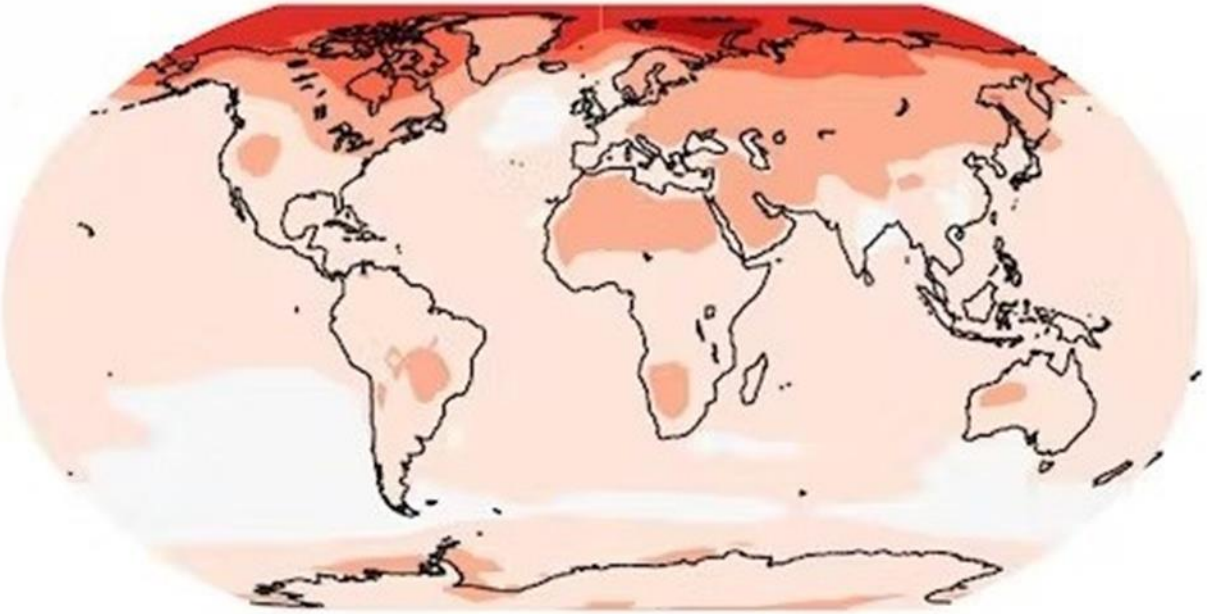
Real-Time Water Monitoring Workshop Nov 7-8, 2023

Special thanks to

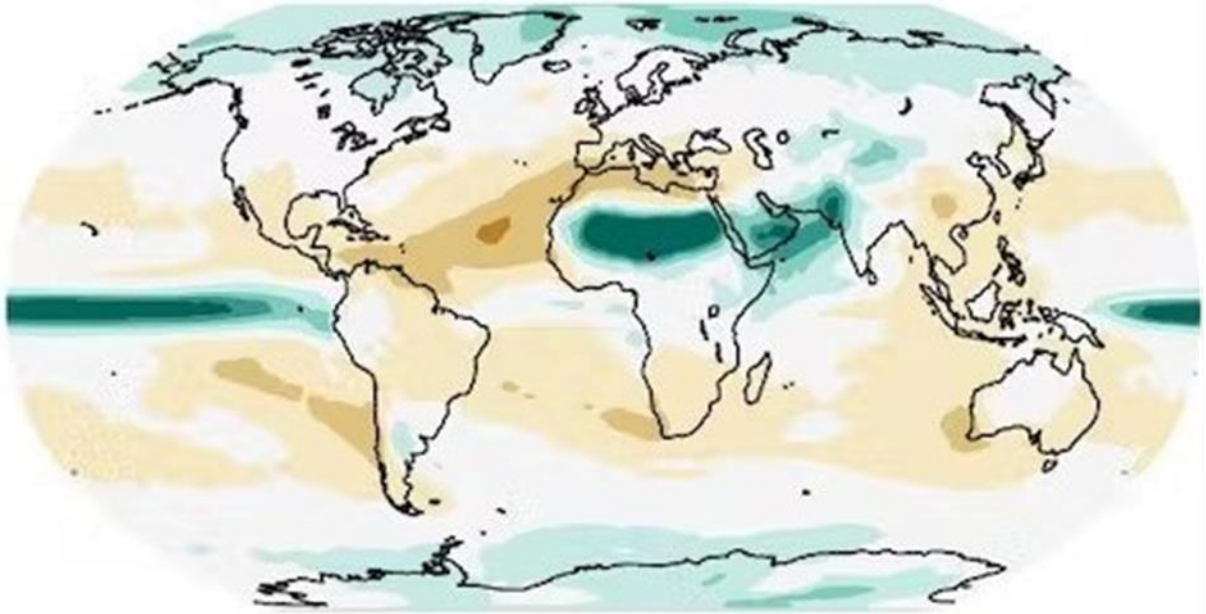
Omid Heydari, Christian Gaviria, Zach Gate, Alison Pond, Caroline Ofosu, Andrea Skinner, Kristen Millbury, Darrell Harris, and Skyler May.

Climate Change is not uniform around the globe!

Warming will be **stronger** in the Arctic, on land and in the Northern Hemisphere



Precipitation will **increase** in high latitudes, the tropics and monsoon regions and **decrease** in the subtropics



