Mitigating the Impact of Natural Hazards

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https://commons.wikimedia.org/wiki/File:Hurricane_Sandy_damage_Long_Beach_Island.jpg

Overview

In this project, students are posed with a problem: A consortium of New England States received a grant for $100M from the Federal government to invest in protection against natural hazards. After some discussions, the consortium decided to invest the money in protecting its communities from the most devastating natural hazard. The consortium is soliciting guidance in choosing how to spend the money. The students will have to research natural hazards that affect their local region to determine the impact of each one. They will then present their findings and vote on which natural hazard should receive funding. Students will have to consider the variety of solutions that people use to mitigate the damage caused by these natural phenomena. Finally, students will design their own solution to mitigate the impact the chosen natural hazard will have on the region and present their solutions to the group, or as an extension, by writing a report back to the consortium with their recommendations.

Standards - *Note: This project was designed for middle school students; however, it can be adapted to meet numerous state standards at a variety of grade levels. For example, in the lower grades, rather than having students design and build a model, you may decide to have them look at pictures of solutions that have already been created and have them evaluate their effectiveness. As the students mature in their understanding of science and engineering, they will be ready to design their own models on paper and then actually build a prototype to test and evaluate. Therefore, the standards will vary depending on what the teacher chooses to incorporate. A list of grade level standards that link to the activity is given below.*

Earth Science Standards

3-ESS3-1. Evaluate the merit of a design solution that reduces the damage caused by weather.*
Clarification Statement:

- Examples of design solutions to reduce weather-related damage could include a barrier to prevent flooding, a wind-resistant roof, and a lightning rod.

4-ESS3-2. Evaluate different solutions to reduce the impacts of a natural event such as an earthquake, blizzard, or flood on humans.*
Clarification Statement:

- Examples of solutions could include an earthquake-resistant building or a constructed wetland to mitigate flooding.

7.MS-ESS3-2. Obtain and communicate information on how data from past geologic events are analyzed for patterns and used to forecast the location and likelihood of future catastrophic events.
Clarification Statements:

- Geologic events include earthquakes, volcanic eruptions, floods, and landslides.
- Examples of data typically analyzed can include the locations, magnitudes, and frequencies of the natural hazards.

State Assessment Boundary:

- Active analysis of data or forecasting is not expected in state assessment.

Technology and Engineering Standards

3.3-5-ETS1-1. Define a simple design problem that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost that a potential solution must meet.*

3.3-5-ETS1-2. Generate several possible solutions to a given design problem. Compare each solution based on how well each is likely to meet the criteria and constraints of the design problem.*
Clarification Statement:

- Examples of design problems can include adapting a switch on a toy for children who have a motor coordination disability, designing a way to clear or collect debris or trash from a storm drain, or creating safe moveable playground equipment for a new recess game.

3.3-5-ETS1-4(MA). Gather information using various informational resources on possible solutions to a design problem. Present different representations of a design solution.*
Clarification Statements:

- Examples of informational resources can include books, videos, and websites.
- Examples of representations can include graphic organizers, sketches, models, and prototypes.

4.3-5-ETS1-3. Plan and carry out tests of one or more design features of a given model or prototype in which variables are controlled and failure points are considered to identify which features need to be improved. Apply the results of tests to redesign a model or prototype.*

Clarification Statement:

- Examples of design features can include materials, size, shape, and weight.

4.3-5-ETS1-5(MA). Evaluate relevant design features that must be considered in building a model or prototype of a solution to a given design problem.*

6.MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.*

6.MS-ETS1-5(MA). Create visual representations of solutions to a design problem. Accurately interpret and apply scale and proportion to visual representations.*
Clarification Statements:

- Examples of visual representations can include sketches, scaled drawings, and orthographic projections.
- Examples of scale can include ¼" = 1'0" and 1 cm = 1 m.

6.MS-ETS1-6(MA). Communicate a design solution to an intended user, including design features and limitations of the solution.
Clarification Statement:

- Examples of intended users can include students, parents, teachers, manufacturing personnel, engineers, and customers.

6.MS-ETS2-2(MA). Given a design task, select appropriate materials based on specific properties needed in the construction of a solution.*
Clarification Statement:

- Examples of materials can include metals, plastics, wood, and ceramics.

