Great Dayton Flood Inquiry Unit: Celebrating the Centennial of a Defining Flood in American History

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Abstract

Flooding is a natural phenomenon many students have experienced on a first-hand basis. Students may either know someone who has been affected by floods or have witnessed its effects directly through observations of local creeks and rivers. This flood unit uses experiential and place-based learning to educate high school earth science students about the scientific phenomena of flooding through a multi-subject, integrated unit. Students use historical records and maps to calculate the rate and volume of flooding, and are able to use this knowledge to critically evaluate flood mitigation systems in other locations. This allows students to apply techniques from all four of the Science, Technology, Engineering, and Mathematics (STEM) disciplines in order to allow students to see and understand the interconnectedness of multiple academic disciplines, including but not limited to Social Studies, English Language Arts (ELA), and STEM through the lens of Science, Technology, and Society (STS).

Introduction

The Dayton (Ohio) Flood of 1913 (known locally as simply the “Great Flood”) is the foundation for this structured, inquiry-based unit. Though originally written for an earth science course at the Miami Valley Career Technology Center (MVCTC) in Englewood, Ohio, this unit has been taught by dozens of teachers throughout the Miami Valley within the past three (3) school years, and used as a foundation for teachers to create similar units of study for their local watersheds. Multiple disciplines, including science, mathematics, social studies, and English Language Arts (ELA) all intersect to help students understand the natural history of their environment through teacher-led activities. Therefore, this unit empowers teachers from diverse backgrounds to collaborate and team-teach the content material. The objectives of the unit are three-fold:

1) Students will become familiar with the causes and effects of the Great Dayton Flood of 1913 and its lasting impact on food control in the region, in both financial and environmental terms; students determine if the response of the public was appropriate for the threat of future flooding.
2) Students will be able to describe the difference between constructive and destructive earth processes, and identify landforms and features resulting from constructive and destructive forces.

3) Students will be able to discriminate between weathering, soil formation, and erosion, and produce examples of how erosion can happen, and how erosion can be prevented.

The original lesson plan was based upon 45-minute periods, so times for each portion of the unit are provided to allow teachers to plan instruction to fit their schedules. Further, our class had 1:1 computer availability, so students could easily use the internet to access online materials and to do independent research. If Internet access is not available, teachers can complete these activities with their students by reviewing internet material as a group projected on a screen, or by providing the student groups with printed materials to read about the flood (see Sidebar One).

Background

About one-hundred (100) years ago the Great Dayton Flood of 1913 covered the metropolitan city of Dayton, Ohio, with up to 20-feet of water (see Figure 1). Several winter storms in the Ohio River Valley preceded the flooding event with heavy ice and snow. Although the flood impacted other cities along the Great Miami River, Dayton’s unique location along the confluence of five rivers resulted in catastrophic flooding in its downtown area. The community and state mobilized resources to rescue stranded citizens, feed the homeless, and house the displaced. In the aftermath of the flood, Daytonians and Ohioans sought out ways to protect the citizens of the region from future flooding. Therefore, the State Assembly, with the support of Governor James Cox, passed the Vonderheide Act. This act created the Miami Conservancy District, the nation’s first major watershed district in 1915 (Rogers, 2013). Today, there are levees and five earthen dams (Englewood, Germantown, Huffman, Lockington, and Taylorsville) along the tributaries of the Great Miami River which help to regulate the discharge of water through the river system, in order to prevent flooding.

PART 1: Introduce the Dayton Flood with Student Research and Presentations (90 minutes)

The first part of the structured inquiry project is dedicated to allowing groups of students to conduct independent Internet research about the Great Dayton Flood. This activity provides students the opportunity to explore the historical records available online as well as view photographs of the event. By the end of the lesson (day 2), student groups are expected to produce
The presentation includes all of the significant events of the Great Dayton Flood of 1913.

The presentation includes most of the significant events of the Great Dayton Flood of 1913 with one or two items missing.

The presentation includes some of the significant events of the Great Dayton Flood of 1913 with more than two missing items.

The presentation has statistics concerning all three areas. At least three statistics are given for each area.

The presentation has statistics with most of the areas with no more than one missing part. At least three statistics are given for each area.

The presentation has more than one missing section. At least three statistics are given for each area.

Concise and thoughtful explanations are given for each of the three questions. There are no inaccuracies in the presented factual information.

Concise and thoughtful explanations are given for two or more of the questions. There may be one slight inaccuracy or fact left out of the presentation.

Concise and thoughtful explanations are given for at least one or more of the questions. There may be two or more inaccuracies or facts left out of the presentation.

