**Modeling the relationship between climate change, nutrients and hypoxia**

***Background***

The amount of nitrogen that drains off the land and enters Chesapeake Bay is the primary factor affecting the size of the dead zone each year. Two variables that affect each year’s nitrogen load are precipitation and fertilizer use. More rain means that more water is washing over the land and picking up nitrogen from farm fields and other sources along the way. If farmers apply more fertilizer to their fields, more nitrogen is available to be washed away by runoff.

***Models an important practice in science***

*In this section we will explore how, models can be used to predict the impacts of climate change on precipitation and nutrients and how it affects dead zones in the Chesapeake Bay.* Models are central to what scientists do, they can be used to test hypotheses or predict information. The results of models are often used to make very important decisions. Scientists have developed statistical relationships between the amount of nitrogen in runoff, the amount of runoff entering the Bay, and the size of the dead zone each year. The result of this work is a simple equation that serves as a model of these processes.

***Directions***

1. Go to: <https://teachoceanscience.shinyapps.io/dead_zone_app/>

2. Explore the model complete the following table.

***Exploring the Relationship between precipitation, fertilizer use and dead zones***

|  |  |  |
| --- | --- | --- |
| **Changes in precipitation** | **Changes in fertilizer use** | **Observations (predicted changes in dead zone volume)** |
| No change | No change |  |
| No change | 15% more fertilizer |  |
| No change | 15% less fertilizer |  |
| 15% more rain | No change |  |
| 15% more rain | 15% more fertilizer |  |
| 15% more rain | 15% less fertilizer |  |
| 15% less rain | No change |  |
| 15% less rain | 15% more fertilizer |  |
| 15% less rain | 15% less fertilizer |  |

**Analysis and Application**

1. Draw a conceptual model showing the relationship between no changes in precipitation, fertilizer application and dead zones.

2. Explain what is happening to dead zone volume when there is an increase or decrease of precipitation. Use data from the model to support your answer.

3. Explain what is happening to dead zone volume when there is an increase or decrease in fertilizer use? Use data from the model to support your answer.

4. Explain what is happening to dead zone volume when the precipitation decrease and the fertilizer use increases? Use data from the model to support your answer.

5. What do you predict will happen to the volume of hypoxia as a result of climate change? Why?

6. How can we reduce the impacts of nutrients and precipitation changes on the Chesapeake Bay?