Senior High School

DepED
DEPARTMENT OF EDUCATION

Disaster Readiness and Risk Reduction

Quarter 2 – Module 2
Geological Hazards: Geological Maps and Mitigation

ALTERNATIVE DELIVERY MODE
ADM

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

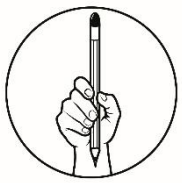
What I Need to Know

This module was designed and written with you in mind. It is here to help you understand Geological Hazards. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module is all about Geological Hazards: Geological Maps and Mitigation.

After going through this module, you are expected to:

1. interpret geological maps; and
2. apply mitigation strategies to prevent loss of lives and properties.



What I Know

Directions: Choose the letter of the best answer and write it on a separate sheet of paper.

1. What do we mean when we say that rock erodes?
    A. It pushes up to the ground.
    B. It forms a new rock or minerals.
    C. It gets thicker and more compact.
    D. It is picked up and moved to another place.

2. What does a rainfall-induced landslide mean?
    A. The opening of a part of the soil like a sinkhole.
    B. A shaking of the earth caused by torrential rain.
    C. A sudden eruption of lava or magma flowing down.
    D. Soil, rock, debris sliding down the slope caused by excessive rainfall conditions.

3. How can a geological hazard map help us?
    A. The map can give out a color-coded design.
    B. This can indicate mining potential in the area.
    C. It can tell whether your area is low or highly susceptible to a disaster.
    D. The map is potentially the way to identify where can you spend your next vacation.

4. Does the legend in a geological hazard map has any use?
    A. Yes, because it gives life to the map.
    B. No, because it just serves as a decoration.
    C. No, because the geohazard map can be interpreted as its own.
    D. Yes, because it describes the indicated color/symbol in the map for interpretation.

5. What information will be useful for rainfall-induced landslide mitigation?
    A. assessing the lot value of the land
    B. observing the movement of the plants
    C. surveying for a limestone bedrock underneath the barangay
    D. studying rainfall patterns, type of soil, land characteristics and the flow of nearby body of water

6. What should we do BEFORE a landslide?
    A. Stay away from the slide area.
    B. Get out of the house during a landslide.
    C. Check your house for damage after a landslide.
    D. Have an emergency preparedness plan in your place.

7. What should we do DURING a landslide?
    A. Get a new insurance for the house.
    B. Check the house for damage while landslide is falling.
    C. Move away from the path of a landslide or debris flow.
    D. Find out if you live in an area where rainfall-induced landslide could occur.

8. What should we do AFTER a landslide?
    A. Have an emergency preparedness plan.
    B. Check the house for damage while landslide is falling.
    C. Move away from the path of a landslide or debris flow.
    D. Stay away from the slide area, there might be another slide coming after.

9. What should we do BEFORE a sinkhole occurs?
    A. Check the area for economic development.
    B. Make the children dig holes to check for sinkholes.
    C. Check the house for cracks or any depression around the house.
    D. Call authorities to inspect the surrounding of the house for possible flooding.

10. What should we do DURING the occurrence of a sinkhole?
    A. Check for the plumbing.
    B. Check for the depression in the area.
    C. Don't refill the sinkhole with trash and debris materials.
    D. Don't get too close on the forming sinkhole, watch out for surface cracks at it might expand.

11. What should we NOT do AFTER a sinkhole emerges?
    A. Keep the children away from the hole.
    B. Refill a sinkhole with trash and debris.
    C. Call authorities to inspect the sinkhole.
    D. Check the house for cracks or any depression around the house.

12. What should a mitigation strategy for sinkholes include?
    A. assessing the property price
    B. being vigilant for any sudden variation in water flow
    C. moving away from the path of a landslide or debris flow
    D. checking for cracks in the vicinity and doing a ground survey

13. What should a highly susceptible for landslide municipality do during a torrential rain?
    A. Suspend the classes.
    B. Listen to local news stations.
    C. Prepare the emergency preparedness plan for possible emergency.
    D. Do nothing as people will not be bothered by the rain after a hot summer.

14. What should we NOT do DURING a landslide?
    A. Check the house for damages.
    B. Be vigilant for any sudden movement.
    C. Move away from the path of a landslide.
    D. Be alert for unusual sounds that could indicate movement of debris.

