Senior High School

DepED
DEPARTMENT OF EDUCATION

Disaster Readiness and Risk Reduction

Quarter 2 – Module 1
Geological Hazards: Landslides and Sinkholes

ALTERNATIVE DELIVERY MODE
ADM

Disaster Readiness and Risk Reduction
Alternative Delivery Mode
Quarter 2 – Module 1: Geological Hazards: Landslides and Sinkholes
First Edition, 2020

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Authors: Emerina Clarisse R. Bernante, Louise A. Ferrer, Mark Anthony C. Mamon, Cheryl A. Retio

Editor: Ma. Lanie A. Socorro, Ed.D.

Reviewers: Raquel M. Austero, Ph.D.

Illustrator: Mark Anthony C. Mamon

Layout Artist: Louise A. Ferrer, Oliver O. Ostulano

Management Team: Malcolm S. Garma, Director IV
Genia V. Santos, CLMD Chief
Dennis M. Mendoza, Regional EPS In-Charge of LRMS
Micah S. Pacheco, Regional ADM Coordinator
Violeta M. Gonzales, CID Chief
Jennifer L. Tubello, Division EPS In-Charge of LRMS & Division ADM Coordinator

Printed in the Philippines by _____

Department of Education – National Capital Region

Office Address: Misamis St., Bago Bantay, Quezon City

Telefax: 02-929-0153
E-mail Address: depedncr@deped.gov.ph

Senior High School

Disaster Readiness and Risk Reduction

Quarter 2 – Module 1
Geological Hazards: Landslides and Sinkholes

DepED
DEPARTMENT OF EDUCATION

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.

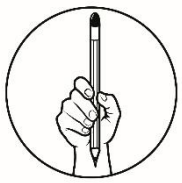
What I Need to Know

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: Landslides and Sinkholes.

After going through this module, you are expected to:

1. discuss the different geological hazards;
2. analyze the causes of geological hazards; and
3. recognize signs of impending geological hazards.



What I Know

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

1. Where will sinkholes be more likely to form?
   A. hotels
   B. fruit trees
   C. waterfalls
   D. limestone

2. What are sinkholes?
   A. holes that form near coastlines
   B. holes that form at the mouths of rivers
   C. holes that form at the bottom of the ocean
   D. holes that form in the ground when rocks and dirt are washed away under the surface

3. What is a limestone?
   A. a kind of rock
   B. a kind of trees
   C. a kind of erosion
   D. a kind of sinkhole

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

5. What does a rainfall-induced landslide mean?
   A. a shaking of earth
   B. an eruption of lava or magma
   C. an opening of earth like sinkhole
   D. soil, rock, debris sliding down the slope

6. What refers to a natural depression or hole caused by some form of collapse of the surface layer of the ground?
   A. sinkholes
   B. landslides
   C. man-made sinkholes
   D. earthquake-induced landslides

7. Which of the following is NOT a type of a sinkhole?
   A. solution sinkholes
   B. dissolution sinkholes
   C. cover collapse sinkhole
   D. cover subsidence sinkhole

8. Which of the following refers to natural earth processes that could cause mortality, damage to property and livelihood?
   A. sinkhole
   B. landslides
   C. earthquake
   D. geological hazard

9. Which is not a cause of landslide?
   A. geology
   B. morphology
   C. human activity
   D. cover collapse landslide

10. Which is not an impending sign for rainfall-induced landslide?
   A. rapid rise in water levels of the creeks
   B. new cracks at the foundations of buildings and houses
   C. a slight rumbling sound that rises in amplitude is noticeable.
   D. unusual noises, such as breaking trees, or knocking boulders together

11. What is the usual cause of natural sinkholes?
   A. deforestation
   B. chemical explosion
   C. man-made forest fire
   D. physical and chemical erosion

12. What is a cause of landslide that pertains to cutting of trees to make way for agriculture and construction?
   A. geology
   B. subsidence
   C. morphology
   D. human activity

13. What type of sinkholes occurs when the bedrock is covered by soil and materials that are not well-knitted together and is usually made from mostly clay or sand?
   A. sinkholes
   B. solution sinkholes
   C. cover collapse sinkholes
   D. cover subsidence sinkhole

14. Which is not an impending sign of a sinkhole?
   A. cracks in an area
   B. depression at ground level
   C. rapid rise in water levels of the creek
   D. rapid appearance of a crater in the ground

15. What type of sinkhole that occurs when the bedrock is covered by a deep layer of soil and earth then the bedrock erodes resulting into a hole?
   A. sinkholes
   B. solution sinkholes
   C. cover collapse sinkholes
   D. cover subsidence sinkhole

Lesson 1 Geological Hazards: Landslides and Sinkholes

Geological hazards are associated with earth materials such as toxic materials or earth processes which include landslides, earthquakes, sinkholes and many more. For some communities, these geological hazards turn into impacts of disaster. These may cause injury, disability, loss of home, loss of income, and even loss of loved ones. 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 landslides and sinkholes.

