Senior High School

DepED
DEPARTMENT OF EDUCATION

Disaster Readiness and Risk Reduction

Quarter 2 – Module 3: Hydrometeorological Hazards

ALTERNATIVE DELIVERY MODE
ADM

Disaster Readiness and Risk Reduction
Alternative Delivery Mode
Quarter 2 – Module 3: Hydrometeorological Hazards
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Development Team of the Module

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

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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

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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.

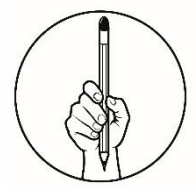
What I Need to Know

This module was designed and written with you in mind. It is here to help you understand Hydrometeorological Hazards. This module provides discussions and activities that will help you learn the concepts, ideas, and relevant information about the lesson. This module emphasizes the guidelines, and importance of disaster readiness, risk reduction, and management in connection to the hazard being discussed.

The module is all about Hydrometeorological Hazards.

After going through this module, you are expected to:

1. recognize signs of impending hydrometeorological hazards;
2. interpret different hydrometeorological hazard maps; and
3. use available tools for monitoring hydrometeorological hazards.



What I Know

Directions: Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What hazard may happen if a dam collapses?
   A. flashfloods
   B. storm surge
   C. tsunami
   D. typhoon

2. Which of the following signs is associated with flashflood?
   A. muddy water
   B. running water
   C. thunder and lightning
   D. increase in temperature of the surroundings

3. Why is it likely for a storm surge to occur during a typhoon?
   A. The sea level rises during a typhoon.
   B. A typhoon is usually accompanied by strong winds.
   C. A typhoon is usually accompanied by lightning and thunder
   D. The atmospheric pressure drops during at typhoon, pushing the waves.

4. Which of the following instruments can be used to track typhoons and cloud masses which may bring thunderstorms?
   A. Doppler radar
   B. Radiosonde
   C. Theodolite
   D. Weather surveillance radar

5. Which of the following may be observed in an approaching thunderstorm?
   A. column of clouds
   B. heavy rainfall
   C. high lying clouds
   D. saturated ground

6. Which hydrometeorological hazard could happen if one observes lightning and thunder?
   A. typhoon
   B. thunderstorm
   C. Both A and B
   D. None of the above.

7. Which of the following information can be obtained from a flood hazard map?
   A. susceptible areas to flood
   B. location of nearby waterways
   C. the possible flood water level that an area could experience.
   D. All the above.

8. Which of the following information may be obtained from a storm surge hazard map?
   A. path of a typhoon
   B. wind speed and force of impact
   C. the possible time that the storm surge will hit
   D. possible height of wave that can hit the surface

9. Which instrument can be used to measure atmospheric pressure?
   A. Barometer
   B. Hygrometer
   C. Radiosonde
   D. Sling psychrometer

10. Why is a flashflood considered more hazardous than a flood?
   A. It is contaminated.
   B. It lasts for a few hours only.
   C. It is characterized by a rapid current.
   D. All of the above.

11. Which of the following increases the likelihood of a storm surge?
   A. lightning
   B. heavy rainfall
   C. strong winds
   D. drop-in atmospheric pressure

12. How do weather satellites benefit people about hydrometeorological hazards?
   A. It provides a visualization of the typhoon.
   B. It helps predict the areas that may be affected by the typhoon.
   C. It relays weather information from remote automatic weather stations
   D. All of the above.

13. Why does the sky turn dark before a typhoon or thunderstorm?
   A. the sky has a dark and greyish tint
   B. clouds filled with water droplets block sunlight
   C. lightning and thunder interfere with the sun's rays.
   D. All the above.

14. What changes would NOT be observed on the ocean as a thunderstorm or typhoon approaches?

   A. the water is receding
   B. the waves are much higher
C. the waves come in much faster
D. the strong winds are present

15. What does it mean when there is no thunder heard after lightning is seen in the sky?
   A. The storm has passed.
   B. Strong wind may have masked the sound of thunder
   C. A thunderstorm is approaching or forming from a distance.
   D. None of the above.

Lesson 1 Hydrometeorological Hazards

Weather and climate provide us with a steady supply of water which is essential to survival. However, they also cause hydrometeorological hazards which are natural processes that may cause loss of lives and livelihood, damage to properties, infrastructures, and the environment as well. It is highly important to prepare ourselves to be able to deal with these hazards and overcome the crisis.

