

Fixing Jordan's Hazard Fact Sheet: Tidal Waves, Due Floods and Soggy Slopes

Learning target: I can find and explain errors in claims about tsunamis, floods and landslides, and rewrite each one so it is scientifically accurate.

Error analysis

About 40 min

Individual

MS-ESS3-2 · practice

writing

independent practice

Standards connections

MS-ESS3-2 (practice, the cause-and-effect and probability ideas behind hazard forecasts): Students correct claims about what causes tsunamis and controls their speed and height, what a flood recurrence interval means and how water and fire change slopes. Accurate versions of these ideas are what students need to forecast hazards and choose mitigation, so the sheet builds toward the PE rather than assessing it.

Purpose: practice · **Time:** about 40 minutes · **Format:** individual

Answers with reasoning

Jordan's fact sheet

1. 1. A tsunami is a giant tidal wave. The pull of the Moon makes the ocean rise up into one huge wave.
2. 2. Tsunamis are tallest far out in the deep ocean, so ships at sea are in the most danger. The wave shrinks as it reaches the beach.
3. 3. Once the first tsunami wave has come and gone, it is safe to go back down to the harbor.
4. 4. A bigger earthquake makes a faster tsunami, so a tsunami from a magnitude 9 earthquake would reach our town sooner than one from a magnitude 8 earthquake in the same place.
5. 5. Our river had a 100-year flood in 2023, so the town is safe from a flood that big until about 2123.
6. 6. A little water makes sand stick together, so a hillside soaked by a week of rain is safer than a dry one.
7. 7. Gravity moves the soil and rock in every landslide. Rain, earthquakes and road cuts only make it easier for gravity to win.
8. 8. The wildfire last summer already burned the hills above our town, so the danger is over now that there is nothing left to burn.

Part A: Diagnose

1. Complete the table for all eight statements. If a statement is partly correct, say which part is right and which part is wrong.

Answer: 1: incorrect; tsunamis are not caused by tides or the Moon, and they are a series of waves. 2: incorrect; height is small in the deep ocean and grows near shore. 3: incorrect; tsunamis are a series of waves for hours, and later waves can be larger. 4: incorrect; depth sets speed, and earthquake size sets height. 5: incorrect; a 100-year flood has a 1 percent chance every year, not one per century. 6: partly correct; damp sand does hold together, but saturated soil is heavier with less friction, so it is weaker. 7: correct. 8: incorrect; burned slopes make debris flows and floods more likely in the next rainy seasons.

Why: Seven statements contain an error; statement 6 begins with a true observation and draws a wrong conclusion; statement 7 is fully correct.

Also acceptable: Accept 'incorrect' for statement 6 if the student also notes that its first sentence is true.

- Statement 7 marked correct
- Statement 6 marked partly correct, with the right and wrong parts named
- Each incorrect statement's error named as an idea, not just 'wrong'

Part B: Explain and rewrite

2. Statement 1: Explain what really causes a tsunami and why 'tidal wave' and 'one huge wave' are both wrong. Rewrite the statement.

Answer: A tsunami is caused when a huge volume of ocean water is suddenly pushed up or down, usually by an undersea earthquake that shifts the seafloor; landslides and volcanic eruptions can also cause them. Tides come from the pull of the Moon and Sun and have nothing to do with it, and a tsunami arrives as several waves, not one. Rewrite: 'Tsunamis are groups of waves that form when an undersea earthquake (or a landslide or eruption) suddenly shoves a huge volume of seawater up or down. Tides do not cause them.'

Why: Both errors in the statement (cause and number of waves) must be corrected.

Also acceptable: Accept 'the seafloor jumps during an earthquake and shoves the water' as the cause.

- Correct cause: sudden displacement of water, usually by an undersea earthquake
- States that tides or the Moon are not the cause
- States that it is a series of waves
- Accurate rewrite

3. Statement 2: Explain how a tsunami's height changes from the deep ocean to the shore, and why. Rewrite the statement.

Answer: In the deep ocean a tsunami is usually less than 1 m tall and its crests are very far apart, so ships barely notice it. As it moves into shallow water it slows down, the back of the wave catches up with the front, and the water piles up, so it grows to several meters or more at the shore. Rewrite: 'Tsunamis are low and fast in the deep ocean and grow much taller as they slow down in shallow water near the shore, which is where they are most dangerous.'

