Analyzing and Visualizing Porewater Nutrient Concentration Data

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AIM

This project has two goals: to produce porewater concentration data for a shore-normal transect at the site of other similar ongoing studies and to explore potential three-dimensional artistic visualizations of this data.

This porewater nutrient data is determined in a lab using standard nutrient spectroscopy alongside concentration standards and its distribution is mapped in SigmaPlot. Meanwhile, rough sketches and digital illustrations are made of a possible sculpture that would represent the collected nutrient data in a novel fashion.

METHODS

The sampling site is located at the Gulf Islands National Seashore: Naval Live Oaks Preservation Area and is the location of other previous and ongoing submarine groundwater discharge (SGD) and porewater nutrient studies, including ongoing studies of the influence of SGD on local seagrass populations. The field site was sampled once using miniature piezometers on 11 January 2020. Porewater from a single shore-normal transect site at distances of 0, 15, and 30.5m offshore with porewater collected at depths of 8, 25, 50, 75, 100, 125, 150cm below the sediment surface. These samples are filtered upon collection and frozen in the field using dry ice.

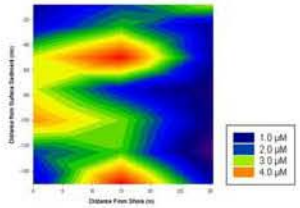
These samples are later thawed and tested in the lab for dissolved nitrate, nitrite, and phosphate concentrations using standard nutrient spectroscopy. Concentration standards are run alongside these samples to produce a standard curve to determine sample concentration in µM. This data is then processed in SigmaPlot to create a filled contour graph that shows the spatial distribution of each nutrient throughout the sampled transect.

Collecting samples using a push-point piezometer.

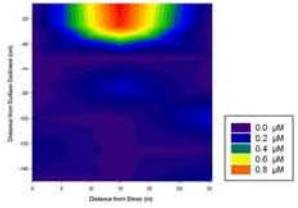
DATA

The following are the graphs produced by processing the nutrient concentration data into SigmaPlot. The y-axis indicates depth below the surface of the sediment in centimeters, while the x-axis indicates distance offshore in meters. Concentration in a given position on the graph is given by color, and each graph is accompanied by a legend indicating the concentration in µM according to these colors.

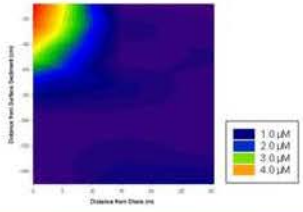
Nitrate Concentration

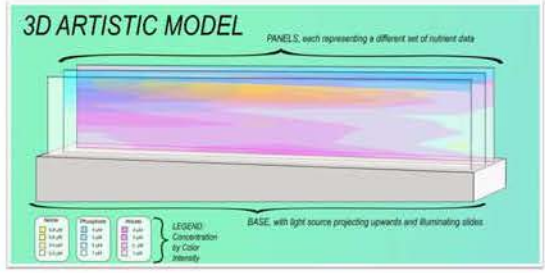


Nitrite Concentration



Phosphate Concentration





INTERSECTION OF ART AND SCIENCE

By utilizing both art and science, this project participates in the ongoing STEAM (Science, Technology, Engineering, Art, and Mathematics) movement. The STEAM movement arises from the addition of art to the traditional STEM fields to explore methods of understanding through the senses. The STEAM movement is important to artists, scientists, and the public because it opens doors of communication by exploring data from a variety of perspectives. This project strives to improve data understanding for scientists by offering a new perspective of their work and to improve communication to public by creating a data visualization that offers more visual and spatial cues to the actual space it represents than more abstracted, digital graphs.

This structure consists of three upright acrylic panels inserted in a plain base (shown in gray) with a small distance separating each. Each panel displays the data for a different nutrient as a function of color opacity and is accompanied by a legend. The more opaque or vibrant the color in a given location, the more concentrated the nutrient is in the place it represents. These panels are translucent so that if this structure is looked upon from a distance, the coloration of the panels layers to form an image that shows all of the collected data at once.

This communicates the data differently from the SigmaPlot graphics by providing more cues for spatial context and allowing all data to be viewed at once as a single visual. By representing the data through the space of a skewed rectangle rather than a square, the real shape of the space is more clearly implied. Additionally, by including a wedge indicating the water above the sediment from which samples are taken, another aspect of the actual environment being represented is shown. By using transparent slides that can be viewed as a layered image, all of the collected data can be viewed simultaneously.

These differences benefit both scientists and the public. Scientists gain the ability to analyze data in new ways and the ability to view all the data at once can make it easier to analyze potential interactions or trends among different nutrients. Meanwhile, the public gains a tool to begin understanding the data produced by these types of studies.

DISCUSSION OF DATA

The graphs created in SigmaPlot show the concentrations of each nutrient of interest throughout the sampled plane (i.e., within the sampled along-shore transect) at a single point in time (11 January 2020). Nitrate is observed to have the most frequent high concentration levels and variation throughout the area, while nitrite and phosphate both display single, highly localized spikes near the surface of the sediment. Additionally, nitrite has a much lower maximum concentration than phosphate and nitrate.

Spatial variability of these nutrient species likely reflects the effects of both biogeochemical processes within the subsurface environment and temporal variation in groundwater-surface water mixing in this subsurface transect. That is, we interpret these results to mean that biological and chemical processes are transforming nutrients (N and P) in the subsurface and that SGD effects change over a tidal cycle.

NEXT STEPS

This project has proven an incredible opportunity to explore the possibilities offered by interdisciplinary work, and efforts to create a sculptural representation of data will continue in Fall 2021. There has been discussion of utilizing programmed LED lights and etched glass to create a model loosely based upon my current draft. In addition to combining data for each nutrient into a single object, this electronic art piece could be capable of animating the change in nutrient concentration and distribution over time, which will likely be a key aspect of future projects.

IMPORTANT LINKS

These links lead to digital illustrations of the three-dimensional art piece I designed for this project:

https://bit.ly/39uvQzt https://bit.ly/31uUyv5

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