What's In

In the last module, you learned about geological hazard maps and mitigation strategies to prevent the damages brought about by geological hazards. What kind of information can a geological hazard map provide? Can you enumerate strategies that can be used to prevent the negative effects of different geological hazards?

We commonly experience geological hazards such as earthquakes, liquefaction, sinkhole, volcanic eruption, and tsunami. Hydrometeorological hazards such as typhoon, storm surge, and flooding are also frequently experienced here in the Philippines. Each hazard has its own characteristics and potential impacts to our community.

Notes to the Teacher

Encourage students to be updated with the latest hydrometeorological information by regularly checking data from Philippine Atmospheric and Geophysical and Astronomical Services (PAGASA). They can access hydrometeorological information from the website of PAGASA: https://www.pagasa.dost.gov.ph/.

What's New

Activity 1. Will it rain or not?

Analyze the scenarios given below. Suppose that you plan to go out for a picnic. Write YES if the scenario shows that it will rain and NO if it will not. Answer the guide questions that follow.

_____A. The sun is shining brightly.
_____B. A high lying veil of clouds is seen on the horizon.
_____C. It looks dark outside.
_____D. It suddenly becomes windy.
_____E. It is bright outside, but I see dark clouds at a distance.
_____F. The temperature of the surroundings feels slightly cool.
_____G. The sky has high-lying clouds.
_____H. The surroundings feel humid.

Guide questions:

1. How can you tell if it will rain or not?

   _____
   _____
   _____

2. Why do you need to be aware of the changes in your surroundings concerning the weather?

   _____
   _____
   _____

What is It

Hydrometeorological hazards are natural processes or phenomena that are of atmospheric, hydrologic, or oceanographic. These hazards may cause the loss of lives, damage to property, social and economic disruption, or environmental degradation. The geographic location of the Philippines accounts for the high frequency of occurrence of these hazards. At times, these hazards concur in a single event and varying intensities.

Signs of impending hydrometeorological hazards

In this module, we will focus on common hydrometeorological hazards experienced in the Philippines.

Typhoon

A typhoon is a violent tropical cyclone that forms over warm waters, North of the equator in the Western Pacific Ocean. It contains winds rotating counterclockwise, with a speed of 118-220 kilometers per hour. It could also develop into a super typhoon if the wind speed exceeds 220 kilometers per hour. The impending signs of a typhoon are felt when it is close to landfall. These include the following:

1. **increased ocean swell–** A swell is a series of ocean waves brought about by strong winds. An incoming typhoon would cause a swell of about a meter in height that hit the shore every 10 seconds. As the typhoon approaches the waves to come in much faster and may also increase in height.
2. **changes in clouds** – Cumulus clouds may fill the sky about 36 hours before a typhoon. As the storm approaches, the sky could be clear of clouds and may later have a mass of cirrus clouds which appear as a veil covering the horizon, eventually covering a large portion of the sky. A few hours before the typhoon landfall, low-lying clouds form which slowly become thick and dark, usually accompanied by rain.
3. **barometric pressure drop** – the atmospheric pressure may start to drop about 36 hours before typhoon landfall. This will continue as the storm approaches.
4. **abrupt changes in wind speed** – wind speed increases due to the drop in atmospheric pressure as air moves from an area with high pressure to low pressure. The increase in wind speed also increases the height of the ocean swell.

Thunderstorm

A thunderstorm is a small-scale storm accompanied by lightning and thunder. A typical thunderstorm only lasts about 30 minutes to an hour and may cover an area as small as 5 kilometers in diameter. However, they bring about other hazards such as strong winds and heavy rainfall. In extreme cases, they may be accompanied by hail or tornado.