Why: Jordan has the height trend backward; the danger is at the coast.

Also acceptable: Accept 'it gets squeezed as the ocean gets shallow' with slowing mentioned.

- Low height in deep water
- Grows taller near shore
- Explains the growth by slowing in shallow water
- Accurate rewrite

4. Statement 3: In 1964, an earthquake in Alaska sent a tsunami to Crescent City, California. The first waves arrived about four hours later, and the fourth wave was the largest and most destructive. Use that history to explain the error, then rewrite the statement.

Answer: Tsunami waves can keep arriving for hours, and the first wave is often not the largest. In 1964 the first waves reached Crescent City about four hours after the earthquake, but the fourth wave was the largest and did the most damage; it struck after people had gone back toward the waterfront. Rewrite: 'Tsunami waves can keep coming for hours, and later waves can be bigger than the first. Stay away from the harbor until officials say the danger is over.'

Why: This error has cost lives; the 1964 Crescent City history is a real example, with 11 deaths in the town that night.

Also acceptable: Accept a rewrite that tells people to wait for an official all-clear.

- Tsunami is a series of waves over hours
- Later waves can be larger
- Uses the 1964 example
- Accurate rewrite

5. Statement 4: Explain what sets a tsunami's speed and what the size of the earthquake does change. Rewrite the statement.

Answer: A tsunami's speed is set by the depth of the ocean it travels through: about 700 km/h over 4,000 m of water and much slower in shallow water. A bigger earthquake lifts more water, so it makes taller, more destructive waves, but not faster ones. Waves from a magnitude 8 and a magnitude 9 earthquake at the same place would arrive at about the same time. Rewrite: 'A bigger earthquake makes a taller, more dangerous tsunami, but the speed depends on ocean depth, so waves from the same place arrive at about the same time either way.'

Why: Separating speed (depth) from height (source size) is what lets warning centers forecast arrival times before they know exactly how big the waves will be.

Also acceptable: Accept 'the depth of the water decides the speed' with the height idea.

- Depth sets speed
- Earthquake size changes height or energy
- Accurate rewrite

6. Statement 5: Explain what '100-year flood' actually means. Rewrite the statement.

Answer: A '100-year flood' is a flood so large that it has a 1 percent chance of being equaled or exceeded in any given year. The 100 years is an average spacing estimated from records, not a schedule, and every year starts with the same 1 percent chance. Rewrite: 'Our river had a flood in 2023 that has about a 1 percent chance of happening in any year. A flood that big could happen again next year.'

Why: The probability does not reset to zero after a flood; floods do not 'know' when the last one happened.

Also acceptable: Accept 'a 1-in-100 chance every year'.

- 1 percent chance each year
- Not a schedule; each year is independent
- Accurate rewrite

7. Check statement 5 with numbers. What is the chance of a flood at least as big as the 2023 flood next year? What is the chance of at least one such flood in the next two years? (Hint: the chance of no such flood in one year is 99 percent; multiply for two years, then subtract from 100 percent.)

Answer: Next year: 1 percent. Two years: chance of no flood in both years = $0.99 \times 0.99 = 0.9801$, so the chance of at least one flood = $1 - 0.9801 = 0.0199$, about 2 percent.

Why: The calculation shows the town is not 'safe': the chance next year is the same 1 percent it always was, and it adds up over time.

Also acceptable: Accept 1.99 percent or 'almost 2 percent'.

8. Statement 6: Which part is right? Explain what changes when the soil goes from damp to saturated. Rewrite the statement.

Answer: The first part is right: in damp sand, thin films of water pull grains together, so damp sand can hold a steeper shape than dry sand. But when the soil becomes saturated, every pore space fills with water. The water adds weight and pushes the grains apart, so friction between them drops and the slope becomes weaker, not stronger. Rewrite: 'A little water can help sand hold together, but a hillside soaked by a week of rain is heavier and its grains grip each other less, so it is more likely to slide than a dry one.'

Why: This is the damp-versus-saturated distinction: Jordan generalized from a sandcastle to a soaked hillside.

Also acceptable: Accept 'soaked soil turns to mush and slides' if weight or friction is also mentioned.