What's In

As what have been discussed on the last module, volcanic hazards include pyroclastic flow, lava flow, ashfall, lahar, volcanic gases, volcanic debris, avalanche and tsunami. On the other hand, earthquake is a sudden and violent shaking of the ground, sometimes causing great destruction, as a result of movements within the earth's crust or volcanic action. Now, what other geological hazards present here in the Philippines? What are the causes of these other geological hazards? What are the signs of an impending geological hazard? Let's find out.

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

Source: https://www.phivolcs.dost.gov.ph/index.php/landslide/introduction-to-landslide

Questions:

1. What do you think happened in the image?

_____
_____
_____.

2. What do you think caused the event in the image?

_____
_____
_____.

3. What will you do if you are to see the same event in real life?

_____
_____
_____.

What is It

Geological Hazards

Geological hazards are gradual or sudden natural earth processes which cause injury, loss of life, property damage, loss of livelihood and services, social and economic disruption, or environmental changes. These include earthquakes, landslides, volcanic eruption, sinkholes etc. This module discusses the geological hazards landslides especially rainfall-induced landslides and sinkholes.

1. Landslide

A landslide is rock, dirt, or debris falling down a sloping section of land. Landslides are caused by storms, earthquakes, volcanoes or other factors which makes the slope unstable.

There are three major causes of landslides:

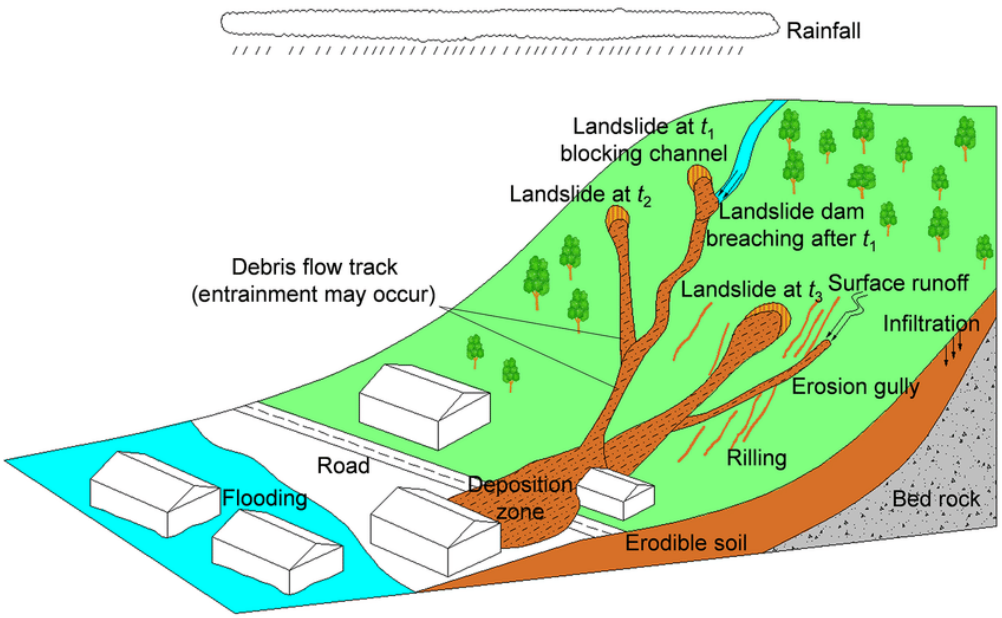
a) Geology – this refers to the material of the soil or rock in the area or can be the layers of earth has weakened or stiffened in some part.
b) Morphology – this refers to the structure of the land. The soil or rock has weakened through loss of vegetation or root system which holds the soil in place. Another is prolonged rainfall or heavy water leakage that increases the weight of the land mass therefore as the water flows, sediments and soils also comes with it.
c) Human activity – to make way for agriculture and construction, trees are needed to be cut down. Irrigation, deforestation, and excavation can weaken the integrity of the earth.

