‘A’ LEVEL

GEOGRAPHY Study Pack

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Acknowledgements

I am indebted to all staff at Turn-Up College for their untiring efforts towards making this publication a success. I express the same thanks to all outside individuals who contributed to this module by way of researching on the contents that make up this study pack. I am particularly thankful to my two lady secretaries, Chiedza Muchena and Crystabell Mudzingwa for the great work they have done by typing all the manuscripts from different contributors. Last but not least, I thank Mr C.K Mhuri who has done the general editing of this publication.

Preface

This Turn-Up CollegeAdvanced Level Study Pack has been designed to meet the needs of both teachers and students of A-level Geography. Its distinct advantage over most resources is the presentation of concepts in a simplified manner. It provides for a gradual, yet permanent transition to the demands of A- Level Geography. Simplicity of explanation is further enhanced by the presentation of all geographical details in one single volume. Thus research time is greatly reduced for both teachers and students.

This study pack has been prepared by experienced classroom practitioners andit adequately covers the syllabus requirements for both Cambridge and ZIMSEC examinations. This edition begins every chapter with well stated content objectives which direct both teachers and learners to skillfully cover the geographical content. In addition, it contains self-assessment exercises as well as typical examination questions that help build skills and examination competences for learners of all aptitude categories.

It should be noted, however, that this resource does not eliminate or downgrade other resources available, but comes as a worthwhile addition to the multiplicity of resources already in use. For best results it is recommended that this resource be used concurrently with **The Turn-Up CollegeA- level geography questions and answers** module.

Foreword

I had the opportunity of discussing this book with several educationists, teachers and students when it was in the process of being made, and I felt that it was likely to prove unusually useful. It gathers together a great deal of information which must otherwise be delved for in many books and all this is arranged judiciously and on practical lines. The authors' outlook might be described as one of liberal commonsense clarity, simplicity of expression, and examination-skills-focused. Our study packs are there to offer a canvas for Zimbabweans to showcase their best ideas to help transform, the country into a knowledge and skills-based society where citizens are free to express their creativity, knowledge and ingenuity. We have set challenging objectives, but we believe that only by striving to achieve the highest, can we elevate ourselves above the elements which tend to hold or country back. However, if your see anything where you feel the elements have failed to deliver, and where we may have failed on issues such as content, depth, relevance and usability, please let us know by using the contact numbers (09 61226/61247, 0773 247 358; or box 2759 Bulawayo; or email at turnupcollege@yahoo.com. We are here to listen and improve.

In my days as a teacher and as a student I would have welcomed this book warmly because:

(i) It approaches the syllabus holistically
(ii) It uses simplified expression
(iii) It has an in-depth coverage of content
(iv) It provides examination skills at the earliest stage of studying
(v) It provides local, international and commonplace examples, illustrations and case studies.
(vi) It provides intelligent questions and answers of the examination type on a chapter by chapter basis.
(vii) Last but not least, it provides a clear platform for self-evaluation as one prepares for the final examinations

I have no doubt that learners and educators would as well find this book to be one of the best. It is certainly a manual for success. Every one would find it worthy to have his/her own copy. I shall not be surprised if the Turn-up College Study pack becomes the best resource in school and out of school.

CHAPTER 1

INTRODUCTION TO "A" LEVEL GEOGRAPHY

1.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

1. Define what Geography is
2. Explain what Geography is
3. Explain the branches and scope of Geography
4. Outline the structure and form of the "A" Level Geography Examination
5. Explain the examination Assessment objectives

1. INTRODUCTION TO A LEVEL GEOGARPHY

Welcome to the "A" Level Geography course. Geography at "A" Level, like any other "A" level subject, is a big jump from your "O" level studies. A practical approach to the subject would be more appropriate at this level. See the exercise below.

2. KICK OFF EXERCISE

Read the short account given below and then critically think about all the questions which are raised at the end of the account.

There is no doubt that our world today is facing a crisis! Land degradation, pollution in water, air and on land; global warming, acid rain, destruction of the ozone layer, melting ice caps, volcanic eruptions, earthquakes, typhoons and cyclones; disruptions of nuclear installations, civic and religious unrest, belligerent nations, disease pandemics, famines, the liquidity crisis, diminishing and unequal distribution of resources, corporate greed and centralization, gender inequality etc, all affect the human being living over the face of the earth.

Ironically, most, if not all the problems, result from anthropogenic (human) activities. It would appear that the human element, once introduced into a pure natural environment, disrupts the ecological balance and upsets sustainable living in a number of ways. This is what we are sure about today.

But our earth has always been changing-as if it is restless! The changes have a direct impact on the peoples of the earth, its flora, fauna and their constant struggle to adjust and survive. Have you ever considered what causes these changes, how they come about, why they occur, how they occur and what effect they have in the survival struggle of the earth's living organisms?

Geographers have answers to these questions. This may sound too bold a statement to make but its implication is that the scope of Geography is so wide and so rich and varied that there is no subject in the curriculum that Geography does not have something to teach about. See the branches of Geography in number 7 below.

3 In the whole of your life, where do you see Geography coming in, especially its knowledge and skills taught and demonstrated at "A" Level?

Geography is woven in the fabric of the whole world around you, your survival in that world and your duty in ensuring that your world can carry on supporting your survival. You see Geography correlated with virtually all your other subjects in the curriculum. Because of the nature of Geography, there is a richer selection of careers than in any other single subject. See the diagram in number 6 below, showing the link between Geography and some other disciplines in your curriculum.

4 As an "A" Level Geography student, what would you suffer if you were not to learn this subject thoroughly right from the start?

The "A" Level, Geography syllabus is a very long syllabus. Virtually every topic introduces peculiar geographic terms, jargon, concepts, skills and values which you must attempt to master. The "A" Level course is a huge jump from "O" Level work; it actually forms a very firm basis for university studies or any further studies in Geography. Besides, you will not get a good pass at the end of your course if your knowledge and skills are weak. A good pass in Geography at "A" Level can qualify your entry into certain disciplines at University where you may not have the direct subject pass pertinent to the entry into those courses. The reason is that "A" Level Geography deals with a variety of concepts and skills that relate to other subjects. Again see number 6 and number 7 below.

To a very large extent, Geography is a science, whose methods of study and research are those used in natural sciences (Chemistry, Physics, Biology) and other sciences. If you study Geography thoroughly at this level, you will gain the basic knowledge and skills that students get in the other sciences.

1.2 The Definition of Geography

The word "Geography" first came from an ancient Greek scholar, Eratosthenes (276-194BC). **Geo**–means **earth** and **graphien** means **to write**. Therefore "Geography" literally means to write about the earth. You can immediately see that this is a very limited definition of Geography. The definition of Geography is a bit elusive, although we all agree that it is a science concerned with places, especially the earth's surface as the space within which the human population exists. Below are some definitions given by a few experts together with some comments on the subject.

Please note that the mode of citation used below indicates the year of publication of the book or the view and the page where the information is found in that publication. The two details are separated by a colon.

Richard Hartshorne (1959)

He wrote that:

Geography is concerned with providing accurate, orderly and rational descriptions and interpretations of the variable character of the earth's surface.

Johnstone et al (1981:175)

They submitted that Geography is:

"the study of the earth's surface as the space within which the human population lives."

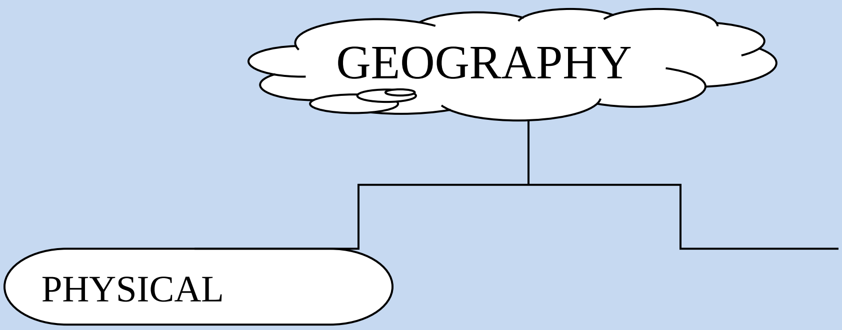
Small and Witherick (1986:89)

Wrote that:

"Geography comprises the study of the earth's surface as the home of the human race. But how much Geography is the science of spatial distribution and spatial relationships, how far it is concerned with the interaction between people and their physical environment, and to what extent the study of the region is the focus of the subject, these are all matters of debate. The fact that Geography is located at the interface between the natural sciences, adds to the difficulty of arriving at a definitive definition."

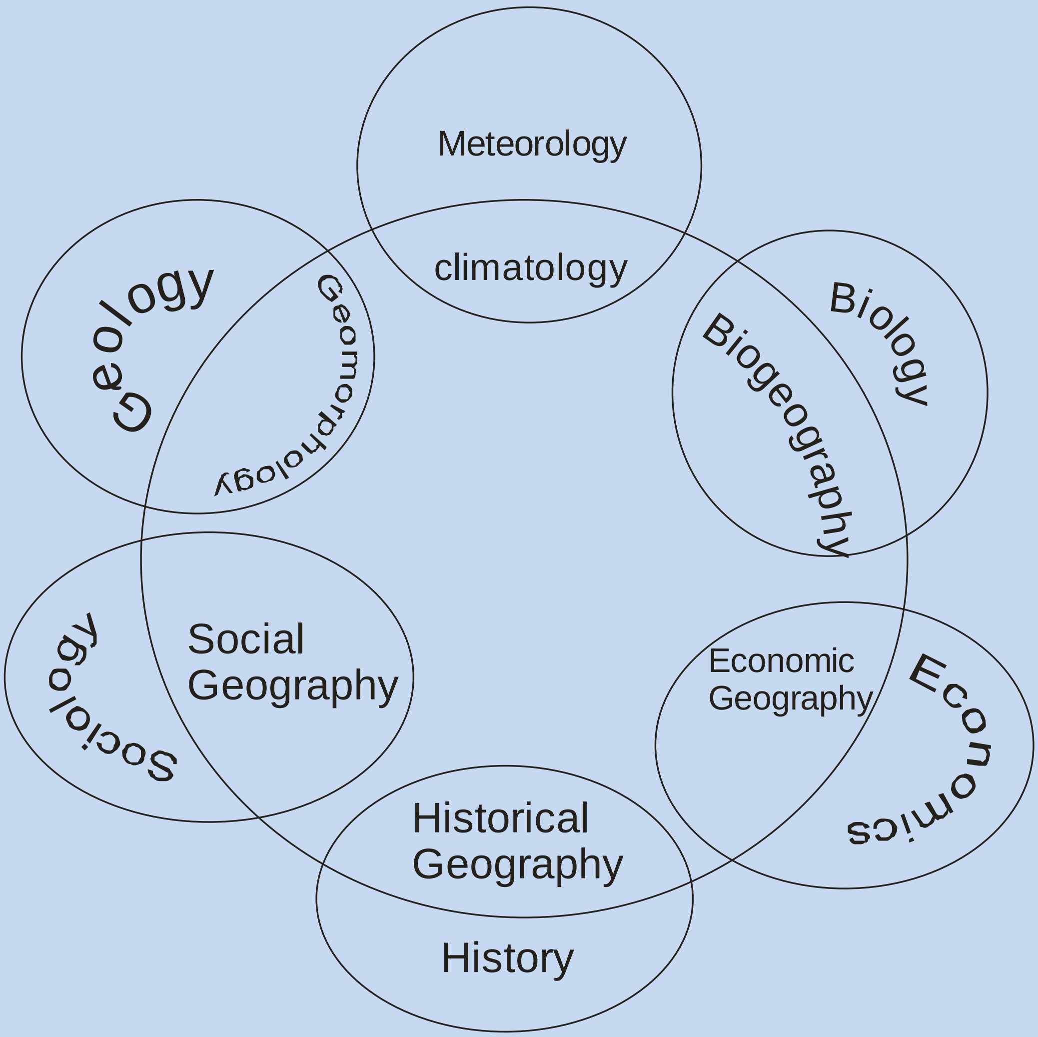
<u>Monkhouse (1965:137)</u>
Submitted that:
"Geography comprises the study of the earth's surface in its areal differentiation as the home of man; how much it is a science of distributions; physical and human, how much man in his spatial setting, is the crux, and to what extent the study of the region is the core of the subject, are all matters of debate. The geographer seeks to describe how the diverse features have come to be what they are, and to discuss how they influence the distribution of man with his multifarious activities. Geography, standing as it does, transitionally, yet centrally, between the natural sciences, the social studies and the humanities, is thus in its concept and content an integrated whole."

Today scholars agree that Geography is an all-encompassing discipline that, foremost, seeks to understand the earth and all of its human and natural complexities not merely where objects are, but how they have changed and come to be. Geography has been called "the world discipline' and "the bridge" between the human and the physical science. Hence Geography has two main branches as shown below.



1.3 The link between Geography and other subjects

Fenneman (1919) summarised the link between G iplines in a diagram that explains the circumference of Geograp



The circumference of Geography (Fenneman 1919). As quoted from ZOU (GED101;8)

But that is not all. Other subjects are involved e.g. Mathematical Geography involves research statistics. This brings us to branches of Geography.

1.4 The major branches of Geography

Below is a table showing the main branches of Geography under its two main headings of Physical and Human Geography.

	Physical Geography	**Human Geography**
1	Geomorphology-the scientific study of landforms	Population Geography

2	Hydrology- the scientific study of water	Rural Geography
3	Climatology and Meteorology-the scientific study of weather and climate.	Urban Geography
4	Oceanography- the scientific study of seas and oceans	Transport Geography
5	Biogeography-the scientific study of animals and plant distributions.	Industrial Geography
6	Pedology – the scientific study of soils and their formation processes	Cultural Geography
		Economic Geography
		Historical Geography
		Social Geography
		Political Geography
		Agricultural Geography

5 We are sure that you now have an idea of what your subject is, its scope, its branches and the wide choice it carries and offers.

1.5 Examination Structure Analysis

The Geography Examination Papers

In both Cambridge and ZIMSEC, two papers will be set. The first paper, (Paper 1) is on Physical Geography. The second paper (Paper 2) is on Human Geography. Below is a table that shows the paper syllabus numbers and codes.

CAMBRIDGE	ZIMSEC
9696/1- Paper 1 9696/2 - Paper 2	9156/1- Paper 1 9156/2- Paper 2

Each paper consists of CORE and OPTIONAL topics. All the core topics are very important for the examination, and they must be covered in detail and thoroughly. The optional topics are also important, but you must choose to study at least two options for each paper.

Below is a table detailing the topics that fall under CORE and OPTIONAL topics.

PAPER 1- PHYSICAL GEOGRAPHY	PAPER 2- HUMAN GEOGRAPHY
CORE TOPICS • Climatology • Hydrology and fluvial Processes • Geomorphology • Biogeography **OPTIONAL TOPICS** • Structural landforms on a global scale • Hazardous environments • Coastal Geomorphology • Glacial and peri-glacial environments	**CORE TOPICS** • Population Geography • Settlement dynamics • Agricultural systems and food production • Manufacturing and services industry **OPTIONAL TOPICS** • Mining, Fuel and Power • Environmental management • Transport and trade • Economic development and planning

Each paper is divided into two sections. Section A of each paper is a practical based assessment part.

Each paper is 3 hours long.

1.6 EXAMINATION ASSESSMENT OBJECTIVES

(a) Level 1 – knowledge

When the examiner tests knowledge,they want to find out if you can;

- Define and explain terms and concepts
- Demonstrate a working knowledge of relevant theories, principles, models etc
- Locate accurately where selected places and environments are found, as well as describing their characteristics
- Demonstrate that you have knowledge of the physical and human processes at work.

(b) Level 2 – Understanding and application skills

Here you are required to show that you can;

- Interpret geographical concepts and apply them to new situations.

- Demonstrate your understanding of the complexity and inter-active nature of the physical and human environment.
- Demonstrate how processes bring changes in systems, distributions and environments.
- Show the distinctiveness and generality of places and environments.
- Show the significance of spatial and time scales.
- Apply geographical concepts to new contexts.

The key word at this level is "synthesis" (i.e. assembling of, or building up) of what has been given to explain it in another way, and apply it on new situations or contexts. Concepts gained in one topic can enhance understanding of another topic not necessarily linked to the first. It is important to conceptualize the linkages and inter-relationships that exist in the various components of geography.

(c) Level 3 - Enquiry skills

- At this level you must demonstrate practical skills gained from field work and other research projects.
- You should be able to collect and record and interpret information and statistical data.
- You should be able to interpret a range of map and diagram techniques that display geographical information.
- You should be able to assess methods of enquiry and rationalise limitations of evidence.
- You should be able to analyse, synthesise and hypothesize data.

All this calls for a lot of personal judgement, mastery of data collection and field observation techniques.

(d) **Level 4: Judgemental skills (evaluation and decision making)**

At this level the examiner tests your ability to:

- Give opinions and views on geographical concepts
- Assess the effect of geographical processes and changes on human and physical environments
- Evaluate the relative success/failure of initiatives, and demonstrate a sense of sound judgement.
- Analyse and identify different view points and areas of conflict.
- Undertake decision making processes in human and physical geography

These four levels of assessment objectives form the basis of the study of all your topics in Geography.

10 Conclusion

Now let us go on to the actual study of ‘A’ level Geography. It is hoped that the above introduction has placed you on a pedestal in readiness to begin the actual A’ level work in Geography.

CHAPTER 2

<u>GEOMORPHOLOGY</u> : (Core Topic)

2.1 STRUCTURAL LANDFORMS ON A GLOBAL SCALE

2.2 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a Describe the internal structure of the earth.

b Examine critically, the continental drift and plate tectonics theories.

c Describe the major landforms of the earth

d Describe the processes of faulting and folding bringing out associated landforms.

2 The Internal Structure of The Earth.

The internal structure of the earth is a good starting point for the study of PLATE TECTONICS, a phenomenon that helps to explain the main landform features of the earth's surface. Scientific research continues to gather valuable information about what the internal structure may possibly be like.

If a fruit such as a peach is cut right through the centre to make two equal halves and each half is studied, you can identify three clear parts which are :

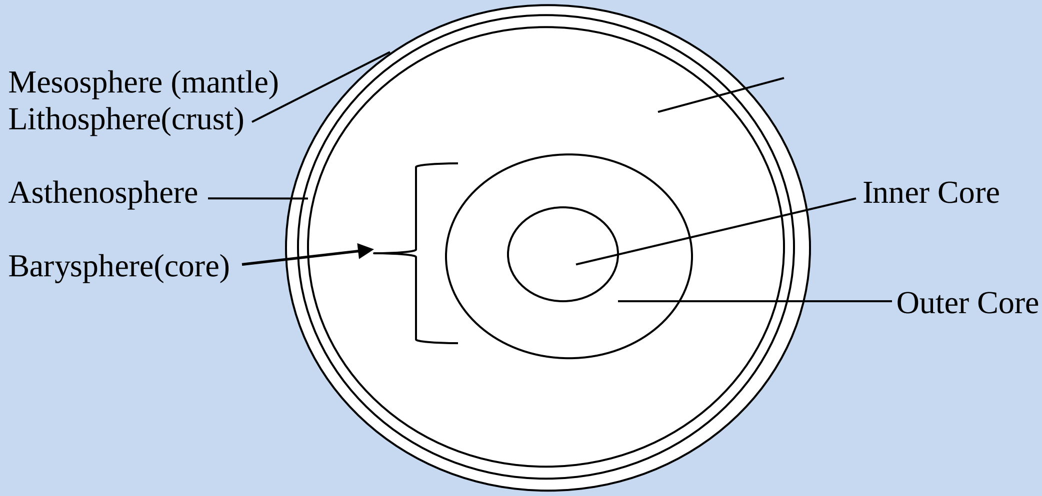
a A very thin outer skin,

b A thick mass of the actual fruit, which we eat, lying under the thin skin.

cA hard seed of significant size, right at the centre.

This is a very good picture of what the internal structure of the earth is like.

Study the diagram below.



A simplified presentation to show the internal structure of the earth

.

In the diagram above you can easily identify:

a The thin outer layer called the LITHOSPHERE or the earth's crust. (*Note that the bottom part of the crust forms a thin layer called the asthenosphere*.)

b The thick layer under the crust, called the MESOSPSHERE or just the mantle.

c The centre part which is significant in size and is called the BARYSPHEREor CORE. (*Note that this core is divided into two parts i.e. the OUTER CORE and the INNER CORE*.)

It is important to point out that as the depth increases from the crust towards the inner core, the following are experienced;

- density of materials increases
- heat and temperatures increase
- pressure due to the weight of above materials also increases.

You would therefore expect the hottest, the densest and the greatest pressure to be in the inner core

.

The Lithosphere or Crust

This is the thinnest layer (0km to about 40km thick) and it runs right over all the land and continues under the seas and oceans. There are two distinct types of crust. First there is the continental crust. Second there is the oceanic crust. As the terms suggest, the continental crust underlies the continents while the oceanic crust underlies most of the areas known as oceans. Below is a table that describes the characteristics of the two types of crust.

OCEANIC CRUST	CONTINENTAL CRUST
a Underlies most of oceans bThinner, less rigid but more dense than continental crust. (The density is due to the silica and magnesium (SIMA) c Composed primarily of basalt rock. Also contains more magnesium and iron than continental crust, but less silica and aluminium than the continental crust. d Lack of sufficient silica makes it darker than continental crust	a Underlies continents b Thicker, more rigid but less dense than oceanic crust and therefore ‘floats’ higher on the earth. cComposed primarily of granite rock. Also has more silica and aluminium (SIAL) than oceanic crust, but less magnesium and iron. d Is lighter in colour than oceanic crust because of the abundance of silica

The earth’s crust overally is largely formed of igneous rock. At the bottom of the crust there is a very thin layer called the asthenosphere which is in contact with the mantle.

The Mesosphere or Mantle

This part of the earth is roughly 2 900km thick and is said to be made up mainly of olivine-rich rock (i.e. magnesium iron silicate). Olivine-rich rock has great rigidity and is of high density. However, it can flow slowly when subjected to unequal forces over long time periods.

The mantle is under different temperatures at different depths, with the lowest temperatures immediately below the earth’s crust. The temperatures increase with depth until the highest temperatures are found where the mantle is in contact with the core(where heat is actually produced). Geologists refer to this steady temperature increase with depth, as the geothermal gradient which is responsible for the varying behaviour of different rocks. The varying rock behaviours are applied as a factor that is used to divide the mantle into two

different zones – the upper mantle and the lower mantle. Rocks in the upper mantle are cooler and brittle (i.e. they fragment more easily) while rocks in the lower mantle are hotter and softer (but not molten). It is noteworthy here that the rocks in the upper mantle are brittle enough to break under stress and produce earthquakes. In the lower mantle the rocks are soft and can flow when they are under forces. They do not break. The bottom limit of brittle behaviour is the boundary between the upper and lower mantle.
The upper mantle is of great interest to us because of its influence on tectonic activities. In general, we note that the mantle is made of iron-magnesium silicates. The whole mantle surrounds the earth's core and it makes up the bulk of the earth.

2.3 The Barysphere or the Core or the Centre Sphere

From information received from the measurements of changes in behaviour of earthquake waves, the core is thought to be made of an inner solid part and an outer liquid part. Again, assumptions based on calculations of the density of the core, have led scientists to think that the core as a whole, is made of an iron-nickel alloy. What has given weight to this assumption is that meteorites which are thought to be portions of the interior of planetary bodies, are made up of iron and nickel.
The earth's core is the source of the earth's internal or geothermal heat, because it contains radio active substances that give out heat when they disintegrate into their more stable states.
The core is said to have an average density of 6 but this figure may be as high as 15 in the inner part. Temperatures range between 2 200°C and 2 800° C and very high pressures of up to 4 000 000 (four million) times the sea level atmospheric pressure, are thought to be exerted.

The Outer Core

This zone of the core is liquid because the temperatures here are so high that the iron – nickel alloy is melted, but the pressure is lower than in the inner core. Very high temperatures but lower pressure, keep the material liquid.

The Inner Core

This part is a solid even though its temperatures are higher than those of the outer core. The temperature of the core is around 5500°C. The reason why this part is solid is that there are extremely high pressures here which are generated by all the weight of the overlying rocks. These pressures are so strong that they squeeze the atoms of the iron–nickel alloy so tightly together that the alloy material cannot be liquid, but solid.

3 The Tectonic Basis Of Landforms.

Let us now make an attempt to outline how the plate tectonics theory evolved from continental drift theory, and use the plate tectonic theory to explain the earth's main physical features. We must here point out that continents and ocean basins are the major structural features of the earth. These very large features which make up our planet are known as the first order of relief.

4 THEORIES ABOUT THE EVOLUTION OF CONTINENTS AND OCEAN BASINS

From far back in history, several perspectives on how the earth's major features came to be where they are, if they have always remained the same where they are, what brought them about and how they came to be what they are, have been developed by various scholars and professionals. These perspectives range from catastrophism to continental drift and plate tectonics. We will not study every single one of them but we shall summarise the thoughts of quite a number of these people.

i. **Francis Bacon**
This man lived in the 17th century. He realised that the coasts of South America and Africa were uniform. There was some likeness in their shapes – more like similar pieces of a jig–saw puzzle.

ii. **Francois Placer**
In 1666 this scholar suggested that before Noah's flood (from Noah in the Bible) the earth was one land mass. During and after the flood, this land mass was flooded and the continent of Atlantis was submerged.

iii. **Alexander Von Humboldt**
In 1804 this scholar noted the parallelism of the coastlines, and the geology of Africa and South America

iv. **Antonio Snider Pellegrimi**
This man in 1858, postulated the idea that the one land mass should have cracked on cooling and that flooding then formed the Atlantic ocean.

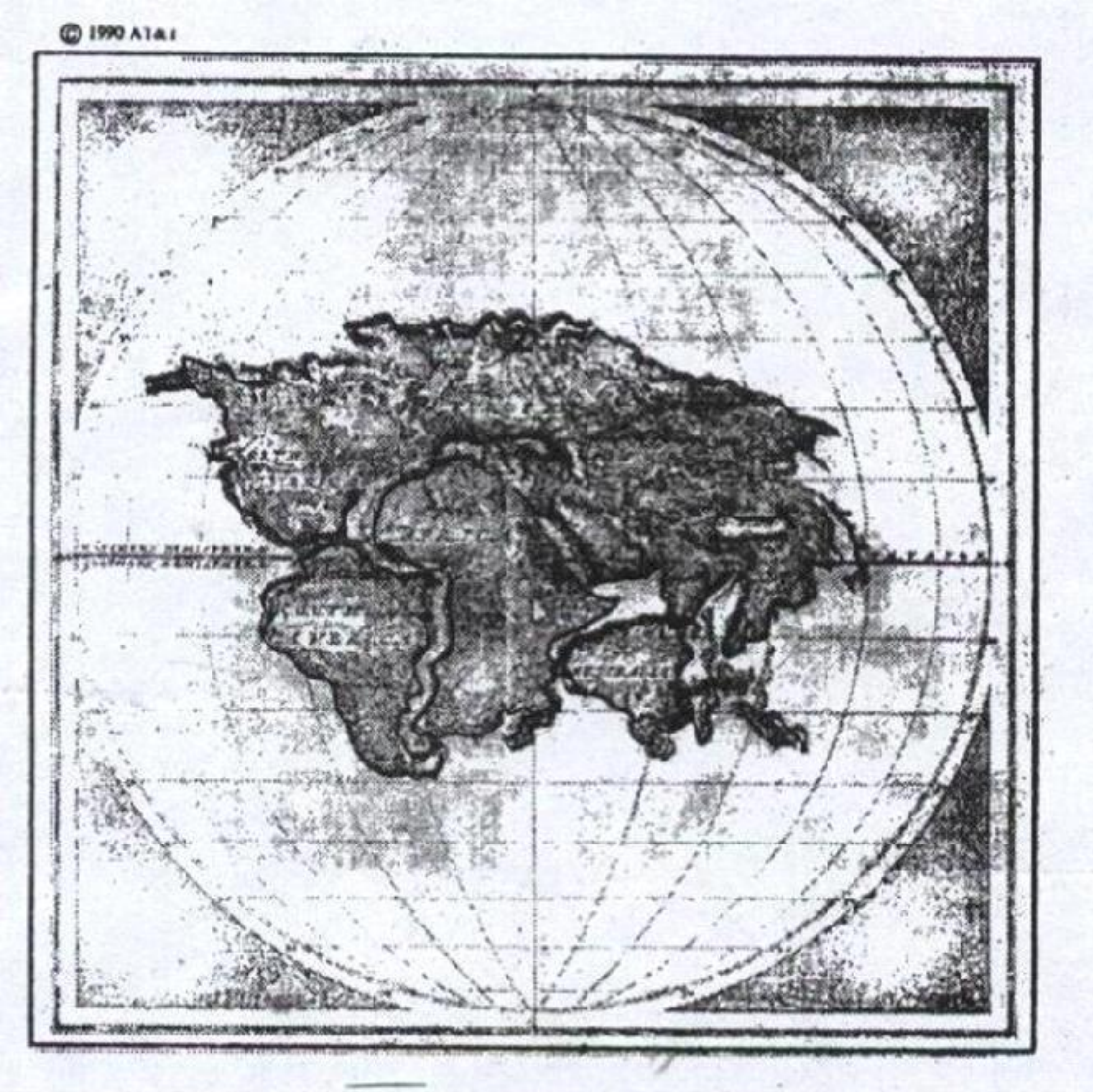
v. **F.B. Taylor**
In 1910, Taylor explained that creeping crystal movements resulted in folding that gives rise to fold mountains. He was an English man who based his evidence on shapes of continents of South America, Africa, India, Australia and Antractica but failed to explain the mechanism behind the shattering and subsequent drifting of continents to their present positions.

vi. **Edward Suess**
This man was an Austrian (from Austria in Europe) who, in 1910, first wrote an essay on the origin of continents. He coined the term "Gondwana" (from which we get Gondwanaland, a theory in the southern continents). His term "Gondwana" suggested continents as remnants of a submerged single super –continent. His ideas were dismissed because of lack of evidence at that time.

vii. **Alfred Wegener**
Wegener was a German biologist who took up FB Taylor's ideas, expanded them and supported them with an array of convincing evidence. He is considered to be the "Father" of Contintal Drift.He read widely in Geophysics Biology, Climatology, Geology and Geodesy in order to amass evidence for continental drift. Already other scholars before him had noted the jig-saw puzzle fitting pieces of Africa and

South America and he wrote, according to Stevens (1980), “it is as if we were to re-fit the torn pieces of a newspaper by matching their edges and then check whether the lines of print run smoothly across”.

You must, study the map shown below and consider how closely it resembles Wegener’s Pangea whose description follows after the map.



AT & T Newspaper Advertisement

Wegener visualised our world, initially as one single super–continent called Pangea. This Pangea was surrounded by one ocean known as Panthalassa. Then Pangea broke up into Laurasia (Northern Continents) and Gondwanaland (Southern Continents, plus India). Laurasia drifted North, while Gondwanaland moved southwards.

During these drifting movements, Laurasia and Gondwanaland rifted (broke apart). The pieces or fragments began moving apart (drifting) as almost separate continents. The gaps remaining among the continents formed ocean basins. In this way the major structural features of our earth, (continents and ocean basins) were formed. It was presumed that South America and North America drifted westward away from Africa creating the Atlantic Ocean, the Caribbean Islands and the Andes and Rocky mountains, in the process.

The actual revolutionary idea introduced by Wegener was that Laurasia and Gondwanaland were continents that fractured and then drifted. These views contradicted the orthodox belief that the continents were the remains of (what people like Suess said) a continent much of which had submerged below the waves. For this controversy Wegener had to show his evidence.

Although during Wegener's time, evidence for continental drift was indeed impressive, the question as to how all this drifting and rifting happened remained. Since the theory of continental drift seems so important, let us consider some evidence in its support.
Suppose Zimbabwe and Zambia were to drift apart along the Zambezi River so that a very wide sea were to remain in between afterwards. If you were to prove that sometime in the past, the two countries were actually joined together at the Zambezi River courseway, where would you begin to look for evidence, what would you look for and why?

To start your thinking, you know that the area on both sides of the Zambezi is made up of the same or similar bedrock soils, contains the same flora, fauna, minerals, is inhabited by the Tonga people, and the shape of the borders follow the same Zambezi River course. Now if the two countries drift apart, these similarities will remain. That is a good starting point. We can then go on to search for evidence along similar guidelines.