15. What should we NOT do BEFORE a landslide?
    A. Always have an emergency plan.
    B. Make sure you have the emergency contact numbers.
    C. Assess the area for damage due to landslide.
    D. Survey the land if your area is highly susceptible to landslides.

Lesson 1 Geological Hazards: Geological Maps and Mitigation

Geological threats are associated with earth materials that include landslides, earthquakes, sinkholes and many others, such as hazardous materials or earth processes. These natural risks transform into catastrophe impacts for some populations. This can cause injury, illness, home loss, income loss and even loved one's loss. Communities can reduce and even eliminate these losses by taking precautionary measures, learning about preparedness and immediate response, and imbibing a culture of safety. In this module we will be focusing more on the geohazard maps and the mitigation in landslides and sinkholes.

What's In

Let us have a review of the past module. A landslide is rock, dirt, or debris falling down a sloping section of land. The common kind of landslide that we experience here in the Philippines is the rainfall-induced landslide. Sinkhole is a depression or hole caused by the collapse of the surface layer of the ground.

Sinkholes and rainfall-induced landslide are some of other geological hazard that we experience here in the Philippines along with other causes of landslides, earthquake, volcanic eruption, and flooding. For this module, we will talk about the geological hazard maps and mitigation strategies to lessen the impact of such disasters.

Notes to the Teacher

Use the latest and current events of disasters that happened in the Philippines as examples to make the students updated and informed. Let the learners be aware on what is happening in their communities.

What's New

Activity 1. After the fall

Directions: Analyze the picture shown below, and answer the questions given.

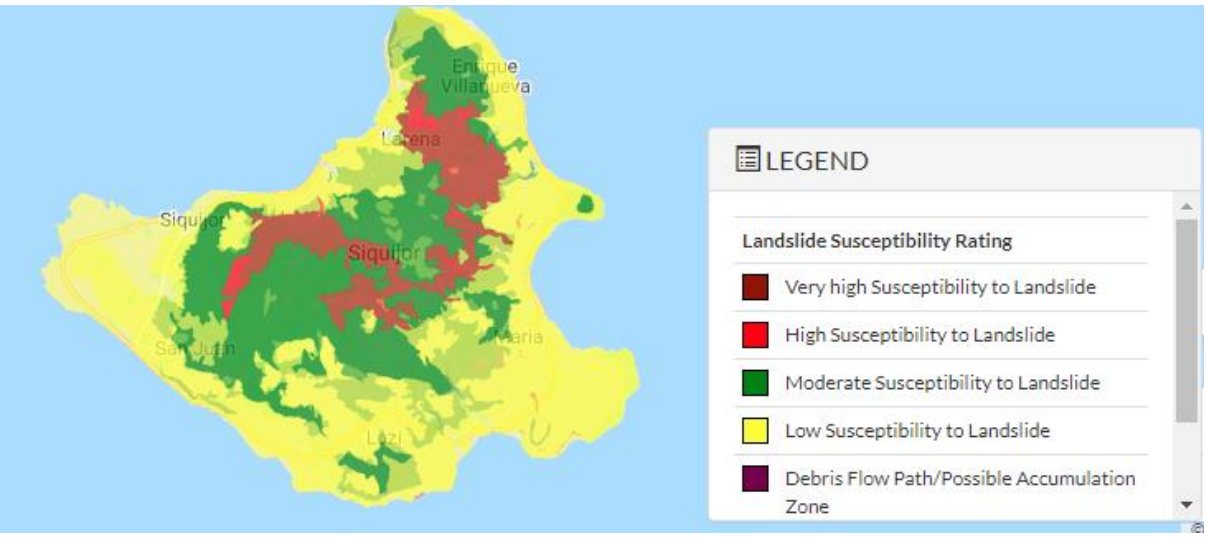


Figure 1. Geohazard map image of Siquijor

Source: http://lgsd.mgb.gov.ph/mgbgoogle/

Questions:

1. What do you think is the image all about?

_____
_____
_____.

2. What do you think the color code is for?

_____
_____
_____.

3. What do you think is the purpose of this kind of image?

_____
_____
_____.

4. Do you think the image can be easily understood? Why or why not?

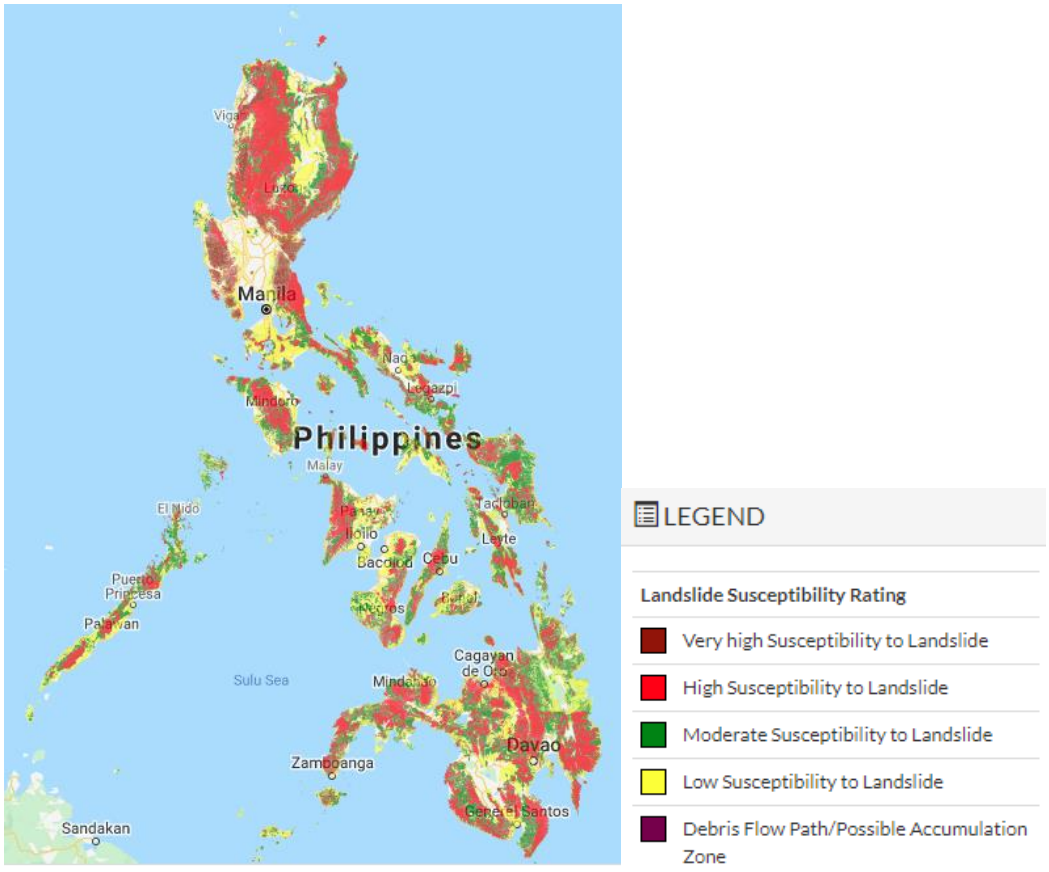
_____
_____
_____.

What is It

Geological Hazard Maps

A map of geological hazards is a map showing the areas that are vulnerable to earthquake threats, volcanic eruptions, and landslides. It is a tool that scientists and local authorities use to anticipate any hazard that a geological event could bring. It also helps educate the public about and train them for the geological threat. We can read the geological hazard map using the legend provided. This can help us understand what areas are prone to such disasters.

For example:



Source: http://lgsd.mgb.gov.ph/mgbgoogle/

There are different geological maps or geological hazard maps we have per municipal here in the Philippines. The maps depend on what disaster it focuses on. Based on the given sample, we can interpret the susceptibility of an area to rainfall-induced landslide by using the legend above.

Legend per type of geological map varies, it describes the severity of the disaster in that area.

Mitigation for Rainfall-induced landslide

Mitigation strategies for rainfall-induced landslide include studying rainfall patterns, type of soil, land characteristics and flow of nearby bodies of water. This information can be gathered from a landslide geologic map. Areas with steep slope and coarse, bare soil are more susceptible to landslides. Coarse materials generally have low cohesive strength. Deforestation and urban development in an area may leave a region barren and reduce land strength. Rainfall and flooding from nearby bodies of could make the land unstable, thereby increasing susceptibility for landslide. So, what should we do before, during, and after a rainfall induced landslide?