The most common landslide we have experienced here in the Philippines is the rainfall-induced landslide. This is what we will be focusing on in terms of the impending signs and on the mitigation in the next module.

Rainfall-induced Landslide

This occurs due to prolonged or heavy rainfall, increasing the weight of the land mass. The development of a rainfall-induced landslide may take several days but the landslide itself will only take a few minutes to cause a disaster. Rainfall-induced landslides can form debris flows when they mix with additional water and sediments from their path. It may sweep away a whole community in an instant.

The diagram shows an example of a rainfall-induced landslide:



Source: https://www.researchgate.net/publication/326382991_EDDA_20_Integrated_simulation_of_debris_flow_initiation_and_dynamics_considering_two_initiation_mechanisms/figures?lo=1&utm_source=google&utm_medium=organic

As you can see in the picture above, as the water flows down the slope of a mountain, some sediments and soil may be swept away. If the integrity of the soil is compromised for example poor vegetation or weakened earth, much more of it will come flowing down.

The impending signs of a rainfall-induced landslide

Rainfall-induced landslide can happen anytime during a heavy and prolonged rainfall. We cannot tell when exactly it will happen but there are some signs that may indicate so:

- Unusual noises, such as breaking trees, or knocking boulders together, can mean moving debris.
- As the landslide nears, a slight rumbling sound that rises in amplitude is noticeable.
- Rapid rise in water levels of the creeks, likely followed by increased turbidity (soil content).

The Early Warning System (EWS) of the Philippine Institute of Volcanology and Seismology (PHILVOCS) and Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) are monitoring systems designed to forecast events accompanying landslides in order to provide a warning about hazards. By reducing the impact, it mitigates risk.

2. Sinkhole

A sinkhole is a depression or hole caused by the collapse of the surface layer of the ground. Water is the primary cause of most sinkholes when it dissolves soluble rocks such as limestone, dolomite, and gypsum.

Sinkholes has two kinds, natural or man-made. **Natural sinkholes** are caused by physical or chemical erosion. The natural flow of water may erode rock material while acidic substances may also dissolve and eventually weaken it. **Man-made sinkholes** are caused by drilling, mining, road construction, and broken water or underground pipes. Water may penetrate through mud and rocks and eventually erode the ground underneath.

Types of sinkholes

1. Solution sinkholes – are common in areas that have thin cover of soil on the surface of the ground which exposes the bedrock to water erosion. As the bedrock erodes, particles collect in the spaces it leaves and a small depression is formed over a period, eventually forming a hole. The bedrock may collapse suddenly, or it may happen over time.
2. Cover Subsidence Sinkholes - this occur when the bedrock is covered by soil and materials that are not well-knitted together. The soil in these areas are made mostly of clay or sand. Once the bedrock starts to erode, the clay or sand starts to enter through the cracks and settles into the spaces left behind, creating a cavity on the surface of the soil.
3. Cover Collapse Sinkholes – occur when the bedrock is covered by a deep layer of soil and earth. A crack starts once the bedrock begins to get eroded. Weak points begin to form in the layers of soil above it. The weak points eventually become a large hole within the bedrock that cannot support the weight above it. The collapse occurs in an instant and can create large holes in a matter of minutes.

The impending signs of a sinkhole

Sinkholes either man-made or natural can occur anytime. We cannot tell when will the hole emerge but there are some signs that may indicate an impending disaster.

- New cracks at the foundations of buildings and houses
- Cracks in an area
- Depressions at ground level
- Rapid appearance of a crater in the ground

What's More

Activity 2. Landslides and Sinkholes

Directions: Share to a family member or anyone you are with in your home, the causes of landslides and the different types of sinkholes then interview them using the guide questions below. Make sure to take note of the emotions and their opinions in answering. Use another sheet of paper to answer.

Questions:

1. What do you think will be most likely to occur in our barangay, a landslide or a sinkhole? Why?
2. What do you think the cause of landslide or the type of sinkhole that will occur in our barangay? Why?
3. Do you think we have an element/factor in our home that can contribute to the cause of a landslide or sinkhole? What is it and why?
4. What do you think are the signs we can observe in our surroundings before the event will occur?

Activity 3. News Flash!

Directions: Read the article given on this activity then answer the questions on a separate sheet.

14-wheeler truck falls into hole on Roxas Boulevard in Manila

Published June 23, 2019 11:50am

A 14-wheeler dumper loaded with 16 tons of sand fell into a hole before dawn Sunday when the pavement on a portion of Roxas Boulevard in Manila collapsed under the truck's weight.

