

Living on the Edge: City Planning in the Shadow of a Volcano!

The Volcanic Hazards & City Planning Board Game

Timeframe

1 Fifty minute class period

May need additional time to introduce volcanic hazards; can be extended to multiple class periods if needed

Target Audience

High School but easily adapted to Grades 6-8

Materials

Included in Kit (per group):

- 1 board game
- 10 monopoly houses
- 4 monopoly buildings
- 1 dry erase marker
- 1 set of game cards (24)

Not included (per group):

- 1 ruler (with centimeters)
- 1 basic calculator (optional)
- Scratch paper (for calculations)

Description

This is a game about city planning and budgeting when living next to an active volcano. A group of students (preferably 3-5) will first need to outline where they think the lahars will flow when the volcano erupts. Next, students build their town with constraints (proximity to water, required town facilities) and working within a budget of \$5 million. Every year, the team receives an influx of taxes based on their town's population and draws a card, which describes a natural or societal event that affects the town. They have the option to purchase research credits, which are a tool to mitigate the expenses that result from natural disasters and showcase that funding research can prepare society for events before they happen. The game is flexible and can end whenever needed.

Objectives

- Students will understand primary hazards associated with Cascade volcanos
- Students will learn to keep track and manipulate a budget in response to disasters and other events
- Students will practice reading a topographic map

Teacher Background

From USGS: Mount Hood is an active volcano close to rapidly growing communities, recreation areas, and major transportation routes and therefore imposes heightened risk. Potential hazards include collapse of growing lavadomes and generation of pyroclastic flows, which in turn melt snow and ice to form

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lahars that flow far down valleys; the long-term adjustment of river channels to the large quantities of volcanogenic sediment dumped into valleys that head on the volcano; and landslides of hydrothermally altered material from steep upper slopes of the volcano that spawn debris avalanches and related lahars. The most likely widespread and hazardous consequence of a future eruption would be for **lahars** to sweep down the entire length of the Sandy and White River valleys. Modest production of tephra would also pose chiefly non-life-threatening hazards to nearby communities.

More background information on volcanic hazards (and potential student readings): <https://volcanoes.usgs.gov/vhp/hazards.html>

Activity

1. **Introduce the Game:** Prior to the game, students need an adequate grounding in hazards associated with the Cascade Volcanic Arc. Sharing the provided presentation might be adequate. Another option is to play a video about Mount St. Helens so students can understand the gravity and also the primary hazards related to this arc: <https://www.youtube.com/watch?v=Ec30uU0G56U>

****Remind students that *it is okay to go into debt* - having a limited budget is part of managing a city, and it is especially difficult when living next to an active volcano! However, you do want to try to save your funds for the end of the game if possible.**

****Make sure to stress how important it is to *invest in research*! They will need research credits at the end of the game to help their town prepare for the eruption.**

2. **Play the Game:** Have students follow the directions on their instructions sheet to: **1.** Outline estimated lahar hazards using dry erase marker, **2.** Build town within listed constraints, **3.** Name their town, **4.** Play the game and keep track of budget on worksheet.
3. **End the Game:** When you have approximately 15 minutes left in the period, announce that the volcano is erupting. Use the [USGS volcanic hazard map and report](#) or the 3-D hazard map (see extension activity) to show students where scientists predict the greatest danger is within the region. At this point you can also announce that the volcano is **Mt. Hood!** Students can see if their town was in the hazard zone and assess the damage.

Key Vocabulary

Lahar: An Indonesian term that describes a hot or cold mixture of water and rock fragments that flows down the slopes of a volcano and typically enters a river valley

Tephra/Ash: Fragments of rock that are produced when magma or rock is explosively ejected

Lava: Streams of molten rock that pour or ooze from an erupting vent

Volcanic Gas: As magma rises towards the surface and pressure decreases, gases are released from the liquid portion of the magma and continue to travel upward and are eventually released into the atmosphere.

MORE STUDENT GROUPS THAN GAME BOARDS?

If you need to have two student groups share a game board, it is easy to build more than one city in the game board space and share one deck of cards between 2 teams. Both teams should work together to identify the lahar hazard zone. With a die, have students roll to see who goes first. This team will also get to build their city first. To expand to three or more teams per game board, you will need to either duplicate or create new cards.

Loose script (Optional: Sound a siren!):

The volcano is erupting! Ash is filling the air and suddenly, a great wall of steaming water, ash, trees, and boulders is hurtling towards your town!

Now is the moment of truth: **Have you built your cities wisely?** Check with the instructors to see the lahar hazard map. Depending on where you built, you still have a chance!

If you built your town outside of the lahar hazard zone, congratulations!! You considered each hazard carefully and built a resilient city!

