Keeping Streams Cool: Disentangling the Impacts of Local Groundwater Discharge vs. Mountain Headwater Contributions During Summer Low Flows

Groundwater Resources Research Group

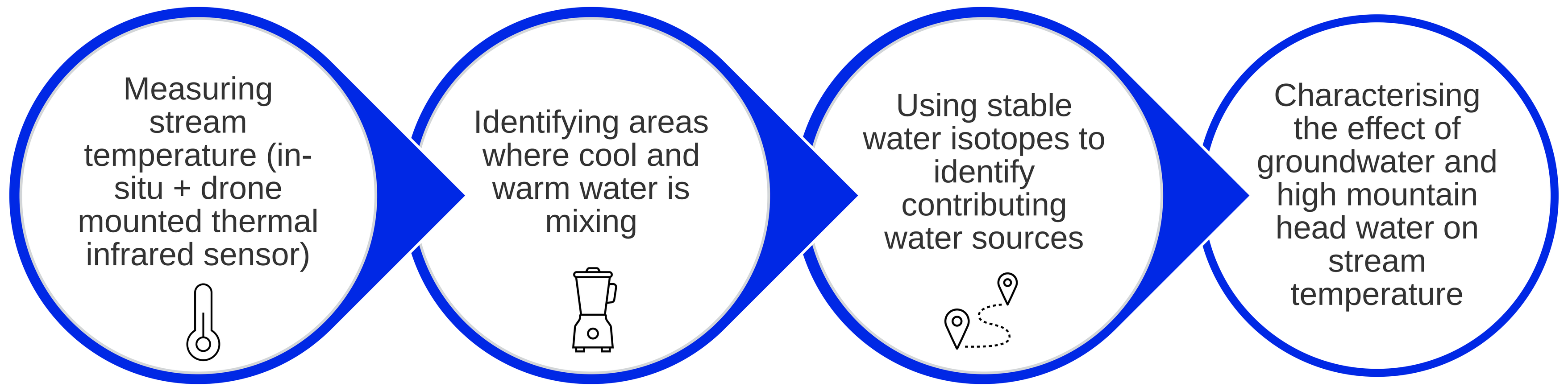
Lea Antesz[1] (lea_antesz@sfu.ca), Julia DeWeerdt[2], Diana M. Allen[1], Willam J. Hahm[3], Eric Saczuk[2]

[1] Department of Earth Sciences, Simon Fraser University; [2] Department of Geomatics Engineering, British Columbia Institute of Technology; [3] Department of Geography, Simon Fraser University

