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The "Why" and "Where" of the Tappan Zee Bridge
A Lesson in Site Location, Physical Geography, and Politics

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"…Although geographers believe there are reasons for things being where they are, they also have to realize that those reasons may not always seem reasonable,"—Phil Gersmehl, *Teaching Geography*[1]


Photo by Brett Weinstein, with permission

Figure 1. Tappan Zee Bridge, viewed from Tarrytown, New York.

Bridges are some of the most majestic features in the American landscape. Where Sydney, Australia, has an iconic opera house and Paris has a monumental tower, in San Francisco, Brooklyn, and many other cities, a bridge is the defining landmark. These engineering marvels—many several miles in length and hundreds of feet tall—connect the inaccessible, and dramatically alter the relationships between newly-joined spaces. For our classrooms, the bridge serves as an important component of one of the main themes of geography: movement.

The Greater New York City area is home to many bridges, including the Verrazano-Narrows, the George Washington, and the aforementioned Brooklyn Bridge. They are the connective arteries through which the city's lifeblood flows. One bridge, north of Manhattan and crossing the Hudson River, is the Tappan Zee. The Tappan Zee Bridge (Tappan was the name of an area Native American tribe and *zee* the Dutch word for sea) was opened in 1955 and is a fairly non-descript cantilever bridge (See Figure 1). But one aspect stands out in a way that does not at all appear reasonable: the bridge is situated at one of the widest points of the Hudson River. A quick "fly to" via Google Earth (type "Tappan Zee") allows viewers to see the span crossing a three-mile section of river, when a comparatively short crossing (one mile) exists less than five miles downstream (See Figure 2). At the very least, this construction decision does not seem to make economic sense.

We believe that unraveling the *why there* of the Tappan Zee Bridge is useful for understanding the interplay between physical and political geography, and for

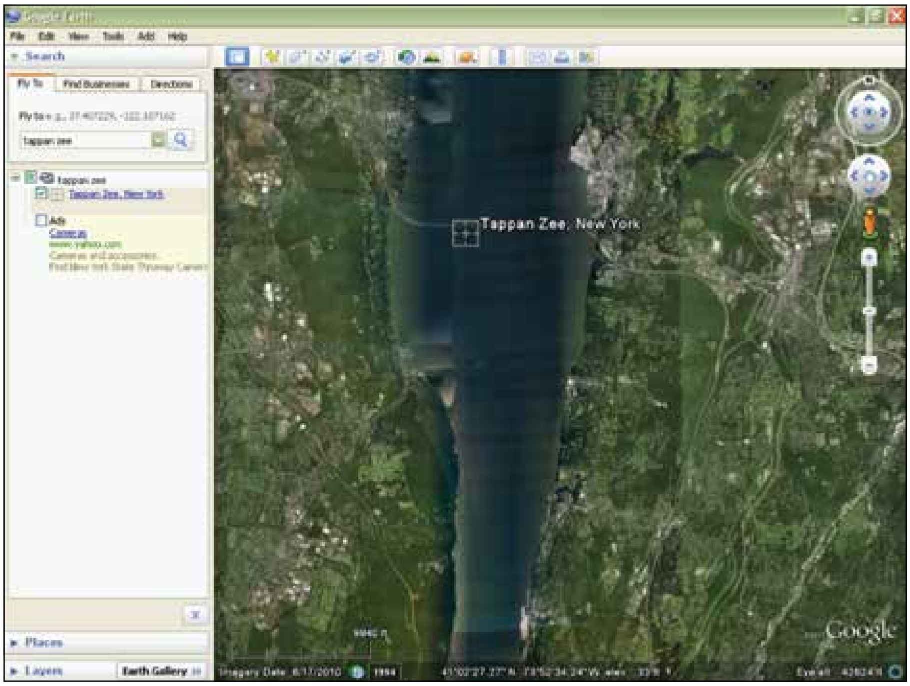

Figure 2. Tappan Zee Bridge, aerial view. (Image sourced from Google Earth)

providing students with the opportunity to use geospatial technology. The lesson described here explains the Tappan Zee case by using Google Earth and an online geographic information system (GIS) to uncover plausible siting motives. In the end, when the real siting decision is revealed, students realize that the reasonableness of a bridge's location is also related to the context of its time.