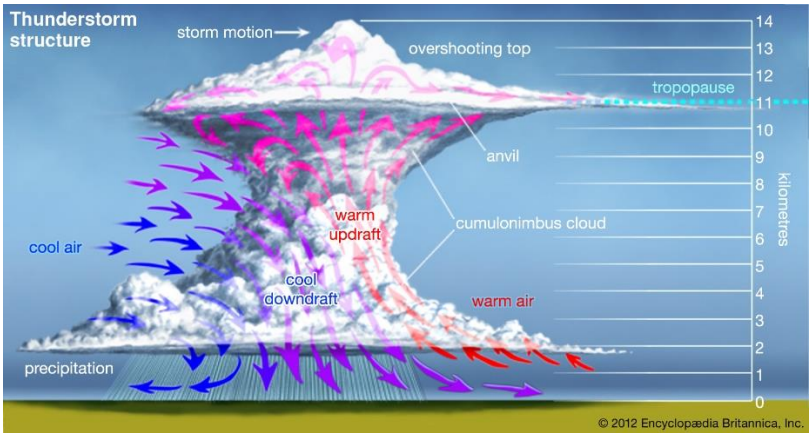


Figure 1: Structure of a thunderstorm

Source: https://cdn.britannica.com/28/24028-050-DD042B9F/updrafts-thunderstorm-Structure-atmosphere-downdrafts-thundercloud-top.jpg

The impending signs of a thunderstorm include the following:

1. **system of cumulonimbus clouds** – unequal heating of the Earth's surface cause the upward movement of moist air, forming a tower of cumulonimbus clouds that continuously accumulate in the sky, signaling an incoming thunderstorm (Figure 1).

2. **the sky turns dark** – the cumulonimbus clouds filled with water droplets serve as a barrier for sunlight. The sky darkens with a greyish tint or may also have hues of green, yellow, or violet. As clouds start to have dark bases, they may be in the process of becoming thunderstorm clouds.
3. **lightning and thunder**– flashes of lightning followed by thunder may be observed. This may occur even before the rain falls. In some cases, thunder that follows the lightning is inaudible which could mean that the thunderstorm is approaching or forming from a distance. As the atmosphere is becoming electrically charged, a radio static may also be experienced.
4. **gusts of wind and change in wind direction** – Figure 1 shows downdrafts which are rapidly descending air columns. Downbursts descend even faster and maybe as strong as a tornado.

Storm surge

Storm surge is a rapid rise of seawater above normal sea level on the coast, generated by strong winds brought about by typhoons and thunderstorms. This means that the impending signs of storm surge are similar to that of the two aforementioned hazards. Unlike a tsunami that has visual signs such as receding water level, a storm surge is a rather fast and unexpected hazard that can sneak in anytime during a storm. It is advised that residents of low-lying coastal areas should evacuate upon observing signs of an incoming storm.

Flood and Flashflood

The flood occurs when land areas which are normally not covered with water are being submerged, often after heavy and continuous rainfall. In some cases, heavy rainfall may cause temporary overflow from bodies of water, adjacent lands, or floodplains causing the flood. The impending signs of the flood are similar to that of typhoons or thunderstorms as they are usually accompanied by rain. People should also watch out for overflowing water from manholes as this could mean that the area may be flooded soon. Flooding may last for days and even weeks.

Flashflood is a flood characterized by a raging current that occurs when the water level rises due to heavy rainfall. Unlike flood, flashflood lasts from a few minutes to a few hours only. It is common along rivers, mountain canyons, coastline, creeks, and even urban areas. The impending signs of a flashflood include the following:

1. **weather forecasts typhoon or thunderstorm** – they may bring intense and prolonged rainfall.
2. **water collecting in puddles and rapidly rising water** – this could mean that the ground is saturated with water and flooding may follow. Water could be stocked up in a distant area and a flash flood could occur anytime soon.
3. **muddy water** – this may mean that calm water has been disturbed and the dirt has mixed with the water.
4. **roaring sound from upstream** – this may be from stones, branches, or logs being carried in the water.
5. **floating debris in water** – twigs, leaves, and sticks may be from bigger branches and logs carried by the water.

Hydrometeorological hazard maps

A hydrometeorological hazard map is a guide that highlights areas that are vulnerable to potential hazards like storm surge, typhoon, and flood. They are created to identify the areas that are prone to or affected these hydrometeorological hazards. Hazard maps can also help prevent serious damage and deaths.

