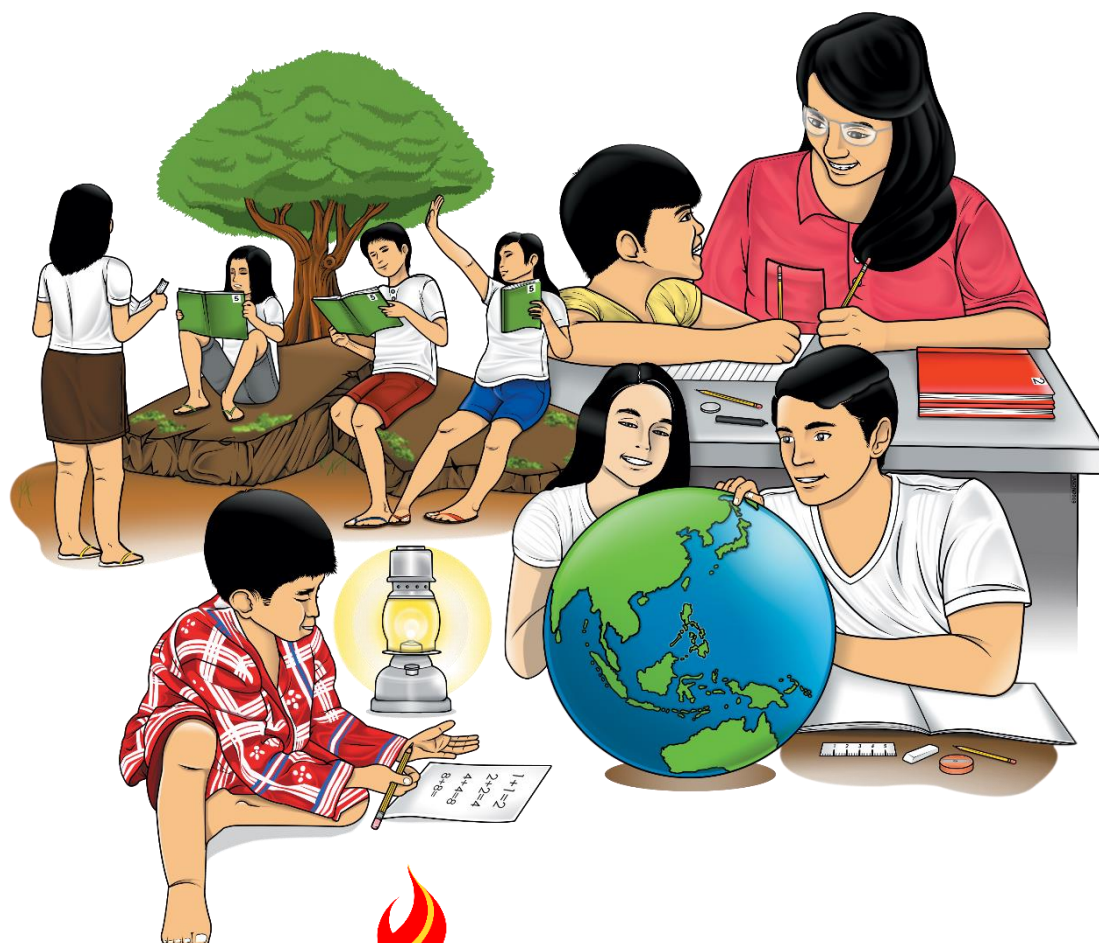


Disaster Readiness and Risk Reduction

Quarter 2 – Module 2: Causes of Other Related Geological Hazards



Disaster Readiness and Risk Reduction
Alternative Delivery Mode
Quarter 2 – Module 2: Causes of Other Related Geological Hazards
First Edition, 2021

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Disaster Readiness and Risk Reduction

Quarter 2 – Module 2: Causes of Other Related Geological Hazards

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 master the Other Related Geologic 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 intended to equip you with knowledge concerning causes of geological hazards.

After going through this module, you are expected to:

1. Enumerate the causes of a landslide and a sinkhole.
2. Explain the causes of a landslide and a sinkhole
3. Accurately conclude the causes and their respective geological hazard outcome.
4. Appreciate the importance of knowing the causes of different geological hazards.



What I Know

From the previous module, students are already knowledgeable about landslide and sinkholes and their different types. This module will tackle the possible series of events that may cause these geological hazards that pose a threat to human lives and property aside from heavy rainfall.