The presentation includes an articulate explanation about how watershed management developed out of the flood. Further, the name of the agency is also included with a thorough explanation.

The presentation includes an adequate explanation about how watershed management developed out of the flood. Further, the name of the agency is also included with a brief explanation.

The presentation includes an explanation about how watershed management developed out of the flood. Further, the name of the agency is also included in the presentation.

Every slide has excellent visual components.

Most slides have excellent visual components.

Some slides have excellent visual components.

All group members actively participated.

Most of the group members actively participated.

Some of the group members actively participated.

Sidebar 1

Discerning History - Great Dayton Flood:
http://discerninghistory.com/2013/03/the-great-dayton-flood/

Miami Conservancy District - Great Dayton Flood:
http://www.miamiconservancy.org/about/1913.asp

The History Channel - Great Dayton Flood
http://www.history.com/news/the-superstorm-that-flooded-america-100-years-ago

PART 2: Analysis of the Upper Great Miami River Watershed (90 minutes)

Next, students review J. David Roger’s presentation titled 1913 Dayton Flood and the Birth of Modern Flood Control Engineering in the United States (Rogers, 2013). Students use a worksheet (titled “The Flood of 1913”) to study timeline of the flooding events, the destruction caused by the flood, and also an introduction to the history of the Miami Conservancy District (Figure 4). Students are also provided with an excerpt from the Miami Valley Conservancy’s report on the Dayton Flood (Morgan, 1917) and data on the structure and size of the levees to analyze the ability of Dayton’s dam and levee system to prevent a future flood. Students are guided by a worksheet that introduces the mathematics of flooding events. Through a series of calculations, students determine the volume of water that fell upon the Great Miami River Basin upstream of Dayton and the runoff volume during the storm event. Additionally, students are required to calculate the average depth of water in the flooded downtown area. The key content the students learn is that when precipitation exceeds the rate of infiltration, there can be a significant amount of resulting runoff, which can cause local or widespread flooding.
PART 3: Flood Prevention in the Dayton Region and Miami Valley (90 Minutes)

Hoover Dam, one of the world’s most famous dams, is well-known for its engineering design. Using it as a case study in dam construction provides a way to introduce the engineering design of the five dams in the Miami Conservancy District. Unlike the dams associated with the Miami Conservancy District, Hoover Dam generates electricity through hydropower, but all of these dams help to provide flood control and management, and recreational opportunities. The DVD, “American Experience - Hoover Dam” was produced by PBS in 2006, and in 56-minutes describes the need for Hoover Dam, its engineering and construction, and financial and environmental impacts to the West. Further, this provides a contrast to the purpose of the Dayton dam and levee system, and a comparison of environmental impact. The students are provided with several questions about Hoover Dam to provide focus and to guide their thinking during the film (see the worksheet titled “Building Hoover Dam” in the sidebar).

It is common for students to have difficulty with dimensional analysis (Arons, 1997), so before proceeding to the “Holding Back Water” worksheet, teachers are encouraged to spend some time discussing equivalences, conversions, and units. Supplemental calculations could be conducted and demonstrated to help the students prepare for the math-heavy “Holding Back Water” worksheet. The literacy and mathematics connected to the Great Dayton Flood inquiry unit aligns with the Common Core State Standards (CCSS) (National Governors’ Association (NGA), 2010) (see Figure 5).

The first set of area and volume calculations utilizes a simple model of a pickup truck bed to help students calculate the volume of water in the bed. With this value, students can calculate the time required to fill that volume with water given a rate of flow. Using this idea, students are challenged to calculate whether the Miami Conservancy District dams could retain the runoff water from the Flood. Students are expected to show all work and explain the calculations by writing several, complete sentences. Through the calculations and structured work, students discover that the Miami Conservancy District’s five (5) dams are not enough to prevent a recurrence of the Great Dayton Flood of 1913, and this is why the Miami River mitigation system includes levees in addition to the dams.

Sidebar 2
Great Dayton Flood Inquiry Unit
http://www.libraries.wright.edu/special/exhibits/1913_flood/faq

Click on the text “lesson plan” toward the bottom of the page and a copy of the Great Dayton Flood lesson plan will load up in .pdf format. Please e-mail Christina O’Malley, Ph.D., for a copy of a teacher answer key at omalley.47@osu.edu or Kurtz Miller, Ed.S., at millerkk@muohio.edu

Figure 4. Street map of the City of Dayton, Ohio and vicinity with the Great Dayton floodwaters demarcated in blue.
Source: Dayton Metro Library, Dayton, Ohio.