What to do BEFORE a landslide

1. Have an emergency preparedness plan in your place.
2. Find out if you live in an area where rainfall-induced landslides could happen.
3. Listen to local news and weather reports for any potential rainfall-induced landslide warnings in your area.
4. Talk with your family and neighbors on what you would do and identify a safe place to gather.
5. Become familiar with the land around where you live and work so that you will understand your risk in different situations.
6. Have municipal emergency contact numbers on hand and have an emergency kit ready.

What to do DURING a landslide

1. Listen to local news stations on a battery-powered radio for the warnings of heavy rainfall.
2. Be alert for unusual sounds that could indicate movement of debris, such as trees cracking or boulders knocking together.
3. Move away from the path of a landslide or debris flow as quickly as possible. The possibility of mudflow increases near flowing bodies of water and with heavy rainfall.
4. Be vigilant for any sudden variation in water flow if you are near a stream or channel. Observe whether the water changes from clear to muddy. These changes could indicate debris flow. Be prepared to evacuate at once.

What to do AFTER a landslide

1. Go to a designated evacuation center if you have been told to evacuate or you have a feeling that it is unsafe to remain in your home.
2. Stay away from the slide area. There may be danger of additional slides.
3. Listen to local radio or television stations for the latest emergency information.
4. Report broken utility lines and damaged roadways and railways to appropriate authorities.

5. Check the building foundation and surrounding land for damage. These may help you assess the safety of the area.
6. Seek advice from a geotechnical expert for evaluating rainfall-induced landslide hazards to reduce landslide risk.

Mitigation for Sinkholes

Mitigation strategies for sinkholes include ground surveys and checking for signs of this impending disaster. It is necessary to check for cracks in the land area and establishments, sloping of floor and any other sign of weakness in land integrity.

What to do BEFORE a sinkhole

1. Check for the cracks in the exterior and interior of your property such as areas along joints, windows, doors, sloping or uneven floors and muddy or cloudy well water.
2. Check for previously buried items such as fence posts, trees that are becoming exposed as the ground sinks.
3. Check for a circular pattern of ground cracks around the sinking area.
4. Check for the formation of small ponds as rainfall accumulates in new areas.
5. Check for the slumping or falling trees or fence posts, sudden ground openings or ground settlement.
6. Check for the interrupted plumbing or electrical service due to damaged utility lines.

What to do DURING a sinkhole

1. Don't get too close, stay well back and watch out for the surface cracks.
2. If the hole is very large and a risk to others, call the authorities or emergency responders.
3. Keep the children away.
4. Place a piece of plywood over small holes to secure the area and by marking the hole for safety. Use posts with caution tape or rope.
5. Take photographs for documentation, but do not get too close to the edges.
6. Don't allow unauthorized or inexperienced persons to investigate the sinkhole.

What to do AFTER a sinkhole

1. Don't refill a sinkhole with trash because filling a sinkhole with waste materials may cause groundwater contamination.
2. Prevent construction of building or other physical structures near the sinkhole area.
3. Call the authorities so they may plan to mitigate the effects of the sinkhole.

What's More

Activity 2. Don't be scared, be prepared!

Directions: Write your own precautionary safety measures for the following geological hazards. Write your answers on a separate sheet of paper.

