   

**Project EDDIE: NUTRIENT**S **MONITORING IN THE CHESAPEAKE BAY**

**Student Handout**

This module was initially developed by Oni, A. and Koissi, N. 29 October 2019. Project EDDIE: Nutrients Monitoring in the Chesapeake Bay. Project EDDIE Module 14, Version 1. Module development was supported by NSF DEB 1821567.

Learning Objectives:

* Define water impairment and the surrounding issues.
* List some of the factors that contribute to water impairment.
* Define nutrient pollution and surrounding issues.
* Explain the effects of nutrient pollution leading to water impairment in the Chesapeake Bay.
* Evaluate the effects of phosphorus concentration in waters of the Chesapeake Bay.
* Explore the effects of natural and anthropogenic fluxes of Phosphorus into the waters of the Chesapeake Bay.
* Determine the effects of concentrations of other types of nutrients into the Bay.

Why this matters: Water impairment occurs when a lake, river, or stream fails to meet specific water quality standards, according to its classification and intended use. The Chesapeake Bay waters receive input from rivers and streams of areas of the Washington D.C, Maryland, Delaware, Virginia, West Virginia, and some part of New York and Pennsylvania. Historically, humongous amounts of water pollution from nutrients discharged from these locations have reportedly occurred in the waters of the Chesapeake Bay region, such that it was included in the list of the “Clean Water Act Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs) compiled by the EPA.

Over the years, there have been efforts to reduce input of nutrients and improve water quality. Are these efforts effective? Is the water quality of Chesapeake Bay improving? According to the Chesapeake Bay Program, established in 1983 to reduce pollution and restore the ecosystem, “Plants and animals need nutrients to survive. But when too many nutrients enter waterways, they fuel the growth of algae blooms and create conditions that are harmful to underwater life.” Source: <https://www.chesapeakebay.net/issues/nutrients>.

Outline:

1. PowerPoint Presentation and Discussions on topics related to the subject matter.
2. Activity A: Determine the changes in Phosphorus concentrations over time at a chosen sampling location.
3. Activity B: Explore changes in Phosphorus concentrations over time at another sampling location in the dataset. Compare your results with those of Activity A.
4. Activity C: Explore other nutrient inflow from other locations.

**Activity A: Determine the changes in Phosphorus concentrations over time at a chosen sampling location.**

For this part of the module, do the following:

1. Formulate your hypotheses with regard to the concentration of Phosphorus entering into the Chesapeake Bay. Remember you already gained background knowledge from the pre-class reading activities.
2. Access the water quality data set available at the website of the Chesapeake Bay Program at <https://datahub.chesapeakebay.net/WaterQuality>
3. Follow the listed prompts below to select a dataset for Phosphorus:

- CBP Water Quality data (1984 -present)

- Water Quality Data

- 10/29/2014 to 10/29/2019

- Data Stream – All Data

- SWM- Shallow Water Monitoring Programs

- CMON-Tidal Continuous Water Quality Monitoring Project

- Small Watershed (HUC12)

- Select Attribute “Potomac River Channel”

- Select Parameter “Total Dissolved Phosphorus”

1. Download the .csv file. You can open this file in Excel and then save it as an Excel workbook file (.xlsx or .xls) on your computer in a location where you may be able to easily locate and access it again.
2. There are many columns of data, and not all of these are needed for the graph. To make the graph, you will only need to select the data in the columns labeled SampleDate and MeasureValue. You may wish to clean up the dataset by deleting unwanted column(s), which you can do by highlighting the columns of data you don’t need, and selecting delete. Below are the examples of steps to follow to clean up a dataset:

* Select columns A – I, delete (as shown on sheet WaterQualityWaterQualityHUC12).
* Select columns J – S, delete (as shown on sheet clean up).
* Select columns U – AD, delete (as shown on sheet clean up).
* Sheet Clean data set is the final product.

1. Make a scatter plot of Phosphorus concentration over time. Below is an example of the axes:







1. Before you conduct your analysis, you should first make your predictions (formulate a hypothesis, such as the following):

* What slope would indicate a changing concentration of Phosphorus?
* What slope would indicate Phosphorus concentration not changing? 
* Make a sketch line in the axes above to show what the expected slopes would be. Based on the history of the sample location, what may account for the concentration of Phosphorus at this location?

1. Now, determine the rate of change. Determining rates of change graphically is straight forward. The average rate of change is just the change in concentration divided by the change in time, or change in y divided by the change in x, or the slope of a line that fits through the data. These are all the same thing. Be aware that Excel can calculate the slope of a line very easily. So, to determine the rate of change (slope), add a trend line. When you do this, make sure to select the options to show the equation of the line and the R2 value. The equation is written in the form *y = mx + b*, where *m* is the slope and *b* is the intercept. The value for *m* is the rate of change.

The R-squared (R2) is a statistic resulting from a linear regression analysis, which is the statistical name for what you just did by adding a trend line. It describes the proportion of variation in the dependent variable explained by the independent variable. When R2 is ~1, the data align in a perfectly straight line. As the data become more scattered from the line, R2 decreases toward 0. Higher R-squared values indicate a stronger relationship between the two variables. Record your R2 value along with your slope.

* 1. Equation for the line:
  2. R2 =
  3. Rate of Phosphorus concentration change (include units):
  4. Given your analysis, is Phosphorus concentration changing? How do you know?

**Activity B: Explore changes in Phosphorus concentrations over time at another sampling location in the dataset. Compare your results with those of Activity A: (Do trends in phosphorus concentration differ at different locations?).**

For this part of the module, do the following:

1. Formulate your hypotheses with regard to the concentration of Phosphorus entering into this newly chosen location of the Chesapeake Bay.
2. Access the water quality data set available at the website of the Chesapeake Bay Program at <https://datahub.chesapeakebay.net/WaterQuality>
3. Follow the below listed prompts to select a dataset for Phosphorus:

- CBP Water Quality data (1984 -present)

- Water Quality Data

- 10/29/2014 to 10/29/2019  
 - All Data

- SWM- Shallow Water Monitoring Programs

- CMON-Tidal Continuous Water Quality Monitoring Project

- Small Watershed (HUC12)

- Select Attribute “of your choice (different from the first example)”

- Select Parameter “Total Dissolved Phosphorus”

1. Download the .csv file and convert to Excel file by saving as .xls or .xlsx on your computer in a location where you can easy locate and access it again.
2. Open the dataset and clean up. (Example: remove/delete unwanted row(s) and column(s)). Refer to step (e.) in activity A.
3. Make a scatter plot of Phosphorus concentration over time.
4. Next, on the same graph, plot the dataset from Activity A and B.
5. Do trends in phosphorus concentration differ at different locations?

**Activity C: Explore other nutrient inflow from other locations.**

For this part of the module, you will need to repeat the steps in “Activity A” but you now choose a different nutrient, say for example, Nitrate or Nitrogen, etc. Based on your general knowledge, how and where do you think this level of nutrient may have been generated (source location), and how might this impact the aquatic ecosystem and environment?

You can then do the following:

1. Formulate your hypotheses with regard to the concentration of the ‘Nutrient’ entering into the Chesapeake Bay.
2. Access the water quality data set available at the website of the Chesapeake Bay Program at <https://datahub.chesapeakebay.net/WaterQuality>
3. Follow the below listed prompts to select a dataset for the ‘Nutrient’:

- CBP Water Quality data (1984 -present)

- Water Quality Data

- Choose your own date range.

- All Data

- SWM- Shallow Water Monitoring Programs (or choose a program of choice)

- CMON-Tidal Continuous Water Quality Monitoring Project (or project of choice)

- Small Watershed (HUC12) (or any other)

- Select Attribute for your “Location”

- Select Parameter for your “Nutrient”

1. Download the .csv file and convert to Excel file by saving as .xls or .xlsx on your computer in a location where you may be able to easily locate and access it again.
2. Open the dataset and clean it up. (Example: remove/delete unwanted row(s) and column(s)). Refer to step (e.) in activity A.
3. Make a scatter plot of Nitrate concentration over time. Below is an example of the axes:







1. Before you conduct your analysis, you should first make your predictions (formulate a hypothesis such as the following):

* What slope would indicate a changing concentration of your ‘Nutrient’?
* What slope would indicate the ‘Nutrient’ concentration is not changing?

1. Now, determine the rate of change. Determining rates of change graphically is straightforward. The average rate of change is just the change in concentration divided by the change in time, or change in y divided by the change in x, or the slope of a line that fits through the data. These are all the same thing. Be aware that Excel can calculate the slope of a line very easily. So, to determine the rate of change (slope), add a trend line. When you do this, make sure to select the options to show the equation of the line and the R2 value. The equation is written in the form *y = mx + b*, where *m* is the slope and *b* is the intercept. The value for *m* is the rate of change. 

The R-squared (R2) is a statistic resulting from a linear regression analysis, which is the statistical name for what you just did by adding a trend line. It describes the proportion of variation in the dependent variable explained by the independent variable. When R2 is ~1, the data form a perfectly straight line. As the data become more scattered from the line, R2 decreases toward 0. Higher R-squared values indicate a stronger relationship between the two variables. Record your R2 value down with your slope.

* 1. Equation for the line:
  2. R2 =
  3. Rate of ‘Nutrient’ concentration change (include units):
  4. Given your analysis, is the Nutrient’ concentration changing? How do you know?

Proceed to repeat the steps for Activity C, but select a different sampling location for your ‘Nutrient’ then compare your results.

1. Finally, use the information you have determined in your exploration throughout this activity to address this question: How is water quality changing in Chesapeake Bay? Is it improving?