H42D-1275

1. Research Question + Approach

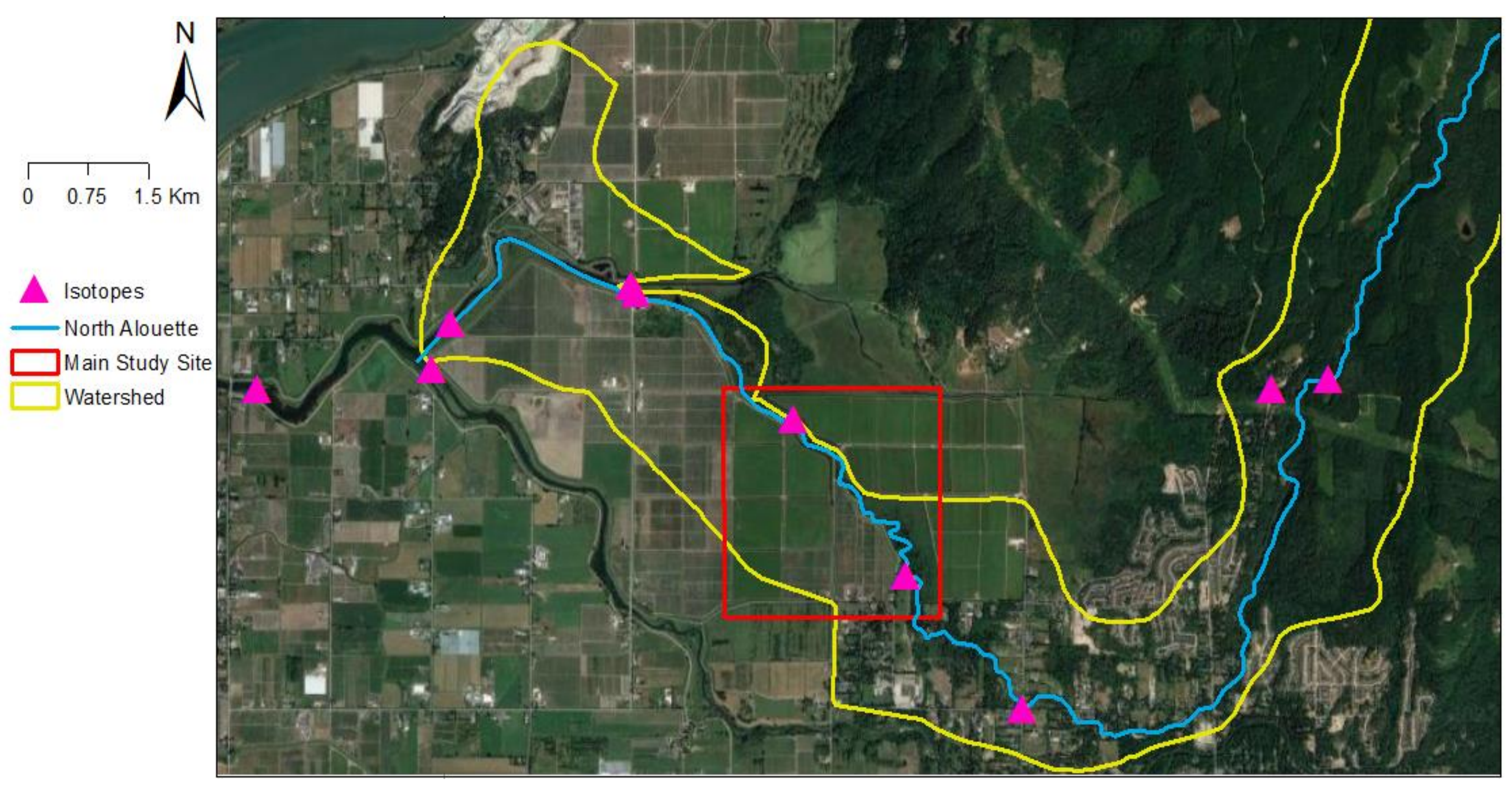
What are the relative contributions of headwaters and groundwater in cooling the stream during summer low-flow conditions?