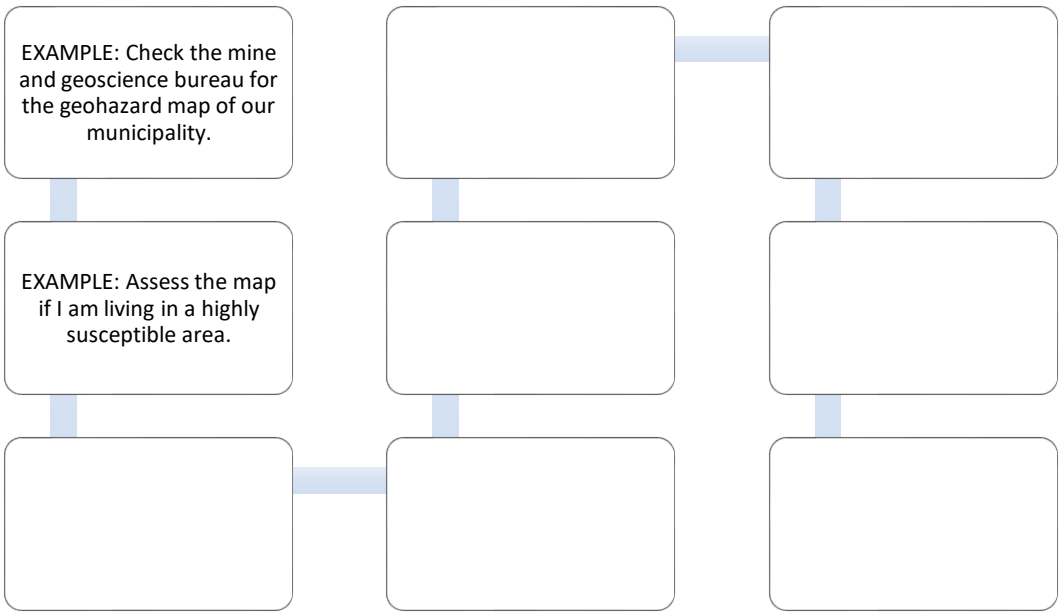
Table 1. Precautionary Safety Measures

	BEFORE	**DURING**	**AFTER**
1.RAINFALL-INDUCED LANDSLIDE	Example: check the weather forecast.		
2. SINKHOLE			

Activity 3. What's the flow?

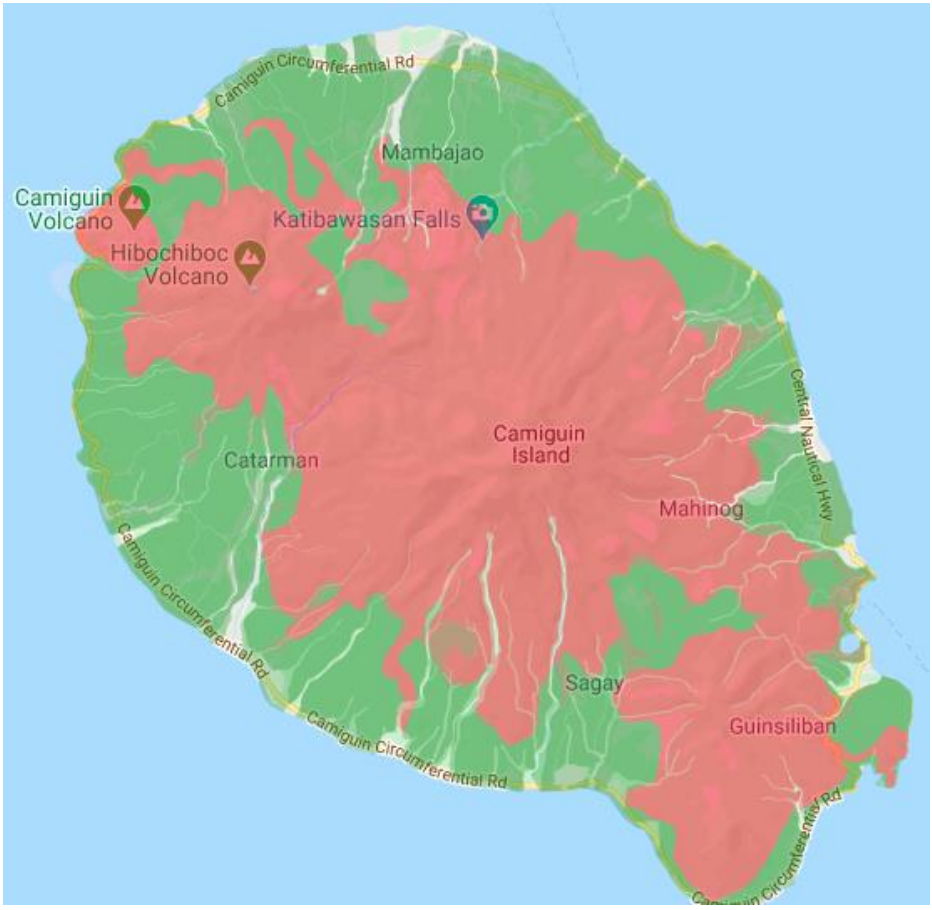
Directions: Think of ways on how you can mitigate at home if a rainfall-induced landslide or sinkhole is to happen. Fill out the flowchart of the step or process you have thought, you may still add another line or boxes if the given sample is not enough. You may use another sheet of paper to answer.