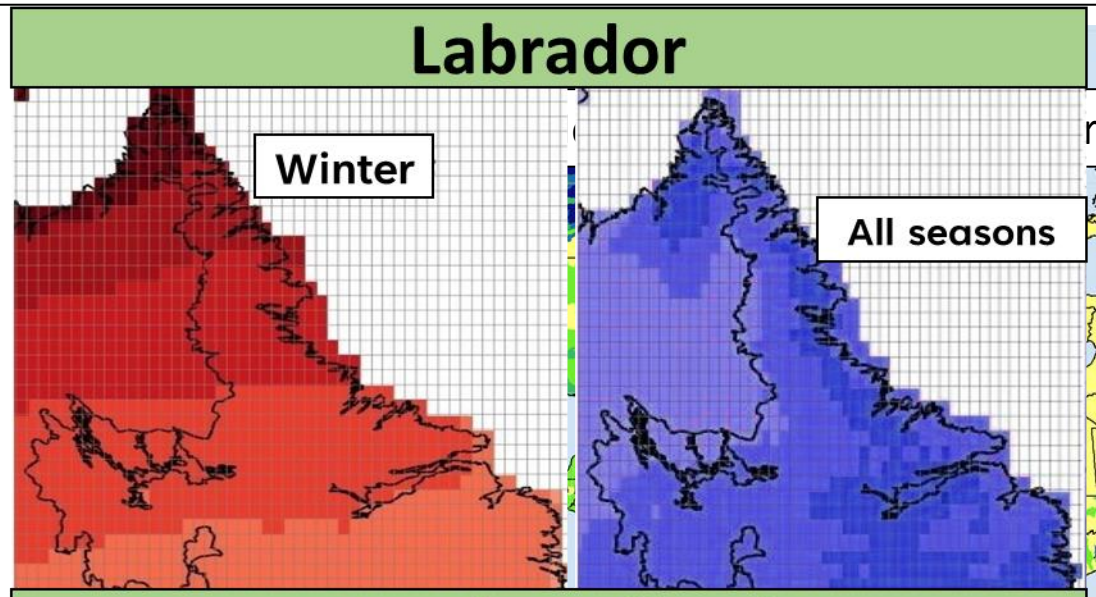
Temperature

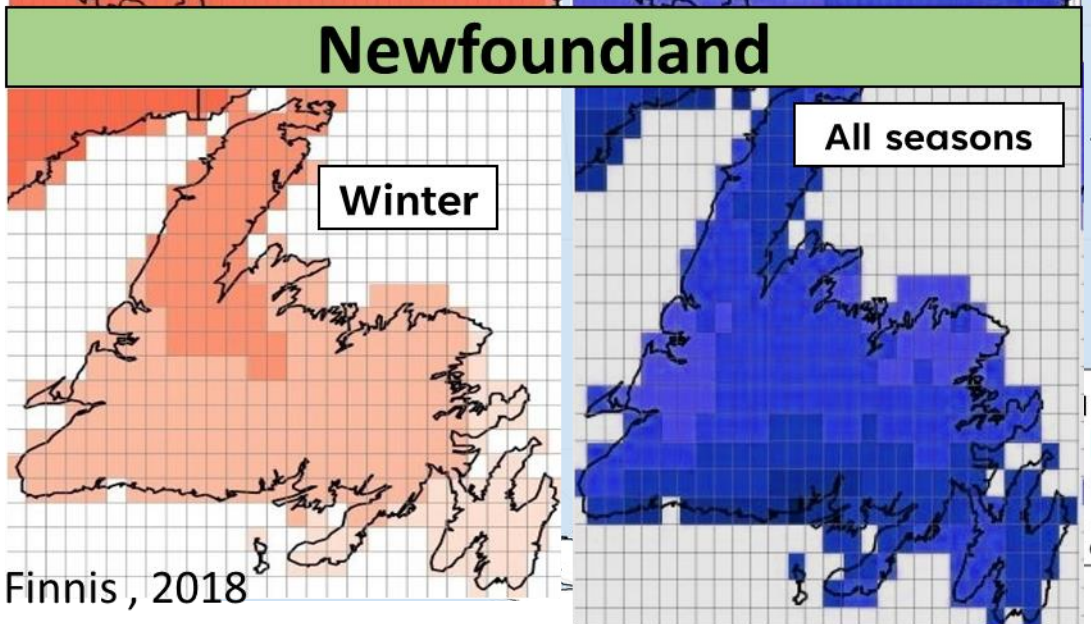
Form, Frequency and Intensity of Precipitation

IPCC, 2021

NOAA National Centers for Environnemental Information (2023).

Newfoundland and Labrador is going to experience Warmer Winter, Wetter and Stormier Climate





Finnis , 2018

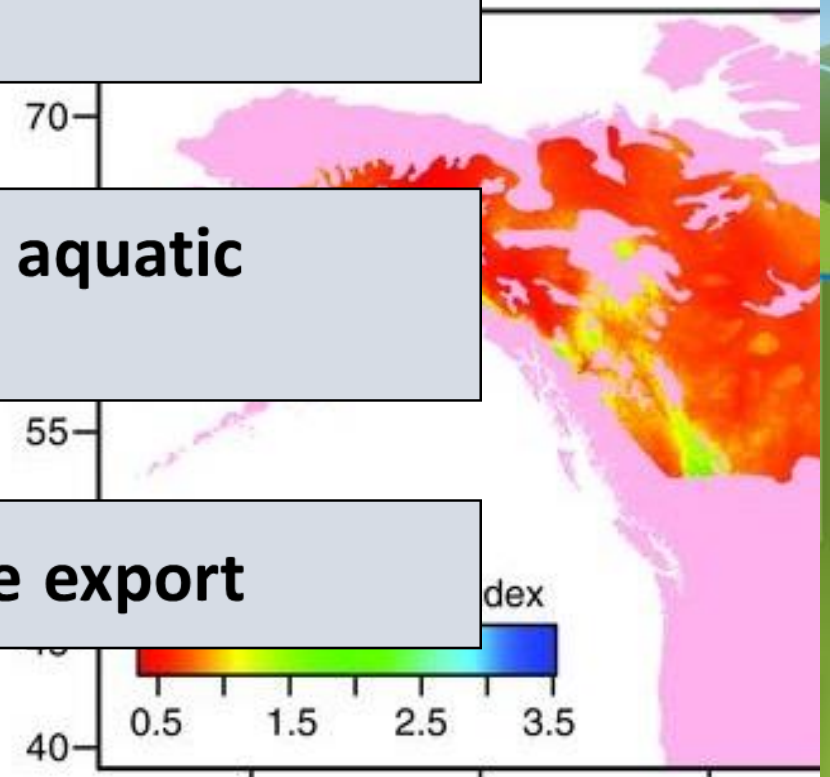
boreal headwater streams play a crucial role in connecting terrestrial and aquatic ecosystems!!!