Read each item comprehensively and write the letter of the correct answer on extra sheet of paper.

1. Which of the following is not a natural cause of landslides?
 - a. climate
 - b. erosion
 - c. weathering
 - d. cross cutting

2. When there is a significant upsurge in precipitation it would cause a/an _____ in the level of ground water.
 - a. decrease
 - b. increase
 - c. insignificant
 - d. stable

3. Which of the following is responsible for saturating the soil with water which causes landslides?
 - a. climate
 - b. erosion
 - c. sunlight
 - d. weathering

4. These are tectonic plate movements that cause the soil covering in steep slopes to slip leading to landslides.
 - a. climate
 - b. erosion
 - c. sunlight
 - d. weathering

5. Which of the following is a natural procedure of rock deterioration that weakens the landslide-susceptible materials?
 - a. climate
 - b. erosion
 - c. sunlight
 - d. weathering

6. Which of the following is a natural cause of landslide?
 - a. clear cutting
 - b. mining
 - c. cultivation
 - d. liquefaction
7. Which of the following is a factor that affects the stability of the slope?
 - a. wind speed
 - b. heat change
 - c. light intensity
 - d. soil nutrients
8. Which of the following is not an effect of landslides?
 - a. earthquake
 - b. tsunami
 - c. death
 - d. depopulation
9. Which of the following pertain to vibrations that weaken soil due to blasting technique?
 - a. clear cutting
 - b. earthquake
 - c. gravity
 - d. mining
10. Which of the following can cause dissolution sinkholes?
 - a. exposed carbonate rock
 - b. dissolved igneous rock
 - c. narrowing wetlands
 - d. wilted vegetation
11. Ground water pumping is an artificial cause of sinkholes, how does it contribute to the formation of a sinkhole?
 - a. It transfers the water upward.
 - b. It dissolves acidic water to the soil.
 - c. It creates new water diversion systems.
 - d. It carries the water further downstream.
12. Which of the following is not an effect of frequent submersion of soil in water?
 - a. curving
 - b. weakened soil
 - c. formation of spaces
 - d. shriveled soil particles
13. Which of the following statement/s is true about how does a forest fire cause a landslide?
 - I. it makes the soil water-resistant
 - II. it burns resin, oil, fat stored in vegetation
 - III. it strengthens the adhesiveness of the soil
 - IV. it increases runoff
 - a. I, II, IV only
 - b. I, II, III only
 - c. both I and II only
 - d. both III and IV only

14. Which of the following is/are true about how a volcanic eruption trigger a landslide?

- I. it attracts rain clouds
- II. by altering minerals to clay
- III. volcanic gas dissolved in groundwater weakens rock
- IV. vibrations loosen the soil surrounding the volcano

- a. I, II, IV only
- b. II and III only
- c. II, III, IV only
- d. I, II, III, and IV

15. Which of the following is true about the relationship of gravity to landslides?

- I. steeper slope can trigger massive landslide
- II. steep slope means faster landslide
- III. steep slope means nearer landslide debris
- IV. steeper slope can cause more viscous landslide

- a. I only
- b. II only
- c. III only
- d. IV only

Lesson

2

Causes of Geologic Hazards

Geologic hazards pose a threat to humans and properties alike. The different types of geologic hazards were discussed in the previous module. How these actually occur is also discussed in the previous lesson.

In this module we're about to discuss the possible causes of these geologic hazards in order to be prepared for possible threats.



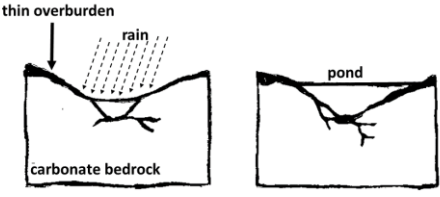

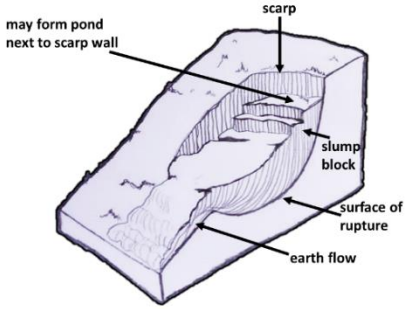
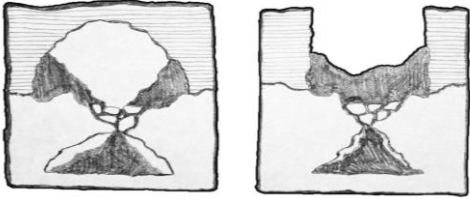

What's In

Activity 1: Determine if the illustration is a landslides or a sinkhole and determine its type. Choose from the spool of words inside the box below.