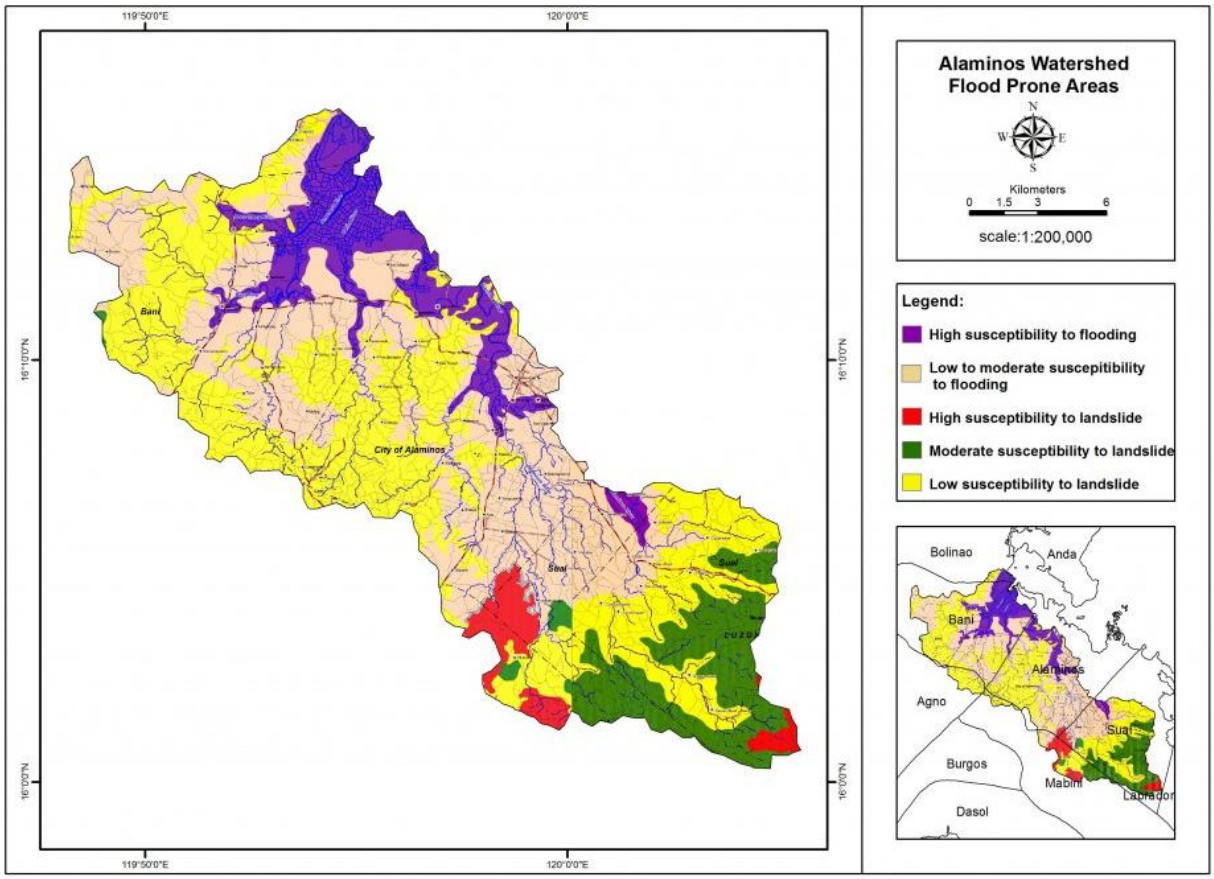


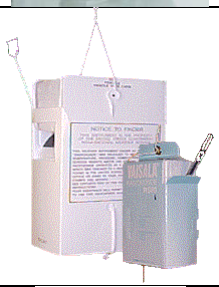
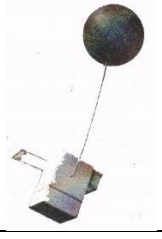
Figure 2: Flood and Landslide Hazard Map of Alaminos Watershed

Source: https://phil-lidar.iccem.com.ph/wp-content/uploads/2015/02/alaminos-1024x724.jpg

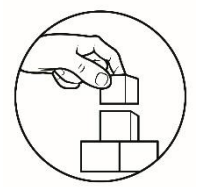
Figure 2 shows that areas in the northern part of Alaminos are highly susceptible to flooding. The hazard map can inform people about where they can relocate before they can be affected by the disaster. By knowing the possible threats in their area, they can plan accordingly and act to prevent any damage or devastating effect of the disaster.