The Tappan Zee Bridge

In some ways the Tappan Zee Bridge, currently used daily by 138,000 vehicles, is the poster child example of deteriorating infrastructure in America. A current renewal effort has been expedited for this "major economic artery" and is intended "to correct substandard structural, operational, mobility, safety and security features" by constructing a replacement bridge. The new bridge—not without controversy itself, related to its cost, environmental implications, and public input—will parallel the existing structure.[2]

Generally the siting of a bridge is related to the physical environment, or local geographic site characteristics. When choosing a location, engineers primarily rely on a combination of common sense and science; failing to address any one variable can result in unfavorable outcomes, ranging from habitat destruction to bridge failure.[3] Of prime interest is hydrology—studying the properties and flow of water to determine the most feasible part of a waterway in which to place a bridge. Engineers also look at geomorphologic and geologic concerns, hoping to understand how channel stability and the underlying rock can provide a long-term, stable base for the bridge. Local ecosystems are also important as engineers try to build a bridge in a place where it will have the least negative impact on the local habitat and wildlife. How the bridge might integrate other, existing roadways to form a connective whole is also important. Each of these factors, and others, is encountered for large bridge design and construction. But for the Tappan Zee, a different story emerges.

Many of the bridges and tunnels in the New York City area fall under the operational jurisdiction of the Port Authority of New York and New Jersey. Given increased automobile use and commuting in the metro area, by 1950 the Authority had plans to erect a bridge near Dobbs Ferry, along one of the narrower parts of the Hudson. This plan was abandoned in favor of a more costly and lengthy crossing to the north. The reason? Political geography, or how we understand the power and consequences of imaginary lines to control Earth space.

The Port Authority's jurisdiction extends approximately 25 miles around the Statue of Liberty in New York

continued on page 209

LESSON RESOURCES

Digital imagery for exploring the areas around the Tappan Zee Bridge is available via Google Earth: **www.google.com/earth/index.html**

This page links to state geologic maps at the U.S. Geological Survey. By selecting your state of interest, you are able to download a .kml file for Google Earth use. The geologic data available here is useful for understanding large areas. Specific locations would require more detailed study: **http://tin.er.usgs.gov/geology/state/**

The Web Soil Survey (WSS) provides soil data and is operated by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS): **http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm**

Time needed: 1-2 days (less time may be needed if the instructor presents the maps rather than having the students complete the computer-based investigation themselves).

Materials: computer lab access for students with Internet and Google Earth software; computer with Internet access, Google Earth software, and digital projection in classroom.

Supplemental materials: See list of suggested resources.

Objectives:
Identify factors—both physical and social—that shape decision-making about features in our landscape (e.g., hydrology, geology, and political and economic systems).

Explain how the "reasonableness" of locating features in our landscape is place and time dependent (i.e., what makes little sense now may have had valid reasons at one time).

Reflect on the impact and permanency of spatial decision-making (e.g., site location and geographic inertia).

Gain procedural knowledge of geospatial technology using an online geographic information system and visualization software (Google Earth).

Procedures:
Build background for questioning the location of the Tappan Zee Bridge.

Begin by asking students if they know what the Tappan Zee is and where it is located. Use the "fly to" feature in Google Earth to zoom into the Tappan Zee Bridge (see Figure 2). Explain that the bridge is north of New York City and has served that large metropolitan area since 1955. Ask students: Take a look at this aerial image of the Tappan Zee Bridge. Does anything in this image strike you as unusual?

After sharing ideas, explain that the bridge is located at one of the widest points in the river. Ask students: Does this make sense? What reasons might someone have for locating the bridge in that particular place? Possible answers might include: the geology or soil (stability) was better; existing roads or towns were nearby; the slope was flat and easier for building; the water depth was shallower; the land was for sale and less costly, and so on. Explain that the students will investigate some of these factors to see if they were more advantageous at the Tappan Zee Bridge site.

Geologic Site Investigation
Different options exist here: (1) the instructor may construct the map ahead of the lesson and present it via overhead or digital projection; (2) the instructor may complete the investigation step by step during class from the classroom computer; or (3) the students complete the investigation themselves in a computer lab. These procedures are written for the third option.