Avalanche	Debris flow	Rock fall
Cover collapse	Dissolution	Slumping
Cover-subsidence	Lateral spread	Soil creep

1.

5.

<p>2.</p> 	<p>6.</p> 
<p>3.</p> 	<p>7.</p> 
<p>4.</p> 	



What's New

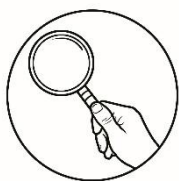
Activity 2: Essay.

Watch the short video in the youtube (youtube.com/watch?v=wUBtX2kLu4w or youtube.com/watch?v=wVLDsjk7A3c). Construct a brief essay about it. Include in your essay the following details:

1. What natural phenomena can trigger landslide?
2. Describe what you saw and explain why that place is vulnerable to landslides.
3. What effects might it cause if it happens?
4. As a Senior High School student, what advice can you give to those people living near mountainous areas to prevent landslides.

In case you have no internet signal or cannot access in the youtube channel, you may interview someone in your household or community who has seen or encountered a landslide.

Criteria	4	3	2	1	TOTAL SCORE
Focus	All information is distinct and focused on the topic.	Most of the information is distinct and focused on the topic.	Some of the information is relevant to the topic.	Very little of the information is focused on the topic.	
Organization	With exceptional arrangement of content and subtle transitions.	One or two of the content is in logical order with some evidence of transition.	Inconsistent arrangement of content with no transition.	No evident arrangement of ideas.	
Required Elements	The essay includes required elements as well as additional information from their personal perspective.	All required elements are included on the essay	All but 1 are included on the essay	Several required elements are missing	
Content	All content is strongly interconnected and developed with adequate explanation.	Most of the information is sufficiently developed and explained adequately.	Some of the content is limited with inadequate elaboration oft eh explanation	Very little of the content is relevant to the topic.	



What is It

There are different causes of landslide and sinkhole. Any of the triggers are only caused by a triggering element. A landslide can be caused by a natural or mechanical factor / human. Natural causes of landslides can be due to Climate, Earthquakes, Weathering, Flooding, Volcanic Activity, Forest Fires and Gravity while Humans triggered landslides triggered by mining or clear cutting of trees.

In this lesson, we will discuss the causes of geological hazards such as landslides and sinkholes. Types of landslide will also be addressed with you so that you will be able to determine the various effects of rainfall-induced landslides and so that you will be able to determine the soil or soil response in such a situation. It is crucial that you know the various cause of landslide so that you can also process the interaction of these causes with each other in mind.

CAUSES OF GEOLOGIC HAZARDS

❖ LANDSLIDE

NATURAL CAUSES OF LANDSLIDES

– Climate

Long-term climatic changes can significantly impact soil stability. A general reduction in precipitation leads to lowering of water table and reduction in overall weight of soil mass, reduced solution of materials and less powerful freeze-thaw activity. A significant upsurge in precipitation or ground saturation would dramatically increase the level of ground water. When sloped areas are completely saturated with water, landslides can occur. If there is absence of mechanical root support, the soils start to run off.

– Earthquakes

Seismic activities have, for a long time, contributed to landslides across the globe. Any moment tectonic plates move, the soil covering them also moves along. When earthquakes strike areas with steep slopes, on numerous occasion, the soil slips leading to landslides. In addition, ash debris flows instigated by earthquakes could also cause mass soil movement.

– Weathering

It is the natural procedure of rock deterioration that leads to weak, landslide-susceptive materials. It is brought about by the chemical action of water, air, plants and bacteria. When the rocks are weak enough, they slip away causing landslides.

- Erosion
Erosion caused by sporadic running water such as streams, rivers, wind, currents, ice and waves wipes out latent and lateral slope support enabling landslides to occur easily.

- Volcanic eruption
If an eruption occurs in a wet condition, the soil will start to move downhill instigating a landslide. Stratovolcano is a typical example of volcano responsible for most landslides across the globe. Volcanic gases partially dissolve in groundwater which turns into acidic hydrothermal systems that weakens rock by altering minerals to clay.