Study Site

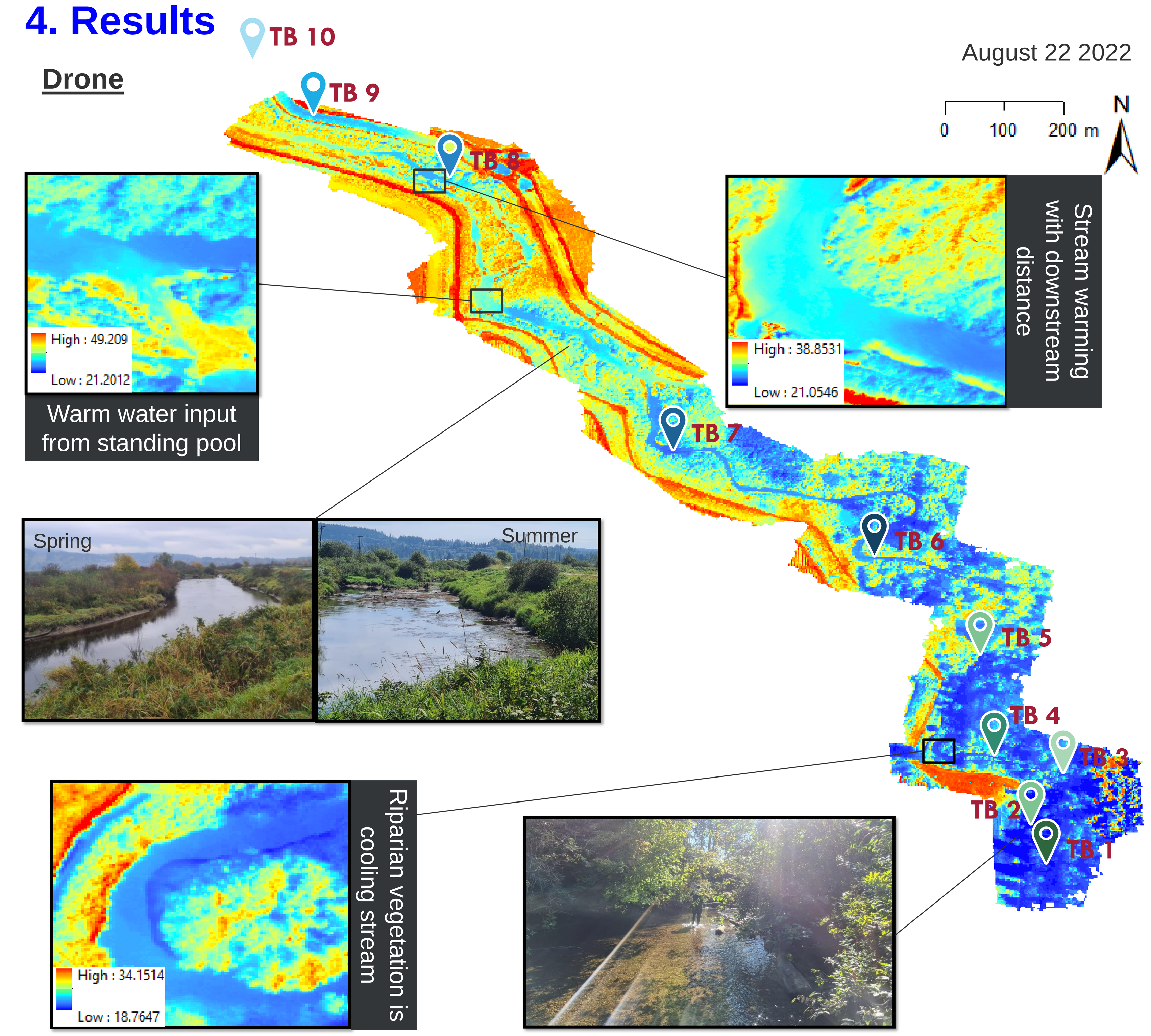
The North Alouette watershed extends from the moderately pristine forest in the headwaters down through urban-rural developments at the base of the mountain to agricultural lowlands.

The watershed is snow-melt dominated. Precipitation falls dominantly during winter and the watershed experiences hot summer low flow conditions.