- Names the true part (damp sand sticks)
- Saturation adds weight and reduces friction
- Accurate rewrite

9. Statement 7 is correct. Explain why, and give one example of a trigger that 'makes it easier for gravity to win' and how it does so.

Answer: Gravity is the only force pulling soil and rock downhill in every kind of mass wasting; the other factors change the balance. Example: heavy rain saturates the soil, adding weight and lowering friction, so the same pull of gravity can now move it. Other good examples: an earthquake shakes grains loose and briefly adds sideways force; a road cut steepens the slope and removes material that was holding up the soil above it.

Why: Distinguishing the driving force (gravity) from the triggers is the key idea of the chapter's mass-wasting section.

Also acceptable: Accept wildfire (loss of roots) or river erosion at the base of a slope as the example.

- Gravity is the driving force in all mass wasting
- One trigger explained with a mechanism

10. Statement 8: Explain how a wildfire changes the hillside so that a new hazard appears in the rainy season. Rewrite the statement.

Answer: Fire burns away the plants and roots that held the soil and slowed rain, and it can leave the surface water-repellent. In the rainy season, rain runs off fast instead of soaking in and picks up ash, soil and rock, so debris flows and floods become more likely for the next few rainy seasons until plants grow back. Rewrite: 'The wildfire burned the plants that held the hills together, so for the next few rainy seasons intense rain could send debris flows and floods toward our town.'

Why: In Montecito in 2018, debris flows from the Thomas Fire burn area killed 23 people weeks after the fire; the hazard shifts from fire to water.

Also acceptable: Accept a rewrite that adds 'until plants grow back' or names debris basins or warnings.

- Loss of plants or roots
- Water-repellent soil or fast runoff
- Debris flows or floods in later rain
- Accurate rewrite

Part C: The rule behind the mistakes

11. Several of Jordan's errors (statements 3, 5 and 8) come from the same kind of thinking: treating a hazard as if it happens once and then is 'used up' or 'over.' Write a rule Jordan could follow to avoid this kind of error, and explain how the rule would change what the fact sheet tells people to do.

Answer: Example rule: 'Treat every hazard as something that can happen again: a series of waves, a chance that repeats every year, or a danger that changes form, never as a one-time event that is now finished.' With this rule the fact sheet would tell people to stay away from the harbor until an official all-clear, to keep flood insurance and flood plans after a big flood instead of dropping them, and to prepare for debris flows after a wildfire with warnings, debris basins and evacuation plans.

Why: The common thread is the belief that a hazard gets 'used up.' A rule that names this thinking and replaces it with repeating chance or ongoing danger earns full credit.

Also acceptable: Accept a rule phrased as a question ('Could this happen again tomorrow?') if applied to at least two statements.

- A rule that states hazards repeat or remain as chances, not schedules or one-time events
- Applies the rule to at least two of statements 3, 5 and 8
- Describes how the fact sheet's advice would change

Teacher notes

Every error here is common outside school, and statements 3 and 5 have real consequences: in Crescent City in 1964, the first waves arrived about four hours after the Alaska earthquake, the fourth wave was the largest, and 11 people died in the town, some of them after returning to the waterfront during a lull between waves. Statement 6 is deliberately partly true; let students argue about it, because the sandcastle observation is real. For statement 8, burned watersheds are most likely to produce debris flows in the first one or two rainy seasons after a fire, and the danger declines as vegetation returns; avoid giving a fixed number of years. This sheet pairs well with W5 (flood probability) and W6 (tsunami speed and height).

Scaffold offered to students: Three checks for any hazard claim

For each statement ask: (1) Cause: what really starts this hazard, and what really controls how it behaves? (2) Time: does the statement treat a hazard as a single event or a schedule, when really it is a series of events or a chance that repeats every year? (3) Place: does the danger really sit where the statement says (deep ocean or shore, dry slope or soaked slope)? Write C, T or P next to each statement for the check it fails.

Extension: Write the corrected fact sheet

Turn your rewrites into a one-page fact sheet for the town, with one short section each for tsunamis, floods and landslides. Every section must include one forecast stated as a chance or a time window (not a date) and one mitigation the town has done or could do. Then add a 'Myth or fact?' box that uses two of Jordan's errors, because people remember corrections better when they see the myth named.