7.MS-ETS1-2. Evaluate competing solutions to a given design problem using a decision matrix to determine how well each meets the criteria and constraints of the problem. Use a model of each solution to evaluate how variations in one or more design features, including size, shape, weight, or cost, may affect the function or effectiveness of the solution.*
7.MS-ETS1-7(MA). Construct a prototype of a solution to a given design problem.*
HS-ETS1-2. Break a complex real-world problem into smaller, more manageable problems that each can be solved using scientific and engineering principles.*
HS-ETS1-6(MA). Document and present solutions that include specifications, performance results, successes and remaining issues, and limitations.*

Science and Engineering Practices (https://ngss.nsta.org/PracticesFull.aspx)

- Asking Questions and Defining Problems
- Developing and using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Arguments from Evidence
- Obtaining, Evaluating and Communicating Evidence

Vocabulary

- **Blizzard** – *A severe snowstorm characterized by strong sustained winds for a prolonged period with reduced visibility.*
- **Drought** – *A prolonged shortage of rainfall resulting in a deficiency in the water supply whether surface or underground water.*
- **Earthquake** – *A shaking and vibration at the surface of the earth resulting in underground movement along a fault plane or as the result of volcanic activity.*
- **Flood** – *A rising of a body of water and its overflowing onto normally dry land.*
- **Hurricane** – *A severe tropical cyclone usually with heavy rains and winds moving from 74+ mph.*
- **Natural Hazard** – *A natural hazard is a threat of a naturally occurring event that will have a negative effect on people or the environment.*
- **Tornado** – *A localized and violently destructive windstorm occurring over land, characterized by a funnel shaped cloud extending toward the ground, usually attached to a thunderstorm.*
- **Criteria –** the requirements that must be met by the project
- **Constraint –** a limitation or condition that must be satisfied by a design. *(common constraints include time, cost, and materials)*
- **Prototype –** the first model of the solution

Materials

- Cardboard and other recycled materials (boxes, plastic bottles or containers, etc…)
- Craft materials (popsicle sticks, plastic cups, tin foil, construction paper, clay, etc…)
- Scissors
- Rulers
- Tape (masking tape, duct tape, etc…)
- Sand (for droughts, landslides, hurricanes (storm surge))
- Dish tub (for flooding)
- Fan (for hurricane, tornado)
- Shake table or other solution (for earthquake)

Lesson Timeline *(Five to six 45 min class periods)*

Duration	Activity	Instructions
5 mins	Introduction	Read "The Problem" to the class
40 mins	Research natural hazards	In groups of 3-4, have the students research natural hazards that affect their local region: Examples may include, but are not limited to - earthquakes, tornados, hurricanes, floods, blizzards, and droughts. Students complete the "Student Research" handout, recording a brief description of the hazard, when and where it has affected their region and examples of specific events. Based on this information, students make a recommendation as to whether they think the consortium should consider funding the mitigation of this natural hazard.
30 mins	Presentations	Groups present their research *(you may choose to have the students create a poster or slide presentation to the class)*
15 mins	Vote	Each person *(or group)* votes on the one hazard that they feel the consortium should invest money in for protection against this hazard.
45-90 mins	Design challenge	Complete the Natural Hazards Design Challenge Packet and design a protection from the chosen natural hazard.
45 mins	Group share	Students share their design solutions (allow time for comments, questions or concerns. Students should then decide which design solution they would recommend to the consortium.
45 mins *(optional)*	Write a letter	Have the students write a formal letter to the consortium with their recommendation. They should explain what the natural hazard is, how it affects their region and the type of mitigation solution they recommend.

Learning Targets

- **Day 1** - I can gather and analyze data about a natural hazard to determine whether the government should invest money into mitigating for this hazard.
- **Day 2** - I can present my research to the class and give my recommendation as to whether or not the government should invest money into mitigating for this hazard.
- **Day 2** - I can use information presented to make an informed decision as to which natural hazard the government should invest money into mitigating for this hazard.
- **Day 3 & 4** - I can utilize the engineering design process to design and test a prototype that will protect the region/community from the natural hazard.
- **Day 5** - I can present my solution and share my test results with the class to evaluate if this would be an appropriate use of the government funds.

RESOURCE PAGE

Hurricanes:

1. https://www.usgs.gov/news/usgs-hurricane-response-met-challenges-2017-prepares-2018
2. http://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/tropical-storms-hurricanes-typhoons-and-cyclones/
3. https://www.ncdc.noaa.gov/stormevents/
4. https://www.n-d-a.org/hurricane.php

Tornados:

1. https://earthobservatory.nasa.gov/NaturalHazards/view.php?id=50854&src=n
2. https://www.n-d-a.org/tornado.php
3. https://www.midsouthtornadoes.msstate.edu/
4. http://www.tornadohistoryproject.com/
5. https://www.ncdc.noaa.gov/stormevents/

Earthquakes:

1. https://www.usgs.gov/news/earthquake-early-warning-vital-city-transit
2. http://www.sciencemag.org/news/2016/08/deadly-italian-quake-highlights-continuing-struggle-communicate-risk
3. https://www.bbc.com/news/world-asia-36045140
4. https://www.n-d-a.org/earthquake.php

Droughts:

1. http://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/drought/
2. https://www.n-d-a.org/heat-drought.php
3. https://drought.unl.edu/droughtmanagement/Home.aspx
4. https://www.drought.gov/drought/

Floods:

1. http://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/floods/
2. https://hazards.uw.edu/water/
3. https://www.n-d-a.org/flooding.php
4. https://www.fema.gov/risk-map-flood-risk-products
5. https://catalog.data.gov/dataset?tags=nfip

Blizzards:

1. https://www.n-d-a.org/snow-hail-storm.php
2. https://www.washingtonpost.com/news/capital-weather-gang/wp/2018/03/13/the-northeast-storm-is-officially-a-blizzard-with-up-to-2-feet-of-snow-in-the-forecast/?noredirect=on&utm_term=.dc6846b609d2
3. https://nsidc.org/cryosphere/snow/science/weather.html
4. https://snowstudies.org/winter-storm-data/

Mitigating the Impact of Natural Hazards
THE PROBLEM

A consortium of New England States received a grant for $100M from the Federal government to invest in protection against natural hazards. After some discussions, the consortium decided to invest the money in protecting its communities from the most devastating natural hazard. The consortium is soliciting guidance in choosing how to spend the money.

Your group must research one hazard, and present the following:

1. Describe the hazard
2. Determine if this hazard impacts your region
3. Provide data/evidence of specific events that have occurred in your region
4. Decide if the consortium should invest money in protection against the hazard
5. Report your recommendation back to the class.
6. Extension – write a letter to the consortium with your recommendation

Name:_____ Date: _____

Mitigating the Impact of Natural Hazards
STUDENT RESEARCH

Name of Natural Hazard: _____

Briefly describe this natural hazard:

_____

_____

Does this natural hazard occur in your region/community? **YES** **or** **NO**

More specifically, **where, when, and how often** does it occur?

_____

_____

_____

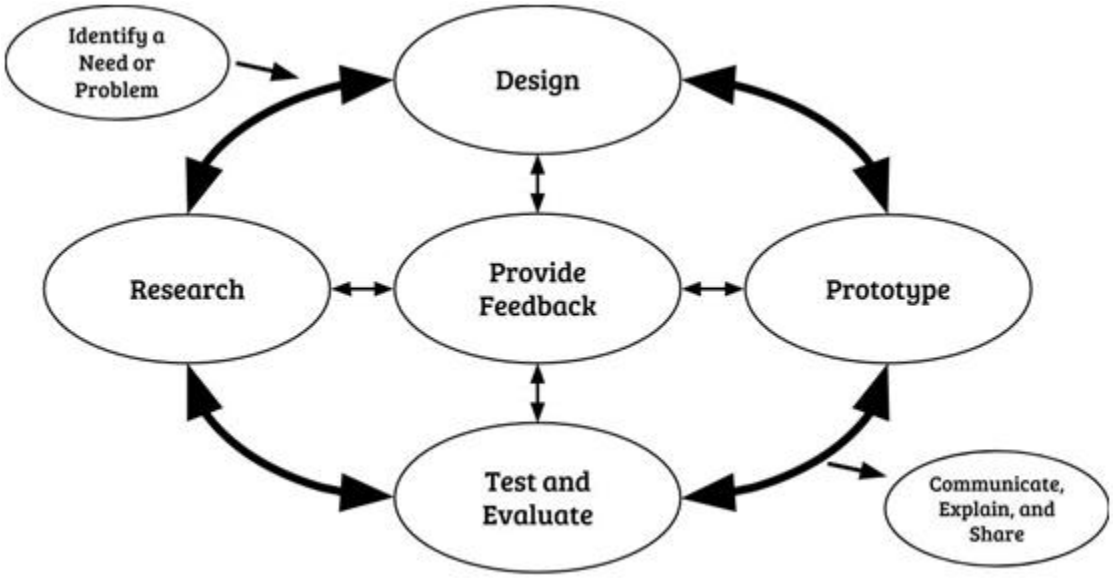
What data or evidence supports this? *(give specific examples with numbers)*

Event	**Date**	**Explanation of what happened**

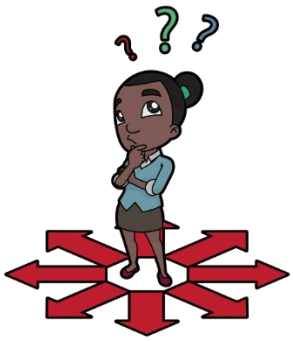
Based on the evidence, I believe the government _____ *(should or should not)* invest their funds into mitigating for this hazard.