(a) The jig-saw visual fit of the western coast of Africa to the eastern coast of South America shows the two land masses were once joined together along these coastlines. The same can be said of the eastern coast of Africa to Madagascar (Malagasy) and the western coast of Australia.
(b) The geometric fit of Brazil and the east coast of South America, if rotated at an angle of 57°, would fit snugly into the west coast of Africa (Ghana through Nigeria and down to Gabon and the western coastline of Africa).

(c) Wegener demonstrated some matching geology (rocks and minerals). There were similar rock sequences in the Karoo beds off the plateaux of Brazil as well as similarities of rocks and fossils throughout the southern continents which would only have been formed under similar glacial periods at the time they were once joined together.

(d) There are some matching orogenic belts whereby the fold mountain ranges of the Falkland Islands and Argentina are of similar age and structure to those of the South West Cape in South Africa.

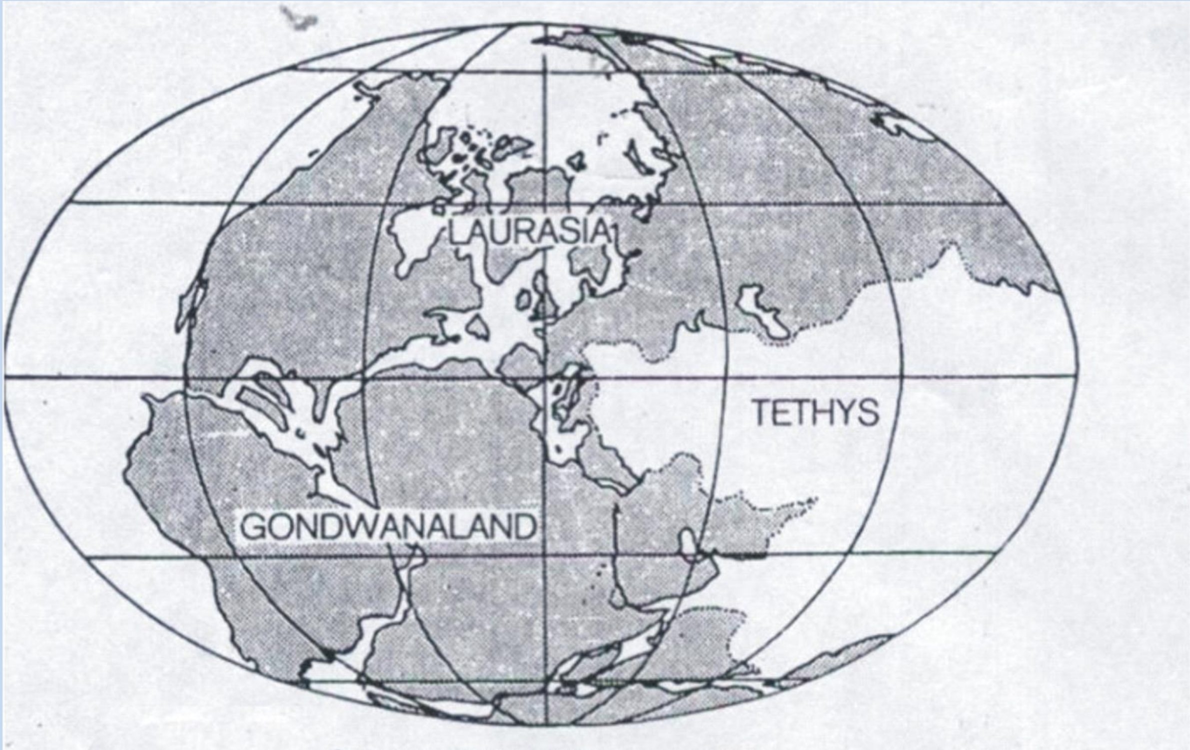
(e) There is glacial evidence shown by thick deposits of fossilised glacial moraine (tilted) located in eastern Brazil, Paraguay and Argentina and these findings are exactly the same as those in Southern Africa. They could have been formed when a vast ice sheet covered Gondwanaland, when Africa and South America were still joined together.

(f) Sedimentary basins add further evidence. Similar sedimentary rock sequences exist along part of the north–eastern coast of Brazil, South Eastern Nigeria and Cameroon. These could have formed during the same geological period when the two continents of Africa and South America were joined.

(g) Paleomagnetic evidence suggests that there are magnetic properties in rock particles which have allowed geophysicists to reconstruct the position of the poles. From such experiments, scientists have concluded that southern Africa and South America once lay within the Arctic Circle and have migrated 40° closer to the equator. (The phenomenon is known as “polar wandering”). Although there was a lot of evidence for continental drift, Wegener died in 1930 leaving behind an unfinished story. Between 1930 and the 1950’s the continental drift theory was in the doldrums.

viii. Rudolf Staub

In 1924 Rudolf noted that “Laurasia” was a super continent in the northern hemisphere (Note that <u>Eurasia</u> refers to Europe and Asia. It excludes North America). Below is a map showing the relative positions of Laurasia and Gondwanaland.



Snider's Views (Stevens, 1980).

i. **<u>The Expanding Earth Theory</u>**

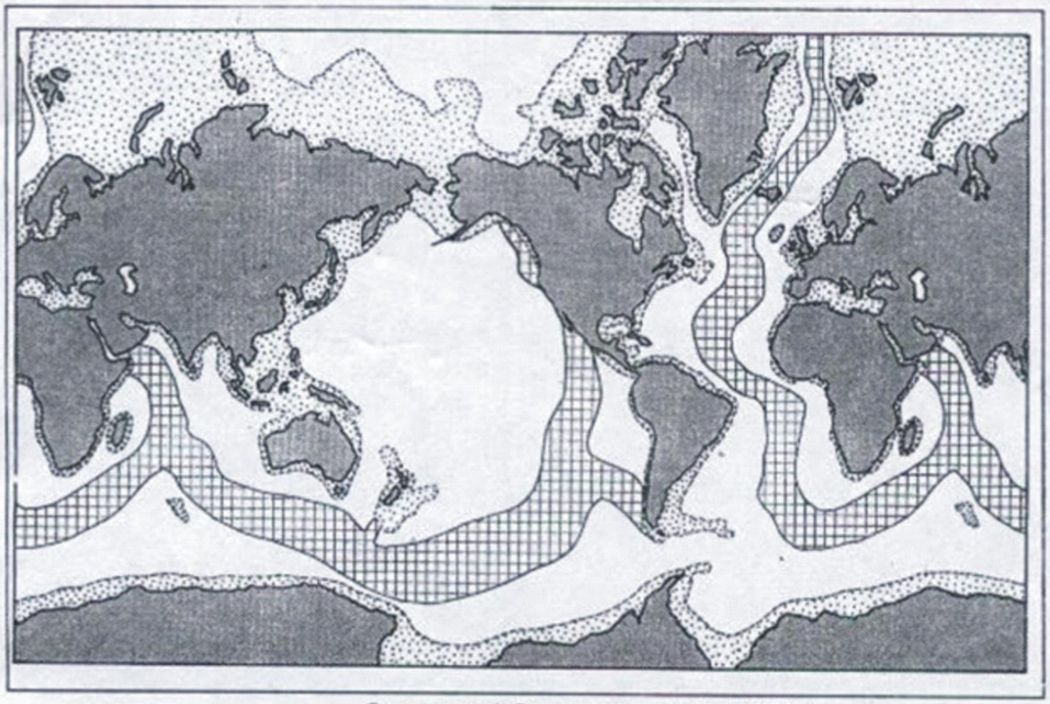
This theory was propounded in the 1950"s in an attempt to explain the rifting and consequent drifting of continents. Remember this was the challenge Wegener had been faced with.

The theory suggested that radio–active isotopes within the interior of the earth must have generated sufficient stress or force for the crust to crack along radial lines and then the pieces or fragments drifted westwards and eastwards. Of course, the weaknesses of the theory were its failure to explain why continental land masses drifting away from the African continent failed to collide and the lack of evidence on contracting or shrinking oceans.

We have already noted that continents and ocean basins are the major structural features of the earth. So far we have been concentrating mostly on evolution of continents. We need to add some propositions about what concerns oceans. To get a good connection between what we have done and what we are about to discuss, I would like you to study very carefully the two helping annotations that follow. They summarise the structural features of continents and ocean basins.

The first annotation is a map. This map shows that the earth's surface may be divided into four categories as the key denotes:

Category 1.	Continents – shown by the heavy dark dot pattern.
Category 2	Continental margins or continental platforms and shelves – shown by the light dot pattern.
Category 3	Oceanic ridges and rises – shown by a squared pattern.
Category 4	Abyssal ocean floor – shown by absence of shading



Oceans and Continents. (Stevens 1980)

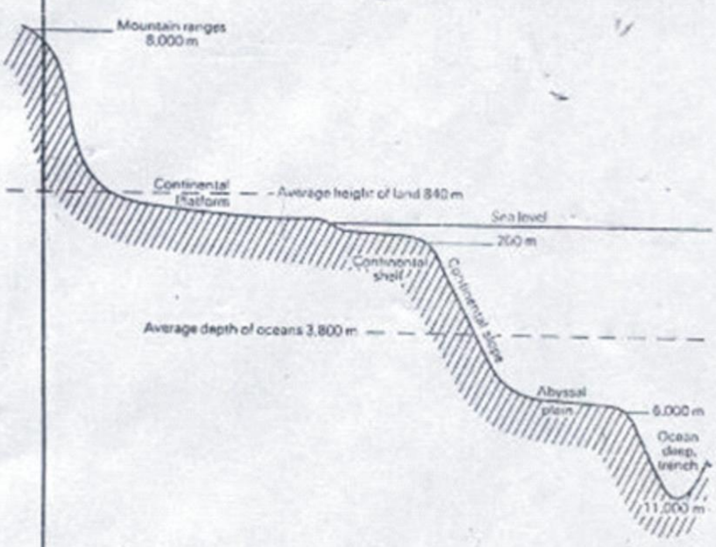


Fig. 2.2 *The major topographic features of the Earth's surface. Note how a small rise or fall of sea level would considerably change the areas of land relative to sea.*

Hypsometric Curve

Note carefully the locations of each of these four categories.

The second annotation is a section drawn from the summit of a high mountain on land cutting downwards below the sea level to the lowest depth of an ocean trench or ocean. This section is known as an hypsometric curve.

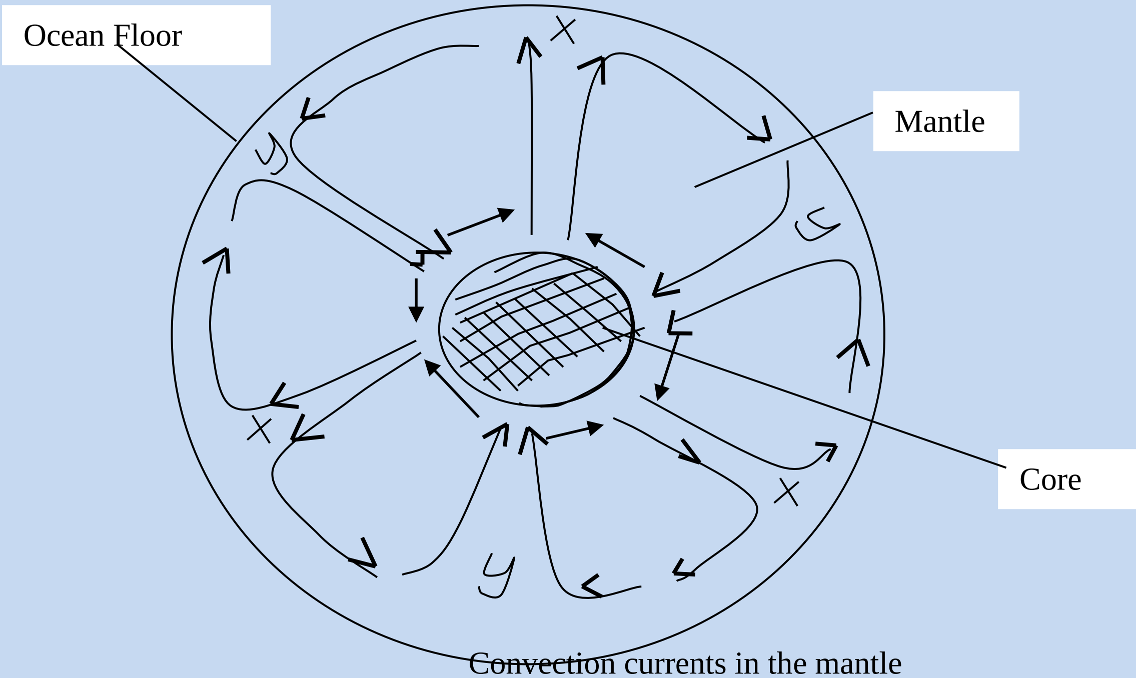
Note that the highest mountain (measured from sea level upwards) is shorter than the deepest ocean trench (measured from sea level downwards). Also note that a small rise in sea level submerges the land surface and thus reduces the area of land exposed above sea level. A small fall in sea level exposes more land surface. Think about what this implies in relationship to global warming and melting ice caps!

Compare the two annotations by trying to map the second onto the first. For instance, on which category would the ocean deep of annotation 2 fall if placed on annotation 1?

One more point to emphasise about the two annotations above is that the ocean basins make up about 70% while the continents take the other 30% of the total surface of the earth.
We are now better placed to consider yet another theory, but this time, one that concerns the oceans and ocean floor features.

ii. The Spreading Sea Floor Theory

During the Second World War, techniques were developed to identify submarines under water. These techniques also gave information about the form of the earth's surface under the oceans. When the war ended, these techniques were employed to study the nature of the floor of the oceans. It was Professor Harold Hess, a former US Navy troop carrier commander in the Pacific Ocean, who became a key contributor to the studies. He used data that he had collected during the war and proposed the theory of sea floor spreading- his bid to explain the ocean floor features. Much earlier after 1930, one of Wegener's staunch disciples, Arthur Holmes of Edinburgh University, had suggested sub crystal convection currents as the driving force of continental drift. Now after the war, Professor Harold suggested that convection currents within the earth's solid interior, directly gave rise to the major structures of the sea floor. Study the diagram of the interior structures of the earth given below. The diagram is a hypothetical presentation. Take the upper boundary of the mantle to be the ocean floor. Note the directions of the convection currents and the positions of X and Y.



Convection currents in the mantle

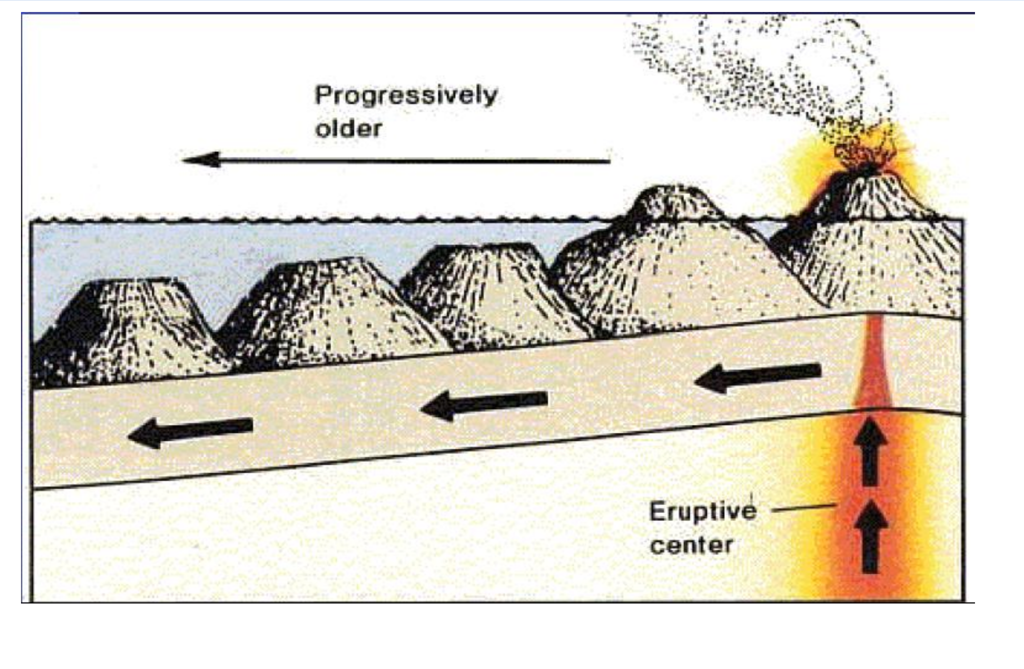
Key

→	Direction of convection currents
X	Points where magma rises to ocean floor
Y	Points where magma descends downwards

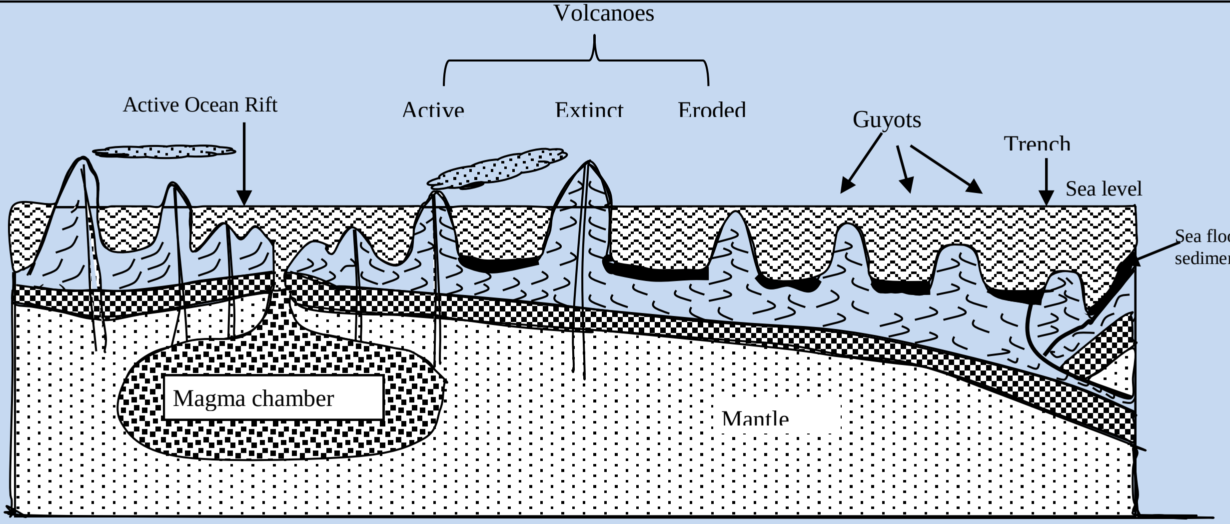
Remember the core is the source of geothermal heat in the earth. Mantle material which is in contact with the core heats up and melts. The hotter molten material is less dense and it rises. The rising molten mantle material constitutes what is known as the rising limb of the convection cell. On the diagram, it is represented by any part of the convection arrows from the core up to X. Upon reaching the sea floor at (X), the rising limbs spread equally sideways (i.e laterally to either side from X) along the ocean floor. On the diagram, this sideways movement is represented by any part of the convection arrows from X to Y.

. The space or hole through which the molten magma upwells, is called the ridge or spreading centre. As new molten material up wells through the ridge, it pushes the older material further towards Y and may heap upon the older material as well. When the molten material reaches Y, it is cooler and therefore denser. Zone Y represents the ocean trenches. The ocean trenches are the opposites of ridges. At the trenches, the sea floor is swallowed downwards and this movement of its cooler denser material is represented on the diagram by any part of the convection lines from Y to the core. Once at the core surface, this material is heated, melted and it rises towards the ridges. Thus, connection currents continue to rise and descend in the mantle.

Note that molten mantle material, once having reached the ocean floor, forms ocean structures that continue to spread along the ocean floor. This way, the sea floor behaves like a gigantic conveyor belt system that transports such materials as sea mountains and volcanoes away from the ridge. This action of the sea floor, in spreading materials on it to areas far away from the ridges, has earned it the theory name of <u>spreading sea floor theory</u>. It is clear then, that according to this theory, there is new oceanic crust created at the ridges, which is transported by the conveyor process to the trenches (which are adjacent to some continental margins as shown in the first annotation just studied on page– .) into which the transported crust is swallowed and destroyed. Thus new crust is created at mid oceanic ridges (spreading centres) and old crust is consumed at the trenches. This explains why the older ocean structures are located far away from the ridges while newer ones are found closer to the ridge as indicated by the diagram below.



To get a better view of some of the oceanic crust features created and destroyed during such processes, study the diagram shown below.



(b) The mid-oceanic ridges are a system of mountains that straddle the whole earth.

(c) Volcanoes that were active were those closest to the ridges, while those that were dormant were furthest. Most of the dormant volcanoes showed signs of erosion since their tops were worn off. This indicated that quite some time had elapsed from their formation at the ridges and during their transportation along the great conveyor belt of sea floor spreading processes.

iii. **<u>The Plate Tectonics Theory</u>** (*Note that this theory applies to both continents and ocean basins)*

In the 1960's the continental drift theory was revived. A lot of research had now been done and some of the ideas which previously had been dismissed were now tolerated. It seemed the time was ripe for synchronising all the different ideas. In 1967, at the Goddart Symposium, the different findings on sea floor spreading, continental drift, seismology and polarity reversal concepts, were put together to give birth to the <u>PLATE TECTONIC THEORY.</u> This theory is constantly being re-examined as evidence from current researches come up, but it looks like a grand modern theory. We can summarise the main points of the theory postulated back then in 1967 as follows.

(a) The earth's crust is made up of a mosaic of plates which are in constant slow motion because of the mantle's convection currents.

(b) Earthquakes take place in narrowly defined zones. They are not just random occurrences.

(c) The active earthquake zones are also sites of the earth's volcanic activities.

(d) These active earthquake zones surround relatively quiet places referred to by some scholars as <u>plates.</u>

(e) **Many plates include both the oceanic crust as well as the continental crust. These plates therefore are not merely oceans or continents only.**
(f) **Movement of the plates relates to earthquake and volcanic activity.**

Below is a map of the world showing the major tectonic plates.

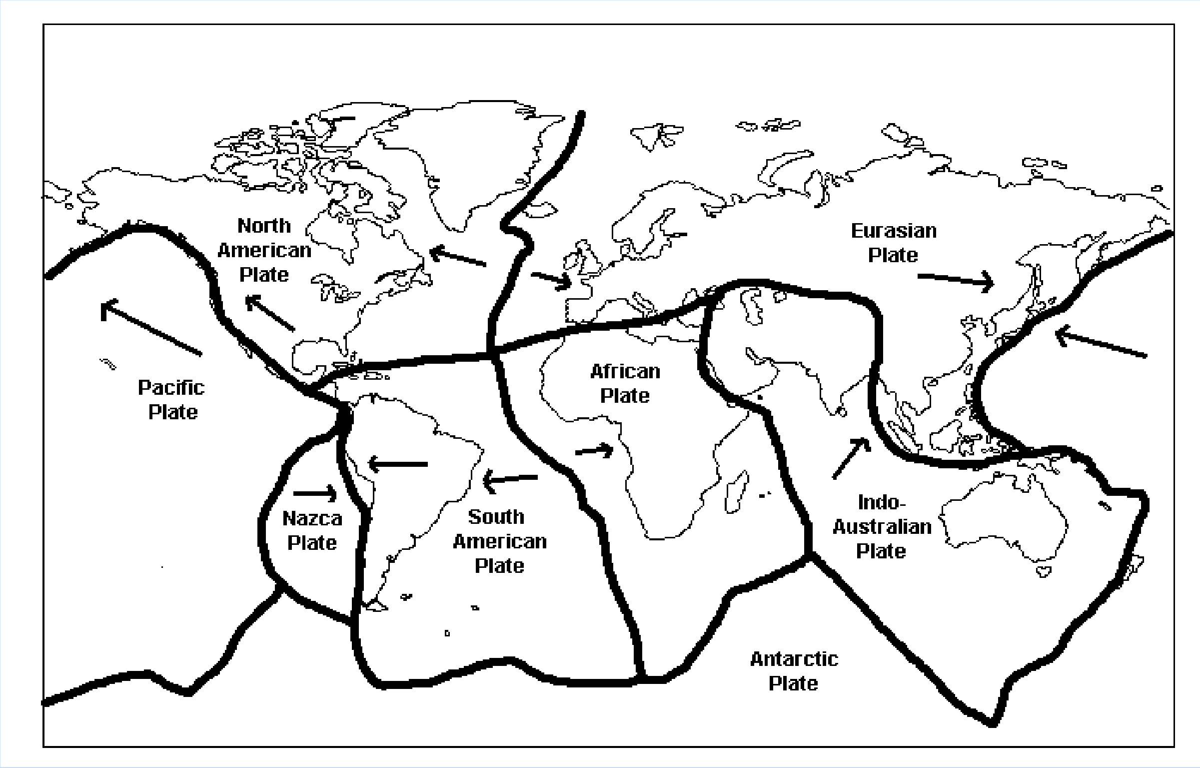


Plate tectonics theory is a powerful framework in explaining the chief structural features and processes on our planet, how these first order features have evolved and how they change their positions through time.

Mantle current movements are most pronounced at plate margins i.e. the plates interact at their edges or boundaries because that is where the results or effects of plate tectonic forces are most evident. It is very important to note that there are basically three different types of plate margins or plate boundaries. These are as follows.

(a) **Divergent plate boundaries or constructive boundaries: These are margins where plates are moving apart.**
(b) **Convergent plate boundaries or destructive boundaries. These are margins where plates are moving towards each other.**
(c) **Transform boundaries or neutral boundaries. These are margins where plates slide past each other.**

(d) Sometimes when it is difficult to define a clear boundary, we have a fourth type known as a Boundary zone.

Below we explain each of the major types of plate margins.

(a) <u>Divergent or Constructive Plate Margins</u>

To <u>diverge</u> is to increase the distance between any two things and to <u>construct</u> is to build up. From this term, we can see two plates moving away from each other widening the distance between while up welling of molten mantle material comes up through the gap to construct or build new crust. This takes place on continents and ocean basins. Most of the earth's newcrust forms at divergent boundaries.Study the diagrams shown below.

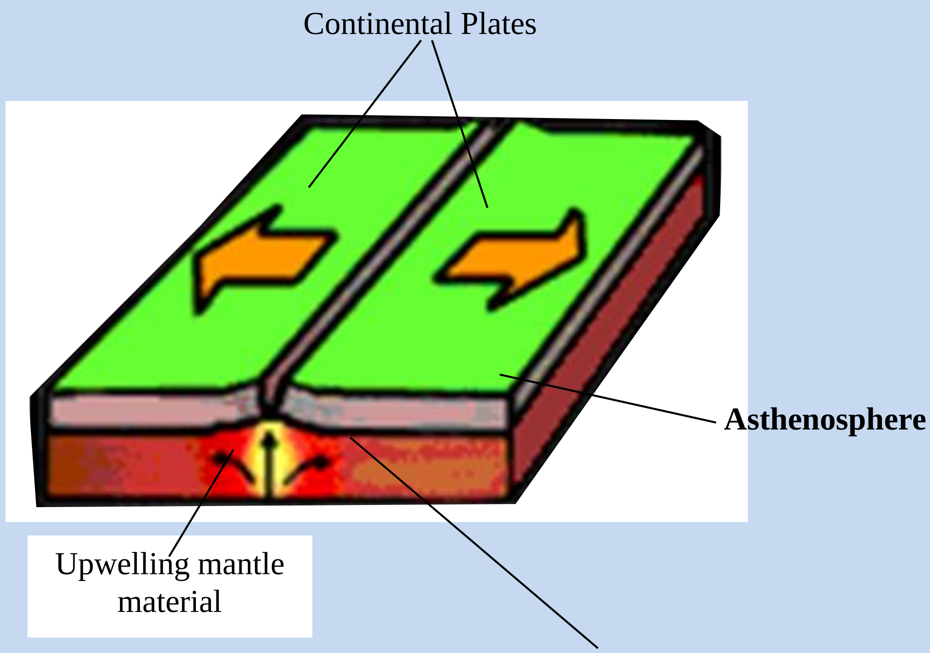
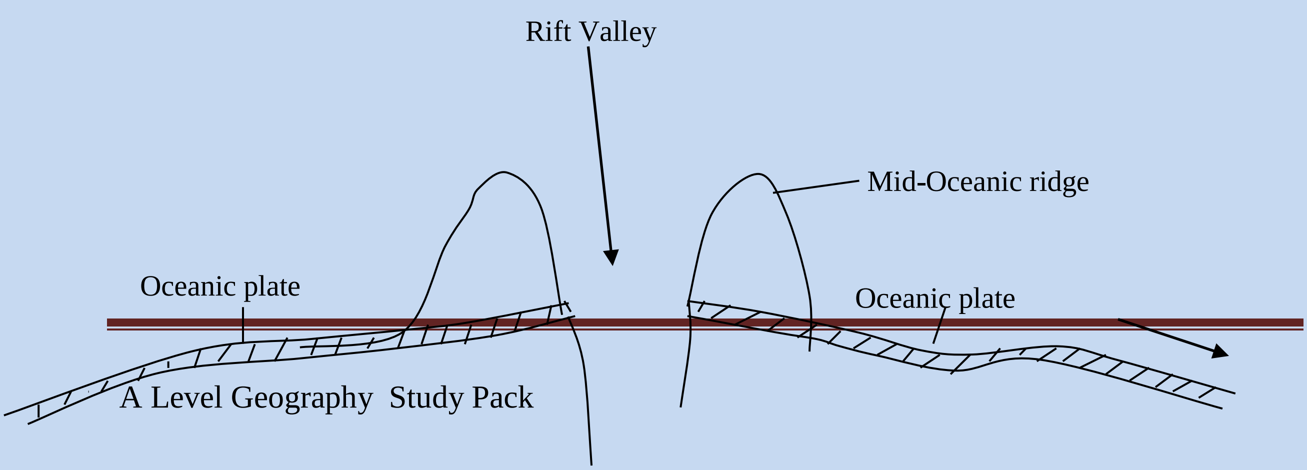
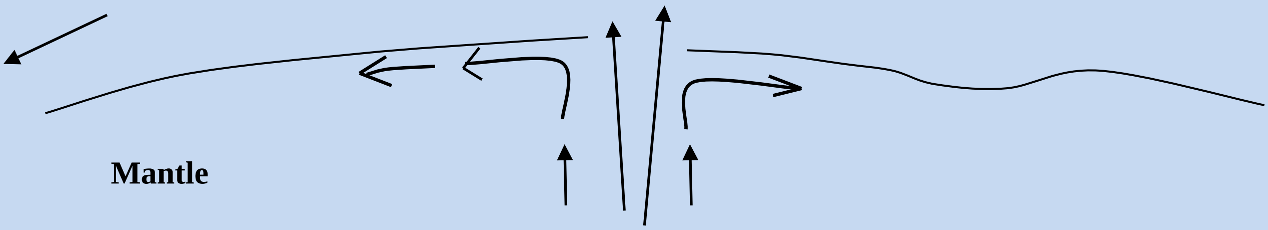


Diagram showing divergent plate margins on continents



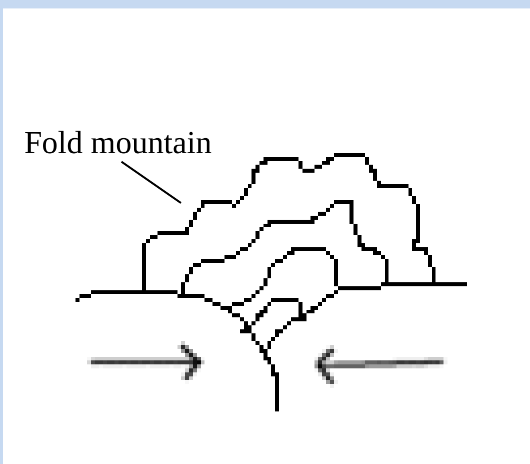


Upwelling convection currents

One of the best examples of divergent boundaries is the Mid-Atlantic Ridge, a submerged mountain range. It extends from the Arctic Ocean to beyond the southern tip of Africa. It is only one segment of the global mid-ocean ridge system that encircles the earth. Estimates of spreading along the ridge are at 2,5 cm per year, resulting in the wide vast ocean we see today from just a tiny inlet of water between the continents of Europe, Africa and America (in the far distant past).