Small Stream

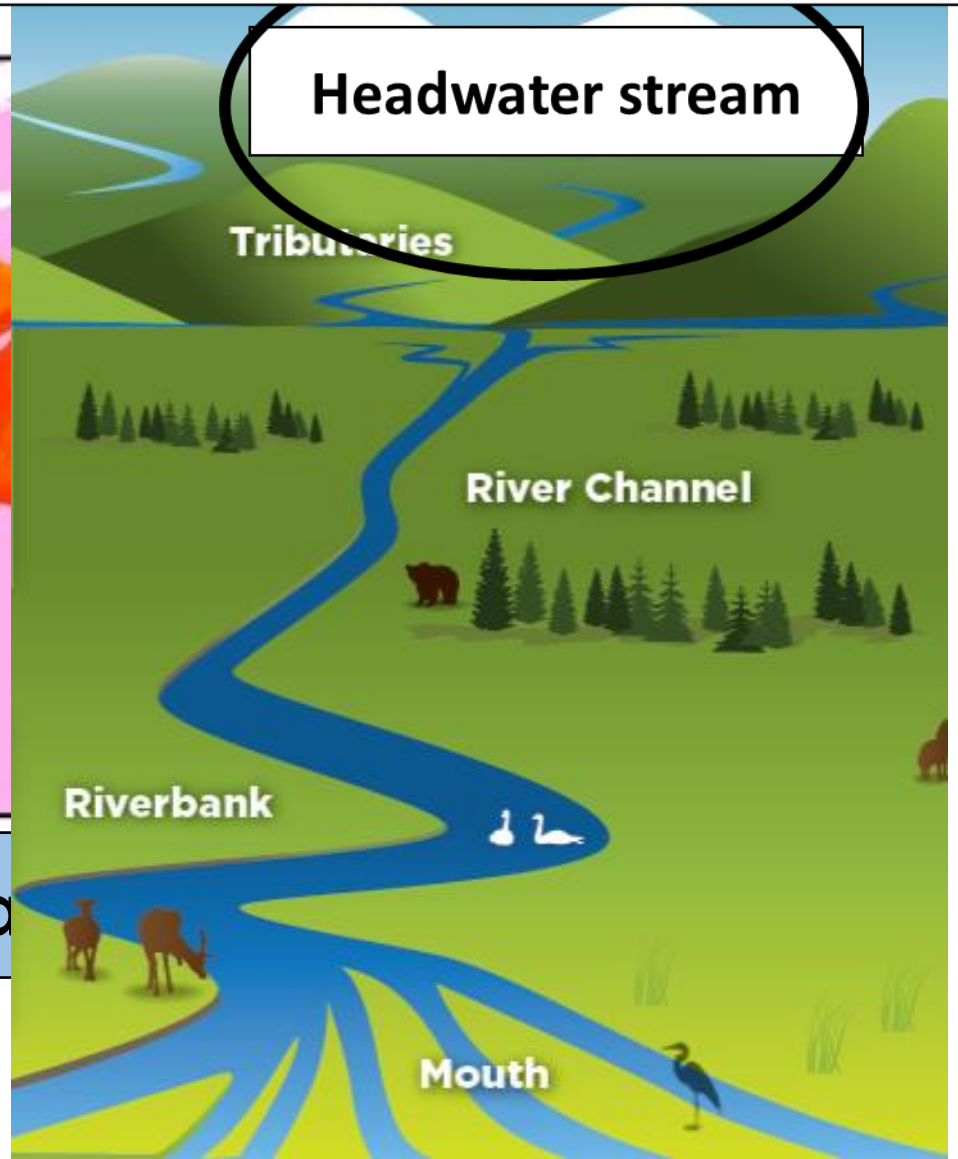
Key to terrestrial to aquatic interface

Carbon Storage

First point for solute export



Water Availa



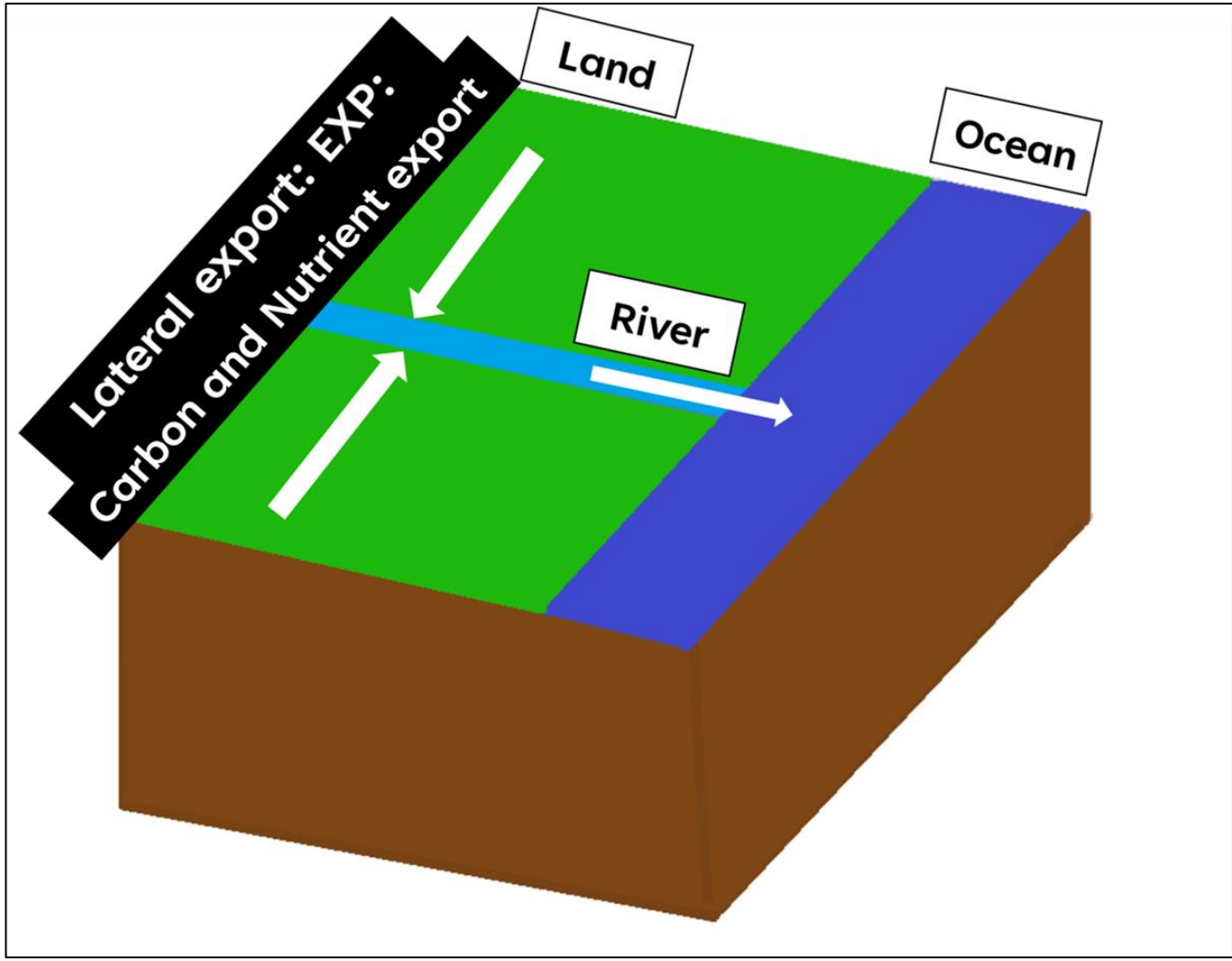
Climate change can impact the hydrology of a catchment

Raising Temperature

Timing, Intensity and frequency of precipitation

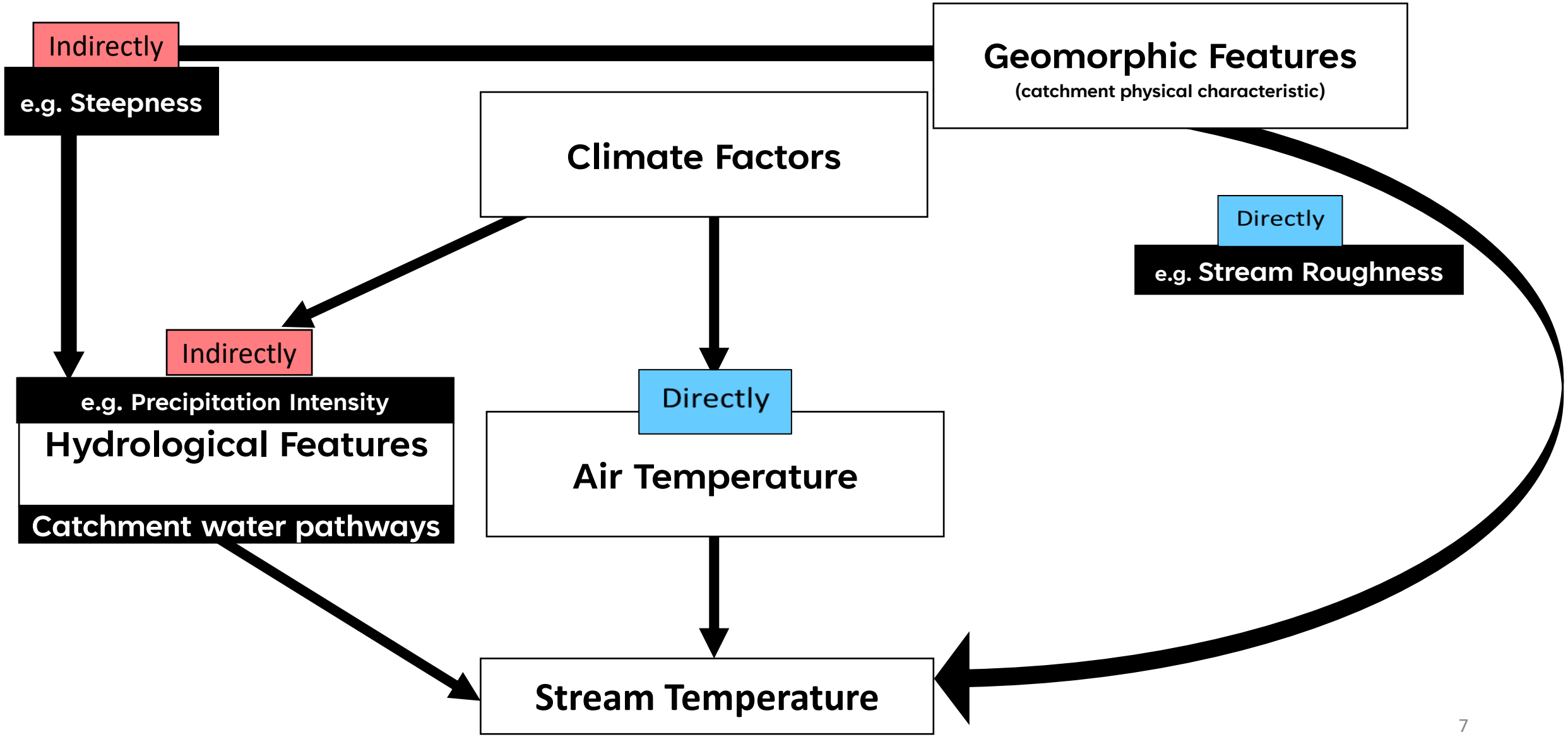
Runoff, Erosion, Soil moisture, Groundwater Recharge

