

Project Title: Integrating Arsenic Well Water Citizen Science Project into Water Resources Course.

School: Colby-Sawyer College

Grade Level: Second year students in College

Your Name: Nick Baer

Project Partners: An adjunct faculty, Jeremy Lewis at Colby-Sawyer College, and Mary Wright at the Kearsarge High School.

Teacher/Scientist Partner Profile: My areas of expertise are in ecology, aquatic entomology, hydrology, water chemistry, water resources and conservation biology. I have been teaching at Colby-Sawyer College since 2004 and I am currently a full professor in biology and environmental science. I have designed two field courses to take students outside the classroom and learn about environmental challenges and explore solutions with stakeholders. I have deeply enjoyed being part of the All About Arsenic project as it has connected me to Mary Wright and her students at Kearsarge High School and engaged my students and me in a citizen science project. It ties in wonderfully with my Water Resource (ENV201) course I teach every fall semester. This project gets students discussing ground water quality issues and exploring the relationship between geology and water chemistry. When I am not teaching my family has a small farm where we raise sheep, chickens and turkeys, grow lots of fruits and vegetables and make maple syrup. I also enjoy exploring the many lakes and rivers and vast forested landscapes of New England in every season.

Summary: In our Environmental Science program we are interested in scaffolding applied projects in our 200 level courses in preparation for the students' 300 series Community-Based Research project courses usually taken in their junior year. The goals of integrating this All About Arsenic project into the Water Resources (ENV201) and Geographic Information Systems (GIS) (ENV204) courses are to engage students with data collection and analysis in one class followed by a deeper look at the data using new tools in GIS. In the Water Resources course the project goals are to: 1. Learn about groundwater contaminants, 2. Introduce skills to manage and coordinate research projects, 3. Develop data management and analytical skills, 4. Expose students to citizen science projects and get students to engage in working with the public, and 5. Develop communication skills through research papers and presentations.

Project Details:

- This year we had a total of 17 undergraduates involved in the advertising in the local paper, putting together the sampling kits, entering the data once kits were returned, and writing research papers on groundwater contaminants, and contributing to a presentation on arsenic in well water. There were 8 students involved in the GIS course who then used the data collected in the fall as well as the larger dataset to explore and learn GIS tools.
- The All About Arsenic website was a useful tool the students used to develop a background knowledge about arsenic. We also did reading in our text by Cech
- Students in the Water Resources class were assigned a research paper early in the semester with the goal of doing a literature review of what is known about a specific groundwater contaminant. There were a few students who focused on arsenic while others chose a variety of other water contaminants including MtBE, Uranium, Radon, and PFAS. The student papers focused on reporting about the specific contaminant, its origin, use, human and ecological health concerns, regulation, management and mitigation. All students were asked to contribute to a presentation for the high school students focused on arsenic. The class developed the presentation outline, and in small groups students were responsible for contributing specific slides to the overall presentation including a script with the key points to be presented. The arsenic project was described to the class and an advertisement was

placed in the local paper to make the community aware of the project and how to get a sample kit to have their 2022 well water tested. The goal was to augment the number of wells tested in the region to add to the data collected by Mary Wright's high school students. Students organized and put together the well water sampling kits. Once samples were returned, the students entered the data into the anecdata.org portal through the All About Arsenic website. The class discussed the importance of quality control and quality assurance and students were encouraged to have one person enter the data and a second student check the entries before submitting to reduce errors in the data. The class examined the data from previous years to explore the larger data set from Maine and New Hampshire and looked at arsenic concentrations measured within Merrimack county. The final component of this project was integrated in the spring semester Geographic Information System (GIS) course where students learn spatial mapping skills using the GIS software. The well water sample data collected with citizen science partners in the fall semester was used along with the larger NH and ME data to have students look at the data spatially and analyze patterns. Students created maps looking at arsenic concentrations while learning the functionality of GIS and the tools within the software. While the maps were shared amongst the class this spring, an area of improvement will be to disseminate this information to a wider audience through sharing them with the high school and local community.

Discussion:

- We had an adjunct professor teach the GIS component this year which resulted in less depth of using the arsenic data in the curriculum than in the past. I am looking forward to implementing this project next year as we have hired a new faculty whose expertise is in spatial analysis and can expand the use of the data and outreach.
- Students learned about a broad range of groundwater contaminants in addition to arsenic. The research paper was an effective way for students to learn quite a lot about specific contaminants and to share what they learned with their peers. One of the highlights was a student group who sampled about 15 roadside drinking water springs throughout New Hampshire. They were particularly interested in the water quality of these springs as they are commonly used. They found that the majority had water quality measures in the safe drinking water range. The students were excited to expand their study as there are many more of these roadside wells that they wanted to test in the far north and southern areas of the state.
- I learned that I need to allocate more time if I want to have meaningful community outreach component to this project. Because this is one section (groundwater) for the Water Resources class, I have to decide how to add another lab time and additional class time to the community outreach.
- Overall the arsenic well water project worked well to engage students in groundwater contaminants and fit well within the course curriculum. Mary Wright and I had talked about getting our students together to collaborate this year, but we weren't able to make it happen. In part it has to do with the timing of the college semester and the high school calendar being quite different. I only have my Water Resources students for one semester while Mary has her chemistry students for the year. I would like to try a student collaboration with the high school next year to see if it might get the students engaging with one another more. Perhaps trying a blog where both groups of students can contribute will be an engaging activity. Getting students involved in the citizen science well water sampling was an excellent part of the project that gave the students an appreciation for the level of organization and work needed to successfully collect data. I would like to spend more time with the data exploration so students can have multiple opportunities to see and ask questions about the data they are gathering. Integrating the data into the GIS course has been well received by students who helped to collect the data.
- This project continues to be an excellent tool in my college Water Resources (ENV201) course as it ties the curricular concepts to an ongoing public health campaign to ensure people have clean and safe

drinking water. It allows me to dive deeper into groundwater contaminants as a subject matter that has always been a part of the curriculum covered in this course.

Conclusion:

Having the opportunity to engage students with a broader community of researchers as part of a class is incredibly valuable. We are learning more about best teaching practices and pedagogical approaches, and we are being encouraged to integrate curricular concepts into experiential projects for students. The All About Arsenic project does just that. It gives value to the groundwater material covered in our class readings and gives students the opportunity to be part of a larger scientific community trying to make a difference through science and community outreach. The ability for students to contribute to the project and make connections from the course material to the application is directly meeting and enhancing the learning outcomes I hope students gain through taking the Water Resources course. This collaboration fits well within our courses and curricular outcomes for the Environmental Science and Studies program here at Colby-Sawyer College.

Acknowledgement:

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