2.4 Convergent or Destructive Plate Margins

To <u>converge</u> is to come together and to <u>destroy</u> is to put to nought what was built. Here, two plates come together "head on" like a crash between two cars which get destroyed, but some crumbled, folded metal form remains. When two plates collide, new, <u>fold mountains</u> result.Study the diagram shown below



Collision plate boundaries occur when two continental plates move towards each other. Fold Mountains such as the Indo-Australian and the Eurasian Plate are typical examples of fold mountains

hen two continental crusts converge

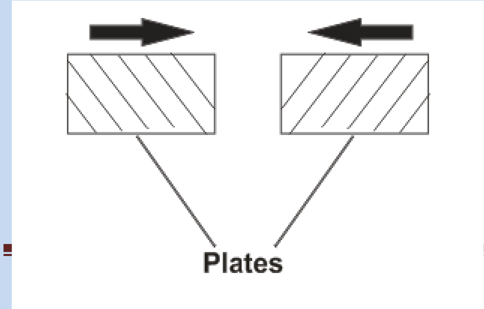
Fold mountains

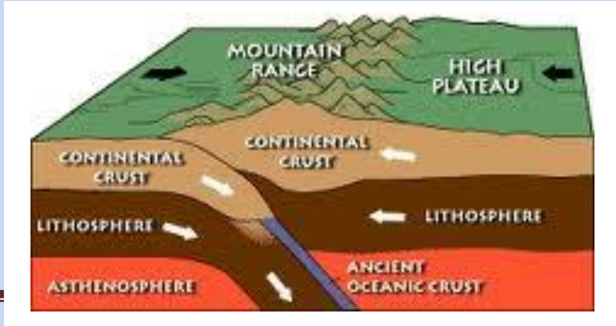
Block diagram showing fold mountains

We must however note one point. The earth's size does not change. This implies that the crust must be destroyed at about the same time it is being created. At plate boundaries, two plates meet 'head on". One sinks (is subducted) under the other. The subduction zone is the location where sinking of a plate occurs. The type of convergence depends on the type of lithosphere involved. Convergence can occur between two large continental plates or between two large oceanic plates. Convergence can also occur between an oceanic and continental plate. In short, converging processes carrying different types of crystal rocks have three different effects.

(i) First Effect.When two continental plates converge, the two sialic crusts tend to buckle upwards and foldmountains are created.

Continental plates converge



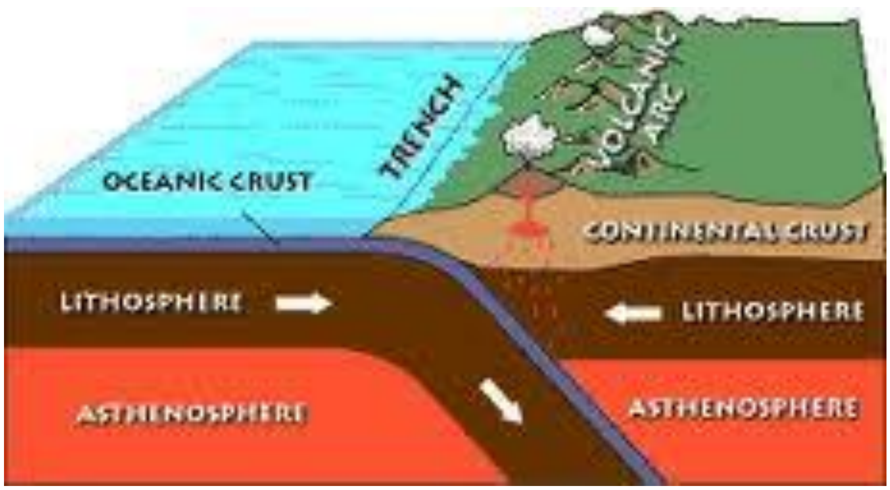


POSITION I **POSITION II**

A good example is the Himalayas, formed when India collided into Asia causing the Eurasian Plate to crumble up against the Indian Plate.

(ii) <u>Second Effect</u>When an oceanic and a continental plate collide (converge), the denser simatic ocean crust is subducted below the lighter sialic continental plate which is up-warped (folded upwards). The denser oceanic plate descends, re-melts in the mantle and joins the convection currents. Magma rises up the fold mountain .e.g. Honshu in Japan was formed from collision of the Eurasian plate and the Pacific Plate. The tongue slab of the descending oceanic plate triggers numerous earthquakes because of frictional drag.

Oceanic and continental plates converge

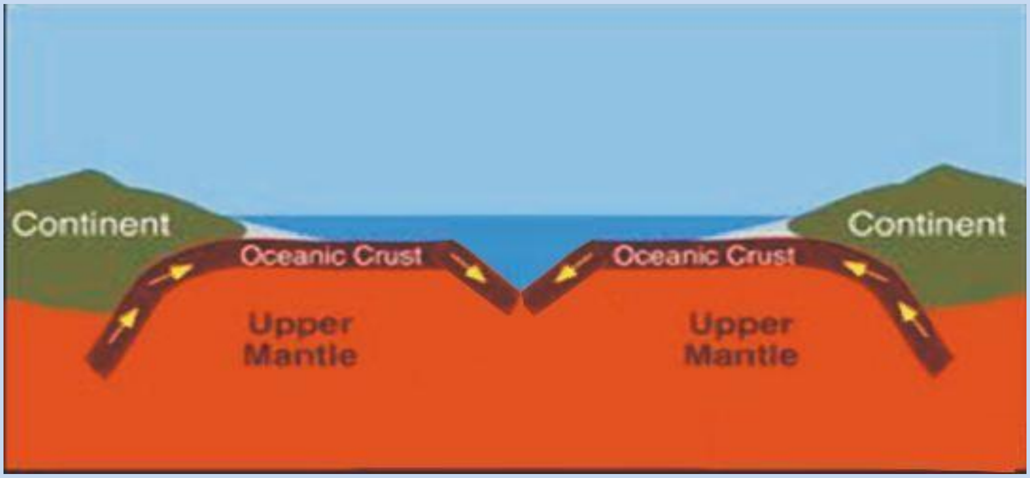


As they sink, they leave behind an oceanic trench at the surface of

(iii) <u>Third Effect.</u>When two oceanic plates converge, they descend, since both are dense plates.

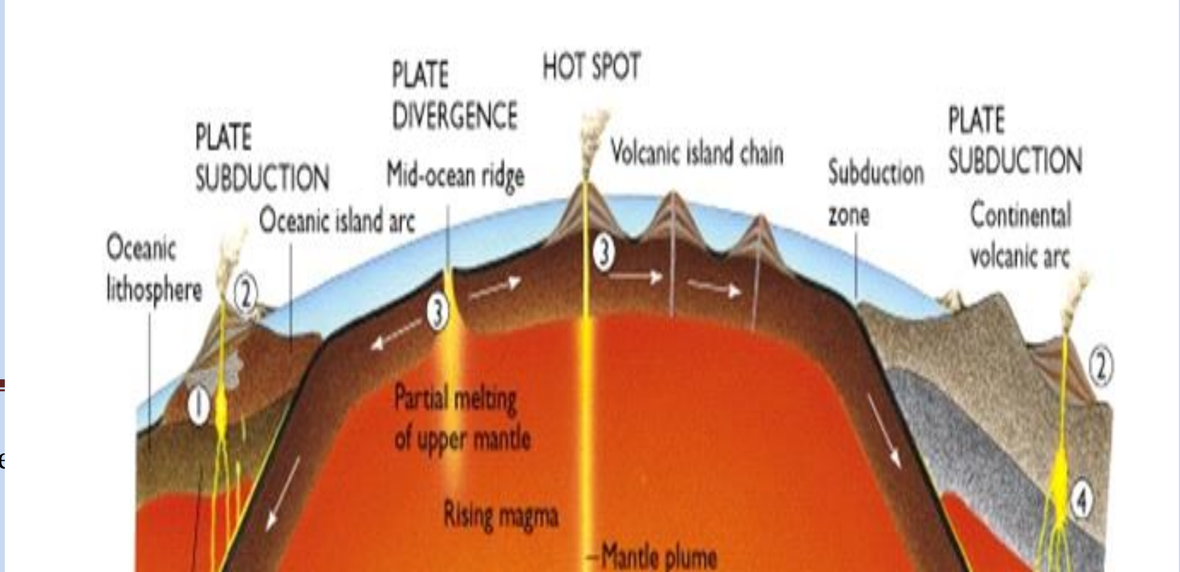
Refer to the diagram below as you read this description.

Diagram showing two oceanic crusts converging



As the oceanic plates sink, they leave behind an oceanic trench at the surface of the crust e.g. the Tonga Trench formed from the collision of the Pacific and the Indo-Australian Plates. Another example is the Marianas Trench (Paralleling the Mariana Islands). It marks an area where the fast moving Pacific Plate converges against the slower-moving Philippines Plates.

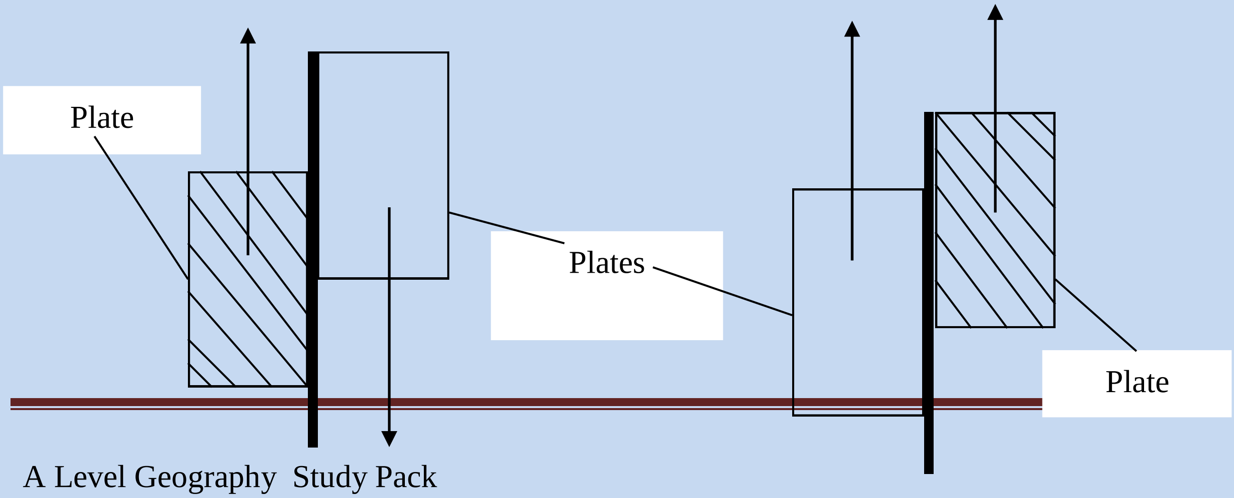
Oceanic to oceanic crust convergence also results in volcanoes. The erupted lava and volcanic debris pile up on the ocean floor until what is known as a submarine volcano rises above sea level to form an <u>island volcano</u>. Such volcanoes form a chain known as <u>island arcs.</u> They run parallel to the trenches and are generally curved.
Study the diagram below.



(c) **<u>Transform or Neutral Boundaries or Transform Fault Boundary or Conservative Plate Margins</u>**

Two plates slide pasteach other in opposite directions.Quite often mantle currents moving in the same direction at different speeds or in opposing directions may cause lithospheric plates to slide past each other along a tear.(wrench or fault.)

Most transform faults are found on the ocean floor. They very often offset the active spreading ridges, producing zig-zag plate margins, and are normally characterised by shallow earthquakes. However, a few transform fault margins are found on land e.g. the San Andreas Fault Zone in California, which is the most well-known (and most deadly) translational interface. As the two plates slide past each other, a great deal of frictional coupling occurs. Sometimes the plates get locked in some local region and a great deal of strain energy is stored in that region. Eventually, the strain energy builds up to the point where it is suddenly released creating a large scale earthquake.



Fault or Tear or Wrench

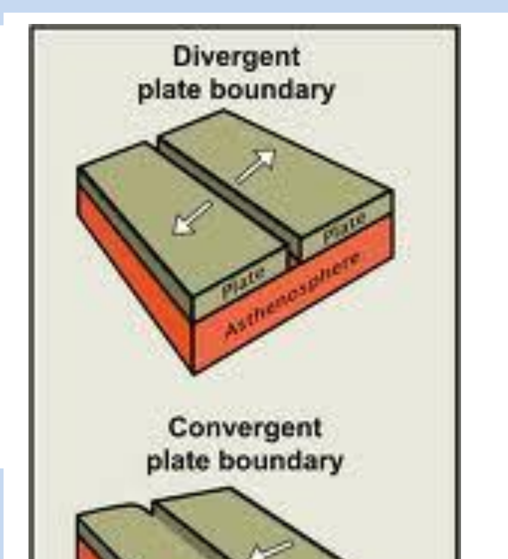
Plates sliding pasteach other.

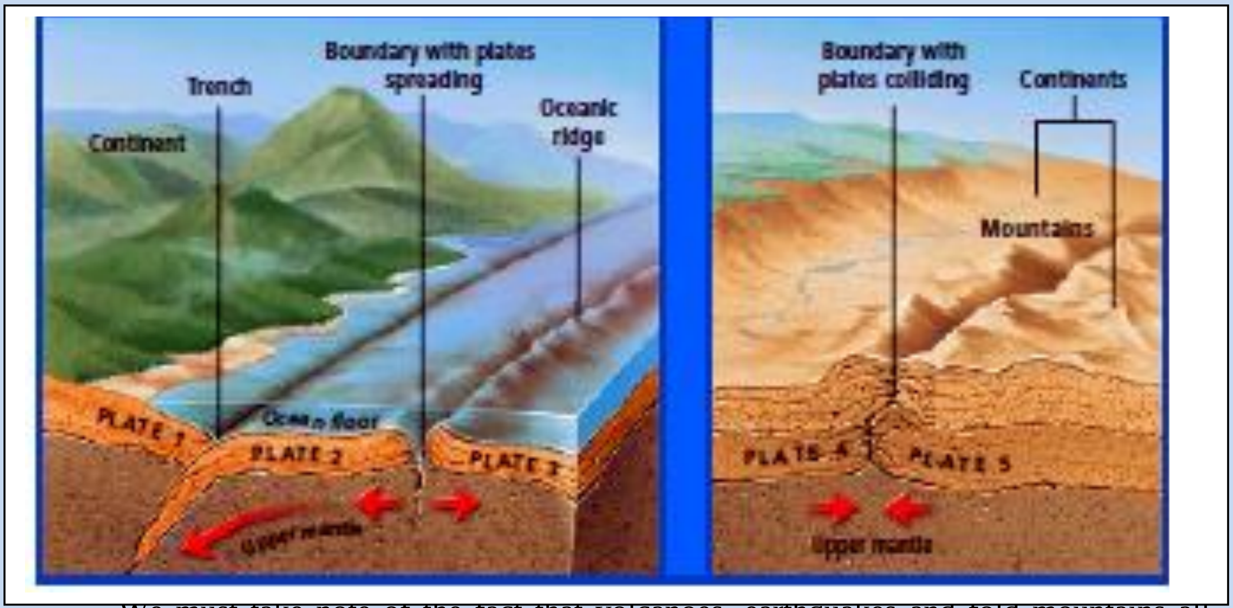
No loss or gain of crystal material is experienced. The diagram on the left shows two plates sliding against each other in the opposite direction. The diagram on the right shows two plates moving in the same direction, but at different speeds so that one overtakes the other.

(d)<u>Plate Boundary Zones</u>

These are broad plates in which boundaries are not well defined and the effects of plate interaction are not clear.

Below is a diagrammatic summary of three main types of plate margins.





We must take note of the fact that volcanoes, earthquakes and fold mountains all occur at active plate boundaries where crystal rock is being formed (i.e. faulting and volcanicity) or where crystal rock is being destroyed (fold mountains, earthquakes foci, ocean trenches and volcanic island arcs.)

2.5 VULCANICITY

"Vulcanicity" refers to all the tectonic processes of intrusion and extrusion of molten mantle material into and/or out of the earth's crust, along fault lines.

What causes vulcanicity?

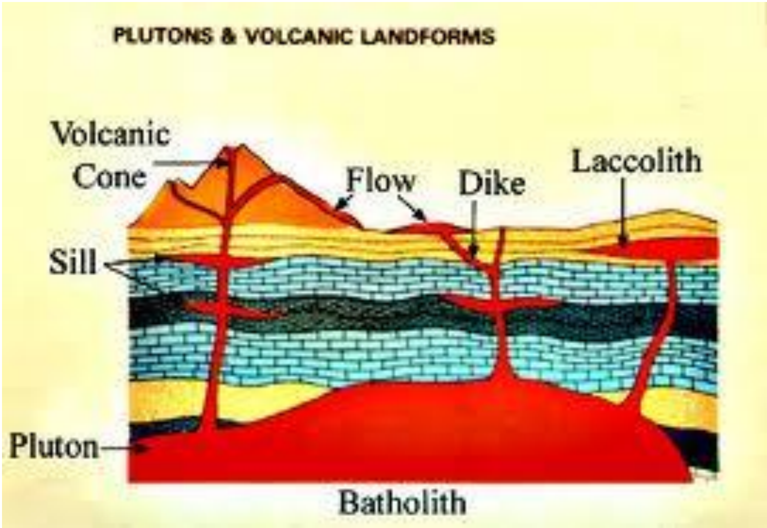
In the mantle, heat and pressure exerted by the weight of the crust, causes rocks to melt into magma which is forced to rise along fault lines.

Types of Volcanic Material

Materials are classified by percentage of silica and gas in them. This composition also influences the nature of eruption i.e. effusive (oozing out) or ejection (violent). Basically, materials are lava or pyroclast. Lava comes from liquid magma with plenty of gas. Pyroclast comes from solid pieces of lava, ash and rocks.

Volcanic Landforms

Study the diagram below. It shows extrusive and intrusive volcanic features. Intrusive features do not appear above the crust, they form inside. Extensive features form out of the crust.



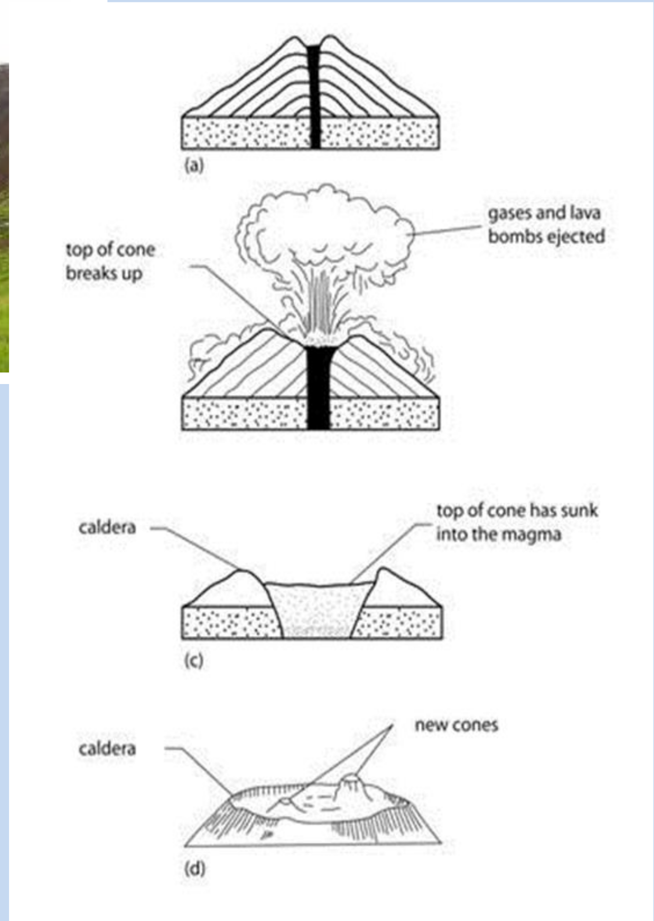
Types of Volcanic Extrusive Landforms

Explosion Craters

Violent lava eruptions of gases blow off the top of a volcano creating a large 'u' shaped depression at the top. The structure is called a crater.

Caldera

The crater may subsequently subside or be blown off extending in diameter, thus creating a caldera. When water fills the caldera, a caldera lake is formed.

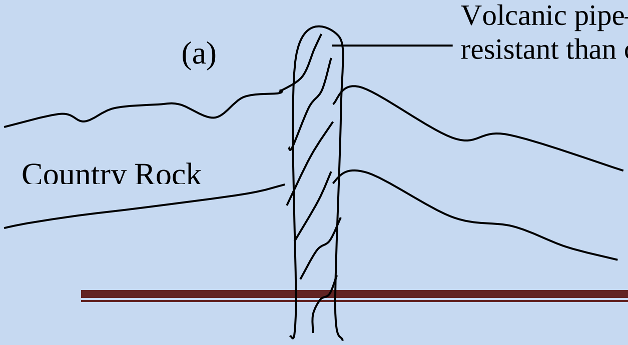


Volcano Pipe

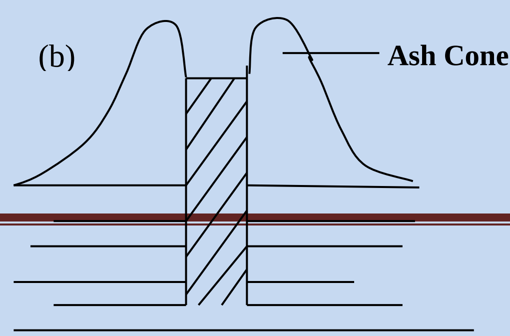
This is the vent that feeds lava to the crater of a volcano. When the volcano is eroded, the pipe sticks out if it is harder than the surrounding rock. If the pipe is softer, it will get worn away faster, leaving a hollow which may feel up with water to form a lake e.g. lake Xan in Botswana. Volcano pipes are rich in diamonds e.g. Shinyanga Pipe in Tanzania.

Study the diagrams below. They show other types of landforms

(a)

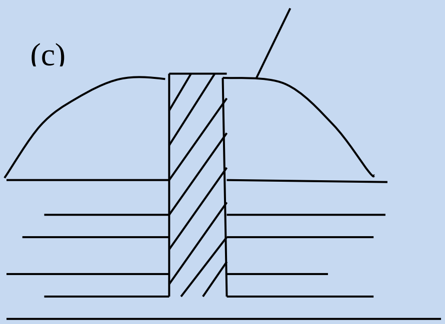


(b)

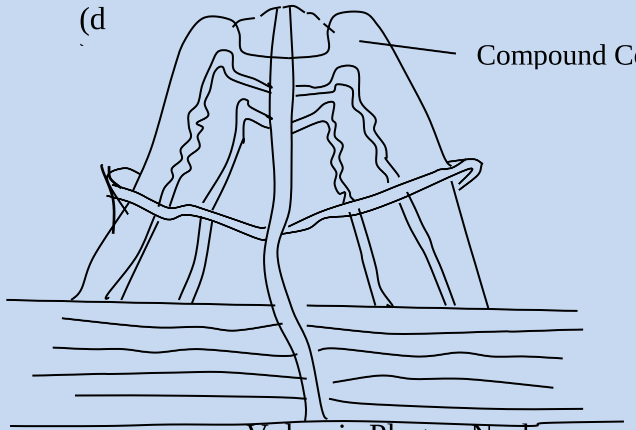


Silica lava dome

(c)

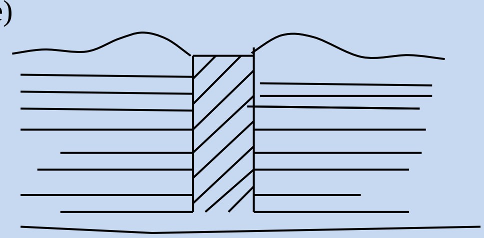


(d

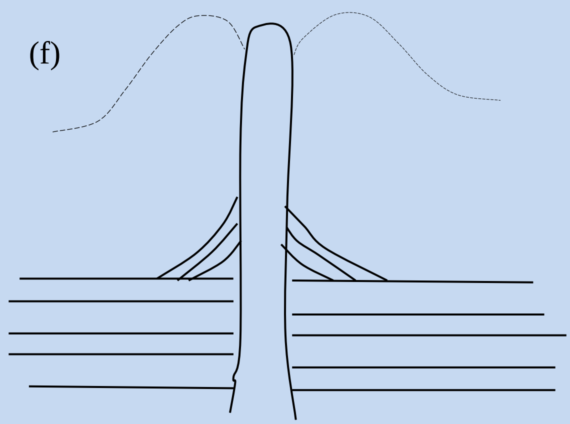


Basaltic lava shield

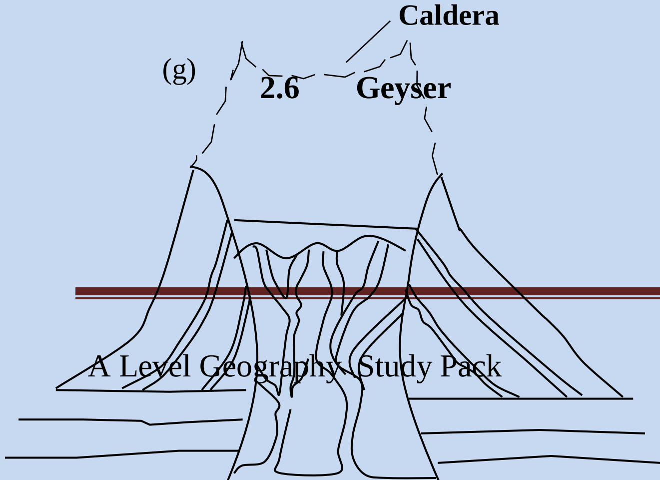
(e)



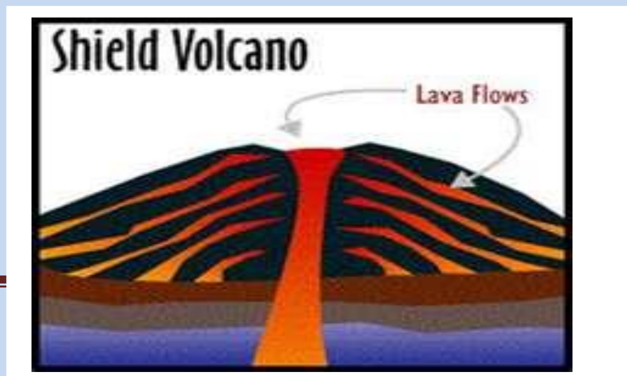
(f)



(g)



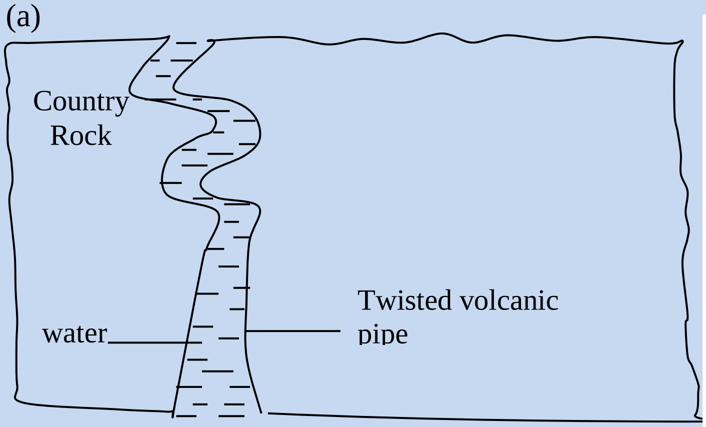
2.6 Geyser



This is a hot spring that ejects hot water and steam into the air either at regular or irregular intervals. Superheated steam below the volcanic pipe builds up pressure, expands and forces hot water into the upper parts of the pipe to be violently sprayed into the air.
Study the diagrams drawn below

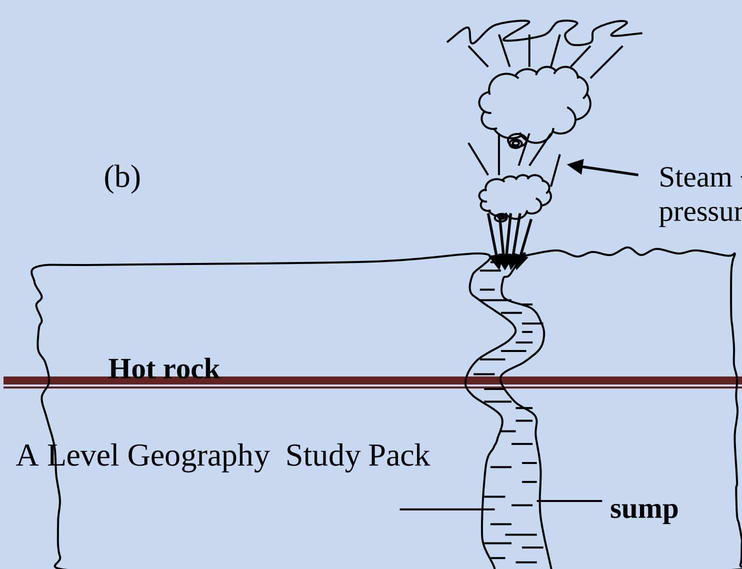
Formation of a geyser

(a)



(i) Hot country rocks heat water trapped inside long narrow twisted pipe.
(ii) Pockets of steam from superheated water below pipe gather in the twisted pipe.
(iii) Superheated steam builds up enough pressure.

(b)



Steam + boiling water shoot out until pressure goes sufficiently down

iv) sudden expansion of superheated steam forces the water into upper pipe.
v) Pressure forces water to shoot through top opening of pipe with violence

Hot Springs

These are springs of water seeping from th ThehuvolcaIcelananLubimb Zimbabwe.

Fumaroles

These phenomena are small vents which puff out sulphur fumes (gaseous sulphur) and steam. They are a common sights in New Zealand National Parks and are associated with volcanic activity.

Cycle of a volcano

There are usually three stages through which volcanoes pass.

(a) Eruptions are frequent during the early stage. The volcano is said to be active e.g. Mt Cameroon and Nyiragongo.

(b) Later the eruptions become less frequent. The volcano is said to be sleeping or dormant e.g Mt Kilimanjaro and Katimandu.

(c) There is a long period of inactivity. If a volcano has not erupted in historic times, it is said to be an extinct one – e.g. Mount Nyangani and Mt Everest.

The advantages of volcanoes

(a) Some volcanic material e.g. volcanic pipes are rich in minerals

(b) Craters and other volcanic similar structures may fill up with water to form natural lakes with all their attendant advantages.
(c) Geothermal electricity can be trapped from geothermal heat.
(d) Educational tours for research and experimentation can be conducted at volcanic locations.
(e) Hot springs provide healthy natural baths and energy for cooking
(f) Volcanic mud flows eventually rejuvenate the soil and provide better, richer agricultural land. Volcanic soils are also a source of scenic floral beauty.
(g) Sight–seers and natural aesthetics seekers flock to the beautiful landscape made by molten rocks and mud flows (pyroclastic materials)
(h) Volcanic areas bring in tourism, jobs and their downstream industries e.g. showbiz, dance shows, hotels, restaurants, airports etc.
(i) Lavas called Perlite can be heated in furnaces. They can be made into light concrete.

Disadvantages of Vulcanicity

(a) Active volcanoes may destroy vegetation, houses, animals, infrastructure, marine life, people etc.
(b) Volcanic eruptions create a terrible, unbearable heat wave.
(c) Volcanic eruptions cause acid rain
(d) Settlement land and farming land can be minimised
(e) Volcanic eruptions can cause flooding and this can cause diseases.
(f) Volcanoes can act as climatic barriers
(g) When volcanoes destroy expensive infrastructure and capital goods, they cause massive loss of profit which may cost many years to be recovered.
(h) Transport and communication may be blocked
(i) Food and cash crops may be destroyed.

2.7 EARTHQUAKES

Remember volcanic activity and earthquakes are closely knit phenomena.

Definition

(j) An earthquake (also called a quake, tremor or temblour) is the sudden release of energy in the earth's crust creating seismic waves

(ii) An earthquake is the trembling, shaking or vibration of the earth resulting from internal earth movements such as faulting and folding. Earthquakes can also come as a result of destruction and re-melting of crystal rock in subduction zones.
From definition (i) above, seismicity or seismism or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time. Seismometers are used to measure earthquakes. One type of seismometer called the

Moment Magnitude is the commonest scale used to measure earthquakes with a magnitude of about 5. Such readings are reported globally. The Richter scale is used to measure and record nationally any earthquakes smaller than 5 on the first Moment Magnitude. The two scales are numerically similar over their range of validity. As of March 2011 a 9.0 magnitude earthquake was recorded in Japan. It was the largest since records were taken in Japan. Intensity of shaking is measured on the Mercalli scale. Generally, the shallower the earthquake is, the more damage it causes (all else being equal). At the earth's surface, earthquakes show themselves by shaking and sometimes by displacement of the ground. When the epicentre of a large earthquake is located offshore, the seabed may be displaced sufficiently to cause a tsunami. Earthquakes can trigger landslides and sometimes, volcanic activity
.