Lateral Export

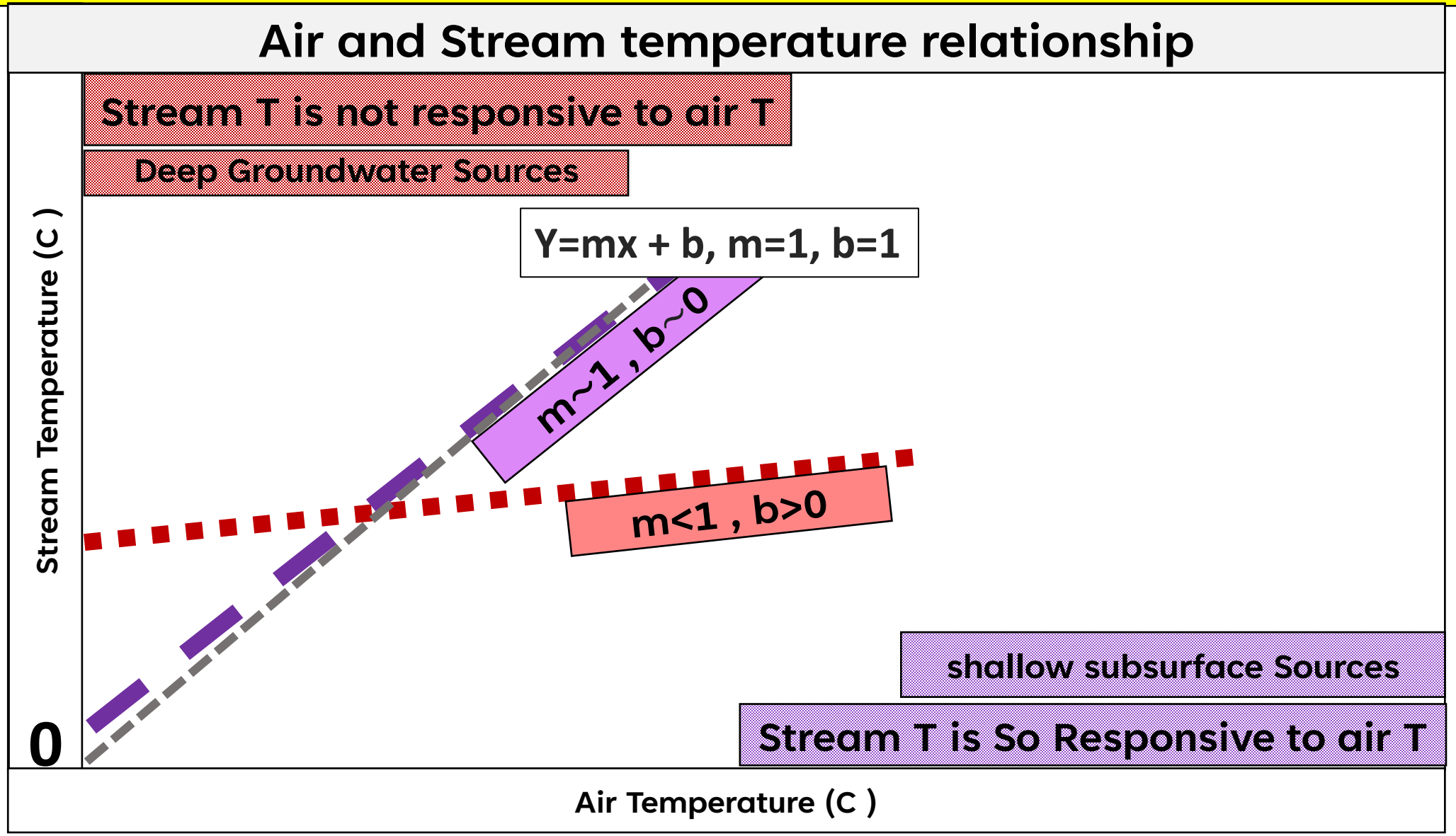


Schematic Illustration of the Terrestrial-Aquatic Export Process

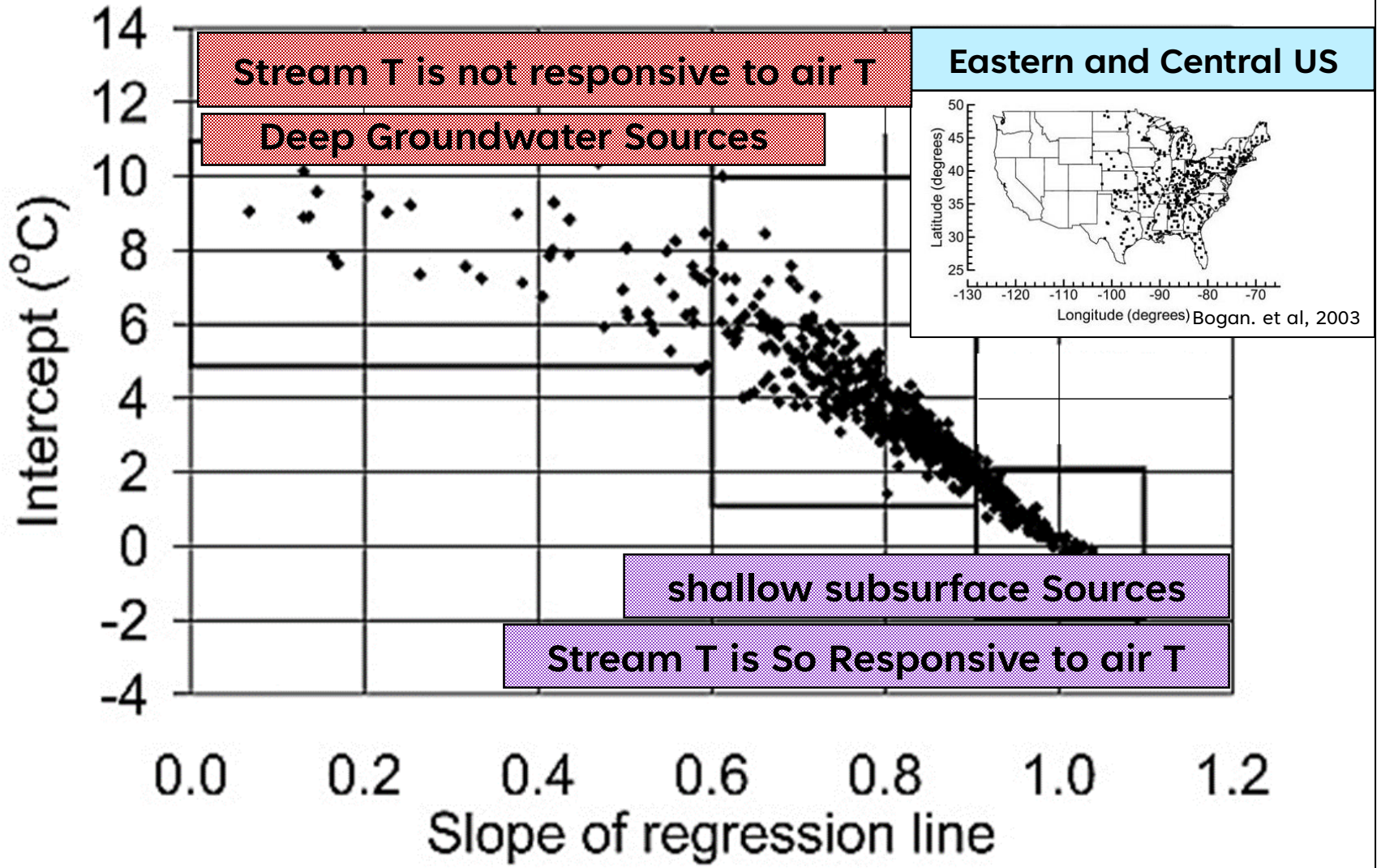
Influence of Catchment Characteristics and Climate Factors on Stream Temperature



