The Influence of Topography on Hydrology in the Hotel Gulch Watershed

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Samantha Motz [1], Sara Warix [2], Dr. Alexis Navarre-Sitchler [2], Dr. Kamini Singha [2]

[1] Earth and Atmospheric Sciences, Georgia Institute of Technology, [2] Hydrologic Science and Engineering, Colorado School of Mines

1. Objective

Comprehending our water systems is critical. Hydrology is influenced by topography, but ***the full extent of topography's influence remains unclear***.

Question:

- Does **topographic wetness index** correlate to a *lower* variability in *discharge* and a *higher* variability in *specific conductivity* in surface water?

2. Site Description

- Hotel Gulch resides in the Manitou Experimental Forest, which is a **semi-arid climate** between 2,601 m and 2,835 m in elevation (Fig. 1).
- Hotel Gulch has **limited anthropogenic activity** and is **prone to impacts of climate change**; its easy access makes it ideal for determining how climate change will impact similar watersheds.

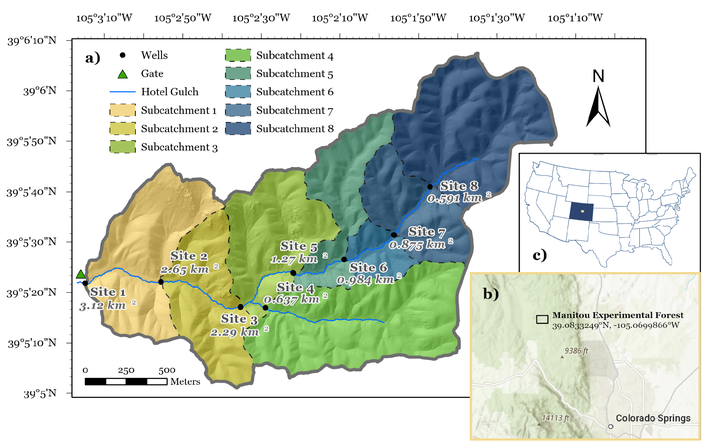

Fig. 1: Map and location of the Hotel Gulch Watershed. a) Site locations, subcatchments, and contributing area measurements in the Hotel Gulch Watershed. Each lower subcatchment includes upper subcatchments, ***except 4 is a tributary***. For example, subcatchment 2 includes 3-8, subcatchment 4 is isolated, and subcatchment 5 includes 6-8. b) Location in the Manitou Experimental Forest within the southern part of Colorado's Front Range. c) Location in Colorado, United States.

3. Methods

- Topographic analysis in comparison to discharge and specific conductivity data from stilling wells in the Hotel Gulch Watershed.
  - Coordinate collection
  - Watershed delineation in **ArcGIS Pro**
  - Topographic calculations
  - Data analysis in **MatLab** and **Excel**

4. Results

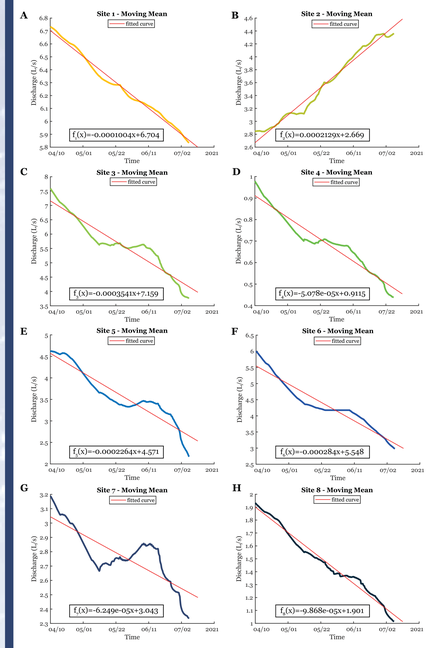

Fig. 2: Graphs representing the moving mean of discharge over time for each site fitted with a slope intercept equation to display the differences in trends between sites.

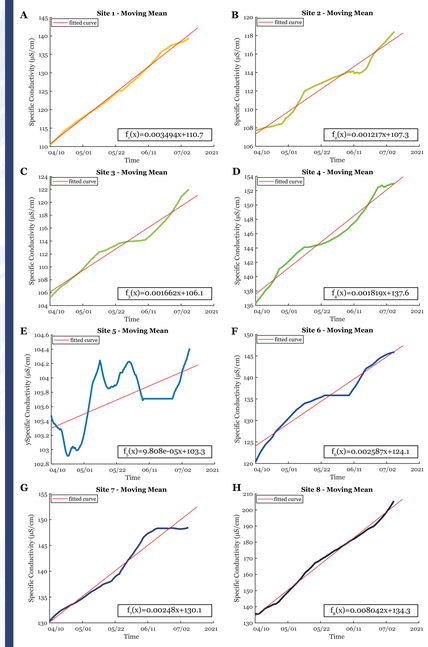

Fig. 3: Graphs representing the moving mean of specific conductivity over time for each site fitted with a slope intercept equation to display the differences in trends between sites.

Topographic Wetness Index: *ln(α / tanβ)*

α = upslope flow accumulation area (m)
tanβ = tangential slope (°)

- **Sites 1, 4, 6, 7, and 8:** *lower* standard deviation in *discharge* and *higher* standard deviation in *specific conductivity*. Additionally, these same sites have ***lower topographic wetness index*** values at the wells (Fig. 4 & 5).
- **Sites 2, 3, and 5:** *higher* standard deviation in *discharge* and *lower* standard deviation in *specific conductivity*. These sites also have ***higher topographic wetness index*** values at their wells. (Fig. 4 & 5)

Outliers:

We note that Site 2 has a positive relationship between discharge and specific conductivity (Fig. 2 & 3). Additionally, discharge is very dynamic at site 2 (standard deviation = 1.64 L/s) relative to site 1 (standard deviation = 0.59 L/s), even though the two sites are only 570 meters apart.

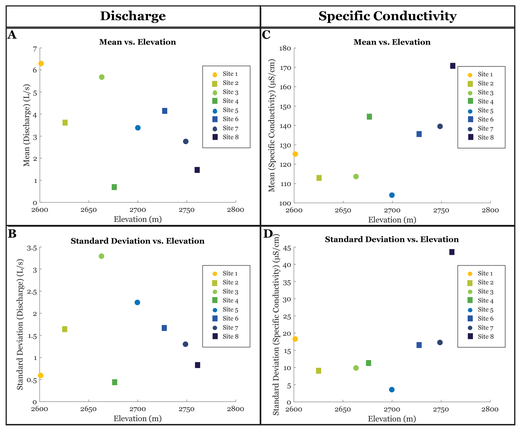

Fig. 4: Statistics from discharge and specific conductivity graphed against elevations at the site.

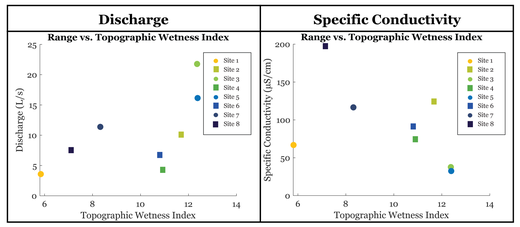

Fig. 5: Graph representing the range of discharge for each site against the topographic wetness index at the well.

5. Conclusion

- Topographic wetness index as an *indication* of hydrologic parameters—discharge and specific conductivity—in a mountainous, semi-arid watershed
  - **High topographic wetness index** correlates to a *high* standard deviation in *discharge* and a *lower* standard deviation in *specific conductivity*.
  - **Low topographic wetness index** correlates to a *low* standard deviation in *discharge* and a *higher* standard deviation in *specific conductivity*.
- A foundation of how the **topography plays a role in this area**; *this work will be continued to be built upon in future studies.*

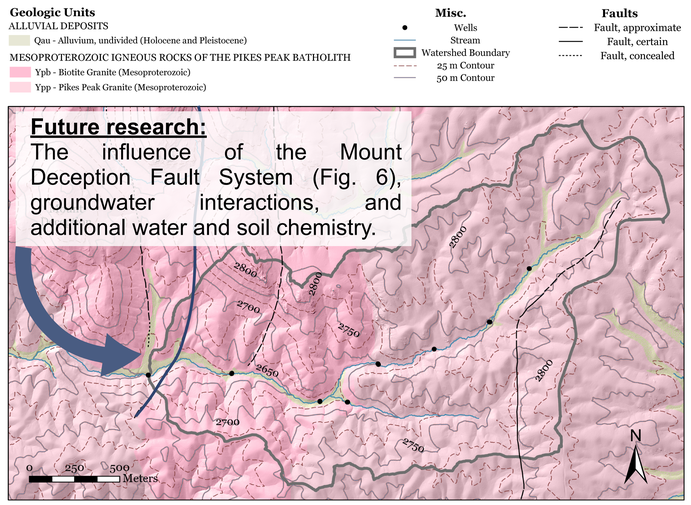

Fig. 6: Geological and topographical map of the Hotel Gulch Watershed. Hotel Gulch is underlain by the Pikes Peak Batholith. An en-echelon fault from the Mount Deception Fault System resides between sites 1 and 2. Geologic data adapted from Temple et al. (2007).

Acknowledgments

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(See manuscript for more references!)

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