2.8 CAUSES OF EARTHQUAKES

In a very general sense, earthquakes refer to any seismic event which may be caused by human beings or occur naturally. In most cases they are caused by rapture of geological faults, volcanic activity, landslides blasts, nuclear tests etc. We shall get into details when we come to deal with earthquakes under the broad topic of HAZARDOUS ENVIRONMENTS. Below, we list some more causes, but one point we would like to emphasise is that the focus or hypocentre of an earthquake is its point of initial rapture. The epicentre on the other hand, is the point at ground level directly above the hypocentre.

(a) Faults

By adjusting to internally built up stresses, by releasing some of the stress through faults or lines of weakness.

(b) Volcanic Activity

Magnetic intrusions into country rock disturbs rock alignments, triggering tremors as rocks adjust to new pressures and weight deposits.

Collision of Plates and Formation of Folds

When plates converge at plate margins or rocks fold as a result of tectonic activities, tremours and quakes may develop.

Friction of Crystal Rocks

Earthquakes are associated with such intense tectonic activity e.g. along the San Andreas Fault in California where plates are either sliding past each other or moving in the same direction but at different speeds.

Dam Construction and Acquifers

Bedrock disturbances occur when adjusting to the weight of dammed water, triggering tremors that can be experienced some distances away from the site of the reservoir. Also the draining of underground water sources on a large scale, leads to tectonic re-adjustments.

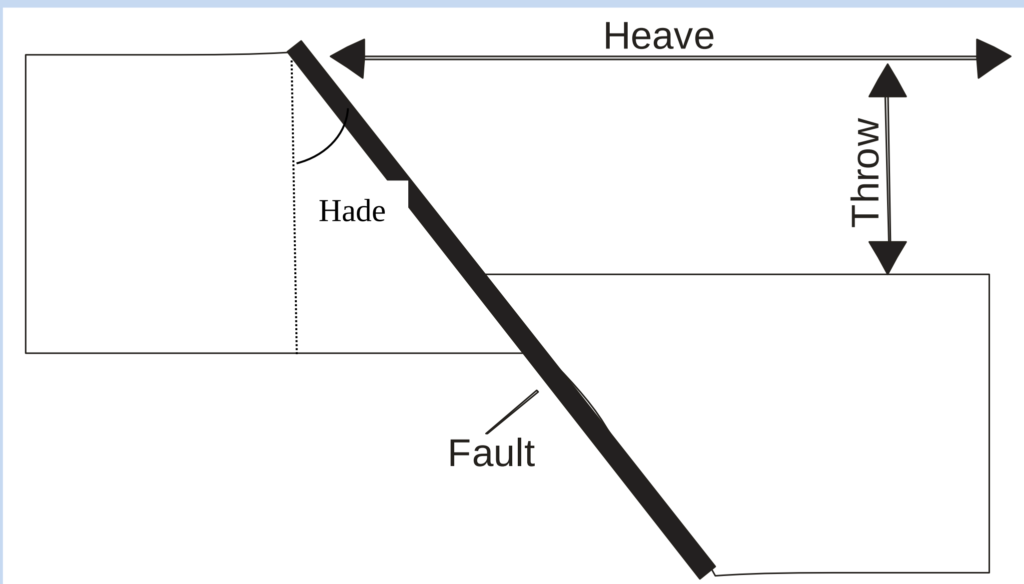
2.9 FAULTS AND THEIR ASSOCIATED LANDFORMS

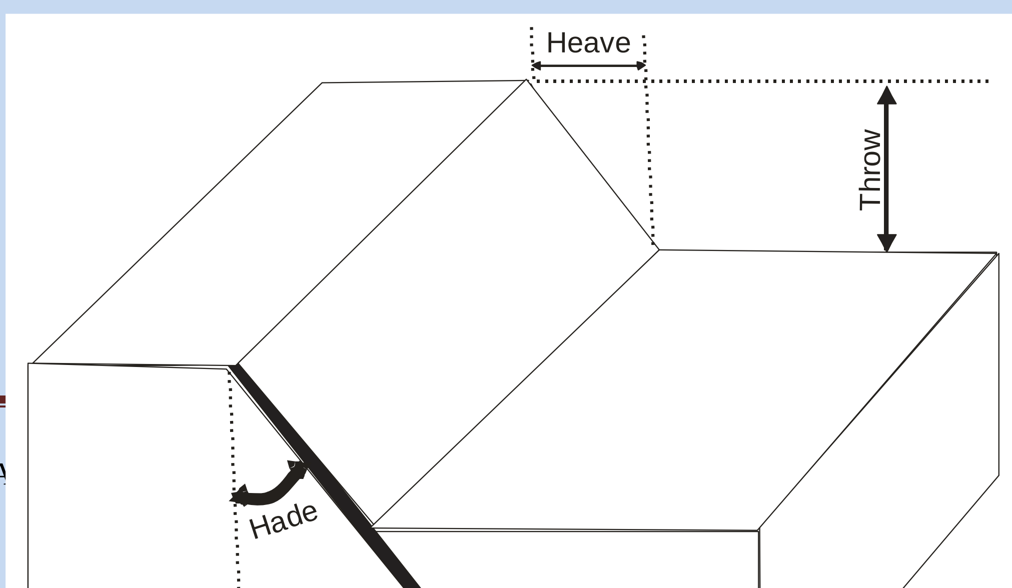
Definition

A fault is a line of weakness or a fracture within the earth's crust. It occurs when rocks have been displaced as a result of tensional (divergent currents) or compression (convergent currents) forces. On the other hand, joints are fractures in crystal rocks of shallow depth where no displacement takes place.

2.10 CHARACTERISTIC FEATURES OF A FAULT

Study the diagram shown below





(a) Heave - the forward horizontal displacements of the rock layers
(b) Throw - the vertical displacement of rock strata to give different tilts
(c) Hade - the angle of displacement of faulted rock beds. (e.g.
(d)
(e)
(f)

(a) Heave - the forward horizontal displacements of the rock layers
(b) Throw - the vertical displacement of rock strata to give different tilts
(c) Hade - the angle of displacement of faulted rock beds. (e.g. 30° – 45° in a normal fault)

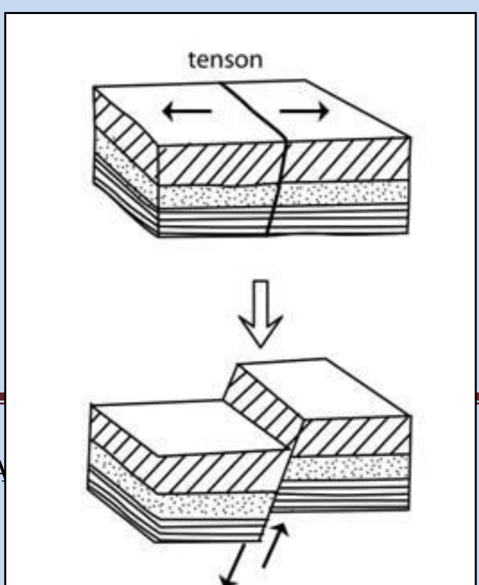
2.11 TYPES OF FAULTS AND STRUCTURES CREATED BY FAULTING

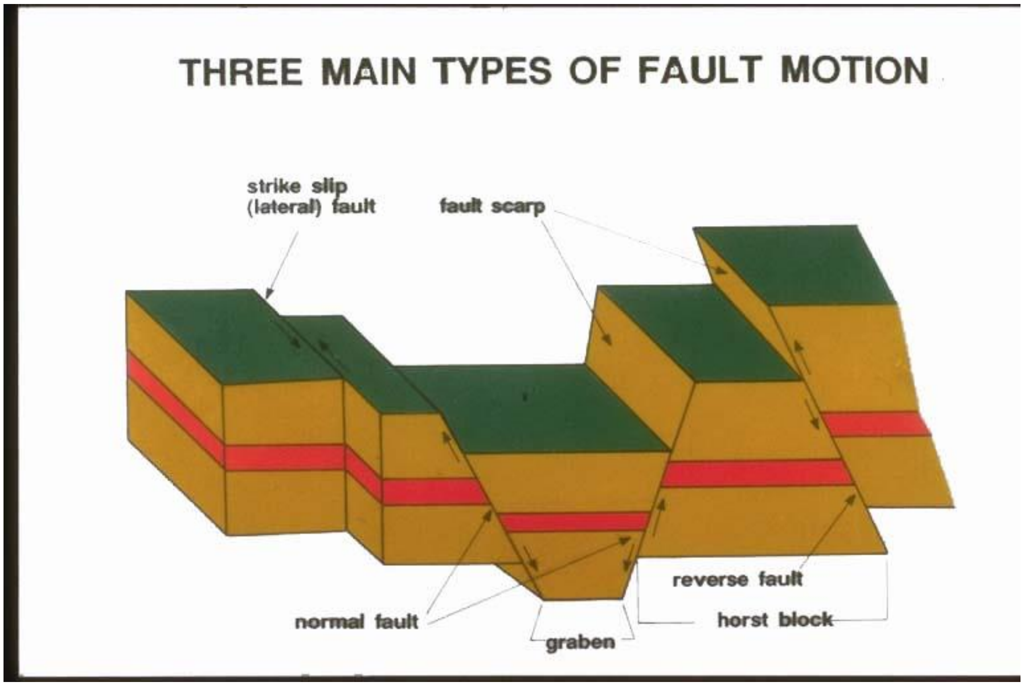
Read through the following descriptions carefully and study the diagrams with care.

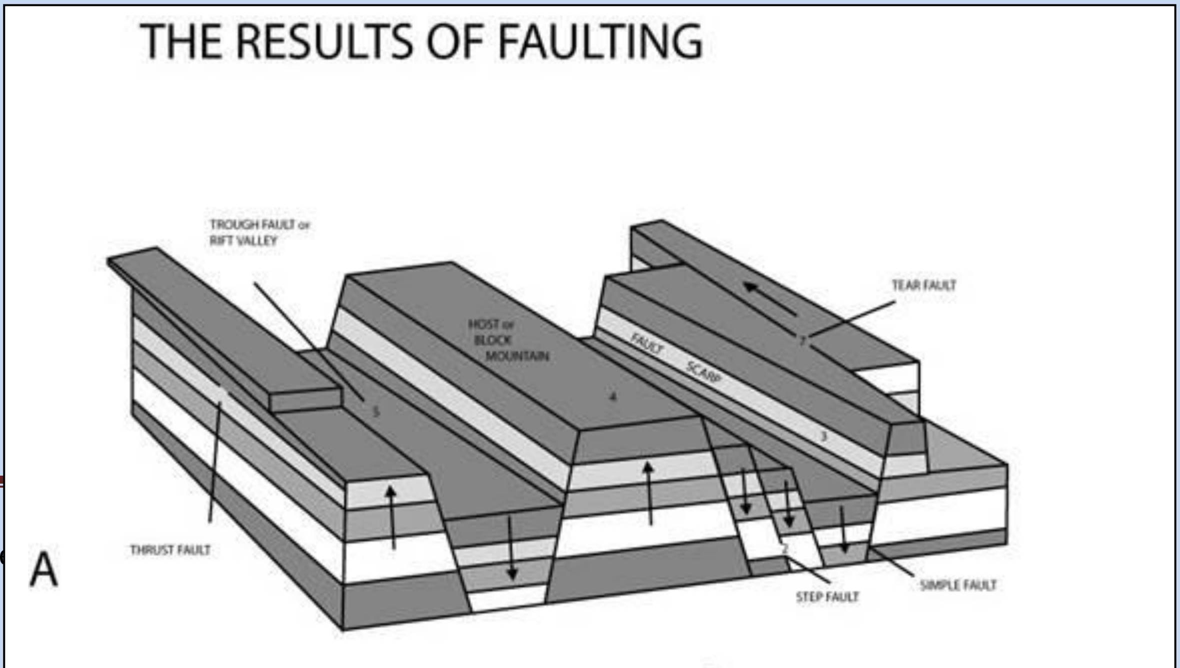
NORMAL FAULT

This results from tension forces. If the rocks are under tension, faults will be formed. Extensive displacement occurs. Movement occurs down the dip of the fault plane. Strata is forced apart while one side is pushed down. A fault scarp may be produced through the upward block. Normal faults are common in East Africa.
A rift valley may result. See diagrams below.

Normalfaults



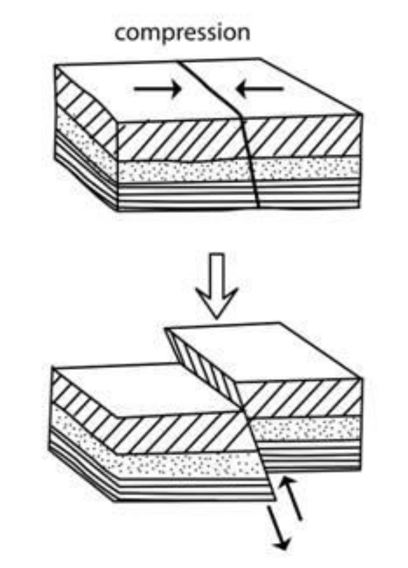

THREE MAIN TYPES OF FAULT MOTION
strike slip
(lateral) fault
fault scarp
normal fault
graben
reverse fault
horst block


THE RESULTS OF FAULTING
TROUGH FAULT or
RIFT VALLEY
HOST or
BLOCK
MOUNTAIN
TEAR FAULT
FAULT SCARP
THRUST FAULT
STEP FAULT
SIMPLE FAULT
A

REVERSE FAULTS

These are also known as thrust faults and are caused by the forces of compression. When the strata or layers are compressed or pressed together, the rocks will crack and faults will be formed. One block of rocks may override another sometimes depressing it. A rift valley or a block (horst) mountain, may also develop. Because strata tend to overlap, the surface area decreases.

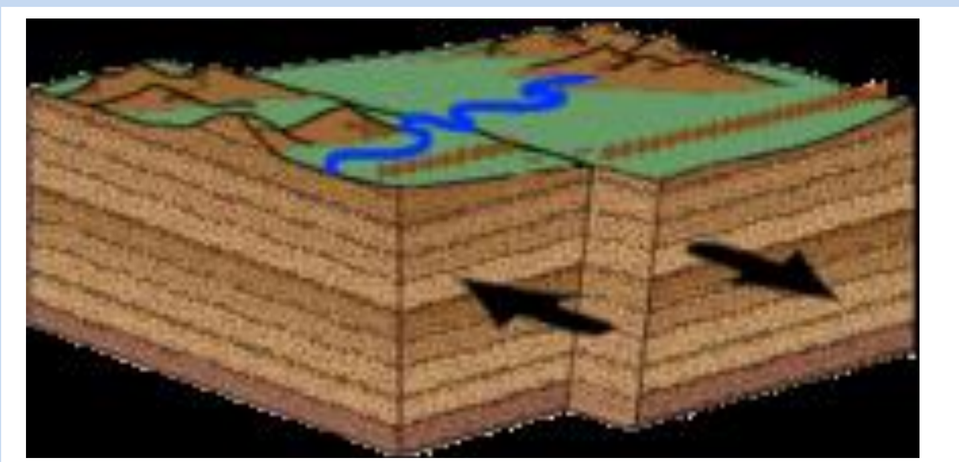
Such faults are common in western Uganda. The Ruwenzori Mountain is an example of a block mountain formed by thrust faults.



TEAR OR TRANSFORM AND TRANSCURRENT FAULTS

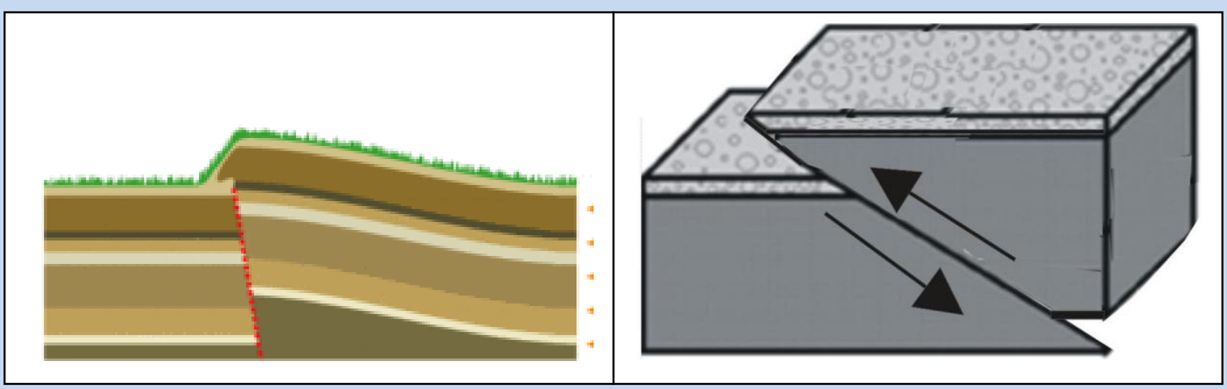
.

Tear faults are also known as wrench or transform faults.When lateral movement is taking place particularly during an earthquake, tear faults may occur. Displacement of blocks is horizontal without vertical movement.. Such faults are associated with earthquakes and they are located at the margins of plates.
If a tear fault occurs across the course of a river, then the river's course may be slightly offset.



OBLIQUE FAULT

Displacement is both horizontal and vertical with one block over- riding the other. See diagram below.



FAULTED LANDFORMS AND LANDSCAPES

Thrust faults

These are faults which are localised low-angle compression faults which cause one block or crystal rock to over-ride another. They are common in intense folded strata.

Slicken sliding fault

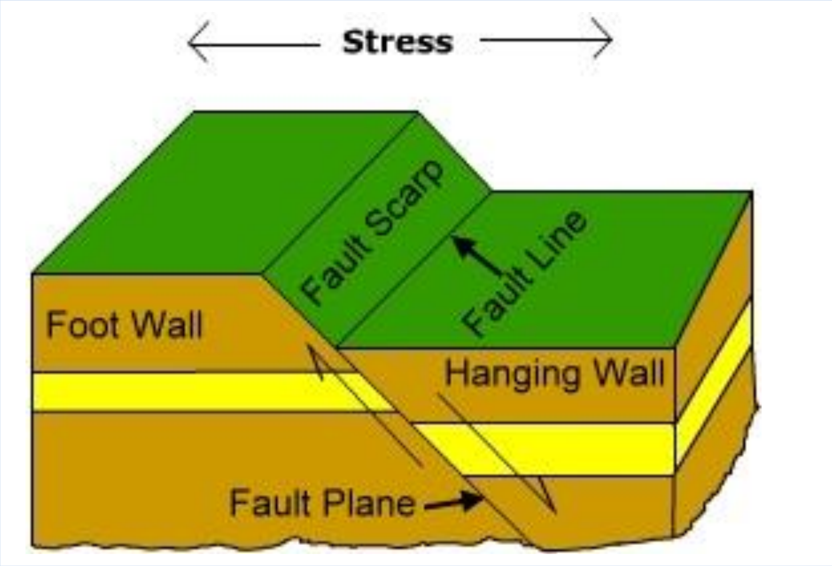
This is a striated or smooth-fault that results from the grinding movement of one fault face against another.

Fault Breccia

These are shattered rock fragments filling up a fault line and they are caused by the crushing of rocks between two parallel faults lying close together.

Fault Scarps

This refers to the slope formed after faulting, and it matches the degree of throw during the faulting process. See diagram below.

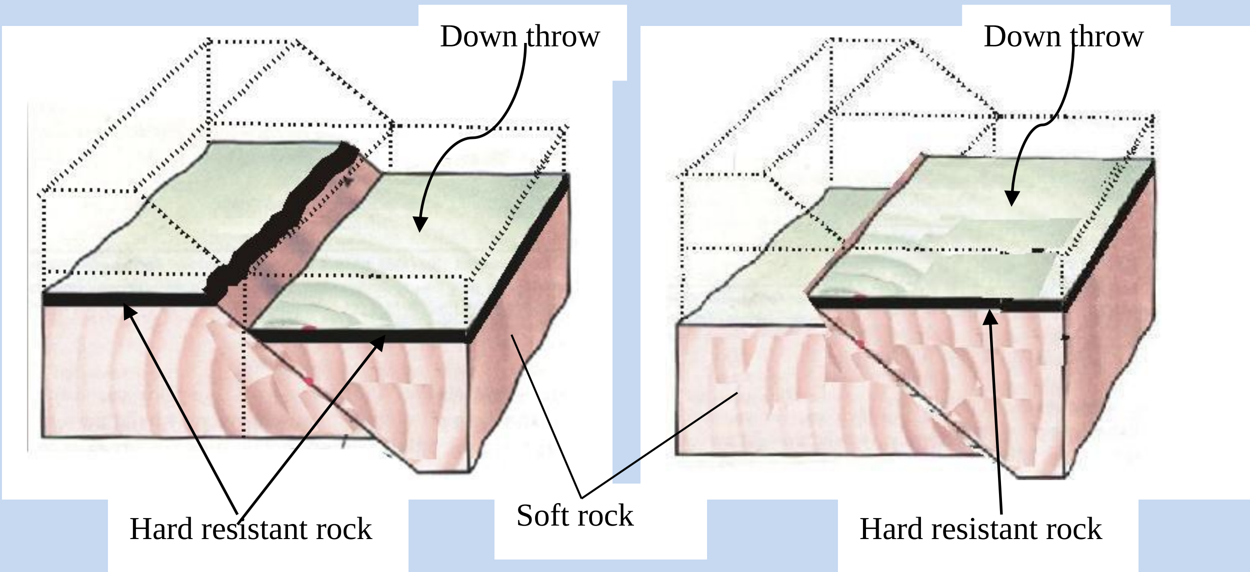


Fault Line Scarp

This refers to what results when faulting brings up rocks of differing resistance to denudation, into juxtaposition. The less resistant rock is eroded first, resulting in an obsequent fault line scarp. (i.e. facing the opposite side of the original fault scarp). Further erosion on the harder rock (though slower), results in the development of a resequent fault-line scarp which faces the same direction as the initial fault scarp.

In simpler terms when the relief features of a true fault scarp are compared with those of a fault line scarp, we find that the difference is a result of erosion due to the presence of hard resistant rock and weak rock.

Study the diagrams shown below.



Fault Line Scarp

The dotted lines at the top of each diagram show that the two diagrams were,at the beginning, equal in all respects i.e. in size, shape, where their scarps were facing (to the right) and in substance composition.. There was only one difference nevertheless.The diagram on the left, had two belts of hard resistant rock at its top whereas the diagram on the right had only one, as shown. Now, after years of erosion and denudation, each feature appears as shown in the diagrams above. The heights of both diagrams have been reduced downwards .and the space inside the dotted lines indicates the volumes of soil material lost by erosion. During the process of erosion, the soft rock wore down first and faster than the hard resistant rock resulting in the diagram on the right having an obsequent fault line scarp (i.e.the scarp facing the opposite side of the original fault scarp).The diagram on the left has resulted in thedevelopment of a resequent fault-line scarp (i.e. a scarp which faces the same direction as the initial fault scarp.)Further erosion on the harder rock on the feature on the right, (though slower), results in the development of a resequent fault-line scarp which faces the same direction as the original fault scarp.

Fault Splinters

These are created when faults do not develop fully. This results in fault splinters which produce low escarpments running only a few hundred metres, then, disappearing.

Step Faulting

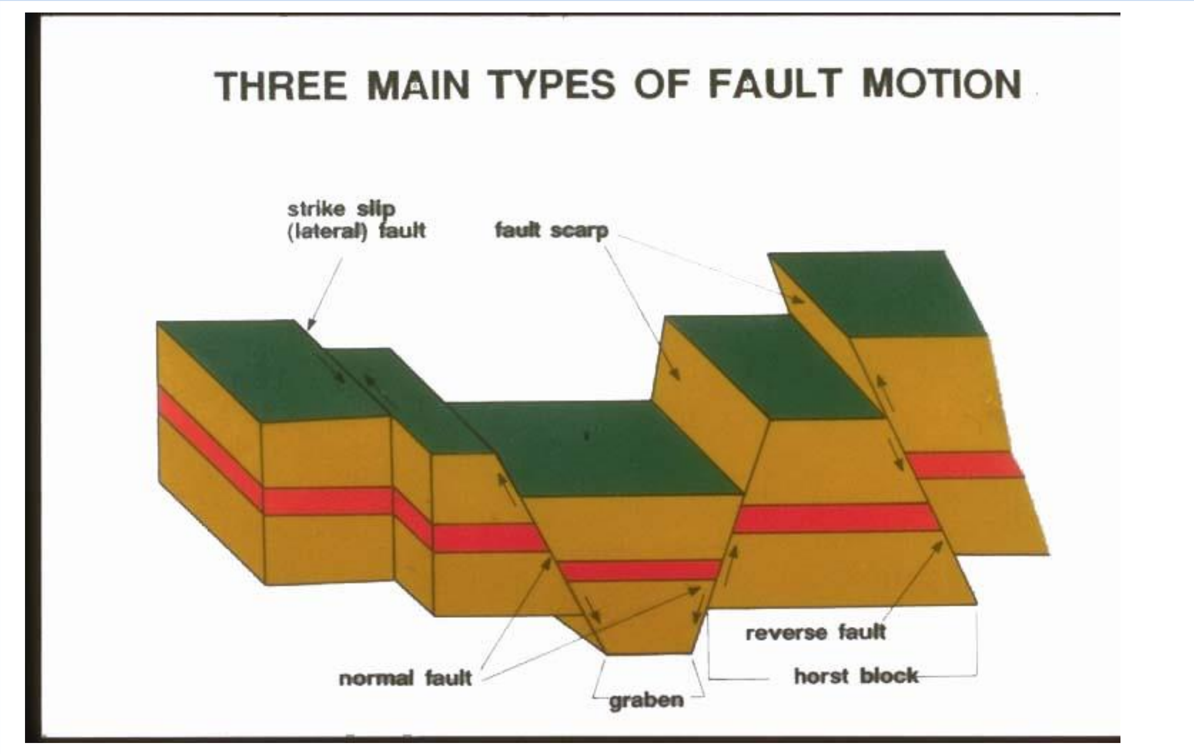
This type of faulting produces a terraced landscape. Tension allows each section between a series of parallel faults to slip down relative to their neighbouring sections, thus producing step faults.

Some more Faulted Landforms and Landscapes

Faulting results in many types of land features. Below is a table that summarises a few features and some examples. After the table, we shall give a few details about some very important features such as the rift valleys.

FEATURE	EXAMPLE
Fault scarps	Glenmore in Scotland and the African rift valley
Block Mountains	Table mountains, CapeTown The Ruwenzori Range
Rift Valleys	African Rift Valley The Rhine

See diagram below.

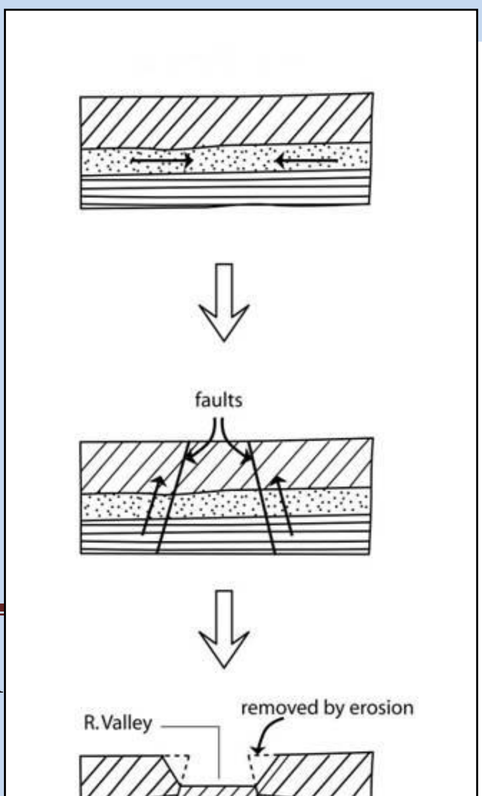


RIFT VALLEYS

The word ‘rift’ means tearing apart. There are two common theories which explain how rift valleys were formed e.g. The Great African Rift Valley.

(a) Rift Valley formation due to compression and tectonic forces

Study the diagram given below



Theory 1. Compression forces

a) Layers of rocks are subjected to compression forces.

b) Faults develop and the outer blocks move upwards (Reverse faults are formed).

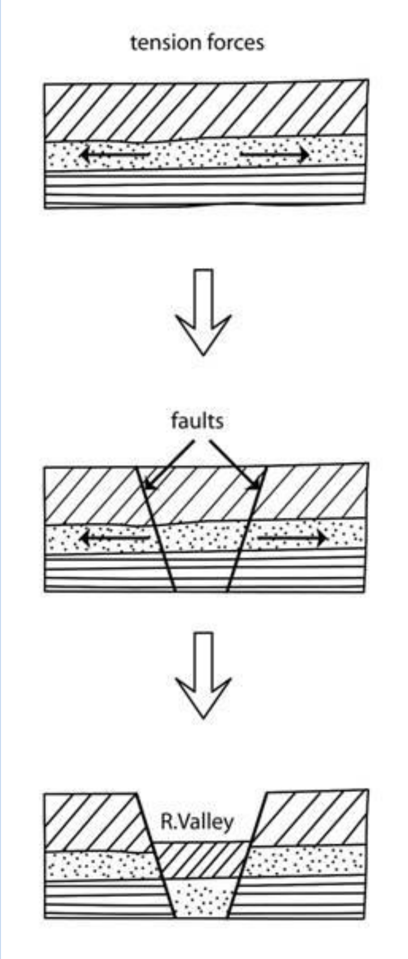
c) Central block stays in place and a rift

A

Compression forces may force the central block to be over-ridden by the two blocks on either side, thus creating a garben or rift valley at the centre. All the three blocks of fractured land may be rising, but the central block is overwhelmed by the compression–forced limbs at the sides. The angular hanging cliffs are later modified by denudation due to erosion.

(b) <u>Rift Valley Formation due to Tensional Tectonic Forces</u>

Study the diagrams given below



Theory 2: Tensional forces

a) Tension forces act on the layers of rock.

b) Gradually two faults appear and the central block begins to subside (sink).

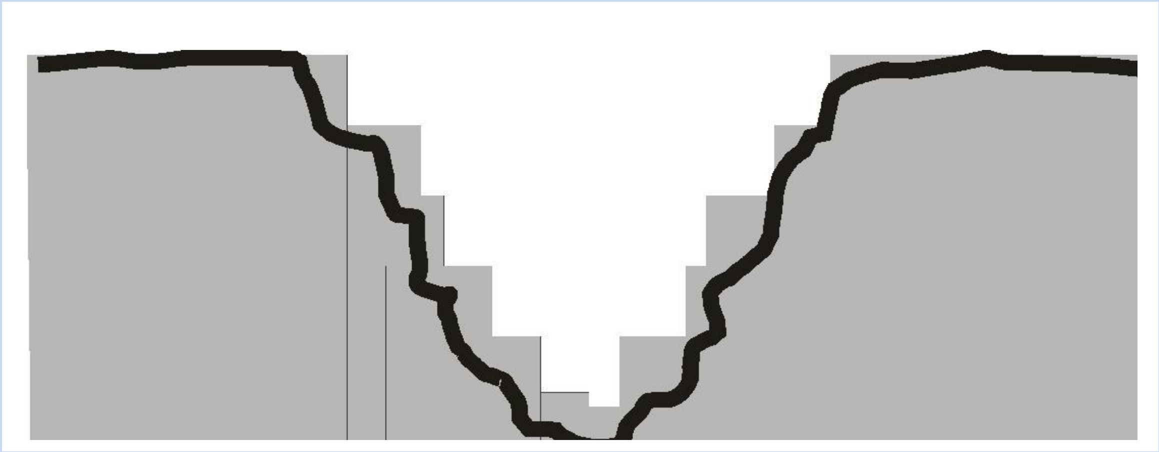
c) Land in between sinks in forming a rift valley. The land on either sides stays in place. After subsidence a depression with steep fault scarp sides i.e. a rift vallev is formed. I

Tensional forces may pull the outer blocks upwards and outwards such that the central block slips downwards creating the rift valley.

Rift valleys are not peculiar to continents only but to ocean basins as well. In oceans they are soon filled up with sediments which form folded features after getting compressed.