Disaster event: _____



Activity 4. The 5 Sense

Directions: Analyze the geohazard map of a rainfall-induced landslide then answer the questions below.



Geohazard map of Camiguin Island
Source: http://lgsd.mgb.gov.ph/mgbgoogle/

Questions:

1. What do you think will happen in the area of Mahinog in case there is torrential storms?

_____
_____
_____.

2. Is Guinsiliban's susceptibility to landslide low? Why?

_____
_____
_____.

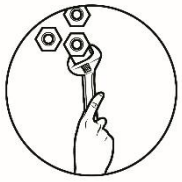
3. The Camiguin circumferential road is the primary access to circumnavigate the island of Camiguin. If there would be a landslide to happen in every area with high susceptibility, what do you think will happen in terms of search and retrieval operations? Why?

_____
_____
_____.

What I Have Learned

Directions: Think about what you have learned in this module then complete the phrases given below.

1. I have learned that _____.
2. I want to share _____.
3. I want to research on _____ because _____.
4. I appreciate that _____.
5. I feel strongly about _____ because _____.



What I Can Do

Landslides and sinkholes can be a major issue affecting people, homes and public land. We can never really tell the exact second that a disaster event will occur. It is in our hands to be aware and observe what is going on in our surroundings.

Directions: Look outside your home, observe and take note of the possible indicators that might lead to a disaster. Fill out the box of what you have observed and what you will do to mitigate such indicators. Use another sheet of paper for your answers.

Disaster Indicators	Mitigation

Assessment

Directions: Choose the letter of the best answer and write it on a separate sheet of paper.

1. A barangay near the mountain needs to assess the land to build a new building for a school. The area is prone to rainfall-induced landslide. What information do you think will be useful for assessing the area?
    A. assessment of the total lot area for the new building
    B. movement of the plants and animals
    C. data on the presence of limestone, depression, and bedrock underneath the barangay
    D. rainfall patterns, type of soil, land characteristics and the flow of nearby body water

2. The side of the Mt. Arayat is slowly exposing a big rock underneath it and is forming a crack on the side of it. The local government unit told the residents nearby that the soil is eroding and is expected to cause a landslide during a torrential rain or a big earthquake. What do they mean when the soil is "eroding"?
    A. The soil rises to the ground.
    B. The soil form new rocks and minerals.
    C. The soil is getting thicker and more compact.
    D. The soil is picked up and moved to another place.

3. After the Juan Corporation cut down the trees on a mountain slope where they plan to create a subdivision, a torrential rain poured down that caused the soil, rock, and debris to slide down the slope. What occurred in the area?
    A. a rainfall-induced landslide
    B. a mudflow
    C. a sinkhole
    D. an earthquake-induced landslide

4. How can a geological hazard map benefit a community?
    A. The map can identify where a typhoon could hit the area.
    B. It can tell whether your area is low or highly susceptible to a geological disaster.
    C. This can indicate mining potential in the area therefore increasing the wealth of the community.
    D. The map can give out a color-coded design that increases the mental health capacity of the community.

5. After the earthquake, a big hole appeared right outside the home of Emilia. She quickly ran out to peek what was inside the hole. She saw a depression like something collapsed under the soil. What do you think Emilia should do next?
    A. Fill the hole with soil to cover.
    B. Go down the hole to inspect some more.
    C. Call the authorities and inform them of the big hole.
    D. Create a diversion to secure the ownership of the big hole.

6. What is the use of a legend in a map?
    A. It gives life to the map.
    B. It just serves as a decoration.
    C. It serves as a color palette to the map.
    D. It describes the indicated color/symbol in the map for interpretation.