Slope and Intercept can tell us about water sourcing



Exploring Regional Variability in Water Sourcing through Variations in Slope and Intercept



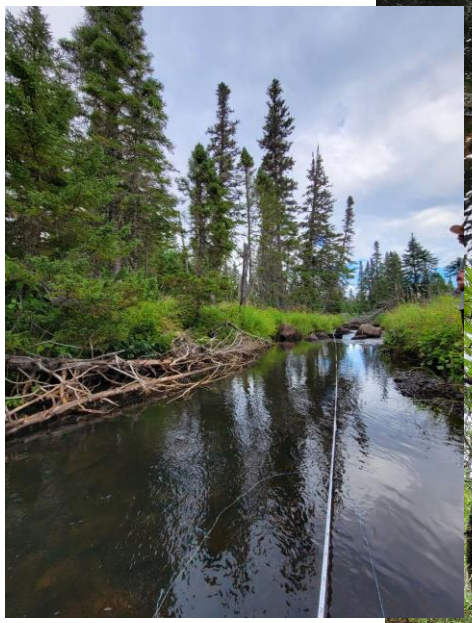
Research Question:

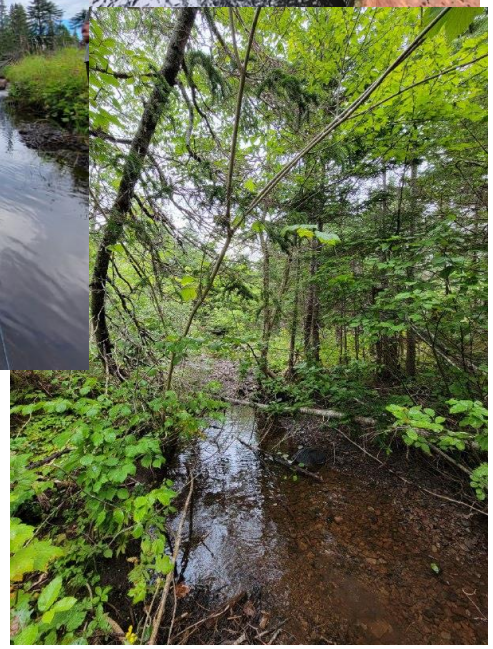
Will climate change affect the source of stream water in the future?

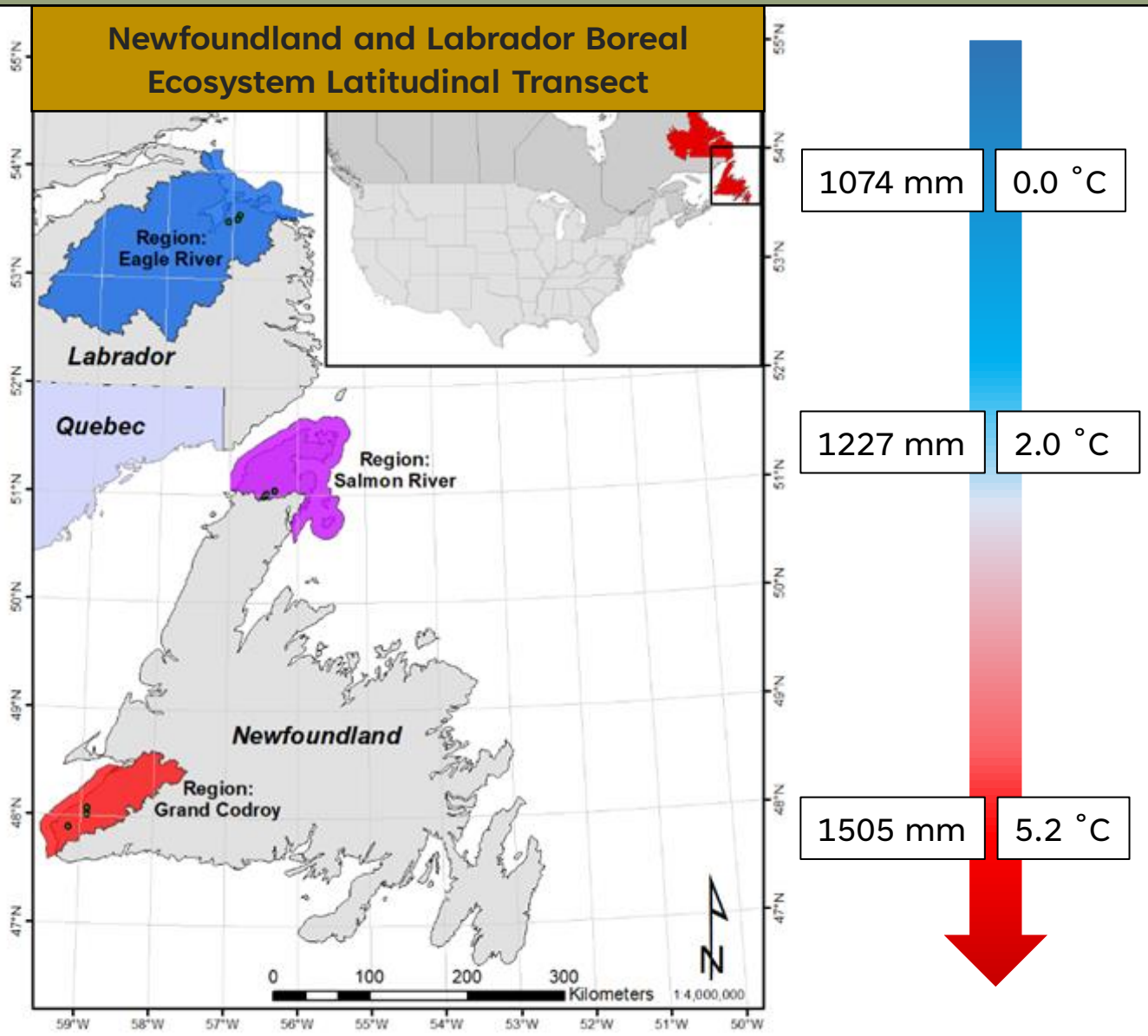
1. Does catchment geomorphology affect water sourcing in headwater streams?