STEPPED RIFT VALLEY

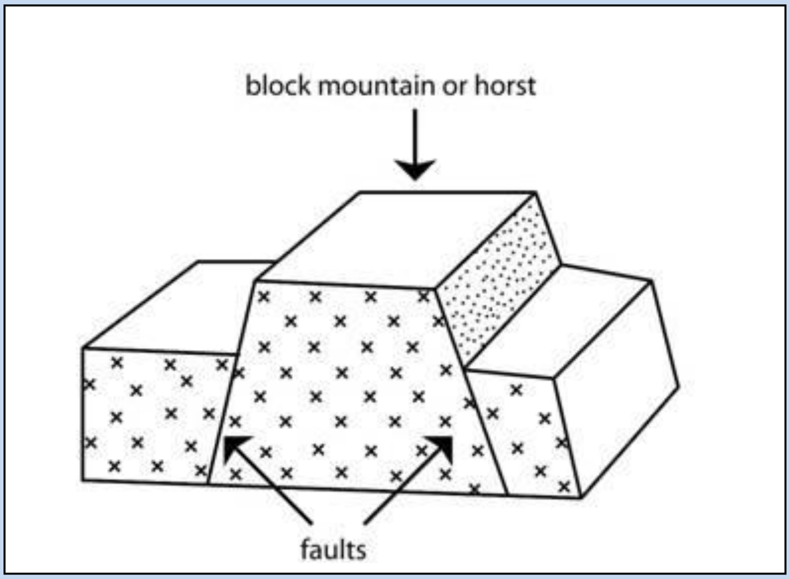
This type of faulting produces a terraced landscape on both sides of the rift valley as shown inthe diagram below.



Stepped rift valley

BLOCK MOUNTAINS

Tensional stresses, with upwelling mantle currents, may give rise to the central block and the stretching downwards of the side land masses to create a host block mountain e.g. the Ruwenzori Range in the western arm of the Great East African Rift Valley. Study the diagram below



FAULT- GUIDED DRAINAGE

Fault lines may cross one another to create grid-faulting. These lines develop natural waterways and produce a rectangular drainage pattern.

Waterfalls

Plunge down fault scarps in uplifted landscapes along normal faulted rocks,form natural gradients and water courses for water to flow downwards.These falls are very spectacular e.g. the Victoria Falls and Niagara Falls.

Lakes

These are natural or man-made large water reservoirs. They may develop naturally where, in reserve faulting, the lower part of the river is raised and the original course is thus obstructed (reserved), creating a mountain side lake in the former upper reaches of the river, now downthrown. One of the largest man-made inland lakes, is the Kariba, dammed across the mighty Zambezi River.

2.12 RIVERS IN FAULT SHATTERED ROCKS

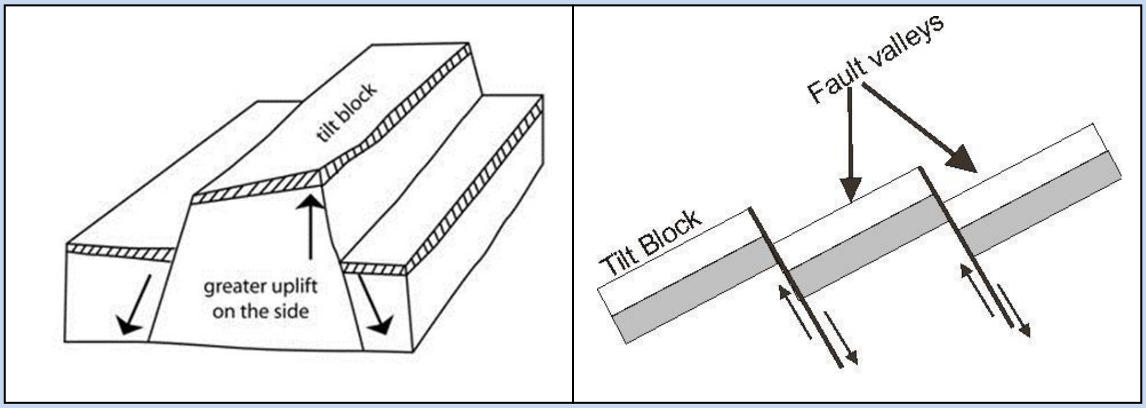
Such rivers carve fault-guided valleys which are long and straight. Examples are the Batoka Gorge along the Zambezi River below the Main Victoria Falls. The gorge is partly a result of rock fracturing by a number of intersecting faults.

Rift faulting may form an enclosed basin resulting in a lake of rivers which flow into the basin.

Tear faulting may offset the original course of a river at the point where it crosses the tear fault.

TILT BLOCK LANDSCAPE

Study the diagram below

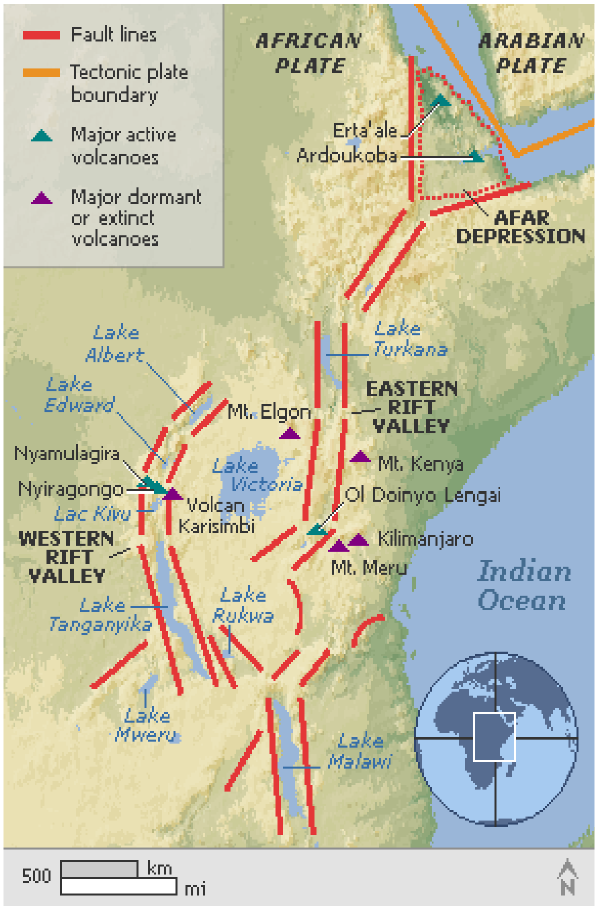


This landscape is also known as the "basin and range country". A series of tilted blocks may create angular ridges and depressions. These may cover a large part of the landscape e.g. in the western USA.

FEATURES OF THE EAST AFRICAN RIFT VALLEY

This is a great valley extending from the Jordan section to the coastal region of Mozambique at Beira-- a distance of some 7 200 km with 5 600 km lying within Africa itself. Its average width is 50 km and its broad scarp heights reach 600 metres

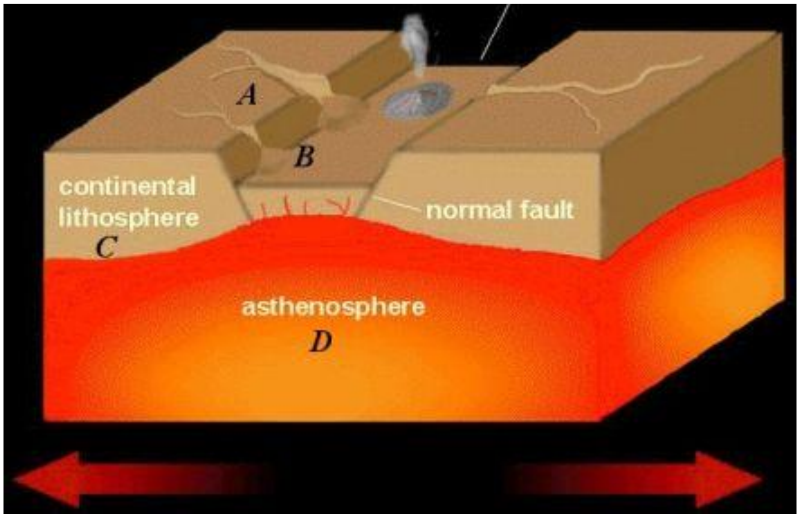
Study the map shown below.



Formation

This can be considered to fall into four main sections. There is first, the Ethiopian rift which extends from the Afar Triangle to Lake Turkana (formerly Lake Kudolf),.Secondly, there is the Eastern Rift in Kenya and Tanzania which are branches in which lie Lakes Eyasi and the Kawirondo Gulf, north-east of Lake Victoria. The third is the western rift extending from Lake Mobutu (formerly Lake Albert) to Lake Tanganyika. Last, is the Malawi Rift in the South, bounding Lake Malawi and the Shire

Valley. This section also includes the Urena Trough of Mozambique and the Luangwa Valley of Zambia.



The origins of the Rift Valley are not very clear because several theories have been formulated. One theory may attempt to explain out a particular section of the valley but never for the whole feature.

In East Africa however, it is postulated that the Rift Valley was formed on a huge up-warped swell or tectonic arc, the central position of which sagged to form the downward region occupied by Lake Victoria, while the flanks over up-warped and faulted to create the western and eastern arms of the rift valley. Thus tensional forces applied in this section of the valley.

2.13 THE EAST AFRICAN RIFT VALLEY LANDFORMS

The whole rift valley system formed by tensional forces is the actual landform. The whole system has branch arms e.g. the central rift valley in Kenya.

There are horst block mountains e.g. Mount Ruwenzori formed by the uplift of rift valley bounding ridges. Some ridges are as high as over 5 000 metres. Mount Ruwenzori lies within the rift valley.
Volcanoes such as Mount Kenya and Kirikiti Basalts are in-fills on the floor of the rift from the fractured valley.

Fault scarps are evident in the valley system. The eastern scarps are gentler, up to stepped faulting, while the massive up throws on the western side are steeper. Thus in cross section, the western parts of the valley would be higher than the eastern part, thus giving the rift valley section a tilted appearance.

There is also evidence of Fault-guided valleys.
Deep, long narrow lakes develop within the rift valley floor due to the confirming bounding fault scarps e.g. Lake Tanganyika. By contrast, Lake Victoria, developing on a basin between the Western and Eastern Rift Valleys, is shallower and broader and more circular. Thus the fractured rift valley permits deepening of the rivers and lakes on otherwise hard resistant rocks, as seen from the perspective of the shallow Lake Victoria. To further confirm this observation, Lake Tanganyika drops to 650 metres below sea level. The deep valleys are straight and steep sided.

Tilt-block landscape is shown by large blocks of the crust which have been tilted and down-faulted in the Triangle on a very large scale. This is particularly observable in the region of the lava fields extending south of Lake Afrera where a tilt block landscape covers several kilometres NNW to SSE. Subsidence has left the summits of the horsts at a lower level than the surrounding plateau.

2.14 TECTONIC LANDFORMS DUE TO FOLDING

Definition

A fold is a crease or dome on the earth’s crust resulting from compression forces

Explanation

Strong lateral compression forces, initiated by converging mantle currents, cause the bending or buckling upwards of sedimentary rocks, resulting in upward ridges (anticlines) and down folded troughs or synclines.

FOLD-GUIDED DRAINAGE AND LANDFORMS

Study the diagrams below

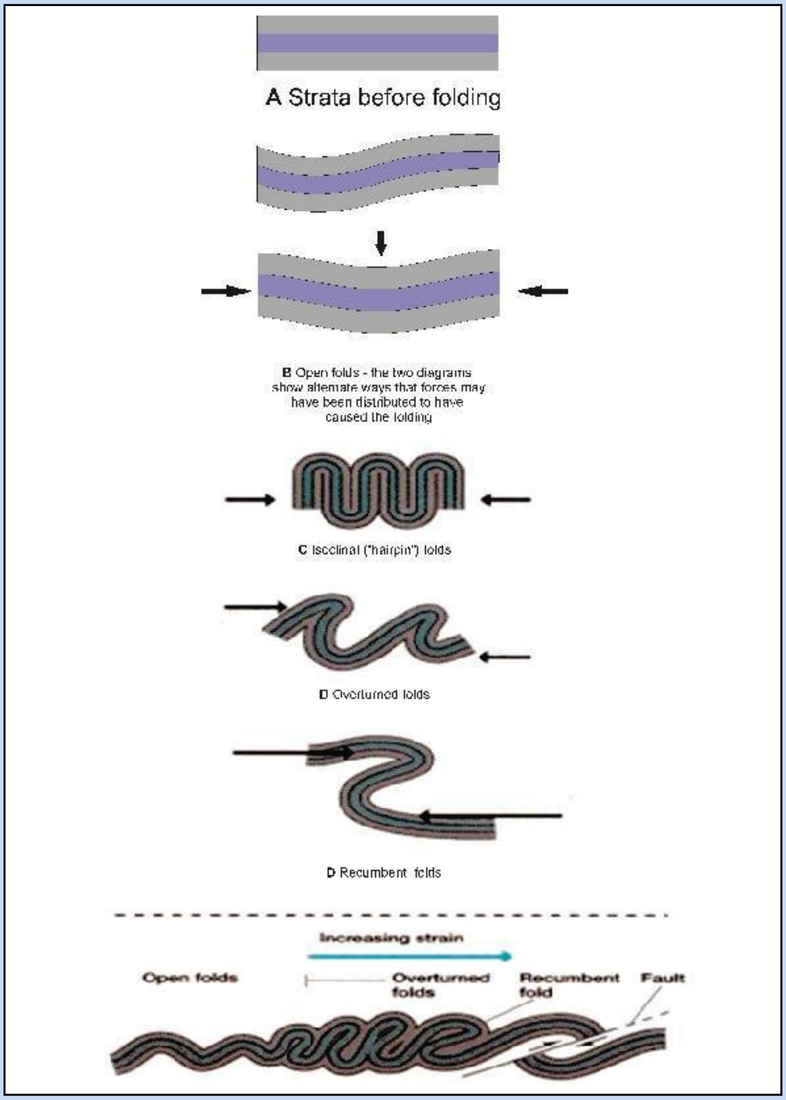
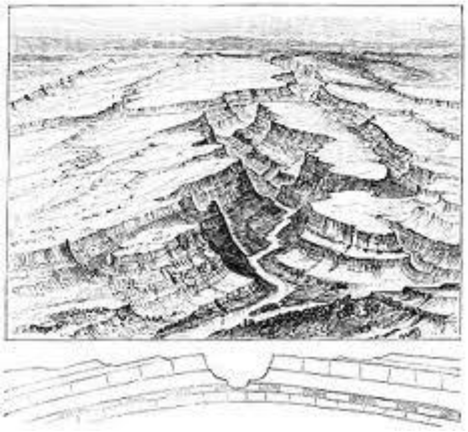


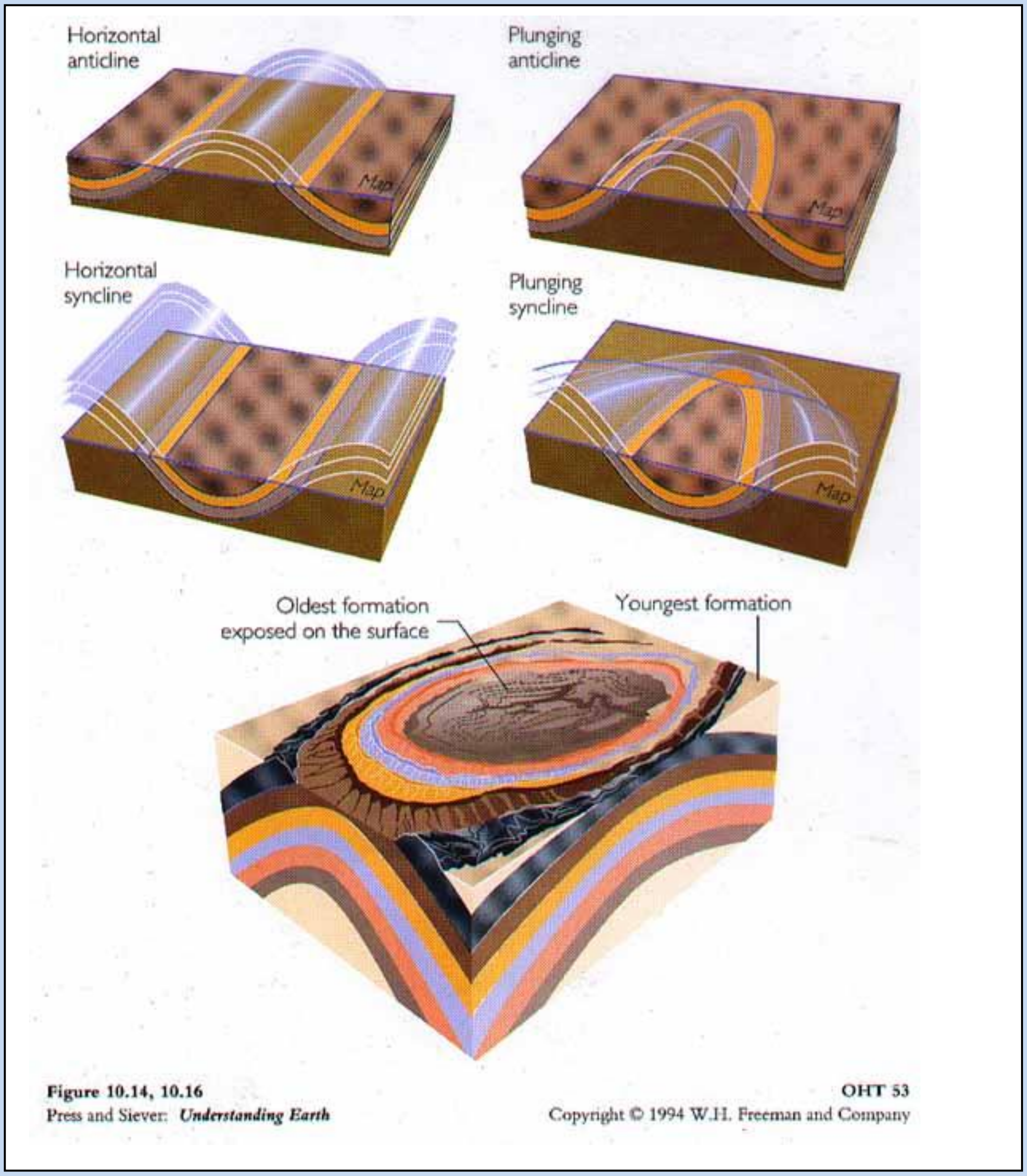
Diagram here

Anti-cline ridge

Anticlinal

Anticlinal Valley

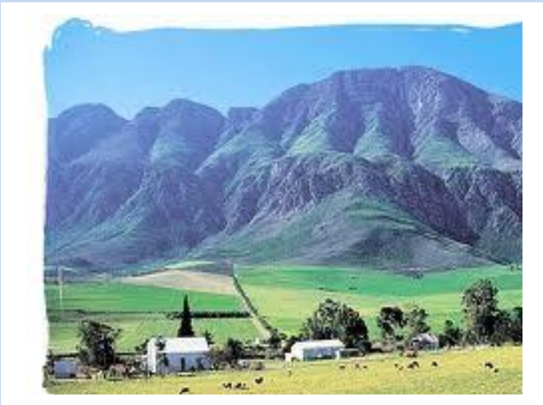




Anticlinal Ridges - up-warping of rock strata forms natural ridge landscapes

(a) Anticlinal valleys - these develop on the weak cresting fold which is quickly worn down, and along the narrow valley, opens up at the summit. Discordant drainage results.
(b) Synclinal Mountain - continued wearing down of the anticlinal rock may cause inversion of topography such that the syncline becomes a mountain ridge.
(c) Hornoclinal ridge. This occurs where the strata in a ridge dips in one direction only.
(d) Hornoclinal valley - this is a valley of weak rock (like shale or limestone) in which the layers all dip in one direction only.
(e) Trellis Drainage is a common drainage pattern on a folded strata whereby anticlinal ridges shed water down slope into the elongated synclinal valleys. Thus a parallel drainage pattern in which ridges from watershed separating troughs or furrows of parallel streams, develops.
(f) Antecedent Drainage occurs when streams cut through sharply-defined ridges by narrow water gaps. These streams are likely to have existed prior to folding but maintained their courses due to slow up-warping of folded strata or due to rock weakness in the anticlines.
(g) Anticlinorium and synclinorium are structures that develop as a series of wrinkles or smaller folds within large anticlines and large synclines e.g. the Swartberg and Langebert Mountains of the Southern Cape folded belt in S.A.

Swartbergmountains



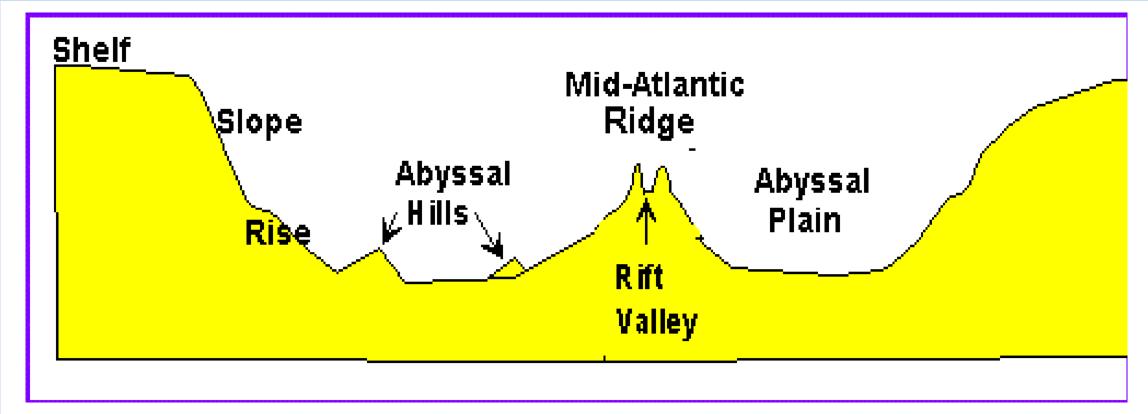
Langebertmountains

2.15 MAJOR RELIEF FEATURES OF THE EARTH

Mention has already been made that the major relief features of the earth are known as the "first order" relief features and they are the continents and ocean basins comprising about 30% and 70% of the earth's surface respectively. The closer actual percentages are 35% and 65% respectively. Since some parts of the continental landmasses are submerged, most of the continental land surfaces are less than one kilometre above sea level. Only Mount Everest rises above 5 km (8 847 metres) in altitude.

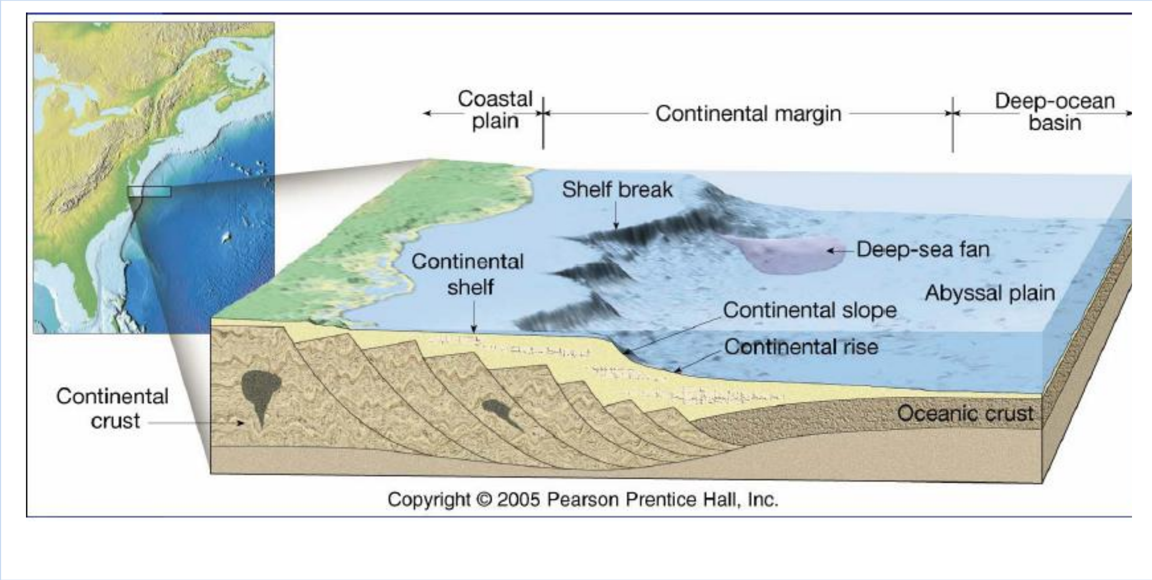
The structure of ocean basins

The most studied ocean basin is the North Atlantic Ocean Basin. The cross section below illustrates a representative profile stretching from the United States to Europe.



CROSS-SECTION OF THE NORTH ATLANTIC OCEAN BASIN FROM THE U.S. TO EUROPE

There are three major units of ocean basins. Refer to the Hypsometric Curve we studied on the above page and the diagram below



(a) **The continental margin** - this area extends from the coastal beaches into the ocean depths for about 3 700km offshore. It is made up of the following:

(i)Continental shelf, which is a fairly smooth sloping plain (120–160 km) wide and reaching a depth of 180 metres at its outer edge. The shelf is a zone of deposition of sedimentary rock layers transported by streams and spread over the sea floor by currents. At its outer edge, the shelf abruptly gives way to a descending continental slope.

(ii) The continental slope is dissected by numerous submarine canyons which seem to be a result of eroding streams or turbidity currents (flows of muddy water) produced when storms or earthquake shocks disturb soft sediments at the canyon heads. These flows are denser than sea water, hence they flow swiftly down the continental slope and come to rest on the deep sea floor where sediments have spread broad layers which gradually accumulate to bury the irregular sea floor topography, thus developing an Abyssal plain.

(iii) The continental rise is a greater slope that blends imperceptibly with the true ocean basin floor.

(b) **The ocean basin** floor is composed of :

(i)The Abyssal plain, a broad flat basin at depths of 5 500 metres and

(ii) Sea mounts which are isolated submarine mountains, some of which may be of volcanic origin.

(c) **The Mid-Oceanic Ridge** e.g. the Mid Atlantic Ridge, is at the centre of the Atlantic Ocean. Its topography is comparable to the Rocky Mountain Chain in size and relief but is totally submerged, except for the Azores Islands. It is part of a single continuous mid-oceanic ridge system traced through South Atlantic, South –East Pacific and Arctic Oceans. It represents a major fracture system of the earth's crust where the crust is being pulled apart at rates of about 2 cm per annum, in the North Atlantic (for instance). This pulling apart is a separation that is causing a rift valley to form along the centre of the elevated ridge and to attach itself at the rear of other magmatic spreading material which are similarly ejected.

2.16 OTHER OCEAN FLOOR FEATURES

Ocean Trenches or Fore Deeps

These are long narrow depressions whose bottoms reach depths of more than 10 000 km. They represent down-folded or down-warped zones associated with recent orogenic movements. The trench floors remain as deep depressions due to slow sediment accumulation on the ocean basin floor. Examples are the Alentian Trench (associated with the Alentian Island Arc) and the Japan Bonin Marianas next to the Marians Island Arc.Some fore deeps have developed parallel to continental margins e.g. the Peru –

Chile Trench that lies immediately offshore from the Andes fold mountain chain in South America.

Island Arcs

These structures occur near the margins of ocean basins and are distributed along long narrow curving zones. The curving ridges or island arcs, rise from the sea floor and are associated with young fold mountains. They represent zones of crystal destruction and are associated once again, with chains of active volcanoes and earthquakes

2.17 THE STRUCTURE OF THE CONTINENTS

The second order relief units of continents, consist of two main geological components.
(a) Shields or Cratons or Crystalline Basement Complexes. These are the most stable heartlands of the continental crust consisting of very ancient rocks. This implies that these rocks have undergone several periods of mountain building (orogeny) metamorphism of ancient sedimentary layers and intrusions of granite to form batholiths, all of which were effectively levelled by erosion from towering mountains down to their roots. Today, shields are level ancient rock basins, featureless plains and low Deccan plateaus.

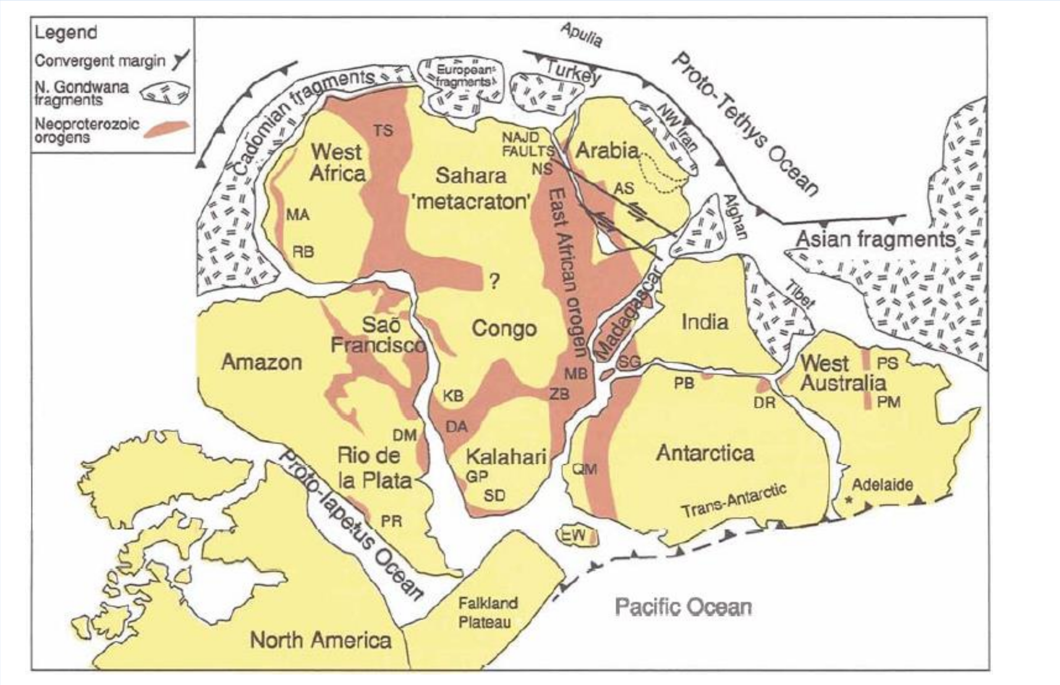
Their only movement is confined to Eparogenic movements i.e. rising (positive) or sinking (negative) of the crust over large areas without bending or breaking of rocks. This reflects great crystal stability compared to compression and tensional movements experienced on unstable zones. Shields are very stable sedimentary basins.

Shields respond to pressure exerted on them by sediment deposition or by the setting of an ice age. Such pressures cause the shields to sink (negative epeirogenic movements) leading to their coastal submergence. Positive or rising epeirogenic movements (from sediment removal or snow/ice melt) expose shields to denudation processes levelling them to hills and plateaus. This shield response by gently sagging in is what is generally known as isostatic adjustment.

Shields in the Northern Hemisphere comprise:

(a) The Canadian Shield which is North America’s heart land.
(b) he Russian–Balsatic Shield or the Fenno Scandinovian Shield. which is the heart land of Europe. Rocks in (a) and (b) above are very ancient.
(c) The Angara Shield

In the Southern Hemisphere, similar shields occupy parts of Australia, the Deccan Plateau of India, the African Shield of Africa and the South American Shield and that of Antarctica.



<u>MOUNTAIN BELTS</u>

Mountain belts surround these stable shield zones. Mountain belts are long narrow orogenic zones in which the crust has been compressed and forced to buckle into tight folds while simultaneously being raised. They comprise old and young fold mountains.

Following is a table of comparison between Old Fold Mountains and Young or New Fold Mountains.

2.18 Examination Type of Questions

1a) Describe the main features of young fold mountains and island arcs.(9)
b) Describe and explain the global distribution of young fold mountains and island arcs. (16)
2a) Account for the global distribution of mountain chains oceanic ridges, deep trenches and island arcs. (9)
b) Compare the physical landscape of ancient shields (cratons) with those of young fold mountains. (16)

CHAPTER 3

WEATHERING AND LANDFORM DEVELOPMENT

3.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Outline the main physical and chemical weathering processes.
b) Discuss the major rock types in the earth's crust.
c) Describe main factors affecting weathering
d) Assess influence of climate on the basal surface of weathering
e) Outline main landforms associated with weathering processes.

3.2 Major Rock Types in the Earth's Crust

Rocks are normally mixtures of minerals which themselves have definable chemical composition and physical properties which help to make rocks unresistant or resistant to denudational processes.

3.3 Rock Types

(a) Igneous Rocks

These are formed by the cooling and crystallization of molten magma derived from the mantle. They are either intrusive (in the earth's crust e.g. granite) or extrusive volcanic (on the earth's surface for example. basalt).