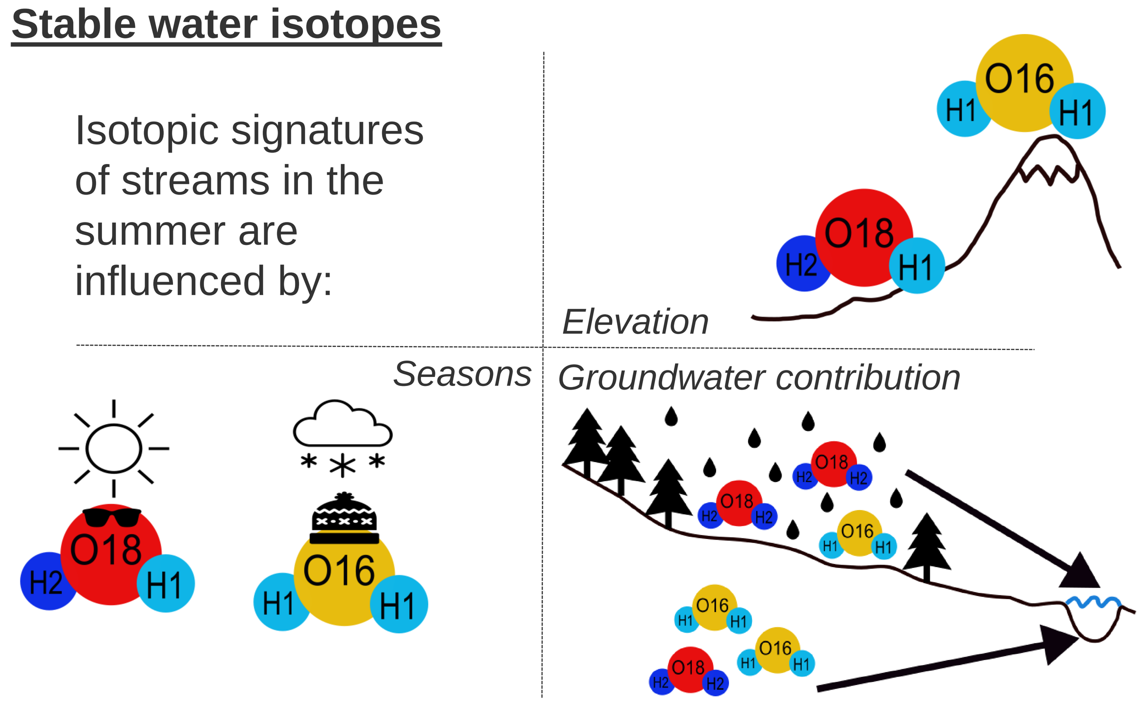
4. Results

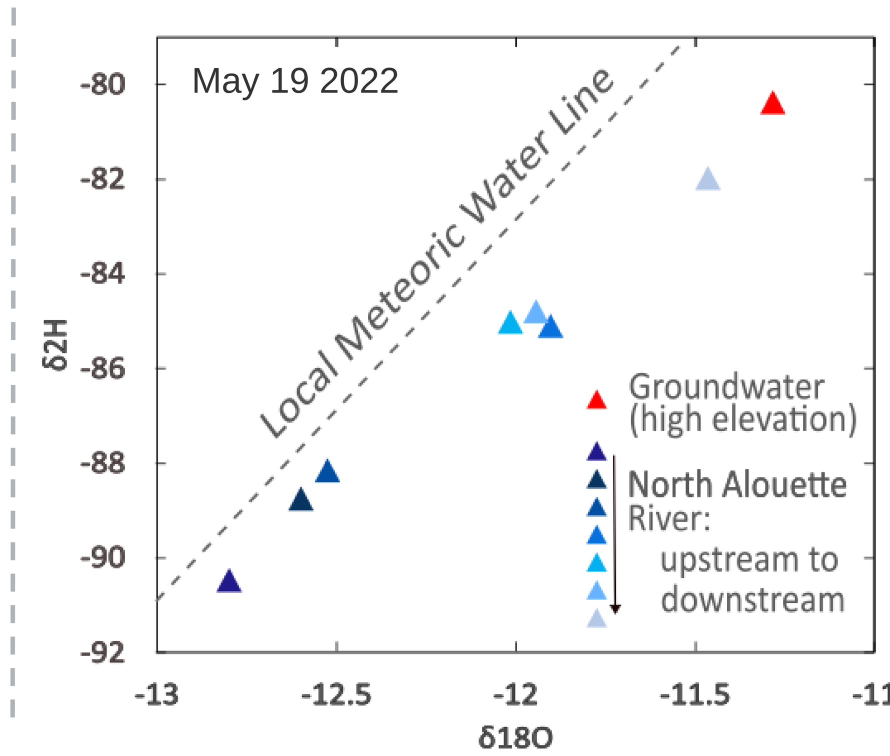
Drone



Stable water isotopes

Isotopic signatures of streams in the summer are influenced by:

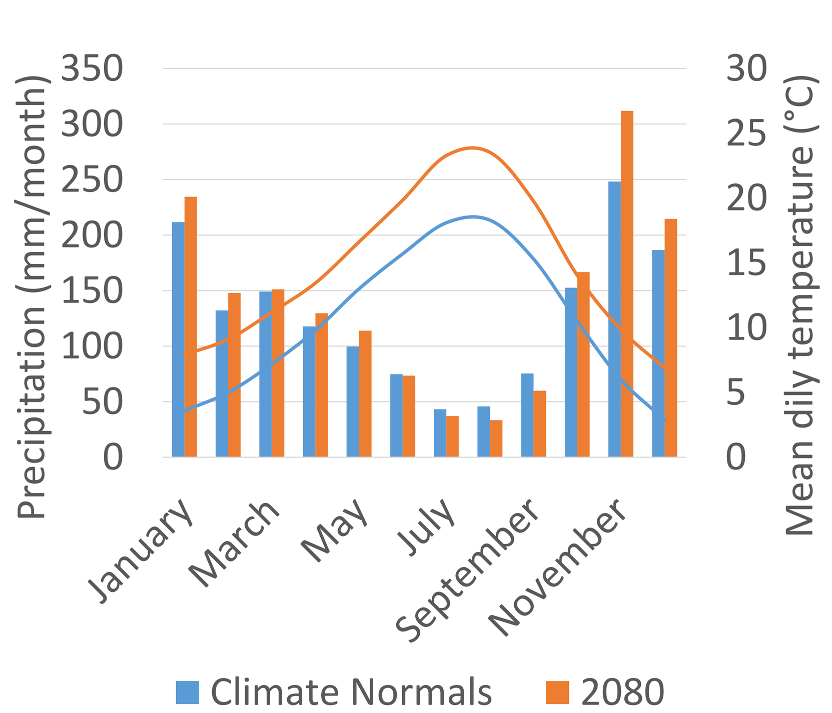




→ With downstream distance, water sources shift from headwater dominated to more important local sources

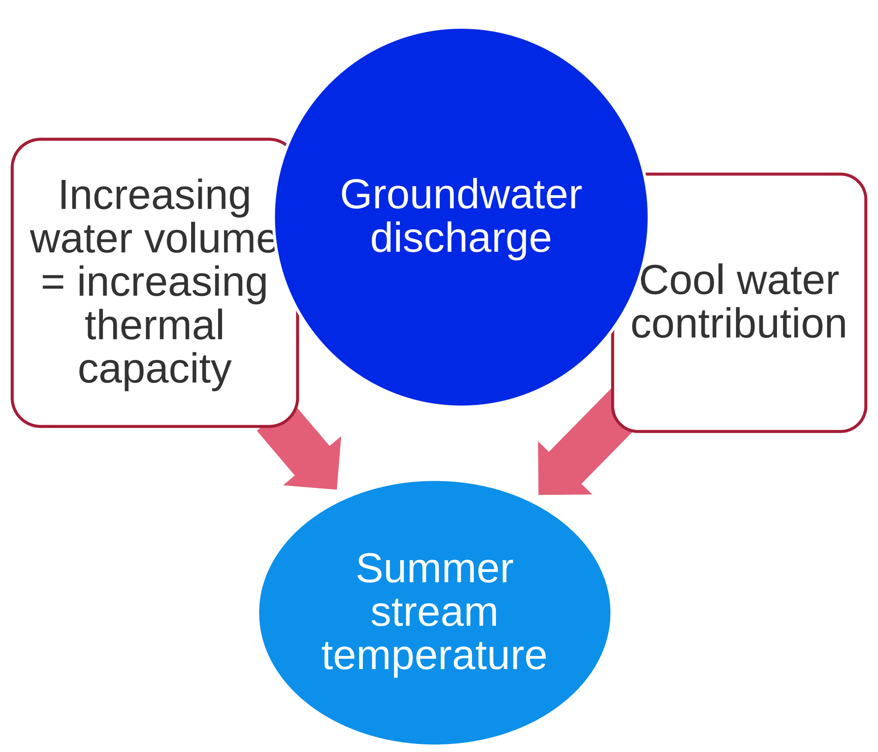
2. Background

- Temperature influences many important stream parameters that directly affect the health of aquatic organisms.
- Western North America:
  summer air temperatures + frequency of extreme heat events are expected to increase.
  Droughts + extreme precipitation are expected to become more frequent.