The student will use Google Earth to discover possible geologic reasons for the location of the Tappan Zee Bridge:
Using the Internet, go to **http://tin.er.usgs.gov/geology/state/**

1. Select "New York" and download "nygeol.kml" (20 mb file) to the computer; repeat for New Jersey, "njgeol.kml" (11 mb file). It is best for each student to have these files stored on their local machine.
2. Open Google Earth and then open both kml files from the File tab.
3. In the "Fly to" window, type "Tappan Zee, New York"; you may use the "Adjust Opacity" tab to view the aerial imagery and the bridge location "under" the geology files.
4. Students can click on the geology layer to display information about the geologic structure (see Figure 3).

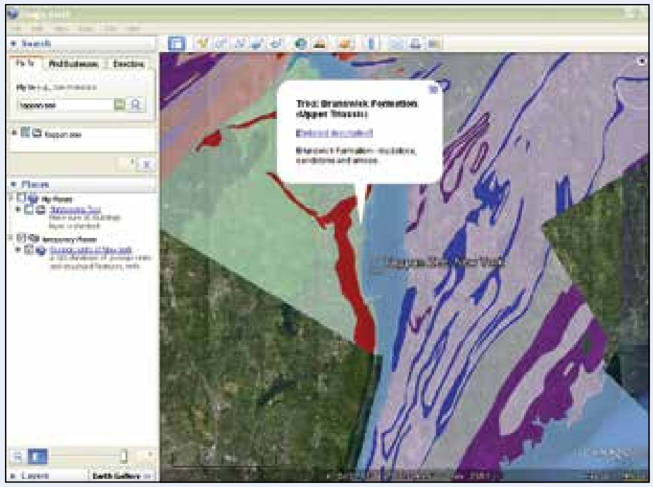

Image sourced from Google Earth; data layer from U.S. Geological Survey

Figure 3. New York Geology. Each polygon can be selected for information about its geologic structure. Using the "Adjust Opacity" tab in Google Earth, the geology layer can be made more or less transparent to view the Tappan Zee Bridge.

5. Students will observe the color schemes on each side of the Tappan Zee Bridge.

   a. Students will find that on the western edge of the bridge, the geologic components are primarily mudstone, sandstone and arkose both north and south of the bridge.

   b. Students will find that on the eastern edge of the bridge, the geologic components are primarily gneiss and amphibolites.

   c. Students will pan north and south on the image and see that these broad geologic aspects do not vary much. For example, after zooming in to about 7,000 feet, have the students move north along the river (the Borders and Labels tab must be "turned on" to view town names). A few miles north of the bridge is West Haverstraw and Oscawana Island. Both places contain the same geologic structure at a much narrower part of the river. Ask students: Why do you think this location was not chosen? Does it appear that geologic considerations played a significant role in choosing the bridge's location?

   d. Students may also pan south along the river to see similar circumstances that include New Jersey. The layer colors will change, not because the rock type is different, but merely because New Jersey is now represented.

6. Explain that clearly there were other suitable areas from a geologic standpoint, including some at much narrower parts of the river.
7. After allowing for additional questions and exploration, direct the students to the Soil and Topography Investigation.

Soil and Topography Site Investigation
The student will use an online GIS to discover possible soil and topographic reasons for the location of the Tappan Zee Bridge. The instructor may wish to demonstrate this portion of the lesson

as students follow along with the classroom's main computer/ projection system. It is possible that the website may not handle each student requesting data from it at the same time.

1. Using the Internet, go to **http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm**
2. Click on the green "Start WSS" button to access the data and maps.
3. Locate the Tappan Zee Bridge in New York State by typing "Tappan Zee Bridge" in the address box under "Quick Navigation."
4. Using the toolbar on the "Area of Interest Interactive Map," select the box with a red rectangle and "AOI."
5. Using this box, highlight the area surrounding the Tappan Zee Bridge, making sure to include both sides of the river where the bridge begins and ends (note: the AOI tool can only highlight areas of 10,000 acres or less, so do not select too large an area).
6. Once the AOI is created, select the tab "Soil Data Explorer."
7. Under "Suitabilities and Limitations Ratings," select "Building Site Development." Then select "Corrosion of Concrete" and "View Rating" (see Figure 4). The small "legend" tab can be clicked to view the ratings. The same may be done for "Corrosion of Steel."