(b) Sedimentary Rocks

These are derived from pre-existing rocks by mechanical and chemical processes. Some of them are buried deep in the earth's crust and therefore are affected by great heat or pressure. There are either organic or inorganic sedimentary rocks e.g. coal or limestone.

c) Metamorphic Rocks
These are rocks which have undergone changes in their characteristics due to intensive heat and pressure from earth movement.

3.4 Types of weathering

Rock Weathering
This is the gradual disintegration of rocks in situ, (that is) due to mechanical, chemical or biological processes.

Physical/ Mechanical Weathering

Pressure release/dilation/unloading
Pressure release structures develop in rocks formerly covered by considerable thickness of strata now exposed to the surface of the earth by erosion.The release of pressure is manifested in the development of the sheet structures parallel to the ground surface.
Sheeting is also responsible for the formation of exfoliation domes.

Frost shattering / freeze thaw action
It occurs in rocks which contain crevices and joints (e.g. joints formed in granite as it is cooled, bedding planes found in sedimentary rocks and pore spaces in porous rocks) and in places where there is limited vegetation cover and temperatures fluctuate around 0°C .Water enters the rock during the day and expands as it changes into ice, there by exerting pressure within the joints. This process slowly widens the joints and in time causes it to shatter from the main body. It is common in upland regions of Britain where temperatures fluctuate around freezing points for several months in winter than in polar areas where temperatures rarely rise above 0°C.

Salt crystallization
It occurs when water entering pore spaces in rocks is slightly saline, then as it evaporates, salt crystals are likely to form. As these crystals become larger they exert stresses upon the rock causing it to disintegrate. This process occurs in hot deserts where capillary action draws water to the surface and where the rock is sandstone. It also occurs on coasts where the constant supply of salt can lead to the development of weathering pits.

Thermal expansion/Insolation/onion /exfoliation
This is a major process in the deserts. Rocks expand when heated and contract when cooled. As the daily temperatures exceed 50°C, the outer layer of the rock warms up faster and cools more rapidly than the inner ones, this gradually causes the outer thickness to peel off. Changes in temperature also cause different minerals within a rock to expand and contract at different rates and this causes granular integration in rocks with several minerals whereas when there is one mineral block, disintegration occurs.

Biological Weathering
Tree roots may grow along bedding planes or extend into joints, widening them until blocks of rock become detached.

It is also claimed that burrowing creatures such as worms and rabbits which may play a minor role in the excavation of partly weathered rocks.

Chemical Weathering types

Oxidation

It occurs when the rocks are exposed to oxygen in the air or water e.g. when iron in a ferrous state is changed by the addition of oxygen into a ferric state, rocks which have lack of oxygen being blue or grey will be discoloured into reddish brown.
Oxidation causes rocks to crumble more easily.

3.5 Hydration

Certain rocks are capable of absorbing water into their structure, causing them to swell and to become vulnerable to future breakdown.
This process is active following successive periods of wet and dry weather and is important in forming clay particles.
It is a physio-chemical process as the rocks may swell and exert pressure as well as change their chemical structure.

3.6 Hydrolysis

It is the most significant chemical process in the decomposition of rocks and formation of clays.
Hydrogen in water reacts with minerals in the rock, water combines with the mineral rather than dissolve it.
An example of hydrolysis is the breakdown of feldspar on a mineral in granite into a residual clay deposit known as Kaolinite Canina clay.

Carbonation

Rain water contains carbon dioxide in solution which produces carbonic acid (H2CO3) which reacts with rocks which are composed of calcium carbonate such as limestone. Limestone dissolves and is removed in solution by running water.
Carboniferous limestone is well jointed and bedded and results in the development of distinctive groups of landforms.

Solution

Some minerals e.g. rock salts are soluble in water and simply dissolve without eliminating them. The rate of solution can be affected by acidity since many minerals become more soluble as the pH of the solvent increases.

Chelation

Humic acid is derived from the decomposition of vegetation (humus) and contains important elements such as calcium, magnesium and iron which are removed by a process called chelation.The presence of organic life increases the concentration of carbon dioxide in the soil and thus the level of carbonation.Lichens can extract iron in certain rocks and concentrate it at the surface.The presence of vegetation cover dramatically reduces the extent of mechanical weathering.

3.7 Acid Rain

Human economic activities such as power generation and transport release more carbon dioxide, sulphur dioxide and nitrogen oxide into the atmosphere.These gases form acids in solution in rain water.Acid rain readily attacks limestone and to a lesser extent sandstones as shown by the crumbling buildings and statues e.g. Taj Mahal, the Acropolis and St. Paul's cathedral.The increased level of acidity in water passing through the soil tends to release more hydrogen and so speeds hydrolysis.

3.8 Block Disintegration

This is a form of mechanical weathering. Water penetrates pores and joints, freezes and ice crystals grow and exert pressure on rocks. Pressure causes rock to fragment and crack along lines of weakness producing a surface littered with large angular boulders. It may be due to salt weakening in deserts. It occurs along joints producing blocky inselbergs.

Granular Disintegration

Weathering is a process involving breakdown of rock into individual grains. Both mechanical and chemical weathering processes may be responsible for granular disintegration. It occurs shiftily in coarse grained rock. In granite rocks different minerals that make up the rock expand and contract at different rates when subjected to large stresses of temperatures such as in deserts. This causes pressure in the rock leading to its break up. Granular disintegration also occurs in porous rocks such as sandstone containing water that is subjected to freezing. Expansion of water on freezing stresses the rocks leading to disintegration.

3.9 Conditions under which disintegration occurs

-Cold conditions where temperatures always alternate above and below 0°c following groups of crystals.
-Water that should penetrate the cracks.
-Rocks containing joints or fissures or with ample pore spaces.
-Mid and high latitudes.
-High altitudes e.g. mountain summits.
-High evaporation rate in deserts allowing growth of salt crystals.

3.10 Results of disintegration

-Extensive slopes of angular and waste talus or screen slopes.
-Block fields.
-Felsenmeer-area of large angular boulders- sea of rocks.
-Block inselberg.

3.11 Factors determining types and rate of weathering (and erosion)

The main factors affecting weathering are out- lined below:

Rock hardness
Chemical composition of rocks
Rock characteristics
Rock type- formation
Mineral composition
Rock hardness
Rock joint
Rock colour
Rock texture
Climate
Relief
Aspect(the position of slope in relation to the sun).
Vegetation

3.12 Rock hardness

Hard rocks are, as a general rule, more up shooting than softer rock. The reason is that less susceptible to stream erosion. As a result, the development of valleys is restricted because the rock is able to withstand the pressure of a great weight from other processes such as glacial abrasion and others. However, the relationship between rock strength and erosion processes is by no means straight forward.

Mechanical strength directly impedes erosion by running water but the latter may also be determined by the nature of the stream bed which in turn is influenced by rock composition, texture and by past or present weathering processes e.g. platonic igneous rocks such as granite may be broken down by granular disintegration into its constituent crystals. Thus forming coarse sand, which by comparison with small stones and boulders, are very ineffective as corroding tools. Rock hardness not only exerts a considerable influence on corrosive processes but may help to determine the form and steepness of such basic landscape forms as valley sides and mountain shape.

Generally, the resistance is controlled by the minerals found within the rock e.g. according to Moh's scale of hardness, talc, gypsum, calcite are soft and quartz, topaz and diamond are hard minerals.

3.13 Chemical composition.

Because of their particular chemical composition, certain types of rocks are inherently prone to weathering processes and corrosion by running water.
The most obvious of these is limestone whose principal constituent calcium carbonate is rapidly acted upon by acidulated water. But many sandstones, particularly those bound by ferrous and calcirous cement, are also readily attacked especially if the prevailing climatic conditions are warm and humid

A soft homogeneous limestone e.g. chalk, with a close and evenly spaced system of minor joints and bedding plains will be attacked uniformly by chemical weathering.

The case of granite provides a good example of how minerals contained in a rock could be weathered chemically. Granite is made up of 20 to 40 per cent quartz, feldspar, mica, hornblende and other minor minerals. In humid tropical environments where there is abundant rainfall and high temperatures, it is easily weathered chemically (R.J.Small).
Water attacks the weaker feldspar and mica leaving the harder quartz upstanding. The former minerals ultimately fall down to form a layer of regolith, which explains the roughness associated with grate surfaces.

Rock jointing:
It is acceptable that joints are the most important of the rock characteristics, in that they influence landform development on a micro-minute scale. They have a considerable influence on both chemical and mechanical weathering for they allow the penetration of corroding agents into the heart of sound rock thus accelerating its decay and provide lines of weakness which can be utilized by frost wedging and riving. Joints have an equally important effect directly and indirectly on erosion.
A rock with a well developed joint system will be permeable to some degree thus reducing the amount of surface runoff. This in turn will correspondingly reduce erosion and transportation by streams.

***Task**: Explain how rock jointing influences weakening and landform developments in Tropical regions:*

Granite	Limestone
- Orthogonal joint pattern may be rounded off by sub-surface spheroidal weathering developing under tropical conditions.	- Joints are pathways for underground water.
- rounded residuals-core stones	- Carbonation- solution is very effective along joints.
- development of granite tors	- development of grikes (grykes) and clints, stalagmites, stalactites
- Domes- due to sheet jointing tensed by pressure release or dilation/ dilatation.	- dolines
- Where jointing is wider and decomposition less advanced, rounded sub-surface boulders are produced by reduction of joint bounded rectangular block of granite.	- dry valleys
- Increases of close jointing granite is decayed due to instability of feldspars and kaolin residue containing quartz particles is formed.	Sinks
	Underground passage (caves) – related to master joints.

3.14 Permeability and porosity

A non-porous igneous rock, such as granite, is, by no means, totally impermeable but support the water table. Granite out-crops especially in upland areas of Zimbabwe has invariably abundant surface water but this is a reflection of:

(1) Sheer volume of rainfall.
(2) The fact that the joints, except in the immediate sub-surface zone have not been widened by weathering to form effective storage conditions.
(3)The slow rate of run-off itself related to the gentle relief, the layers of peat and water logged vegetation occupy many valley floors.
Poorly jointed limestone will however be impermeable or semi-permeable.

Permeability- refers to the capacity of rock for allowing water to pass through it.
A prime factor determining the degree of permeability is the presence of bedding planes and joints. However, in some instances porosity can promote or enhance permeability.

Porosity –refers to the presence of small pore spaces between the constituent mineral particles of a rock. Sometimes these pore spaces are quite large and are in some degree inter-connected and water flows rapidly in pore spaces- with a result that water can pass easily through the rock. Permeability most obviously assists in the mechanical breaking down of rocks as in the process of block disintegration by frost action.
Porosity is an important aid for water contained within pore spaces exerts pressure as it freezes and either granular disintegration e.g. in sandstone or general weakening of the rocks coherence.

Permeability and porosity are factors in chemical decomposition particularly under hydrological conditions, that favour alternating melting and aeration of the rock's interior.
A permeable rock may be resistant to erosion and as a result will form upstanding counting landforms because stream erosion is prohibited or prevented.

Impermeable rock such clay and shale which promote a high degree of slope wash and channel flow and not mechanically strong are eroded into gentle undulating vales and lowlands. The carboniferous limestone, a hard well bedded and a strongly jointed rock is highly permeable and forms high plateaux, escarpments and ridges.

3.15 Climate and weathering

Climate plays a vital role in determining the rate and type of weathering on a global scale.Their role is mainly determined by the interaction of two variables within the environment, that is temperature and rainfall.The role of climate can best be explained with reference to the world's climatic main regions.

Weathering types increase or decrease in intensity.It is important to note that the diagram shows the dominant forms of weathering in particular regions, it does not mean that where one part of the classification can further be explained through the valuation of the depth of the weathering front in each climatic region as well as the depth of the weathered layer. The weathering front or basal surface of weathering can be defined as the extent to which weathering processes can operate on a particular rock, beyond this zone weathering cannot operate as a result of factors such as absence of joints, oxygen or chemical reaction and existence of a permanent zone of saturation.

Climate and weathering types according to Peltier's classification

Areas experiencing extreme temperature variations such as the polar regions (also referred to as the peri-glacial zone) are characterized by very low temperature variations, these conditions favor mechanical weathering and the most dominant process is frost shattering. The depth of the regolith is very shallow due to the fact that most of the ground permanently frozen and rock surfaces are covered by ice caps through out the year thus offer the protective cover.
NB: All weathering processes, both physical and chemical, seem to operate less rapidly today in the temperate regions than in the past.

The humid mid latitudes are characterized by slightly high rainfall totals and temperatures that fluctuate between -5°C and 10°C. This promotes active mechanical weathering due to abundance of water and low temperatures. The depth of the weathered material ranges from 0m and 10m but there is very slightly fully decomposed rock as a result of very slightly chemical weathering.

The dry continental areas form the transition zone between the seasonally humid and the very dry regions. They are characterized by generally high temperatures and moderate amount of rainfall, this promotes a lot of salt weathering. Rainfall total, insufficient to promote vegetation growth and as a result chemical weathering operates at a very small scale, as result the depth of the regolith is very shallow which averages less than 5m.

The seasonally humid tropics are characterized by two distinct seasons i.e. the hot wet summer and the cool dry winters. During the wet season high rainfall and temperature promote intense chemical weathering processes to occur. During the dry season, chemical weathering is most dominant. Therefore this region is characterized by vegetation growth which hold the soil together and promotes a deep weathered layer.

The humid tropics are characterized by high rainfall totals throughout the year, ranging between 1500m-2500m per annum. Temperatures are very high throughout the year, fluctuating between 25 and 30°C. This has led to the development of very thick vegetation cover, the primary source of humid acids. Chemical weathering processes are very intense and the availability of water promotes the leaching of water into water buried deep underground as a result the humid tropics are characterized by well developed weathering profiles with depths up to 30m as stated by L C King in his study of some regions in West Africa.

3.16 Weathering and Landform Development.

Weathering processes are generally believed to be the main agents of landform evolution. They are very much responsible for the major structural landforms of the globe. Weathering has led to the development of features on a large scale.

Characteristics of granite as a rock

It is an igneous rock formed through intrusive vulcanicity.

It is crystalline in nature (trilistic: composed of three minerals, different in colour; quartz- light, feldspar- dark).

It is a hard rock.

It is well jointed, vertical and horizontal joints formed as a result of pressure release

It is very impermeable.

Characteristics of limestone.

It is a sedimentary rock

Formed through deposition of plants and animal matter over a period of time

It is a soft rock

It is monolithic

It is very permeable

It is well jointed (horizontal joints were formed as a result of different layers of sediment accumulating over each other to form bedding planes and vertical joints were formed as a result of compaction and increase of sediment leaf).

Landforms resulting from the weathering of limestone

The weathering of limestone is mainly associated with the development of underground curves. These are formed as a result of the action of solution acting upon the vertical and horizontal joints underground thereby dissolving calcium leaving behind large underground cravens. There is a development of underground pillars which are formed as a result of the hardening of calcium that has been dissolved in solution. Limestone regions are also associated with the development of cast landscape. This is an area where limestone has been weathered leaving behind extensive remnant features of a limestone landscape characterized by collapsed covers and disappearing rivers.

Weathering and landform development

Weathering processes have led to the development and evolution of the earth's geological landscape. Weathering processes gradually break down the rock in situ and erosion agents are constantly transporting weathered debris thereby exposing rock surfaces for further attack from weathering agents.

3.17 Examination type questions

1.(a)What are the characteristics of a granite as a rock? (6)

(b) In what ways do the characteristics you have identified in (a) above influence the rate and type of the weathering of granite? (14)

2. (a) Distinguish between block and granular disintegration. (6)

(b)Show how weathering landforms can be attributed to either block or granular disintegration. (18)

3. With reference to **specific examples** account for the variation of weathering types from place to place and from time to time. (25)

CHAPTER 4

GEOMORPHOLOGY OF TROPICAL REGIONS

4.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Outline conditions necessary for the development of a deep weathering lager.
b) Describe in detail the development of a weathering profile.
c) Outline the conditions necessitating the removal of the deep weathering layer.
d) Describe Landforms associated with removal of a deep weathering layer.

Introduction

Geomorphology is the scientific study and interpretation of the origin and development of the landforms of the earth, focusing on the shape of the earth's surface. Geomorphology is a branch of Geography that studies the earth's relief features. This is concerned not only with the shape of the landforms but also with the agencies, which create them.

4.2 Land-forming processes may be grouped broadly into two types:

1. Internal or endogenous processes stemming from tectonic forces beneath the earth's surface.
2. External or exogenous processes related to surface weathering, water, wind, ice and sea.

Weathering in the humid tropics

The humid tropics are regions that lie within the equatorial belt between latitudes 0-15° North and South of the equator. The sun is always overhead this zone and high temperatures create a permanent low pressure region which promotes high atmospheric turbulent action leading to high rainfall throughout the year. This region is characterized by intensive deep weathering material which has developed over a period of time as a result of reasons outlined below.

4.3 Factors promoting the developmental of a deep weathered layer

High rainfall totals have led to the growth of thick vegetation cover which holds the oil together and penetrates rock joints through root action.

Water also dissolves humic acids released by decaying vegetation and enables their transportation to rocks buried underground.

High temperature changes enable chemical reactions to take place rapidly as well as the promote the growth of thick vegetation cover.

Most humid tropical regions are characterized by a granolithic base rock. This promotes the decomposition of granite in situ leading to the creation of a well developed profile (contrast with areas characterized by limestone).

The tropical regions are located on a ‘stable continental shelf’. These regions are tectonically stable and are rarely affected by earth movements. This has also influenced the development of a thick regolith in these regions.

4.4 The development of a weathering profile

A weathering profile can be defined as a theoretical framework that seeks to explain the development of the deep weathering layer in the humid tropics. It attempts to explain the gradual development of each distinct weathering layer up to the point where the whole rock has been fully decomposed. Each stage is outlined below.

Stage one

This is the initial stage where the basal surface of weathering is on the surface. Weathering agents gradually breakdown the rock to create a distinct zone characterized by a fully weathered rock.

Stage two

As weathering processes operate within the region, a distinct secondary layer develops. This layer consists of a decomposed rock characterized by the existence of un-weathered particles known as “core stones.”

Stage three

This stage is characterized by the development of a third profile characterized by un-weathered rock, with decomposed rock particles.

Stage four

Weathering in this stage is totally completed to produce a deep weathering layer. The boundary of the weathered material and parent rock is well defined; Thislimit of weathering is called **Basal Surface of Weathering**.

Overtime, the first stage develops further down decomposing the outer profiles. This will lead to the creation of a distinct zone of totally weathered rock and un-weathered rock.

4.5 Factors promoting the removal of deep weathered material

Low rainfall leads to less vegetation cover thereby promoting the process of weathering. This leads to reduced amount of water to percolate through the ground and subsequently reduced chemical reaction. Low temperatures reduce the speed of chemical reactions and inhibit plant growth resulting in less vegetation cover leading to a reduction in the amount of humic acid. Reduced vegetation cover leads to rapid removal of weathered material due to the process of erosion. **Tectonic uplift:** creates an erosive gradient (more energy to erode that weathered material).

4.6 Formation of Inselbergs

Definition: An inselberg is an "Island Mountain" (**Pritchard J. M)**

It is described as an "Island" in the sense that, it is surrounded by continuous plains.

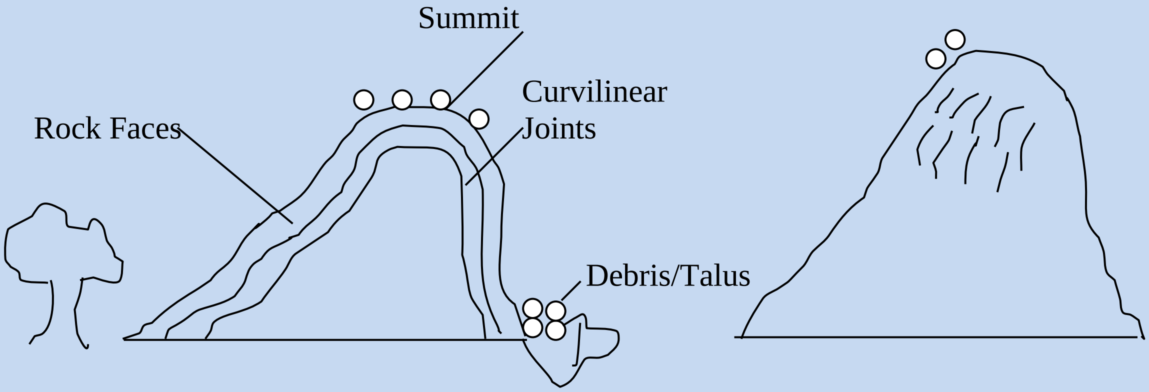
4.7 Types of Inselbergs

i) Bornhardt (Inselberg dome)
ii) Castle Kopje (Blocky Inselberg)
iii) Tors
iv) Ruware/Dwala/Whaleback

<u>Bornhardt</u>

It was first observed by Bornhardt, a German Geomorphologist in Uganda, East Africa, The dome–shaped inselberg was named after him. It is also steep – sided. A Bornhardt is highly distinctive. Sometimes it is found to be symmetrical and at times asymmetrical.

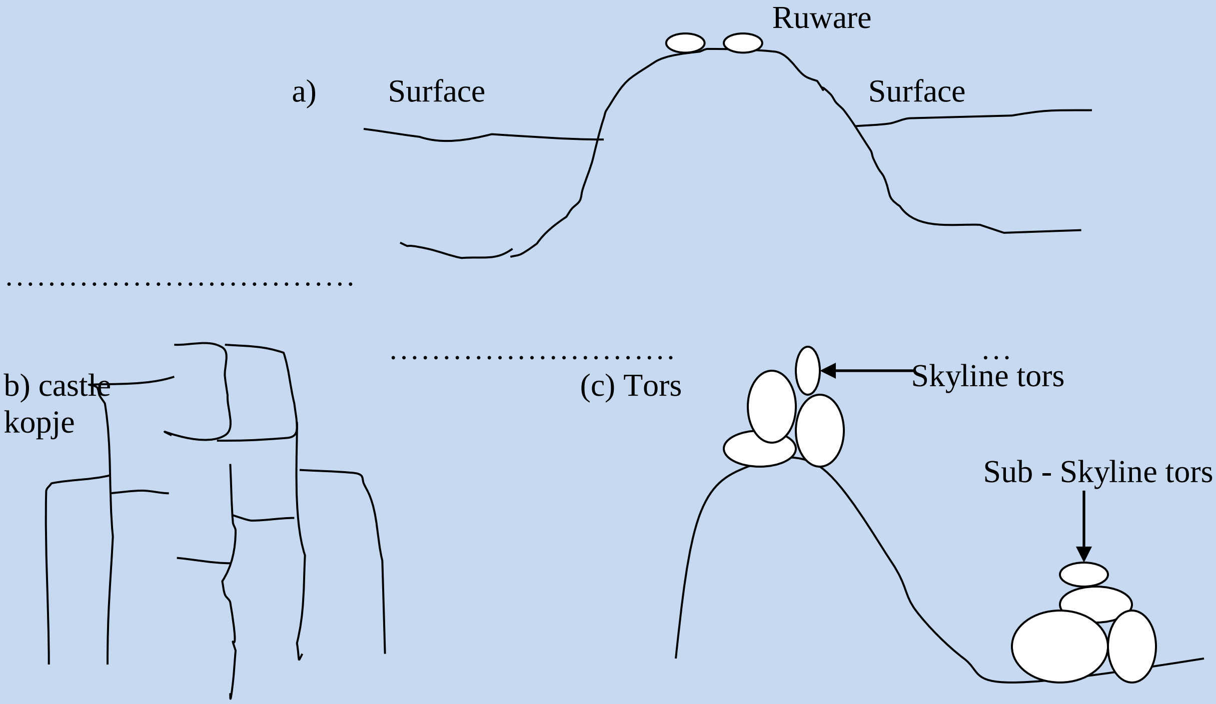
Fig 50



There is a convex, and the curve linear joints, which are a result of dilation/ dilatation. The minor features are in the form of debris or talus or scree resulting from exfoliation (Insolation weathering-refer to weathering). The Bornhardt has been associated with tropical landscape. A more modern view is that, while inselbergs of this type are very characteristic of tropical areas, they are by no means exclusive to the tropics and therefore cannot be regarded as zonal landforms (confined to a specific region).

Bornhardt domes are best-developed in foliated gneiss and granites of ancient shield rocks. Bornhardts have been referred to as shield inselbergs by Budel.
Thorpe makes a simple distinction between dome and blocky inselbergs. Inselberg domes are characterized by smooth convex faces.
Related to the borhhardt is a very common low whaleback dome referred to as ruware. It is shaped like the back of a whale.

Fig 51 <u>Diagram of a whaleback dome</u>:



Castle Kopje:

Blocky inselbergs are marked by a complex system of rectangular joints, which have guided weathering to give it its architectural aspect. Thus the castle kopje is derived from the degeneration of the Bornhardt. They seem to develop from the disintegration of rectangular joints by prolonged selective weathering (spheroidal). These are low irregular hills.

In practice, there is a wide variety of inselbergs and they result from:

1) Lithological changes (mineral composition of rocks).
2) Different joint spacing.
3) Weathering processes operating in the dome.

The stripping results in local exposure of the basal surface of weathering, in the form of tors .Ruware (dwalas – Whalebacks) Castle Kopjes and Bornhardts which initially are intrusive features

4.8 Exhumation hypothesis: Falconer

This is the mechanism of inselberg formation, which was proposed by Falconer in 1911. It was adopted by Bailey Willis in 1956 in East Africa. It has been recently revived through researchers such as Thomas and others. In this hypothesis inselbergs are assumed to originate as domical rises in the basal surface of weathering (the weathering front- chapter 4) and to be revealed to the ground through the removal of overlying saprolite (regolith or weathered debris).

Possible causes of the exhumation process:
- Local uplift
- Stream rejuvenation
- Changes in climate

<u>Detail</u>

A humid period is associated with dominant chemical weathering (deep weathering). A subsequent arid phase reduces the rate of chemical weathering. An example of an area undergoing this process is in the TsavoNational Park in Kenya where active erosion is removing the deeply rooted rock to expose numerous smooth and elongated whaleback domes of about 15 meters or more in height.

4.9 Effects of weathering

In some areas, (that is in the Tsavo National Park) somewhat higher domes which may be 300m or more in height can be found. The process of exhumation produces a smooth rounded top dome.

<u>Critique - problem with the hypothesis:</u>

The difficulty arising from the exhumation hypothesis lies in the fact that in most cases the Bornhardt domes are up to 300m or more. In the sub-surface they are found to be up to 50m high.

When exposed to the surface, they can only form ruwares and certainly not the bold inselbergs surrounded by many tropical plains. The implication of this hypothesis is that prominent inselbergs are of great antiquity perhaps dating back to the Mesozoic times (These are 100 million years ago on the geological calendar).

In other words, they are the most ancient landforms on the earth’s surface.

<u>Pedi-planation Hypothesis:</u>

Lester King has argued that Inselbergs should be regarded as late stage residual hills resulting from the gradual disruption of the interfluves drops by the twin processes of scarp retreat (erosion) and weathering.

In a general way the hypothesis seems applicable to some tropical landscapes where bold erosional scarps flanking uplands are seen to surmount low angle basalt slopes.
Out-layers of these scarps may result from a combination of selective scarp wearing (lateral erosion) and down weaving (vertical incision or erosion) the pattern of which is determined by variable rock type and joint spacing.

By subsequent pressure release and formation of these sheets joints, these hills may be converted into domes of the Bornhardt type.
This process is observable at the margins of the Machacos Hills, an irregular upland of hard granite and guises in the southeastern part of Nairobi-Kenya.

<u>Critique</u>

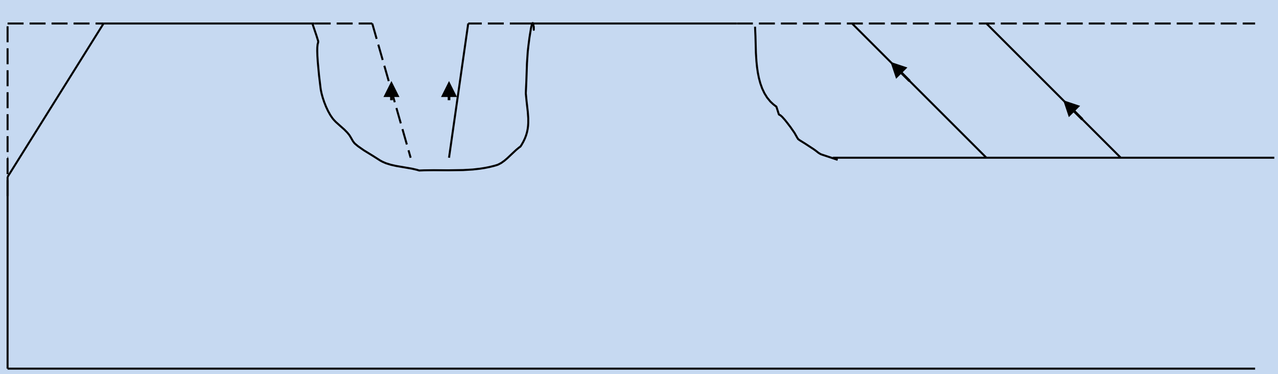
However, many domes are far removed for retreating scarps and are likely to have originated from other processes. Moreover, the Pedi-planation hypothesis seems to take in sufficient account of deep weathering and its possible role in inselberg formation.

a) The roughening out and subsequent reduction of major hill blocks by pedi-planation.
b) Differential vertical weathering of valley floors and lowlands.
c) Eventual exposure of un-weathered cores to form domes as the weathered material is steadily transported away.

<u>Parallel or scarp retreat and pedi-planation</u>

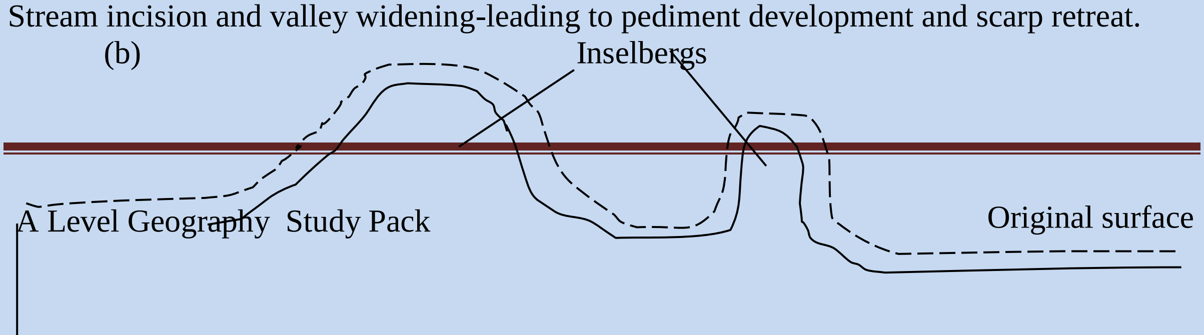
Scarp retreat

(a)



Stream incision and valley widening-leading to pediment development and scarp retreat.

(b)



4.10 Landform evolution (summary)

The landforms found on the earth's surface are constantly undergoing modification as a result of the forces operating on them, i.e. weathering, erosion and transportation. A number of theories have been put forward to explain the subsequent evolution of the earth's physical landscapes. Most of these theories seek to explain for the existence of inselbergs that appear as remnant pictures of past periods.

Exhumation

To exhume is to bring up to the surface.

This theory explains the development of tropical inselbergs; it states that tropical landforms are remnant features of past deep weathering periods. Masses of rock that resisted weathering were brought up into the surface when erosion agents stripped away the material.A typical case study is the Matopo Hills Region South East of Bulawayo in Zimbabwe.The exhumation hypothesis does not however explain the existence of landforms that tower high above the ground beyond the average height of which 30m (the depth of weathered material in most regions covers between 20-30m,(related to weathering in humid tropics).

Pedi-Planation Hypothesis

This is based on the ideas of scalp retreat put forward by L.C King. It assumes that as slopes decline due to the process of block and granular disintegration in the seasonally humid tropics, they retreat to heir former scalp faces. As the slopes retreat, they leave behind a pediment known as a pediplain. The river down cutting leads to the breaking up of highland. This means that in the end a distinct highland surrounded by low lying pediplain will remain.

The pediplanation hypothesis explains the theory of the existence of high towering isolated highland characterized by steep slopes in most tropical regions.

The slope is continuously eroded and wasted away reducing the slope and leaving a flat area as the pediplain.

