



# Land Use as a Factor in Nutrient Loading in Karst Streams

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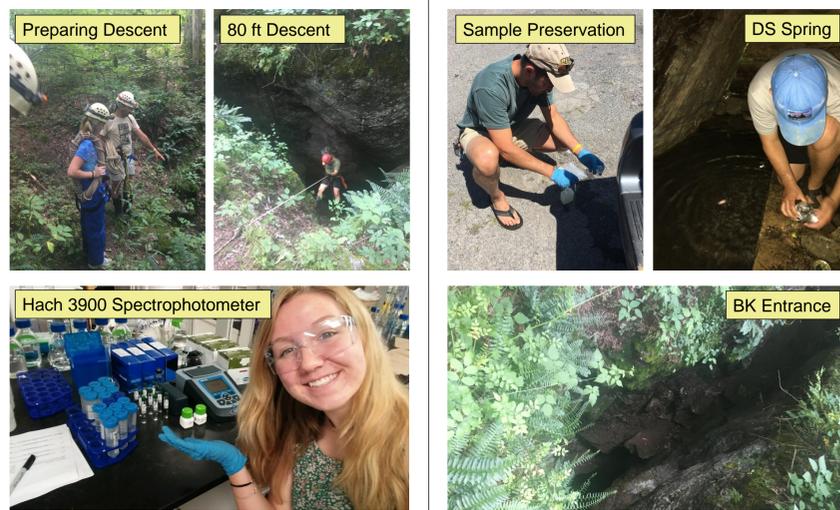
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## Introduction

- Valley and Ridge Province of Virginia is characterized by bands of limestone valleys and sandstone ridges between the Blue Ridge Mountains and the Appalachian Plateau (Fig. 1a).
- Valleys formed as a result of limestone being more soluble than the quartz-rich ridges.
- Karst landscape acts as conduit transmitting groundwater easily.
- Gentle slopes and soil characteristics allow for prime farmland, which is the source of nutrient loading in cave streams.

## Objectives

- To determine if local cave streams show elevated nitrate due to agricultural runoff contamination.
- To determine if land use is a factor in nutrient loading in subsurface karst streams.



## Methods

- Analyzed nitrates in 6 cave streams located in Southwest Virginia and Northeast Tennessee (Fig. 1).
- Nitrate samples were collected in triplicate in 50mL vials and preserved with 2 drops conc. H<sub>2</sub>SO<sub>4</sub>, placed in cold storage, and analyzed within 4 days.
- Read on a Hach DR3900 spectrophotometer using Hach method 10206, by adding a dimethylphenol reagent.
- Using ArcMap, a 1km buffer was drawn around sample locations. NLCD land use data (Fig. 1b) was clipped and calculated within the 1km buffer, outputting land use area.

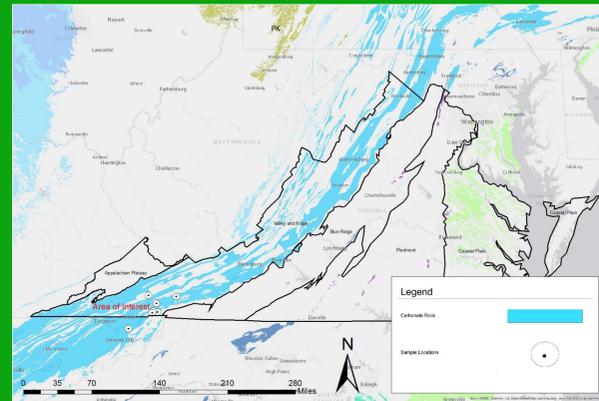


Fig.1a

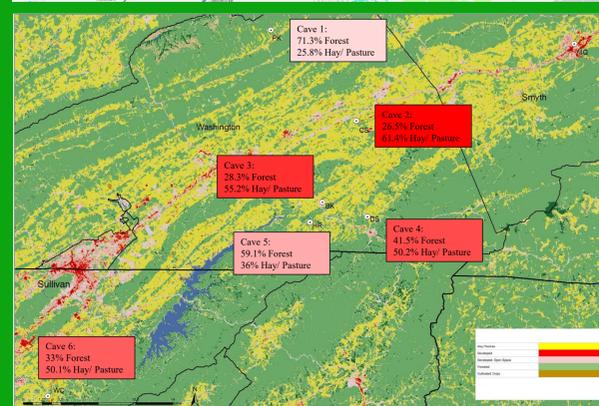


Fig. 1b

Figure 1: Area of interest is in the Valley and Ridge physiographic province, due to soluble rock strata and presence of agriculture.