Citing initial information, GMA News reported the incident occurred at about 2 a.m. Sunday at the corner of Roxas Boulevard and Remedios St.

According to the truck's driver, they came from Pampanga to deliver sand for the Manila Bay rehabilitation project.

Driver Michael Layco was quoted as saying they were supposed to pass through Roxas Boulevard, but traffic enforcers directed them to take the service road to give way for the Manila marathon 2019 event, and as he turned at Remedios Street

corner, the concrete covering a huge drainage canal collapsed, leaving the truck half-buried in the hole.

As of Sunday morning MMDA personnel were still finding ways to pull the truck from the hole.

For its part, the Department of Public Works and Highways (DPWH) said it was looking into the matter.

"DPWH is currently investigating the incident in Roxas Bouleverad involving a 14-wheeler-truck loaded with sand. Equipment and personnel have now been deployed," DPWH Secretary Mark Villar said in a statement.

The department also explained that the double-barrel box culvert along Remedios street was constructed in the 1970s. — ***Jon Viktor Cabuenas/LBG/DVM, GMA News***

Source: https://www.gmanetwork.com/news/news/metro/698615/14-wheeler-truck-falls-into-sinkhole-on-roxas-boulevard-in-manila/story/

1. What do you think caused the sinkhole?

_____
_____
_____
_____

2. What do you think will happen if the truck will not be removed?

_____
_____
_____
_____

3. Do you think there were signs of sinkholes before the event happened? What are those signs?

_____
_____
_____
_____

Activity 4. The 5 Sense

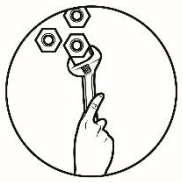
Directions: List in the box of what we could experience using our 5 senses on the impending signs of rainfall induced landslide and sinkholes.

SMELL	SIGHT	SOUND	TOUCH	TASTE

What I Have Learned

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

1. I'm thinking about _____
   _____.
2. I'm wondering _____
   _____.
3. I'm noticing _____
   _____.
4. It reminds me of _____
   _____.
5. I'm feeling _____
   _____.



What I Can Do

Sinkholes can be a major issue affecting people, homes and public land. This can be caused by the natural wearing away of one of the underground rock layers, and aging utility pipes or broken septic tanks can cause sinkholes. There are no known ways to prevent sinkholes, but this can be avoided by taking care of your home and land and being aware of local concerns.

Directions: Interview one of your family members or any members in your home using the following guide questions. Write your answers on another piece of paper.

1. What do you think will happen if a sinkhole will occur in our home?
2. What damage can it cause in our home?
3. How do you think we can prevent this kind of scenario to happen?
4. How can we lessen the damage it can bring?

Assessment

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

1. After the 7.2 magnitude earthquake in Bohol last 2013, almost 100 sinkholes were said to be found all over the city of Tagbilaran. How were these sinkholes formed?
    A. The city was near the coastlines.
    B. The rivers lead up to the holes that why it was found.
    C. The holes formed at the bottom of the ocean then rose to the surface.
    D. The holes formed in the ground when rocks and dirt moved away under the surface.

2. What is the primary cause of sinkholes?
    A. Water B. fallen trees C. infrastructures D. nutrient dense soil

3. The side of the mountain is slowly exposing a big rock underneath it. The local government unit told the residents nearby that it is eroding and will expect that it may cause a landslide during a torrential rain. What do they mean when the LGU said it 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.

4. During the La Niña in the Philippines, torrential rain usually occurs from time to time and pours over a large area of the land. Overtime on the slopes of the mountains, rainfall-induced landslides happen. Why do such events occur?
    A. Because the area is a slope, it is natural that the excessive water will run down the hill and bring with it soil, rocks, and other debris.
    B. The possibility of having no trees to absorb water or to hold the soil and debris on the slope of the mountain may contribute to the rainfall-induced landslide.
    C. The soil in the area may already be saturated with water due to the occurrence of torrential rains every now and then.
    D. All of the above.

5. Bohol island is covered with limestones, this is usually the cause of sinkholes in the island. What best describes a limestone?
    A. A kind of rock that can cause sinkholes.
    B. A kind of tree that can be used for lumber.
    C. A kind of sinkhole that is usually associated with sudden rupture of the ground.
    D. A kind of erosion that happens when the trees are cut down to make way for human development.