2. How does catchment geomorphology interact with regional climate factors to influence water sourcing in headwater streams?

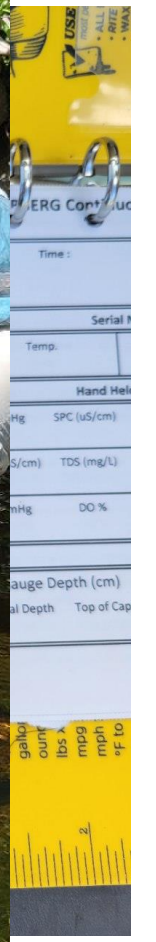
Exploring the boreal headwater stream water sourcing across Newfoundland and Labrador







In site



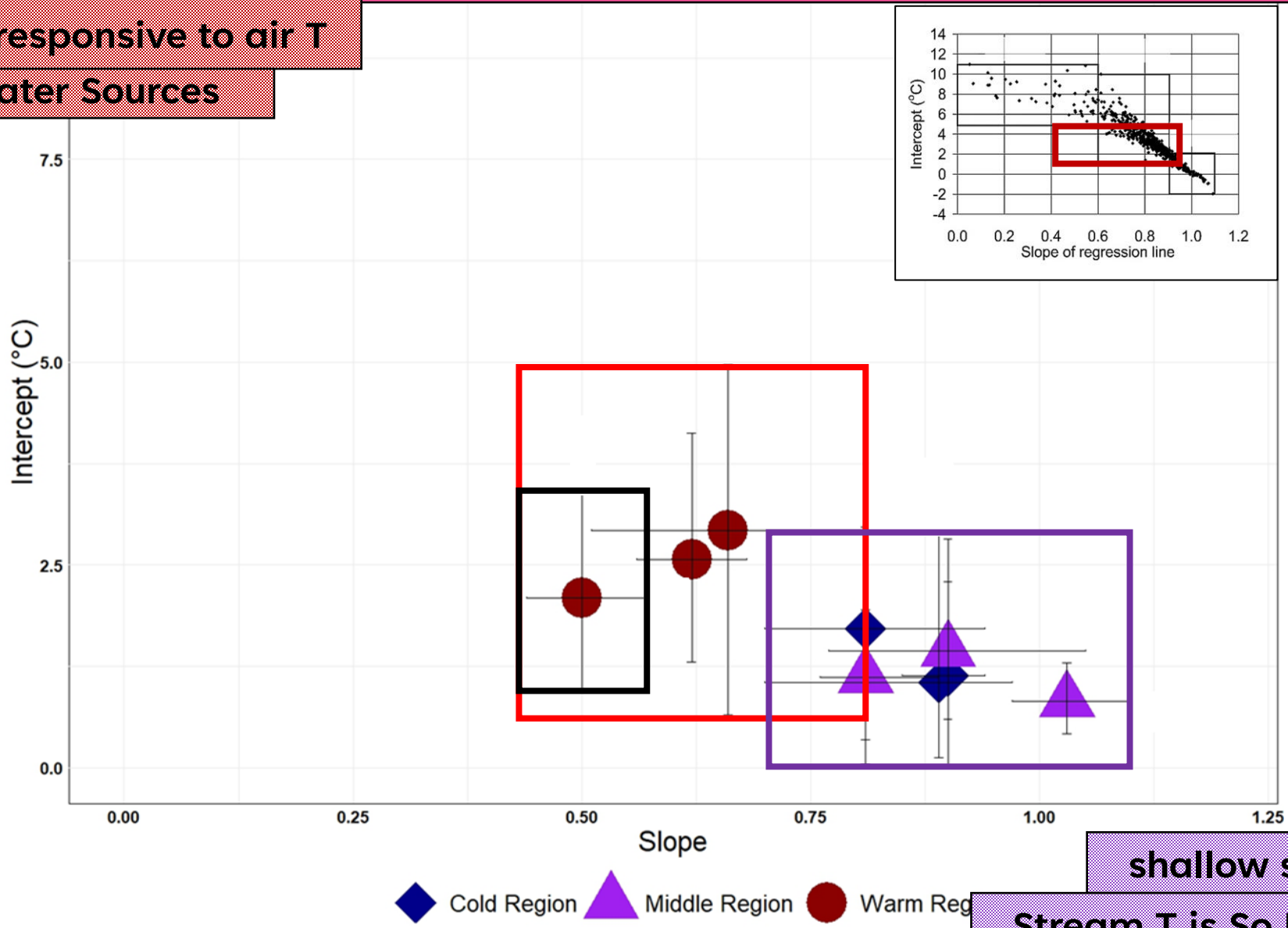
Cond

er

Yearly and Regional variability was observed in boreal headwater streams

Stream T is not responsive to air T

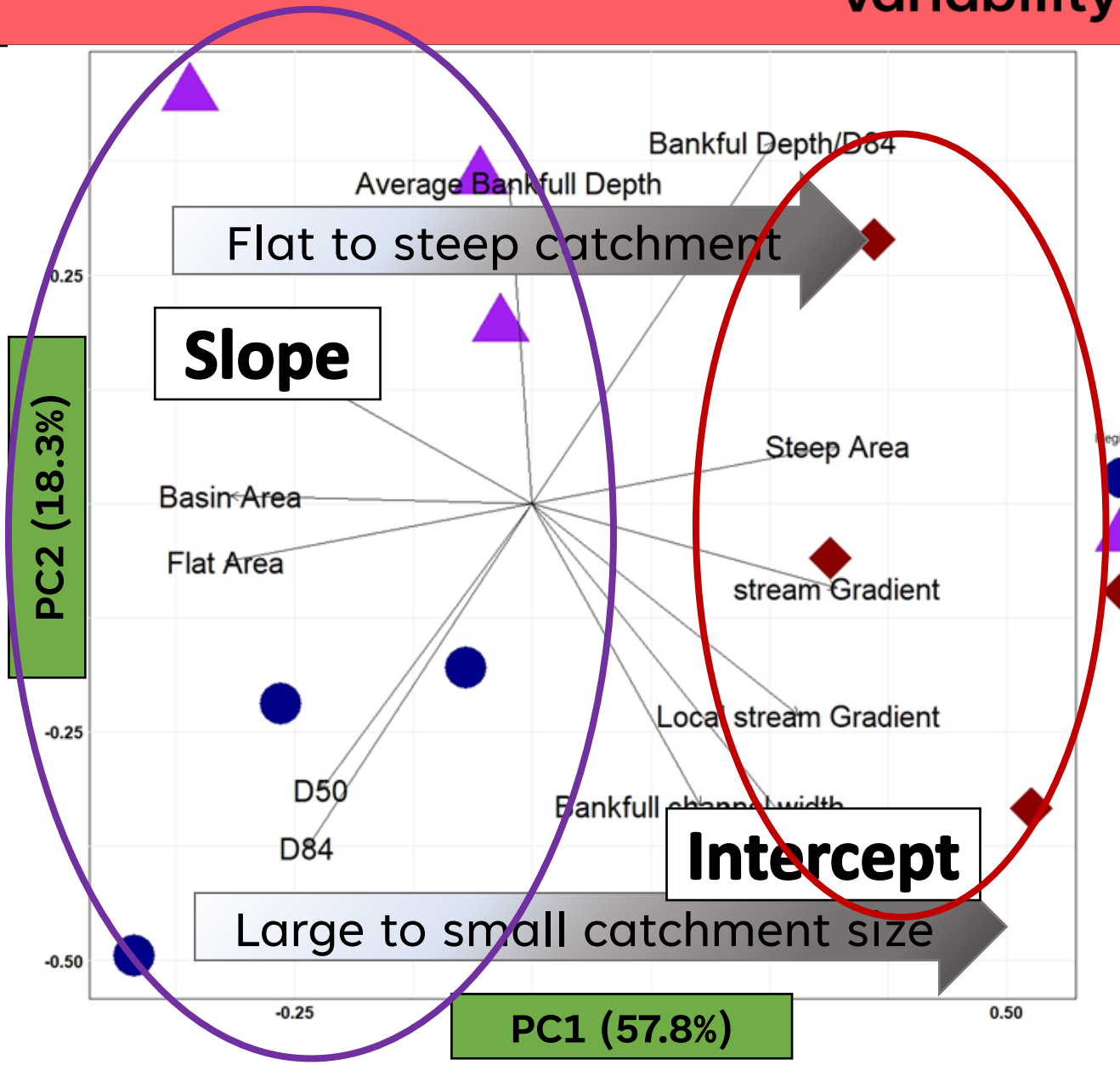
Deep Groundwater Sources



shallow subsurface Sources

Stream T is So Responsive to air T

Steepness and catchment size are important factors on slope and Intercept variability



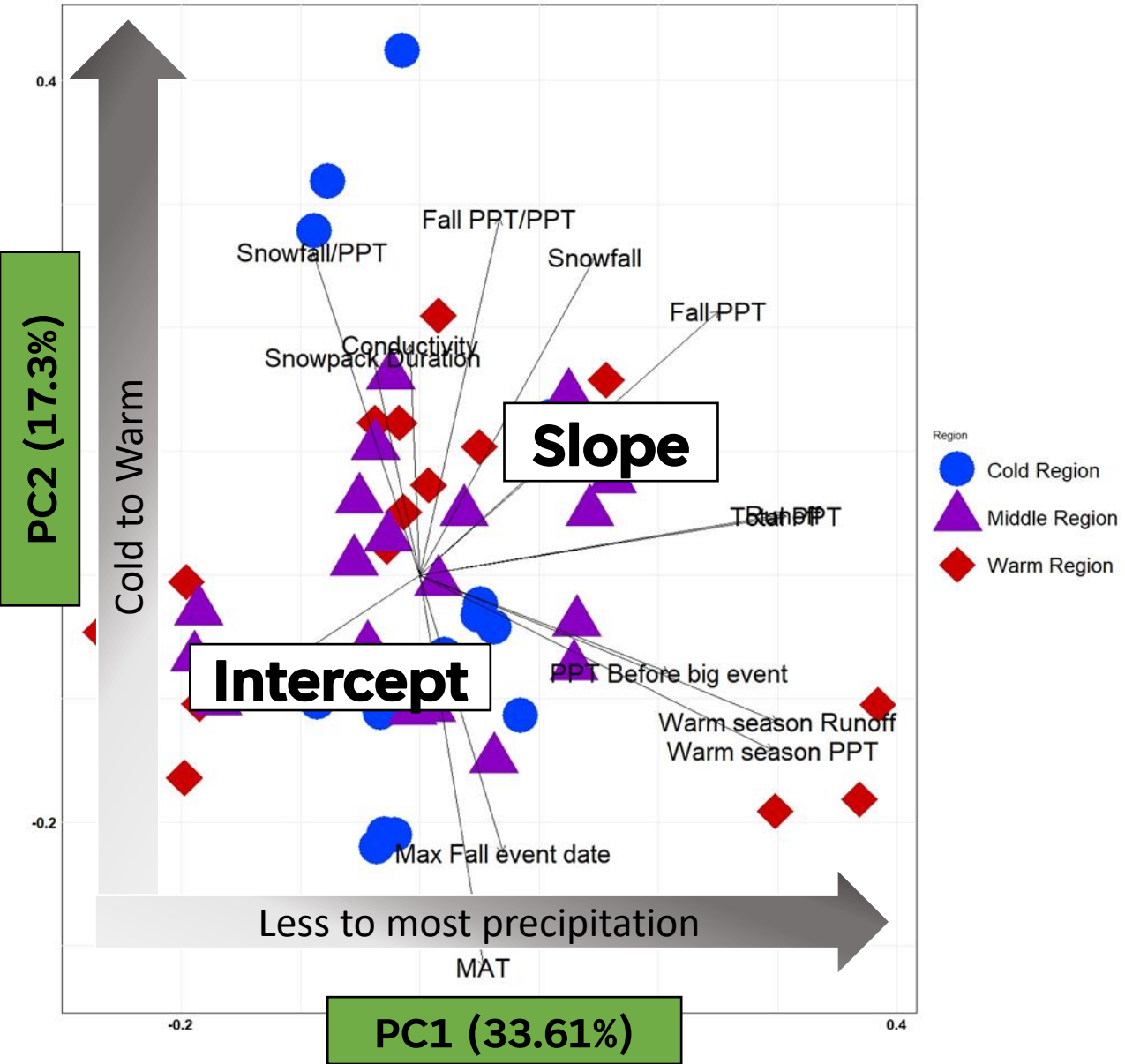
PC1 explains almost 58% of the variability in the dataset.

Warm and cold Regions separated based on PC1

Catchment in warm region are smaller and more steep in comparable to cold regions

Warm Region has higher intercept and lower slope and cold regions have higher slope and lower intercept

Slope varies annually based on water availability in warm regions, while intercept varies yearly due to temperature changes in cold regions.



PC1 explains almost 34% of the variability in the dataset.

Warm Region varied based on the water availability

Cold Region varied based on the Air temperature

In warm region by increasing precipitation slope and intercept increasing and decreasing respectively

The ranking model shows that catchment size, steepness, and fall precipitation affect slope variability.