- Forest fires
Burns vegetation that holds soil in place. Since it takes time for vegetation to re-establish on steep slopes, the risk of landslides prevails or up to 20 years in dry climates. Wildfire removes the protective ability of vegetation which increases runoff, erosion, and debris flow because the water cannot penetrate through the soil thus carrying the debris downslope. burrowing insects also play a role by aerating the soil destabilizing it during a wildfire because they tend to seek for cooler soil to survive.

- Gravity
Steeper slopes coupled with gravitational force can trigger a massive landslide. Steeper slopes can also cause the debris to move farther from the foot of the area.

HUMAN CAUSES OF LANDSLIDES

- Mining
Mining activities that utilize blasting techniques contribute mightily to landslides. Vibrations emanating from the blasts can weaken soils in other areas susceptible to landslides. The weakening of soil means a landslide can occur anytime. Earthwork alters the shape of a slope, imposing new loads on an existing slope.

- Clear cutting
Clear cutting is a technique of timber harvesting that eliminates all old trees from the area. This technique is dangerous since it decimates the existing mechanical root structure of the area. It changes the amount of water infiltrating the soil.

Rainfall-Induced landslides are the most common and widespread damaging landslides in the Philippines, with an average of 20 typhoons each year due to prolonged or heavy rainfall. Most rainfall-induced landslides are shallow (less than a few meters deep), thin, and move quickly.

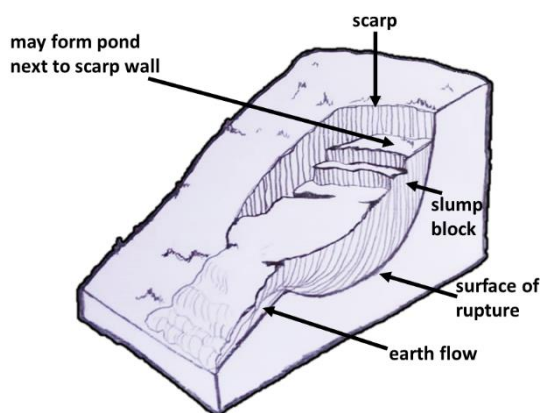
Rainfall can be a cause for landslides, but soil conditions are also very critical. Researchers wanted to take into account a number of variables, including weather type, soil type and land-cover characteristics. However, there was no single source for the data they needed.

The features of precipitation occurrences, including the accumulated volume of rainfall, length and severity, and the slope of the terrain show the greatest effect on the stability of the slope and the rate of occurrence of landslides and debris. In addition, the precipitation-induced landslide depends on the type of land covered and the type of soil. In short, the cause of rainfall-induced landslides still rely on the factors mentioned.

Types of Landslide

1. **Soil Creep Landslide** is a very slow downslope movement of particles that occurs in every slope covered with loose, weathered material (Britannica dictionary).

The level of creep induced by one rainfall has a strong association with the amount of rainfall and changes in soil moisture. For the valley-head slope, the dirt creeps down and accumulates a hollow portion of the head at the bottom of the bottleneck, under which the dirt is compressed and forms a wave-shaped soil.



2. **Slumping Landslide** is a downward movement of rock debris, usually the consequence of removal of buttressing earth at the foot of a slope of unconsolidated material (Britannica dictionary).

- 3. Debris Flow Landslide** happens when the slope becomes saturated with water, this then triggers a landslide of water-soaked mass of rock and soil that slides down the slope.



Colluvial landslide in a debris flow valley is a common occurrence that is quickly caused by rainfall. The direct destructiveness of this type of landslide is limited, but if failure occurs, the resultant blockage of the channel can lead to a series of magnified secondary hazards. For this cause, it is important to explore the possible response of this type of landslide to rainfall.



- 4. Rock Fall landslides** are sudden slides caused by heavy rain the rock on the slope loosens and then slides down the slope.

❖ SINKHOLE

NATURAL CAUSES OF SINKHOLE

- Dissolution of sedimentary rocks
 - ✓ Sinkholes occur when sedimentary rocks are dissolved. When these rocks are dissolved, it can either form a void of water or air. A void filled with air forms a hole and a void filled with underground water makes a lake or a pond. Sinkholes can be in the form of holes or depressions on the ground.