Groundwater-surface water interactions

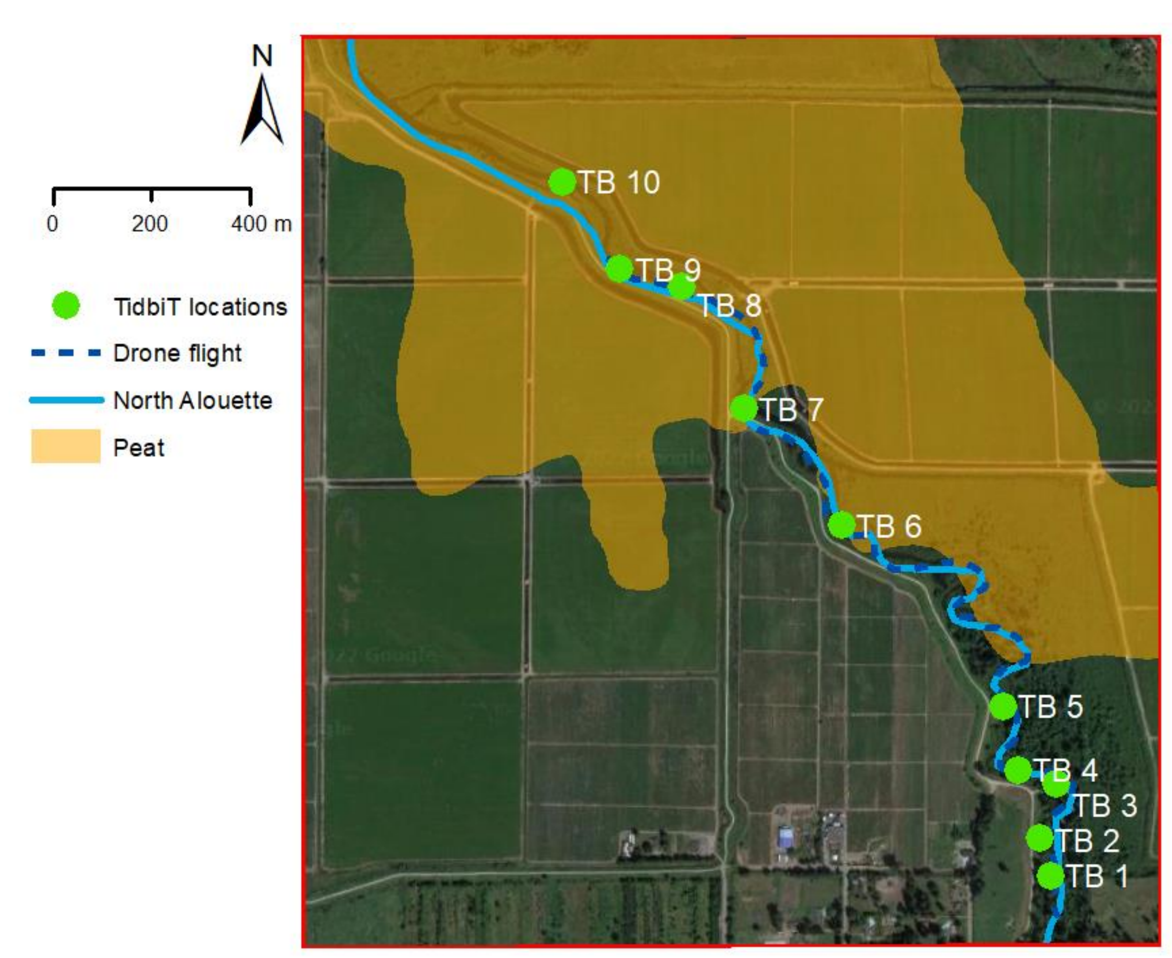
- Groundwater is assumed to have a constant temperature that is approximately equal to the average annual ground temperature.