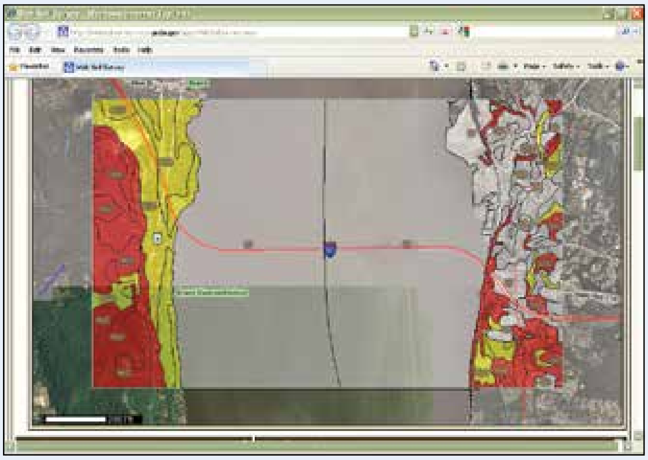

Image sourced from U.S. Department of Agriculture's Web Soil Survey

Figure 4. Sample soil investigation for concrete corrosion around the bridge site. Other options include selecting a topographic map layer to investigate slope as a building impediment.

8. Ask the student: What does this information mean for a bridge that is largely made of concrete and steel? Was this a good place to put the bridge for corrosive reasons?
9. The student should click back on the "Area of Interest (AOI)" tab at the top of the screen, then click the "Clear AOI" button under "AOI Properties."
10. Using the "Pan" button, the student can move up and down river to investigate other areas, repeating the steps above to create and investigate AOI sections and the corrosive qualities of the soil found. Two suggested locations would be the towns of Piermont and Westchester, where a seemingly opportune peninsula can be found jutting across nearly half of the river. The second suggested area would be further downriver between Bergen, N.J., and Westchester, N.Y., by the N.J. palisades.
11. The student may also click on the "Legend" tab to select other map layers, including topography. Ask the student: Are there areas where a less steep slope would have made building the bridge easier?
12. If time permits, have the students investigate other bridges, such as the George Washington Bridge to the south, to see what site properties exist there.
13. At this point the students have looked at basic geologic structures, soil properties, and topography to find that other suitable sites along the river were as likely as the final, chosen site. Many of these are shorter crossings. Not finding a definitive explanation for the bridge's location when considering these factors, the student returns to Google Earth to reveal how the bridge location was determined.

Port Authority Influence on Site Selection

The student will use Google Earth to discover the political process behind the location of the Tappan Zee Bridge:

1. Open Google Earth and in the "Fly to" window, type "Tappan Zee, New York."
2. Pan south to the end of Manhattan Island and find Liberty Island, the site of the Statue of Liberty.
3. Explain that the Port Authority of New York and New Jersey, administrator of bridges and tunnels in New York City, has jurisdiction 25 miles around the Statue of Liberty.
4. Using the Ruler tool found in the Google Earth taskbar, the student should measure 25 miles from Liberty Island north toward the Tappan Zee Bridge.
5. The student will see that the bridge is just outside the 25-mile limit. Explain that the Port Authority's ability to issue bonds and reap toll money benefits from bridges ends there and that the New York Thruway Authority had jurisdiction beyond this limit. The first decision made in locating the Tappan Zee Bridge was a political and economic one. Geologic, topographic, and hydrologic considerations came later.
6. Explain that it would be extremely costly and difficult to re-locate a future bridge because of geographic inertia—a resistance to change given the other landscape features that have grown up around the bridge, namely other roads, towns, and the businesses and residences they serve and contain.

In bringing closure to the lesson, the instructor might ask students to consider how other landscape features such as interstates connect places of social, political, and economic importance, and not always in the most direct way. Another historic example would be the transcontinental railroad where government subsidies encouraged routes over steeper terrain, ultimately influencing the location of some settlements we still see today.

Expansion Activity

If time permits, students might also download Census data for viewing in Google Earth. They might ask questions about population size in the area and how moving the bridge could impact local communities. Students could also hypothesize about alternate transportation without the bridge. Could the New York City subway system serve the same purpose? Math integration is also possible by asking how many crossings occur daily and determining the tolls generated. For a civics extension, students could debate the role of public-benefit corporations (e.g.: port authorities) vis-à-vis local and state government in determining land-use planning.