HUMAN CAUSES OF SINKHOLE

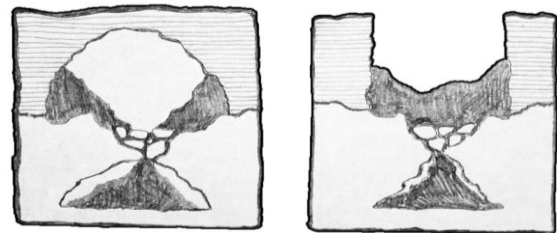
- Underground water pumping
 - ✓ Pumping water underneath the ground causes drainage to alter their flow which causes the soil to be eroded by water. Broken pipes underneath the ground can also cause internal erosion making a void underneath the ground. Altering drainage systems cause water to branch into other routes where there is soluble rock can cause erosion through the flow of water.

Types of Sinkholes

- Different types of sinkholes are made by various causes.

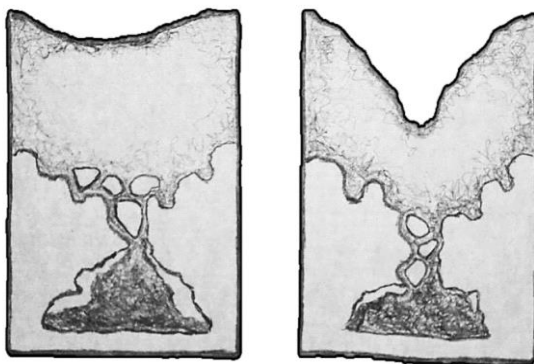
1. Cover Collapse Sinkhole

Develop abruptly (over a period of hours) and thus cause catastrophic damages. They occur where the covering sediments contain a significant amount of clay. Over time, surface drainage, erosion, and deposition of sinkhole into a shallower bowl-shaped depression



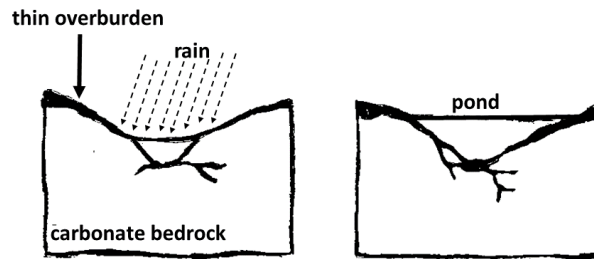
2. Cover Subsidence Sinkhole

Develop gradually where the covering sediments are permeable and contain sand. In areas where cover material is thicker or sediments contain more clay, cover-subsidence sinkholes are relatively uncommon and therefore may not be seen frequently. They are smaller and thus may go undetected for long periods.



3. Dissolution Sinkhole

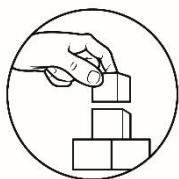
Occur in areas where limestone is exposed at land surface or also is covered by thin layers of soil and permeable sand. Dissolution of the limestone or dolomite is most intensive where the



water first contacts the rock surface. Aggressive dissolution also occurs where flow is focused in pre-existing openings in the rock, such as along joints, fractures, and bedding planes, and in the zone of water-table fluctuation where groundwater is in contact with the atmosphere. Solution sinkholes are generally small in size and also slow to develop.

4. Artificial Sinkhole

These types of sinkholes can be caused by various human activities, including groundwater pumping and construction activities. However, the most common activities that result in artificial sinkholes are mining, drilling, considerable changes in weight, as well as a tremendous increase in water flow, such as a construction of an artificial pond.



What's More

Activity 3: Word Hunt

Find eleven causes of landslides in the pool of letters below. Encircle your answer.

M	W	P	Y	M	S	G	W	I	H	V	P	L	B	J	V
K	I	A	O	L	I	R	D	E	E	O	O	E	H	O	N
E	N	N	U	U	O	A	S	T	A	B	O	N	L	G	A
E	N	M	I	N	B	V	O	A	G	K	G	C	N	O	N
L	E	E	G	N	T	I	Y	M	I	F	A	M	O	K	O
I	R	S	L	J	G	T	K	I	D	N	E	S	I	A	I
M	K	W	A	I	U	Y	U	L	I	G	R	F	S	D	T
S	A	E	B	L	R	P	A	C	K	X	D	E	O	A	U
T	T	A	A	E	Y	K	E	O	F	S	O	M	R	Y	L
S	E	T	W	E	A	R	T	H	Q	U	A	K	E	C	O
U	H	H	S	I	U	I	K	L	S	Z	S	T	W	I	S
J	S	E	L	P	U	M	P	I	N	G	G	A	I	Q	S
T	G	R	T	O	P	W	E	T	I	L	U	Y	K	A	I
N	O	I	T	A	T	S	E	R	O	F	E	D	R	V	D
V	O	N	G	G	A	I	N	D	P	U	T	F	U	T	V
N	K	G	I	S	P	E	R	I	F	T	S	E	R	O	F

Categorize the words that you found into Natural and Human Causes of Geologic Hazard:

Natural Causes	Human Causes



What I Have Learned

Activity 4. Complete the following sentences.