7. What should we do AFTER a landslide?
    A. Evacuate the landslide area.
    B. Check the landslide area for possible debris flow.
    C. Create a plan when such disaster happens the next time.
    D. Check and assess the house for damage while landslide is falling.

8. The Cruz family heard that there might be a possibility that a typhoon will pass by their area and they will become susceptible to a rainfall-induced landslide. What should the Cruz family do before the potential landslide occur?
    A. They should lock the door shut.
    B. They should stay away from the slide area.
    C. They should get out of the house during a landslide.
    D. They should create an emergency preparedness plan.

9. What should we do during an occurrence of a sinkhole?
    A. Check the depression in the area.
    B. Check for possible leaks in the house.
    C. On a presence of a shallow depression, dig a hole inside to check if there are limestones.
    D. Do not go to the sinkhole area, stay away as much as possible as the cracks may widen.

10. The Larger rehabilitation and garbage processing company wants to use a newly formed massive sinkhole a few miles near a lake as a new dumping ground. It can accommodate as much as 15 billion tons of garbage that can give solution to the rising garbage problem. Do you think it's a good idea to dump garbage in the sinkhole?
    A. Yes, because it gives solution to the rising garbage problem.
    B. Yes, because it can accommodate 15 billion tons of garbage.
    C. No, because it will require so many garbage to fill in the sinkhole.
    D. No, because the garbage may further damage or weaken the soil below.

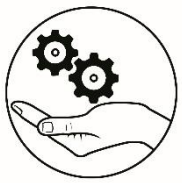
11. Can we do construction on an area where a landslide has occurred?
    A. Yes, because it can serve as memorabilia of what happened in the area.
    B. No, because the mud has taken over the area. It will be hard to transport materials.
    C. Yes, because the land already removed the withered soils therefore leaving the soil stable.
    D. No, because the area is already vulnerable to landslide. An event like that could occur again.

12. How can we assure the safety of our home from sinkholes and landslides?
    A. Survey the area for any slope with few vegetations.
    B. Dig a hole to check if the soil is made up of limestone.
    C. Check the house for cracks or any depression around the house.
    D. Call the local authorities to check if the area is susceptible for sinkholes and landslides.

13. What should a mitigation strategy for sinkholes include?
    A. checking for the water source and quality in the area
    B. creating subdivisions on top of the dormant sinkholes
    C. moving away from the depression formed in the ground
    D. asking the local government unit about the ground quality of the area

14. What should a municipality with a low susceptibility for landslide do during a torrential rain?
    A. Evacuate the area.
    B. Nothing, there is no chance for any landslide to occur.
    C. Announce to the community that they are safe to any disasters.
    D. Check the area if there would be any other disasters that can be caused by the rain.

15. How do you think the hazard map will be able to help the people?
    A. The hazard map can help us predict the scope of the onset of the disaster.
    B. The hazard map can be used to interpret the susceptibility of the area on disasters.
    C. The hazard map can help us identify the areas that are much more vulnerable to disasters.
    D. All of the above.



Additional Activities

Directions: Ask one of the members in your home to help you create an emergency plan. Use the guide questions in creating your plan for your home.

1. What disaster might strike in your home?
2. What should you do before, during, and after the disaster?
3. What contact numbers should we have to call in time of emergencies?
4. What should we include in the safety kit?
5. What is the fastest route to go to the evacuation area?

Answer Key

What I Know	What's New	Assessment
1. D 2. C 3. C 4. D 5. D 6. D 7. C 8. D 9. C 10. D 11. B 12. D 13. A 14. A 15. C	**Activity 1** 1. Landslide susceptibility. 2. To act as a guide in the legend. 3. To identify the susceptibility of an area to a landslide. 4. Answers may vary. Yes, because every element is well represented and explained in the legend. **What's More** **Activity 2** Answers may vary. **Activity 3** Answers may vary **Activity 4** 1. High chance of landslide 2. No, because based on the hazard map they are under high susceptibility. 3. Answers may vary. It may be hard to do that kind of operation due to the run-off of the landslide might settle in the road blocking our access.	1. D 2. D 3. A 4. B 5. C 6. D 7. A 8. D 9. D 10. D 11. D 12. D 13. D 14. D 15. D

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