6. Which of the following is an impending sign for rainfall-induced landslide?
    A. Lower water levels of the creeks.
    B. Trees are swaying with the wind.
    C. New cracks at the foundations of buildings and houses.
    D. Unusual noises, such as breaking trees, or knocking boulders together.

7. In other countries, some of the large sinkholes that form on their lands are used as dumpsites. If the Philippines would adopt this kind of activity, what do you think will happen?
    A. The country's problem with trash will have a solution.
    B. Water resources near the sinkholes could be contaminated.
    C. The sinkhole may further collapse if tons and tons of trash will be thrown in the hole.
    D. All of the above.

8. Which of the following does NOT cause a landslide?
    A. Rocks flowing down the stream.
    B. Trees being cut down to make way for development.
    C. Soil that have fractures and is weak.
    D. Slopes losing the vegetation due to drought.

9. The Juan corporation bought a piece of land to build their new project. Together with the local government unit they identified possible sinkholes that may appear on the land. They observed that there is only a thin layer of soil covering the bedrock underneath the land and the bedrock is starting to erode and to have a depression. What type of sinkhole did the land surveyors identified?
    A. solution sinkholes
    B. dissolution sinkholes
    C. cover collapse sinkhole
    D. cover subsidence sinkhole

10. Which of the following is a geological hazard?
    A. sinkhole
    B. earthquake
    C. landslides
    D. All of the above.

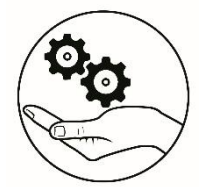
11. The Juan corporation wants to create a subdivision overlooking the sea. They acquired a good sum of land on a mountain slope near the bay but before they can proceed with construction, they need to cut down all the trees in the area. What do you think will happen if torrential rain pours after all the trees were cut down?
    A. Soil erosion due to drought could transpire.
    B. A sinkhole might form due to the presence of limestone in the area.
    C. Rainfall-induced landslide is prevalent during the typhoon season thus creating more rain drops over the coming months.
    D. Removing the trees and vegetation may increase the risk of a landslide.

12. What will happen if the sides of a hill regularly experience a rainfall-induced landslide?
    A. The bottom of the hill will be covered with mud and other debris present in the slope.
    B. The slopes of the hill will be mostly run down due to the regular occurrence of landslides.
    C. During torrential rains, the water will just continue to flow down the bottom of the hill and flood the area.
    D. All of the above.

13. Natural sinkholes are usually caused by physical and chemical erosion. A sinkhole may appear overtime but sometimes may suddenly form after a large earthquake. How can you tell if there is a possibility of a sinkhole forming in your home?
    A. There are cracks on the foundation of the house.
    B. There are cracks on the soil surrounding the house.
    C. There are craters and depressions forming in the ground.
    D. All of the above.

14. Mark observed that the soil at their backyard was made of a mixture of clay and sand, and somewhat a bit loose. A shallow depression can be seen forming. He called the attention of their barangay and they said that a sinkhole is forming. What kind of sinkhole is being formed?
    A. sinkholes
    B. solution sinkholes
    C. cover collapse sinkholes
    D. cover subsidence sinkhole

15. What type of sinkhole occurs when the bedrock is covered by a deep layer of soil and earth then the bedrock erodes resulting into a hole?
    A. sinkholes
    B. solution sinkholes
    C. cover collapse sinkholes
    D. cover subsidence sinkhole



Additional Activities

Directions: Read the personal blog: *Anda, Bohol's Enchanting Sinkhole: Cabagnow Cave Pool,* then answer the questions that follow on a separate sheet of paper.

Anda, Bohol's Enchanting Sinkhole: Cabagnow Cave Pool

January 28, 2019 Author: rexlimlim52 2019

That specific stimulus in my brain triggered a fear, a tinge of fear as a response, when I steadily gripped the rungs of the ladder leading down into a deep cave pool. The thalassophobia (fear of the sea) is about to kick in anytime as I have always felt when swimming into the open, but this time, I was in a pool, inside a cave, the ones with creepy stalactites protruding from the ceiling.

"Heto na talaga!" ("This is it!") I told myself as I let go of the ladder and went completely underwater.

A picture of a dark cave with a deep blue pool from beneath its ceiling tickled my wanderlust. Eventually I learned that it is called the Cabagnow Cave Pool in Anda, Bohol. Aside from The Plunge in Danao Adventure Park, it is also one of my must do's in Bohol, to jump down into this enchanting cave pool.