Landslide and sinkholes are both geological hazards but are distinctly different. Complete the following paragraphs based on what you have learned in the lecture.

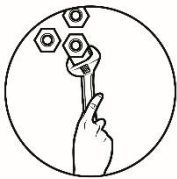
Rubrics: 10 points for each paragraph. The student will be given 1 point for the first two lines, 2 points the third line, and 3 points for the last two lines of the paragraph.

Landslide

I have learned that causes of landslides can either be _____ or _____. Their effect to the environment and people is/ are _____. These are caused by _____ and intensify the occurrence of landslides by _____.

Sinkhole

I have learned that causes of sinkhole can either be _____ or _____. Their effect to the environment and people is/ are _____. These are caused by _____ and intensify the occurrence of sinkhole by _____.



What I Can Do

Activity 5:

Read the article “The 17 February 2006 rock slide-debris avalanche at Guinsaugon, Philippines: a synthesis” by Guthrie et. al.. A copy of the article is attached in the end part of this module. Write notes describing the event and the conditions that have led to its occurrence. Construct a reflection paper regarding the article. Your paper should include the following:

1. Summarized version of your notes including details.
2. Explanation of your point of view regarding the article.
3. Relationship between the possible causes of the event.

Criteria's	4	3	2	1	TOTAL SCORE
Focus	All information is distinct and focused on the topic.	Most of the information is distinct and focused on the topic.	Some of the information is relevant to the topic.	Very little of the information is focused on the topic.	
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Required Elements	The essay includes required elements as well as additional information from their personal perspective.	All required elements are included on the essay	All but 1 are included on the essay	Several required elements are missing	
Content	All content is strongly interconnected and developed with adequate explanation.	Most of the information is sufficiently developed and explained adequately	Some of the content limited with inadequate elaboration of the explanation	Very little of the content is relevant to the topic.	



Assessment

Post Test

Direction: Read each item comprehensively and write the letter of the correct answer on extra sheet of paper.

1. Ground water pumping is an artificial cause of sinkholes, how does it contribute to the formation of a sinkhole?
 - a. It transfers the water upward.
 - b. It dissolves acidic water to the soil.
 - c. It creates new water diversion systems.
 - d. It carries the water further downstream.
2. Which of the following is not an effect of frequent submersion of soil in water?
 - a. curving
 - b. weakened soil
 - c. formation of spaces
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3. Which of the following statement/s is true about how does a forest fire cause a landslide?
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4. Which of the following is/are true about how a volcanic eruption trigger a landslide?
 - I. it attracts rain clouds
 - II. by altering minerals to clay
 - III. volcanic gas dissolved in groundwater weakens rock
 - IV. vibrations loosen the soil surrounding the volcano
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 - b. II and III only
 - c. II, III, IV only
 - d. I, II, III, and IV

5. Which of the following is true about the relationship of gravity to landslides?

- I. steeper slope can trigger massive landslide
- II. steep slope means faster landslide
- III. steep slope means nearer landslide debris
- IV. steeper slope can cause more viscous landslide

- a. I only
- b. II only
- c. III only
- d. IV only

6. Which of the following is a natural cause of landslide?

- a. clear cutting
- b. mining
- c. cultivation
- d. liquefaction

7. Which of the following is a factor that affects the stability of the slope?

- a. wind speed
- b. heat change
- c. light intensity
- d. soil nutrients

8. Which of the following is not an effect of landslides?

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- b. tsunami
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- b. earthquake
- c. gravity
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 - sunlight
 - weathering
15. Which of the following is a natural procedure of rock deterioration that weakens the landslide-susceptible materials?
- climate
 - erosion
 - sunlight
 - weathering



Additional Activities

Enrichment Activity

Since plant roots hold water and help prevent landslides, grown plants in your community or household which is vulnerable to landslides. Document your progress and send a narrative paper to your teacher. The narrative should include the following:

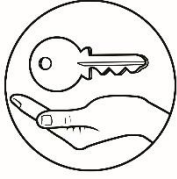
- Specific name of the plant and location.
- Documented pictures of the step by step process. A before, during and after documentation.