Tools for Monitoring Hydrometeorological Hazards

Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA), as the National Meteorological and Hydrological Services (NMHS) of the Philippines is authorized in providing the warning for the public safety of the people. They used various instruments to monitor environmental conditions. You may be familiar with common weather instruments such as thermometer, anemometer, barometer, rain gauge, and sling psychrometer. They are still used today. Below are other tools used to monitor weather and hydrometeorological hazards:

Image	Instrument Description
	**Barograph –** a barometer that reads and records atmospheric pressure continuously. *Source: https://upload.wikimedia.org/wikipedia/commons/8/8c/Barograph_01.jpg*
	**Thermograph** – an instrument that measures and records air temperature continuously. *Source: https://upload.wikimedia.org/wikipedia/commons/8/8a/Thermograph_hg.jpg*
	**Ceiling light projector -** an instrument that projects a light beam to the clouds. *Source: http://bagong.pagasa.dost.gov.ph/themes/hiraia//assets/images/learning_tools/weather_instruments/ceiling_projector.jpg*
	**Clinometer –** an instrument that determines the height of the cloud base by measuring the distance of the cloud base to the ground. *Source: https://upload.wikimedia.org/wikipedia/commons/b/b2/Clinometer_commonly_used_by_foresters.JPG*
	**Ceiling balloon –** a balloon filled with hydrogen or other gas lighter than air, which is used to determine the height of the cloud base. This is done by measuring the time that the balloon disappears into the clouds from the time that it is released. *Source: https://upload.wikimedia.org/wikipedia/commons/b/b4/NWS_weather_balloon_station%2C_Riverton_WY.jpg*
	**Theodolite –** an instrument that determines wind speed and direction. It is attached to a hydrogen-filled pilot balloon and is allowed to float in the atmosphere at different heights to reach its different levels. *Source: https://upload.wikimedia.org/wikipedia/commons/6/6b/Th1_theodolite.jpg*
	**Radiosonde** – an instrument attached to a balloon and is used to measure temperature, pressure, and relative humidity in the atmosphere. It is equipped with a transmitter that sends data to a radiosonde receiver on the ground. *Source: http://bagong.pagasa.dost.gov.ph/themes/hiraia//assets/images/learning_tools/weather_instruments/radiosonde.gif*
	A **rawinsonde** is like a radiosonde, but it is also capable of measuring wind velocity *Source: http://bagong.pagasa.dost.gov.ph/themes/hiraia//assets/images/learning_tools/weather_instruments/radiosonde.jpg*

	**Wind finding radar** – it measures wind speed and direction thru radar echoes. It works by attaching a radar target to a balloon that is sent to the atmosphere. The time interval and bearing of the radar echoes are evaluated by a receiver ground radar. *Source: https://upload.wikimedia.org/wikipedia/commons/a/aa/Darwin_Ap_WF3_Radar.jpg*
	**Weather Surveillance Radar** - it detects and monitors the track of typhoons and cloud masses within 400 kilometers. *Source: https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcTHDs-zsVRNXYIVFAJpg0h4APHRcwydH76SHA&usqp=CAU*
	**Doppler Radar -** calculates the motion of precipitation, estimates its type, and determines the structure of storms and their potential to cause severe weather. *Source: https://upload.wikimedia.org/wikipedia/commons/f/f0/Advanced_Radar_for_Meteorological_and_Operational_Research.jpg*
	**Weather Satellite -** provides the synoptic view and coverage area of a weather disturbance and the capability to relay weather data from remote automatic weather stations. *Source: https://assets.climatecentral.org/images/made/2_27_13_Brian_GPMSatelliteSpace_1050_788_s_c1_c_c.jpg*



What's More

Activity 2. What is happening?

Directions: Analyze the given situations or events. Write the hydrometeorological hazard that you can associate with these situations. Choose from the list of hydrometeorological hazards in the box below. You may have more than one answer for each item.

flashflood	Flood	storm surge	thunderstorm	typhoon

Situation/ event	Associated hydrometeorological hazard
1. Heavy rainfall	

2. Puddles of water	
3. Strong winds	
4. Dark clouds	
5. Thunder and lightning	

Guide question:

How can you relate the observation of changes in the surroundings to the preparation for a hydrometeorological disaster such as typhoon, storm surge, flash flood, etc.?

_____
_____
_____

Activity 3. Watch out!

Directions: The signs of an approaching thunderstorm can be seen, heard, and felt by anyone. They can also be detected by meteorologists. Write the signs of an impending thunderstorm in the appropriate column.

Guide question:

What should you do if you observe the signs of an impending disaster such as a thunderstorm?

_____
_____
_____

Activity 4. Flood risk

Directions: Study the flood hazard map of Metro Manila below and answer the questions that follow.