## Results

- Average nitrate levels are significantly higher in cave streams located in areas dominated by agricultural land use, versus a control group of forested land (fg. 2a).
- There is a strong positive correlation between hay/pasture land use and nitrate levels; and a strong negative correlation between forested land use and nitrate levels (fg. 2b).

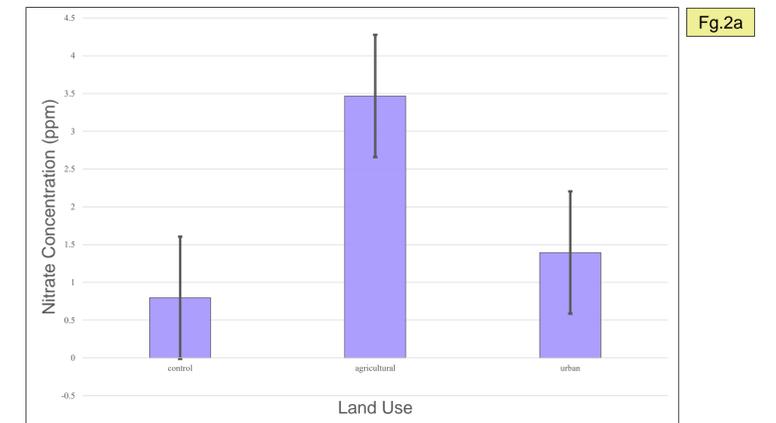


Fig.2a

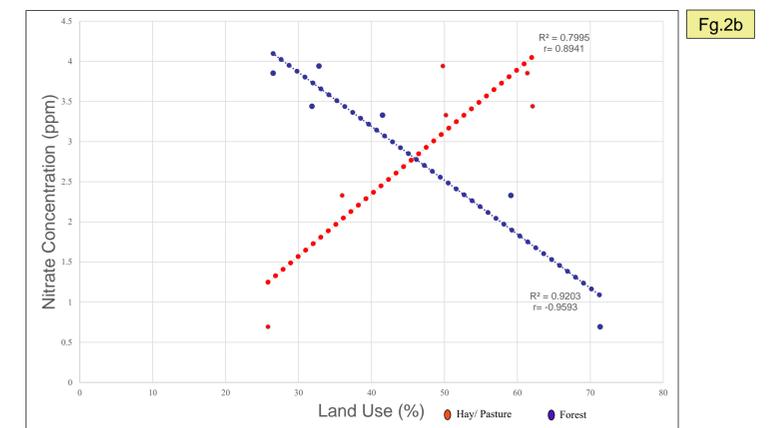
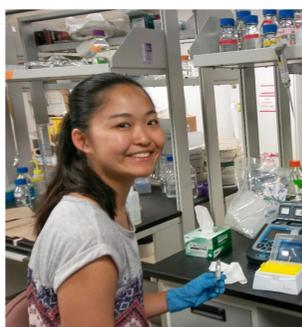


Fig.2b

Figure 2: (a) Levels of nitrate in cave streams impacted by different land uses; and (b) correlations between nitrate concentration and percentage of agricultural land use and forest land use.

## Discussion and Connection to Secondary Education

- The high nitrate levels in cave streams classified as draining from agricultural land and the low nitrate levels of cave streams draining from forested land suggest that nutrient loading of groundwater could be attributed to infiltration of surface nutrient contamination. For example, percolation of nitrate due to the application of fertilizer on agricultural lands.
- Next steps: 1) A dye trace study of the hydrology of the study area to better determine sources of karst streams and to help better delineate the watershed 2) A cave drip analysis of water seeping into caves to further determine if nitrate is entering cave streams through nonpoint infiltration from agricultural 3) Future expansion of the study to include more caves.
- These further studies will be performed by local high school Environmental Science students at Holston High School. The intent of this study was to lay the groundwork for long-term experiential education studies in a Project Based Learning (PBL) format for high school students.



Acknowledgements: Special thanks to VT CSES, NSF, Water EcubeG RET, Dr. V. Lohani, Jeremy Smith, Dr. Madeline Schreiber, Wil Orndorff, and Jason Lachniet. This material is based upon work supported by the National Science Foundation under Grant No. 1609089. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.