TAPPAN ZEE BRIDGE *from page 206*

Harbor.[4] Dobbs Ferry on the Hudson River is at the upper end of these bounds; a bridge located there would be under the Authority's control, as would its tolls. This outcome did not sit well with New York governor Thomas Dewey. Dewey dreamed of connecting the New York State Thruway with its New England counterpart, and funding that project required toll monies to go to the Thruway Authority not the Port Authority. The power of public-benefit corporations such as the Port Authority and the Triborough Bridge Authority in New York City, an entity run by "master builder" Robert Moses and largely out of reach by local and state governments, helped to convince Dewey of an alternative solution: to construct a bridge as close as possible to the New Yorkers using it, while still out of the 25-mile controlling grasp of the Port Authority.[5]

And so the Tappan Zee Bridge connects Nyack and Tarrytown at one of the widest points of the Hudson River. In essence, political geography trumped physical geography. Environmental site advantages, namely a shorter crossing, fell victim to how people organize themselves spatially (and politically). With the siting decision—the original reason for the bridge's location—revealed, we leave it to the student or the reader to decide for themselves the reasonableness of the decision.

Planning a Lesson around the Tappan Zee Bridge

The presentation of this case study has two distinct aims. The first is related to the third theme in the National Curriculum Standards for Social Studies, *People, Places, and Environments*. Here, "students learn where people and places are located and why they are there."[6] Where this case study differs from others that examine the influence of physical and human systems on one another is its outcome—the odd placement of the Tappan Zee Bridge. Students and teachers seeking explanations for landscape patterns should remain open to alternate reasons that may challenge previously learned concepts—in this case, the supposed primacy of physical systems in determining the ideal location for a bridge. But in the end, physical systems (hydrology and geomorphology) are also shown as important. This, here, is crucial as the social studies classroom too often treats Earth as merely a stage for human activity. A second aim is exposure to and use of geospatial technology. Directly applicable to the social studies, virtual globes and geographic information systems provide for analysis and visualization of complex data that truly do open up new worlds for students.[7]

Summary

Social studies educators prepare students to think holistically, typically integrating the political, social, and economic realms. But they also need to teach about spatial relationships and how those human attributes interact with the natural world, often differently depending upon the time and the place; in other words, educators must impart that geography matters. As shown here, these human attributes (political, social, and economic) do not operate independently of the physical environment, but they can be the prime movers in creating environmental conditions that appear curious at best. At first glance, the Tappan Zee Bridge seems to be oddly located across a wide section of the Hudson River. Further investigation of physical site conditions and ultimately the political jurisdiction shows that the bridge is strategically located just outside of the bounds of the Port Authority, illustrating how political considerations trumped more logical locations. By examining the Tappan Zee case, students discover how human and physical systems interact and can result in interesting and sometimes "unreasonable" outcomes.

Notes

1. Phil Gersmehl, *Teaching Geography* (New York: Guilford, 2008), 57.
2. Christine Haughney, "U.S. Says It Will Expedite Approval to Replace Deteriorating Tappan Zee Bridge," *The New York Times* (October 12, 2011): A21; New York State Thruway Authority, "Replacing the Tappan Zee Bridge," (2012): www.thenewtzb.ny.gov; Peter Applebome, "Faulting a Plan to Replace the Scorned Tappan Zee," *The New York Times* (June 27, 2012): A21.
3. Wai-Fah Chen and Lian Duan, eds., *Bridge Engineering Handbook* (Boca Raton, Fla.: CRC Press, 1999).
4. The Port Authority of New York and New Jersey, *Comprehensive Annual Financial Report for the Year Ended December 31, 2002* (New York: Author, 2002).
5. Robert Caro, *The Power Broker* (New York: Knopf, 1974); David Kestenbaum, "A Big Bridge in the Wrong Place," National Public Radio (August 19, 2011): www.npr.org.
6. National Council for the Social Studies, *National Curriculum Standards for Social Studies: A Framework for Teaching, Learning, and Assessment* (Washington, D.C.: NCSS, 2010), www.socialstudies.org.
7. Andrew J. Milson and Marsha Alibrandi, eds., *Digital Geography: Geospatial Technologies in the Social Studies Classroom* (Charlotte, N.C.: Information Age Publishing, 2008); Todd Patterson, "Google Earth as a (Not Just) Geography Education Tool," *Journal of Geography* 106, no. 4 (2007): 145-152.

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