The paper should also answer the following questions:

- What plant did you grow or replant in your backyard or home?
- Why did you choose that plant and what are its characteristics that make it helpful in preventing landslides?

3. Where did you place the plants? What is your basis of placing the plants in that particular location?
4. What must you do in order for it to be sustainable?

Criteria's	4	3	2	1	TOTAL SCORE
Focus	All information is distinct and focused on the topic.	Most of the information is distinct and focused on the topic.	Some of the information is relevant to the topic.	Very little of the information is focused on the topic.	
Organization	With exceptional arrangement of content and subtle transitions.	One or two of the content is in logical order with some evidence of transition.	Inconsistent arrangement of content with no transition.	No evident arrangement of ideas.	
Required Elements	The narrative includes required elements as well as additional information from their personal perspective.	All required elements are included on the essay	All but 1 are included on the essay	Several required elements are missing	
Content	All content is strongly interconnected and developed with adequate explanation supported with documentation.	Most of the information is sufficiently developed and explained adequately, with proper documentation.	Some of the content limited with inadequate elaboration of the explanation with some documentation.	Very little of the content is relevant to the topic and has no documentation.	



Answer Key

Assessment		
1. C		1. B
2. D		2. B
3. A		3. A
4. C		4. B
5. A		5. D
6. D		6. D
7. D		7. D
8. A		8. A
9. D		9. D
10. A		10. A
11. B		11. C
12. B		12. D
13. A		13. A
14. B		14. C
15. D		15. A

What's More	
1. Soil creep	
2. Dissolution	
3. Slumping	
4. Debris flow	
5. Cover subsidence	
6. Rock fall	
7. Cover collapse	

What I Know	
1. B	
2. B	
3. A	
4. B	
5. D	
6. D	
7. D	
8. A	
9. D	
10. A	
11. C	
12. D	
13. A	
14. C	
15. A	

M	V	J	L	B	J	V	N	O	O	G	A	N	E	N	E	L	I	M	S	T	S	T	S	U	J	T	N	V	N
W	I	H	E	N	L	O	N	C	M	S	F	D	O	X	S	F	C	O	E	P	A	E	T	H	S	G	O	O	K
P	A	E	N	N	O	A	M	A	E	R	D	O	S	Z	G	A	T	W	I	R	E	A	T	H	E	R	I	N	G
Y	O	O	O	U	U	I	G	L	J	A	W	B	A	E	L	A	W	S	L	T	B	A	T	H	E	R	I	N	G
M	L	O	U	U	U	N	N	I	N	J	I	L	R	P	Y	U	E	A	P	E	K	R	I	U	P	O	T	G	I
S	I	R	A	O	O	V	B	A	V	G	T	Y	K	C	O	E	T	K	P	E	S	T	A	P	O	T	G	I	
G	D	E	S	O	S	O	A	M	Y	T	I	U	A	O	E	R	T	I	M	W	E	S	T	A	P	O	T	G	I
W	E	E	T	D	S	O	A	G	I	D	I	U	K	L	C	O	H	L	P	E	E	R	O	I	T	R	D	I	
I	E	E	B	O	B	K	G	F	N	G	X	D	E	S	G	U	Q	S	N	I	T	F	O	I	L	U	U	T	
H	E	O	O	O	O	G	C	M	S	F	R	D	E	S	G	U	Q	S	N	I	T	F	O	I	L	U	U	T	
V	O	O	O	O	O	G	C	M	A	E	R	D	O	S	G	U	Q	S	N	I	T	F	O	I	L	U	U	T	
P	O	O	O	O	O	G	C	M	A	E	R	D	O	S	G	U	Q	S	N	I	T	F	O	I	L	U	U	T	
L	E	E	N	N	L	O	C	M	S	F	R	D	O	S	G	U	Q	S	N	I	T	F	O	I	L	U	U	T	
B	H	L	N	L	N	O	C	M	A	E	R	D	O	S	G	U	Q	S	N	I	T	F	O	I	L	U	U	T	
J	O	O	G	G	O	K	O	A	I	D	S	F	R	D	O	S	G	U	Q	S	N	I	T	F	O	I	L	U	
V	N	O	O	A	N	O	N	E	N	O	A	U	T	U	L	C	O	S	S	I	Q	A	V	I	A	V	D	V	

Human Causes

Mining

Deforestation

Pumping

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