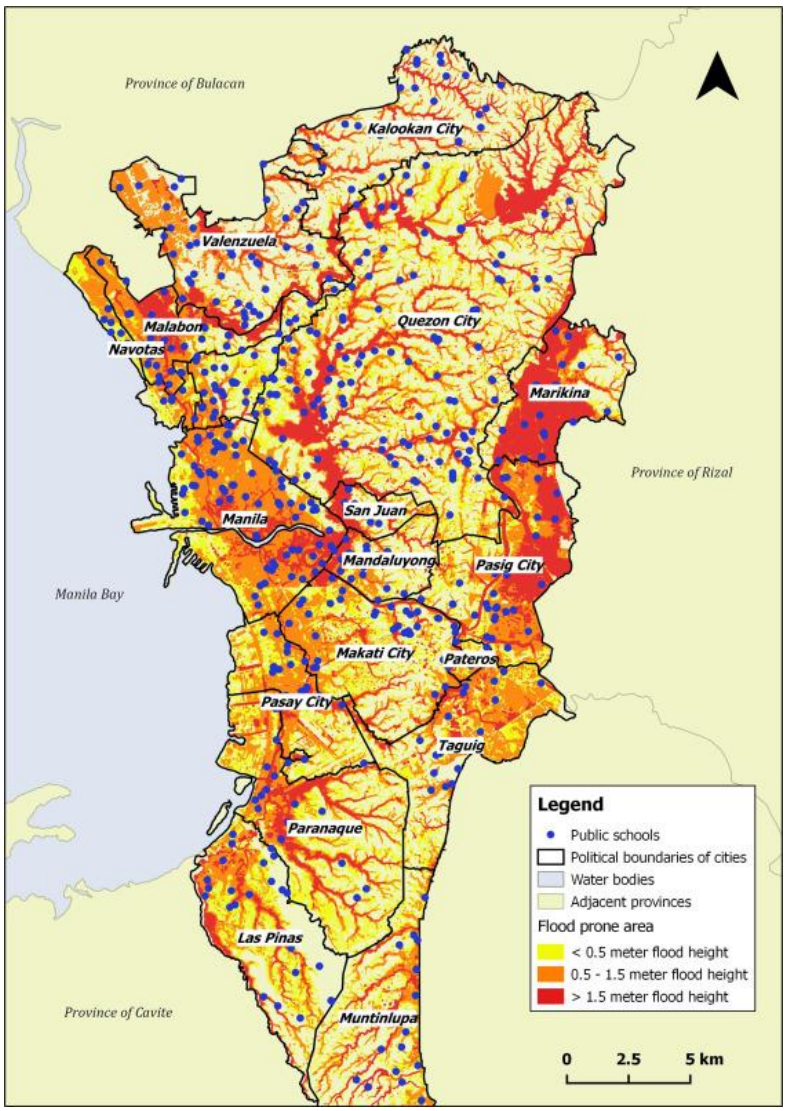


Image source: https://ars.els-cdn.com/content/image/1-s2.0-S2212420917302200-gr2.jpg

Answer the questions:

1. According to the hazard map, which localities would be affected as a whole by flooding?

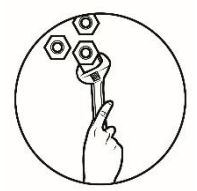
   _____
   _____
   _____

2. What measures can be done by these localities to address this concern?

   _____
   _____
   _____

What I Have Learned

1. What are the signs of different hydrometeorological hazards?
2. What information can you obtain from hazard maps?
3. What tools are used to monitor hydrometeorological hazards?



What I Can Do

Common hydrometeorological hazards affecting the Philippines come in the forms of typhoons, storm surge, and flood. Extend your help to your community as a young citizen by sharing what you have learned in this module.

Directions: Interview an adult in your family or barangay about hydrometeorological disasters that they have experienced. Share to them the signs of those impending hazards. Let them recall if they recognized those signs.

Assessment

Directions: Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which is a sign of an impending typhoon?
   A. receding water
   B. continuous rainfall
   C. drop-in temperature
   D. rapid rise of water level

2. Which of the following would lead to raising a storm surge alert?
   A. calm seas
   B. muddy water
   C. public storm signal announcement
   D. None of the above.

