



# GRADE 11 GEOGRAPHY

## UNIT MODULE 2

### NATURAL PROCESS AND DISASTERS

- |               |  |
|---------------|--|
| <b>11.2.1</b> | <b>Air Pressure and Global Wind Patterns</b> |
| <b>11.2.2</b> | <b>Climates of the World</b>                 |
| <b>11.2.3</b> | <b>Natural Vegetation</b>                    |
| <b>11.2.4</b> | <b>Natural Disasters</b>                     |



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**DIANA TEIT AKIS**



Flexible Open and Distance Education  
Papua New Guinea

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Papua New Guinea

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## SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is a part of the new Flexible, Open and Distance Education curriculum. The learning outcomes are student-centred and allows for them to be demonstrated and assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution, Government Policies and Reports. It is developed in line with the National Education Plan (2005 -2014) and addresses an increase in the number of school leavers affected by the lack of access into secondary and higher educational institutions.

Flexible, Open and Distance Education curriculum is guided by the Department of Education's Mission which is fivefold:

- to facilitate and promote the integral development of every individual
- to develop and encourage an education system satisfies the requirements of Papua New Guinea and its people
- to establish, preserve and improve standards of education throughout Papua New Guinea
- to make the benefits of such education available as widely as possible to all of the people
- to make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced to provide alternative and comparable pathways for students and adults to complete their education through a one system, many pathways and same outcomes.

It is our vision that Papua New Guineans' harness all appropriate and affordable technologies to pursue this program.

I commend all those teachers, curriculum writers, university lecturers and many others who have contributed in developing this course.

**UKE KOMBRA, PhD**

Secretary for Education



Below are the steps to guide you in your course study.

- Step 1: Carefully read through each module. In most cases, reading through a lesson once is not enough. It helps to read something over several times until you understand it.
- Step 2: There is an instruction below each activity that tells you to check your answers. Turn to the marking guide found at the end of each module and mark your own written answers against those listed under the **Answers to Activities**. Do each activity and mark your answers before moving on to the next part of the module.
- Step 3: After reading the summary of the unit module, start doing the Practice Exercise. Refer to the module notes. You must do only one practice exercise at a time.
- Step 4: Below each Learning activity, there is an instruction that says:

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 1.**

- Turn to the marking guide at the end of the Module Unit and mark your own written answers against those listed under the Answers to Learning Activity.
- Step 5: When you have completed a practice exercise and marked your answers, go back to the module and correct any mistakes you may have made before moving on to the next module.
- Step 6: Study the entire module following Steps 1, 2, 3, 4 and 5.

Here is a sample Study Timetable for you to use as a guide. Refer to it as a reminder of your study times.

TIME	MON	TUE	WED	THU	FRI
8:00-10:00	F O D E S T U D Y				
10:00-11:00					
1:00-2:00					
2:00-4:00					
6:00-7:00					
7:00-9:00	Listen to or watch current affairs programmes. Write your diary or read a book.				

A timetable will help you to remember when you should be doing your FODE studies each day.



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## UNIT MODULE 11.2: NATURAL PROCESSES AND DISASTERS

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### INTRODUCTION

This unit introduces you to the study of physical geography at the upper secondary level. The unit provides learning information about the elements of natural processes that influence the earth and the environment we all live in. The unit generally focuses on 'climate' and other processes linked to it.

This unit covers four main Topics.

1. **Air Pressure and Global Wind Patterns**
2. **Climates of the World**
3. **Natural Vegetation**
4. **Natural Disasters**

Throughout the unit you will learn about the natural processes. Natural processes are natural events, activities or happenings that influence our local PNG environment and the World wide environment.



### Objectives or aims

On successful completion of this module, students will be able to:

- discuss earth's movements and their effects
- define and explain pressure systems and global wind patterns
- describe and explain different types of world climates
- describe and explain world vegetation zones
- discuss natural hazards and suggest ways to manage the impact, with emphasis on PNG and the Pacific
- define important geographical terms
- use and apply related range of geographical skills
- communicate geographical information, ideas and issues using appropriate written and/or oral, cartographic and graphic forms if available.



### Time Frame

This unit should be completed within ten weeks.

If you set an average of 3 hours per day, you should be able to complete the unit comfortably by the end of the assigned week. Try to do all the learning activities and compare your answers with the ones provided at the end of the unit. If you do not get a particular exercise right in the first attempt, you should not get discouraged but instead, go back and attempt it again. If you still do not get it right after several attempts then you should seek help from your friend or even your tutor. Do not pass any question without solving it first.



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## TOPIC 11.2.1: AIR PRESSURE AND GLOBAL WIND PATTTERNS

---

### INTRODUCTION

This topic mainly provides the information about Atmospheric and Air Pressure. The Topic presents the two (2) main movements of the earth, and their effects on the earth that we live in. You will also discover that Earth's rotation causes day and night, and the difference of time in different places. You will also find out about the heating and cooling of the land and the sea, which is linked to the atmospheric or air pressure that exist in a particular area.

The low and high pressure is influenced by certain factors which you will study in this topic. You will also discover that the high and low pressure system will result in the formation of 'winds', blowing from a high pressure area to a low pressure area.

The different types of wind, their characteristics, and location will be part of the topic as well. Interesting natural events such as 'Coriolis Effects' and 'Monsoon' will also be discussed in the reading.



### Objectives or aims

- define important terms; earth's rotation, earth's revolution, orbit, air pressure, winds, high pressure, low pressure, global winds, local winds, convectional currents, on-shore winds, off-shore winds.
- compare and explain the importance of earth's rotation and earth's revolution
- explain the difference of time around the world
- state and distinguish the important line of latitudes and lines of longitudes
- explain why and how there are differential rates of heating and cooling over land and sea.
- explain how atmospheric or air pressure develops
- discuss the main factors that influence air pressure
- explain how winds develops
- compare and explain the global winds and local winds.



### Time Frame

This topic should be completed within (4) weeks.

If you set an average of 3 hours per day, you should be able to complete the unit comfortably by the end of the assigned week. Try to do all the learning activities and compare your answers with the ones provided at the end of the unit. If you do not get a particular exercise right in the first attempt, you should not get discouraged but instead, go back and attempt it again. If you still do not get it right after several attempts then you should seek help from your friend or even your tutor. Do not pass any question without solving it first.



### 11.2.1.1: The Movements of the Earth

---

Do you think the earth that we live in stays in one place and does not move? Have you ever felt the earth moving?

The earth does not stay in one place but it moves and you cannot feel that because the earth is moving very slowly.

#### Earth movements

There are two main types of earth movements. They are:

1. **Earth's Rotation**
2. **Earth's Revolution**

"Earth's rotation happens when the earth rotates or spins on its axis". The earth stays in the same position but spins on its own axis from east to west.

You can see a good example of the earth's rotation, when someone is spinning a ball on his/her finger tip. The ball spins or rotates while it sits on the fingertips.

Revolution means to move around someone or something in a complete circle or arriving back at the place you first started.

"Earth's revolution refers to the earth moving around the sun in a complete circular form". The word '**orbit**' is sometimes used in place of 'revolution'.

Earth's rotation and Earth's revolution occur at the same time. What happens is that the earth is rotating on its axis, while it revolves around the sun.

#### Earth's Movements and their effects

1. Rotation of the earth will cause the following things to happen.
  - a) Day and Night
  - b) A difference of 1 hour between two meridians or longitudes  $15^{\circ}$  apart.
  - c) The deflection of winds and ocean currents
  - d) The daily rising and falling of the tides
2. Revolution of the earth around the sun will result in;
  - a) Changing altitudes of the mid-day sun at different times of the year
  - b) The varying lengths of day and night at different times of the year
  - c) The four Seasons (summer, autumn, winter and spring)



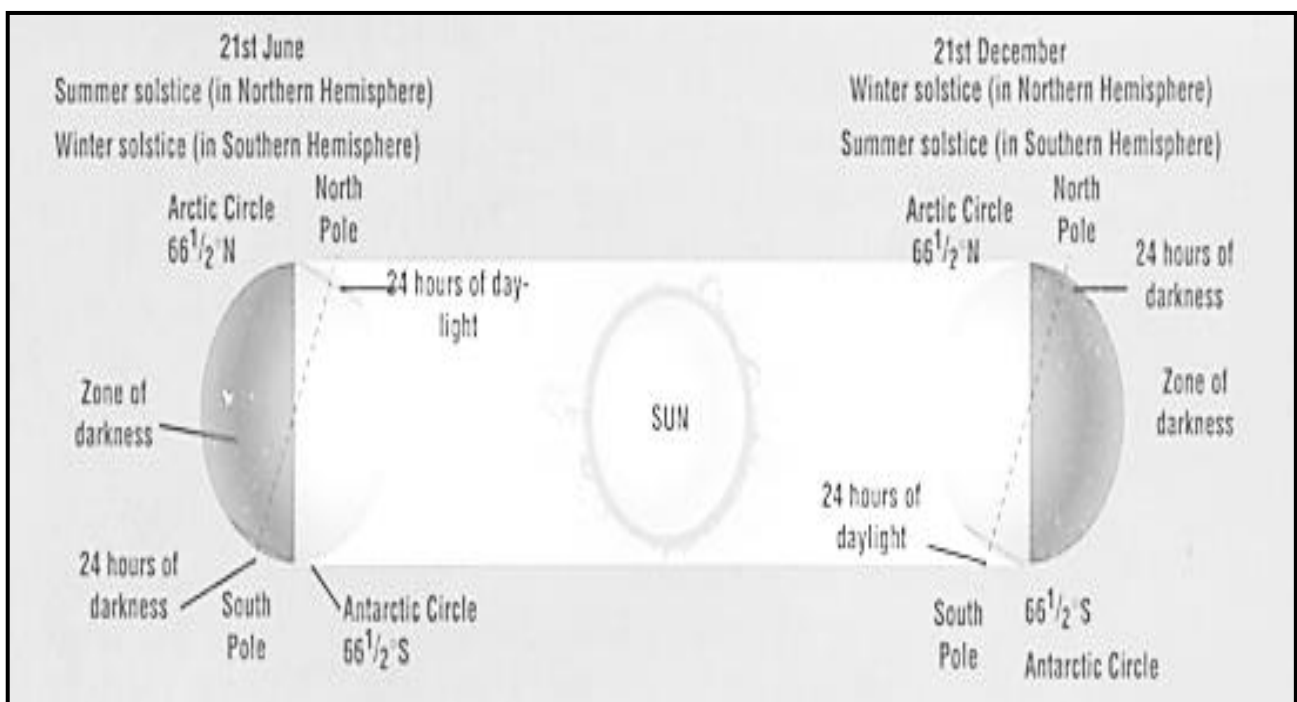


### How Day and Night occur

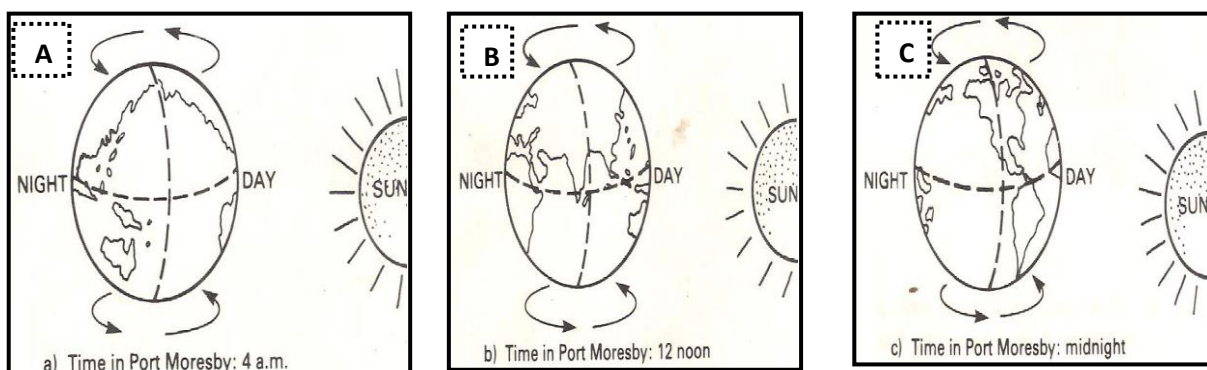
The earth we live in is round like a globe. When the sun shines on the earth's surface, the side facing or tilted towards the sun will be in light and the other side facing or tilted away from the sun will be in darkness. The side of the earth facing the sun will have day and the dark side of the earth will have night.

As the earth rotate slowly time changes from sunrise, to noon, to sunset, mid-night and to a new day. The change in day and night is a continuous cycle.

**Fig: 1.0 Day and Night.**



**Fig: 1.1 Changing day and night in Port Moresby, PNG.**





We will study how day changes to night in Papua New Guinea by using a global map and focusing on the map of Papua New Guinea. **Figure 1.1** above shows three different view of the earth facing the sun and the position of Papua New Guinea on the globe as the earth rotates. Remember that earth's rotation leads to day and night.

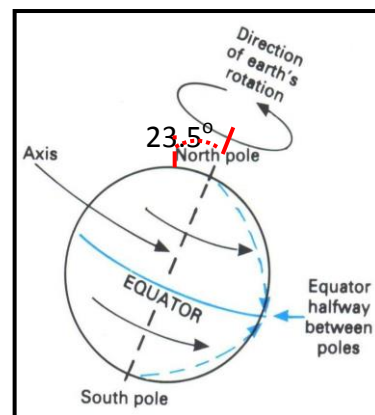
Can you see Papua New Guinea at diagram 'A,' on the global map? On its current location, PNG is turning towards the sun. Therefore Port Moresby is still 4 am in the morning at diagram 'A'. Every turn of  $15^\circ$  longitude means a change of 1 hour, as the earth keeps rotating the time in Port Moresby changes from 4 am to 5 am, and at 6 am we actually get to see the sun rises. Papua New Guinea is directly facing the sun at its position in diagram 'B', and the time is 12 noon. As the earth continues to rotate, Papua New Guinea will start to turn slowly away from the sun. At the position in diagram 'C', Papua New Guinea has turned completely away from the sun and its time is now 12 midnight.

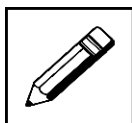
### Tilting of the earth

The earth's axis is tilted at an angle of  $23\frac{1}{2}^\circ$ . In December the Northern Hemisphere is tilted away from the sun and experiences winter. The sun is much more closer to the Southern hemisphere and summer occurs there. High pressure develops in the Northern Hemisphere as it is further away from the sun, and Low pressure develops in Southern Hemisphere as the sun is overhead and closer. The opposite occurrence takes place in July when the Northern hemisphere is tilted closer to the sun with the Southern hemisphere tilted away from the sun.

Now do activity on the next page.

**Fig: 1.2 Earth's Tilt.**





### Student Activity 1

1. Define each type of earth movement.

i) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

ii) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. List 2 effects for each type of earth movement.

i) a. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

b. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. What is the angle in which the earth is tilted? \_\_\_\_\_

4. Explain in your own words how day and night take place.

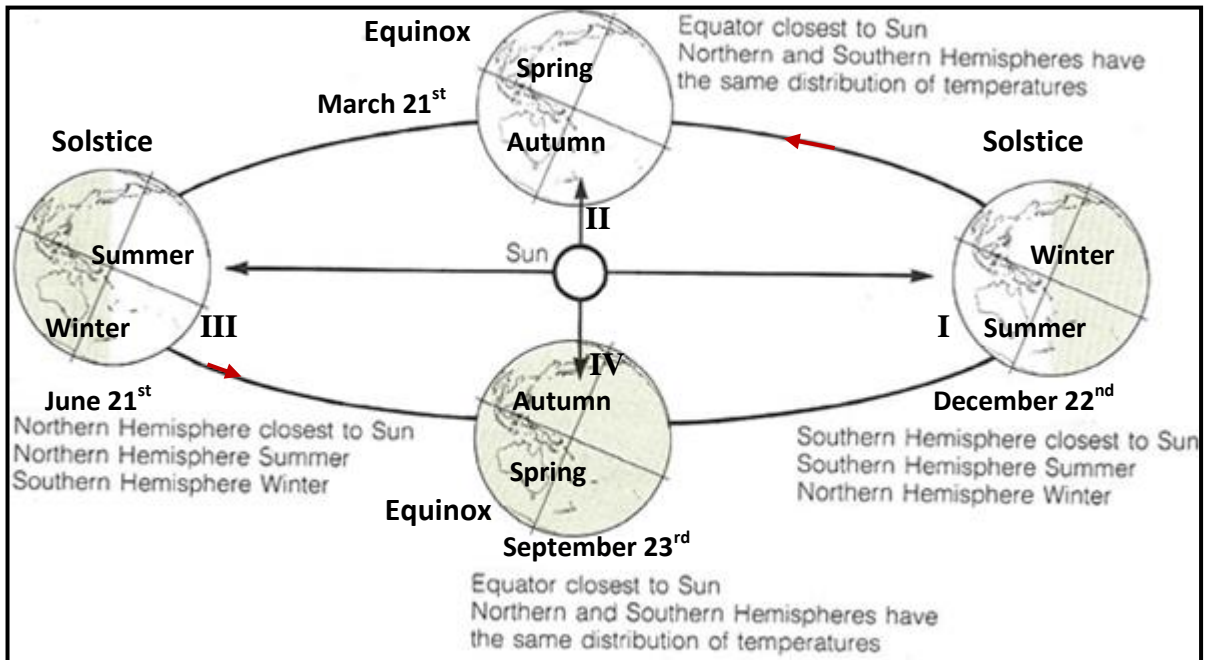
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



How does the seasonal cycle happen?

Fig: 1.3 Seasonal Cycle



The diagram above shows the seasonal cycle of the four seasons; summer, autumn, winter, spring in the correct order of occurrence.

The two main seasons are summer and winter. The two seasons in between are spring and autumn.

Each season has a length of three months to start and finish its cycle. The four positions of the earth around the sun shows the time when each type of season is experienced.

Study the table to understand the months when each season occurs in relation to the position of the earth and the type of season in each hemisphere.

Fig: 1.4 Correct order of seasons in each hemisphere.

Earth's Position	Months	Seasons in the <i>Northern Hemisphere</i>	Seasons in the <i>Southern Hemisphere</i>
I	Dec – Feb	Winter	Summer
II	Mar – May	Spring	Autumn
III	Jun – Aug	Summer	Winter
IV	Sep – Nov	Autumn	Spring



## Features of the Four Seasons

**Summer** is very hot and it is the harvesting season. Animals look for water and they wander around waterholes.

**Autumn** is also known as 'fall' and it is generally cool. In autumn, trees stop producing their sap or the liquid in the trees needed for leaves to grow and make their food. Leaves start to fall during this season, hence the name 'fall'. Animals build shelters, collect and store food to have during winter.

**Winter** is cold and snow falls are experienced. During winter the trees stand bare with no leaves. Animals and plants lie dormant or go to sleep (hibernate), waiting for the spring season to come.

**Spring** has warm conditions and it is the season of 'new beginnings and growth' when animal and plant life are very busy. New plants grow, while other plants are pollinated and bear flowers and fruits. The animals mate during this season and young animals are born, and they start to grow.

## Comparison of Equinoxes and Solstices

The term 'equinoxes' means 'equal night and day'. Equal hours of day and night will be experienced in both the Southern and Northern hemisphere. This occurs only during spring and autumn equinoxes on the 21<sup>st</sup> March and 23<sup>rd</sup> September when the sun is above the equator.

The word 'solstices' means 'sun standing still'. In the Northern Hemisphere, winter solstice is on 22<sup>nd</sup>, December and the summer solstice is on 21<sup>st</sup> June. Solstices link to the unequal length of day and night. This occurs when the sun is above the Tropic of Cancer on June 21<sup>st</sup> in the Northern hemisphere, and over the Tropic of Capricorn on December 22<sup>nd</sup> in the Southern Hemisphere.

**Summer will have longer days and shorter nights, while winter has longer nights and shorter days.**

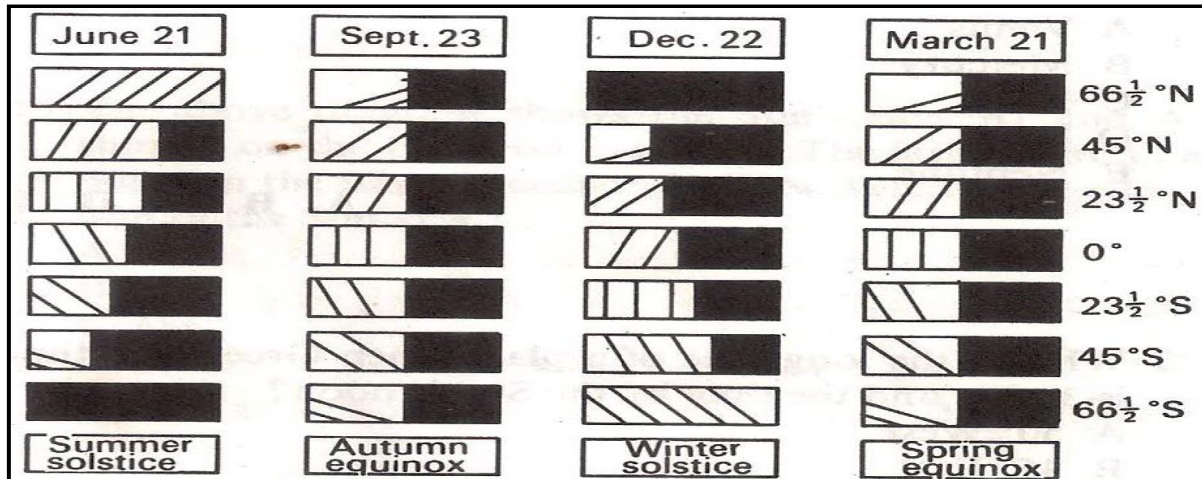
At the Equator there is little change with seasons. The further away from the Equator, the greater the difference between summer and winter. There are 12 hours of daylight and 12 hours of darkness every day at the Equator. The further away from the Equator, the greater the changes with the number of daylight hours.

Study **figure 1.5** on the next page to see how 24 hours of daylight and 24 hours of darkness is experienced during the summer and winter solstices to the North and South Pole. The North Pole has 24 hours of daylight during summer (21<sup>st</sup> June) and 24 hours of darkness (22<sup>nd</sup> December) in winter. The reverse happens in the South Pole where there is 24 hours of



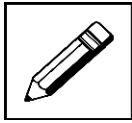
darkness in winter (21<sup>st</sup> June) and 24 hours of day light (22<sup>nd</sup> December) during summer. Refer to **figure 1.0** on page 9 to see how this is possible.

**Fig: 1.5 Length of day and night.**



*Each rectangle represents 24 hours. Night is shaded and day is left white.  
The lines in the rectangle represent the altitude and/or angle of the sun at mid-day.*

Now turn to the next page and do activity 2



## Student Activity 2

1. Which of these countries will have summer in the middle of the year?

A. New Zealand      B. Australia      C. South Africa      D. USA

2. What type of season will a country in Europe have in January?

---

3. What is the difference between a Solstice and an equinox?

---

4. What season will there be long nights and shorter days?

---

5. The Poles will have 24 hours day during what season?

---

---

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.1.2: Earth's Rotation and Time

#### Test your knowledge:

- Is PNG located right on the Equator?
- Do you think PNG is situated in the Western Hemisphere?
- Is the Tropic of Cancer in the Northern Hemisphere?

#### Important lines of Longitude and Latitudes

**Latitudes** – imaginary horizontal lines that runs across the globe from east to west. The lines run parallel to each other.

**Longitudes** – imaginary vertical lines that runs from the top to bottom or north to south of the globe. The lines meet at the north and south poles.

Fig: 1.6 Main climate zones and the important lines of latitude and longitude.

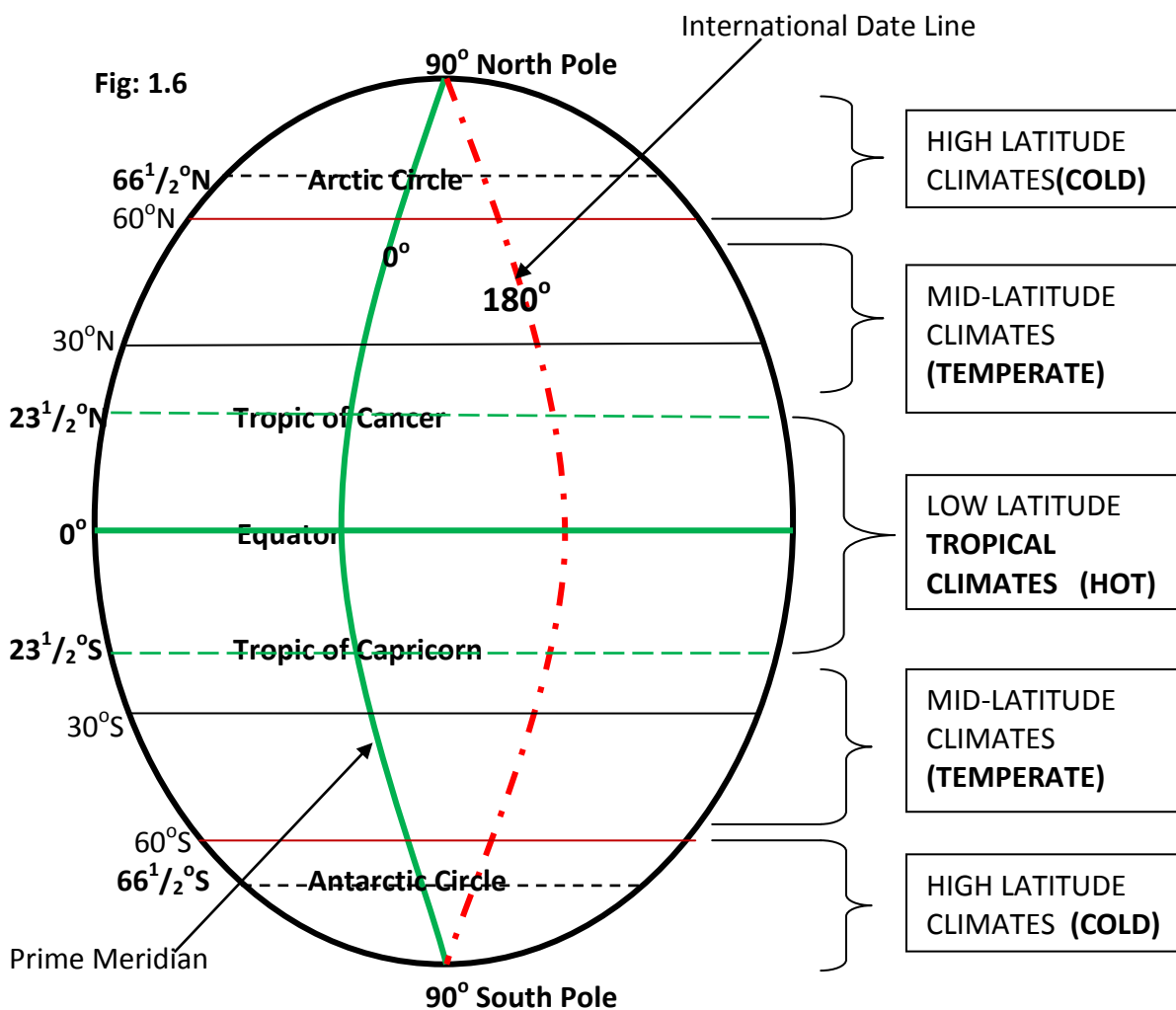
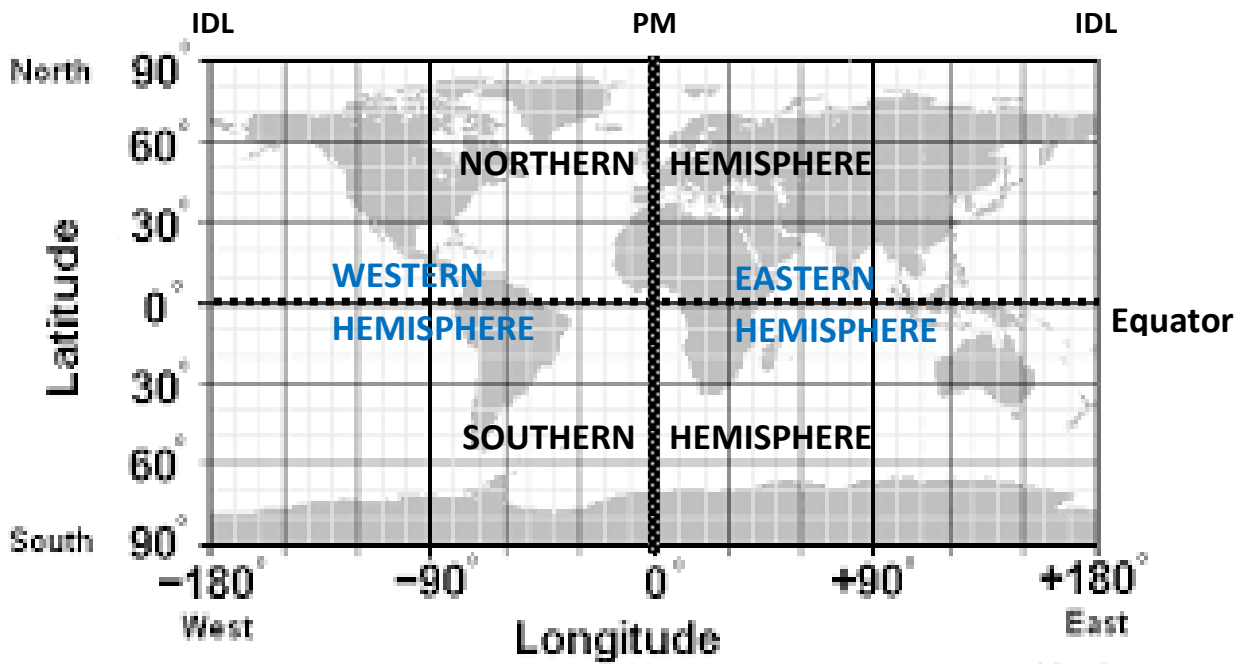






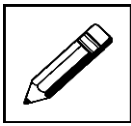
Fig: 1.7 distinguishing the four (4) different Hemispheres.



**Equator** divides Northern and Southern Hemisphere.  
**Prime Meridian** divides the Eastern and Western Hemisphere.

**PM** – Prime Meridian  
**IDL** – International Date Line

Now do activity 3 on the next page.



### Student Activity 3

1. Define the meaning for 'lines of Longitude' and 'lines of Latitude'.  
Latitude \_\_\_\_\_  
Longitude \_\_\_\_\_
  
2. What other names can you use to refer to the lines of latitude?  
\_\_\_\_\_
  
3. A line of longitude is also known by other names. What are those names?  
\_\_\_\_\_
  
4. Give the definition to these important lines of longitude and latitude.
  - i. Equator – \_\_\_\_\_
  - ii. Prime Meridian – \_\_\_\_\_
  - iii. International Date Line – \_\_\_\_\_
  - iv. Tropic of Cancer – \_\_\_\_\_
  - v. Tropic of Capricorn – \_\_\_\_\_
  - vi. Arctic Circle – \_\_\_\_\_
  - vii. Antarctic Circle – \_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



## Greenwich Mean Time and Local Time

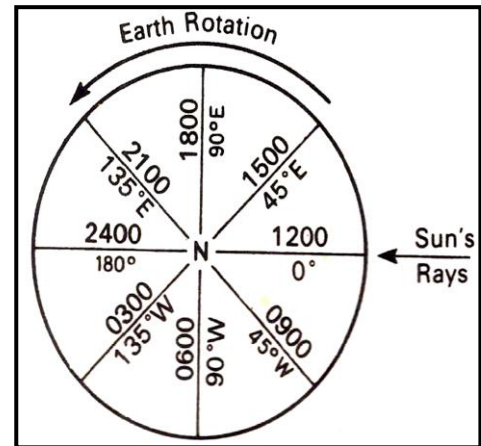
When the Greenwich Prime Meridian ( $0^{\circ}$ ) lies under the sun the local time along this meridian or longitude is 12 noon, but this local time is 1200 noon Greenwich Mean Time or G.M.T.

### Behind and Ahead of G.M.T

All meridians or longitudes to the east of Greenwich Meridian have sunrise before that Meridian. Local times along these meridians are therefore ahead of G.M.T.

Meridians to the west of Greenwich Meridian have sunrise after this meridian and therefore their local times are behind G.M.T.

**Fig: 1.8 different times at different longitudes or meridians.**



**Overhead view at the North Pole is shown above.**

### Significance of the International Date Line (IDL)

International Date Line is the line at which a day is lost or gained. If you are in PNG and you cross the IDL, you will subtract a day (e.g. Monday in PNG, when you cross over the IDL you will discover that places in the Western Hemisphere are still on Sunday).

### Time Zone

#### Facts:

Do you know that when you have your breakfast, people in countries west of PNG are still in bed?

Do you know that lines of longitudes separate times, and not the lines of latitudes?

Do you know that London has a different time to PNG and Japan?

Do you know that Port Moresby has the same time as Sydney?

Do you know that when it's Monday in PNG, it is Sunday in USA, which is a day behind?

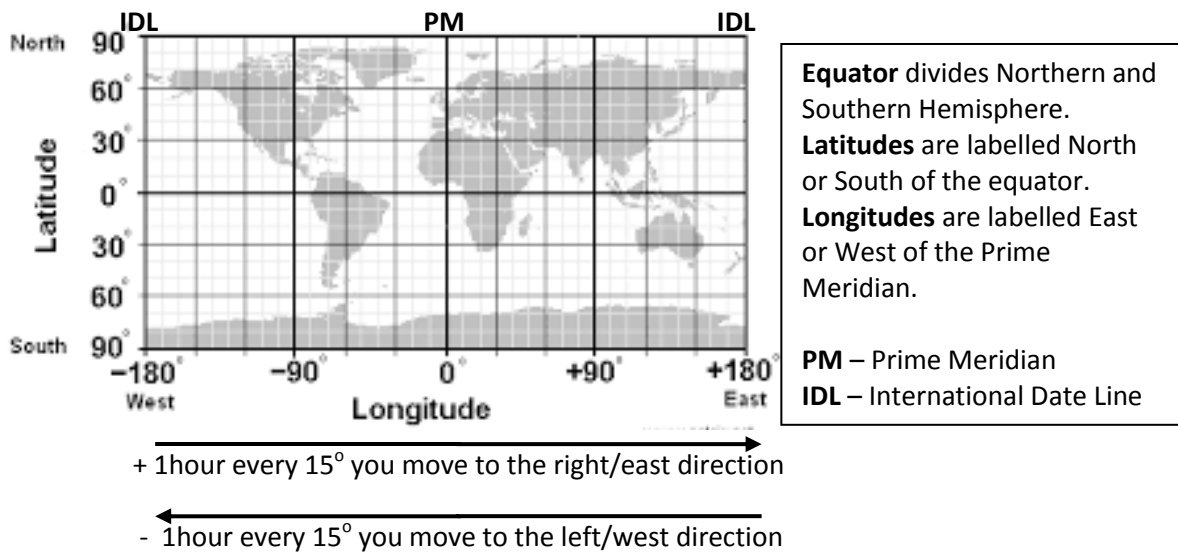
**Turn to the next page to find out more about time in different locations.**

**Fig: 1.9 World map showing different Time Zones****Calculating Time**

1. The earth takes 24 hours to complete a rotation, therefore, the earth is divided into 24 time zones.
2. 1 complete rotation =  $360^\circ$ , so 24 time zones means each zone covers  $15^\circ$  of longitude ( $15^\circ \times 24 = 360^\circ$ )
3. Every  $15^\circ$  longitude rotation of the earth takes 1 hour.
4. Earth rotates towards the east; so places in the East see the sun rise first and are ahead in time from places in the West.
5. Each new day begins in the time zone to the west of the IDL, that is in the Eastern Hemisphere.
6. When you are calculating time between 2 places within the same hemisphere (e.g. PNG and Bangladesh in the eastern hemisphere), you find the difference of longitudes to work out whether the time is ahead or behind between the 2 places (e.g. Port Moresby is  $150^\circ\text{E}$  and Bangladesh is  $90^\circ\text{E}$ . Subtract  $90^\circ\text{E}$  from  $150^\circ\text{E}$  before you continue working out)  
 **$150^\circ\text{E} - 90^\circ\text{E} = 60^\circ$ .  $60^\circ \div 15^\circ = 4$  hours. Port Moresby is 4 hours ahead of Bangladesh, and Bangladesh is 4 hours behind Port Moresby.**
7. When you are finding time between a location in the Eastern hemisphere and a location in the Western Hemisphere (e.g. Port Moresby and Guatemala City), you add the longitude to work out whether the time is ahead or behind between the 2 places (e.g. Port Moresby is  $150^\circ\text{E}$  and Guatemala City is  $90^\circ\text{W}$ . Add  $90^\circ\text{E}$  to  $150^\circ\text{E}$  before you continue working out)  
 **$150^\circ\text{E} + 90^\circ\text{W} = 240^\circ$ .  $240^\circ \div 15^\circ = 16$  hours. Port Moresby is 16 hours ahead of Guatemala City, and Guatemala City is 16 hours behind Port Moresby.**

**Note:**

- 1) If all longitude numbers are increasing from  $0^\circ$  Prime Meridian (PM) to the  $180^\circ$  IDL. You will add (+) 1 hour for every  $15^\circ$ .
- 2) If all longitude numbers are decreasing from the IDL to the Prime Meridian (PM). You will subtract (-) 1 hour for every  $15^\circ$ .

**Fig: 1.10. Prime Meridian separates the east from the west****Example:**

Harry Potter lives in London (which is  $0^\circ$  Prime Meridian) and his aunt lives in country X which is located at  $60^\circ$ E. Harry Potter wakes up at 7:00 am in London; he then decides to call his aunt in city X.

**What would be the time in city X?**

**Working out:**

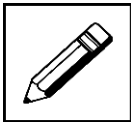
Harry Potter is at Prime Meridian ( $0^\circ$ ), & Aunt at  $60^\circ$ E

$60^\circ$  divide by  $15^\circ = 4$  hours

Check if city X is ahead or behind time from London

City X is East of London, and it is in the Eastern Hemisphere so city X would be +4 hours ahead of London. So you add 4 hours to 7:00 am (7:00am + 4 hours) and this gives you 11:00 am.

So the time at city X is 11 am while it is 7 am in London.



### Student Activity 4

1. Is London ahead or behind time from Los Angeles?  
\_\_\_\_\_
2. Is Los Angeles ahead or behind time from London?  
\_\_\_\_\_
3. How many hours separate London from Los Angeles ( $120^{\circ}\text{W}$ )?  
\_\_\_\_\_
4. How many hours separate PNG ( $150^{\circ}\text{E}$ ) and Philippines ( $120^{\circ}\text{E}$ )?  
\_\_\_\_\_
5. Sibasi called at 8:00 am in Darwin ( $130^{\circ}\text{E}$ ) to talk to his brother LJ in Canberra. What would be the time in Canberra?  
\_\_\_\_\_
6. If the time in PNG is 10: 00 am, then what would the time be in the following places
  - a) Tokyo \_\_\_\_\_
  - b) Israel \_\_\_\_\_
  - c) Tonga \_\_\_\_\_
7. An Area at  $175^{\circ}\text{E}$  is Monday 12: 00 noon. What is the time and day at the following places?

Locations	Time	Day
a) Prime Meridian		
b) $55^{\circ}\text{E}$		
c) $30^{\circ}\text{W}$		
d) $55^{\circ}\text{W}$		
e) $175^{\circ}\text{W}$		
f) $150^{\circ}\text{E}$		

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.1.3: Differential heating and Cooling of Land and Sea

The land heats up quickly during the day and loses heat (cools down) quickly during the night. This means that the land is hot during the day and cold during the night.

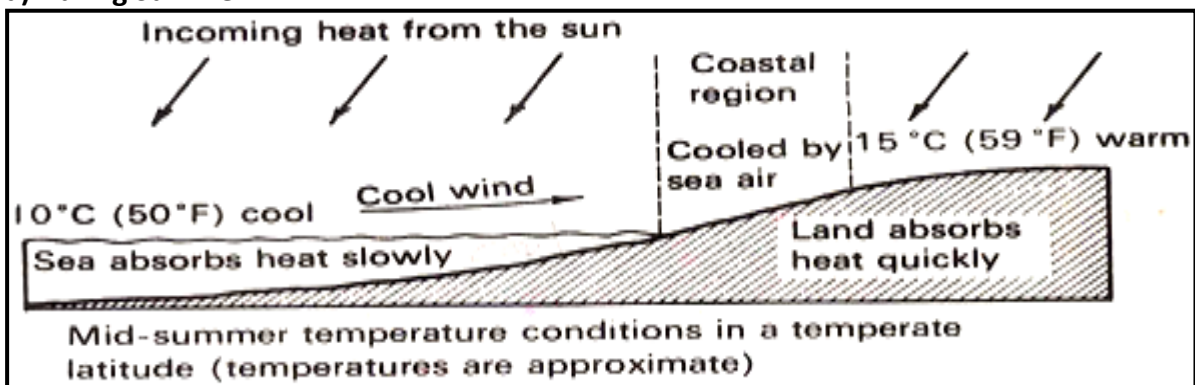
The sea heats up slowly during the day and loses heat (cools down) slowly during the night. This leads to the sea being cool during the day and warm during the night.

**Remember:**

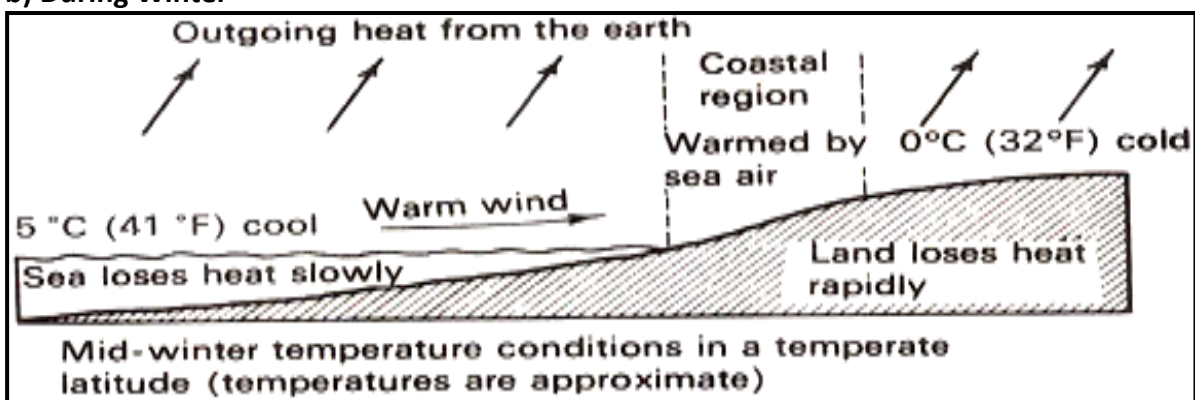
**Land heats up quickly and cools down quickly while the Sea heats up slowly and cools down slowly.**

**Fig: 1.11 Heating and Cooling of Land and Sea during Winter & Summer.**

**a) During Summer**



**b) During Winter**



The way in which the land and the sea heat up during the day and cool during the night happens as well in summer and winter.

During summer, the land heats up quickly because of plentiful sunlight while the sea heats up slowly. In winter, the land cools down quickly while the sea cools down slowly.

**What causes the land to heat up quickly and the sea to cool down quickly?**

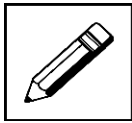
Different places receive different amount of heat depending on the molecules that forms the land and the sea.

The land, sea and air and their ability to gain and loose heat depends on their molecule structure. The land is solid and its molecule structure is compact together and heat is gained quickly as it spreads quickly. Sea, being liquid has molecules spaced further apart from each other. This means heat passes very slowly through the molecule structure from one particle to the next.

The land has solid molecules (particles are closed together) that enables heat or the cooling effect to pass easily to all the particles very quickly.

Now do activity 5 on the next page.





### Student Learning Activity 5

1. What is the most important rule about the heating and cooling of land and sea?

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2. Is it the land or the sea that is hot during the day?

---

3. Is it the land or the sea that has high pressure during the day?

---

4. Is it low or high pressure on land during the summer?

---

5. Is the sea warm or cool during the winter?

---

6. Why are places on the coast cooler in summer and warmer in winter, while places further inland are very hot in summer and very cold in winter? Because \_\_\_\_\_

- A. the land is cooler in summer.
- B. the sea is cooler in winter.
- C. of the warm sea breeze during winter and cool sea breeze in summer.
- D. of the warm sea breeze in summer, and cool sea breeze in winter.

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.1.4: Atmospheric or Air Pressure

#### Define terms:

**Air or atmospheric pressure** – is the weight (density) of air pushing down on the earth's surface at a particular point.

**Pressure systems** – is the result of temperature difference over the earth's surface.

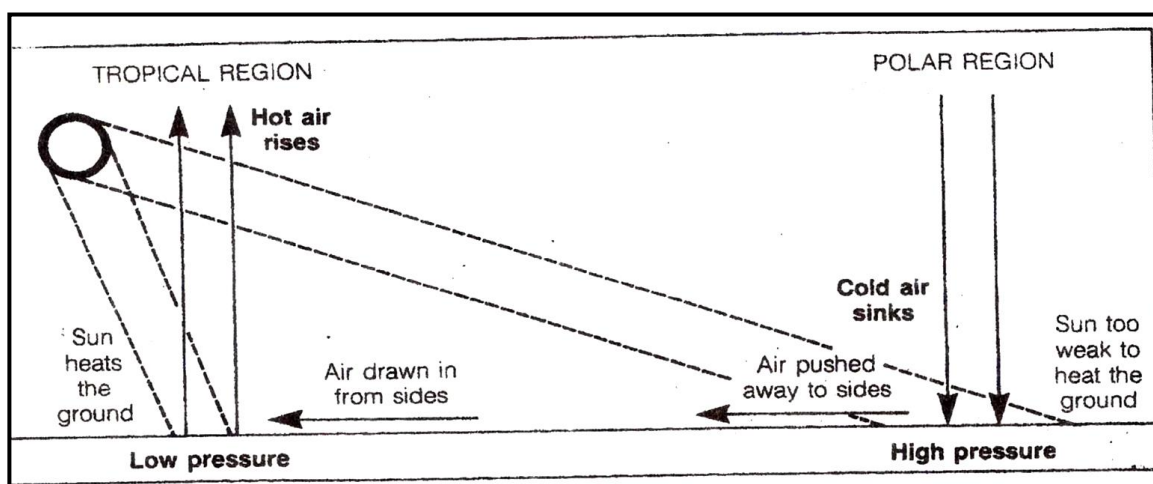
**Low Pressure systems** – generally associated with warm, light rising air and moist conditions.

**High Pressure systems** – associated with stable, dry conditions and heavy cold sinking air.

The earth is surrounded by layers of gases called the atmosphere. The air we breathe is part of that atmosphere. Although it feels weightless to us, the air or atmosphere does have weight and it puts pressure on the earth's surface. This pressure is measured by a **barometer** and expressed in terms of **hectopascals**.

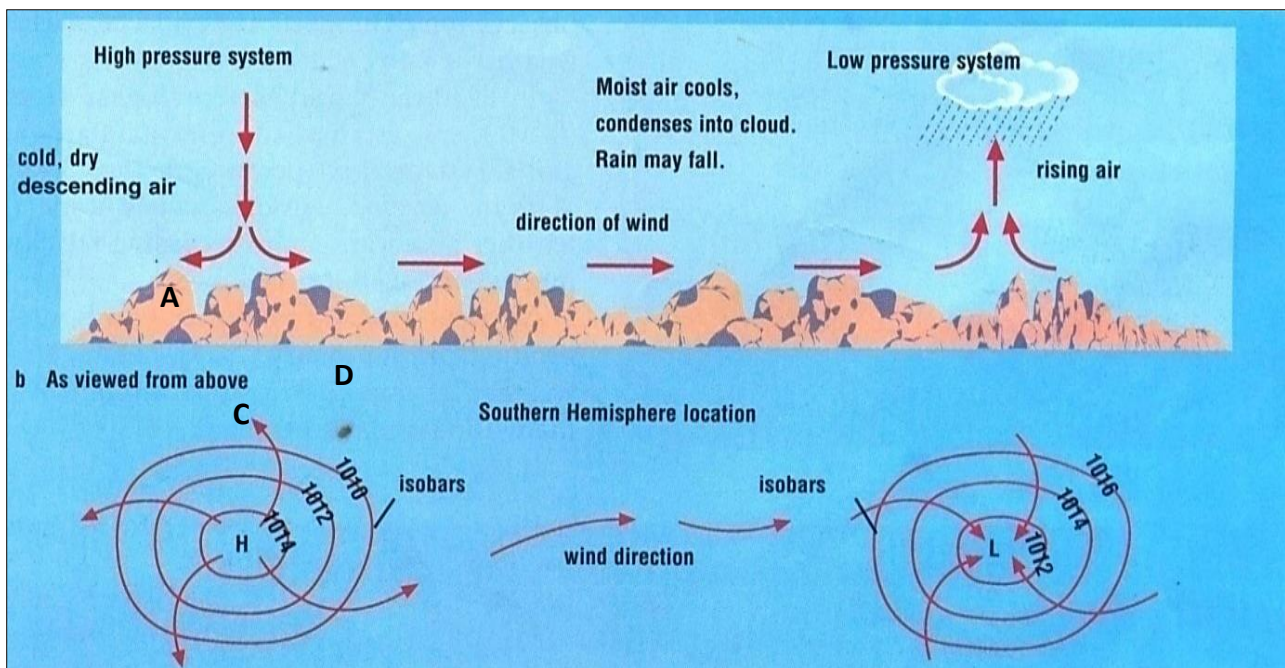
Atmospheric pressure varies from place to place and from time to time. Pressure increases when air is descending or sinking and decreases when air rises. This changes the atmospheric pressure which cause changes in the weather.

**Fig: 1.12 Diagram showing convectional current.**



Heated air rises 'convectional current' and cold air sinks. When air becomes warmer or is heated up, it expands and becomes lighter in weight and therefore, it rises. Cold air is much heavier than warm air, therefore, cold air sinks to take the place of the rising warm air.

**Fig: 1. 13 Pressure Systems; Wind moves from high pressure to low pressure system.**



Heated air expands and ascends or rises and cold air descends or sinks. Places where heated air rises will experience low pressure while areas where cold air is descending are likely to have high pressure system. When warm air rises at low pressure areas, the cold air descending at high pressure areas will flow from the high pressure area to low pressure area to fill up the space left by the rising warm air (convictional current).

**Figure 1.12** and **figure 1.13** are similar. For example: both diagrams illustrate ‘convictional current’ and ‘pressure systems’, however, **figure 1.13** illustrates pressure systems more clearly.

### Isoline Maps

#### What are isoline maps?

Isoline maps consist of lines that connect different places on a map that have the same value or amount (measurement) of pressure, rainfall, temperature, sunshine and altitude.

The lines in an isoline map are drawn to connect or join all the places that have the same amount of pressure, temperature, rainfall or altitude. For example: A, C and D in **fig: 1.13** have the same value of pressure (1010mb).

Examples:

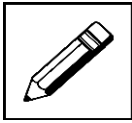
- Isobar lines (isobars) show the value of pressure in milibars (mb) on a map.
- Isotherms are lines that show the value for temperatures in degree Celsius on a map.
- Isohyets are lines that show the value of rainfall in millimetres on a map.



- Isohels show the amount of sunshine in a particular location on a map
- Contour lines show the different altitudes on a map. Maps with contour lines are called **contour maps**

Isobars on a map (e.g. weather map) shows the pressure systems in a particular area. Isobars with the highest value starting from the centre outwards, shows a high pressure (Look at the bottom left hand corner of **fig: 1.13** on page 23). Isobars with the lowest value starting from the centre going outwards, shows a low pressure (Check the bottom right hand corner of **fig: 1.13** on page 23).

Now turn to the next page and do activity 6.



### Student Learning Activity 6

1. What is atmospheric or air pressure?  
\_\_\_\_\_
  
2. What type of pressure system is associated with high temperature?  
\_\_\_\_\_
  
3. What is convectional current?  
\_\_\_\_\_
  
4. What type of pressure system exists in deserts?  
\_\_\_\_\_
  
5. What type of pressure system is associated with rainfall?  
\_\_\_\_\_
  
6. What is the name of the line that shows the same amount of pressure on a map?
  - A. Isohels
  - B. Isotherm
  - C. Isobar
  - D. Isohyets
  - E. Contour
  - F. Isoline

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.1.5: Factors Influencing Air Pressure

#### Definition of terms:

**Atmosphere** – Layers of air that surrounds the earth

**Air** – Layers of gases that makes up the atmosphere

**Wind** – moving air currents which mainly blow from high pressure to low pressure areas.

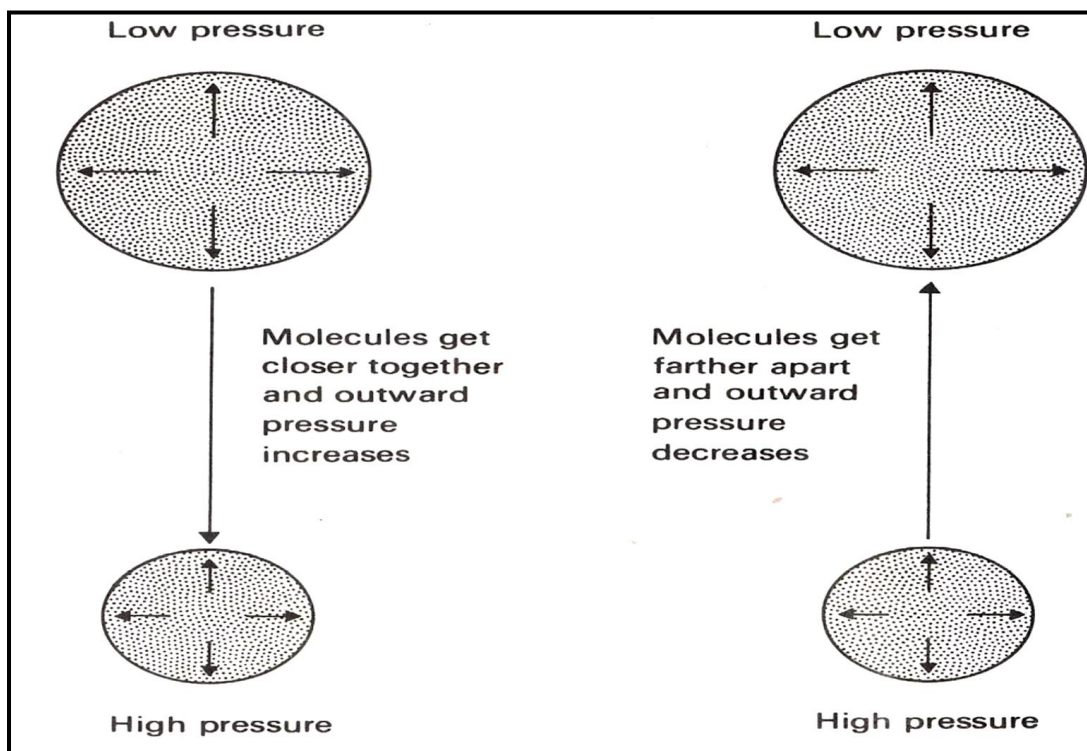
#### Atmospheric pressure depends primarily on three factors:

1. Altitude
2. Temperature
3. Earth's Rotation

#### Influence of altitude on Pressure

The pressure of air at ground level or sea level is higher than that of air at the top of a high mountain. The air at ground level has to support the weight of air pressing down above it and the molecules (air particles) in the bottom air must push outwards with a force equal to that exerted by the air above it. The molecules (air particles) of air at the top of a mountain are pushing outwards with much less force because the weight of the air above it is less or lighter.

Fig: 1.14 Pressure and air molecules.





### Why pressure increases when air sinks and why the volume of a rising sample of air increases while its pressure decreases?

When air sinks its pressure increases. The volume of the sinking air decreases but the number of molecules in it remain the same. The outward pressure of these molecules is spread over a small area. Similarly, when air rises its volume increases and the outward pressure of its molecules is spread over a larger area and its pressure decreases. Refer to **figure 1.14**.

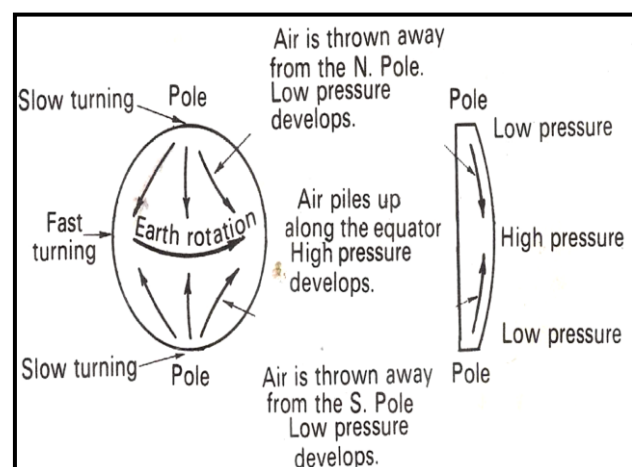
### Influence of Temperature on Pressure

1. We have seen that when air sinks its pressure increases because it becomes compressed. And when it becomes compressed its molecules move quickly and heat is produced. *The temperature of air therefore rises when its pressure rises.*
2. When air rises its pressure decreases because it expands. When air expands its molecules move more slowly and heat is used up. *The temperature of air therefore falls when its pressure falls.*
3. When air is heated it expands and when this happens the outward pressure of its molecules is spread over a larger area. This means that the pressure of the air decreases. *The pressure of the air therefore falls when its temperature rises.* As the temperature rises, air becomes warm and light, then rises up causing pressure to decrease creating low pressure zones.
4. When air is cooled it contracts and when this happens the outward pressure of its molecules is spread over a smaller area. This means the pressure of the air increases. *The pressure of air therefore rises when its temperature falls.*

### Influence of Earth's Rotation on Pressure

The rotation of the earth causes air at the poles to be thrown away towards the equator. In theory this should result in high pressure at the equator, and low pressure at the poles as shown in **figure 1.15**. However, in reality temperature influence pressure more than earth's rotation. This means that the 'equator has high pressure', while the 'Poles have low pressure'.

**Fig: 1.15** Rotation and its effect on pressure.





### **Combined Influence of Rotation and Temperature on Pressure**

Both Rotation and Temperature have a combine influence on the type of pressure system at the poles and the equator.

**Firstly, temperature is the main influence of the type of pressure at the poles and the equator.**

1. **Low temperature** at the poles results in contraction of air (cold air sinking) and the development of high pressure.
2. **High temperature** along the equator result in the expansion of air (warm air rising) and the development of low pressure.

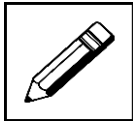
**Secondly, the effect of rotation on pressure mainly occurs, and influence:**

1. **Low pressure at 60°N and 60°S:** Air blowing away from the poles spreads out to occupy greater space, it expands and its pressure falls at latitudes 60°N and 60°S.
2. **High pressure at 30°N and 30°S:** Air rising at the equator moves out and occupies less space. It contracts and its pressure rises at latitudes 30°N and 30°S (called Horse Latitudes)

Dry conditions are associated with high pressure areas and low pressure is associated with rainfall conditions. Air (in the form of wind) is forced out from high pressure areas and moves into low pressure areas bringing rain to the low pressure areas, while the high pressure areas remain dry.

Now do activity 7 on the next page.





### Student Learning Activity 7

1. What is atmosphere?  
\_\_\_\_\_
  
2. What is wind?  
\_\_\_\_\_
  
3. List the gases that make up the atmosphere. Write the percentage of the gases in the atmosphere next to the name of each gas you listed.  
\_\_\_\_\_  
\_\_\_\_\_
  
4. What type of pressure exists on mountain tops?  
\_\_\_\_\_
  
5. List the 4 important rules regarding the influence of temperature on pressure.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
6. Which locations or latitude does the temperature has more influence on pressure?  
\_\_\_\_\_
  
7. What type of pressure area is PNG located in terms of global pressure systems?  
\_\_\_\_\_
  
8. Which of these statements is **not** true?
  - A. When air sinks its pressure increases
  - B. When air rises its pressure decreases
  - C. Volume of air particles contract when air sinks
  - D. Volume of air particles expand when air sinks

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

**11.2.1.**



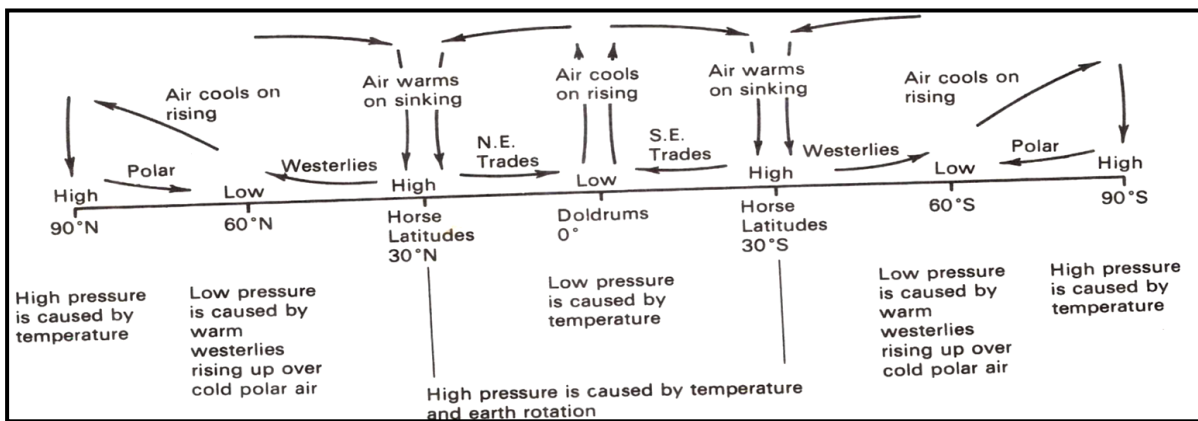
## 6: Global Winds

### What are Global winds?

Global winds occur on a large scale and over a large area. Global winds are also called **planetary** winds, **prevailing** winds, **consistent** winds or **persistent** winds.

Planetary winds are the major winds that occur over the earth's surface on a global or on a large scale (i.e. Trade winds, westerly, and polar winds in the north and south of the equator). Refer to the diagram in figure 1.13 to understand more about how winds develop.

**Fig: 1.16 A cross-section prevailing winds between the equator and the poles.**

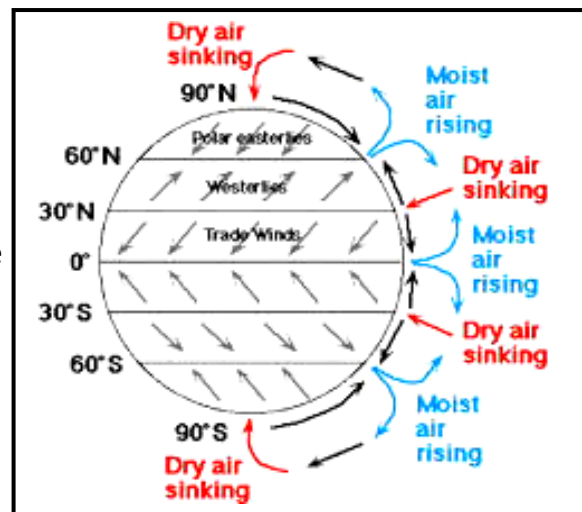


### Name and location of global wind

- |                           |                       |
|---------------------------|-----------------------|
| 1. North East Polar Winds | } Northern Hemisphere |
| 2. South Westerly Winds   |                       |
| 3. North East Trade Winds |                       |
| 4. South East Trade Winds | } Southern Hemisphere |
| 5. North Westerly Winds   |                       |
| 6. South East Polar Winds |                       |

Winds are given their names from the direction which they blow from.  
e. g. North East Polar Winds, blow from the North East direction towards the South West.

**Fig: 1.17 Global winds – Ariel view.**





### What is the Coriolis Effect?

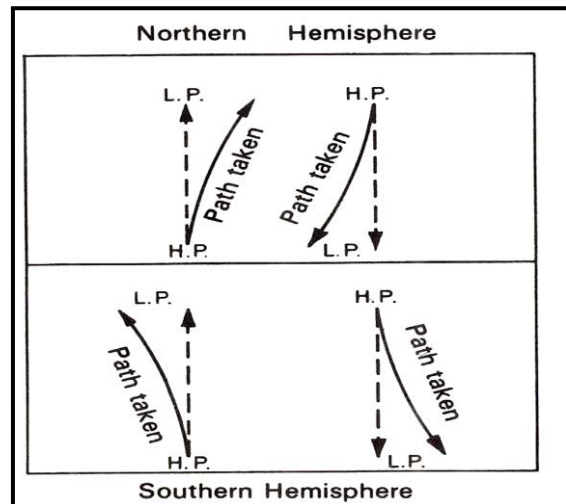
If the earth is steady and is not rotating, the wind will move from high pressure to low pressure areas in a straight line or at a right angle. The rotation of the earth causes the freely moving air masses to be deflected from their original course.

The diagram on **fig: 1.18** shows how the winds deflect from their original course. The dotted lines represent the original paths which the wind would have taken if the earth was not rotating. Figure 1.16 shows the deflection of the winds on a Global map.

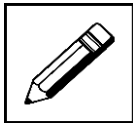
**Coriolis effect:**

The deflection of the wind to the right in the Northern Hemisphere, and to the left in the Southern Hemisphere as a result of the earth's rotation.

**Fig: 1.18 Coriolis effect.**



Now do activity 8 on the next page.



### Student Activity 8

1. What are global winds?

\_\_\_\_\_

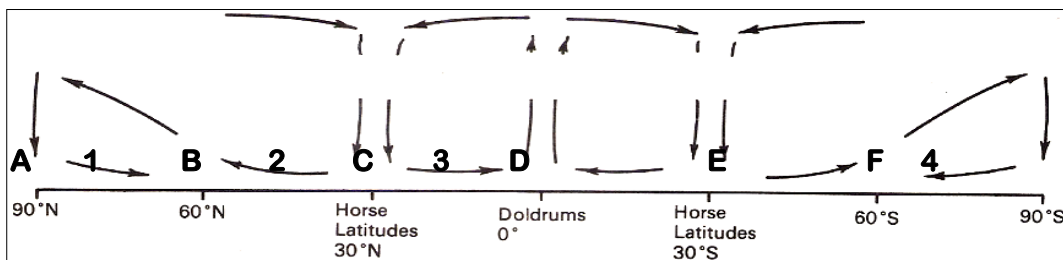
2. What are the other names for global winds?

\_\_\_\_\_

3. What is the Coriolis effect?

\_\_\_\_\_

Refer to the diagram below and answer questions 4 and 5.



4. Write the name of the 6 major prevailing winds marked A – F in the correct order.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. What is the pressure at areas marked 1, 2, 3 and 4?

\_\_\_\_\_  
\_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.1.7: Prevailing and Seasonal Winds

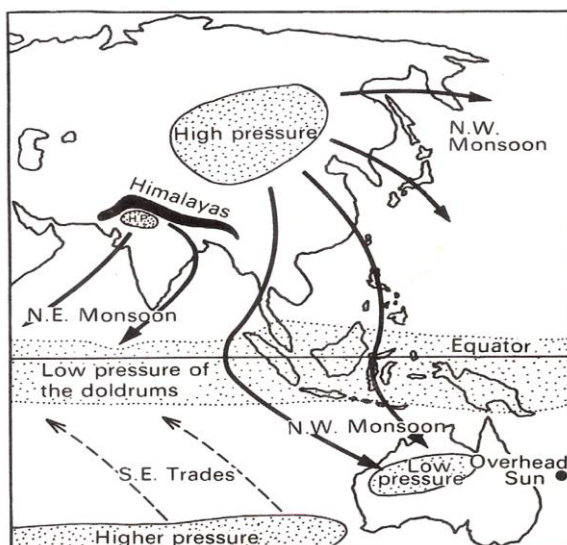
A wind which blows frequently than any other wind in a particular region is called a **prevailing wind**. **Seasonal winds** are winds that change directions from one season to the next season e.g. monsoon winds.

#### Monsoon winds

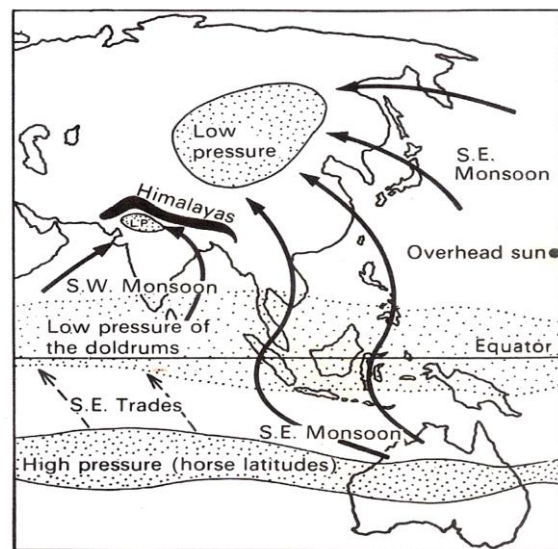
Monsoon winds are seasonal winds that change their direction from which they are blowing from one season (winter) to the next (summer). Monsoon winds bring heavy rainfall. The area or region that monsoon winds best develops is in South East Asia. India and Australia also experience monsoon winds. Countries in South East Asia have a tropical climate that is affected by the monsoon rains. Monsoon climate have a dry season with little rainfall and a wet season of very heavy rainfall. Monsoon winds reverse their direction completely from one season to the next.

**Fig: 1.19 Monsoon Wind in S.E. Asia and Australia.**

January



July



#### (Dec to April)

The Sun is directly overhead the Southern Hemisphere (Australia) and summer develops in Australia resulting in **low pressure**. Meanwhile winter occurs in the Northern hemisphere resulting in **high pressure** in South East Asia.

The monsoon winds blow from the **high pressure system** in South East Asia into the **low pressure system** in Australia. These monsoon winds pick up moisture from the sea and transports it to Australia resulting in heavy rainfall.

#### (May to Nov)

The Sun is directly overhead the Northern Hemisphere and summer develops in South East Asia resulting in a **low pressure**. Meanwhile, winter occurs in the Southern Hemisphere which leads to a **high pressure** in Australia.



The monsoon wind blows from the **high pressure system** in Australia to the **low pressure system** in South East Asia. Likewise, these monsoon winds pick up moisture from the sea and transports it South East Asia resulting in monsoon rains.

### Effects of Monsoon on Agriculture and the People

The monsoon winds has a great influence on agriculture, especially cultivation of rice in South East Asia. Rice is planted in very large fields called 'paddy'. Rice is planted just before the monsoon winds bring heavy rainfall. The rice plants need a lot of water to grow. Subsistence farmers in south-east Asia depend on rice crop for their livelihood. If the monsoon brings less rain, or is disrupted in any way, the farmers will be greatly affected. affected.

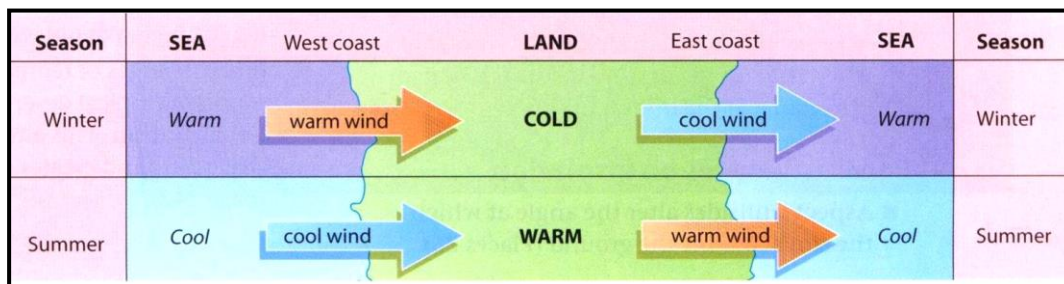
### Effect of Prevailing wind on climate

How are the broad climatic regions affected by the global wind patterns?

Prevailing winds can influence the climate. Winds can bring warmth or a cooling effect into the area they blow to. The off-shore winds pick up and carry the warmth or coolness of the sea towards the land. And the on-shore winds pick up and carry the warmth and coolness of the area inland to the coast and towards the sea. Off-shore winds are winds that blow **from** the sea **to** the land. On the other hand, on-shore winds blow **from** the land **to** the sea.

Winds do assist in changing the day to day weather and the overall climate of a place. Winds can provide warmth or coolness to an area and can bring along rain as well.

Fig: 1. 20 Effects of wind



### Characteristics of Prevailing Winds or Global Winds

#### 1. Polar Winds

- blow **from** Polar high pressures ( $90^{\circ}$ ) **to** Temperate low pressures ( $60^{\circ}$ )
- better developed in the Southern Hemisphere than in the Northern Hemisphere
- deflected to the **right** to become the North East Polar Winds in the Northern Hemisphere and to the **left** to become the South East Polar Winds in the Southern Hemisphere



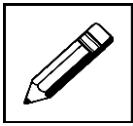
2. Westerly Winds or Westerlies:

- blow **from** Horse Latitudes high pressures ( $30^{\circ}$ ) **to** the Temperate low pressures ( $60^{\circ}$ )
- deflected to the **right** to become the South Westerlies in the Northern Hemisphere and to the **left** to become the North Westerlies in the Southern Hemisphere
- vary in strength.

3. Trade Winds

- blow **from** the Horse Latitudes ( $30^{\circ}$ ) **to** the Doldrums (Equator  $0^{\circ}$ )
- deflected to the **right** to become the North East Trades in the Northern Hemisphere and to the **left** to become the South East Trades in the Southern Hemisphere
- constant in strength and direction (except when an El Nino occurs)
- contains intense depressions (cyclonic conditions).

Now activity 9 on the next page.



### Student Learning Activity 9

1. What is the meaning of 'prevailing winds'?

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2. What is the difference between a prevailing and a monsoon wind?

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---

3. What is an on-shore wind?

---

---

4. What is an off-shore wind?

---

---

5. Explain how prevailing winds affect the climates.

---

---

---

---

6. Which of these is the correct characteristic of polar winds?

- A. north-east polar winds deflect to the right
- B. south east polar winds deflect to the right
- C. blow from 60° N/S to 90°N/S
- D. blow from 90° N/S low pressures to the 60° N/S high pressure areas

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**





### 11.2.1.8: Local Winds

Local winds are small scale winds that are confined to a smaller area. Local winds occur in a local setting (your local community or environment).

Local winds are different to Global Winds. They are small scale winds that occur locally, that is land and sea breeze; and mountain and valley breezes.

**The main types of Local Winds are;**

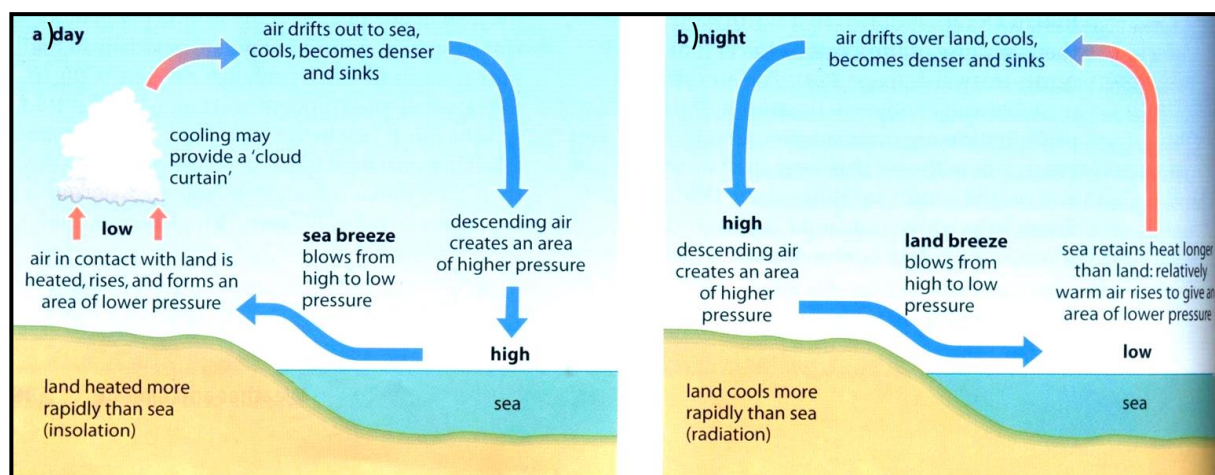
1. Land and Sea breeze
2. Mountain and Valley breeze
3. The Fohn or Chinook

Land and sea breezes and mountain and valley breezes are caused by local temperature differences. **Fohn** results from pressure differences on either side of a mountain range.

When a region is hotter than a neighbouring region air moves into the hot region from the cooler region to take the place of the hot air which has expanded and risen. **The surface movement of air from the cooler region to the hotter region is called wind.**

#### Land and Sea Breeze

**Fig: 1.21 illustration of land and sea breeze.**



#### Sea Breeze

During the day the land heats up faster than the sea and therefore, air pressure is low over the land than the sea. So wind blows from the sea (high pressure) to the land (low pressure) as a sea breeze.

#### Land Breeze

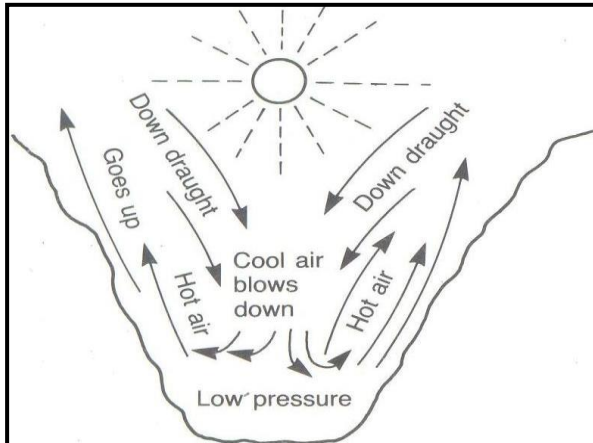
During the night the land cools faster than the sea and the reverse processes happen. Wind blows from the land (high pressure) to the sea (low pressure) as a land breeze.



## Mountain and Valley Breeze

Fig: 1.22 Mountain and Valley Breeze during the day and the night.

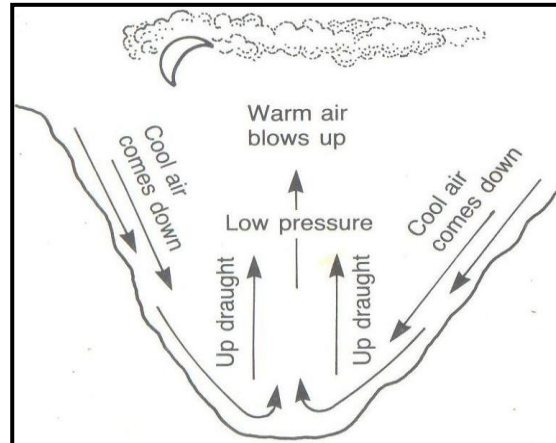
### a) Valley Breeze (Day)



Wind (breeze) blows **up** the valley sides.

During the day, the base and the sides of the valley heat up and warm air expands and rises up along the slopes. Cool air moves down the centre of the valley causing down-draught. Wind blows up-valley and up the valley sides.

### b) Mountain Breeze (Night)

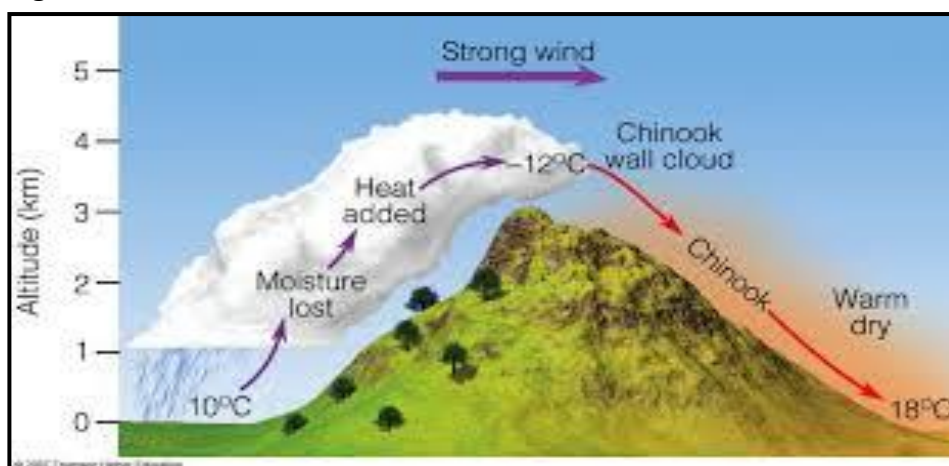


Wind (breeze) blow **down** the valley sides.

During the night, the mountains and valley base cool. Air moves down the sides of the valley lifting air up the centre of the valley causing up-draught. Wind blows down-valley. Sinking cold air may form fog.

## Fohn or Chinook

Fig: 1. 23 Illustration of the Fohn or Chinook



The Fohn or Chinook occurs on both sides of mountains or mountain ranges that have one side facing the sea called the **windward slope**. The wind that blows in from the sea will **bring moisture**, and as it reaches the windward slope it will rise.

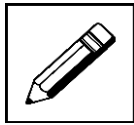


**As the wind rises it will cool the windward slope.** The moisture in the wind rises and increases in size, **condense and fall as rain** on the windward slope.

The wind will continue up the mountain and will **flow down** the other side of the mountain range. The side of the mountain that faces away from the wind is called the **leeward slope**. The leeward slope receives a **dry warm** wind because most of the moisture contained in the wind has been given off as rain on the windward slope. The wind flowing down the leeward slope also **increases in temperature as pressure increases**. The warm, dry wind will not result in rainfall thus creating an effect called the **rain shadow**.

**The Föhn or Chinook is the breeze that provides a cooling effect and rainfall on the windward slope, and causes a warming effect and rain shadow on the leeward slope. This type of local breeze also results in orographic or relief rainfall.**

Now do activity 10 on the next page.



### Student Activity 10

1. There are three types of local winds. What are the two main types of local winds?  
I) \_\_\_\_\_  
II) \_\_\_\_\_

2. Copy and complete this short passage using; *high, low, sea, land, day and night*.

Sea breeze blows from **1**\_\_\_\_\_ pressure area at **2**\_\_\_\_\_ to the **3**\_\_\_\_\_ pressure area on **4**\_\_\_\_\_. Sea breeze happens during the **5**\_\_\_\_\_. Land breeze blows from **6**\_\_\_\_\_ pressure area on **7**\_\_\_\_\_ to the **8**\_\_\_\_\_ pressure area at **9**\_\_\_\_\_. Land breeze takes place during the **10**\_\_\_\_\_.

3. Choose the best term to complete the sentence.

The valley breeze blows from the *valley/mountain top* to the *valley/mountain top*. The valley breezes happen during the *day/night*. Mountain breeze blows from the *valley/mountain top* to the *valley/mountain top*, during the *day/night*.

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

**END OF TOPIC 11.2.1**



## 11.2.2 CLIMATES OF THE WORLD

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### Introduction

This topic will provide you with information about 'climate' and the different types of climates in PNG and the world.

Countries in the world have a dominant type of climate with various macro (smaller) climates. A good example is the dominant tropical hot and wet climate of PNG, and macro climates such as maritime climate, mountain climate and swampland climate.

There are different types of climates in the world, and these climates change as you move from the equator to the poles. The different types of climates have their boundaries, and each climate has its own characteristic, temperature, and amount of precipitation.



### Objectives or aims

- Define these terms: weather, climate, temperature, precipitation.
- State and explain the main factors that influence climate.
- Explain and distinguish the main factors that influence temperature.
- Compare and explain the main types of rainfall.
- Identify the different types of climates on a world map.
- Explain and compare the characteristics of each type of climates.
- Explain each type of climates and their influences.
- List some countries and their type of climates.
- Identify and explain the different types of climates in PNG.



### Time Frame

This topic should be completed within three weeks.

If you set an average of 3 hours per day, you should be able to complete the unit comfortably by the end of the assigned week. Try to do all the learning activities and compare your answers with the ones provided at the end of the unit. If you do not get a particular exercise right in the first attempt, you should not get discouraged but instead, go back and attempt it again. If you still do not get it right after several attempts then you should seek help from your friend or even your tutor. Do not pass any question without solving it first.



### 11.2.2.1: Introduction to Climate

What is weather? What is climate? And what is the difference between weather and climate? Follow the reading to find out.

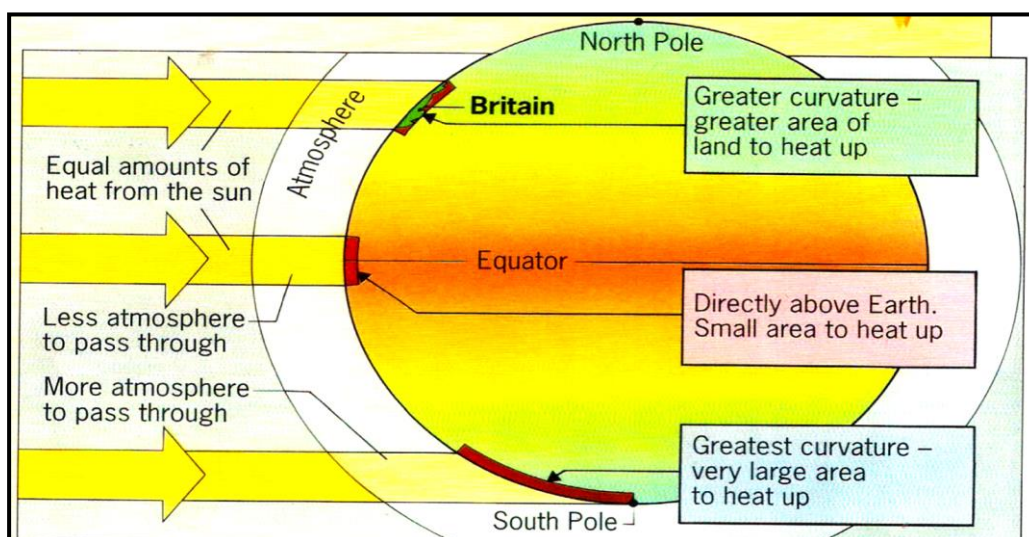
**Weather** refers to the *'daily conditions of the atmosphere'*. If you were to say 'Today is a bright sunny day,' or 'It is raining heavily today', or 'Yesterday was a cloudy day', then, you are making a statement about the weather. Weather involves such elements as temperature, rainfall, humidity (moisture in the air), wind and air pressure.

**Climate** is a measure of the conditions of the atmosphere over a long period (For example; one year or 20 years). Climate is concerned with seasonal changes that occur over time. We refer to climate when we say 'PNG is always hot and wet', or 'Our rainy season will start soon'. We can even say that climate is made up of many daily weather conditions or average conditions put together over a long period of time.

#### Heating of the Earth

Different places on earth receive different amount of sunlight from the sun. Places around the equator directly face the sun and receive a lot of sunlight and heat. Places further away from the equator receive less sunlight. The poles receive very little sunlight, that's why it is always cold.

**Fig: 2.0 Illustration of how sunlight heat up different areas (latitudes).**



#### Why do places on earth receive different amount of sunlight?

1. The sun's rays travel a short distance to the equator than to the north and south poles. This is because of the tilt of the earth.
2. The surface area that receive sunlight is small at the equator and gets bigger towards the poles. This is called the 'angle of incidence'.



### The three main features of climate are;

1. Temperature
2. Precipitation
3. Pressure.

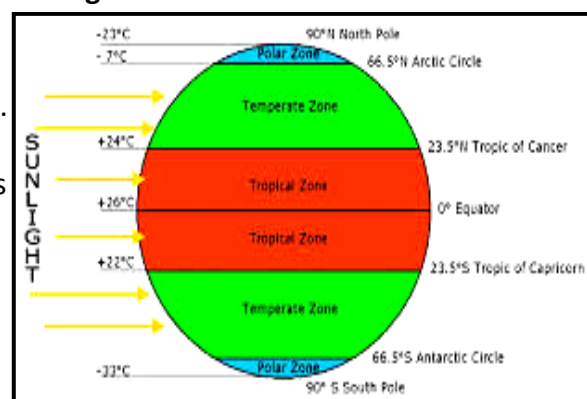
### Factors that influence temperature

Here are the main factors that cause climates to be different in different places. Different types of climate in PNG are also influenced by these same factors.

#### 1. Latitude

As you move away from the hot equatorial latitudes towards the polar latitude the temperature decreases and become colder. We can say that temperature decreases as latitude increases or temperature increases as latitude decreases.

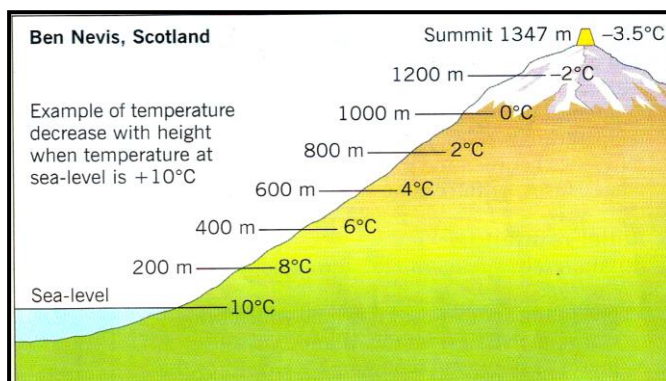
Fig: 2.1 Latitude



#### 2. Altitude

Altitude is also called 'height above sea level'. How high the land is, is measured from the sea level up. Sea level is always at 0 metres but, different location will have different heights as you move from a flat land area at sea level to high ground. At sea level the temperature is warmer than the mountain top. This is clearly illustrated in Fig: 2.2.

Fig: 2.2 Influence of altitude on temperature



**When height increases, temperature drop or decreases. When height decreases, temperature increases. This is because air particles become fewer as you move from the sea level to higher altitude or greater height.**



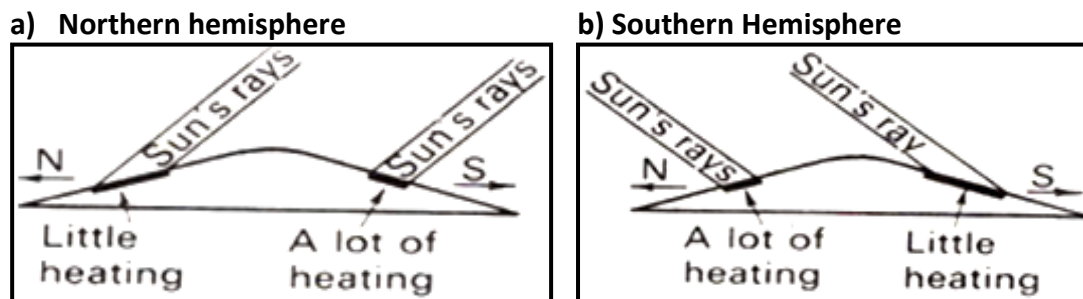
### 3. Winds

There are two different types. Winds can bring warmth or a cooling effect to adjacent land areas that they blow into. You can go back to **fig: 1.20** to see a good illustration on the effects of winds.

### 4. Aspect or Topography

Two different sides (slope) of a mountain will have varying temperatures. The side that is facing the sun will be warmer with higher temperature than the mountain side that is facing away from the sun.

**Fig: 2.3 Topography and Aspect**



The influence of aspect is only noticeable in temperate latitudes. In the tropics, the mid-day sun is always high in the sky and aspect is of little significance. South-facing slopes are warmer than North-facing slopes in the Northern Hemisphere, whilst the opposite occurs in the Southern Hemisphere.

In the high latitudes (temperate region), the mid-day sun is at low angle in the winter. Blocks of flats are usually built far apart to enable all the flats to receive some amount of sunlight.

### 5. Cloud cover

During the day the clouds help to reflect the sun's heat to help lower the temperature. At night, the clouds act as a blanket that traps out-going earth's radiation (heat) and warm up the air.

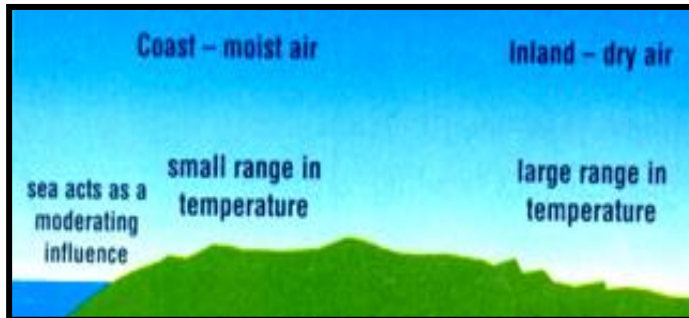
### 6. Distance from the sea or Closeness to the sea

Winds blowing towards land tend to influence the coastal areas more than the areas further from the coast.





**Fig: 2.4 Distance from the sea.**

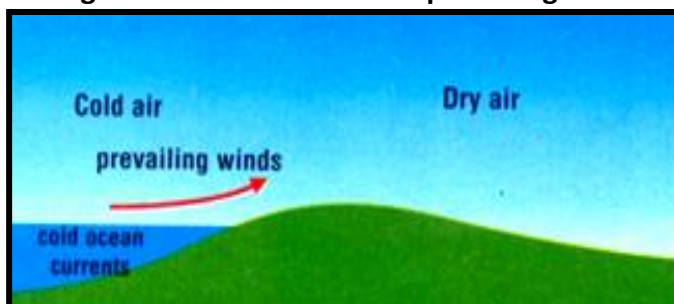


In temperate regions onshore winds blowing towards the land in summer have a cooling effect on the coastal areas and as the wind continues inland it becomes dry leaving the inland area to be hot still in summer.

During winter warm wind from the sea cools the places near the sea, while the places further away remain cold in winter. **Fig: 1.11** will also provide a good diagram to help you understand more.

## 7. Ocean currents

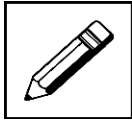
**Fig: 2.5 Ocean currents and prevailing winds.**



Warm currents and cold currents are the two main types of ocean currents. The warm currents originate from the tropics and bring warmth into the temperate and polar regions, while the cold currents originate from the poles and move towards the tropics bringing a cooling effect.

Off-shore winds blowing across warm currents pick up moisture bringing rain to coastal land areas. Off-shore winds blow across cold currents collecting no moisture and blow towards land as dry winds.

The temperature feature of climate is influenced by the seven factors that we have already discussed.



### Student Learning Activity 11

1. What is climate?

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2. What is the weather?

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3. List the 5 factors that influence climate, apart from altitude and latitude.

i) \_\_\_\_\_ ii) \_\_\_\_\_  
iii) \_\_\_\_\_ iv) \_\_\_\_\_  
v) \_\_\_\_\_

4. Explain the similarity on how latitude and altitude influence climate.

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5. What instrument is used in measuring the temperature of a place?

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6. Which side of a mountain in the Northern Hemisphere will receive more sunlight?

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7. Why does 'aspect' have more influence on temperature in high latitudes than in the tropical region?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

## Precipitation

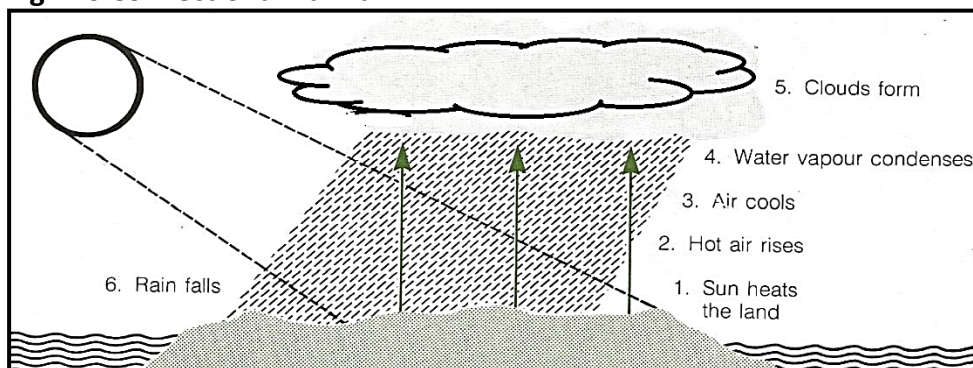
Precipitation is the second feature of climate. Precipitation refers to the descent of water onto the earth's surface. The main forms of precipitation are rain, snow, hail, sleet and dew.

### Types of Rainfall

1. Convictional rainfall
2. Depressional rainfall (Cyclonic or Frontal rainfall)
3. Orographic or relief rainfall

1. *Convictional Rainfall*: Rainfall that occurs anywhere when the sun's heat evaporates water and causes water to change from liquid to gas (water vapour) and rise into the atmosphere.

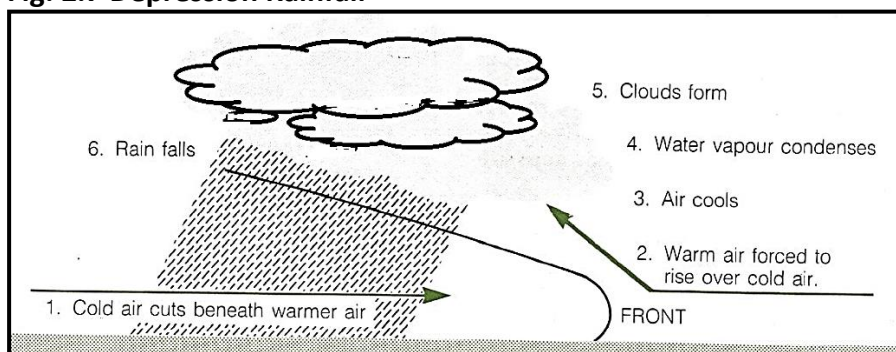
**Fig: 2.6 Convictional Rainfall**



Convictional rainfall occurs often in hot low lying coastal areas, especially the hot tropical region. Hot air containing water vapour rises to higher altitude in the air. The tiny water particles cool and become large enough to fall as rain. Convictional rain is common in the afternoons after a hot day in the tropical region. Thunder and lightning sometimes occur with convictional rain.

2. *Depressional, Cyclonic or Frontal Rainfall*: This type of rain mostly happens in temperate areas. It occurs when two different types of air masses meet each other.

**Fig: 2.7 Depression Rainfall**





When the warm air masses meet the cold air masses, the cold air masses is heavy so it forces the warm air masses to rise above the cold air masses. The rising warm air masses is cooled by the cold air masses at the front (boundary) where they meet, resulting in the frontal rainfall.

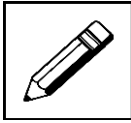
3. *Orographic or Relief Rainfall*: This type of rainfall takes place around mountain ranges where one side of the mountain range faces the sea and the other side faces away from the sea.

Wind carrying moisture (water particles) is forced to rise up the mountain side. As the wind goes higher, the water particles cool, condensation occurs and clouds form. Further cooling and condensation result in rainfall on the side facing the wind (wind ward slope). All the moisture in the wind has been given off, but the wind continue over the mountain top and move down-hill. The wind is now hot and dry without any moisture in it. This side of the mountain slope will have a 'rain shadow'. Rain shadow will occur on the (leeward slope) other side of the mountain, where there is no rainfall.

**Fig: 2.8 Relief or Orographic Rainfall**



Now do activity 12 on the next page



### Student Activity 12

1. What is precipitation?

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2. List the 3 main types of rainfall.

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3. Explain about the rainfall that occurs around mountain ranges.

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4. What is the name of the mountain side that experiences a rain shadow?

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5. What type of rainfall is common in temperate region?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

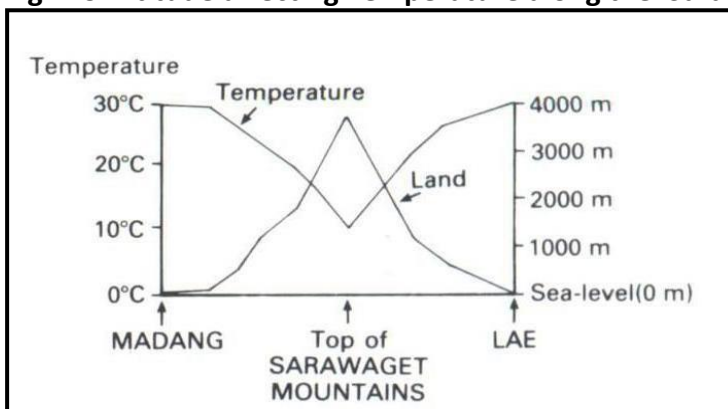


### Influence of altitude, temperature and rainfall patterns in Papua New Guinea

The differences in height or altitude will have an effect on the temperature and rainfall patterns in the area. Temperature changing from a flat lowland at sea level area to a highland area is the same as temperature changing from the equator to the poles.

It is hot at the equator and as you move to the poles it becomes cold. At sea level it is hot, and as you move to the highland areas it becomes cold. For example; it is hot in Lae and as you go up to Goroka and Mt Hagen it becomes cold and very cold if you climb Mt Wilhelm.

**Fig: 2.9** Altitude affecting Temperature along the Sarawaget Mountains.

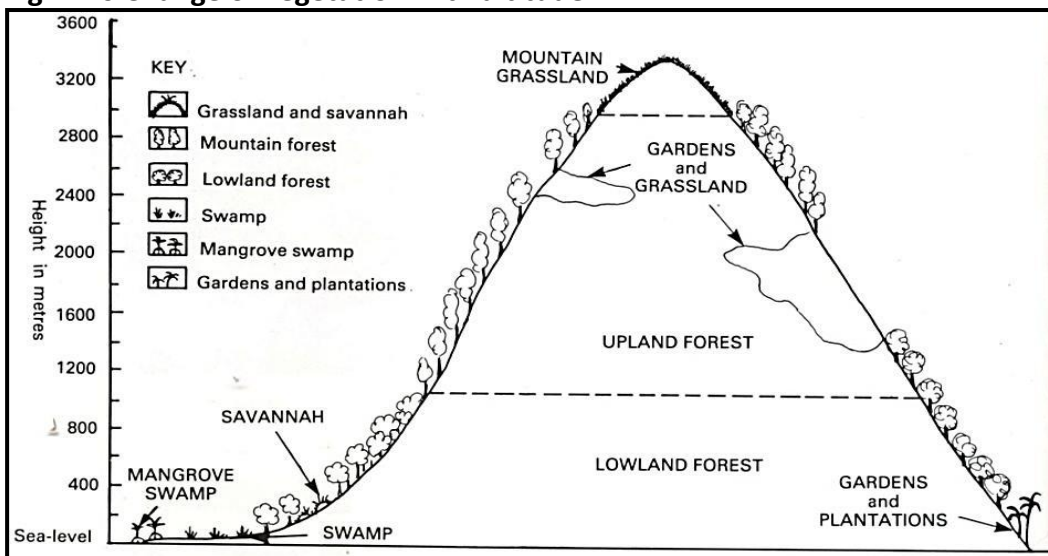


**Figure 2.9** shows a mountain region between Madang and Lae. Study the diagram and see how temperature changes as you move up the side of the mountain.

**When altitude increases, the temperature decreases and when altitude decreases the temperature increases.**

The different types of vegetation growing at different heights above sea level is the result of different macro climates (amount of temperature and rainfall) found at that particular altitude or height.

**Fig: 2.10** Change of vegetation with altitude.





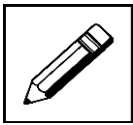
### **Types of Climates in Papua New Guinea**

PNG has a tropical hot and wet climate that encourages the growth of tropical rainforests. However, small (micro) climates also exist in PNG.

Let's look at some types of micro climates that can be found in PNG.

- 1. Maritime climate:** This type of climate is found mostly in coastal areas and small islands around PNG. Places with this climate have been influenced by the winds blowing in from the sea.
- 2. Equatorial climate:** This type of climate occurs in places that are closer to the equator.
- 3. Mountain grassland climate:** Occurs above the alpine forest climate, in cooler temperatures.
- 4. Mountain alpine forest climate:** Alpine forest grows on the cool mountain climate.
- 5. Mangrove climate:** climate that is suitable for mangroves to grow.
- 6. Savannah climate:** climate that has grassland and few scattered trees.
- 7. Swampland climate:** climate of areas that is water-logged.

Now do activity 13 on the next page.



### Student Learning Activity 13

1. What will be your definition for the word 'altitude'?

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2. Write the important rule about the relationship of altitude and temperature.

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3. List 5 types of climate that can be found in PNG.

- i. 

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- ii. 

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- iii. 

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- iv. 

---
- v. 

---

4. What is meant by the term 'micro climate'?

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5. Why are there different vegetation growing at different altitude?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**





## Rainfall and Patterns of Wind in PNG

### Why are the winds important?

Winds are very important in PNG because the change in seasons is marked by the change in the direction of the winds. The strongest winds in PNG usually occur between May and October and come from the south-east.

During the wet season, between December and March, the winds generally come from north-west. However, these winds are often much weaker.

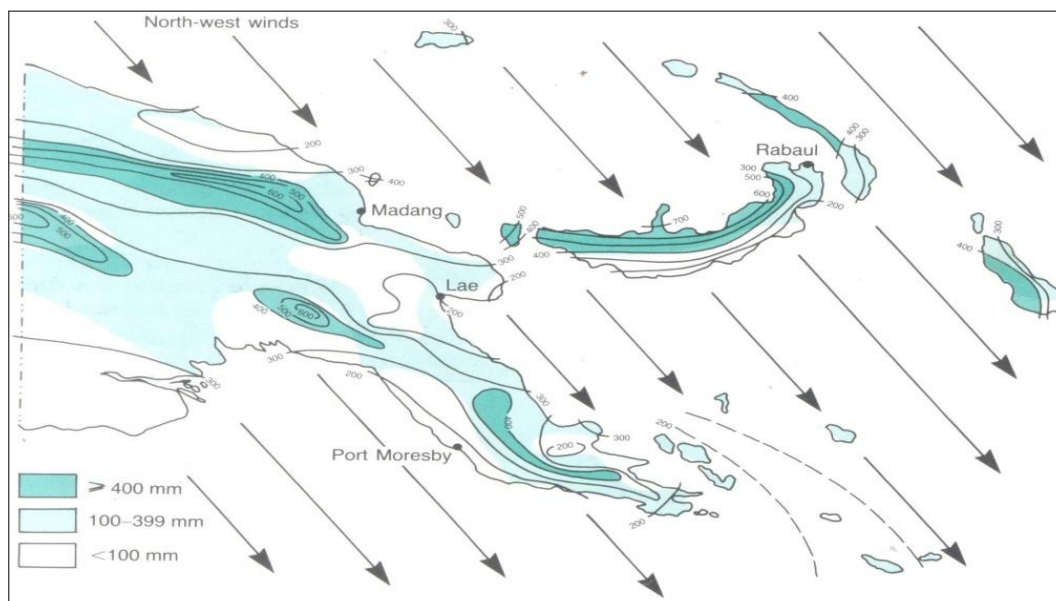
In April and November when the winds are changing, the air is often very still. Because of the stillness of the air it often seems hotter than it really is.

### Effects of North-West Monsoons and South-East Trade Winds

The South-east Trade winds are strong and do not carry as much moisture as the north-west Monsoon winds. However, winds can produce rain if they are forced high enough by the mountain barriers lying across their path. This wind occurs between December to March.

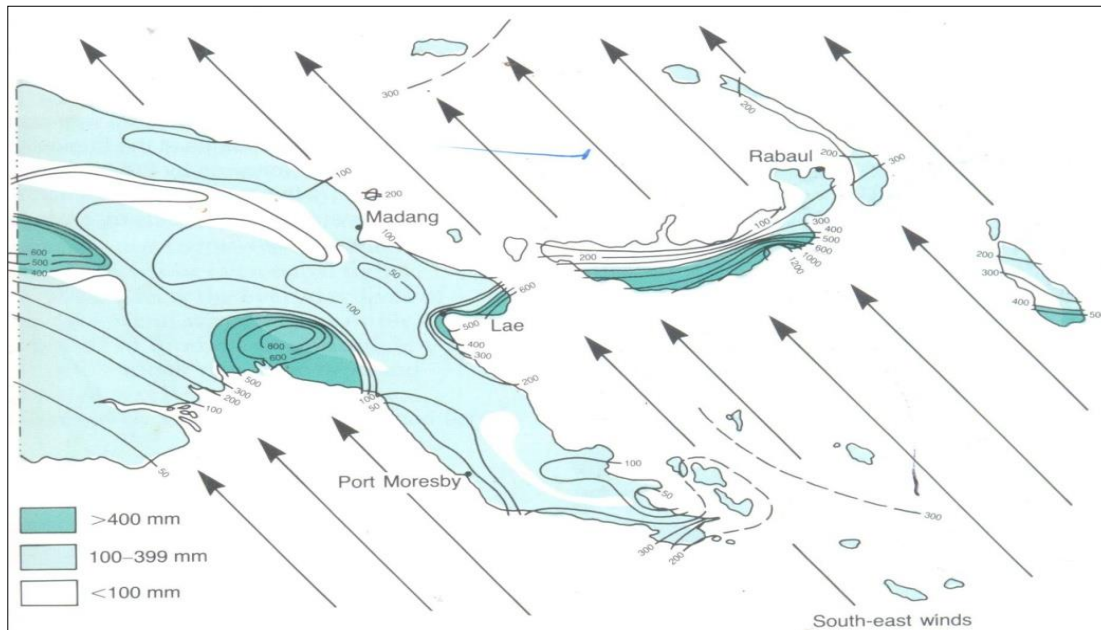
Because of their position in relation to the mountains, some parts of PNG do not have a distinct dry season. In these places the change in season is not from wet to dry season, but from wet to very wet season. Examples of this include parts of Western and Gulf provinces, and parts of New Britain and Autonomous Region of Bougainville (AROB). This wind occurs from May to November.

**Fig: 2.11 Winds in PNG during January (North-West Monsoons).**

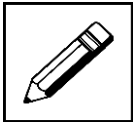




**Fig: 2.12 Winds in PNG during July (South-East Trade Winds).**



Now do activity 14 on the next page



### Student Learning Activity 14

1. What are the names of the two main types of winds that blow across PNG?  
\_\_\_\_\_  
\_\_\_\_\_
2. During which months does each of the winds blow?  
\_\_\_\_\_
3. When does the dry season occur?  
\_\_\_\_\_
4. Which 3 areas in PNG mostly have high rainfall throughout the year?  
\_\_\_\_\_
5. Explain how altitude and latitude influence temperature in a 'similar, but different way'.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
6. Which of the two winds in PNG blows strongly?  
\_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2**



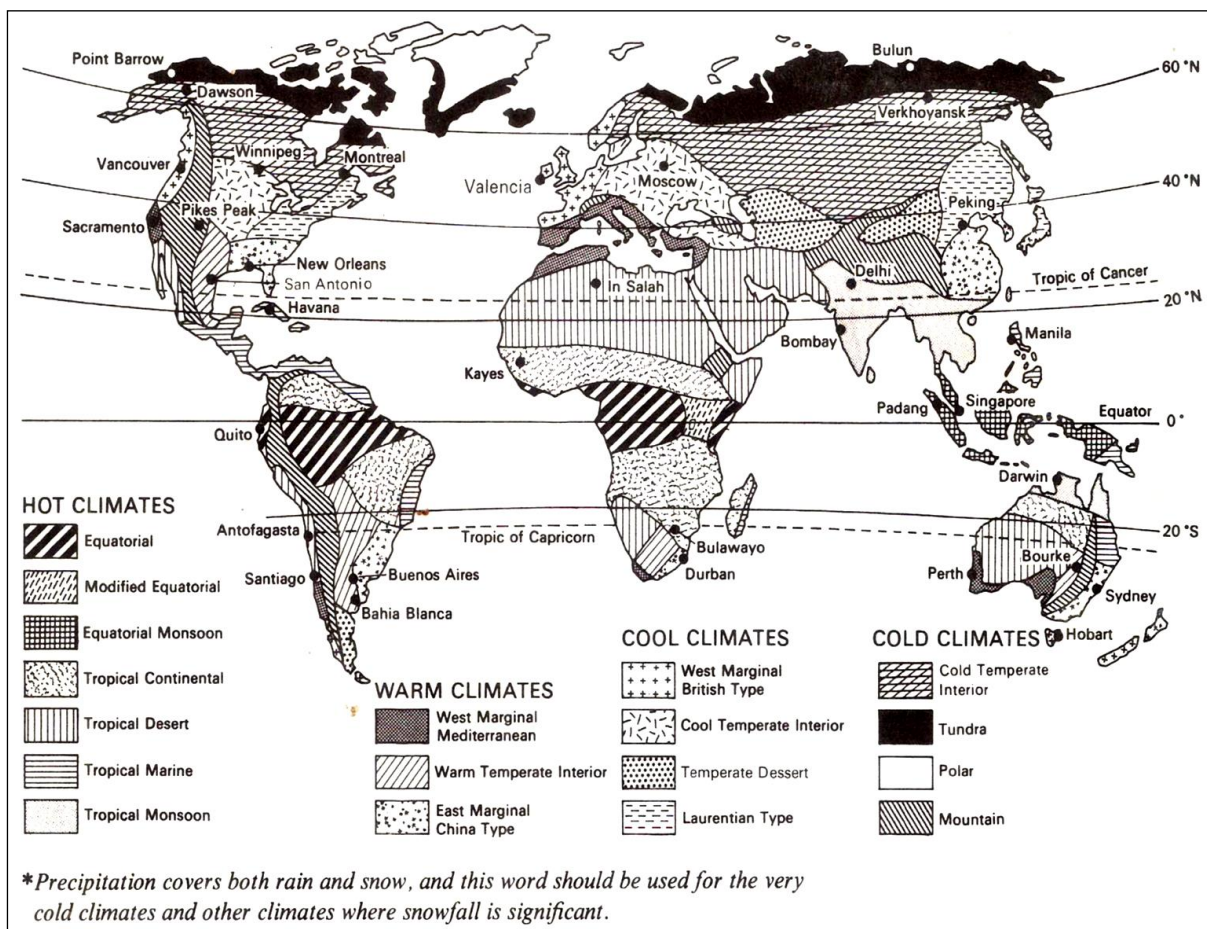
### 11.2.2.2 World Climatic Zones

Do you know that the earth is divided into five main climatic zones?

As shown on the globe, the climatic zones are the same when you move from the equator to the north or south Pole.

The five climatic zones according to temperature are: **Hot; Warm; Cool; Cold; Very Cold.**

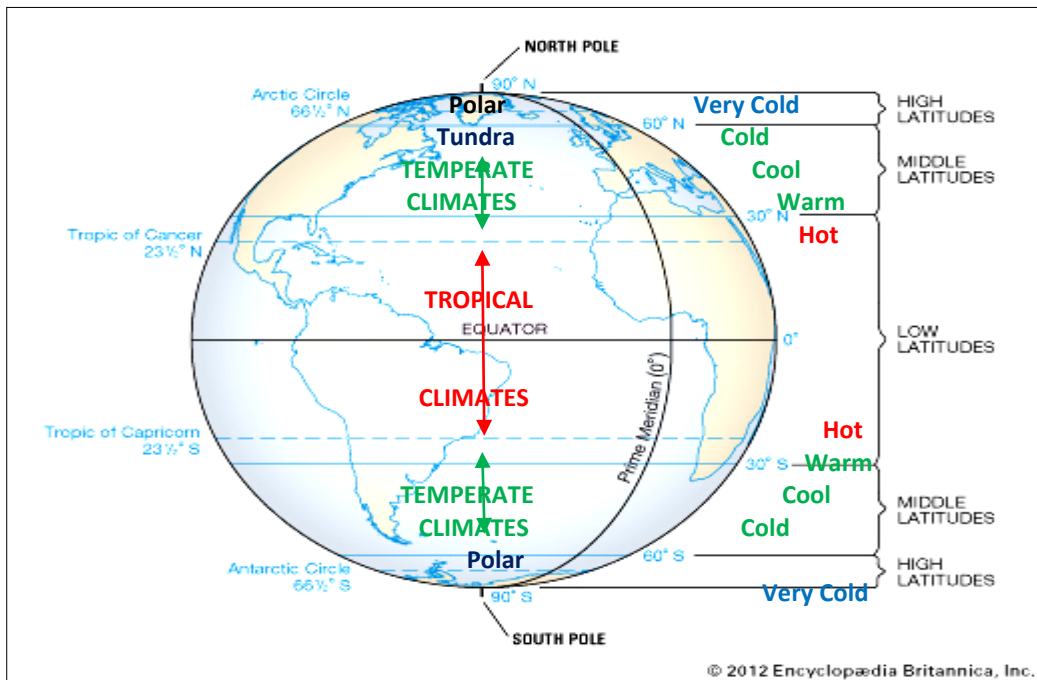
**Fig: 2. 13 World Map showing Type of climate distribution.**



Study the different types of climate and the regions they are found on the world map. Then compare **figure 2.13**, **figure 2.14**, and **figure 2.15** to find out about the type of prevailing wind occurring in a climatic zone. You will see the relationship of a type of climate and the prevailing wind that exist together in the different climate zones.

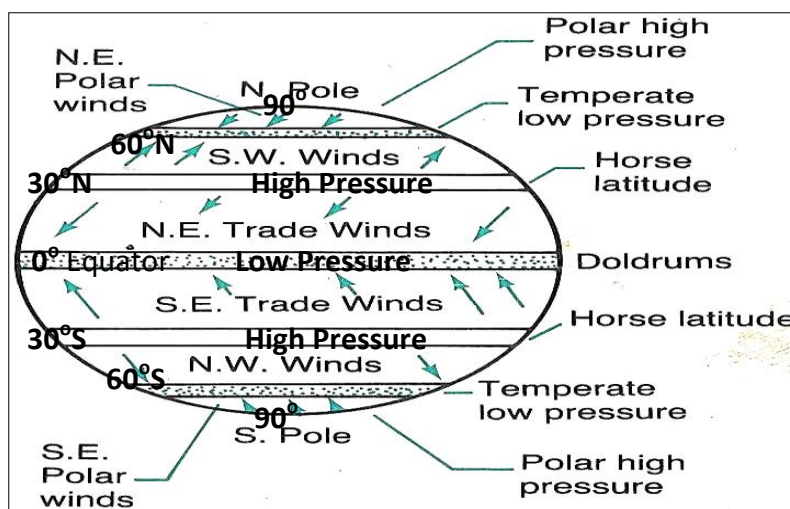


**Fig: 2.14 Climatic Zones or Regions**

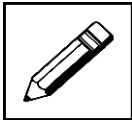


The Prevailing wind blowing in each climatic zone helps to influence the climate by changing the temperature of an area as well as bringing rainfall.

**Fig: 2.15 Global winds and the climatic region they blow in.**



Each climatic zone is influenced by a prevailing wind. For example, North East Trade winds and South East Trade winds mainly blow over Tropical climates in the hot climatic zone. North east Trade Winds blow over tropical climates north of the equator, whereas South East Trade Winds occur to the south of the equator.



### Student Learning Activity 15

1. List the five main climatic zones.

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**Study Fig: 2.13 to Fig: 2.15 to help you answer the questions below.**

2. Name all the types of climate found in Australia?

3. What type of climate does each of these countries have?

- |                   |                     |
|-------------------|---------------------|
| a) Malaysia _____ | e) Egypt _____      |
| b) Mexico _____   | f) Japan _____      |
| c) India _____    | g) UK _____         |
| d) Italy _____    | h) Madagascar _____ |

4. List the prevailing wind that will influence the climate of;

- |                    |                   |
|--------------------|-------------------|
| I. Japan _____     | III. Sydney _____ |
| II. Ice land _____ | IV. PNG _____     |

5. Which of these types of climates is not found in the Southern Hemisphere?

- A. Hot Desert      B. Savannah      C. Equatorial      D. Tundra

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



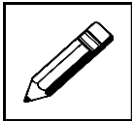
### 11.2.2.3 Tropical Climates and Influences

There are five main types of tropical climate. Each type of climate has its own unique characteristics.

**Fig: 2.16 Location and characteristics of the different types of tropical climates.**

Type	Location	Temperature and Rainfall (annual)	Other Characteristics
<b>Equatorial</b> Near the equator	Lowlands 5°N – 5°S e.g. Amazon / Zaire Basins	Average daily temperature is 26°C, average daily temperature range is 6°C Rainfall: 2 000mm plus	- No seasons - Mid day sun is always overhead - High humidity
<b>Continental</b> Inland away from the sea	5°N/S – 15°N/S e.g. Africa, Asia Australia, North and South America	Hot wet summers, cool dry winters. Heavy rain in summer, winters are dry. <i>Wet &amp; Dry</i>	- Humidity is high in summer - Savannah vegetation
<b>Maritime</b> Influence from sea	East coastal areas and Islands	Temperature is similar to Continental climates. Rainfall: 1 000 – 2 000mm <i>Wet &amp; Dry</i>	- Offshore winds bring rain daily every year. Heavy falls in hot season.
<b>Monsoon</b> Influence by monsoon winds	South east Asia, India and Northern Australia	Hot & cool season. High, heavy rainfall in wet season & very little rainfall in dry seasons. <i>Wet &amp; Dry</i>	Cool, dry season or Hot, dry season  Hot, wet season Very high humidity in wet season
<b>Desert</b>	Western sides and interior of land masses	No or less rainfall, Temperature varies, being very hot (day) & cool (night). large daily (diurnal) temperature range.	- Deserts occur in high pressure areas. - No cloud formation - Evaporation rate is very high. i.e. 20 times that of rainfall





### Student Activity 16

1. What is meant by the term “hot and wet” climate?  
\_\_\_\_\_  
\_\_\_\_\_
  
2. What is the meaning of a “wet and dry” climate?  
\_\_\_\_\_  
\_\_\_\_\_
  
3. What is meant by the term ‘arid’ climate?  
\_\_\_\_\_  
\_\_\_\_\_
  
4. List 3 countries that will have a tropical hot and wet climate like PNG.  
\_\_\_\_\_
  
5. Which type of tropical climate is influenced by the sea?  
\_\_\_\_\_
  
6. List one unique characteristic of a Desert climate.  
\_\_\_\_\_
  
7. Which of the following tropical climates has the largest diurnal temperature range?  

A. Tropical Monsoon	C. Hot Desert
B. Equatorial	D. Savannah

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



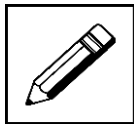


#### 11.2.2.4. Warm Temperate Climates and Influences

Warm Temperate climates have hot summers & mild winters – rainfall in both seasons)

**Fig: 2.17 Location and characteristics of warm temperate climates.**

Type	Location	Temperature and Rainfall	Other Characteristics
(Western margin) Mediterranean	Western sides of continents: S. Africa, Australia., Chile, California (USA)	Bright sunny, hot and dry summer & wet (mild rainy) winters	- Woodland vegetation - Grapes, citrus, olive trees are common
Interior	Interior of continents excluding Asia	Hot summer & less warm winter Rainfall: 380 – 700mm	- Semi-desert & shrubs
Eastern Margin	Eastern sides of continents	Hot summers with rain, & mild winters with light rain	- Temperate mixed broadleaf forest and coniferous trees



### Student Learning Activity 7

1. What is the most common characteristic of Warm temperate climates?

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2. What is another name for a Warm Temperate Western Margin climate?

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3. Which of these countries will have a Warm Temperate Western Margin climate?

- A. Brazil                      B. China                      C. Greece                      D. Thailand

4. Which type of warm temperate climate supports a type of forest vegetation?

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5. Which type of warm temperate climate will be very hot in summer, and very cold in winter?

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6. Which type of warm temperate climate will receive less rainfall?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.2.5 Cool and Cold Temperate Climates and Influences

Cool and Cold temperate climates usually have cold winter snow & warm summer rain.

#### Cool Temperate Climates

**Fig: 2.18** Location and characteristics of cool temperate climates.

Type	Location	Temperature and Rainfall	Other Characteristics
Western Margin	Western sides of continents. Europe, Canada	Cool winter: 2°C – 7°C Warm summer: 13°C – 15°C	mixed deciduous forest and coniferous forest
Interior	Continental Interior: N. America & Eurasia	Cold winter: -19°C Warm summer: 18°C	Temperate short grassland Best soil for growing cereal crops like wheat, corn, barley, oats, & rice
Eastern Margin	(N. America / Asia), S. America	Cold winter: -9°C to -7°C Warm summer: 15°C – 24°C	Deciduous forest and coniferous forest

#### Cold Temperate Continental Climate

**Location:** occur in latitudes before the Tundra climate latitudes; N. America & Eurasia

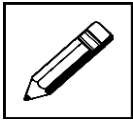
**Characteristics:**

Very cold winter: -34°C to -45°C; warm summer, average 21°C

Seasonal temperature range is high.

Annual summer rainfall rarely exceeds 380mm.

- Subsoil is frozen for most of the year, and this prevents most types of agriculture from taking place.
- Carpet floor vegetation, with coniferous forest only



### Student Learning Activity 18

1. What is the most common characteristic of a Cool and Cold temperate climate?

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2. Which type of cool or cold temperate climate will likely have either grassland or desert vegetation?

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3. List three countries that will have a cool or cold temperate climate.

I) \_\_\_\_\_

II) \_\_\_\_\_

III) \_\_\_\_\_

4. Which type of temperate climate do you think have mainly coniferous trees?

---

5. What is the summer and winter temperature for a cool western margin temperate climate?

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6. What is the summer and winter temperature for a cold temperate climate?

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7. What type of crops will be best grown on a temperate grassland area?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



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### 11.2.2.6 Tundra, Polar Climate and Mountain Climates

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#### Tundra Climate

**Location:** N. Canada & Asia

**Characteristics:**

Long and very cold winter (-29°C to -40°C)

Cool short summers (10°C)

- Carpet floor vegetation (colourful flowers and shrubs) with no trees.
- **Permafrost** - The subsoil (layer below the top soil) is permanently frozen all year
- The **top soil** is frozen and bare in winter and the frozen surface break up only during the warm summer to enable the growth of short grass, flowers and shrubs
- Flowers and shrubs only grow during the summer and perished when winter arrives.
- Many animals, birds and insects migrate to the tundra areas during the summer.
- Insects and some birds migrate to the tundra to drink the nectar and pollinate the flowering plants. Animals that feed on plants (herbivores) also migrate there, thus attracting meat eating animals (carnivores and top carnivores) to migrate to the tundra as well. Summer is the busiest time for plant and animal activities to occur.

#### Polar Climate

**Location:** Towards the North Pole & South Pole.

**Characteristics:**

- Temperatures are permanently below 0°C, even in summers.
- Blizzards are frequent
- Top soil is permanently frozen
- Referred to as '*polar deserts*' & '*climate without summers*'.
- Sun may not shine at all in several winters.

#### Mountain Climate

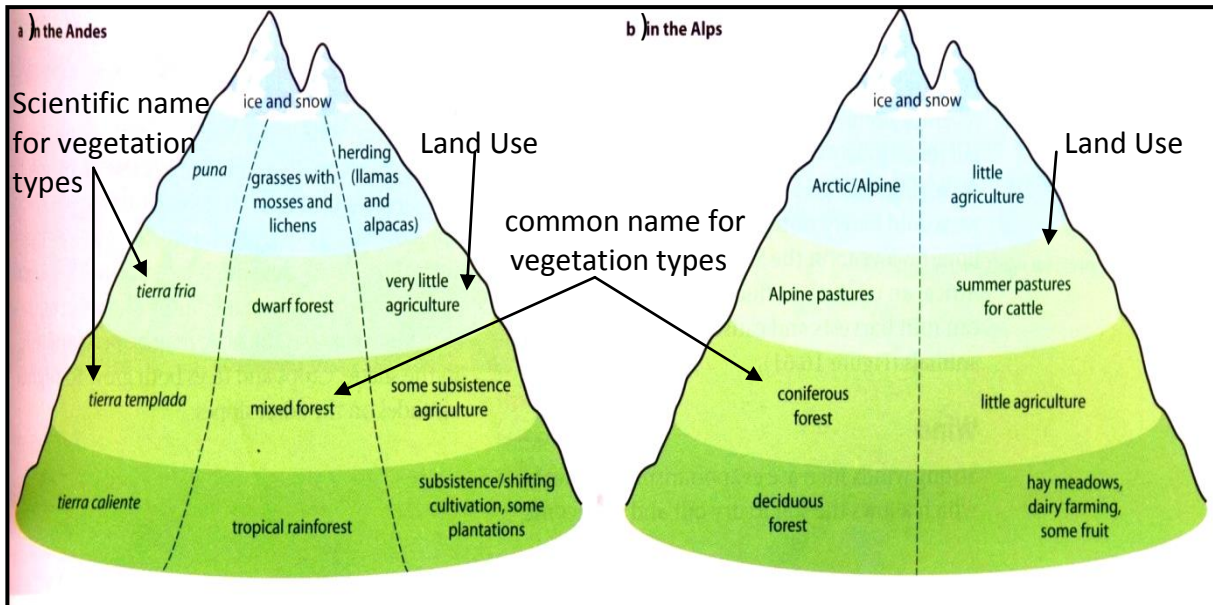
Mountain climate can be found in any place on earth where there are mountain ranges such as the Himalayas, Alps and even the mountain ranges of PNG. Different altitudes on the mountain side have different zones of temperatures and rainfall, which influence vegetation growth on the mountain side.

The climate in mountain areas changes due to the altitude and aspect which affect temperatures and cause variations in precipitation.

- **Altitude** is the height above sea level. Everyone can feel that it gets colder as you go up a mountain. Temperatures fall at a rate of 6°C every 1000 metres. This is because the air contains less oxygen, becoming 'thinner' at high altitudes.

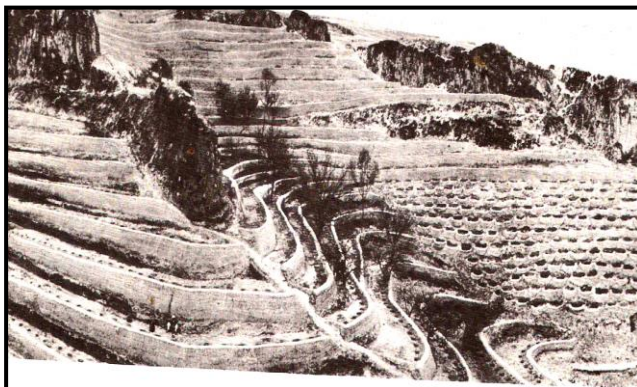
- Aspect** is the direction of the slope faces. Slopes that face the sun (north-facing slopes in the Southern Hemisphere and south-facing slopes in the Northern hemisphere) receive much more sunshine and have higher temperatures. Certain slopes always get sunshine while others are often in shade and tend to be cooler. This factors influence both natural vegetation and human activities.

**Fig: 2.19 Plants and land use change with altitude.**



In South East Asia rice farming take place on slopes. The method of farming used is called 'terracing'. Terracing is the cultivation and irrigation of crops on the hillsides that have steep-like appearance as shown in Fig: 2.20. Terracing is a similar form of 'contour ploughing'.

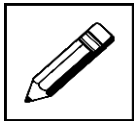
**Fig: 2.20 Rice Terracing**



**Fig: 2.21 Grapevines in Europe**



Grapevines in Europe are grown on the south-facing slopes because the slopes receives more sunlight than the north-facing slopes.

**Student Learning Activity 19**

1. Why is the temperature at the Polar climates always below  $0^{\circ}\text{C}$ ?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. What is the meaning of the term '*permafrost*'?  
\_\_\_\_\_
3. Do you think the land can be cultivated in Polar climates? Why?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. List the main mountain ranges of the world for each continent where mountain climate exist.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
5. Name some main land uses on mountain slopes in highland mountain areas.  
\_\_\_\_\_  
\_\_\_\_\_
6. What are the 2 factors that cause changes of climate on the mountains?  
i) \_\_\_\_\_  
ii) \_\_\_\_\_
7. What is the rate at which temperature drop for every 1000 metres?  
A.  $3^{\circ}\text{C}$       B.  $5^{\circ}\text{C}$       C.  $8^{\circ}\text{C}$       D.  $6^{\circ}\text{C}$       E.  $7^{\circ}\text{C}$

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

**END OF TOPIC 11.2.2**



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### 11.2.3 NATURAL VEGETATION

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#### Introduction

Is vegetation important for life to exist? Does the word 'vegetation' refer to vegetables, or grass growing on a hillside? Does the term 'vegetation' refer to trees and flowers?

The answer is 'Yes' and the importance of vegetation will be looked at later on in the topic.

**The term 'vegetation' refers to all types of plants growing in an area. Vegetation refers to grass, herbs, flowers, crops, trees and shrubs.**

You will discover the 'important requirements' that plants need to take, as well as the 'two important processes that plants carry out in order to make their food to grow and survive.

There are different types of vegetation and these vegetation types changes from the Equator to the Poles. Vegetation changes from the Equator to the Poles is similar to the way climate types changes from the Equator to the Poles.

Throughout this topic you will study the different types of vegetation. Each type of vegetation has a preferred location – the place where the vegetation grows best. And each type of vegetation has its own unique characteristics. There are similarities and differences between the different types of vegetation.



#### Objectives or aims

- define important terms: vegetation, habitat, subsoil, permafrost, shrubs, buttress roots
- identify the classification of forest, grassland and desert vegetation on a world map
- explain the photosynthesis and transpiration processes which plants perform
- explain the influence of temperature and water on plants
- explain the influence of drought and cold on plants
- explain and compare the characteristics of the different types of vegetation
- describe and explain the different layers of a rainforest
- explain the difference in vegetation from the equator to the poles
- identify the location of the different types of vegetation





## Time Frame

This topic should be completed within three weeks.

If you set an average of 3 hours per day, you should be able to complete the unit comfortably by the end of the assigned week.

Try to do all the learning activities and compare your answers with the ones provided at the end of the unit. If you do not get a particular exercise right in the first attempt, you should not get discouraged but instead, go back and attempt it again. If you still do not get it right after several attempts then you should seek help from your friend or even your tutor. Do not pass any question without solving it first.



### 11.2.3.1 What is Vegetation?

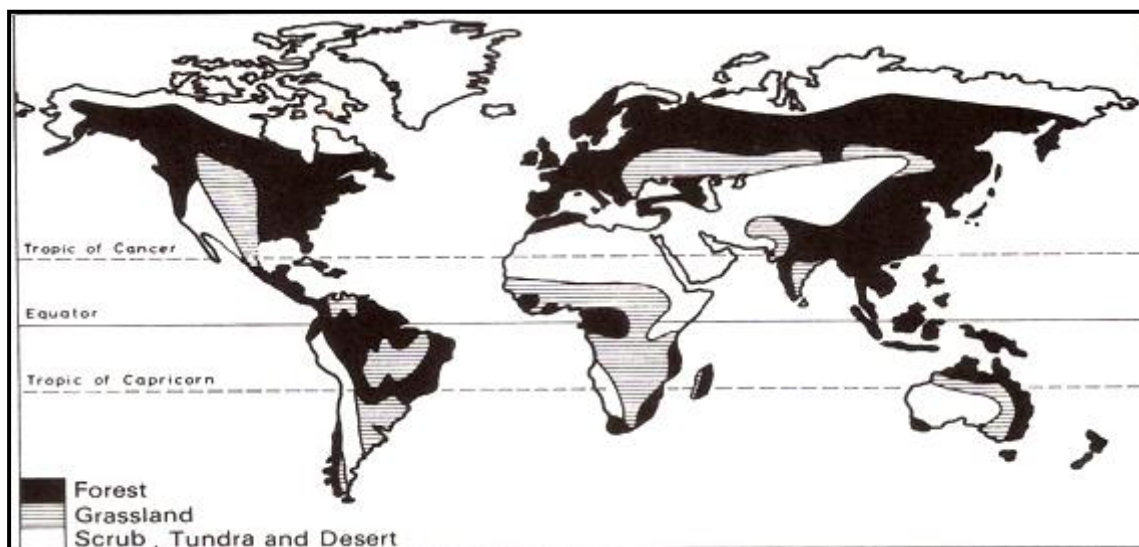
So what would be a good definition for the word 'vegetation'?

Vegetation refers to plants considered collectively, especially those found in a particular area. Vegetation refers to a community of plants. All the plants or plant life of a place taken as a whole makes up the vegetation of an area.

Geographers divide the world's vegetation into four basic types;

1. Forest
2. Grassland
3. Desert
4. Tundra

Fig: 3.0 World Map showing the Main Classification of Vegetations.



#### Plant Requirements

Green Plants make their own food by using *water, sunlight, carbon dioxide* and *mineral salts*. In order for the plant to survive, it carries out two processes called photosynthesis and transpiration.

The **two main** functions that are basic to plant growth and development are;

- Photosynthesis** – The process of capturing light energy and converting it to sugar energy, in the presence of chlorophyll using carbon dioxide and water.
- Transpiration** – The loss of water through the stomata of leaves.

The main difference between plants and animals is the plant's ability to manufacture its own food.

**Photosynthesis is the process by which green plants make nutrients for themselves from carbon dioxide and water in the presence of water in the presence of sunlight.**



Sunlight, water, minerals and carbon dioxide are all absorbed by the plant. The plant then uses them to make glucose/sugar, which is the energy/food for the plant. Oxygen is also produced by the plant in this cycle, which is then given off into the air through the pores (small openings) on the leaves. Have you noticed how clean and pure the air feels when there are plants around? They are filling the air with oxygen.

### A simple chemical equation for photosynthesis

carbon dioxide + water + light energy = glucose + oxygen



Transpiration occurs when plants 'give off moisture' (or release water) into the atmosphere. The water (moisture) is taken from the plant roots and given off through the small pores or openings on the leaves.

### Influence of Temperature and water on plant growth

Plant growth normally ceases when the temperature falls below 6 degree Celsius. In polar regions the temperature is always below 6 degree Celsius and there is no plant life. In some areas, temperature is seasonal (above or below 6 degree Celsius) so the plant life is also seasonal. Plants like animals try to adapt to their physical environment. Plants have a 'optimum (favourable) range' of temperature in which they survive.

Plants need water to grow, however, different plants need different amounts of water to survive. Too much water or too little water can kill certain plants. Too much rain before the harvest time can destroy crops, as well as very little water during drought periods can also kill the plants.

### Influence of Drought on plants

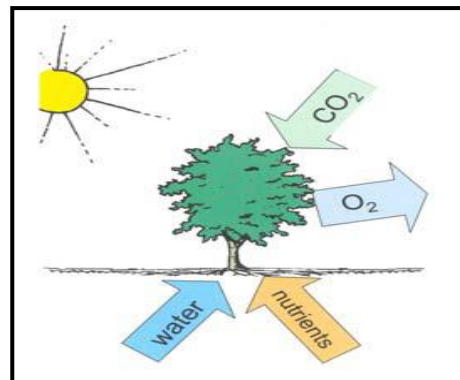
Plants adapt to dry areas such as savanna and desert areas. How do the plants adapt? The plants survive in a dry or arid area by adapting and developing certain important characteristics.

Some plants:

- develop long roots to reach water far below the surface.
- develop water storage organs, e.g. The baobab tree stores water in its trunk.
- have special leaves which reduce transpiration e.g. thorn-like leaves, rolled up leaves, leaves with waxy surfaces.
- shed most of their leaves when the dry season is also hot.
- develop sprawling or elongated root system.

### Influence of Cold on Plants

Fig: 3.1 Photosynthesis





When temperature falls below 6 degree Celsius plants are unable to obtain water from the soil and may shed their leaves. Others withstand cold because:

- i. their leaves are rolled and little transpiration take place.
- ii. they need less water than other trees.
- iii. they adapt, by having needle-like leaves.
- iv. They shed or lose their leaves in the colder seasons.

Now do the activity on the next page.



### Student Learning Activity 20

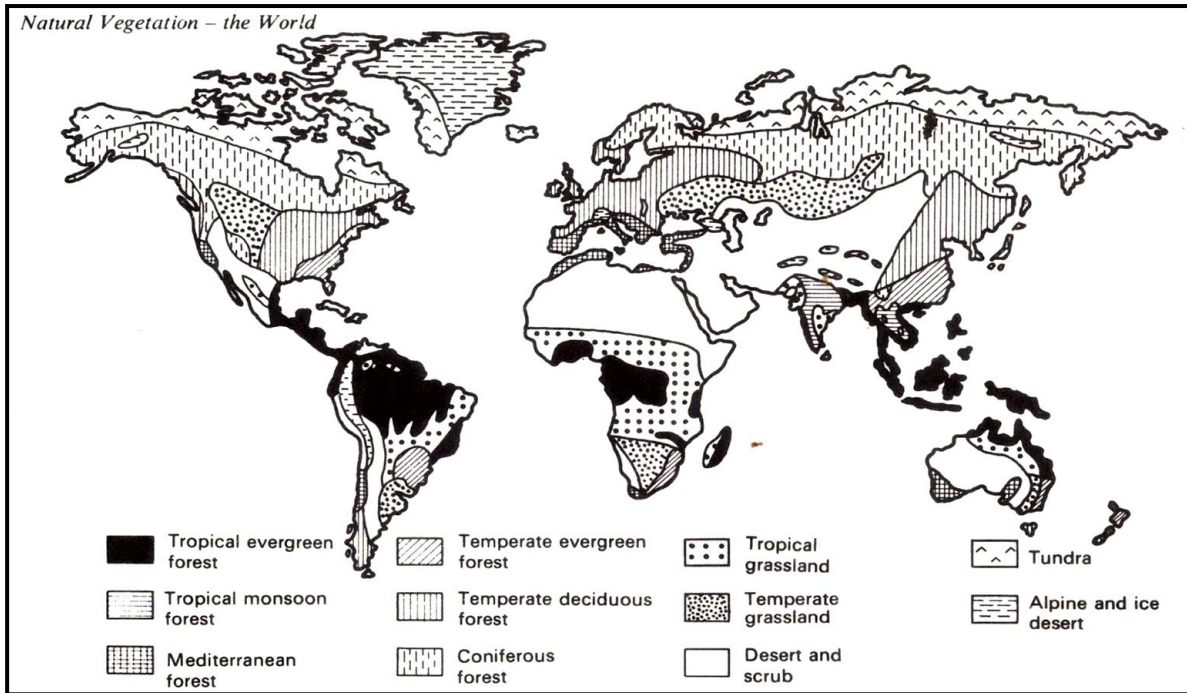
1. What is the meant by the term 'vegetation'?  
\_\_\_\_\_  
\_\_\_\_\_
2. List the things plants need in order to grow.  
\_\_\_\_\_
3. What are the 2 main processes that plants perform in order to survive?
  - i. \_\_\_\_\_
  - ii. \_\_\_\_\_
4. What is the formula of Photosynthesis? Give the formula in 'words' and 'equation'.  
\_\_\_\_\_  
\_\_\_\_\_
5. What is the amount of temperature required for plants to grow?  
\_\_\_\_\_
6. Which of these 2 climatic factors are very important for plants to grow?
  - A. Temperature and water
  - B. Pressure and temperature
  - C. Wind and water
  - D. Soil and ocean currents
7. List 2 ways that plants adapt to survive in cold climates.
  - i) \_\_\_\_\_
  - ii) \_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.3.2 Global Vegetation Zonation/Distribution

Fig: 3. 2 Global distribution of vegetation.

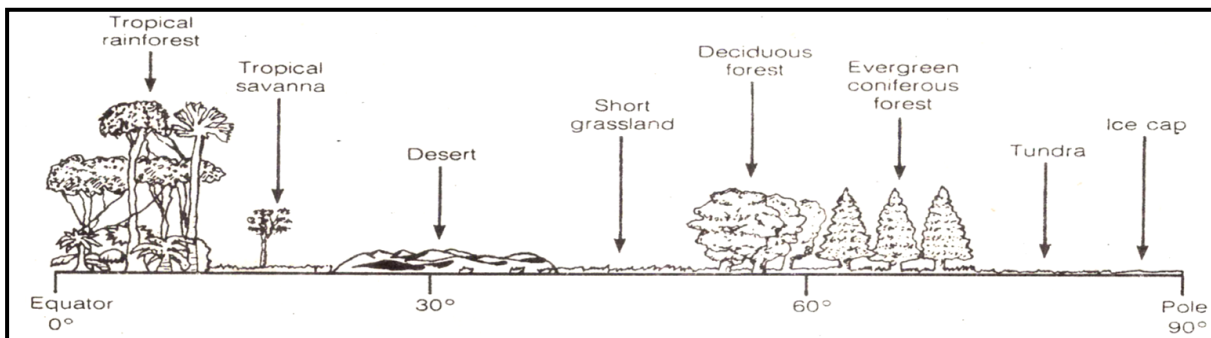


There are different types of vegetation found on the map. The different types of vegetation can only be found in the same latitudes e.g. Tropical Rain forests can only be found between the Tropic of Cancer ( $23\frac{1}{2}^{\circ}\text{N}$ ) to Tropic of Capricorn ( $23\frac{1}{2}^{\circ}\text{S}$ ).

#### Vegetation change from the Equator to the Poles

Vegetation changes as you move from the Equator ( $0^{\circ}$ ) to the Poles ( $90^{\circ}$ ). Study the diagram below to see how vegetation changes from the Equator to the North and South Poles.

Fig: 3.3 Profile of vegetation change between the equator and the poles.

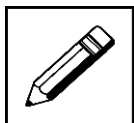




The type of vegetation in an area is mainly influenced by:

1. climate (temperature and rainfall)
2. Soil type

The climate of a place primarily determines the vegetation types from the Equator to the poles and from the base of the mountain to the top of the mountain. As temperature and rainfall decreases towards the Poles, vegetation and wildlife decreases as well. The same thing happens with wildlife and vegetation as you move from the sea level to the highest altitude or the mountain top.



### Student Learning Activity 21

**Study Fig: 3.2 World map of vegetation distribution and answer these questions.**

1. Name all the types of Vegetation that is found in Australia.

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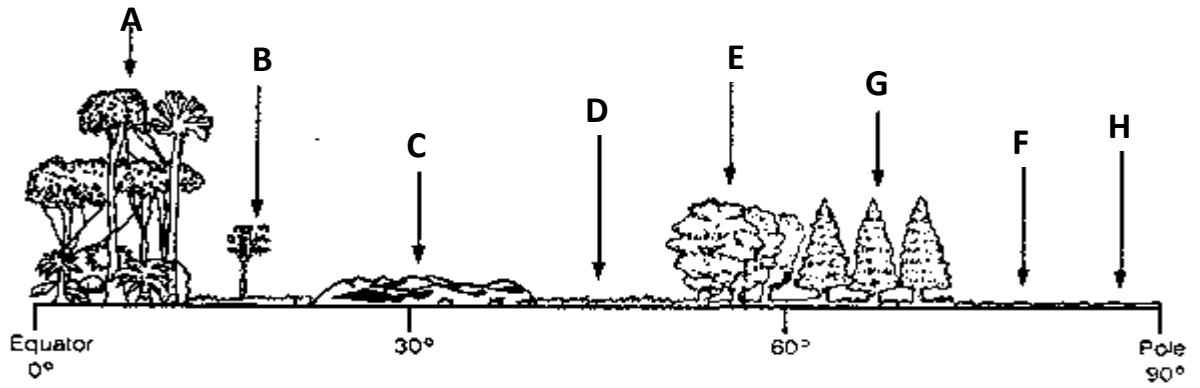
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2. What type of vegetation does each of these countries have?

COUNTRY	CLIMATE TYPE	COUNTRY	CLIMATE TYPE
a) Malaysia		e) Egypt	
b) Mexico		e) Japan	
c) India		g) UK	
d) PNG		h) Italy	



3. List the name of the vegetation marked 'A – G' below.



A. \_\_\_\_\_

B. \_\_\_\_\_

C. \_\_\_\_\_

D. \_\_\_\_\_

E. \_\_\_\_\_

F. \_\_\_\_\_

G. \_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**





### 11.2.3.3. Forest Distribution and Characteristics

There are five main types of Forests

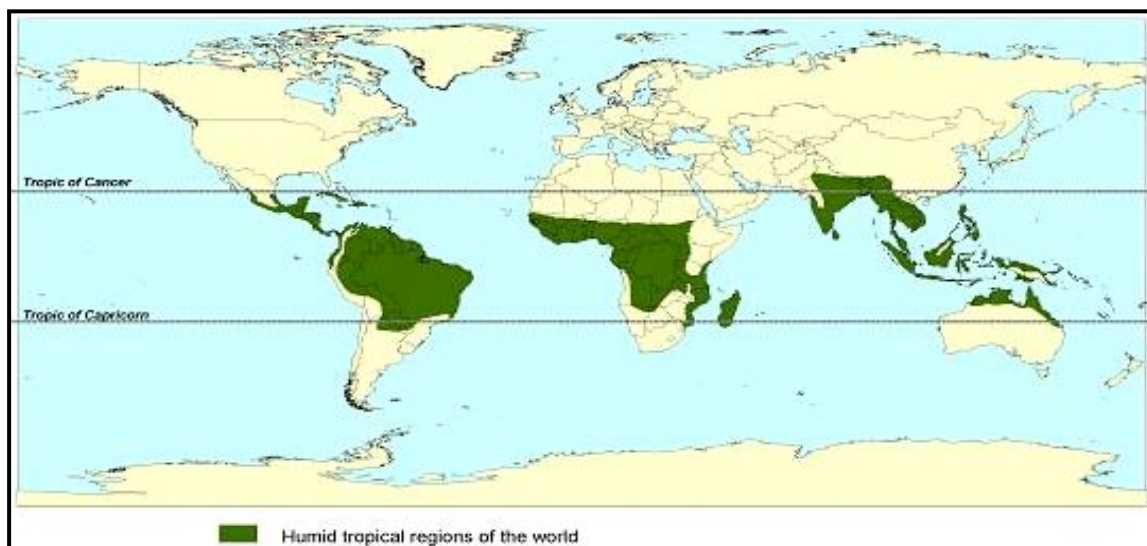
1. Tropical Evergreen Rainforest
2. Tropical Monsoon Forest
3. Mediterranean
4. Cool Temperate Deciduous forest
5. Coniferous Forest (also known as Boreal, Taiga)

#### A: Tropical Forests

There are two main types; Tropical Evergreen Rainforest and Monsoon Forest

##### 1. Tropical Evergreen Rainforest

Fig: 3.4 Distribution of Tropical Rainforest.

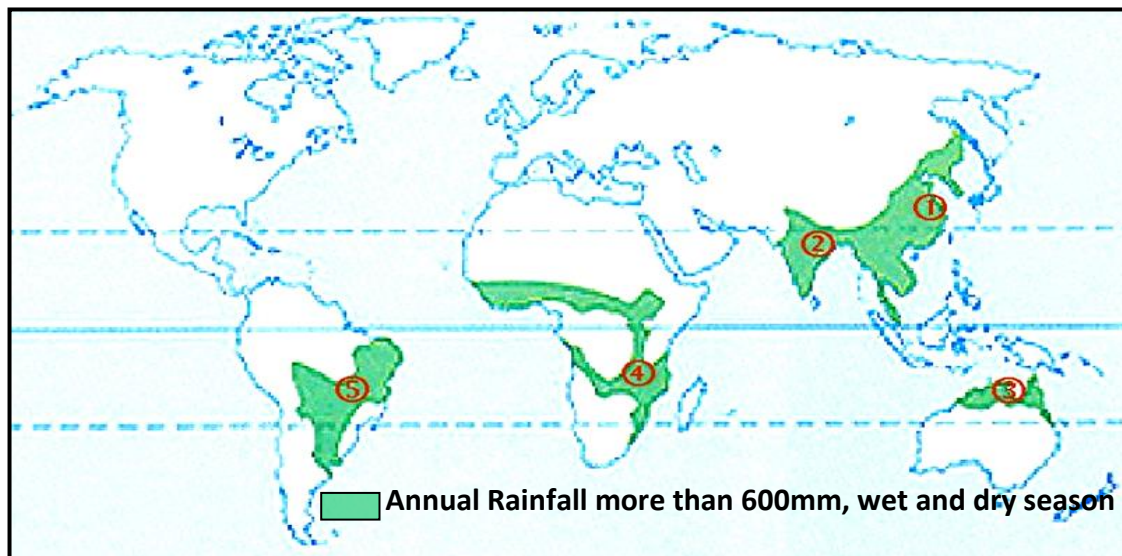


#### Characteristics:

1. has three layers/tiers (bottom, middle and top layer), called the forest floor, canopy and the emergent
2. contains the greatest variety of plants which are very close together
3. high temperatures and evenly distributed rainfall permit vegetation growth throughout the year
4. dense broadleaved canopy shuts out most of the sunlight to the ground level. This result in little or sparse undergrowth
5. leaves are broadleaf and evergreen and fruiting occur all year round
6. large tall trees have tripod or buttress roots to support their weight
7. when tropical rainforest is cleared, a secondary type of forest takes over. This forest consists of short trees and dense undergrowth

**Examples of valuable hard wood trees:**

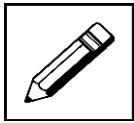
Mahogany, ebony, rosewood, ironwood and greenheart are common. Palms and tree ferns also occur. Different trees and plants grow together and there are rarely extensive stands of a particular tree. Mangrove trees are common along certain coastlines. Mangroves are also examples of tropical rainforests.

**2. Tropical Monsoon Forest****Fig: 3.5 Distributions of Monsoon Forests.****Characteristics:**

1. small number of species compared to a Tropical Evergreen Rainforest
2. tall deciduous trees which are not so close together as in a Tropical Evergreen Forest  
Because of these, under growth is thick. Bamboo forests are a common example of a monsoon forest
3. heavy rain and high temperature in the wet seasons result in rapid growth and trees soon become covered with leaves
4. these forests merge into equatorial forest where the dry season is short or non-existent, and into grasslands where wet season is short and rainfall is less heavy
5. contain valuable hardwoods (i.e. teak in Burma, Thailand, Cambodia and Laos)
6. leaves are broadleaf but are deciduous in winter
7. trees are deeply rooted in search of water in the dry season

**Examples of hardwood trees:**

teak, bamboo (Vietnam, Thailand, Cambodia and Laos), sal; sandalwood; lianas; acacia; eucalyptus and casuarinas (E. Java and N. Australia).



### Student Learning Activity 22

1. What are the 5 main types of forests?

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2. Why is there only a few plants growing on the floor of a Tropical forest?

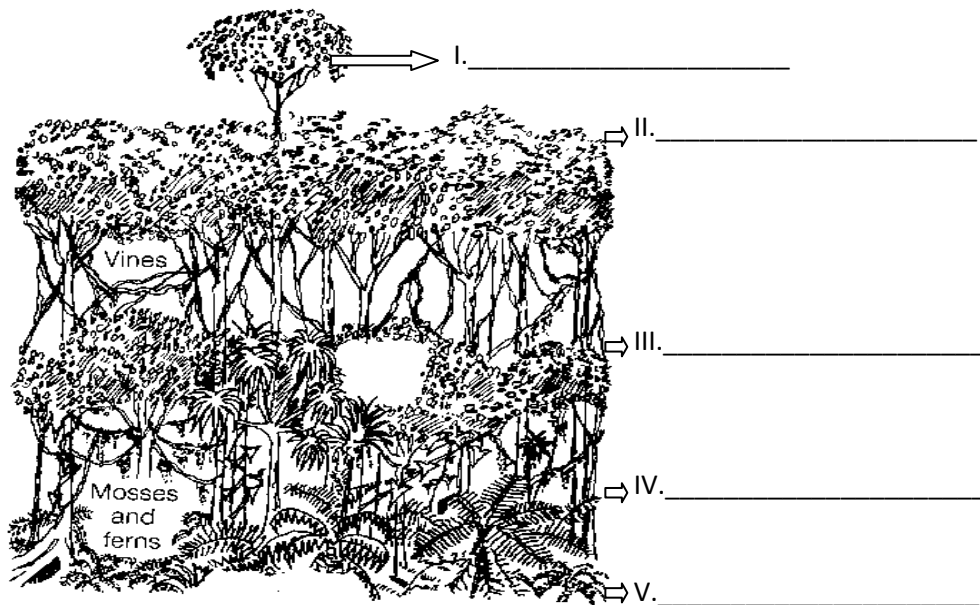
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3. What is the importance of a buttress root?

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4. Label the correct names of each forest layers of a Tropical rainforest below.



**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



## B: Temperate Forests

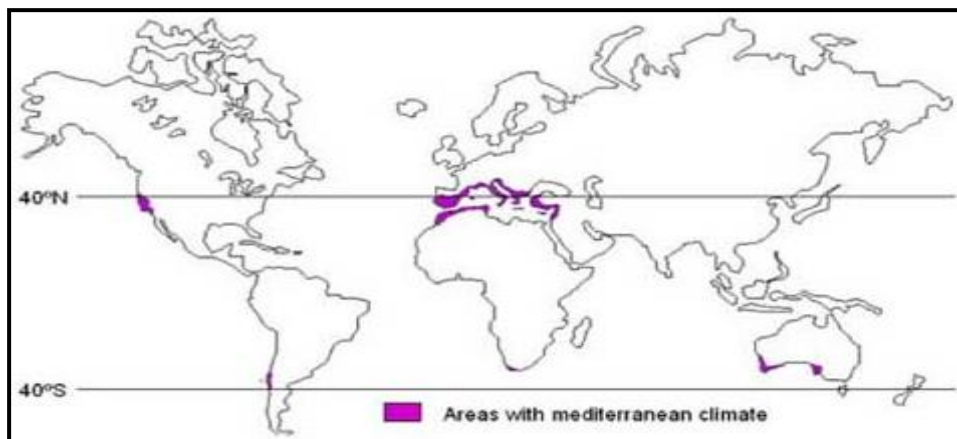
Temperate forests are located in the warm, cool and cold temperate region north and south of the equator. Below are the five (5) main types of temperate forests.

1. Mediterranean forest
2. Temperate Deciduous forest
3. Coniferous (Boreal or Tiga) forest
4. Temperate Rainforest
5. Temperate broadleaf mixed forest

You will only study the first three types of temperate forests in this topic.

### 3. Mediterranean

**Fig: 3.6 Distribution of Mediterranean Forests**



**Location:** western sides of land masses in warm temperate latitudes. Lowlands of Mediterranean; S.W. Australia; S.W Africa; central Chile; central California.

#### **Characteristics:**

1. scattered woodland type (originally a forest, but much of it was cut down and the rest was ravaged by foraging goats).
2. hot and dry summers make plant growth difficult (plants have adapted via storing water from winter rains in leaves and barks, e.g. waxy, spiny or small leaves to cut down the rate of transpiration. Grape wines have long tap roots to reach far below for water).
3. vegetation in drier parts becomes scrub-like consisting of sweet-smelling herbs and shrubs like lavender, rosemary, myrtle, thyme and oleander.
4. coniferous trees are common in wetter parts e.g. mountain slopes.

**Examples of trees:** evergreen oak; cork oak; eucalypts, jarrah and karri (S.W. Australia); cedar, cypress and sequoia or red wood (California), all of which are coniferous trees. The shrub like vegetation which includes the sweet smelling herbs are a secondary type of vegetation.



#### 4. Cool Temperate Deciduous Forest

**Fig: 3.7 Distribution of Temperate Deciduous Forests**



**Location:** Western and Central Europe; Eastern USA; Northern China; Northern Japan; Korea; Southern Chile and Southern New Zealand.

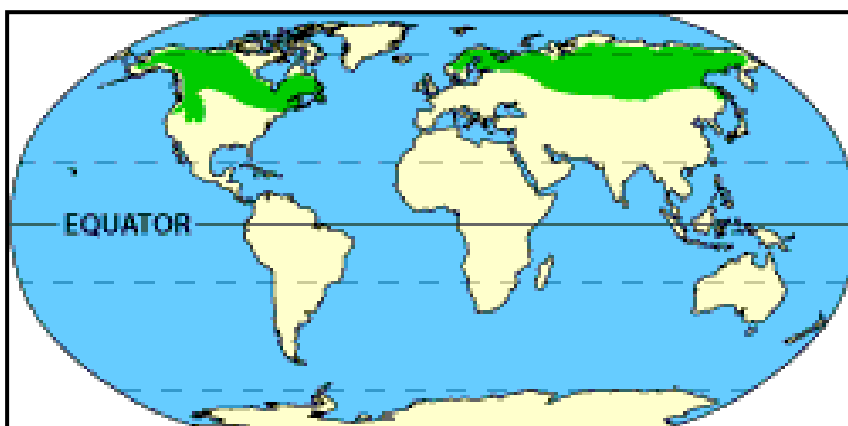
**Characteristics:**

1. winter falls below 6.1°C (minimum temperature for plant growth, which results in most trees shedding their leaves).
2. forest consist of deciduous hard wood trees which are of great economic value
3. has the richest soil in comparison to Tropical Rainforest and Coniferous forest.

**Examples of trees:** oak; beech; hazel; elm; chestnut; poplar; walnut; maple; hickory; cedar and spruce (both conifers).

#### 5. Coniferous Forest (also known as Boreal, Taiga or Temperate Evergreen forest)

**Fig: 3.8 Main Zone of Taiga Forests.**





**Location:** Most extensive in high latitudes (cold latitudes towards the pole) and on high mountains.

- (a) Across Eurasia – extending from the Atlantic ocean to the Pacific ocean.
- (b) Across North America – extending from coast to coast.

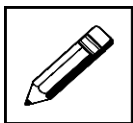
**Characteristics:**

1. coniferous evergreen trees are well adapted to long cold snowy winters
2. trees have needle-like leaves which reduce transpiration; the leaves have tough thick skin which protects them from winter's cold; The tree is composed of straight-trunked, conical and flexible short branches which allow the snow to slide off.
3. coniferous trees produce soft wood which is a great demand for making paper (especially news print), matches and synthetic fibers such as rayon.
4. forest has no undergrowth because the top soil is frozen for many months annually.
5. coniferous forest floor has a carpet type of vegetation because of the very slow rate of decomposition.

**Examples of trees:**

hemlock; spruce; pine and fir; coniferous trees of the Mediterranean are chiefly cedar and cypress.

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### Student Learning Activity 23

1. Why do the deciduous trees lose their leaves?

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2. Why is there a 'carpet type of vegetation' on a coniferous forest floor?

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3. List 3 ways of adaptation that the coniferous tree has done to survive in cold conditions.

---

4. An equatorial forest may contain all of the following trees except;

A. Ebony                      B. Iron wood                      C. Baobab                      D. Greenheart



5. List the similarities and differences between the 3 main types of forest in the table below.

<b>Forest Types</b>	<b>Similarities</b>	<b>Differences</b>
Tropical rainforest ... &... Deciduous forest		
Tropical rainforest ...&... coniferous forest		
Deciduous forest ...&... coniferous forest		

6. How many types of vegetation does Australia have?  
A. 3                      B. 4                      C. 5                      D. 6                      E. 7
7. Which of these trees is not a coniferous tree?  
A. Hemlock              B. Spruce              C. Fir                      D. oak

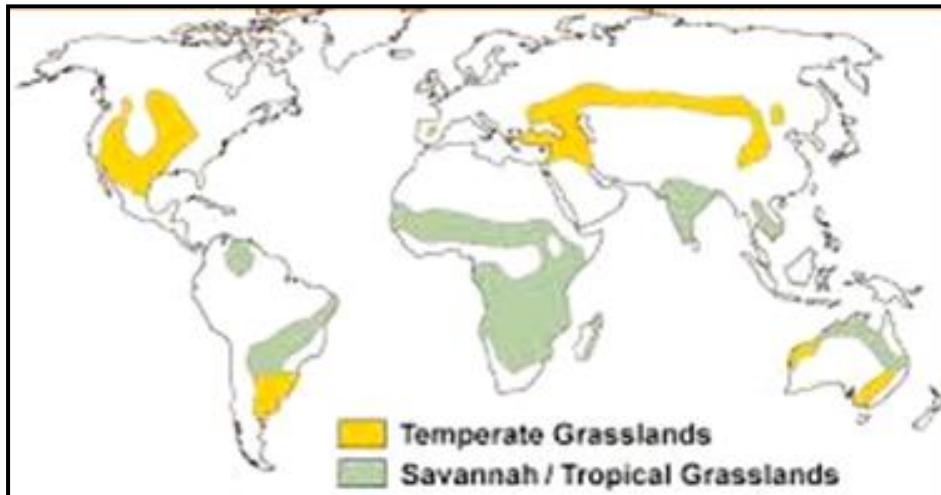
**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**





### 11.2.3.4 Grassland Distribution and Characteristics

Fig: 3.9 Distributions of Grassland Areas.



#### 1. Tropical Grassland

**Location:** occur where rain falls in the hot season which last for 5 months; (Africa) parts of Zaire, West and East African Plateaus, Guiana Highlands, Brazil, Australia and Indian Deccan Plateau.

#### Characteristics:

1. tall grasses usually 2 metres high or more dominates with trees commonly growing near water courses
2. the tall grasses grow in compact tufts, with long roots to reach down for water; in dry season leaves of grasses turn yellow and die but the roots remain dormant (sleeping); grasses are therefore deciduous
3. trees are also deciduous, shedding leaves in dry season. Some trees i.e. baobabs and bottle trees store water in swollen trunks and are able to survive in dry season
4. where grassland merge with the hot deserts, vegetation changes. There is no continuous vegetation cover, instead clumps of scrub-like plants scatter the surface

**Savannah** is an area of grassland with scattered trees. The trees are scattered some meters away from each other because of the lack of water in the soil.

A **grassland** area consists only of tall grasses growing in the area, whereas a savannah area consists of grassland and scattered trees.

**Grassland names:** different names according to location; Campos (Brazil); Llanos (Guiana); Savanna (Africa and Australia)





## 2. Temperate Grassland

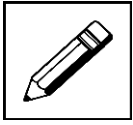
**Location:** best developed in continental interiors of temperate latitudes; example hearts of Asia and North America; Less extensive in South America, South Africa and Australia.

**Characteristics:**

1. Grasslands are almost tree less and contrast greatly with tropical grasslands
2. In wetter regions (rainfall over 500 mm) the grasses are tall, but not as tall as those of Tropical grasslands, and they are nutritious for animals. These grasses are typical of the black earth region of Ukraine (south of Russia) and American prairies (now under wheat cultivation). In drier regions (rainfall under 500 mm) the grasses are shorter, tougher and less nutritious for grazing animals. The grasses are typical of the high plains (USA) and the Asian steppes
3. Summer heat causes the grasses to wither and most of it dies in autumn. The roots are dormant, and they grow again in spring
4. Trees such as poplars, willows and alders grow in damper soils flanking water courses.
5. On the pole ward side, temperate grassland merge with coniferous forests while on the Equator ward side, they merge with scrub of semi-deserts
6. The richest soil in the world is located where the temperate grassland is growing

**Grassland names:** steppe (Eurasia); prairie (N. America); pampas (Argentina); veldt (S. Africa); downs (Australia)

**Note:** The leaves of grasses in most grassland areas wither and die in the dry seasons (tropics) or cold season (temperate). The roots remain dormant until the rainy season when the aerial parts of the plant start to grow afresh.



### Student Learning Activity 24

1. What is the difference between the tropical grassland and the temperate grassland?

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2. The temperate grasslands of the interior Eurasia are called;

- A. Prairie      B. Steppe      C. Veldt      D. Downs      E. Pampas

3. What is the difference between a grassland area and a savannah area?

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4. What happens to the grass during the dry season?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

### 11.2.3.5 Desert Vegetation

Fig: 3.10 Distribution of deserts

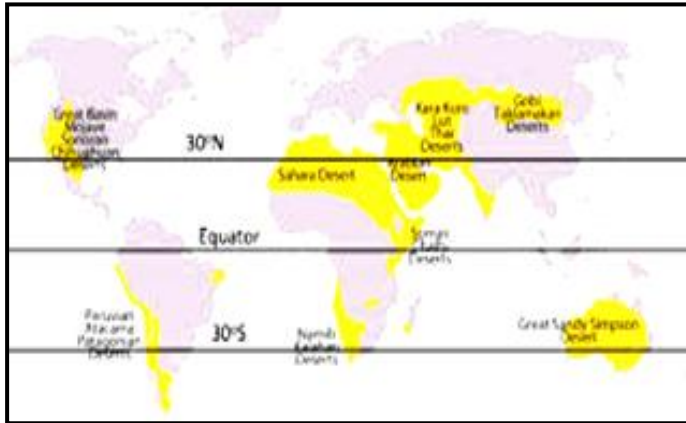


Fig: 3.11 Desert plants



#### 1. Tropical desert

**Location:** between  $15^{\circ}$  N/S and  $30^{\circ}$  N/S; lie on the western sides of land masses except for Africa where they extend from coast to coast, linking up with the Asian deserts. Sahara; Arabia; parts of Iran, Iraq, Syria, Jordan and Israel; part of Pakistan; central Australia; Atacama (Costal Peru and north of Chile); Southern California and Northern Mexico; parts of Arizona (North America).

#### Characteristics:

1. small parts of tropical deserts are without any type of vegetation
2. desert plants are very special in that they can withstand high temperatures and long periods when no rain at all falls. These types of plants are called **xerophytes**
3. adapt to drought in special ways i.e. some plants have long roots; have few or no leaves
4. many plants produce seeds which lie dormant for years until a little rain falls and then they germinate. These plants are called **ephemeral plants**
5. common plants are cacti, thorn bushes and grasses

#### 2. Semi-desert and scrub

**Location:** type of vegetation occur in regions which either border the tropical deserts, or in the interiors of continents where the rainfall is just insufficient to maintain a continuous cover of vegetation.

#### Characteristics:

1. in tropical scrubland the chief plant is the thorny acacia; during rainy periods short-lived grasses and flowering plants cover large areas. Sage bush is common in North American scrubland.



### 11.2.3.6 Tundra

The tundra biome is a cold and treeless plain where harsh conditions make it hard for plants and animals alike to survive. Tundra means a **'barren or treeless land'**. The tundra has few nutrients to support plant and animal life. It has a short growing season and a slow rate of decay.

Tundra can be classified under grassland, because very short grasses and plants grow during the short period of summer months (about 2 months). Trees do not grow in a Tundra climate. It is mainly a 'desert' with no plants during the long winter months.

#### There are two (2) types of Tundra

- Alpine tundra - Alpine tundra is the area of land high in the mountains above the tree line. Alpine tundra exists on mountain ranges such as the Andes and Himalayas. Alpine tundra also occurs in high mountains in the tropics (Tanzania and PNG).
- Arctic tundra - The Arctic tundra is located far north in the northern hemisphere along the Arctic Circle. There are large areas of tundra in northern North America, northern Europe, and northern Asia.

**Fig: 3. 12 Distribution of Tundra (Arctic Tundra)**



**Location:** Vegetation is confined to the Northern Hemisphere, bordering the Arctic Ocean in the continents of Eurasia and N. America. Tundra is also found on high mountain regions such as Himalayas and Andes.

#### Characteristics:

1. tundra is a 'barren' with no vegetation except snow and ice during winter, and has large areas of 'marshy plain' in summer
2. has a short growing season (about 2 months) and at this time the surface soil thaws,



however the subsoil remains frozen. Water lies on the surface. This influences the pattern of vegetation

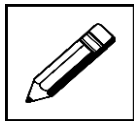
3. where the tundra meets the coniferous forest there are stunted willows and birches.

4. consists of very short vegetation made up of lichens, mosses, sedges, and flowering shrubs such as bilberry and bearberry

5. there are few plant species in tundra compared to other types of vegetation environment

6. the plants grow very short to protect themselves against the wind

7. five (5) common plants: lichens, mosses, grasses, cushion plants and low shrubs



### Student Learning Activity 25

1. State 2 reasons why human settlement in a Tundra environment is very difficult.

i) \_\_\_\_\_

ii) \_\_\_\_\_

2. List 3 ways in which plants adapt to dry climates.

i) \_\_\_\_\_

ii) \_\_\_\_\_

iii) \_\_\_\_\_

3. List 2 common plants that grow in the Tundra climate.

i) \_\_\_\_\_ ii) \_\_\_\_\_

4. What is the name of the desert plant in the picture?

i) \_\_\_\_\_

ii) \_\_\_\_\_



5. List the 2 main types of tundra.

i) \_\_\_\_\_ ii) \_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

**END OF TOPIC 11.2.3**



## 11.2.4 NATURAL DISASTERS

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### Introduction

The last major topic of your unit booklet provides a helpful awareness about changes in climate and the Extreme Natural events, Natural hazards and Natural Disasters that are always part and parcel of our environment system. The last topic discuss an overview of disaster management methods and strategies in PNG. These disaster management methods can help prevent more harm to the people as well as adjusting to the disaster risk areas and coping after the disaster strike.

The earth is made up of one big environment system with smaller environment systems and natural processes working in a state of balance to support and maintain the natural environment's system of the earth.

Our climate is changing, and has been continually changing in the last how many years that the earth has exist. Climatic factors of temperature, precipitation and pressure played an important part as the atmospheric processes. Each natural processes works interdependently from others. Atmospheric processes such as weather, climate seasonal changes in heat from the sun and water cycle affects our atmosphere.

The biotic processes such as ecosystems and food webs depend on the atmospheric processes. Geomorphologic processes of weathering and erosion and deposition will likely influence the atmospheric and biotic processes and vice versa.

Geological processes of plate tectonic activities also influence topography and other features that can have an effect on other processes in one way or the other.

This topic concludes with the strategies and methods of disaster management and how the PNG government, the International Organisations and NGO's respond to natural hazards and disasters.



### Objectives or aims

- define important terms: hazards, disasters, climate change, global warming, disaster management, plagues
- explains the difference between a natural disaster, natural hazard and extreme natural event.
- distinguish between natural hazard and man-made hazard.
- explain the different types of natural hazards and disasters.
- examine the severity and causes of these hazards and disasters including its damage potential.
- discuss the characteristics of each type of natural hazard and disaster recorded in png and the pacific.
- discuss the impact of a natural hazard and suggest ways to mitigate the impact



### Time Frame

This topic should be completed within three weeks.

If you set an average of 3 hours per day, you should be able to complete the unit comfortably by the end of the assigned week.

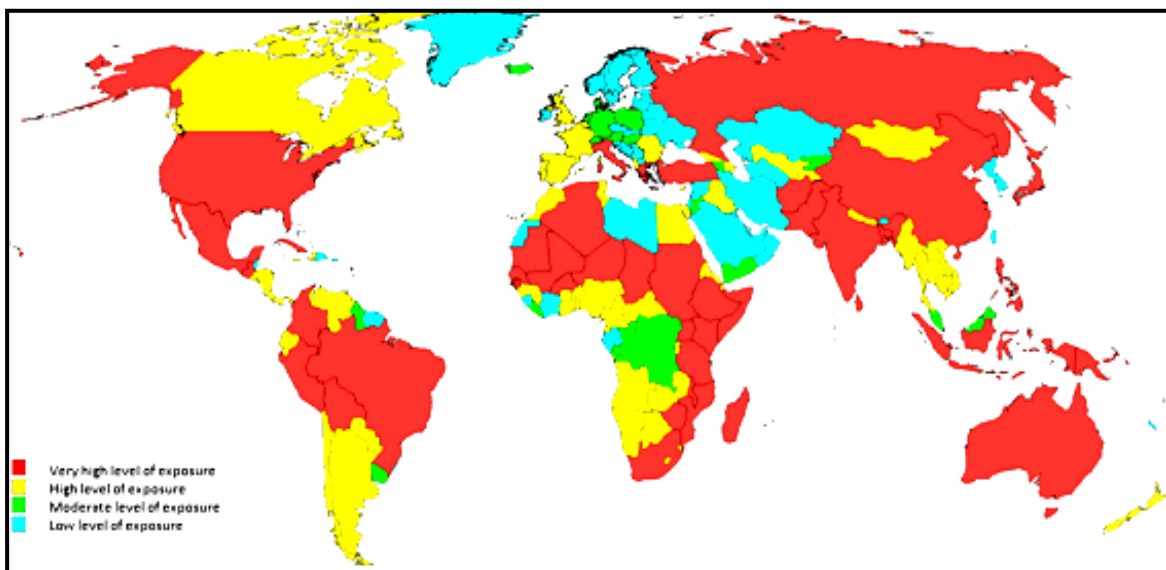
Try to do all the learning activities and compare your answers with the ones provided at the end of the unit. If you do not get a particular exercise right in the first attempt, you should not get discouraged but instead, go back and attempt it again. If you still do not get it right after several attempts then you should seek help from your friend or even your tutor. Do not pass any question without solving it first.



### 11: 2.4.1 Extreme Natural Events, Natural Hazards, and Natural Disasters

Natural **hazards** and **disasters** result from natural (**physical**) processes interacting with human systems. The natural hazards and natural disasters take place in the environment and are seen as natural events or activities. These natural processes can operate inside the earth (**geological**), on the surface of the earth (**geomorphologic**), in the **atmosphere** (atmospheric) and in the **biosphere (biological)**. Other hazards are caused by the actions of people.

**Fig: 4.0 Map estimating the levels of exposure of different countries to natural hazards.**



#### Comparing natural events, natural hazards and natural disaster

An **extreme natural event** is an act of nature that has caused damage to people and their environment **e.g.** earthquakes, tsunamis, tornados, volcanoes, erosion, cyclones running rivers, changes in ocean currents and many more. An extreme natural event is an unusual event that happens naturally. The extreme natural events are part of our environment system.

A **hazard** is defined as an event that threatens, or has potential to destroy lives and properties.

‘A **natural disaster** is an event that causes harm in significant amount; so a disaster is a type of extreme event that causes significant harm’. When we say significant harm we mean causes destruction to people’s properties, homes, buildings, roads and loss of lives.

An important aspect of all hazards is **risk**. Risk is also what people take knowing that they are ‘exposed’ to a natural event that might prove hazardous. This is particularly so if they remain in that location or do not take precautionary actions, known as **adjustment** or **mitigation**.



**It is important to remember these aspects of hazards:**

- **Distribution** - where the hazard occurred (area of damage)
- **Scale** - how strong or large the event was (intensity of impact)
- How long the event lasted (duration of impact)
- Whether the event occurred quickly or slowly over a period of time (Time, rate or speed)

**Category definitions of hazards****Fig: 4.1 Main classifications of hazards.**

Type of Hazard	Definition	Examples
<b>Geological</b>	Events that occur as a result of tectonic plate movements	tsunami, volcano and earthquake
<b>Geomorphologic</b>	Occur on the land surface and change the landscape of an area	Floods, landslides and mud flow
<b>Atmospheric</b>	Events caused by changes in the weather conditions in the air	cyclone, draught, hail, frost and tornado
<b>Biological</b>	Disaster spread or caused by the living organisms e.g. human beings	Plagues, pests and bushfires

**Disasters can occur as a consequence of the impact of a natural or a human-caused hazard.**

A **natural hazard** is one produced by environmental processes. E.g. earthquakes, volcanic activity, landslides, tsunamis, tropical cyclones and other severe storms, tornadoes and high winds, river and coastal flooding, wildfires and associated haze, drought, sand and dust storms, and infestations.

**Human-caused hazards** are also hazards that are created by people. E.g. industrial explosions, nuclear warfare, air and road crashes, fire and the collapse of buildings. Most of these are caused by human errors or mistakes.

Some may be intentional, such as the illegal discharge of oil, or accidental such as toxic spills or nuclear meltdown.

All of these hazards can expose people, ecosystems, flora and fauna to threats. The poor are the most vulnerable to disasters because they have fewer resources and capacity to prevent or cope with the impacts.

**The important point to remember is that, if there were no people, there would be no hazards because hazards in this context mean hazards to people.**





## 11.2.4.2 Geological Hazard and Disaster

### Nature of Geological Hazards and disasters

A geological hazard is an extreme natural event in the crust of the earth that poses threat to life and property, for example, earthquakes, volcanic eruptions, tsunamis (tidal waves) and landslides. The value of the property destroyed amounts to millions and billions of money.

The earth's crust is made up of large broken-up pieces of unstable tectonic plates. These plates sit on top of hot liquid molten rocks. The movement of these plates and the pressure of the molten rocks beneath the crust will eventually lead to earthquake, tsunami and volcanic eruptions.

### Earthquakes

#### What are earthquakes?

**Earthquakes** are the 'shaking or trembling of the earth's crust'. They are unpredictable and strike without warning. Earthquakes range in strength from slight tremors to great shocks lasting from a few seconds to as long as five minutes. They can come in a series over a period of several days. Most earthquakes are so slight that they are not felt by humans. However, some earthquakes create vibrations resembling those caused by the passing of a heavy truck. The vibrations of major earthquakes can destroy entire cities in seconds.

#### What causes earthquakes?

1. Rock under great strain cracks and releases energy in the form of **seismic waves**.
2. The release of huge stresses due to underground volcanic forces.

#### The effects of earthquakes

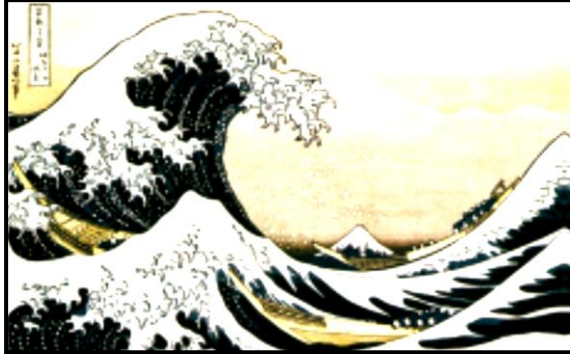
Most earthquake casualties result from falling objects or debris because shock waves may damage or demolish buildings and other structures. Electricity and telephone lines, gas, sewer and water mains can be damaged; **landslides**, ground displacement (faulting), and even **tsunamis** (huge seismic sea waves) may be caused, leaving many people dead, **injured** or **homeless**. After a major earthquake, there may be a series of further tremors, some of them severe enough to cause additional damage. These tremors are called **aftershocks**.

Some of the greatest damage from an earthquake happens when faults shake the soil under buildings in low-lying, water-logged areas, causing what's called **liquefaction**. Near coastlines, harbours and rivers, earthquakes can make the wet, sandy soil jiggle, turning it temporarily from a solid to a liquid state. Heavy sand and rock sinks, while water and lighter sand bubble to the surface.



## Tsunami

**Fig: 4.2 Tsunami illustration**



Another major hazard produced by earthquakes and **volcanic eruptions** are tsunamis.

**What are tsunamis?** Tsunamis are large waves which reach great heights near the shore where they can cause massive damage and loss of life.

### General Characteristics

Tsunami differs from ordinary ocean waves, which are produced by wind blowing over water. The tsunamis travel much faster than ordinary waves. Compared to normal wave speed of 100 kilometres per hour, tsunami in the deep water of the ocean may travel the speed of a jet airplane - 800 kilometres per hour! And yet, in spite of their speed, tsunami increases the water height only 30-45cm and often passes unnoticed by ships at sea.

### Tsunami Hazard in PNG

- Coastal communities in the Bismarck and Solomon seas are particularly vulnerable to tsunamis.
- High risk areas are those adjacent to active volcanoes and sea trenches.
- In 1998, an earthquake off the coast of Aitape, West Sepik Province triggered a tsunami causing 2,183 deaths and completely destroying 2 villages.
- The 2011 Japan tsunami caused damage to coastal towns in the outer islands of the Bismarck Sea including Wewak, East Sepik Province.
- The Madang and Morobe provinces remain highly vulnerable to volcanic tsunamis.

**Fig: 4.3 List of Earthquakes and Tsunami in the Pacific region.**

Date	Location	Magnitude	Natural Disaster
1998	Sissano, Sandaun PNG	7.0	Earthquake and Tsunami <i>5<sup>th</sup> deadliest tsunami</i>
2004	Indian Ocean	9.1 – 9.3	Earthquake and Tsunami <i>The deadliest tsunami</i>
2007	Solomon Island	8.1	Earthquake and Tsunami
2009	Samoa	8.1	Earthquake and Tsunami <i>9<sup>th</sup> deadliest tsunami</i>
2013	Solomon Island	8.0	Earthquake and Tsunami

## Volcano

### Volcanic eruption

Volcanoes erupt when pressure in the mantle builds up and hot liquid magma forces its way out. Hot molten rocks flow out, and/or materials of ash, rocks, gas are thrown out with great force. Volcano eruption can happen on land or under the sea.

### The Effects of Volcano

#### Destructive effects

Volcanic eruption exposes people to natural hazard such as lava flows, poisonous gas and ash and rock falls which can directly damage homes, properties, roads, buildings, water supply and electricity and even cause deaths. Volcanic eruption can indirectly cause fires, famine, hunger and disrupt the flow of normal services. Volcanic eruption can also cause tsunami which can further leave many people dead, injured or homeless.

#### Constructive effects

Even though Volcanoes are natural hazards, many people and communities still live near these volcanoes because of the fertile volcanic soil and the food provided by the birds and animals that are attracted to the area. Volcanic areas also attract tourists. Volcanic activity inside the earth plays a part in the formation of minerals as well. Geothermal energy is a potential source of energy around hot volcanic areas.

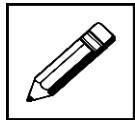


### Volcano Hazard in PNG

- Volcanoes are the most common (22%) and most deadly natural disaster activity in PNG.
- PNG has a lot of volcanoes of various sizes and height. There are fourteen active and 22 dormant volcanoes. Ten of the fourteen active volcanoes and all the dormant volcanoes are located within the Bismarck Volcanic Arc, of which five are located in West New Britain Province potentially threatening many people. Six of the active volcanoes are classified as high risk.
- The 1994 Rabaul volcanic explosion caused roughly K330 million worth of damage.
- Manam Island in Madang Province has the most active volcano in the country. There have been 24 recorded eruptions since 1900. Evidence suggests that eruptions have been occurring with increasing frequency and intensity. There were no recorded deaths as a direct result of the 2004 eruption but some 3,000 houses, as well as infrastructure, crops and forests were damaged or destroyed. By January 2005, 85% of Manam island was buried in ash and lava rock and fewer than 200 people remained. Today most Manam islanders are now living on the Bogia mainland.

**Fig: 4.4 Recent Volcanic eruption in PNG.**

Name of Volcano	Year of eruption
Pago (WNB)	2003
Ulawun (WNB)	2005
Manam (Madang)	2005
Rabaul (ENB)	2006
Bagana (AROB)	2006
Tavurvur (ENB)	2014



### Student Activity 27

1. What is an earthquake?

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2. What causes an earthquake?

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3. What is a tsunami?

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4. What causes a tsunami?

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5. What causes volcanic eruption?

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6. List 3 constructive effects of a volcano.

i) \_\_\_\_\_

ii) \_\_\_\_\_

iii) \_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.4.3 Geomorphologic Hazards and Disasters

#### Nature of Geomorphologic hazards and disasters

Geomorphic natural events operate at or near the earth's surface to change and shape the landscape of an area. Geomorphological hazards include mass movements, river flooding, glacial hazards, soil erosion, and asteroid and comet impact. Rock falls, land slide, earth flows and mud flow moving down a slope are good examples of mass movement.

#### Landslide or Land slipe

**Fig: 4.5 Landslide in Southern Highlands 2014.**



#### What causes the landslide to happen?

Landslides occur when the stability of the slope changes from a stable to an unstable condition. A change in the stability of the slope can be caused by one or more factors.

There are so many factors, but here is a list of four main factors;

1. excess ground water
2. loss or absence of vegetation cover
3. earthquakes
4. deforestation, cultivation and construction on slopes.

#### Effects of Landslides

PNG has experienced a lot of landslides in the Highlands and other parts of the country. The landslides that occurred in PNG have destroyed and buried gardens, homes, people, roads and property in their path. Landslides can take lives, cause injuries and make people homeless. Landslides that occur under sea, or have impacted the water can generate tsunamis.





## Flooding

### What is a flood?

It is a natural event or occurrence where a piece of land (or area) that is usually dry land, suddenly gets submerged under water. Some floods can occur suddenly and recede quickly. Others take days or even months to build and discharge.

### What causes flooding?

**1. Heavy Rainfall**

Each time there are more rains than the drainage system can take, there can be floods.

**2. River overflow**

Rivers can overflow their banks to cause flooding.

**3. Strong winds in coastal areas**

Sea water can be carried by massive winds and hurricanes onto dry coastal lands and cause flooding.

**4. Dam breaking**(ruptured dam or levee) Embankments or walls, known as levees, are built along the side of a river and are used to prevent high water from flooding bordering land.

Dams are man-made blocks mounted to hold water flowing down from a highland.

**5. Ice and snow-melts**

In many cold regions, heavy snow and ice sometimes melts when the temperature rises, resulting in massive movement of flood water into places that are usually dry.

### Effects of flooding

#### Economic

During floods (especially flash floods), roads, bridges, farms, houses and cars are destroyed. People become homeless. Additionally, the government deploys firemen, police and other emergency apparatuses to help the affected. All these come at a heavy cost to people and the government. It usually takes years for affected communities to be re-built and business to come back to normal.

**Did you know that the cost of all flooding in the USA in 2011 was US \$8.6 billion?**



## Environment

The environment also suffers when floods happen. In 2011, a huge tsunami hit Japan, and sea water flooded a part of the coastline. The flooding caused massive leakage in nuclear plants and has since caused high radiation in that area. Radiations are very dangerous to human health and the effects of radiation can sometimes last for many years.

Additionally, flooding kills animal and others insects are introduced to affected areas, damaging the natural balance of the ecosystem.

## People

Many people are killed in flash floods. Many more are injured and others made homeless. Water supply and electricity are disrupted and people struggle and suffer as a result. Flooding also brings a lot of diseases and infections including military fever, pneumonic plague and dysentery.

However, there is also something good about floods, especially those that occur in flood plains and farm fields. Floodwaters carry lots of soil nutrients that are deposited in the plains. These deposits are called **alluvium soil**. Farmers love such soils, as they are perfect for cultivating certain types of crops.

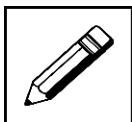
## Example of Flooding in PNG

The 2008 Papua New Guinea floods displaced roughly 75,000 people located in Papua New Guinea, prompting an international response to provide support for the region. The country was struck by large waves on 16<sup>th</sup> December, which was caused by "strong storms", which affected over eight provinces and caused at least one death.

Apart from the swells (powerful waves) that cause flooding in PNG on 2008, there has been a lot of flooding in the Highlands that have affected gardens, homes and properties. Low lying coastal areas like Western Province and other areas in PNG will likely experience serious flooding.

Flooding in Oro in 2011 and 2012 affected 11, 125 people, while 20, 000 people in East Sepik were affected in the 2010 floods.

Now do activity 28 on the next page.



### Student Activity 28

1. What is a flood?

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2. What causes floods to happen?

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3. List one advantage of floods.

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4. What is a land slide?

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5. What causes land slide to happen?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.4.4 Atmospheric Hazard and Disaster

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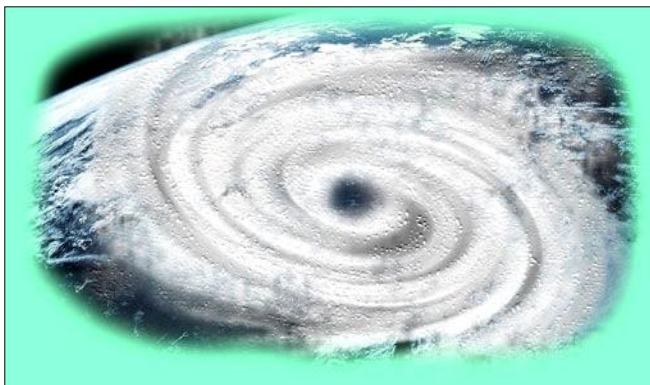
#### Nature of Atmospheric hazard and disaster

Atmospheric hazards form in the air first before affecting specific places. The atmospheric hazards include **storms** of various types, damage to coastlines by ice or wave action, **droughts, floods, snow, hail, lightning** and natural fires.

**Tropical cyclones** are the worst and most widespread natural hazard, causing damage not only directly by wind action but also by flooding. Flood hazards in some areas have further increased due to changes in land use such as the growth of towns, and deforestation. Natural fires caused by lightning such as **forest fires**, can cause widespread devastation but many of the most serious fires result from peoples' actions.

#### Cyclone

Fig: 4.6 Cyclone with the eye at the centre.



**What is a cyclone?** It is a powerful, spiral weather that results from **low pressure systems**. (*low pressure system explained below*) It is seen as a massive storm (powerful winds often with rains, thunderstorms and lightning) that usually moves, covering a stretch of 500-600 miles.

#### Low Pressure System

This is an area where the atmospheric pressure is lower than that of the area surrounding it. Typically, there are winds around and the air is a lot warmer, causing atmospheric lifting. Low pressure systems result in cloud formation and bad weather. Hurricanes, typhoons, tropical storms and tropical depressions are all examples of low pressure systems.

Tropical cyclones develop in warm waters of 26°C and above. Tropical cyclones always occur in the hot tropical waters of the Pacific Ocean and other warm ocean surfaces in the Indian, and Atlantic Ocean. PNG has experienced tropical cyclones but with less damage compared with other Pacific nations like Solomon Island and Fiji as well as Australia. USA is the country that experiences the highest number of cyclones and tornados every year.



### General Characteristics

- 1) Strong winds                      (2) Exceptional rain                      (3) Storm surge

Cyclones are generally accompanied by strong winds which cause a lot of destruction. In some cases it is accompanied by heavy downpour and also the rise in the sea which intrudes inland thereby causing floods.

### Effects of hurricanes or cyclones

The effects of hurricanes can be grouped into two: weather and economic.

#### i) Storm Surge

Hurricanes bring about storm surges. What is a Storm surge? This is a rise in the ocean's water level as a result of extreme winds blowing over the sea's surface. Water levels can rise up to 5 metres and a lot more. As the storm makes a landfall, the high sea level brings water inland, causing major flooding and destruction.

#### ii) Floods

Hurricanes carry a lot of rain with it and even after the hurricane has subsided, it may continue to rain. This causes a lot of flooding and brings about other types of destructive results.

#### iii) Winds

Houses, cars, farms and many other structures are blown away by the powerful winds that come with hurricanes.

### Impact on the economy

Any time there is a disaster caused by a natural phenomenon like hurricanes, floods and fires, there is extensive damage to property. Peoples' livelihoods are wiped away and may take many years to get things together again. In many cases, there are fatalities and entire communities are greatly affected.

People may be forced to stay home for so long and businesses suffer as a result. In addition to that, the states (or governments) spend huge amounts of resources in preparation for these occurrences. Emergency work and rebuilding of infrastructure costs the city a lot of money.

### Do you know where the most deadly tropical cyclone disaster took place?

The most deadly tropical cyclone ever recorded hit Bangladesh in 1970 killing approximately 300,000 people as a result of the storm surge. Many more died after a period of diseases and post hurricane challenges.



**Fig: 4.7 Five of the most destructive hurricanes the world has seen.**

NAME	CAT	YEAR	DEATHS	DAMAGE (billions US\$)	AREAS
Katrina	5	2005	1, 833	125	Bahamas, USA
Sandy	3	2012	286	68	USA East Coast
Ike	4	2008	195	37.5	Greater Antilles Texas Louisiana Midwestern United States
Rita	5	2005	62	12	Cuba-USA Gulf Coast
Mitch	5	1998	11, 000+	6.2	South Florida USA

### Tropical Cyclone Hazard in PNG

- Tropical cyclones affect southern PNG between November and April. Between 1969 and 2010, 23 tropical cyclones passed within 400 km of Port Moresby, with an increasing frequency in **ENSO** (El Nino Southern Oscillation) neutral phases.
- During the cyclone season, Milne Bay, northern and the southern coastline of PNG experience strong winds.
- An average of seven tropical cyclones occurs per year during wet seasons along the latitude 8-20 degrees south of the equator.
- Salt water intrusion is common in low lying coral atolls and coastal communities.
- PNG lies just outside of the main Tropical Cyclone belt within the Southwest Pacific region. On average, tropical cyclones hit the country at the rate of about one cyclone per year. Despite being free from the main areas of where cyclones form compared to neighbouring areas, there is a far higher probability of tropical cyclones forming outside and moving into the country.

Different places have different names for Tropical cyclone. Pacific and Indian ocean - Tropical cyclones; Japan – Typhoons; America and Caribbean – Hurricanes; Australia - willy willies.

### Drought

Drought can be seen as ‘a relatively long time where there is not enough water than there usually is, as a result of dry weather, to support human, animal and plant life’.

Droughts may not be an issue just because there is less or no precipitation. However, it becomes an issue when it begins to affect water supply for irrigation, household use, industries, energy and ecosystem function.



Water scarcity is made worse by a lengthy period of sudden dry spell in the Pacific region. The 1997 drought affected 500,000 people across PNG and caused extreme hunger for many people in the highlands and low-lying islands. Drought in PNG is caused by lower than normal rainfall for a continuous period of two months or more. In the recent years, Western, Simbu, Eastern Highlands, Central, Milne Bay, Oro and other outer islands and atolls in the Solomon and Bismarck seas are becoming more drought prone.

### **What causes drought?**

#### **Lack of rainfall (or precipitation)**

Droughts can occur when there is lack of 'expected' precipitation (rain and snow). Note that we say 'expected' because lack of rain alone does not mean a drought. Some regions can go for months without any rain and that would be 'normal' for them.

#### **Human factors**

Forests (trees) play a key role in the water cycle, as they help reduce evaporation, store water and also contribute to atmospheric moisture in the form of transpiration. This means, cutting down trees (deforestation) in the name of economics, will expose surface water to more evaporation. It will also reduce the ability of the ground to hold water and make it easier for destruction to occur.

#### **Global Warming**

Even though some people do not accept that the average temperature of the earth has risen, it is on record that human actions have contributed to more **greenhouse gases** in the atmosphere. As a result, there are warmer temperatures, often resulting in more dryness and bush fires. These conditions also tend to speed up drought conditions.

#### **Effect of El Nino**

El Nino is also known as ENSO. It is a warm ocean current which flows in the Pacific Ocean. The warm ocean can cause drought conditions. El Nino results from the warming of the ocean in the Eastern Pacific and the cooling of the ocean in the Western Pacific which reverse the normal wind direction bringing heavy precipitation to the Eastern Pacific and south America and drought to the western Pacific. The location of Papua New Guinea in the Western Pacific ocean means PNG will get to experience drought during El Nino periods.

#### **Effects of droughts**

Water is involved in every part of human life and also important for plants and animals. There are so many ways that water affects us both **directly** and **indirectly**. Let us consider this scenario:

Assuming that the rains do not come in a particular year. What happens? Crops yield will be very low and farms will have to close production. Local farm produce sellers will have nothing to sell. That will be a **direct** impact on farmers and sellers. But that is not all, because farmers closed production, they will not buy farming materials such as seeds,

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fertilizers, tractors and so on. That means many more businesses that produce and sell these materials and equipment will also be affected. They will also lose sales and have to lay people off. When people are laid off, they cannot buy things and cannot take care of their families. That is an **indirect** effect and it can be even more devastating, complex and long term.

That is just one way of looking at it. Here are some more:

Imagine that you turned the tap on and no water flows, and the water authority officials tell you that water will not flow for weeks or months because there is a drought. Imagine that the lights are off because the Hydro-electric dam that produces power is closed because of low water levels. Imagine that people cannot go to school and work because there is an outbreak of diseases as a result of the lack of water for sanitation purposes.

What if there are many wild fires because of extreme dryness caused by lack of rains and high temperatures. And one of the most interesting effect of droughts occur in the Highlands, in altitudes of 1 220 metres and above, where droughts can result in frost.

So you see, there is a chain of problems that droughts can bring. All the problems can be grouped into three main impact areas.

- (1) Economic impact                      (2) Environmental impact                      (3) Social impact

### **1. Economic impact of droughts**

Economic impacts often involve losing money either by individuals or families, businesses and governments. Here are some examples of economic impact resulting from droughts.

- Farmers will have to spend more money to irrigate the crops and provide water for livestock on animal farms and ranches.
- Low crop yield means farmers lose a lot of money; farm workers have to take pay cuts and some may even have to be laid off.
- Businesses and industries that manufacture farm equipment and resources lose money because farmers do not have the money to buy from them.
- Less or no rains mean dryer conditions and more bush fires. Farms are destroyed, properties are razed down, forests and trees are burned and people lose money this way. Governments also need to spend more resources to fight fires and send emergency supplies to the most needed places.
- Businesses connected to water recreation, such as beaches and lake side activities may close down because of low water levels or dried out water bodies. The livelihoods of people connected to such businesses are all affected.





## 2. Environmental impact of droughts

Plants, animals, climate, soils, rocks and many others are all affected by drought conditions.

- Soil moisture is the key for the breakdown of organic matter. Droughts lower the quality of soils, because there is less organic activity, more wind erosion and soil organisms die.
- Water bodies (lakes, creeks, ponds, lagoon and lakes) dry out, and water animals die. This is called **habitat destruction**. When aquatic animals (and other wild life) die, entire food chains and ecosystems are also affected.
- Desertification is when fertile lands (vegetated lands) become bare and infertile, often as a result of overgrazing, deforestation and other economic activity. Droughts make this process even worse and eliminate any chances of the land recovering.

## 3. Social impact of droughts

Social impact of droughts is perhaps the most felt, as they directly involve us and our families. Some people (especially those from developed countries) have never experienced what it is like to live without enough water. It is a nightmare.

Health has a direct link to the water supply of any settlement. Clean water for drinking and water for cleaning and sanitation help society prevent and manage diseases.

### Hailstorm and Frost

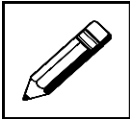
Hailstorm, frost and other atmospheric hazards such as tornados also threats that exist. Frost has been a hazard in the Highlands of PNG for some time now, especially in cold places in Enga and Western Highlands.

**Hail** is a solid precipitation. It is different from sleet, though the two are often confused for one another. Hails consist of small solid ice (cubes) particles which fall during great storms.

Water vapour rises in the air. As the water vapour rises and the temperature goes below freezing point, they cool down and freeze very quickly. **Sleet** is smaller solid precipitation than hail.

**Frost** is the result of dew turning to solid. It is the solid deposition of water vapour from saturated air. It is formed when solid surfaces are cooled to below the dew point of the adjacent air as well as below the freezing point of water. Frost crystals' size differs depending on time and water vapour available. Frost causes economic damage when it destroys plants or hanging fruits.

In 1997 PNG experience a serious frost in the highlands, which severely disrupted food crops. The Government, PNG Red Cross and Church groups, and Aus Aid all helped lessen the impact.



### Student Learning Activity 29

1. What is a cyclone?

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2. What are the general characteristics of a cyclone?

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3. What is drought?

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4. What is the difference between a hailstorm and a frost?

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5. List 5 usage of water.

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6. What is the Japanese name for cyclone?

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**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



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### 11.2.4.5 Biological Hazard and Disasters

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#### Nature and cause of Biological hazard and disaster

Biological hazards (biohazards) refer to biological substances that pose a threat to the health of living things, mainly the humans. This includes medical waste or samples of a micro-organism, virus (from a biological source) that can affect human health. Sources of biological hazards may include bacteria, viruses, insects, plants, birds, animals and humans.

Biological hazards will include Anthrax, HIV/AIDS, Hepatitis, Influenza, bird flu, swine flu, cholera, Yellow fever, Tuberculosis, Ebola and SARS virus.

Bush fires or wild fires are Biological hazards that occur often during hotter months or in drought periods.

#### Diseases and Pests

#### How biological infectious diseases are spread

People can come into contact with infectious micro-organisms as a result of the work they are involved in. This can include people working with, animals (e.g. farming) and people who may be carrying infections (e.g. hospital staff). People whose job may include handling materials which may be contaminated with micro-organisms e.g. refuse (waste materials) and sanitation workers.

Overcrowding of settlements and unhealthy environmental conditions assist the spread of virus, parasitic and bacterial infection. PNG is a developing country with a lot of squatter settlements. Many of the squatter settlements have unhygienic conditions and the spread of contaminated diseases can bring biological disasters.

Many biological hazards exist in PNG and the Pacific and can prove deadly if little attention and awareness is made about the hazards. Tuberculosis, HIV/AIDS, Hepatitis, bird flu, swine flu and cholera have already proved deadly in PNG. Virus such as Ebola is a rising threat that has proven to be a biological disaster in some African countries whose lifestyles and development is similar to PNG.

An **epidemic** is an outbreak of an infectious disease that spreads through a human population. A **pandemic** is an epidemic that spreads globally. There have been many epidemics throughout history, such as Black Death.

In the last hundred years, significant pandemics include:

- **AIDS**: was first recognised in 1980; today millions worldwide have been infected
- The H1N1 Influenza (**Swine flu**) 2009-10
- The 1918 **Spanish flu** which killed an estimated 50 million people worldwide



- The 1957 – 58 **Asian flu** which killed an estimated 1 million people
- The 2002-3 **SARS** (Severe Acute Respiratory syndrome) spread from China to other countries through the movement of people.

Other diseases that spread more slowly but are still considered to be global health emergencies by the World Health Organisation (WHO) include;

- **XDR TB**, a strain of TB that is extensively resistant to drug treatments
- **Malaria** which kills an estimated 1.6 million people each year
- **Ebola** virus disease, which has claimed hundreds of victims in Africa in several outbreaks.

### **Bush fire**

What causes a bush fire? A fire can occur if these three things are present; heat, fuel and oxygen.

**There are different ways that can cause a bushfire to take place.**

- |              |                   |              |
|--------------|-------------------|--------------|
| 1. Campfires | 3. Burning debris | 5. Lightning |
| 2. Smoking   | 4. Fireworks      | 6. Arson     |

### **Effects of bushfires**

1. Destroy the ecosystem of an area.
2. Destroy the organic matter of the soil.
3. Burn down properties, crops, and houses.
4. Cause deaths, and displace people.
5. Add more carbon dioxide into the air, that can increase global warming.

Now do activity 30 on the next page.



### Student Learning Activity 5

1. What is an epidemic?

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2. What is a pandemic?

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3. List any 3 ways that can start a bush fire.

i) \_\_\_\_\_

ii) \_\_\_\_\_

iii) \_\_\_\_\_

4. List 3 sources of pests and diseases.

i) \_\_\_\_\_

ii) \_\_\_\_\_

iii) \_\_\_\_\_

5. List four killer diseases that are biological hazards.

i) \_\_\_\_\_

ii) \_\_\_\_\_

iii) \_\_\_\_\_

iv) \_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.4.6 Climate Change and Associated hazards

#### What is climate change?

The changing of any form of climate into new type of climate or different types of climates. Climate change can occur as:

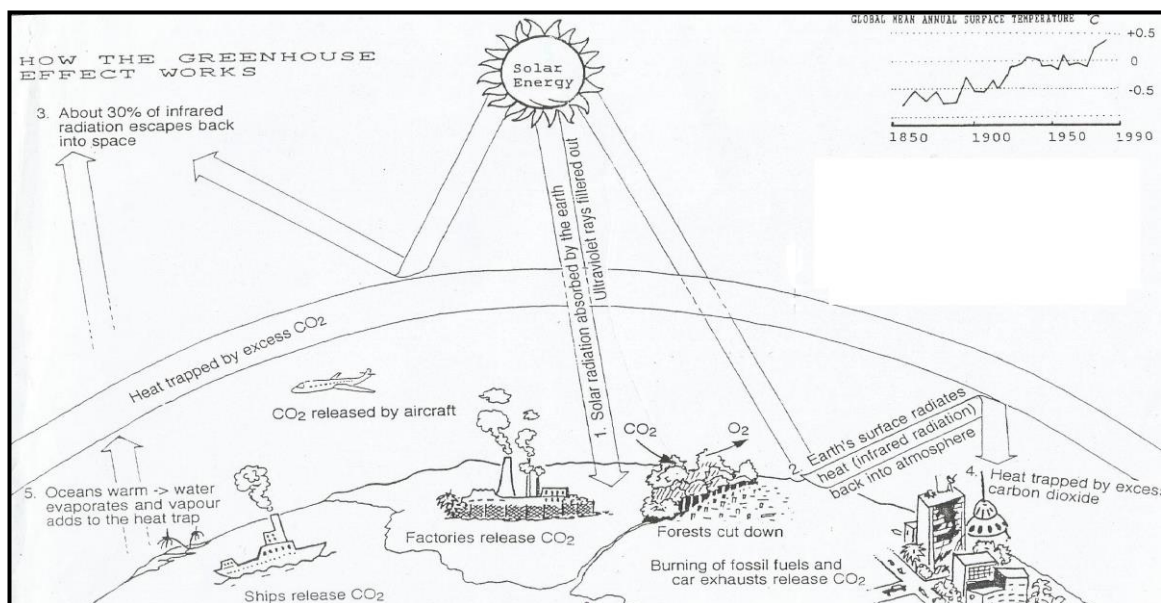
1. A natural cycle through the process of Greenhouse effect.
2. An increasing effect of human pollution and other activities that increase Global Warming.

Climate change is not a new thing, it has been happening throughout history. There are evidences that support the fact that climate has always been changing.

Today, climate change is a hazard because of the harm it can cause on the increasing world's population. Any change in climate will affect the lives of many people.

#### Greenhouse Effect

Fig: 4.8 Illustration of The Greenhouse effect.



The atmosphere traps heat to make the earth suitable for life to exist (greenhouse effect). The numbered writing shows the five (5) steps of how greenhouse effect happens. The writing without the numbers describes the things we are doing to the environment which change the greenhouse effect (causes of global warming). The graph at the top right hand corner of the diagram shows that there has been a small steady rise in the temperature of the earth's atmosphere over the past years.

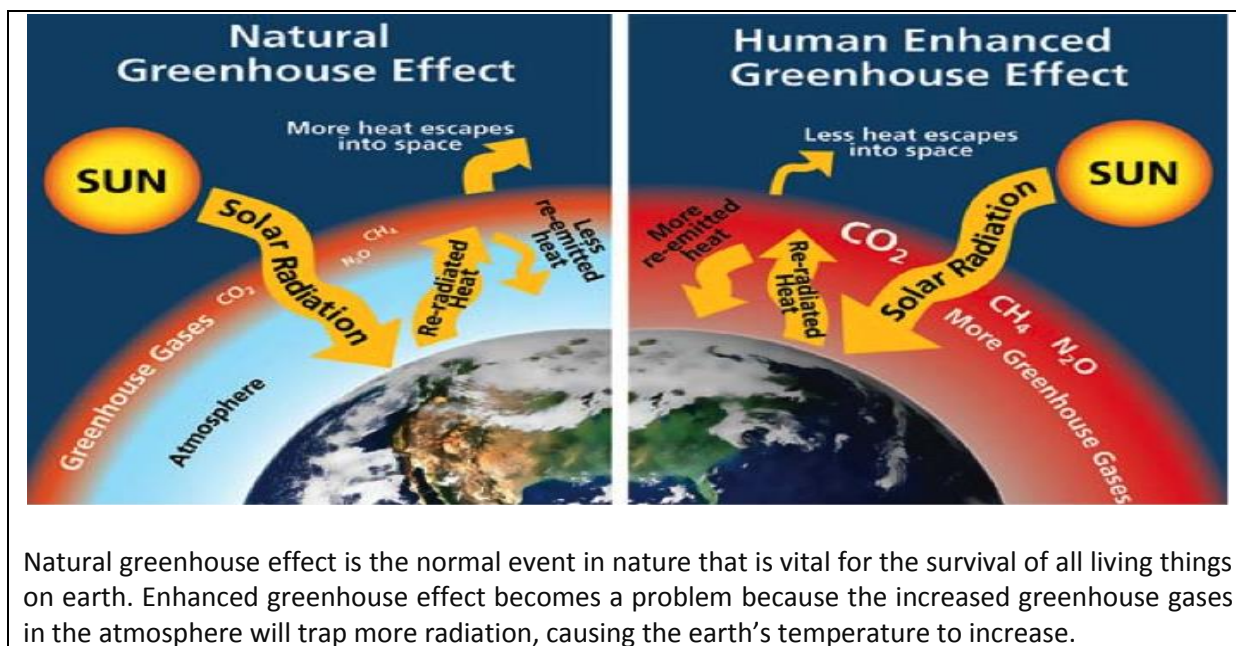


Greenhouse effect is 'the natural warming of the earth's atmosphere that is caused by the presence of greenhouse gases' (**Natural Greenhouse Effect**). **Greenhouse gases** such as water vapour, carbon dioxide, methane in the atmosphere trapped the sunlight to warm the earth and make it suitable for people, plants and animals to survive.

The atmosphere allows most of the visible light from the Sun to pass through and reach the Earth's surface. As the Earth's surface is heated by sunlight, it radiates part of this energy back into space as **infrared radiation**. This radiation, unlike visible light, tends to be absorbed by the greenhouse gases in the atmosphere, raising its temperature. The heated atmosphere in turn radiates infrared radiation back toward the Earth's surface.

If carbon dioxide increases, then more heat will be trapped and the earth will become much warmer. This is called the **Human Enhanced Greenhouse Effect**. Enhanced greenhouse effect is caused by human activities that produced more carbon dioxide into the atmosphere, causing global warming and influencing climate change. The evidence for rapid climate change is compelling:

**Fig: 4. 9 Natural Greenhouse Effect and Enhanced Greenhouse Effect**



Natural greenhouse effect is the normal event in nature that is vital for the survival of all living things on earth. Enhanced greenhouse effect becomes a problem because the increased greenhouse gases in the atmosphere will trap more radiation, causing the earth's temperature to increase.

**Carbon dioxide is a greenhouse gas that 'acts like a blanket'. CO<sub>2</sub> absorb direct heat from the sun and traps radiated heat given off from the earth's surface.**

**Ozone gas is different to CO<sub>2</sub>. The ozone layer consist of ozone gases that 'acts like a shield' to protect us from the strong harmful rays of the sun. Ozone layer reflects ultra-violet rays (UVR) of the sun and allows less harmful rays of the sun to reach the earth's surface.**





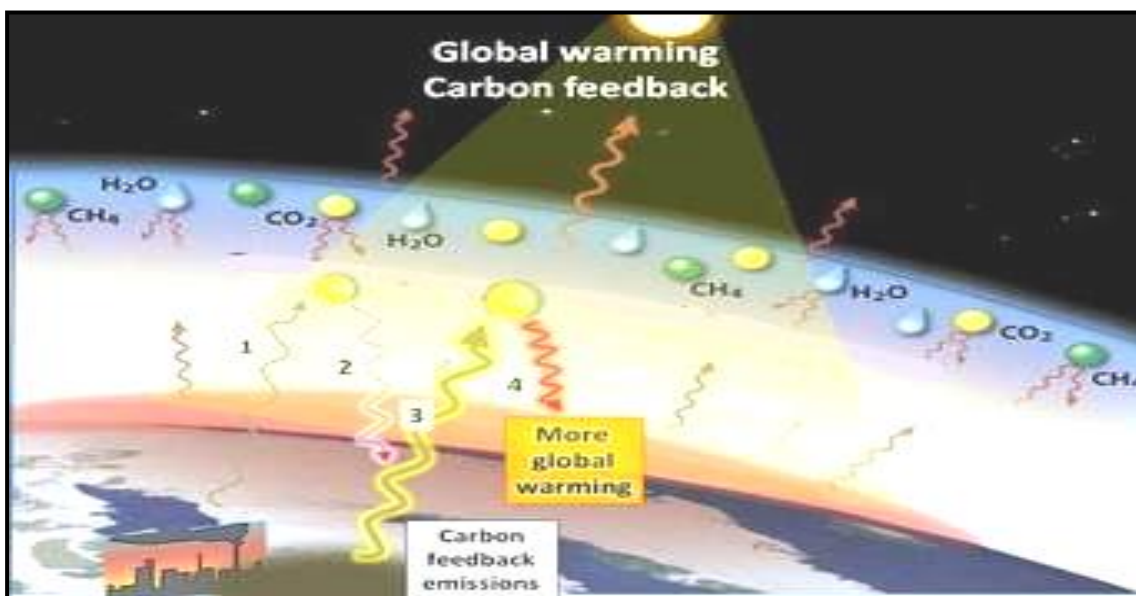
## Global Warming

Global warming is 'the increase in the global average surface temperature' resulting from an increase in the amount of carbon dioxide, methane and certain other trace of greenhouse gases in the atmosphere.

Today, global warming is real and it is a serious threat to the world we live in. The growth in human population has resulted the increase use of fossil fuels such as petrol, diesel, kerosene, cooking gas, gasoline in homes, factories and cars, ships, trains and planes. Carbon dioxide and other gases produced from factories, vehicles as well as burning rubbish waste cause global warming.

Volcanic eruptions and forest fires also contribute to global warming. The rate of deforestation further increase carbon dioxide in the air. All these factors result in the rising level of carbon dioxide in the atmosphere which increase the world's temperature, bringing about global warming. The main reason for Global Warming is the increasing population of the earth.

**Fig: 4.10 Global Warming: Cause and Effects.**



## Global Warming and its Effects

Global Warming can cause **climate change**, **melting of icebergs and ice sheets** at the north and south poles as well as the **melting of glaciers** on top of high mountain regions. Melting of ice and glaciers can **raise the sea level**. What do you think will happen when the sea level rise? The small islands and flat low lying coastal areas will sink as the sea level rise. As the sea level rises, the waves surging to the coastlines will have added volume and power to erode beaches and coastlines.





The rising sea level will also increase the level of underground saltwater on small island and low lying areas. The increase in underground saltwater will create salinisation of soil in coastal areas. Salinisation of soil (adding more salt into the soil) can destroy plants and crops.

The increase in the earth's temperature means that places on earth will experience a lot of extreme cases of heat waves. As the earth becomes warmer, the Tropical climate will spread into the temperate region. The hot and wet climate will also spread into the highland areas and the highlands areas will become warmer than usual.

As the highland region climates become warmer, plants and animals that usually live in a hot climate can now migrate and live in the highland areas such as the Highlands of PNG. Mosquitoes can now breed in the highlands and this can spread the malaria disease into the Highlands. Today, there are reported cases of malaria up in the Highlands of PNG that was never there in the past.

### **Rising sea level in PNG**

Rising sea level and the sinking of small islands is already a disaster in PNG. Many other smaller islands and low lying coastal areas are under threat.

### **Carteret Islands in Autonomous region of Bougainville**

For 20 years, the islanders have built seawalls and planted mangroves in the hope of protecting their island from the destruction of rising sea level. However, storm surges and high tides continue to wash away homes, destroy food gardens and contaminate fresh water supplies. The natural tree cover on the island is also being affected by the advancing of saltwater contamination of the fresh water table.

### **M'Buke Island in Manus Province**

M'Buke island also experience the impact of sea level rising as fresh water supplies dried up. Food crops were lost and damaged as a result of salt water rising below the ground. Other smaller atolls in Manus are likely to experience the same issues in the near future. While other islands have large areas of their coastlines and beaches disappearing.

Most small atoll islands in PNG and the Pacific are at risk from the effect of rising sea level. Kiribati islands are also affected by the rising level of the sea.



## Facts and evidence of Global Warming

**Fig: 4.11 Republic of Maldives: Vulto sea level rise.**



### Sea Level Rise

Global sea level rose about 17 cm in the last century. The rate in the last decade, however, is nearly doubled that of the last century. The sea level is currently rising at about 1.8 millimetres per year.

**Fig: 4.12 Effect of increasing temperature.**



### Global Temperature Rise

The Earth has warmed since 1880. Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past twelve years.

**Fig: 4.13 Warming Oceans**



### Warming oceans

The oceans have absorbed much of this increased heat, with the top 700 meters of ocean showing increased warming since 1969.



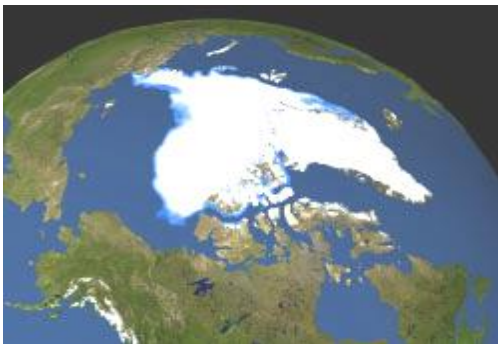
**Fig: 4.14** Flowing melt water from the Greenland ice sheet.



### Shrinking ice sheets

The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost 150 to 250 cubic kilometres of ice per year between 2002 and 2006, while Antarctica lost about 152 cubic kilometres of ice between 2002 and 2005.

**Fig: 4.15** Visualization of the 2007 Arctic sea ice minimum.



### Declining Arctic sea ice

Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.

**Fig: 4.16** The disappearing snow cap of Mount Kilimanjaro, from space.



### Glacial retreat

Glaciers are retreating almost everywhere around the world — including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.



**Fig: 4.17 Cold and Heat waves.**



### **Extreme events**

The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events.

**Fig: 4.18 Ocean acidification**

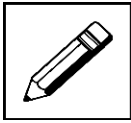


### **Ocean acidification**

The carbon dioxide content of the Earth's oceans has been increasing since 1750, and is currently increasing about 2 billion tons per year. This has increased ocean acidity by about 30 percent.

The facts and evidences of global warming clearly indicate a global problem that every country must play a part in minimising the problem. The facts and evidences of global warming can be clearly seen as the actual effects of global warming or human enhance greenhouse effect.

Now do activity 31 on the next page.



### Student Learning Activity 31

1. What is climate change?  
\_\_\_\_\_
2. What causes climate change?  
\_\_\_\_\_
3. What is the greenhouse effect?  
\_\_\_\_\_
4. List the greenhouse gases  
\_\_\_\_\_
5. What is global warming?  
\_\_\_\_\_
6. What causes global warming?  
\_\_\_\_\_
7. List 3 natural hazards and disasters that have increased as a result of climate change.
  - i) \_\_\_\_\_
  - ii) \_\_\_\_\_
  - iii) \_\_\_\_\_
8. What causes the sea level to rise?  
\_\_\_\_\_
9. What is Infrared radiation?  
\_\_\_\_\_
10. Which type of sunlight plays a big role in warming the earth's surface?  
\_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**



### 11.2.4.7 Disaster Management in Papua New Guinea and the Pacific

#### What is Disaster?

A disaster can be defined as “A serious disruption in the functioning of the community or a society causing wide spread material, economic, social or environmental lose which exceed the ability of the affected society to cope with using its own resources”.

#### What is Disaster Management?

Ways in preparing in advance for disasters and dealing with disasters in order to reduce the impact of the disasters on people’s lives. Disaster management involve methods used before, during and after a disaster.

Fig: 4.19 Disaster Management Phases.



#### Main Disaster Management Phases

##### 1. Mitigation

**Mitigate** means to make (something) less severe, harmful, or painful. **Mitigation** means reducing risk of loss from the occurrence of any undesirable event.

- Hazard is identified as an event that has the potential of affecting the population.
- How people, property and structure will be affected by the disastrous event.
- Eliminate or reduce the vulnerability or the effects of a disaster.
- Mitigation phase begins with conducting hazard identification and vulnerability analysis.
- Hazard identification and vulnerability analysis is a two-step process.



## 2. Preparedness

- State of being ready to react quickly and effectively in the event of an emergency.
- Being prepared means that a plan of action exists for an emergency.
- This Depend upon the analysis of hazard severity and vulnerability.
- Preparedness Plan – to provide a systematic way of responding to an emergency situation.
- This is the most important phase of disaster management..

## 3. Response

- Response activities occur during and immediately following a disaster.
- Designed to provide emergency assistance to victims of the event, and reduce the likelihood of secondary damage.
- The 5 basic stages of response to an emergency or disaster are;
  - 1) Notification/ Warning
  - 2) Immediate Public Safety
  - 3) Property Security
  - 4) Public Welfare
  - 5) Restoration

## 4. Recovery

- Final phase of the emergency management cycle.
- Continues until all systems return to normal, or near normal.
- Short term recovery is the restoration of vital services and facilities to minimum standards of operation and safety
- Long term recovery may include the complete redevelopment of damaged areas.

### **Different Disasters have different Strategies and Methods of management**

Different strategies and methods of management are used when different disasters strike. The disaster management phase for each natural disaster is slightly different e.g. one of your responses to a bad storm is to shelter inside the strongest part of the houses, whereas a tsunami warning should signal you to move to higher ground. These are just two instances of varying strategies of disaster management.

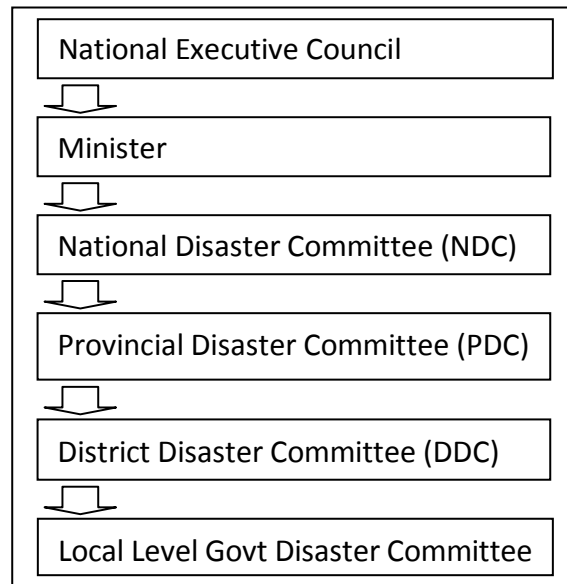




## PNG responses to Natural Hazards and disasters in the last decade

**Fig: 4.20 National Disaster Management Organisation Structure.**

The National Disaster Management Office (NDMO) is an organisation established by an Act of Parliament—the Disaster Management Act 403 of 1987—responsible for managing natural and human-made disasters in PNG. The office of NDMO is headed by Director General, who is appointed by the National Executive Council (NEC). The Ministry of Provincial And Local Government Affairs is the Government ministry directly responsible for disaster management in PNG.



**Below is an article from The National Newspaper showing Papua New Guinea's government commitment towards Emergency Relief Funds for disasters in the country.**

**PORT MORESBY, 18 July 2013 (IRIN)** - The government of Papua New Guinea (PNG) has bolstered its funding for disaster preparedness, strengthening the country's National Disaster Management Centre (NDC) to better respond to crises.

The PNG government allocated 50 million kina (US\$21.8 million) to the NDC in 2013. Though pleased with the increase, NDC hopes that this is not a one-off allocation by the government.

Since 2006, the NDC has been working with a budget of only \$1.3 million annually and before that, less than \$500,000.

Now a team of 10 people in Port Moresby are working to utilize the additional funds for programmes they had shelved for years, including capacity building for communities, response and equipping provincial disaster offices.

"Our response to natural disasters has improved a lot this year. Half the year is gone, and we have [already] spent K10 million (\$4.3 million) of that money on relief operations," the Prime Minister said, citing heavy rains, landslides and flooding in the first quarter of 2013.





## How International Organisations and NGO has assisted in managing natural hazards and disasters in PNG and the Pacific?

- Efforts were made to carry out environmental awareness .
- Focus on integrating disaster preparedness and mitigation into the country's development plans.
- The most recent Country Assistance Strategy (CAS) supports the development of a climate change strategy and PNG's participation in regional disaster risk reduction initiatives.
- **Go PNG** has launched a number of initiatives aimed at mitigating environmental degradation and natural disasters including the Millennium Development Goal (MDG) 7 Initiative on forestry and energy, and work on the Clean Development Mechanism for emissions trading under the Kyoto protocol..
- From 2008-2010, **GFDRR** is supporting a program in the Pacific Islands, which includes Papua New Guinea, to contribute to reduced vulnerability to natural disasters and climate change variability.
- Additional **GFDRR** funds are being allocated for future activities concerning the development of a coordinated hazard policy and mapping system on a national scale; capacity building; and to conduct hazard maps.

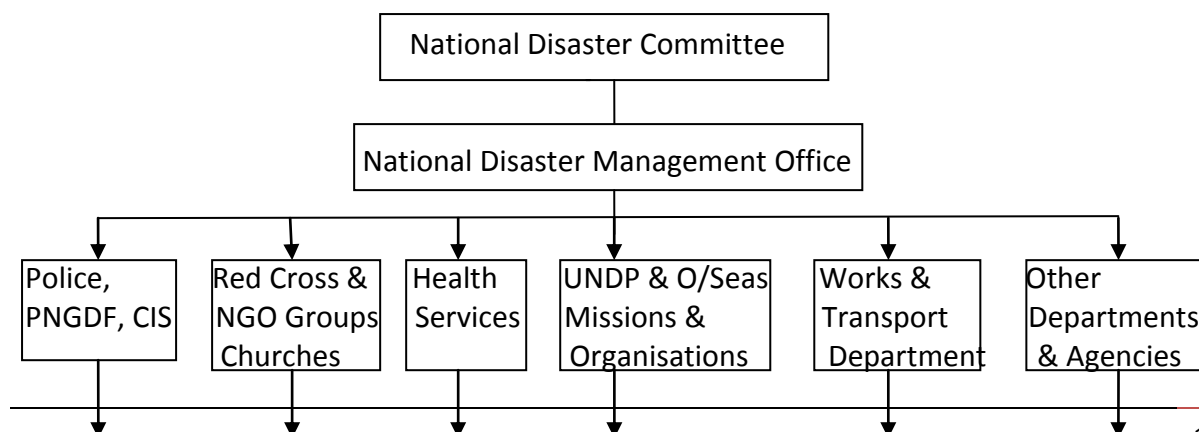
### Effectiveness of response to natural hazards and disasters in PNG and the Pacific

#### 1. Government Response

Both the National Disaster Management Office (NDMO) and the Provincial Disaster Committees are responsible for implementing and co-ordinating the disaster counter measure activities before, during and after disaster and emergency situations.

The PNG National Disaster Management Act allows NGOs and the national Churches as Co-opt members of the Committee. NGOs include the Red Cross Society, Salvation Army, church groups and the Council of Social Services. These organisations are very active in the country with disaster and emergency programs and have representative members in most of the provinces and districts in the country.

**Fig: 4.21 Co -ordination of disaster and emergency activities in PNG.**





## DISASTER AREA

### 2. International Organisations

The Disaster Risk Management Program focuses on two key issues—disaster preparedness and emergency response. Disaster preparedness helps improve vulnerable communities' resilience to natural disasters. By keeping people informed of the risks they live with, such as earthquakes, volcanoes or tsunamis, communities are safer, better prepared to respond, and are able to recover more quickly if a disaster occurs. Disaster preparedness also responds to hazards related to the climate, such as floods and cyclones.

Emergency response involves providing lifesaving assistance when disasters do occur. In partnership with the PNG Government, Australia provides emergency relief assistance in PNG for medium to large scale disasters. Our humanitarian assistance specifically targets the most vulnerable groups such as women, children, those living with HIV/AIDS and the disabled.

#### Examples of International assistance

- In September 2012, AusAID in partnership with the WHO provided 15,000 aqua tabs for safe water to 397 vulnerable women, men, girls and boys in Bougainville communities affected by a dysentery outbreak.
- In November 2012, support was provided for the Rabaul Volcano Observatory's public awareness campaign. A total of 6,761 people benefitted from the awareness training, including 1,559 women and 3703 children who received preparatory training in what to do in the event of volcanic eruptions.
- Through generous assistance from Aus AID, the Japanese Government, the US Government, the World Bank and the National Government and the establishment of the Gazelle Reconstruction Authority, post-disaster reconstruction proceeded efficiently after the 1994 Rabaul volcanic eruption.

The PNG Red Cross Society (PNGRCS) and the International Red Cross always assist in times of disasters.

### 3. NGO's (Non Government Organisations)

Tsunami awareness is conducted through discussion, radio talk back shows, print and telecast media and through tsunami posters and pamphlets distributed to most of the provinces, schools, government offices and NGO groups from 1999 to 2000.



Volcano awareness campaign is conducted by Rabaul Volcano Observatory for Manam Island volcano, Karkar Island volcano, Ritter Island, Ulawun volcano and Rabaul volcanoes.

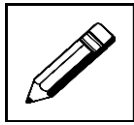
Disaster awareness posters on major hazards in Papua New Guinea printed and distributed to the general public by the Post-Courier, to mark the International Day for Natural Disaster Reduction on 11<sup>th</sup> October 2000.

### **Suggested ways of improving the current methods and strategies of natural hazards and disasters in PNG**

Some ways of improving the current disaster management practices is for the PNG government to;

- 1) provide a greater budget allocation for disaster emergency.
- 2) respective MPs should start preparing their district and province for disaster threat, and saving funds for disaster and relief programmes.
- 3) These losses could be prevented with better data regarding the onset and course of such disasters. Also, training and sponsoring of our personnel to attend overseas institutions and work with experts from neighbouring countries could help identify and overcome natural disasters.
- 4) The Government should examine the role of space, air and ground-based technologies in predicting the creation and development of major natural disasters and in providing advanced warnings to affected populations of our country
- 5) The State should also explore the **potential** of these technologies in assisting the response teams in providing relief in the aftermath of natural disasters. The crucial issue will be the co-ordination of efforts to use such data in emergencies. Rapid decision making has often proved difficult because several countries and many agencies may be involved. But many times, appropriate institutions have not been developed to respond quickly and efficiently to the disasters.
- 6) Without institutions in place to collect and co-ordinate research and response, the data that advanced space technologies provide will be useless in responding to the natural disasters.
- 7) The limiting factor for effective disaster management is communications. Broad sharing of scientific and data applications is an important part of effective detection, monitoring and response.

Now do activity 32 on the next page.



### Student Learning Activity 32

1. What is disaster?  
\_\_\_\_\_
  
2. What is disaster management?  
\_\_\_\_\_  
\_\_\_\_\_
  
3. List the four main phases in disaster management.
  - i) \_\_\_\_\_
  - ii) \_\_\_\_\_
  - iii) \_\_\_\_\_
  - iv) \_\_\_\_\_
  
4. What is the name of the government department that was created to manage disaster in PNG?  
\_\_\_\_\_
  
5. What are the five basic stages of response to emergency or disaster?
  - i) \_\_\_\_\_
  - ii) \_\_\_\_\_
  - iii) \_\_\_\_\_
  - iv) \_\_\_\_\_
  - v) \_\_\_\_\_
  
6. List three international organisations that assist PNG during disasters.
  - i) \_\_\_\_\_
  - ii) \_\_\_\_\_
  - iii) \_\_\_\_\_

**CHECK YOUR WORK. ANSWERS ARE AT THE END OF COURSE MODULE 2.**

**END OF TOPIC 11.2.4**



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## 11.2 UNIT SUMMARY

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### 11.2.1: Air Pressure and Global Wind Patterns

- The two main types of earth movements are;
  1. Earth's Rotation
  2. Earth's Revolution
- Rotation of the earth will cause the following things to happen.
  - a) Day and Night
  - b) Different time on different places on earth
  - c) The deflection of winds and ocean currents
- Revolution of the earth around the sun will result in;
  - a) The varying length of day and night at different times of the year
  - b) The changes in seasons
- The land and sea heats up and cool down at different speed. Land heats up quickly and cools down quickly and sea heats up slowly and cools down slowly.
- The different spacing of the land (solid), and sea (liquid) molecules cause the difference in heating and cooling.
- The earth is surrounded by layers of gases called the atmosphere.  
**Atmospheric or air pressure** is the weight (density) of air pushing down on the earth's surface at a particular point.
- **Low Pressure systems** are generally associated with rising air and moist conditions  
**High Pressure systems** are associated with stable, dry conditions
- **Atmospheric pressure depends primarily on three factors:**
  1. Altitude
  2. Temperature
  3. Earth Rotation
- There are 2 main types of winds
  1. Prevailing winds (e.g. Trade winds, Westerlies, Polar winds)
  2. Local winds (e.g. Land and sea breeze, mountain and valley breeze)
- Global winds occur on a large scale and over a large area. Local wind occur on a small scale in a local environment.
- Coriolis effect is the deflection of the winds to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The deflection of the wind is caused by the rotation of the earth.



### 11.2.2: Climate of the World

- **Climate** is the average measure of conditions of the atmosphere over a long period.
- **Weather** refers to the daily conditions of the atmosphere.
- Different places on earth received different amount of sunlight from the sun.
- **The three (3) main features of climate are;**
  1. Temperature
  2. Precipitation
  3. Pressure.
- **Factors that influence climate**
  - a) Altitude
  - b) Latitude
  - (c) Winds
  - (d) Cloud Cover
  - (e) Aspect
  - (f) Ocean Currents
  - (g) Distance from the sea
- There are 3 different **types of rainfall**
  1. Convectional rainfall
  2. Orographic or relief rainfall
  3. Depressional/ Cyclonic/ Frontal rainfall
- The types of climates in PNG are; Maritime climate, Equatorial climate, Mountain grassland climate, Mountain alpine forest climate, Mangrove climate, Savannah climate, and Swampland climate.
- PNG receive a lot of rain and experience 2 types of winds; north-west monsoons and south-east trade winds.
- The earth is divided into five (5) climatic zones according to **temperature; Hot; Warm; Cool; Cold; Very Cold.**
- The main types of climates are;
  1. Tropical Climates (e.g. Equatorial, Continental, Maritime, Monsoon, and Desert)
  2. Temperate Climate (Warm, Cool and Cold Temperate)
  3. Tundra and Polar Climate
- Mountain climate can be found in any place on earth where there are mountain ranges. Aspect and altitude causes the temperature and precipitation to be different at certain heights.
- Land use is different on different altitudes.



### 11.2.3: Natural Vegetation

- Plants make their own food by using *water, sunlight, carbon dioxide* and *mineral salts*. In order for the plant to survive, it carries out 2 important processes called photosynthesis and transpiration.
- Drought and Cold have influence on plants.
- Different types of climate will have different types of vegetation. Vegetation changes from the equator to the poles.
- There are 3 main types of vegetation;
  1. Forests (Tropical, Deciduous, and Coniferous)
  2. Grasslands (Tropical grassland and Temperate grassland)
  3. Deserts
- Tundra vegetation is either a grassland or desert type of vegetation.

### 11.2.4: Natural Disasters

- Extreme natural events are natural processes that occur in the environment e.g. earthquakes, tsunamis, tornados, volcanoes, erosion, cyclones running rivers, changes in ocean currents, and many more.
- A **hazard** is defined as an event that threatens, or has potential in destroying lives and properties.
- 'A **natural disaster** is an event that causes harm in significant amount. So a disaster is a type of extreme event that causes significant harm'. When we say significant harm we mean causes destruction to people's properties, homes, buildings, roads, loss of lives, and etc...
- There are **four (4) main classification** of different types of **natural hazards**;
  1. Geological (e.g. Tsunami, volcano and earthquake)
  2. Geomorphologic (e.g. Flood, landslides and mudflows)
  3. Atmospheric (e.g. cyclone, drought, hail, frost, tornado)
  4. Biological (e.g. Plagues, diseases and pests, and bush fires)
- Hazards and disasters can be classified as natural hazard and human-caused hazards
  1. **Natural hazard** is one produced by environmental processes. E.g. earthquakes, volcanic activity, landslides, tsunamis, tropical cyclones and other severe storms, tornadoes and high winds, river and coastal flooding, wildfires and associated haze, drought, sand and dust storms, and infestations.



2. **Human-caused hazards** are also hazards that are created by people. E.g. industrial explosions, nuclear warfare, air and road crashes, fire and the collapse of buildings. Most of these are caused by human errors or mistakes and some may be intentional.
- The location of PNG and the Pacific region makes it vulnerable and highly susceptible to most natural hazards and disasters. All the natural hazards and disaster discussed in the book will always exist in the Pacific region.
  - Each natural hazard and disaster have their own causes, but all of them destroy properties, homes, disrupt normal services and affect people's lives.
  - Global climate change has increased the occurrence of extreme weather events, such as droughts and floods, threatening the population, food security, and causing economic disruption.
  - Disaster Management is important in preparing, handling and dealing with the risks of natural disasters.
  - Disaster Management stages include: Preparation, Response, Recovery, and Mitigation
  - Disaster Management in PNG and the Pacific involves the participation and contribution of the government, International Organisations, and the NGOs.





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## ANSWERS TO STUDENTS ACTIVITIES

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### Answers to 11.2.1: Pressure & Wind

#### Student Activity 1

1.
  - i. Rotation – the spinning of the earth on its axis.
  - ii. Revolution – the movement or orbit of the earth around the sun.
  
2.
  - i. Effects of Rotation
    - a) Day and Night
    - b) A difference of 1 hour between two meridians or longitudes  $15^{\circ}$  apart
    - c) The deflection of winds and ocean currents
    - d) The daily rising and falling of the tides
  
  - ii. Effects of Revolution
    - a) Changing altitudes of the mid-day sun at different times of the year
    - b) The varying length of day and night at different times of the year
    - c) The 4 Seasons (summer, autumn, winter, and spring)
  
3. The earth's axis is tilted at an angle of  $23\frac{1}{2}^{\circ}$
  
4. The side of the earth facing the sun will have day, while the other side of the earth that is not facing the sun will be in darkness. As the earth rotate slowly, day and night changes. *(Any similar kind of explanation should be correct)*

#### Student Activity 2

1. D
2. Winter
  
3. *(any 1 of the sample answers below)*
  - Equinox occur in the autumn and spring season while the solstice take place in winter and summer.
  - Equinox have equal length of day and night while solstice have unequal length of day and night.
  - Equinox occurs when the sun is above the equator on 21<sup>st</sup> March and 23<sup>rd</sup> September, whereas solstice occur when the sun is either above the tropic of cancer on 21<sup>st</sup> June or over the tropic of Capricorn on 22<sup>nd</sup> December.
  
4. Winter
5. Summer



### Student Activity 3

1.
  - i) Latitudes: are imaginary horizontal lines that runs across the globe from east to west. Latitudes run parallel to each other around the globe.
  - ii) Longitudes: are imaginary vertical lines that runs from north to south. Longitudes meet at the north and south poles.
2. Parallel lines
3. Meridians, Time lines
4. Definition of important lines of longitudes and latitudes.
  - i. **Equator** is an imaginary line of  $0^{\circ}$  (degree), and it's the base line of all latitudes. Equator divides the northern hemisphere from the southern hemisphere.
  - ii. **Prime Meridian** is an imaginary line of  $0^{\circ}$  (degree), and it's the baseline of all longitudes. Prime Meridian divides the world into the eastern and western hemispheres.
  - iii. **International Date Line** is the imaginary line that separates one day from another. International Date Line shows that time to the west of it (in the Eastern Hemisphere) is ahead in time.
  - iv. **Tropic of Cancer** shows the boundary of the Tropical region and is located of the  $23\frac{1}{2}^{\circ}\text{N}$  equator.
  - v. **Tropic of Capricorn** shows the boundary of the Tropical region and is located  $23\frac{1}{2}^{\circ}\text{S}$  of the equator.
  - vi. **Arctic Circle** is an imaginary line of  $66\frac{1}{2}^{\circ}\text{N}$ , bordering the Temperate region and the North Pole.
  - vii. **Antarctic Circle** is an imaginary line of  $66\frac{1}{2}^{\circ}\text{S}$ , bordering the Temperate region and the South Pole.

### Student Activity 4

1. Ahead
2. Behind
3. 8 hours
4. 2 hours
5. 9:20 am
6. a) 9 am      (b) 2am      (c) 12 mid-day
7. A. 12:20 mid-night / Monday      D. 8:40 pm / Sunday  
B. 4 am / Monday      E. 12:40 mid-day / Sunday  
C. 10:20 pm / Sunday      F. 10:20 am / Monday



### Student Activity 5

1. Land heats up quickly and cools down quickly and Sea heats up slowly and cools down slowly.
2. Land is hot during the day
3. Sea has high pressure during the day
4. Low pressure on land during summer
5. Sea is warmer than the land in winter
6. C

### Student Activity 6

1. Is the weight (density) of air pushing down on the earth's surface at a particular point.
2. Low Pressure, because it is hot.
3. Hot air rises and cold air sinks, and moves to take the place of the hot air.
4. High Pressure
5. Low Pressure
6. C

### Student Activity 7

1. Layers of air that surrounds the earth
2. Moving air currents which mainly blow from high pressure areas to low pressure areas.
3. Nitrogen = 78%, Oxygen = 21%, Carbon dioxide = 0.001%, Other gases = less than 1%
4. Low Pressure
5.
  - i. *The temperature of air therefore rises when its pressure rises.*
  - ii. *The temperature of air therefore falls when its pressure falls.*
  - iii. *The pressure of the air therefore falls when its temperature rises.*
  - iv. *The pressure of air therefore rises when its temperature falls.*
6. Equator 0° (doldrums), and 90° North Pole and South Pole
7. Low Pressure
8. D

### Student Activity 8

1. Global winds occur on a large scale and over a large area.
2. Planetary winds, Prevailing winds, consistent winds or persistent winds.
3. The deflection of the wind to the right in the Northern Hemisphere, and to the left in the Southern Hemisphere as a result of the earth's rotation.
4. **A** – North East Polar Winds                      **D** – South East Trade Winds





## Answers to 11.2.2: Climate

### Student Activity 11

1. **Climate** is the average measure of conditions of the atmosphere over a long period.
2. **Weather** is the day to day condition of the atmosphere e.g. cloudy day or sunny day.
3. (a) Wind (c) Distance from the sea (e) Cloud Cover  
(b) Aspect or topography (d) Ocean currents (f) Latitude
4. Altitude - As the altitude increases, temperature decreases  
Latitude – As latitude increases, temperature decreases. The temperature change from the equator to the poles. Vegetation changes as well.
5. Thermometer or Six-s thermometer (maximum and minimum thermometers)
6. South-facing slope/ South-side/ Southern part of the slope
7. In the tropics the mid-day sun is always high in the sky, whereas in the high latitudes the mid-day sun is at a low angle in winter

### Student Activity 12

1. Precipitation refers to the descent of water onto the earth's surface. The main forms of precipitation are rain, snow, hail, sleet, and dew.
2. i) Convectonal rainfall (iii) Depressional/Frontal/Cyclonic rainfall  
ii) Orographic or relief rainfall
2. wind picks up moisture from the sea and blows towards highland area. The air is forced to rise up the slope. As the wind rises the moisture cools and fall as rain on the windward slope.
4. Leeward slope 5. Depressional/ Cyclonic/ Frontal rainfall

### Student Activity 13

1. Altitude is height above sea level
2. When altitude increases the temperature decreases and when altitude decreases the temperature increases.
3. i. Maritime climate/ Equatorial climate iv. Mangrove climate  
ii. Mountain grassland climate v. Savannah climate  
iii. Mountain alpine forest climate vi. Swampland climate





## Student Activity 16

1. A climate with high temperatures (hot) and heavy rainfall (wet).
2. Climate with 2 seasons, one season of rainfall (wet), and one season of little or no rainfall (dry).
3. A dry climate with little or no rainfall e.g. desert or savanna
4. Most countries in the Pacific e.g. Solomon, Vanuatu, Fiji, etc... is correct  
Central American countries such as Mexico, Panama, Colombia, etc.. is correct  
Others: Brazil, Tanzania and Congo
5. Maritime climate
6. Very little or no rainfall, few or no vegetation, and very hot during the day and cold at night (*any of these answers is correct*)
7. Africa (Sahara, Kalahari, Namib); Asia (Gobi, Turkestan, Arabian, Thar and Iranian);  
North America (Great Basin desert or North American desert); South America (Patagonia, Atacama); Australia (Great Australian Desert)
8.
  - I) cold ocean currents on the western side of continents – when wind blows over the cold currents it picks up little or no moisture and when the wind reaches the land it gives little or no rain. This resulted in the area having little or no rain and changed the western sides of continents into deserts. When the wind continue inland it brings no rain and the interior of the continents also became deserts.
  - II) Rain shadow effect – wind carrying moisture to the land resulted in the windward slope having rainfall. The wind move to the leeward slope without any moisture resulting in no rainfall. The area becomes dry and developed into a desert.
  - III) No cloud cover – Clouds absorb heat and reflect heat into space during the day. The absence of clouds in desert makes the land area hot and unbearable for most living creatures. During the night the clouds reflect escaping heat from the earth surface back to the earth to keep the earth warm. In deserts it is very cold in the night because of no clouds. This also makes it unbearable for most living things to live there.
9. C



### Student Activity 17

1. Rainfall in both the summer and winter
2. Mediterranean
3. C
4. Eastern Margin Climate
5. Temperate Interior Climate
6. Temperate Interior climate

### Student Activity 18

1. Climates usually have cold winter snow & warm summer rain.
2. Interior climates
3. Countries within the cool and cold temperate region e.g. Australia, New Zealand, South Africa, Argentina, USA, Canada, European Countries.
4. Cold Temperate continental climate
5. Cool winter: 2°C – 7°C, Warm summer: 13°C – 15°C
6. Very cold winter: -34°C to -45°C, Warm summer: 21°C
7. Cereal crops e.g. wheat, corn, barley, oats and rice.

### Student Activity 19

1. i. Much ice and snow covered the ground  
ii. Further from the equator and receive less sunlight
2. second layer is permanently frozen during winter, complete and permanent freezing of the subsoil all year round. (*any of these answers is correct*)
3. No, Because the topsoil or surface soil is permanently frozen
4. Europe: Alps; Africa: Ethiopian Highlands; Asia: Himalayas; North America: Rockies; South America: Andes; Australia; Great Dividing Range ; PNG – Owen Staley Range, Sarawaget Range and Finister Range
6. Rice terracing, animal grazing, grape farming, contour ploughing, mining, settlements, cash crop farming such as coffee, vegetables (*any 2 of these answers*)
6. Influence of altitude and aspect
7. D





## Answers to 11.2.3: Natural Vegetation

### Student Activity 20

1. All types of plants growing in an area.
2. Water, sunlight, carbon dioxide and mineral salts.
3. Photosynthesis and Transpiration.
4. Words: carbon dioxide + water + light energy = glucose + oxygen  
Equation:  $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} = \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
5.  $6^\circ\text{C}$  (degree Celsius)
6. A
7.
  - a. their leaves are rolled and little transpiration take place.
  - b. they need less water than other trees.
  - c. they adapt, by having needle-like leaves.
  - d. they shed or loose their leaves

(Any 2 of the above answers)

### Student activity 21

1. Tropical evergreen forest, Tropical grassland, Temperate evergreen forest, Temperate grassland, desert and scrub, Mediterranean forest and Temperate Deciduous forest.
2. What type of vegetation does each of these countries have?
  - a. Tropical Evergreen rainforest
  - b. Tropical Evergreen rainforest
  - c. Tropical Monsoon forest
  - d. Tropical Evergreen rainforest
  - e. Desert and scrub
  - f. Temperate evergreen forest
  - g. Temperate deciduous forest
  - h. Mediterranean forest
3. 

A – Tropical Rainforest	E – Deciduous forest
B – Savanna	F – Evergreen Coniferous/ Boreal/ Taiga forest
C – Desert vegetation	G – Tundra
D – Temperate grassland	

### Student Activity 22

1. 

i) Tropical Rainforest	iii) Mediterranean	iii) Evergreen Coniferous Forest
ii) Tropical Monsoon	iv) Deciduous Forest	
2. Because little or no sunlight reaches the forest floor
3. D
4. Holds the big trees firmly to the ground and support the weight of the huge trees.



5. I) Emergent  
II) Upper canopy/ upper storey  
III) Lower canopy/understorey  
V) lichens, mosses and ferns  
IV) Forest floor

### Student Activity 23

1. Temperature drop below 6°C, so in order to survive the trees must lose their leaves.
2. Because of the slow rate of decomposition. (**except these answers as well; most soil nutrients and water is used up by the coniferous trees and there is very little soil nutrients to support other plant lives; and the temperature is mostly cold for other plants to grow**)
3. i. Trees have needle-like leaves which reduce transpiration  
ii. The leaves have tough thick skin which protects them from winter cold  
iii. The tree is composed of straight-trunked, conical and has flexible short branches which allow the snow to slide off.
4. C
5. Similarities and differences between the 3 main types of forests

Forest Types	Similarities	Differences
Tropical rainforest ... &... Deciduous forest	<ul style="list-style-type: none"><li>➤ Hardwood</li><li>➤ Broad leaves</li></ul>	<ul style="list-style-type: none"><li>➤ Deciduous trees lose leaves</li><li>➤ Tropical forest have well define layers</li><li>➤ Tropical climates and Temperate climates</li></ul>
Tropical rainforest ...&... coniferous forest	<ul style="list-style-type: none"><li>➤ Evergreen forests</li></ul>	<ul style="list-style-type: none"><li>➤ Coniferous trees have needle like leaves</li><li>➤ Tropical forest have a variety of trees</li><li>➤ Coniferous are softwood trees</li><li>➤ Tropical climates and Temperate climates</li></ul>
Deciduous forest ...&... coniferous forest	<ul style="list-style-type: none"><li>➤ Grows in Temperate climates</li></ul>	<ul style="list-style-type: none"><li>➤ Coniferous trees have needle like leaves</li><li>➤ Tropical forest have a variety of trees</li><li>➤ Coniferous are softwood trees</li></ul>

6. E

7. D



### Student Activity 24

1. Tropical grassland is tall, and grows on unfertile soil/ Temperate grassland is short and grows on fertile soil/ tropical grassland grows in tropical latitudes and temperate grassland grows in temperate latitudes. *(any of these answers is correct)*
2. B
3. Savanna have grassland and scattered trees, whereas a grassland area consist mainly of grass.
4. Grasses wither and die in the dry seasons. The roots remain dormant until the rainy season when the top parts of the plant start to grow again.

### Student Activity 25

1. Subsoil is permanently frozen and growing of crops is difficult, strong winds
2. i) Develop long roots to reach water far below the surface.  
ii) Develop water storage organs, e.g. The baobab tree stores water in its trunk.  
iii) Have special leaves which reduce transpiration e.g. thorn-like leaves, rolled up leaves, leaves with waxy surfaces.  
iv) Shed most of their leaves when the dry season is also hot.  
*(any 3 of the answers above is correct)*
3. Any 2 from this list: lichens, mosses, grasses, sedges, cushion plants and low flowering shrubs e.g. bilberry and bearberry
4. **Cacti** (single plant) or **cactus** (many plants)
5. (a) Alpine tundra      (b) Arctic tundra



## Answers to 11.2.4: Natural Disasters

### Student activity 26

1. An act of nature that has damage to people and their environment
2. An event that threatens the safety of people's lives and properties, or actually causes damage and destruction to people, their property and settlements.
3. An event that causes harm to the people and causes destruction to people's properties, homes, buildings, roads and etc...
4. C
5. Atmospheric hazards that occur in the air and influence weather conditions, whereas geomorphic hazards occur on the land surface and change landscapes.
6. Tsunami, volcanic eruption and earthquake
7. Are spread or caused by the living organisms
8. Natural hazards are produced by environmental processes and human-caused hazards are created by people
9. a) Moderate level  
b) High level  
(c) Moderate level  
(d) High level

### Student Activity 27

1. The shaking or trembling of the earth's crust.
2. I) Rock under great strain cracks and releases energy in the form of **seismic waves**.  
II) The release of huge stresses due to underground volcanic forces.
3. Large waves which reach great heights near the shore
4. i) Earth quake  
ii) Volcanic eruption  
iii) Undersea Landslide
5. When pressure in the mantle builds up and hot liquid magma force its way out.
6. Forms fertile soil, create hot springs, provide geothermal energy, helps in the formation of minerals such as diamonds, attracts tourists and encourage tourism.



### Student Activity 28

1. A natural event or occurrence where a piece of land (or area) that is usually dry land, suddenly gets submerged under water.
2.
  - a) Heavy Rainfall
  - b) River overflow
  - c) Strong winds in coastal areas
  - d) Dam breaking
  - e) Ice and snow-melts
3. Floodwaters carry lots of nutrients that are deposited in the plains.
4. Landslides occur when the stability of the slope changes from a stable to an unstable condition.
5.
  - I) Excess ground water
  - II) Loss or absence of vegetation cover
  - III) Earthquakes
  - IV) Deforestation, cultivation and construction on slopes.

### Student Activity 29

1. A massive storm with powerful winds often with rains, thunderstorms and lightning) that usually moves over a large land area.
2.
  1. Strong winds
  2. Exceptional rain
  3. Storm surge
3. Draught can be seen as 'a relatively long time where there is not enough water than there usually is, as a result of dry weather, to support human, animal and plant life'.
4. Hails consist of small solid ice (cubes) particles which fall during great storms. Frost is the solid deposition of water vapour that formed when solid surfaces are cooled to below the dew point of the adjacent air as well as below the freezing point of water.
5. 

i) Irrigation	(iv) energy (hydro-electricity)
ii) Household use	(v) ecosystem function
iii) Industrial use	
6. Typhoon



### Student Activity 30

1. An outbreak of an infectious disease that spread through a human population.
2. An epidemic that spreads globally.
3. Campfires, Smoking, Lightning, Burning debris, Fireworks and Arson  
*(any of these answers is correct)*
4. Bacteria, viruses, insects, plants, birds, animals, and humans  
*(any 3 of these answers are correct)*
5. Anthrax, HIV/AIDS, Hepatitis, Influenza, bird flu, swine flu, cholera, Yellow fever, Tuberculosis, Ebola and SARS virus. *(any of these answers is correct)*

### Student Activity 31

1. The changing of any form of climate into new type of climate or different types of climates.
2. Climate change can occur as:
  - A natural cycle through the process of Greenhouse effect.
  - An increasing effect of human pollution and other activities that increase Global Warming. *(any of these answers is correct)**(accept these answers as well; varying heat from the sun, and varying amount of greenhouse gases in the atmosphere)*
3. The natural warming of the earth's atmosphere.
4. Water vapour, carbon dioxide, methane, nitrous oxide, Chlorofluorocarbons (CFCs)
5. The increase in the global average surface temperature.
6. Factories that burn fossil fuels, Gas produced from vehicles, burning of waste, volcanic eruption and forest fires as well as population increase.
7. Bushfires, tropical storms, flooding, and extreme heat waves
8. Global warming causes the melting of the ice (ice caps and glaciers)
9. The sun's heat that is reflected by the surface of the earth back into the atmosphere.
10. Infrared radiation



### Student Activity 32

1. A serious disruption in the functioning of the community or a society causing wide spread material, economic, social or environmental losses.
  2. Methods and strategies used to prepare people for disasters, and to help the people after a disaster strike.
  3. Preparation, response, Recovery and Mitigation
  4. The National Disaster Management Office
  5. Notification/ Warning, Immediate Public Safety, Property Security, Public Welfare, Restoration.
  6. World health Organisation (WHO), International Red Cross (IRC) or Red Cross, Doctors without Borders, AUSAID, ADRA, World Bank (*any 3 of the sample answers*)
- 

**END OF UNIT MODULE 2**

**NOW TURN TO YOUR ASSESSMENT BOOK AND COMPLETE ALL ASSESSMENT TASKS. SEND THE COMPLETED ASSESSMENT BOOK TO YOUR PROVINCIAL COORDINATOR FOR MARKING.**



## REFERENCES

1. Exploring Geography through PNG, Diane Ranck and Richard Jackson
2. General geography in Diagrams R.B Bunneth, 3<sup>rd</sup> Edition
3. Geography: An Intergrated approach David Waugh
4. Geography In SOSE 1 Jeana Kriewaldt
5. Jacaranda Geo Active 1, Susan Bliss and John Paine
6. Natural Hazard Disasters, Sue Lauer
7. URL



**FODE PROVINCIAL CENTRES CONTACTS**

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2	KEREMA	P. O. Box 86, Kerema	6481303	72228124	The Coordinator	Senior Clerk	72229049
3	CENTRAL	C/- FODE HQ	3419228	72228110	The Coordinator	Senior Clerk	72229050
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**SUBJECT AND GRADE TO STUDY**

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language & Literature
	2. Mathematics - Mathematics A / Mathematics B
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

**REMEMBER:**

- For Grades 7 and 8, you are required to do all six (6) courses.
- For Grades 9 and 10, you must study English, Mathematics, Science, Personal Development, Social Science and Commerce. Design and Technology-Computing is optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) courses to be certified.

Your Provincial Coordinator or Supervisor will give you more information regarding each subject.

**GRADES 11 & 12 COURSE PROGRAMMES**

No	Science	Humanities	Business
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics A/B	Mathematics A/B	Mathematics A/B
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT



**Notes:** You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

<b>CERTIFICATE IN MATRICULATION STUDIES</b>		
<b>No</b>	<b>Compulsory Courses</b>	<b>Optional Courses</b>
1	English 1	<b>Science Stream:</b> Biology, Chemistry, Physics
2	English 2	<b>Social Science Stream:</b> Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

**REMEMBER:**

You must successfully complete 8 courses: 5 compulsory and 3 optional.