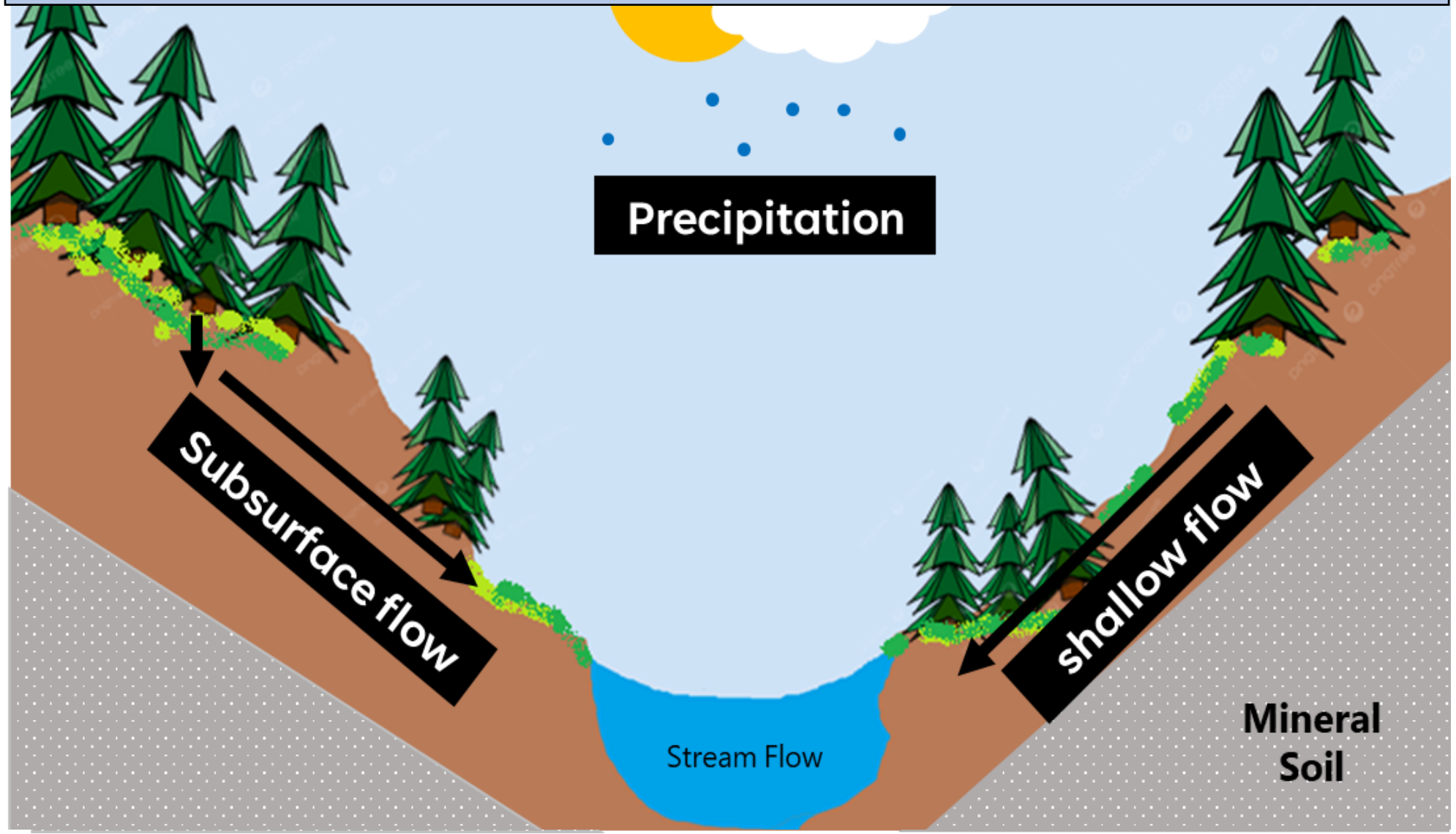
Full Model	Sub-model	AICc	Δ AICc	W_i	Log-likelihood
1a	**BA*FE + E**	-61.1	0.0	0.3	36.2
1b	**BA*FE+ *WD*MAT* + E**	-60.7	-0.4	0.3	40.1
1c	**BA*FE+*WD*MAT +WD*RO* + E**	-60.0	-1.0	0.2	42.8
1d	**BA*FE+*WD*MAT +WD*RO+BA+RO* E**	-59.8	-1.3	0.2	44.3
2	**SG*FE + SG*WD + E**	-73.9	0.0	0.9	45.3

The ranking model shows that steepness, temperature, and fall precipitation affect intercept variability.

Full Model	Sub-model	AICc	Δ AICc	W_i	Log-likelihood
1	W.D*FE + FE*MAT	141.5	0.0	0.81	-62.4
2	SG*SF + W.D*SF + W.D*SD + FE*SF + FE*SD + E	137.2	0.0	0.75	-52.5

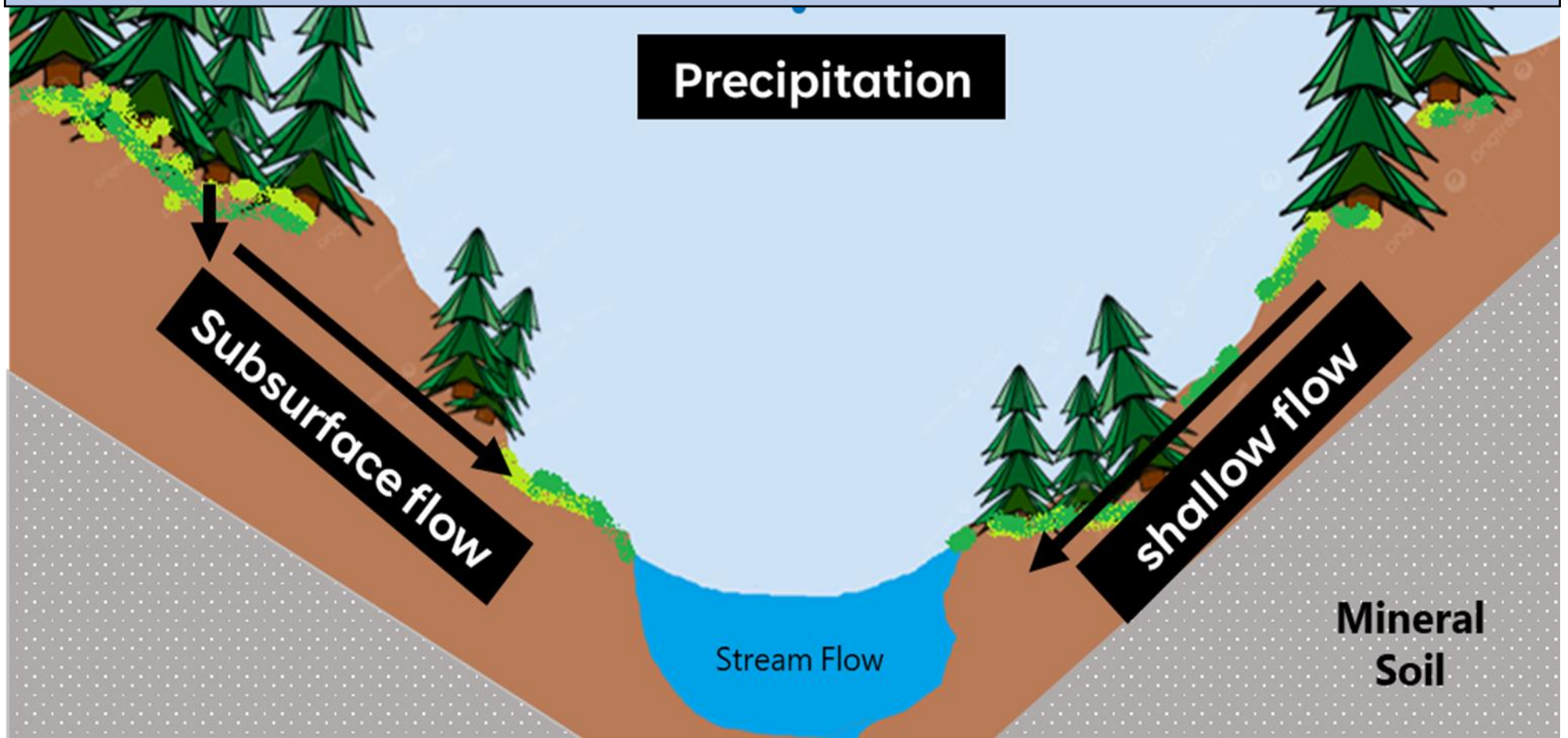
In small, steep warm regions, water sourcing is mainly from deep sources

Timing of water availability (beginning of the fall)



Temperature variations and water availability influenced water stream temperature in a steep catchment.

Timing of water availability (beginning of the fall)



Implication

1. Small and steep catchments are sensitive to future climate change

2. The alteration in streamflow water sourcing and temperature is not linked to catchment water availability; rather, it is associated with when water enters the system.

3. Understanding how climate change will affect water sources is crucial. This knowledge will be instrumental in developing well-informed and effective plans for watershed management.

Thank you ☺

Any question?