Etcheplanation/ slope decline model

It is based on the slope decline model put forward by W.M Davis. It summarizes the Davison cycle of erosion that assets that when forces of weathering act upon landforms they reduce in size and take a new form that is different from the characteristics of the original feature. As these landforms decline, they leave behind low lying areas known as etch planes. These are characterized by low lying rock out-crops that rarely rise above 20m. This theory emphasizes the role of running water as an agent of transportation of the weathered material thereby exposing landform surfaces to erosion. To a large extent it accounts for the existence of low lying residual hills in most parts of the humid tropics.

4.11 Examination type questions

1. Account for the development and evolution of tropical Inselbergs [25]
2. With the aid of fully labeled diagrams describe the development of the weathering profile. (6)
(b) Outline the landform that can be attributed to the stripping of the weathered layer in the tropics. (18)
3) Critically evaluate the applicability of any two theories of landform development you have studied. (25)

CHAPTER 5

The Atmosphere

5.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Describe the structure and composition of the atmosphere.
b) Outline the energy transfers within the atmosphere.
c) Show a working knowledge of the six day and four day factor models of solar radiation.
d) Critically examine the influence of solar radiation on atmospheric processes.
e) Examine the influence and operation of atmospheric circulation systems on a global scale.

5.2 ATMOSPHERIC COMPOSITION
5.3

The atmosphere is composed of a number of gases mainly nitrogen, oxygen, argon, carbon dioxide and ozone. Water vapour makes up over 99, 9% of the atmosphere by volume. The atmosphere provides the air we breathe and also by trapping the sun's heat, it provides a "protective clothing" mechanism through its circulatory motions to the earth's surface and its weather. Air has both mass and volume. The weight of the air expands itself by exerting pressure. Atmospheric pressure decreases rapidly with height.

5.4 STRUCTURE OF THE ATMOSPHERE

Despite its apparent uniformity, the atmosphere reveals considerable variations in its composition, density and temperature. These variations become more evident with increasing altitude and as a result it is possible to identify a series of layers which include the:

Troposphere
Stratosphere
Mesopause
Thermosphere

5.5 Troposphere

It is the lowest and the thinnest layer of the atmosphere; it is the vital layer of the earth that contains about 80% of gases. Within the troposphere- (from a Greek word "Tropos" meaning a turn) the air is continuously re-arranging itself in an attempt to be in equilibrium or steady state. This perpetual (frequent) activity with its many influences continually interacting with one another, is best described as weather. Temperature in the troposphere decreases by 6,5^{0}C per every 1000 m in altitude (0, 65^{0}C per 100m). This decrease in temperature is known as the environmental lapse rate (ELR) – pressure falls as the effect of gravity decreases but wind speed usually increases with height .The troposphere is a very unstable layer and is the focal point in the study of climatology, as most atmospheric processes occur within this region.

5.6 Tropopause

This is the upper limit to the earth's weather and climate. It is marked by an isothermal layer which acts as an insulator regulating the temperature as well as incoming and outgoing terrestrial radiation Temperature is constant despite its increase in height.

5.7 Stratosphere

This is the zone immediately above the Tropopause marked by a steady increase in temperature i.e. a temperature inversion caused by the concentration of an ozone gas that absorbs incoming ultra - violet radiation. Winds are light in lower parts but increase in speed with height whilst pressure falls and the air is dry because of loss of water vapour. The stratosphere acts as a shield against meteorites from outer space. Meteorites burn themselves out as they enter the earth's gravitational field.

5.8 Stratopause

This is another isothermal layer where temperature is constant with an increase in height.

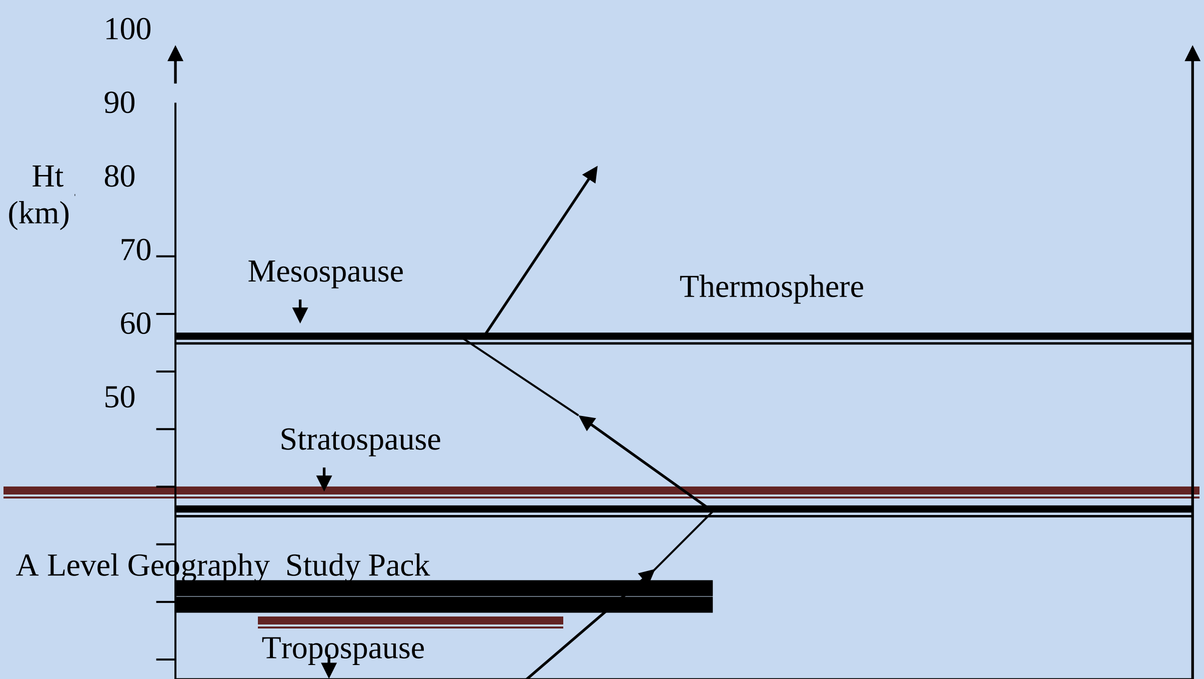
5.9 Mesopause

This is another isothermal layer showing no change in temperature.

5.10 Thermosphere

This is the uppermost part of the atmosphere .Temperature rises rapidly with height reaching 1500^{0}C due to an increase in the proportion of atomic oxygen which like ozone absorbs incoming ultra violet radiation.

The structure of the atmosphere is illustrated diagrammatically below



40 Mesosphere
30

20
Maximum ozone stratosphere

10

-80 -70 -60 -50 -40 -30 -20 -10 0 10 20
30 40
Troposphere Temperature°C

5.11 ENERGY TRANSFERS IN THE ATMOSPHERE

The sun is the earth's main source of energy. Energy from the sun is also known as short wave solar radiation. This energy controls our planets' climate, weather and food when converted by photosynthesis in the green plants. Much in-solation is absorbed and reflected and scattered throughout the atmosphere. Insolation aids in driving the hydrological cycle and other critical processes within the earth surface.
Absorption of insolation is mainly done by the ozone, water vapour, carbon-dioxide and particles of dust and ice. Clouds to a lesser extent reflect amounts of radiation back into the space.
Solar radiation in the atmosphere is transferred through a number of means. These are outlined below.
Radiation
Conduction
Convection
Re-radiation
Scattering: occurs when incoming radiation is diverted by gas molecules. It occurs in all directions and some of the radiation reaches the earth's surface as diffuse radiation. Incoming solar radiation is converted into heat energy when it reaches the earth's surface. The ground radiates energy back into the atmosphere.94% is absorbed and 6% is lost to space. This out- going radiation is called terrestrial or long wave radiation, or infra- red radiation.

5.12 FACTORS AFFECTING INSOLATION

<u>Altitude (height above sea level)</u>

The atmosphere is not warmed directly by the sun but by the heat from the earth's surface. This heat is distributed by convection and conduction. As the altitudes of mountains increase, they represent a decreasing area of land surface hence a decrease in heat, which can affect the surrounding area. As density or pressure decreases, so does the ability to hold heat.

Latitudinal position of the sun

As the angle of the sun in the sky decreases, land area to be heated and depth of the atmosphere through which rays have to pass both increase. Places in lower latitudes e.g. equatorial, have higher temperatures than those in higher latitudes e.g. Polar Regions.

Cloud cover

The presence of clouds reduces incoming and terrestrial radiation. The thicker the cloud, the greater the amount of scattering, absorption and reflection. Clouds may reduce daytime temperature, but also they act as an insulating blanket to retain heat at night ("green house effect").

Prevailing winds

A wind blowing from the sea tends to be warmer in winter but cooler in summer than corresponding wind blowing from land. During summer the land heats up more quickly than the sea. On cooling in winter, the reverse takes place. The oceans act as efficient thermal reservoirs.

5.13 Seasonal Changes

When the sun is over-heat at the equator insolation is distributed equally in both hemispheres. When the sun is overhead the tropics the hemisphere experiencing summer will receive maximum Insolation.

Length of day and night

Insolation is only received during the day light hours and reaches its peak at noon. At night, there is nocturnal radiation from the earth's surface leading to chilling of the ground and atmospheric air adjacent to it.

Albedo

The ratio between incoming radiation and the amount reflected is expressed as a percentage called the Albedo, varies according to cloud thickness e.g. cumulonimbus clouds (very thick clouds) reflect 90% of solar radiation whilst 10% reach the atmosphere below cloud level. Albedo also varies over different land surfaces-85% over reflecting fresh snow- 15 % in dark soils. Urbanisation has also influenced the Albedo in that covering the land with concrete and buildings creates urban heat islands

Pressure belts and winds

Wind can be defined as air in motion. Compared with temperature and rainfall, winds are relatively insignificant as elements of weather and climate. Nevertheless, they may be regarded as controllers of temperature and precipitation. Apart from maintaining a balance of heat in the atmosphere, they do transport water vapour from the oceans to the lands where condensation occurs and rain falls. Rainfall distribution is closely associated with wind systems.

5.14 Causes of wind

Wind is mainly caused by the differences between solar and terrestrial radiation (short and long wave radiation) Atmosphere pressure, temperature and density are all related. Changes in temperature produce changes in air density, which set up movements resulting in differences in air pressure. Over a warm area, air becomes heated, expands and overspills to adjacent regions where the temperatures are lower. The obvious result is that the weight of air is reduced in the warm region and increased in the adjacent cooler ones. High temperatures tend to produce low sea-level pressures; low temperatures produce high sea-level pressures. Wind is therefore caused by differences in density, resulting in horizontal differences in air pressure. This rate and direction of change of pressure can be indicated by the isobaric lines on a chart and are referred to as the “Pressure gradient” It is this gradient, which indicates the velocity and general direction of air movements. The gradient can therefore be defined as the decrease in pressure per unit distance in the direction in which the pressure decreases most rapidly.

The direction of airflow is from areas of high pressure to areas of low pressure, that is down the barometric slope. This can be shown by a line down at right angles to the isobars. The rate of flow or wind velocity is indicated by the steepness of the pressure gradient or the rate of pressure change. Where the gradient is steep, airflow is rapid, where there is shallow gradient, the air flow is weak.

N.B: If a small portion of the atmosphere is stationary, it will commence to move only if the forces acting upon it are out of balance. The only forces, which are acting, are the pressure exerted by the surrounding air and the force of gravity. Gravity is a force, which acts vertically downward. It cannot itself produce wind.

Upper air motion

The study of airflow in the upper troposphere is vital to the understanding of many surface weather patterns, for depressions and anticyclones are essentially a three- dimensional phenomena. Broadly speaking, wind speeds tend to increase with altitude because of lower air densities and the decreasing frictional effects.

Pressure patterns change and wind patterns also tend to be simple, higher up than to those at surface level. Another feature is that pressure patterns visible at the surface, do not always persist into the upper air, and hence directions may change with altitude.

For instance, cold anticyclones, which at ground level are often characterized by intense high pressure seldom persist beyond 2km in altitude and are replaced by relatively warm air with lower pressure than surrounding regions.

Jet streams:

These are concentrated bands or rapid air movement in the upper troposphere.

They are in reality intense thermal winds associated with latitudes where the pole ward temperature gradient is particularly strong.

Two such zones occur in each hemisphere: -

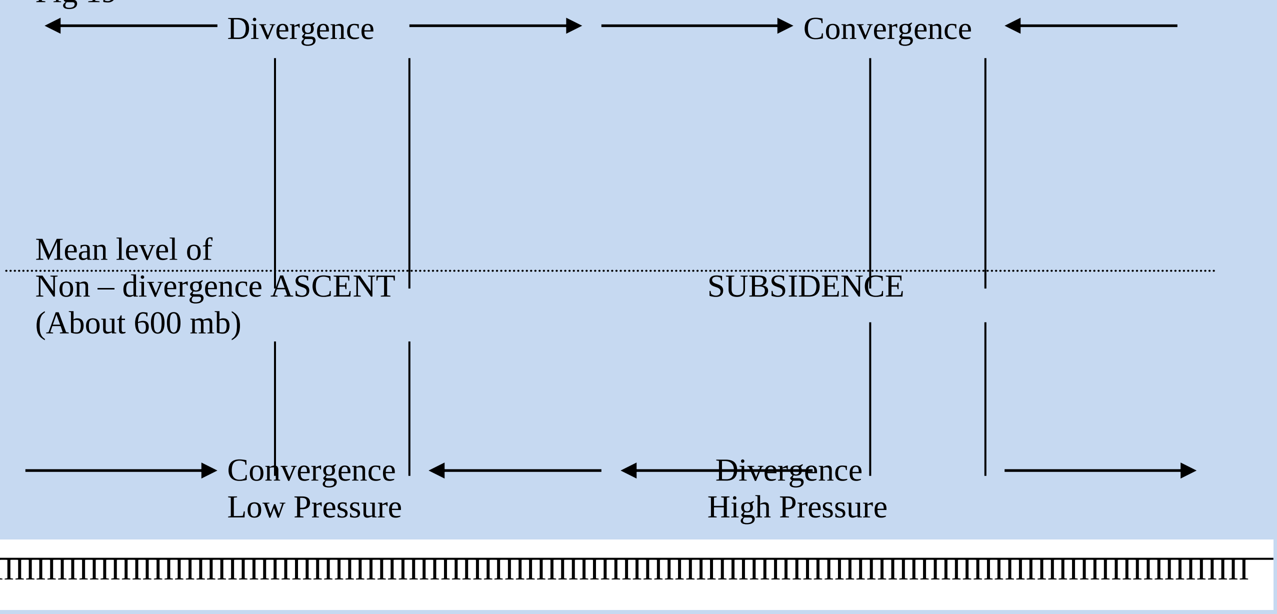
1. A sub- tropical jet stream at about 30^o of latitude and
2. A polar front jet stream

5.15 Convergence and divergence

Large-scale vertical motion is primarily due to non – geo-strophic motion resulting in mass divergence or convergence. It was noted above that geo-strophic wind was only an approximation to real wind. In reality wind speed often varies from geo-strophic value due to local accelerations or decelerations in horizontal flow. If there is deceleration in the horizontal flow, air will pile up in the volume and mass convergence occurs. Because the atmosphere is a continuous medium, configurations of divergence and convergence must be linked. This is particularly the case in the vertical plane; divergence overlaying convergence causes uplift and convergence over divergence courses subsidence

Schematic diagram illustrating the relationship between divergent patterns, vertical motions and surface pressure systems is given below.

Fig 19



If the atmosphere moved exactly geo-strophically, there would be no divergence or convergence and no large-scale vertical motion. Although divergence and convergence can be induced by large-scale topographic features, such as mountain ranges they are usually free atmospheric phenomena and explain, to a large extent, the endless variety of atmosphere motion.

N.B: On the globe, there are two subtropical high-pressure zones of divergence:

- The polar areas of calm winds.

- The inter-tropical convergence zone.

Winds near the earth's surface

Air moving along the earth's surface continually strikes against obstacles which cause eddies and turbulences. Energy is lost in the geo-strophic force. The latter now will not balance the gradient force, and the wind will, at the surface, blow somewhat across the isobars. The angle at which the surface winds cut the isobars depends upon the local surface conditions. Over the sea, where the friction is small, the reduction in velocity and hence in the inflow across the isobars is small. Over wooded and built- up areas, the loss of momentum is large and as a result the effect is also large. Broadly speaking, all the major wind systems around the globe are predominantly zonal or latitudinal in character especially the upper winds. The surface pattern is dominated by two wind belts in each hemisphere.

Trade - wind belt

Covers nearly half the surface of the globe between latitudes 30^0 N and S

The permanency of the subtropical high - pressure zones has an important bearing on the constancy of these winds.

Equatorial westerlies

This is a result of the annual migration of the wind, associated with the overhead sun, leading to winds sometimes crossing into their opposite hemisphere thus giving a narrow zone or equatorial Westerlies.

The mid - latitude Westerlies

They develop out of the pole ward sides of the subtropical high - pressure cells.

The Westerlies of the Southern Hemisphere are the stronger and more persistent as there is minimal interference from land masses, in contrast to the Northern Hemisphere.

Polar Easterlies

These relate to the Westerlies pole-ward, which are high latitude areas.

In the Arctic, the polar-high-pressure area is only a winter phenomenon and these winds tend to be seasonal.

In the Antarctica, easterlies winds appear to be more reliable.

ATMOSPHERIC MOTION

Horizontal air movement or wind occurs on many scales from small eddies to major circum - planetary wind systems, and also tends to be much more powerful than the local vertical motion.

The basic impulsion of air movement is provided by the inequalities in the atmospheric energy budget. Variable heating sets up variations in pressure, and this becomes one of the basic forces governing air movement. Once air is in motion, other factors come into play, including the coriolis force, the deflection caused by the earth's rotation, centripetal force, which acts around circulatory pressure systems, and the frictional force exerted by the earth's surface.

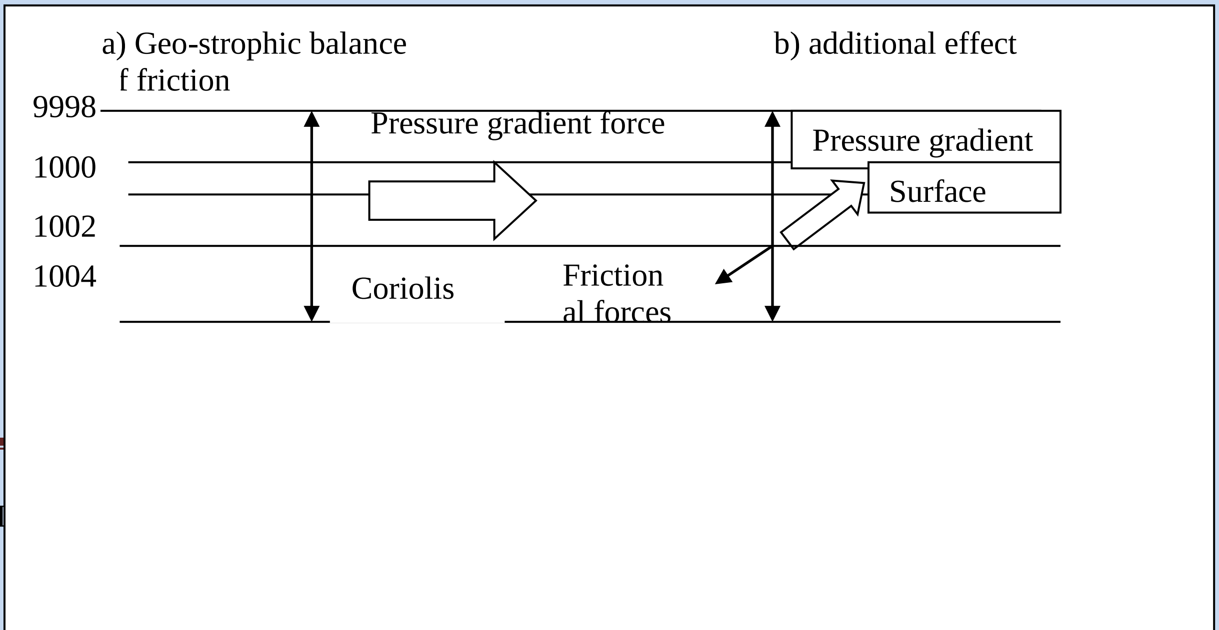
The irregular distribution of atmospheric mass is chosen as the starting point.
As a fluid, air moves from areas of excess to areas of mass deficit.

Mass is measured in two main ways:
1. By the pressure it exerts over an area.
2. By measuring the height of certain pressure surface above the ground.

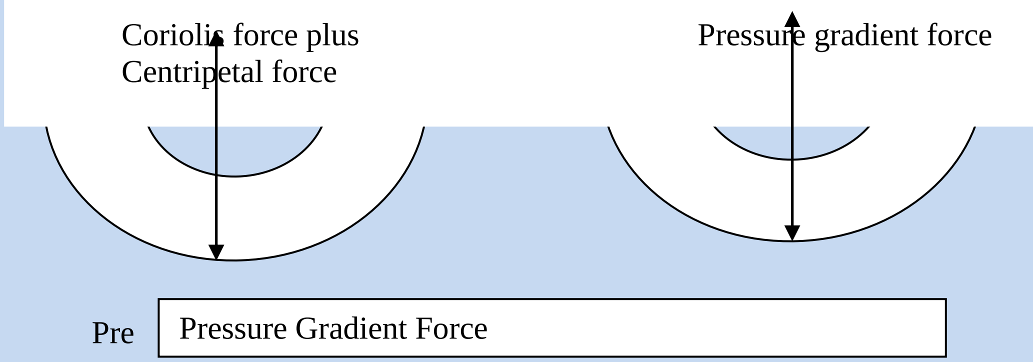
In both cases, the lines on the maps define gradients of pressure, which generate a force from high values to low values perpendicular to the isobars or contours. This is known as **the pressure gradient force.** The steeper the gradient is, the stronger the force and the greater the air speed.

NB.
Once air is forced to move by the pressure gradient, it is immediately affected by the earth's rotation. This rotation means that the direction of the wind appears to change to an observer on the ground. The apparent deflecting mechanism is so real to any one on this planet that it has been called the coriolis "force" after the Frenchman who formalised the concept in the 19th century.

Coriolis force
This is the earth's deflecting force resulting from its rotation. This causes an apparent deflection of moving air to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, whatever the original direction. The phenomenon affects all freely moving objects including ocean currents and projectiles. The deflecting force varies with the speed of the moving air and with latitude: the faster the wind, the more ground it covers in a given time, and the greater the effect of rotation. Near the equator, where the earth's surface is spinning in a plane almost parallel to the axis of rotation, the Coriolis force is very light, but it has marked effects in higher latitudes. Wind direction adopts a condition of equilibrium or balance between various forces, the most important of which is the strophic balance that exists between the pressure gradient and coriolis forces. In the free atmosphere, above the level of flow affected by surface topography, the flow of wind parallel to the isobars indicates that two forces are exactly balanced this sort of air motion is known as geo-strophic wind.



c) Forces acting in high and low pressure systems



A qualitative expression of the geo-strophic situation is by Ballot's Law, which states

that if one stands with one's back to the wind, then in the Northern Hemisphere, low pressure lies to the left and high pressure to the right. The reverse applies in the Southern Hemisphere. In the lowest parts of the atmosphere, frictional damage exerted by the ground, lessens the speed of the wind and in doing so weakens the Coriolis force.
This allows the pressure gradient to exert its greater strength, and thus the usual situation on a surface synoptic chart is that the winds blow at slight angle to the isobars

NB. The geo-strophic winds are a very useful concept because it approximates closely to winds observed in the atmosphere.

5.16 Centripetal Force:

It applies to winds when the isobaric pattern is markedly curved. The fact that is following a curved path, means that in addition to the pressure gradient and coriolis forces, a third force is acting centripetally, pulling the air inwards. Wind that is in balance with three forces is known as the gradient wind. Motion around a low pressure area anticlockwise in the Northern Hemisphere is termed cyclonic, and in this case the result of the centripetal force is to make the coriolis force weaker than the pressure gradient force: The wind is sub – geo-strophic. The anti-cyclonic flow in the high-pressure case is super geo-strophic, since the Coriolis force exceeds the pressure gradient force. Frictional forces will apply in both these cases of the winds if they near the surface.

NB. If the isobars are curved then air motion is subject to centripetal acceleration towards the centre of rotation as well as the other two forces. The centripetal acceleration should not be confused with the coriolis deflection.

5.17 Examination Type Questions

1(a) What is an atmospheric heat energy budget? **[6]**
(b) Outline the factors that cause temperature variations on the earth's surface. **[10]**

(c) Explain how human activities have modified temperatures in recent times. **[9]**

2 (a) (i) Define the terms, long wave radiation and short wave radiation. **[2]**
(ii) Identify the parts of the earth's surface, which receive the most solar radiation each year. **[5]**

(b) Explain how the global; distribution of temperatures is influenced by:
(i) Latitude
(ii) The distribution of land and sea
(iii) Ocean currents. **[8]**

(c) Explain the nature and causes of global warming in recent years. **[10]**

CHAPTER 6

Atmospheric moisture

6.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Define humidity.
b) Explain adiabatic cooling.

c) Discuss the operation of lapse rates and their influences on weather conditions.
d) Outline conditions necessary for condensation to occur.
e) Discuss weather conditions associated with high and low level condensation.

Water in the atmosphere

Water is a liquid compound, which is converted by heat to vapour (that is gas) low temperatures convert it into a solid (ice). Its presence in the atmosphere as a gas serves to absorb, reflect and scatter insolation keeping the earth at a habitable temperature. It is of vital significance as a means of transferring the sun's heat energy from tropical areas either horizontally to polar latitudes or vertically into the atmosphere.

Humidity

This is the amount of water vapour content in the atmosphere and it depends upon temperature of air. At any given temperature a limit is reached when air is saturated. Cold air can hold only relatively small quantities of vapour but this amount increases rapidly when temperature rises. There is the amount of precipitation obtained from warm air is greater than from cold air.

Humidity can be expressed in absolute, specific and relative terms.

Relative humidity (RH)

This can be defined as the amount of water vapour in the air as compared to the amount of water it can hold at that temperature. In other words RH is a variable measure as it depends on temperature. The air becomes saturated when RH is 100%. The percentage of Relative Humidity is increased either by reducing the temperature or increasing the amount of water vapour.

$$\text{RH} = \frac{\text{value of absolute humidity x 100}}{\text{Saturation Vapour Pressure (SVP)}}$$

Specific humidity: is the actual amount of water vapour, which may be contained, in a given volume of air expressed in grams per kilogram of air per kg mass of water in the atmosphere

Absolute humidity

This can be defined as the mass of water vapour in given volume of air measured in grams/m^3. Alternatively it can be defined as the ratio of the weight of water vapour held to the total weight of moist air. It depends on temperature. High temperatures tend to promote higher absolute humidity.

Dew point

This is the critical level beyond which further cooling leads to condensation. The temperature at which condensation takes place is called the dew point temperature. The condensation level, which also shows dew point, indicates the cloud base. If dew point is near or at ground level, the result is dew, fog and mist. Condensation occurs when water vapour changes to water droplets. When air is cooled beyond dew point and there are condensation nuclei, water droplets may be formed. These may be shown by formation of clouds.

ADIABATIC COOLING/WARMING

The heat consumed within the parcel of air is referred to as latent heat (hidden within the parcel). The dry air parcel will continue to rise and in the process further losing temperature. On average the lapse in temperature is 1^0C / 100m or 10^0C / 1000m or km. The air parcel generally loses temperature at 10^0C per 1 km. This means that from 10^0C the air parcel will reach 0^0C if it continues its ascent for another kilometre. This is a critical temperature and it implies that the air parcel is now saturated. The level at which water droplets start to form is known as the condensation level. It also marks the cloud base.

Environmental lapse rate

The term environmental lapse rate (ELR), refers to the rate at which the environment loses or gains temperature with an increase or decrease in altitude respectively. This rate is about $6,5^0$C/ 1000m. The environmental lapse rate varies from place to place and from time due to a number of factors.

From day to night

Generally, the environmental lapse rate tends to be high during the day because of a lot of insolation that is received and absorbed during the day. At night, a lot of heat is lost due to increased short wave radiation and as a result it becomes colder and therefore the environment loses heat much more slowly due to an energy deficit in the evening or night.

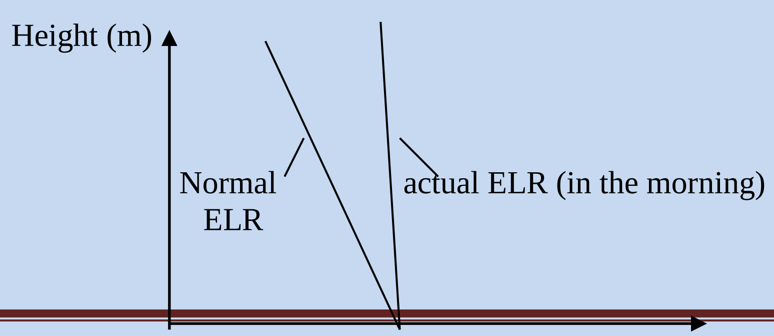
From season to season

In summer in a country such as Zimbabwe, a lot of Insolation is received. As a result of this, the environmental lapse rate tends to be high. In winter less heat or isolation is received with the result that the environmental lapse rate is low.

Variations from time to time

From time to time it can be shown in the morning, afternoon and evening.

Morning the environmental lapse rate is low in the morning. The rate of cooling through still air is low because of the rays of the sun which will be striking the ground at an oblique angle.

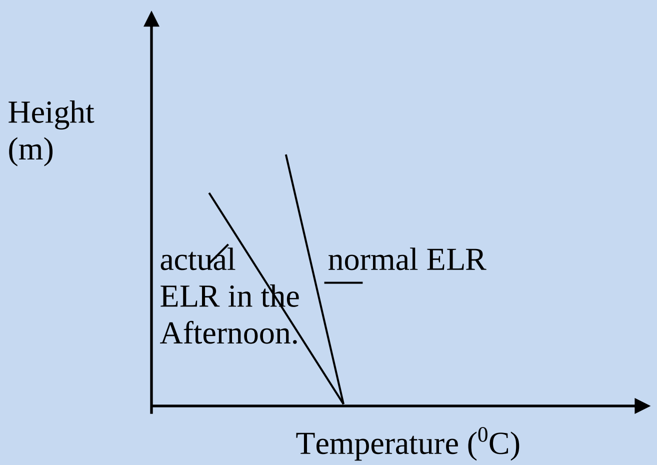


Temperature (^{0}C)

The actual morning ELR is lower than the normal ELR, which is 0,65^{0}C / 100m on average.

Afternoon

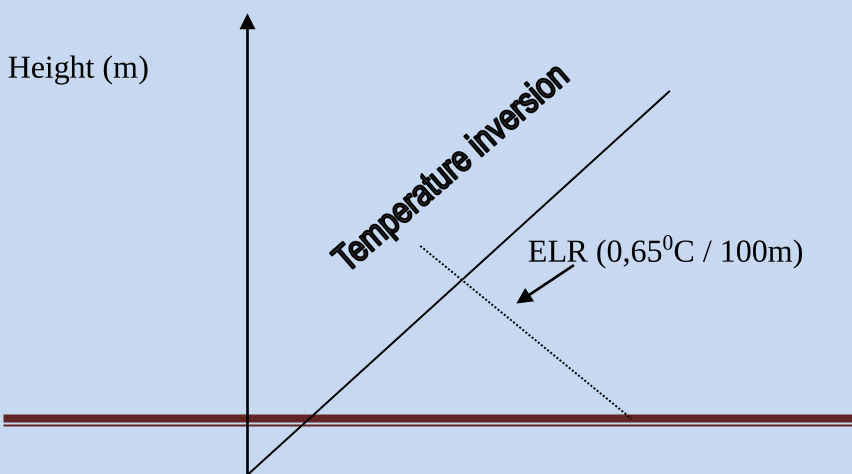
In the afternoon the ELR is very high. This is because the sun's rays are striking the ground almost at right angle. This implies maximum heating of the ground hence the lapse profile will be steep (the rays of the sun are covering a small surface area).



The actual afternoon ELR is higher than the normal one. It will be having a very steep gradient (lapse profile)-meaning to say it will cool faster than the normal environmental lapse rate (NELR).

Evening

In the evening the ELR is inverted, i.e. temperature increases with an increase in attitude. This abnormal environmental lapse rate is known as a temperature inversion. Temperature on the surface is chilled by nocturnal radiation (i.e. radiation which occurs at night). The following temperature height diagram illustrates the situation.



