# Topographic relief effects on groundwater-stream interactions in the Roanoke Valley

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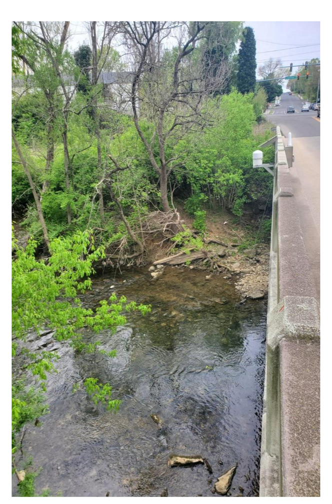
## INTRODUCTION

Groundwater-surface water interactions are vital in all ecological systems.[1] These interactions are particularly important for sustaining flow in mountainous streams. Despite this, they are often understudied and are difficult to characterize. This study investigates groundwater-surface water interactions in the Roanoke Valley and surrounding areas. We specifically looked at how topography and stream morphology differences might influence the baseflow of a stream. **Baseflow** is the portion of streamflow that is not directly generated from rainfall runoff during a storm event. In other words, it's the portion of the streamflow that is sustained by groundwater between these rain events. **Topographic relief** is the change in landscape shape, or the difference between the highest elevation and the lowest elevation in an area. We ask:

**Does topographic relief influence stream baseflow in Southwestern Virginia?**

## SITES



Tinker Creek #1, USGS 02055379, located in western Roanoke City.

Tinker Creek #2, USGS 02055100, located northeast of Carvin's Cove. Stream inaccessible due to private property.

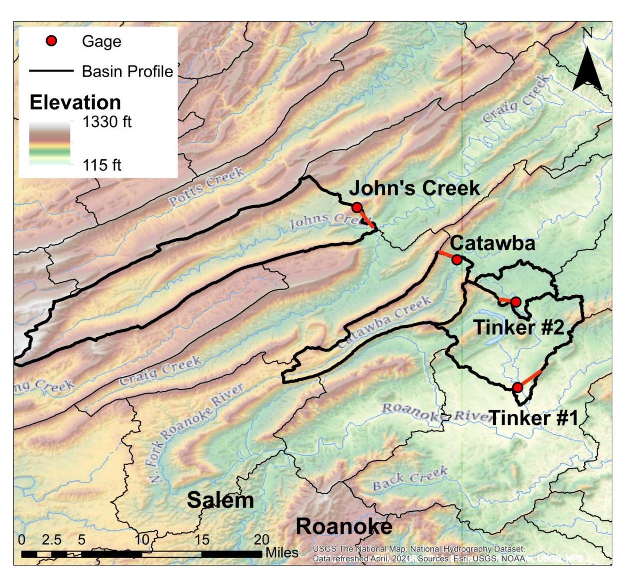
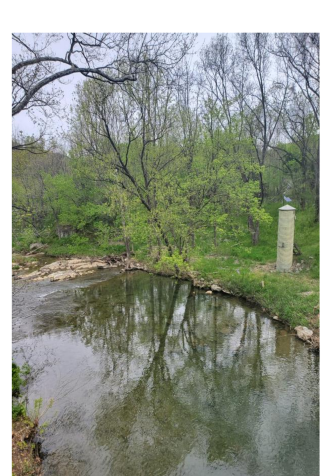
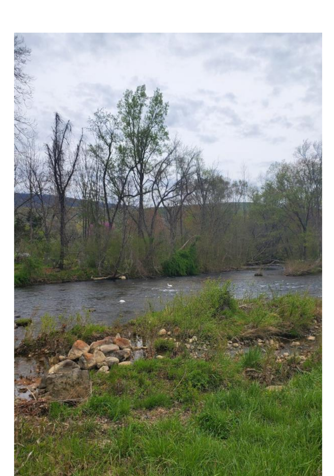



Figure 1. Site location map. Watershed divides are shown in black.




Catawba Creek, USGS 02018500, located in mining area.



John's Creek, USGS 02017500, located in downtown New Castle.