If you built inside the lahar hazard zone, the destruction is coming right for you! But there is still hope!

If you have **at least 3 research credits**, your research team collected enough data to detect the eruption early enough to evacuate the whole city and save everyone! Infrastructure is damaged, but repairable and the city's economy bounces back in a couple years.

But if you have **< 3 research credits**, your town is struck head on by the lahar! There are several casualties and the city's infrastructure suffers severe damage. Many of the remaining residents move to a safer city, and the negative publicity decimates tourism. The city is bankrupt. The economy does not bounce back and falls into disrepair...

Wrap Up Discussion Questions:

1. How does your estimate of the lahar hazard region compare to the scientists'? Did your town survive the eruption?
2. What was the most difficult event to deal with for your town?
3. What would you do differently next time?
4. What other potential hazards might have affected your town?
5. What did you learn from playing this game?
6. Where would you have built your city knowing what you know now? Why?
7. What volcano is this? *Mt Hood*. Are there any real cities in the lahar hazard zones? *Yes, all the major towns and ski lodges are in the lahar hazard zone.*

Potential Extension Activity:

Oregon Volcanoes

In this lesson, students will learn how to read topographic hazards maps and explore how Mt. Hood volcanic hazards will affect the surrounding region. The 3-D hazard map is included in the materials for this lesson!

<http://smile.oregonstate.edu/lesson/oregon-volcanoes>

USGS RESOURCES:

Volcano Hazards in the Mount Hood Region, Oregon (1997):

<http://pubs.usgs.gov/of/1997/0089/>

Mount Hood Volcano Information:

https://volcanoes.usgs.gov/volcanoes/mount_hood/

VIDEO RESOURCES:

What Are Volcanic Hazards?

<https://www.youtube.com/watch?v=BCm6xTZj-vk>

Mount St. Helens: May 18, 1980

<https://www.youtube.com/watch?v=Ec30uUOG56U>

Living on the Edge:

City Planning in the Shadow of a Volcano!

YOU are in charge of building and maintaining a city that is on the slopes of an active volcano in the Pacific Northwest! **You have an initial budget of \$5 million.** Here is your task:

STEP 1: Find the hazards! On the game board, estimate and outline where you think the lahar hazards are using a dry erase marker. **Remember:** Lahars are mudflows/debris flows composed mostly of volcanic materials on the sides of a volcano that rush down valleys and stream channels at speeds of 120 mph in steep places, traveling up to 50 miles! Although there are many other hazards associated with Cascade Volcanos, lahars are considered the deadliest.

STEP 2: Build a town! Use Table 1 on the worksheet to calculate expenses.

Your town must fit within the following constraints (note scale on map):

1. At least **1,000 residents** (1 house represents 200 residents)
2. The town must be within **1.5 km of a body of water**
3. On the map, you will see the present roads in white. If you're city is not within **0.75 km** of a road, you must build one (**\$25,000 per 0.75 km distance**)
4. The town needs to have the following facilities (each represented by a building, costing **\$750,000 each**):
 - a. Town hall
 - b. Water treatment facility
 - c. Garbage & recycling facility
5. Your town cannot be spread out – each structure within 1.5 km or so of another

STEP 3: Name your town!

STEP 4: Remaining budget! Here are your options for what to do with leftover funds:

- **Research credits (\$500,000 each)** → these have an influence on how you respond to different challenges during the game. Putting more money towards research is the best way to prepare for hazards in advance.
- **Build more houses!** For every house you build, that is 200 more residents and **\$50,000/year** in taxes you will receive
- **Save your money!** You will need money to overcome emergencies that will affect your community throughout the game.

STEP 5: Now, the game can begin! Each year equals one turn (and column on Table 2)

1. The town receives an influx of tax revenue (**\$250 per citizen**)
2. Decide to build more houses or invest in research, or save your income
3. Draw a card. Building a town near an active volcano is risky business so this is a game of chance.
4. Fill out **Table 2** on worksheet for each year of play.

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City Planning in the Shadow of a Volcano!

Town Name: _____

Starting Budget: \$5 Million
1 house represents **200** town residents
Annual Taxes: For every **200** residents, **\$50,000** in taxes each year

Table 1. Initial Budget Distribution

Item	Unit Cost	#	Total Cost
House	\$300,000		
Building	\$750,000		
Road /km	\$25,000		
Research /Credit	\$500,000		
TOTAL			

Table 2. Annual Budget Calculation

Year	1	2	3	4	5	6	7	8	9	10
Initial Budget										
Income (Taxes & Bonuses)										
Houses										
Buildings										
Road /km										
Research /Credit										
Emergency/ Other										
Total Expenses										
New Budget										
Total Research Credits										

Expenses