After laying eyes into Candijay, Bohol's attraction, we went back to the Guindulman-Anda Junction then transferred into a Motorella that took us directly to the jump-off point of Cabagnow or Kabagno in Brgy. Bacong. From there it is just a short walk across coconut trees before arriving into a private property.

At first it is nothing but simple underwhelming, since from afar it is just a small circular sink hole fenced in bamboo stakes, but as soon as I craned my head towards what the hole contains, it was a deep blue colored pool that is enchanting and at the same time, fear inducing. We wasted no time and immediately went down the ladders after changing our clothes and tested the inviting waters. I was hesitant at first to jump immediately as I always had this fear of drowning when swimming into deep waters, this one is around 20 feet in its deepest.

The water inside is sea water, owing to its proximity to the sea. I also learned that Anda, just like most of the Chocolate Hills is made up of limestone, and because of the bedrock being dissolved by sea water over time, natural sinkholes are formed.

There are at least six cave pools hidden in Anda which include Combento, Cateres, Kaligoon, East Coast and Cabagnow being the largest of them all.

After being acquainted with the cave pool's water, and my fear getting lesser by the minute, I went back up, before doing what I want to do all along. JUMP!!

There are also floaters inside if you don't want to swim at all.

Source: https://transitpinas.com/cabagnow-cave-pool/

Questions:

1. Are sinkholes dangerous? Why?
2. Do you think that it is safe to swim in Cabagnow Cave? Why?
3. Is there any benefit in the emergence of sinkholes? Why?
4. What can we do to lessen the impact of sinkholes?

Answer Key

Assessment	What's New	What I know
1. D 2. A 3. D 4. D 5. A 6. D 7. D 8. A 9. A 10. D 11. D 12. D 13. D 14. D 15. C	**Activity 1** 1. Answers may vary. Erode / slip in soil or earth 2. Answers may vary. Rain / less trees to hold the soil / earthquake. 3. Answers may vary. Immediately evacuate the area if near / report it to local officials. **What's More** **Activity 2** Answers may vary. **Activity 3** 1. Might be the structural integrity as it was mentioned the road was constructed in the 70s. 2. The hole might collapse even more due to the weight of a loaded truck. 3. Yes, there might be cracks or there is already a depression on that area. **Activity 4** Smell – petrichor or the smell of rain Sight – eroding soil / cracks Sound – rumbling sounds Touch – a slight tremor Taste – none	1. C 2. D 3. A 4. B 5. D 6. A 7. A 8. D 9. D 10. B 11. D 12. D 13. D 14. C 15. C

References

2020. Transitpinas.Com. https://transitpinas.com/cabagnow-cave-pool/.

"Achieve Solutions | Landslides or Debris Flow: Before, During, and After." n.d. Www.Achievesolutions.Net. https://www.achievesolutions.net/achievesolutions/en/Content.do?contentId=17630.

Admin. n.d. "5 Mysterious Sinkholes in the Philippines You Might Not Know." The Summit Express. Accessed August 1, 2020. https://www.thesummitexpress.com/2015/04/in-photos-5-places-philippines-with-mysterious-sinkholes.html.

"Causes, Effects and Types of Sinkholes." 2016. Conserve Energy Future. December 25, 2016. https://www.conserve-energy-future.com/causes-effects-and-types-of-sinkholes.php.

"Connecting Rainfall and Landslides | Earthdata." n.d. Earthdata.Nasa.Gov. Accessed August 1, 2020. https://earthdata.nasa.gov/learn/sensing-our-planet/connecting-rainfall-and-landslides.

"Geologic Hazards." n.d. Accessed August 1, 2020. https://www.colorado.edu/center/mortenson/sites/default/files/attached-files/geohazards_0.pdf.

"Landslides: Before, During & After - Canadian Red Cross." 2019. Red Cross Canada. 2019. https://www.redcross.ca/how-we-help/emergencies-and-disasters-in-canada/types-of-emergencies/landslides.

LECHAT, M.F. 1990. "The International Decade for Natural Disaster Reduction: Background and Objectives." Disasters 14 (1): 1–6. https://doi.org/10.1111/j.1467-7717.1990.tb00967.x.

n.d. Https://Disasterpreparednesscourse.Com/Disaster-Hazards/Subsidence-Sinkholes/Subsidence-Sinkholes-Mitigation-Actions-before-during-After/.

"The 7 Most Common Signs of Sinkholes." 2019. AGIUSA. January 3, 2019. https://www.agiusa.com/blog/7-most-common-signs-sinkholes.

For inquiries or feedback, please write or call:

Department of Education – Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex, Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph