



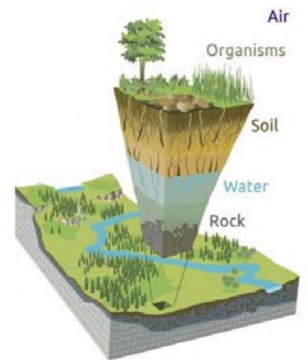
Objective:

This investigation contains three components:

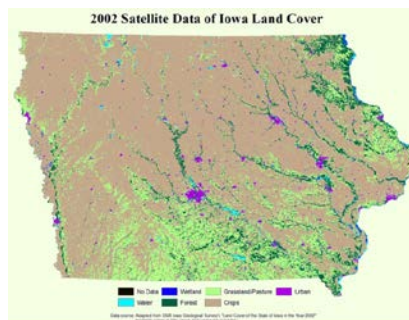
1. To engage the learner in land-use changes in the Midwestern “Corn Belt” that have led to the development of the Gulf of Mexico Hypoxia (Dead) Zone.
2. To investigate the primary components of a Corn Belt watershed.
3. To explore personal questions about the effects of land use in an area that interests them.

These objectives are tied together around Next Generation Science Standards (NGSS) using phenomena bundling, by putting together several standards around a singular primary concept, specifically utilizing 8th grade standards.

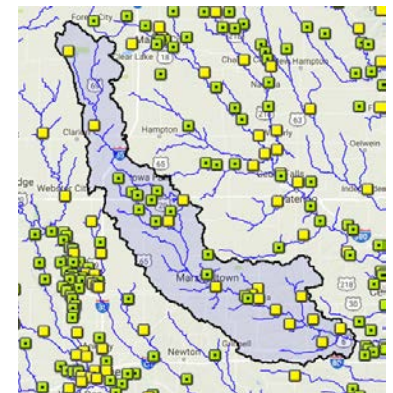
The Critical Zone: Earth’s permeable near-surface layer... from the tops of vegetation to the bottom of groundwater. It is a living, breathing, constantly evolving boundary layer where rock, soil, water, air, and living organisms interact. These complex interactions regulate the environment and determine the quantity and quality of life-sustaining resources, including food production, forest resources, and water quality. CZ Observatories (CZO’s) provide important platforms for studying these critical CZ processes (see www.criticalzone.org). The Intensively Managed Landscapes CZO focuses on understanding how land-use changes through human modification affect the long-term resilience of the critical zone in the Midwest.



Part I: Land Use Change and Gulf of Mexico Hypoxia: The export of nitrogen from agricultural watersheds in the Midwest Corn Belt is the primary cause of the Gulf Hypoxic Zone. (<https://www.ncddc.noaa.gov/hypoxia/>)




Iowa, one of the three largest exporters of nitrogen from agriculture, has lost 99% of its original prairie and wetlands during its transformation to an intensively managed agricultural area. This initial exercise has students research this reality in an area they select in Iowa. Students will utilize the website: <http://ifis.iowafloodcenter.org/ifis/> to select a watershed in Iowa. Students begin by launching “IFIS”, selecting data resources (☞) on the right toolbar, and choosing “stream gauges”. Click any stream gauge and the watershed for that point on the stream will be highlighted (pictured right). Students should choose a subset area of their chosen watershed.





Students are encouraged to use a variety of resources: librarians, Google searches, etc., to gain an understanding of how the watershed has been altered (soil, land surface, water, vegetation and other organisms, etc.) and why that alteration has taken place (social, economic, etc.). Students are required to bring evidence, in the form of images, stories, graphs, tables, or other means to support their understanding. For example, students can use sites

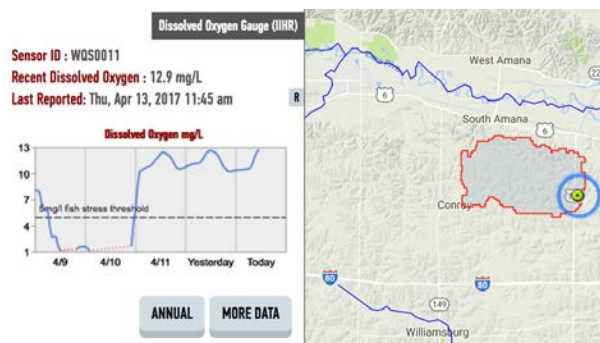
such as: <http://ortho.gis.iastate.edu> and Google Earth to access aerial imagery of land use history and change of their study site. Students should also search for other resources that show how land use has changed over time, for example using: <https://archaeology.uiowa.edu/government-land-office-survey-maps>. Students should be given space and freedom to determine what qualifies as a valuable resource. Differentiation of instruction can occur at this stage by the level of guidance given to students by their teacher. Students need to summarize how their designated area has changed over time, the reasons for the changes and the impacts (positive and negative) of those changes.

Part II: Watershed: Now that students have investigated land use changes over time, it is important to understand what a watershed is and more about the watershed context of the area they selected in Part 1. Students will visit <http://ifis.iowafloodcenter.org/ifis/>, launch “IFIS” and zoom in to their area in Iowa as they did in Part 1. Then, on the right hand side, select the toolbox () and select “Raindrop Flow Tracker”. Click anywhere to see where a drop of water that hits “land” flows to reach the nearest river/stream. Back in the toolbox again, select “Find Watershed Boundary” to determine the area of your watershed. Finally, have students explore the rest of the toolbar to see rainfall, flow, and flood data of their area. This should develop more questions that can be further researched as an extension possibility.

Part III: Water Quality: At this point, students should be highly tuned into the selected area. They will now be pushed to research the quality of the water in this watershed. Students will focus on Nitrate, Nitrite, Temperature, pH, Dissolved Oxygen, Specific Conductance, and Turbidity by using the data from the website: <http://iwqis.iowawis.org>.

Step 1: Launch IWQUS and from the toolbar on the right hand side, select “info panel” from the bottom ICON (). This will provide students with a snapshot of information regarding the significance of each data item listed above.

Step 2: Select the flask () and determine what data set(s) they should view. In the sample shown here, we have selected Dissolved Oxygen. Students can then change the time scale, pull up other data, and even see images of the area where the testing station is located. Step 3: Students will use the data, their understanding of watersheds, and their knowledge of how land use has changed to make a statement, supported by evidence, of their understanding of their watershed. Collectively, they will gain an understanding of how people’s actions, both current and historically, have impacted the region and ultimately the Gulf of Mexico. *Note:* these data collection tools are widely spread around the state and students might have to use an ever larger watershed to get a glimpse of their region. This is a limitation but also an opportunity for students.



NGSS: The Phenomena: The Next Generation Science Standards for 8th grade in Iowa consist of 25 different performance expectations. To address these expectations, our approach is to use a central phenomenon to engage our students in the standards. Our specific phenomenon is: How have local land use changes in Iowa impacted the local environment and produced cascading environmental effects far beyond the state’s boundaries? This big question was created by aligning nine standards from the NGSS:

1. MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
2. MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth’s systems.
3. MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
4. MS-LS4-4: Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment.
5. MS-ESS2-4: Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.
6. MS-PS1-3: Gather and make sense of the information to describe that synthetic materials come from natural resources and impact society.
7. MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
8. MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
9. MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Conclusion: This unit could take between 4-8 weeks depending on previous student knowledge of the subject matter. Teachers should guide the initial investigations, phase I, with the whole group. At that point, differentiation should occur, allowing the teacher to determine what individual’s needs are, then moving forward accordingly. Additionally, this investigation allows for students to take on Part IV: exploring individual questions. Examples could be centered on wetland draining, soil erosion, forestry, commercial fishing, and a number of other local, regional and global issues.