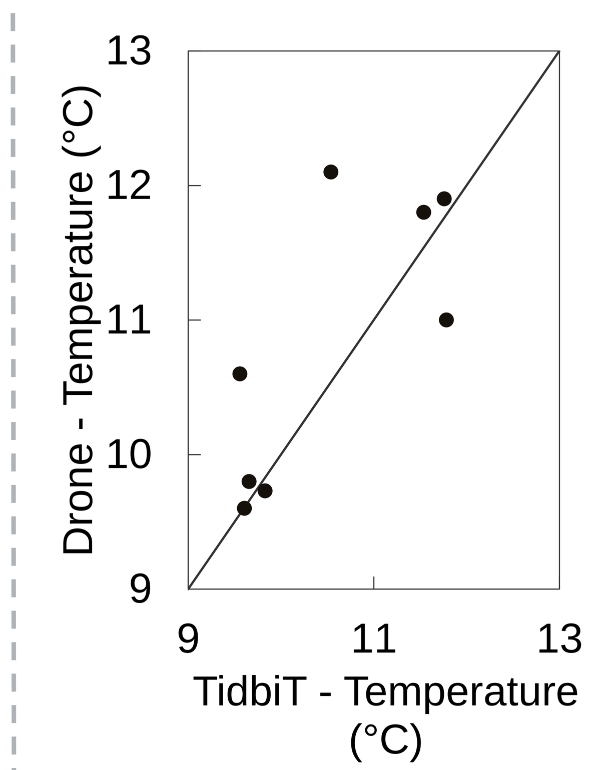
- The surficial geology can influence where and how much groundwater is discharging to the stream.

3. Methods

- 10 In-situ stream temperature measurements (TidbiTs)
- Drone flight capturing stream temperature along ~2Km reach (Aug. 22 2022)
- Water samples analyzed for oxygen and hydrogen isotopes



- Preliminary drone flight during pre-low-flow conditions showed overall good agreement with in-situ measurements. Better agreement was achieved at locations with less spatial temperature variability.



5. Conclusion and Next Steps

Findings:

- Stream temperature at this study site might be influenced by land use and/or geological substrate
- The impact of different water source on the stream temperature is difficult to disentangle due to the complexity of heat transport mechanics and hydrological processes
- Drone mounted thermal infrared survey is a good method to measure stream temperature and could be a good tool to employ in remote or inaccessible streams or stream sections

Nest steps:

- Retrieving and analyzing time series data from loggers that have been monitoring temperatures at the water - streambed interface throughout the summer
- Comparing spring temperature regime with temperatures measured during the peak of summer low flow conditions

References

- Afsin, M., Allen, D. M., Kirste, D., Durukan, U. G., Gurel, A., & Oruc, O. (2014). *Mixing processes in hydrothermal spring systems and implications for interpreting geochemical data: A case study in the Cappadocia region of Turkey*. Hydrogeology Journal, 22(1), 7–23
- Caissie, D. (2006). *The thermal regime of rivers: a review*. Freshwater Biology, 51(8), 1389–1406.
- Clark, I., Fritz, P. (1997). *Environmental isotopes in hydrogeology*. CRC Press.
- Environment and Climate Change Canada (ECCC) – https://climate.weather.gc.ca/climate_normals/index_e.html (last accessed 15.10.2022)
- IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- Lisi, P. J., Schindler, D. E., Cline, T. J., Scheuerell, M. D., Walsh, P. B. (2015). *Watershed geomorphology and snowmelt control stream thermal sensitivity to air temperature*. Geophysical Research Letters, 42(9), 3380–3388.
- Pacific Climate Impacts Consortium (PCIC), http://pacificclimate.org/ (last accessed 02.03.2022)
- Poole, G. C., Berman, C. H. (2001). *An ecological perspective on in-stream temperature: Natural heat dynamics and mechanisms of human-caused thermal degradation*. Environmental Management 27(6), 787–802