Figure 5. The Common Core State Standards (CCSS) aligned to the Great Dayton Flood unit.
Source: National Governors’ Association (NGA).
Part 4: Review and Assessment (90 Minutes)

The final two days of the inquiry unit are dedicated to reviewing and assessing the concepts of the Great Flood, flood control measures, conservancy districts, and dams construction. There is a review sheet and a sample quiz located in the inquiry unit packet on the Wright State University Libraries web page (see the web link in the sidebar). Alternately, this time could be used to draw cross-sections of the Miami Conservancy Districts dams (see Figure 5) in order to better understand their construction in comparison to the Hoover Dam. The dams are composed of earthen materials with a clay lining in the center which acts as an impermeable layer. Some of the dams are built on solid bedrock while others sit on top of unconsolidated glacial materials and soil. Water from the dams is released through a series of gateless conduits that restrict the discharge of the river water. Additionally, during a large flood there is some groundwater seepage of floodwaters under the dam as depicted in Figure 6.

Next Generation Science Standards

The Dayton Flood inquiry unit aligns with the Next Generation Science Standards (NGSS), including standard 3-ESS3-1 and standard MS-ESS3-2 (National Research Council, 2013) (see Figure 7). By the end of the inquiry unit, students were able to clearly articulate the merit of the Miami Conservancy District’s five (5) dams by providing quantitative evidence for the effectiveness or ineffectiveness of the five dams in the prevention of future floods. Additionally, students were able to understand the structure of flood-control dams and how the technologies are able to mitigate the potential reoccurrence of massive floods. In summary, engineering design is an important component of the Great Dayton Flood lesson plan and is well-aligned to the NGSS.

Extensions

There are a number of possible extension activities which could accompany this structured inquiry unit. First, earth science teachers could consider organizing a field trip to a local, flood-control dam if one is in close proximity. Since the early 20th Century, numerous flood-control dams have been built across the entire United States, and may be managed by conservancy districts, state agencies, private entities, federal agencies (e.g., the Bureau of Land Reclamation), or the U.S. Army Corps of Engineers. Also, earth science teachers should consider whether speakers are available from local soil & water conservation districts, municipal water protection agencies, state or federal Environmental Protection Agencies, the Federal Emergency Management Agency (FEMA), or other organizations. Other extension exercises could involve collecting, organizing, and calculating (local) flood frequencies / recurrence intervals. By using online resources, students could easily determine whether their school or specific homes reside within a 100-year or 500-year flood plain. Also, there are a plethora of resources available online including drought, flooding, runoff, and stream flow data from the United States Geological Survey (USGS) (see the USGS link in the recommended web links sidebar). Students may also feel inspired to further discuss the engineering of dam construction, which was a topic of conversation in our classroom because as career tech students, many were actively working toward credentials in the fields of architecture, heavy equipment, construction, carpentry, and natural resources. Other extension activities which could be added to the unit
include investigating the National Flood Insurance Program, zoning requirements in flood-prone areas, or by calculating flood frequency / recurrence intervals by using real-time stream-data.

**Conclusion**

The Great Dayton Flood of 1913 structured-inquiry unit has been tested by dozens of educators throughout the State of Ohio. The unit has served as an excellent way for secondary earth science students to make connections between multiple STEM fields, including the importance of engineering design and Science, Technology, and Society (STS) (National Research Council, 2013; Yager, 1996). Students have been challenged to make multiple calculations to determine whether the Miami Conservancy District’s five (5) dams could prevent the recurrence of a future Dayton Flood. Earth science teachers in remote places in the United States (or abroad) could easily adapt the design of this unit to fit a more localized context, such as a well-known local flood, a catastrophic dam collapse (e.g. the Great Johnstown, Pennsylvania Flood of 1889), or even a tsunami. The place-based nature of this instructional unit provided higher-than-normal levels of student engagement because the MVCTC is a career technology center that drew students from 27 school districts that span four of the five dams that protect against flooding in the Dayton Region.

**References**


Rogers, J. D. (2013). Arthur Morgan ushered in the era of engineered flood control in the wake of the 1913 Dayton Flood. In World Environmental and Water Resources Congress 2013@ Showcasing the Future (pp. 8-20). ASCE.


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**Recommended Books**


**Recommended Web Links**

Bureau of Reclamation Hoover Dam Site: [http://www.usbr.gov/lc/hooverdam/educate/](http://www.usbr.gov/lc/hooverdam/educate/)


The History Channel (Hoover Dam): [http://www.history.com/topics/hoover-dam](http://www.history.com/topics/hoover-dam)

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