3. Which of the following would be observed before a flood?
   A. overflowing water in nearby bodies of water
   B. overflowing water in manholes
   C. heavy rainfall

D. All of the above.

4. Which of the following would indicate that a typhoon is coming?
   A. a drop in atmospheric pressure
   B. heavy and prolonged rainfall
   C. observed lightning and thunder in the sky
   D. a column of cumulonimbus clouds form in the sky

5. Why is it necessary for people to recognize signs of an impending disaster?
   A. to be able to prepare for the hazard
   B. to inform others of the impending disaster
   C. to minimize and prevent the negative outcome
   D. All of the above

6. Which of the following information can be obtained in a flash flood hazard map?
   A. location of nearby bodies of water
   B. areas that could be affected by flashflood
   C. history of water level from previous flash floods
   D. All of the above.

7. Which instrument can be used to monitor the motion of precipitation, its type and determines the structure of typhoons and thunderstorms?
   A. Ceiling balloon
   B. Doppler Radar
   C. Radiosonde
   D. Theodolite

8. What would be observed in the ocean before a typhoon or thunderstorm?
   A. calm waters
   B. heavy rainfall
   C. ocean swell
   D. radio static

9. What role do meteorologists play in disaster readiness and risk reduction?
   A. They warn the people of an impending disaster.
   B. They develop methods to provide accurate weather forecasts.
   C. They interpret observations obtained from weather instruments.
   D. All of the above.

10. Which of the following instruments provides a view of the coverage area of a weather disturbance such as a typhoon?
   A. Thermograph
   B. Weather satellite
   C. Rawinsonde
   D. Clinometer

11. Which of the following signs would indicate that a flash flood could happen?
   A. strong winds
   B. flashes of lightning

C. water in a river turns cloudy
D. None of the above.

12. Which of the following is NOT true about a thunderstorm?
    A. It lasts for a few days.
    B. It can cause radio static.
    C. It is accompanied by rainfall.
    D. It covers a relatively small area, about a few kilometers in diameter.

13. Which hydrometeorological hazard could happen if the sky begins to have dark cloud formations?
    A. flood
    B. thunderstorm
    C. typhoon
    D. All of the above.

14. What information does a hazard map provide a community?
    A. possible hazards that can hit the area
    B. areas where people can relocate or evacuate
    C. areas that are vulnerable and safe to a hazard
    D. All of the above.

15. Which could be a sign that a flood could occur in the area?
    A. water levels are rising
    B. manholes in the street are overflowing
    C. weather forecast reported an incoming strong typhoon
    D. All of the above.

Additional Activities

Directions: Go to your local barangay or municipal office and check what hazard maps and early warning systems are being used to prepare the local community on certain hydrometeorological events. List down the possible hydrometeorological hazards of your home and identify your susceptibility to different hazards.

Answer Key

What I Know

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

What's New

Activity 1

A.	NO	E.	YES
B.	YES	F.	NO
C.	YES	G.	NO
D.	YES	H.	YES

1. There will be signs in the surroundings such as presence of dark clouds, sudden wind change, humid surroundings, etc.
2. Answers may vary. Changes in the surroundings serve as signs of an impending event. Being aware of these changes can help a person plan his activities.

What's More

Activity 2

1. Flashflood, flood, thunderstorm, typhoon, storm surge
2. flashflood, flood
3. typhoon, thunderstorm, storm surge
4. thunderstorm, typhoon, storm surge, flashflood, flood
5. Thunderstorm, storm surge

Answers may vary. The observation of the changes in the surroundings would help to prevent or lessen the negative effects of hydrometeorological disasters.

Activity 3

Answers may vary. I should inform my family members and take necessary actions to prevent it from causing harm.

Activity 4

1. Manila, Navotas, Malabon, Marikina

2. Answers may vary. These localities may conduct studies on the causes of flooding and how to reduce them. They could also conduct awareness programs to residents.

What I Have Learned

1. The signs may vary for different hydrometeorological hazards. These signs include increased ocean swell, changes in clouds, drop in atmospheric pressure, change in wind speed, lightning and thunder for typhoon, and thunderstorm. Signs for impending flashflood include muddy water, roaring sound from upstream or floating debris in water.
2. Hazard maps identify the areas which would likely be affected with the hazard.
3. Some monitoring tools for hydrometeorological hazards include barometer, thermograph, ceiling light projector, clinometer, ceiling balloon, theodolite, radiosonde, wind finding radar, weather surveillance radar, doppler radar and weather satellite.

Assessment

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

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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