## RESULTS

Hydrographs showing flow and baseflow in cubic feet per second (cfs). An elevation profile and watershed divide with the star indicating gage location in top right corner

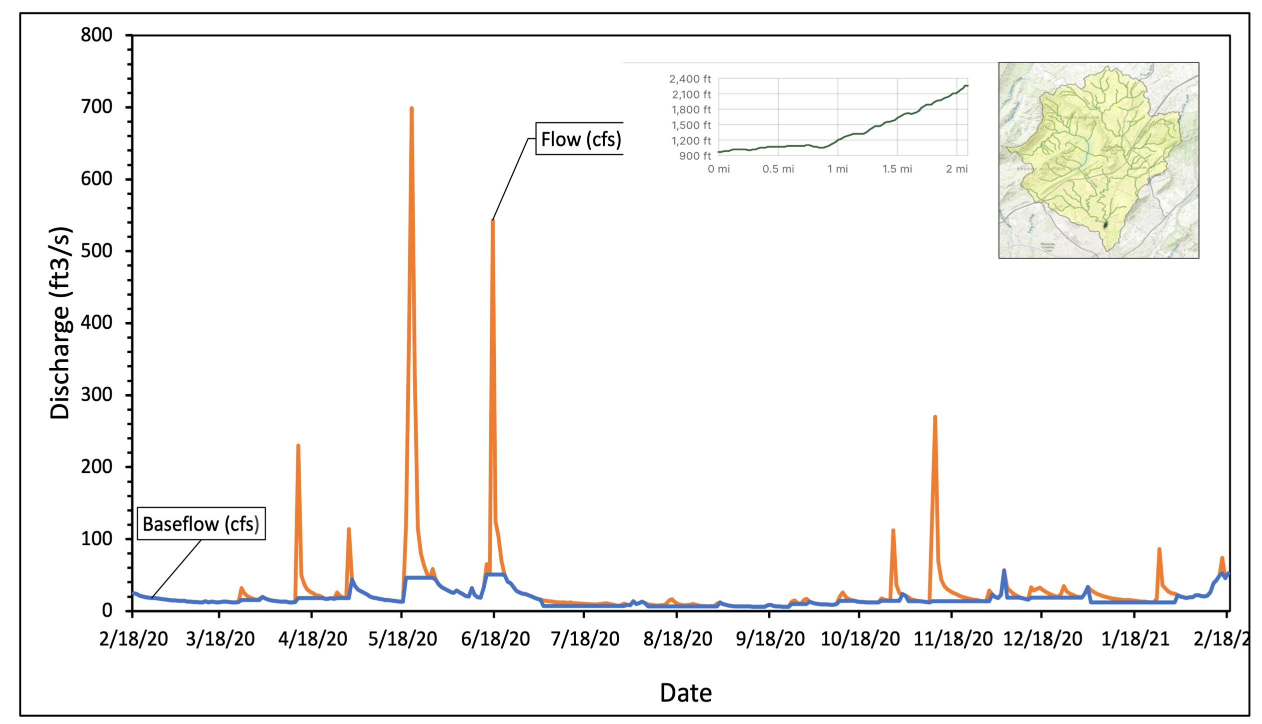



Figure 2. Tinker Creek site #1 had the lowest elevation relief at 392 m of gain, a slope of 0.12, and a BFI of 52%.

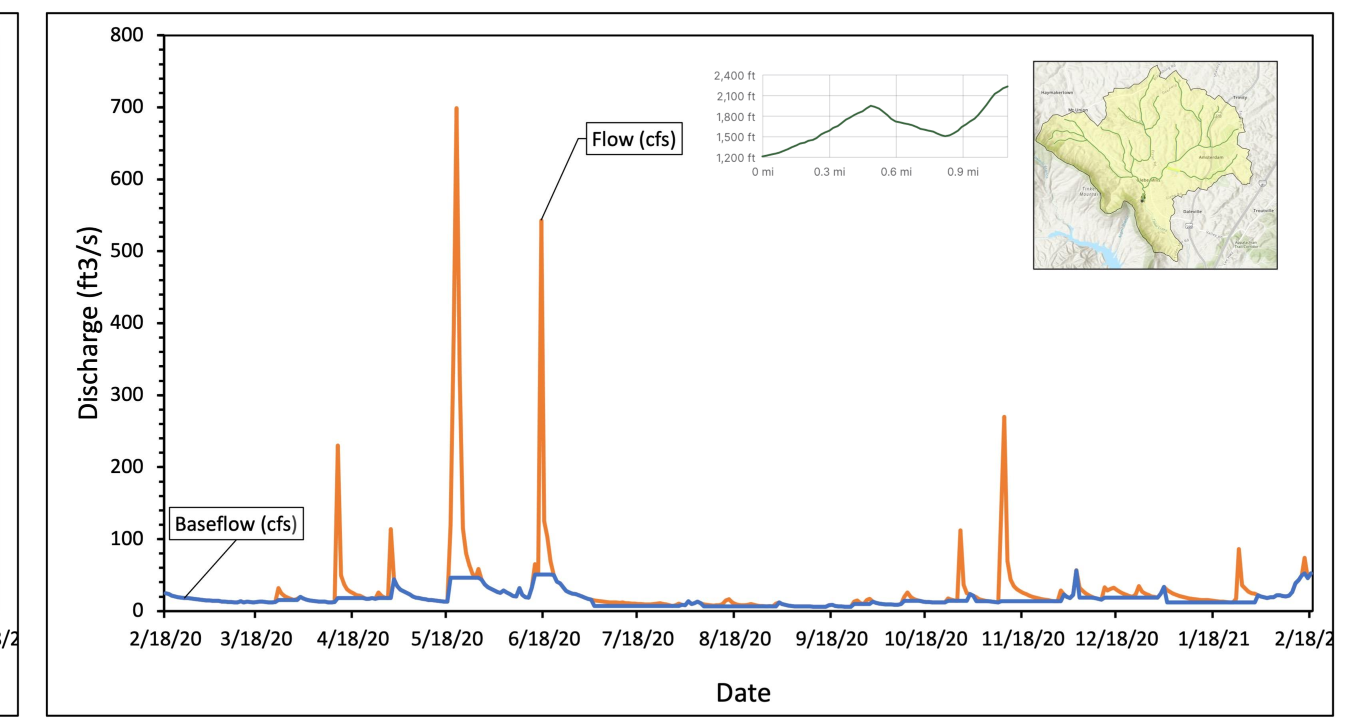



Figure 3. Tinker Creek #2 was the only other site with a BFI of 61%. The site had an elevation relief of 309 m gain. This site had the smallest drainage area at 33 km$^2$.

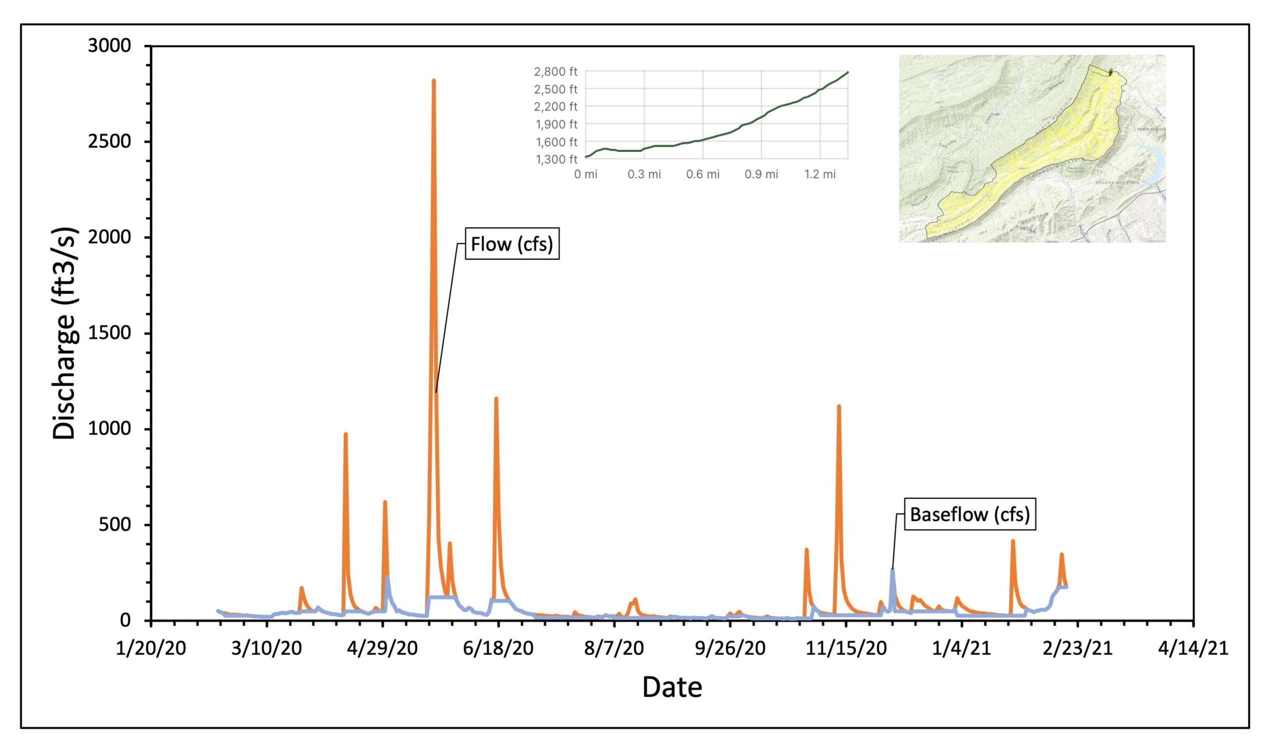



Figure 4. Catawba Creek had the second largest elevation relief at 440 m, a slope of 0.20,and a BFI of 47%.

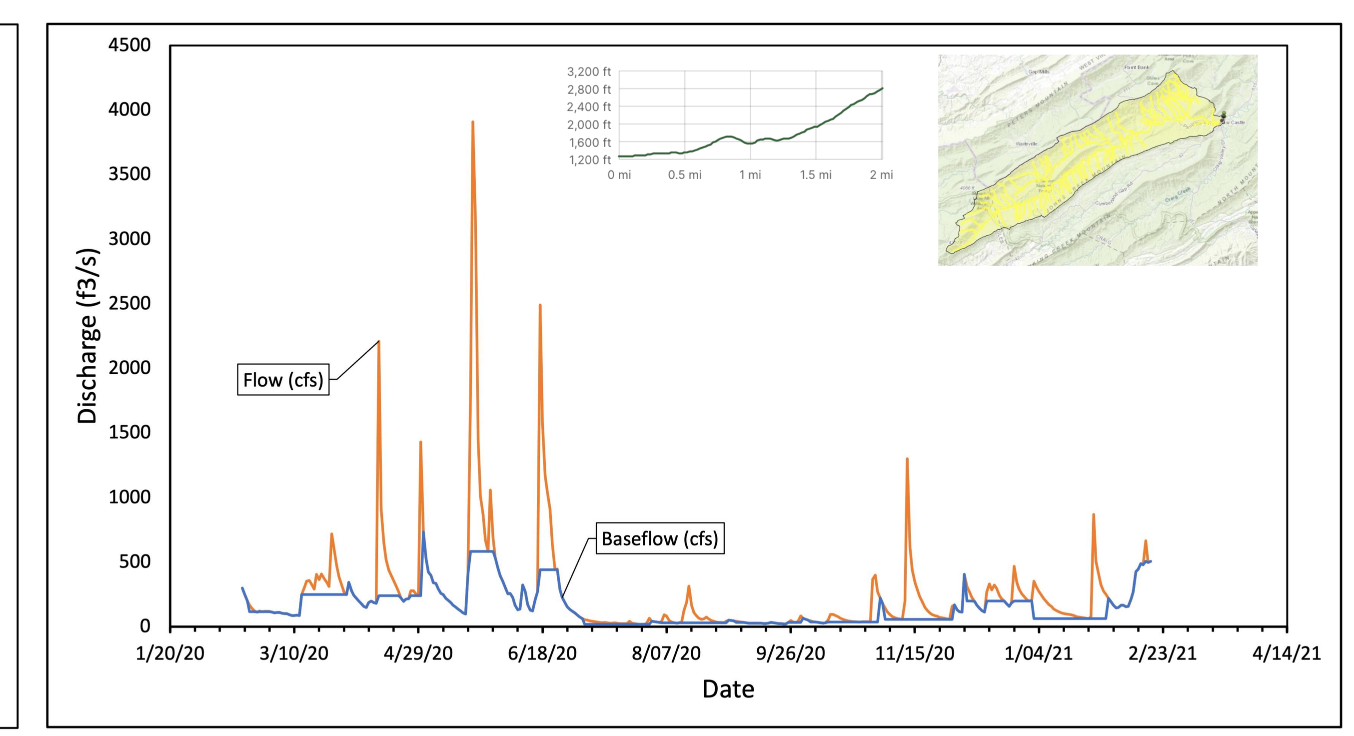



Figure 5. John's Creek had the largest elevation relief at 469 m of gain, a slop of 0.15, and a BFI of 61%.

## METHODS

- A FLIR One Pro thermal imaging camera was used to capture groundwater discharge into surface water.
- Daily discharge data for this analysis was retrieved from the USGS NWIS database. Both long-term and short-term data were used.
- A Baseflow Index (BFI) was calculated for each site, using the Purdue WHAT: web-based Hydrograph Analysis tool, using the local minimum separation method (include citation).
- A Baseflow index (BFI) was calculated from the yearlong data (short-term), which had a start date of 2/18/20 and stopped on 2/18/21. The long-term data still had the end date of 2/18/21, but the start dates varied between the sites
- Gaia GPS was used to aid in finding the longitudinal profiles for each of the streams being investigated. There was some variance in the GPS coordinates between USGS and Gaia, also variance in the elevations (not too dramatic).

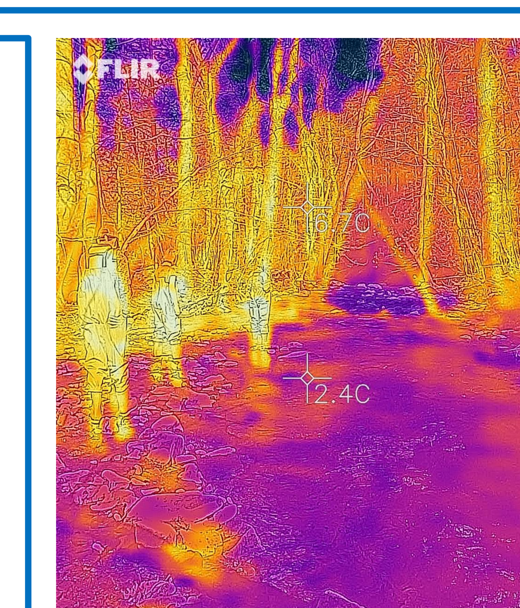



Figure 6. FLIR thermal camera image of stream walk.

## CONCLUSIONS

- Stream gage analysis indicates that there may be a correlation between topographic relief and baseflow.
  - Streams with greater topographic slopes have higher baseflow (Figs. 3 & 5).
  - Despite having low baseflow, Catawba Watershed has high relief (Fig. 4). This river site may have different controls on baseflow due to greater river flow, runoff from nearby impervious surfaces nearby, and/or geology.
  - Groundwater flow through karst systems, like in SW Virginia, is unpredictable because of variable fracture flow paths.[1]
  - Topographic relief affects groundwater flow patterns by shifting pressure gradients that drive water movement.[2]
- A better understanding the relationship between groundwater and surface water, particularly in mountainous environments, will allow better understanding of ecological systems.
- Future investigation is required to assess other controls on stream baseflow.
- The FLIR thermal camera will be helpful to identify sites of localized baseflow and further confirm groundwater-surface water interactions.

Table 1. Summary of landscape and streamflow parameters for each site.

| | Tinker #1 | Tinker #2 | Catawba | John's |
|---|---|---|---|---|
| Drainage area (km$^2$) | 167 | 33 | 90 | 272 |
| Elevation Relief (m) | 392 | 309 | 440 | 469 |
| Distance to Peak (km) | 3.4 | 1.7 | 2.2 | 3.2 |
| Slope | 0.12 | 0.18 | 0.20 | 0.15 |
| Flow (cfs) | 48,450 | 10,122 | 31,089 | 88,775 |
| Baseflow (cfs) | 25,352 | 6,161 | 14,709 | 54,195 |
| Baseflow Index | 52% | 61% | 47% | 61% |

## ACKNOWLEDGEMENTS

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## LITERATURE CITED

1. Winter et al. Ground Water and Surface Water A Single Resource, *U.S. Geological Survey* textbook. pg. 50. (1999).
2. Bloxom L.F., Burbey T.J. Determination of the location of the groundwater divide and nature of groundwater flow paths within a region of active stream capture; the New River watershed, Virginia, USA. *Environmental Earth Sciences* (2015).