Name: _____ Date: _____

Mitigating the Impact of Natural Hazards
Engineering Design Challenge



http://www.doe.mass.edu/frameworks/scitech/2016-04.pdf



https://vectortoons.com/

Identify the Need or Problem: *Design a solution to mitigate the impact that a natural hazard has on your region.*

1. What natural hazard are you designing a solution for? _____

2. What does it need to be able to do? _____

_____

3. What materials can we use?

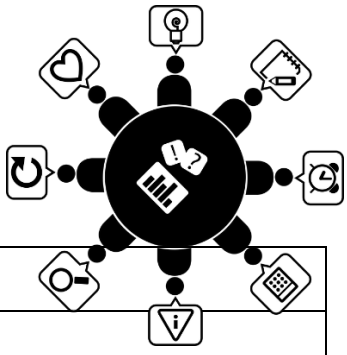
4. Are there any constraints?

<u>Research</u>: *Think about what you learned about this natural hazard*
(or spend some time researching more)

Make a list of all of the kinds of damage it does it do to your region.

<u>Imagine *your own* ideas:</u> *Brainstorm ways to lessen the impact this natural hazard has on people, property, the community, etc…* ***(do this part on your own!)***

Draw a picture of what YOU think your solution could look like *(be sure to label the materials you would use to build your prototype).*



Share ideas and Provide Feedback: *Take a few minutes to listen to and look at each person's design ideas. Record at least one thing you like about each design.*

Team Member Name	What I LIKE about their design (BE SPECIFIC)

Plan your **TEAM** Design: Decide as a TEAM on what your prototype will look like. *Be sure to list ALL of the materials (including how many) you will need for each part:*

Materials:

Draw a picture of what YOUR TEAM thinks your solution could look like *(be sure to label the materials you would use to build your prototype).*

Build your Prototype: *Now it is time to build your prototype! Gather all of your materials and be sure that everyone gets a turn to help build!*

1. How did the **building process** go? _____
2. What went well?

3. What did not go as well as planned?

4. Did you make any adjustments to your original design along the way? *Explain in detail.*

_____

_____

_____

_____

_____

Test your Design: *Now it is time to test your design! Be sure to show any mathematical work.*

Trial Run #	Results of your tests
1	
2	
3	
Average or Summary of results	

Share ideas and Provide Feedback: *Take a few minutes to think about your prototype test. Then take some time to learn about and look at another group's prototype. Provide feedback on their design and test results.*

1. Are you happy with how your test went? _____

2. What went well?

3. What did not go as well as planned?

4. What do you think you could do to make your design better?

_____

_____

_____

_____

_____

Complete questions #5-7 AFTER your share your prototype with another group.

5. What feedback did the other group provide?

_____

_____

_____

6. Do you think this feedback will be useful? _____

7. What additional improvements will you consider?

<u>Improve your Design</u>: *Now it is time to make improvements on your design. Use your groups ideas, but also consider the suggestions from the other group.*

Draw a picture of what <u>IMPROVEMENTS</u> YOUR TEAM **would like to make to your prototype.** *(be sure to label the materials you would use to build your prototype).*

<u>Retest your Design</u>: *Now it is time to retest your design! Be sure to show any mathematical work.*

Trial Run #	Results of your tests
1	
2	
3	
Average or Summary of results	

Communicate Explain and Share: *Now it is time to share your results! Answer the questions below in the space provided and then use this to guide you in your group presentation.*

Complete in paragraph form, making sure to answer all parts, a through d.

a. Did your improvements work?
b. How do you know? (use observations and data)
c. Was your design able to mitigate the impact that this natural hazard has on people, property, the community, etc…?
d. If you were to do this again, what would you do differently?

_____

_____

_____

_____

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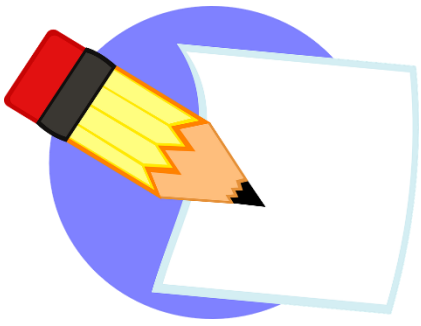

**If time allows, take a look at all of the design solutions presented by your classmates. Then, write a formal letter to the consortium with your recommendation. They should explain what the natural hazard is, how it affects their region and the type of mitigation solution you recommend. Be sure to refer to your data and observations.