Temperature ^{0}C

Aspect
Slopes facing pole –wards are shielded from the sun, resulting in lower ELR.

Altitude (height above sea level)
As already pointed out, temperature decreases with height through still or stationary air. The ELR is therefore low at high altitude (e.g. uplands) and high at low altitudes (e.g. low lands).

Latitude (distance from the sun)
The sun is overhead the equator twice a year. So a high ELR is emphasized along the equatorial belt. It therefore goes without saying that areas near the equator also experience high environmental lapse rates while those further away must experience a low ELR (i.e. as one moves towards the north or south pole)

Water / land surfaces
The ELR is high on land surfaces and low on water surfaces (seas/oceans) during the day.

NB. The opposite is true at night.

Temperature inversion An abnormal Environmental Lapse Rate.
When we were examining the environmental lapse rate from time to time, it was indicated that during the evening, an inverted environmental lapse rate is experienced. Put simply, it is an increase of temperature with height. It is caused by nocturnal radiation. Nocturnal radiation which is re-radiation from the ground at night, leads to the chilling (cooling) of the ground surface which in turn leads to the cooling of the air above it by **contact cooling mechanism (conduction).** This results in the formation of cold layers of air below warm air. This is a temperature inversion because now temperature increases with height instead of decreasing.
Temperature inversions are divided into two:

1. Surface / or near ground temperature inversions.
2. Upper air temperature inversions.

Surface Inversions: This is what is explained above, i.e. which results from nocturnal radiation through the contact cooling mechanism.
Temperature inversions can also be formed in valleys at night. During the day, the valley sides are heated by the incoming solar radiation (insolation).As already indicated earlier, the earth's surface "behaves" like a black body or dark surface. It is therefore a good absorber of heat but a poor retainer as well.

As a result, during the night, all the heat absorbed is lost through nocturnal radiation. The valley sides therefore lose all the heat leading to nocturnal chilling. The air above the valley sides is cooled, thus becoming very dense or heavy. As a result it will sink or descend into the valley. The warm air in the valley is displaced giving rise to anabatic winds (the displaced air) and the katabatic winds (the descending cold air). A layer of warm air is formed over the valley containing cold air. This is a clear example of a temperature inversion in the lower layers of the troposphere.

Upper air temperature inversion

This occurs in the upper layers of the troposphere. This may be caused by the following:

Frontal uplift**:** When two air masses of different characteristics of temperatures, humidity and lapse rate meet, the one with a low density is forced to rise because the two air masses cannot mix. So a front (boundary) is formed. It is warm air mass, which is less dense, so it will be forced to rise at the boundary (or front).

Adiabatic Lapse Rates

These can be defined as the rate at which a pace of air loses or gains heat with ascent or descent. These can be divided into two, that is:

1.Dry Adiabatic Lapse Rate (DALR).
2. Saturated Adiabatic Lapse Rate (SALR)

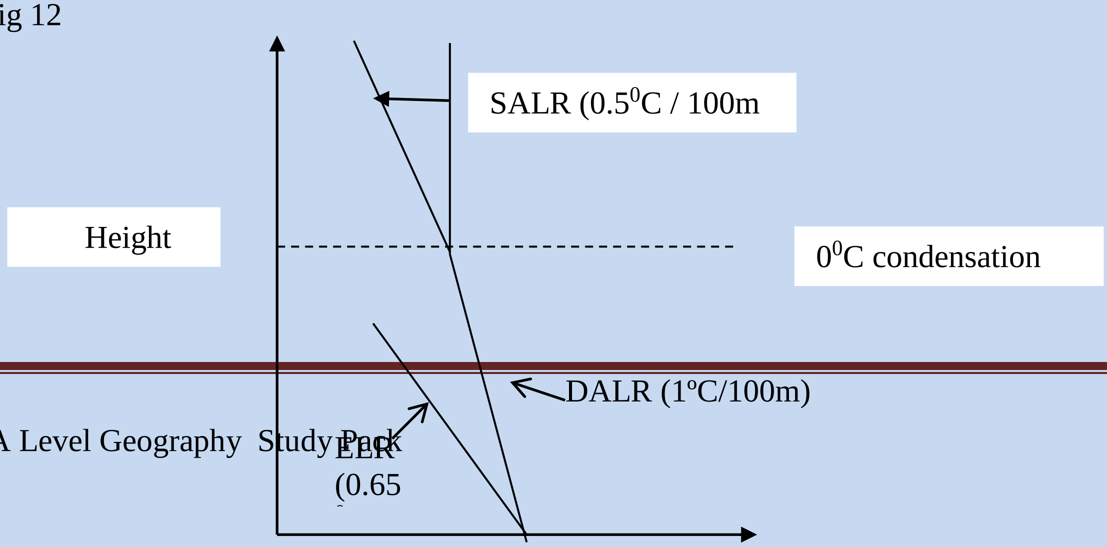
Dry Adiabatic Lapse Rate (DALR).

This is the general decrease in temperature of rising unsaturated parcels of air due to a decrease in pressure with altitude. It is adiabatic because no heat is lost or gained from the surrounding air. The heat is lost through adiabatic expansion -for the air parcel will be occupying a larger volume.

Saturated Adiabatic Lapse Rate.

As shown in the diagram below it is, the rate at which saturated air cools. It occurs when the dry air parcel of air reaches the critical temperatures of 0^0C. This is the saturation point and there is no room for the absorption of moisture by the parcel of air.
Latent heat, (hidden heat) is released as a heat of condensation. The latent heat is converted to sensible heat, which then lowers the rate of cooling. SALR varies and is determined by the amount of latent heat released at the condensation level.

Fig 12



NB: -This is possible especially when the environmental lapse rate is higher or cooling faster than the dry adiabatic lapse rate. The air parcel will be cooling at a lower rate on ascent when compared to the surrounding air. This explains why the air parcel is able to continuously rise. The rising parcel of air remains buoyant because of its low density - hence it can be sustained by the still air, which is denser.

Condensation of water in the atmosphere

Condensation is a process whereby water vapour changes into a liquid after cooling to dew point temperature. Condensation can occur at or near the earth's surface or it can occur in the atmosphere. Condensation in the atmosphere occurs as a result of many causes. The first cause is that the water vapour must be cooled to dew point temperature. This cooling of water vapour takes place through various mechanisms. It should be mentioned that as the moist air rises, it cools adiabatically, which means that as the air rises, its temperature decreases when heat is not taken out of the warm air to the external environment, but this occurs thermo-dynamically.

Condensation nuclei

Condensation does not occur readily in clear air. If air is totally pure water can be cooled below its dew point to become super-saturated with a relative humidity in excess of 100%. However it is rarely pure but contains large numbers of condensation nuclei. These microscopic particles are also known as hygroscopic nuclei because they attract water. Examples may include volcanic dust, dust from blown soils, smoke particles, and sulphuric acid and salt from sea spray.

Mechanisms promoting condensation of water vapour in the atmosphere

Convective adiabatic cooling

On a hot day especially in the tropics, the ground is heated and the ground in turn heats the air close to it through radiation and convection. Convection currents are set up i.e. warm air will rise, expands and cools beyond dew point and condensation takes place.

Orographic cooling

When air is forced to rise by a mountain barrier (Orographic ascent) or when it meets a colder, dense mass of air at a front.

Radiation cooling

This type occurs on calm, clear evenings. The ground loses heat rapidly through radiation and the air in contact with the ground is then cooled by conduction. If the air is moist, some vapour condenses forming radiation fog, dew or if temperature is below freezing point or hoarfrost or rime.

Advection cooling

This results from warm moist air rising over a cooler sea surface. Advection fogs in California and the Atacama deserts are formed when air is from the far drift over adjacent cold coastal ocean currents. As both radiation and advection involve horizontal rather than vertical movements of the air, the amount of condensation created is limited.

Sometimes condensation occurs when the air is not 100 % saturated. Condensation in such circumstances occurs as a result of the availability or pressure of hygroscopic or condensation nuclei. These are substances or particles in the atmosphere which have a strong affinity for water vapour such as sea salts, dust articles and various emissions from industry. These hygroscopic nuclei will therefore attract water droplets and ultimately promote condensation.

ATMOSPHERIC STABILITY AND INSTABILITY

Atmospheric Stability

It occurs when an air parcel resists vertical uplift. It exists when a rising parcel of air is cooling faster than the surrounding stationary air. The DALR will be higher than the ELR. This means that the rising parcel of air will increase in density as a result of rapid cooling. As a result the air parcel will be too heavy or too dense to be sustained by the surrounding air. If there is no mechanism to maintain the ascent, the air parcel will sink to its original position. Stability is determined by comparing the temperature of a parcel of air with that of its surrounding air (ELR). Both dry and saturated air can be stable.

However, on sinking, the air parcel will warm adiabatically resulting in ascent, which is again followed by rapid cooling and descent - so the process will be repeating itself.

Weather conditions associated with stability

Stability is commonly associated with condensation at or near the ground surface. This is associated with the conditions discussed below.
Clear skies
Low level clouds
Little atmospheric turbulence
High pressure

Dew

Water droplets are formed on the surface or on grass, as a result of nocturnal radiation. Dew is formed if it is above freezing point - i.e. above zero (0^0C). During clear nights, ground temperatures fall because of the continuous loss of heat by long wave radiation. Air getting in contact with it is cooled and the temperature falls to dew point resulting in the deposition of dew on leaves and other surfaces. However, not all water on leaves is necessarily dew. It could be fog water collecting on leaves as the fog passes if there is a slight breeze or it could be water continuously moving up the plant system at night but not evaporating into the surrounding cold air.

Hoar frost –This is formed when water vapour does not condense until temperature is well below freezing point. This leads to the initial water droplets freezing forming a soft white ice called hoar frost. Always remember that dew and hoar frost can co-exist.

Rime– This occurs when super-cooled droplets of water often in the form of fog, come into contact with and freeze upon, solid objects such as telephone poles and trees.

Mist and Fog - The two are similar. The difference is mainly in the visibility. Where visibility is more than 1km it is mist if less than 1 km, it is fog. Mist is thin fog and fog is thick mist. The droplets of stratus clouds are the same as those of fog in diameter.

Smog - This is a very thick fog that develops over industrial areas due to the presence of industrial emissions that mix with atmospheric moisture in the form of fog. Smog is very common over the industrialised cities and it reduces visibility to a minimum.

Table showing types and characteristics of fog

TYPE	FORMATION	CHARACTERISTICS
1. Radiation fog	- Nocturnal radiation - Cooling of air above ground. - Cooling occurs so that condensation occurs. - Warmer air remains above.	- Occurs at ground level - In areas of high elevation on mountainsides. - Few meters thick. - With turbulence cooled air is warmed up and this results in thick fog. - Fog evaporates fast at sunrise due to warming of ground. - Dissipated by strong winds.
Advection fog.	- Warm moist air abducted over colder surface and then chills by contact. - Moving of warm / cold air raised RH.	- Thick low-lying fog. - May be close to water surfaces with light winds. - Strong turbulence lifts condensation layer to form low

	- Over ocean areas in early summer when warm winds blow pole-wards from tropical air passes over the cool waters of high latitudes (sea fog)	stratus sheets. - Forms at any part of the day and not limited to cooler nights. - Common along coastlines or regions particularly covered by snow.
Steaming fog	- Cold air blows over warm water. - Evaporation from water bodies quickly saturates cold air. - Occurs in polar areas where there is contrast in temperatures between cold air from ice-covered land and the relatively warm surrounding seas.	- More localised than radiation and Advection fog. - May be wispy. - Rarely deeper than 1-0m. - Quickly evaporates in drier air above.

Atmospheric instability

Atmospheric instability can be defined as an atmospheric condition that exits when a saturated parcel of air rises adiabatically and cools at dew point .Upon reaching dew point, the parcel of air continues to rise due to the release of latent heat energy.

Conditional instability

This occurs when an air parcel, which was stable, is made unstable by an intervening situation (or conditions).The air could have returned to its original position if there was no mechanism to force it to continue rising (refer to the diagram on Absolute stability). The forced up - lift of the air parcel may be in the form of a barrier (see diagram on upper air inversion resulting from Orographic uplift) or a frontal zone.

Conditions associated with atmospheric instability

Condensation of water vapour in the atmosphere

Theories ofraindrop formation

Bergeron - Findersein hypothesis

This theory states that raindrops form when there is co-existence of ice crystal and super cooled water. As a result of differences in temperature, ice- crystals will grow at the expense of super-cooled water leading to the formation of raindrops.

Collision - coalescence theory

The collision - coalescence theory states that rain drops form as a result of the collision and coalescence of small and larger droplets of water to result in the formation of raindrops.

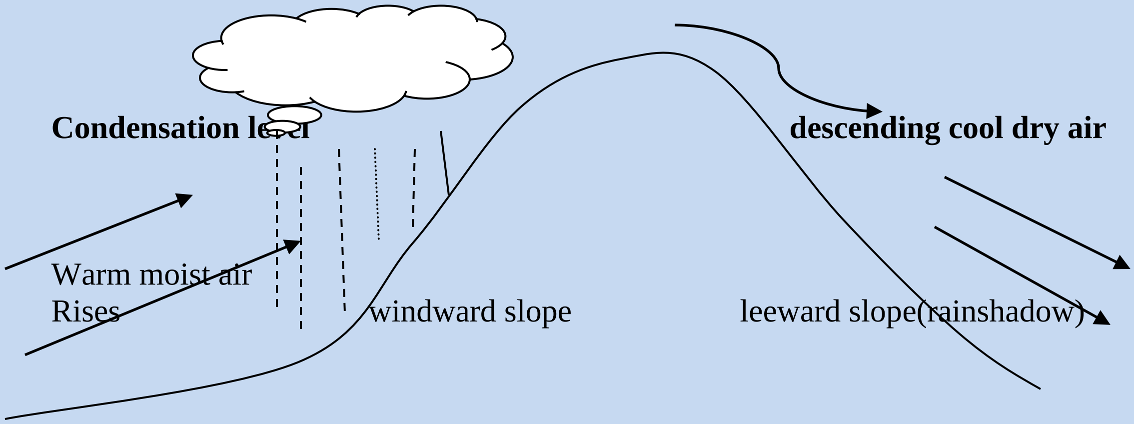
Critic

The type of rainfall is influenced by the mechanism of air uplift. For instance, air forced to rise by a relief feature results in the formation of relief or orographic rainfall and conventional uplift of air results in the formation of convectional rainfall while frontal or cyclonic uplift of air results in the formation of cyclonic or frontal rainfall is of shorter durations. The intensity of rainfall is influenced by the mechanism of air uplift.For instance, convectional rainfall results in clouds of great vertical extent such as the cumulonimbus which yield rainfall of higher intensities. The amount of moisture in the clouds also determines the intensity and duration. For instance, if there is a lot of moisture in the clouds, rainfall is of higher intensity and the opposite is true.

Types of rainfall

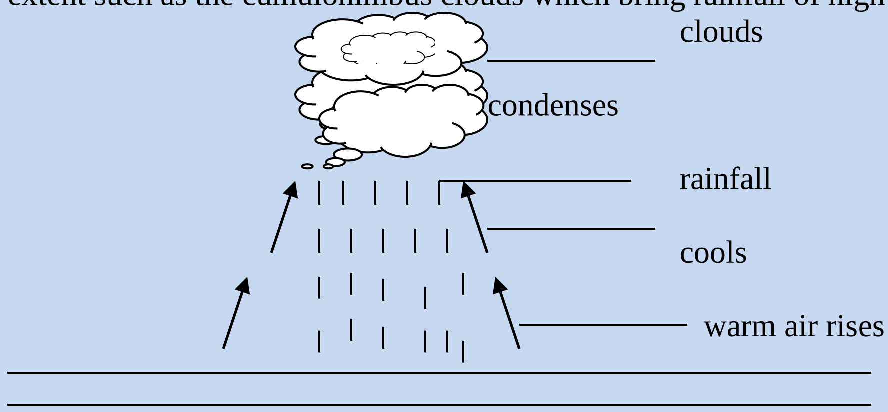
Relief or Orographic rainfall

This is formed when warm moist air is forced to rise by relief/ Orographic features like mountains. It's the warm moist air which is forced to rise, it cools adiabatically forming clouds which bring rainfall. The rainfall is on the windward side of the slope where the leeward or rain shadow area receives little or no rainfall.



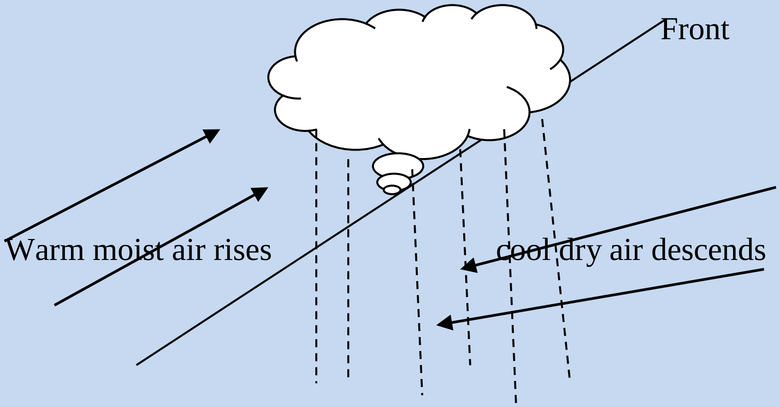
Convectional rainfall

This is formed when there is intense heating of the earth's surface and its water bodies leading to the generation of convectional currents. These convectional currents transport warm moist air upwards, where upon it cools adiabatically forming clouds of great vertical extent such as the cumulonimbus clouds which bring rainfall of high intensity.



Frontal or Cyclonic Rainfall

This is formed when two air masses, (a cold and a warm) converge. SA cold air mass will sink below a warm air mass which rises, cools adiabatically and condenses forming clouds which bring rainfall of longer duration.



Examination type question

1) Distinguish between absolute and relative humidity (6)
b) Discuss environmental factors that cause variations in the environmental lapse rate from place to place and from time to time (12)
c) Show how the knowledge of lapse rates helps in the understanding of atmospheric processes (7)

2)Under what conditions does high level condensation occur? (6)
b) Account for the occurrence of different forms of precipitation (12)
c) Explain the way in which human influence may influence the nature and amount of rainfall received at a particular place? (7)

3) On what basis are clouds classified? (6)
b) With reference to specific examples, examine the influence of types of clouds on rainfall intensity and storm duration (12)
c) Discuss weather conditions associated with low level condensation. (7)

CHAPTER 7

Air Masses

7.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Define air masses.
b) Outline the characteristics of air masses.
c) Show how air masses are modified.
d) Describe the operation of various types of fronts.
e) Outline various weather conditions associated with air masses.

Definition

Air masses by definition are large bodies of air whose physical properties, particularly those of temperature and humidity, are more or less uniform over considerable areas.

The body of air will be travelling horizontally. Gates defines an air mass as a widespread expenses homogenous air in a horizontal direction. Normally the horizontal dimensions are quite large, being of the order of hundreds of kilometres. Since the lower layers of the atmosphere acquire these properties via the earth's surface, it is possible to recognise air mass source regions in which air masses pick up their distinctive features.

7.2 Origins of air masses

Air masses originate from areas where the earth's surface is fairly uniform for example: -

Oceans
Deserts
Land ice and snow covered areas
Continental land masses

In addition, they are also regions of relative calm in the general circulation where homogeneous air mass characteristics can develop. Although air masses can become considerably modified as they travel, it is usual to describe the main types in terms of their region or source region.

NB: When air masses, which have different characteristics, are brought together they do not mix freely with each other. They tend to remain separate with slopping boundary surfaces between them. These boundary surfaces are called "fronts" and they usually separate masses of air with different temperature and humidity features.

7.3 Classification of Air masses

Air masses are classified according to their source of origins (regions) and the paths over which they have moved after leaving them.

This gives three main types of air mass: -

1.Arctic: Air which has originated in extremely high latitudes and moves to the equator (towards the equator) through the following: Maritime regions - giving us Arctic maritime.

2. Polar: Air which has originated over unfrozen land or water in high latitudes and which moves equator ward through;

Maritime regions:- give us Polar maritime.

3. Tropical: Air which has originated over low latitudes and which move pole-ward over.
Maritime regions-giving us Tropical maritime
Continental areas-giving us Tropical continental

N.B: In addition to these, the Equatorial air mass occasionally migrates well beyond their source regions.

7.4 Modification of air masses

An air mass does not only modify the weather of the area it is passing through, but it is also modified by the surface over which it is moving through.

The modifications involves: -

Temperature changes, addition and subtraction of water vapour and vertical motions of air. In other words, the original air mass (Primary air mass) is turned into a secondary air mass.

When an air mass enters a new region, mixing and modification starts, but with time the rate of its energy exchange with the surrounding area will diminish until all its features finally approximate those of the new area. In other words, it will lose its original identity. Some air masses lose their identity faster than others. It all depends on the extent of the source area as well as the pressure pattern that is affecting that particular area.

Air masses are generally modified by two mechanisms i.e. thermodynamic changes and dynamic changes.

Thermodynamic changes involve the addition and subtraction of heat into or out of the air mass. Air masses are heated or cooled from below, all depending on the surface they are passing through. Heating from below increases instability, while cooling at the surface may result in a temperature inversion, which in turn actually limits the vertical spread of the cooling. Thus air masses effectively lose heat through radiation heat loss.

2. Dynamic changes are mechanical in nature. These involve the actual mixing of air due to movement or pressure changes. Surface friction and forced ascent of air over mountain barriers play a crucial part.

Continental polar air mass that is cold and dry, is modified as it moves towards the equator, that is, toward warm landmasses. It is heated from below, resulting in the steepening of its lapse rates. This creates instability and convective activities. Clouds are formed but they are generally of little significance since the air is dry. On the other hand, if Maritime air moves pole ward, that is, over cooler land and water surfaces, the air mass is cooled from below and this results in a temperature inversion. Air becomes stable and they result in the trapping of pollutants if it is moving over industrialised countries. Advection fogs are also common where such a warmer air mass moves over cooler surfaces.

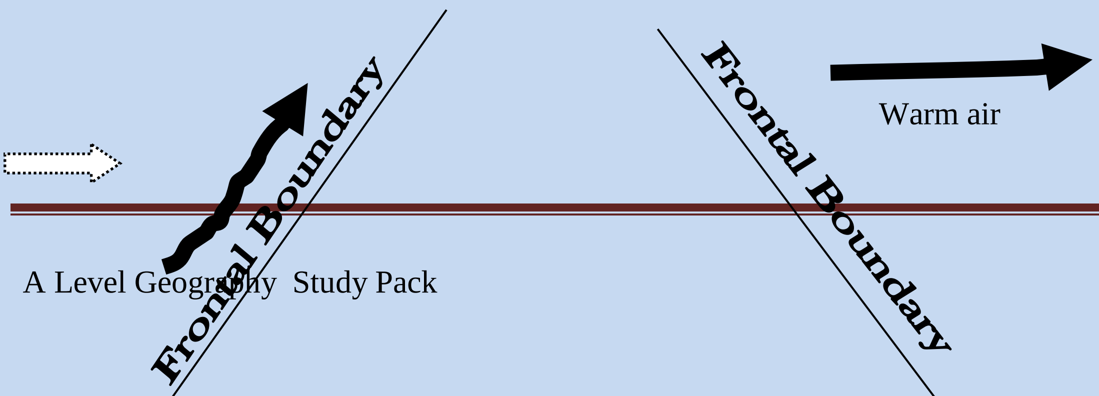
7.5 Fronts

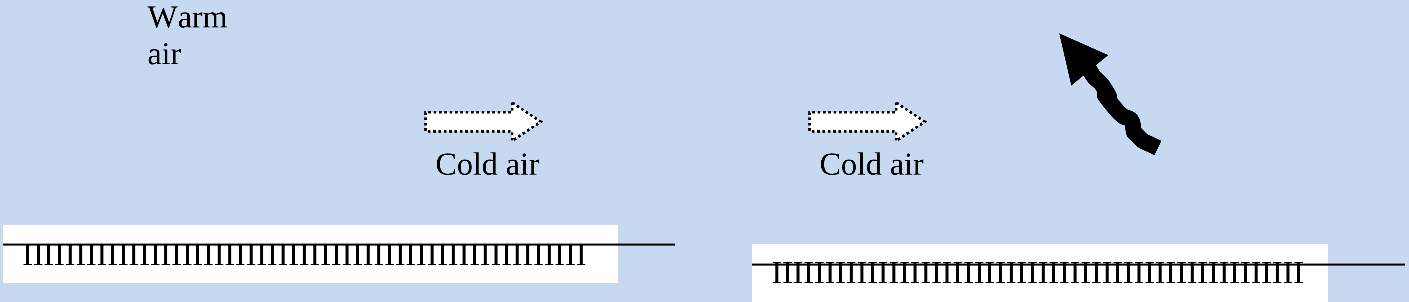
A front is a boundary zone between air masses that have originated in different source areas and with differing temperatures and humidity characteristics. They form where boundary zones intersect with the earth's surface.This is where air masses of different characteristics are in juxtaposition. Broad mixing zones occur, which are called fronts. These are commonly represented on a weather map by single lines but the associated weather may cover an area several hundred kilometres wide.

-Frontal zones also have considerable vertical extent, reaching up to the tropause

-The colder (denser) of the two air masses forms a wedge underlying the warmer air mass as shown below. Conventionally, the slope of a frontal zone is much exaggerated in a diagram, and in reality the slope is very small, often less than one degree. Hence an observer may well see the symptoms of an approaching front many hours before the surface front actually reaches him.

The warm front the cold front





Weather conditions associated with moving fronts: -
The weather conditions are variable; the common denominator is that, it is generally unsettled or unstable. Two factors largely determine the weather experienced: whether the front is warm or cold and the degree of activity.

Types of fronts:

Warm front: - warm air replaces cold air.
Cold front: - cold air replaces warm air.

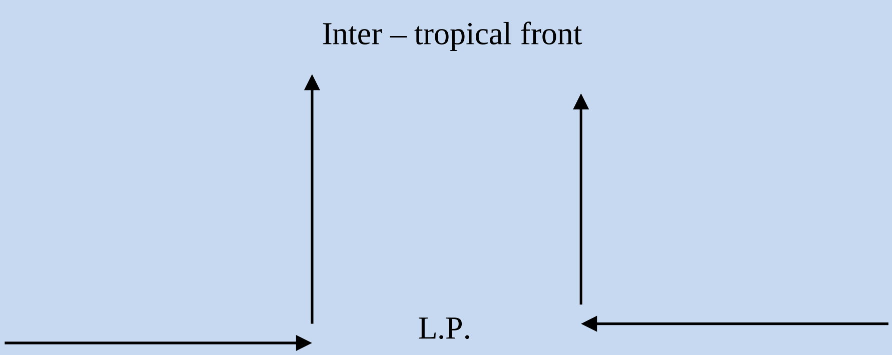
The activity on both types of front is mainly dependent on the vertical motion of air in the warm air mass.

If the air here is unstable and rising rapidly, the resultant active front is called on <u>Ana- front</u> by meteorologists.
Kata - fronts are those characterized by the general sinking of warm air which suppresses weaker activity.

N.B: The warm and cold fronts are part and parcel of the temperature depression.

7.6 Convergence zones

These are conditions caused when horizontal inflow of air into an area is greater than horizontal outflow. This is produced when 2 air masses move towards each other e.g. inter-tropical convergence zone (ITCZ). It involves the meeting of SE and NE trade winds.
Air masses may be of the same characteristics especially over oceans.
The air masses are drawn to a low-pressure centre due to heated ground.



Convergence at the surface

7.7 Examination Type Questions

1) Under what conditions can an air mass undergo modification over a period of time? (6)

b) Describe with reference to examples you have studied the atmospheric changes likely to be experienced by a region whose air mass has undergone modification (12)

c) Critically examine the role of global warming in influencing global weather patterns (7)

2) Define the term Inter Tropical Front (6)

b) Outline the weather conditions associated with the ITCZ (12)

c) Assess possible environmental hazards likely to be experienced by an area experiences weather conditions associated with the inter tropical front (7)

3) What weather conditions are likely to be experienced by an area experiencing the following weather conditions?

i) Warm front. (6)

ii) Cold front. (6)

iii) Frontal occlusion. (6)

CHAPTER 8

MICRO CLIMATES

8.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Discuss the influences of local conditions on micro climates.

b) Describe the urban heat island concept and its influences on climate.

c) Critically examine the influence of human activity on climate.

d) Discuss the contribution of global warming and ozone depletion on climate change.

The human impact on climate and weather

People influence weather and climate in a number of ways. The chief effect includes addition of heat to the atmosphere through the burning of fossil fuels. A fossil fuel is the remains of animals and plant matter.

- Changes in atmospheric composition through emission of artificial pollutants e.g. the popular CFCs in our days (CFS - Chlorofluorocarbons).
- Alterations to the earth’s surface through framing deforestation and urban expansion.

Deforestation

This is the removal of vegetation cover, and it is now a major problem in many parts of Africa since Africa’s majority live in rural areas and use trees for energy especially in the

Sahel (Mali and Sudan) and tropical rainforests e.g. Nigeria. It is estimated that not more than 10% of the original rainforest is still surviving because of overpopulation. Such destruction of the rainforest is serious because of the vital role that the forests play in the hydrological cycle. Trees remove carbon dioxide from the air during photosynthesis.

The urban heat island: re - radiation and re - absorption of heat in towns and cities
Solutions: Afforestation, reforestation, using other sources of energy, fencing places surviving, educating people who refuse to stop cutting trees.

Short - term effects of deforestation include the fact that raindrops will fall directly onto the ground and will no longer be impedded or distracted by trees. This leads to an increase in surface runoff, which may cause an increase in magnitude and frequency of flooding

It also causes reduced evapo-transpiration, which can ultimately lead to decreased rainfall.

Urban climate
The large size of many modern cities means that they make considerable impact on local weather and climates generating heat affecting airflow, changing the Albedo and altering the moisture content of air above.

Temperature High rainfall is promoted by the presence of hygroscopic nuclei, which promote condensation of water vapour over urban areas, leading to urban rainfall. This is also promoted by tall building-(refer to Conditional instability).

Factors that contribute to the urban heat island include

- An increased daytime storage due to thermal properties of city building like concrete, tarmac and bricks (urban fabric).

Daytime heat is absorbed by these materials and is released gradually to air at night.

- A lower evaporation rate is caused by the impermeable nature of many urban surfaces, which aided by drains, promotes rapid runoff after rainfall. Lower evaporation means more heat is available to warm the air.

Air flow: - buildings create sudden changes in wind speed and direction.

Artificial pollutants
Industrial activities lead to the production or artificial pollutants.
Air containing sulphur dioxide or nitrogen gas transforms rainwater into weak sulphuric or nitric acid.
The resulting acid is capable of killing plants leading to a reduction in evapo-transpiration and rainfall amounts.

CFC's (Chlorofluorocarbons) destroy ozone from the atmosphere leading to a decrease in the amount of heat trapped in the atmosphere- resulting in global warming.

<u>Combustion</u>: Large amounts of carbon dioxide are released into the atmosphere when fossil fuels like coal are burnt. Carbon dioxide is an insulator, which traps a lot of heat from the earth's surface (green house effect).
The increase in carbon dioxide levels leads to an increase in atmospheric temperatures (global warming)
Global warming is believed to be responsible for melting ice caps in Polar Regions.
An increase in sea level is experienced and this in turn causes flooding e.g. frequent floods in Bangladesh are believed to be caused by global warming.

<u>Cloud seeding</u>: it is the artificial stimulation of rain
Chemicals (e.g. silver iodide and gases are introduced in the atmosphere, there by changing the atmospheric composition. It has led to a change in rainfall patterns in some areas. However, it is very expensive in less developed countries and they may not afford this method.

NB: Compare the micro-climatic conditions of the Savanna and Tropical Rain Forests.

<u>Examination Type Questions</u>

1. (a) In what ways, and for what reasons, does the local climate vary from place to place within a small rural area with varied relief and vegetation cover? **[15]**
   (b) Discuss the likely influence of a large tropical town on the local climate. **[10]**

2. a) With reference to examples, discuss your understanding of the urban heat island concept (12)
b) To what extent have human activities contributed to climatic change? (13)

3. a) What is meant by the terms <u>green house</u> effect and ozone depletion? (6)
b) Examine the main causes of ozone depletion and global warming. (12)
c) Assess measures that have been taken to reduce the impact of global warming on a global scale. (7)

CHAPTER 9

HYDROLOGY

9.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

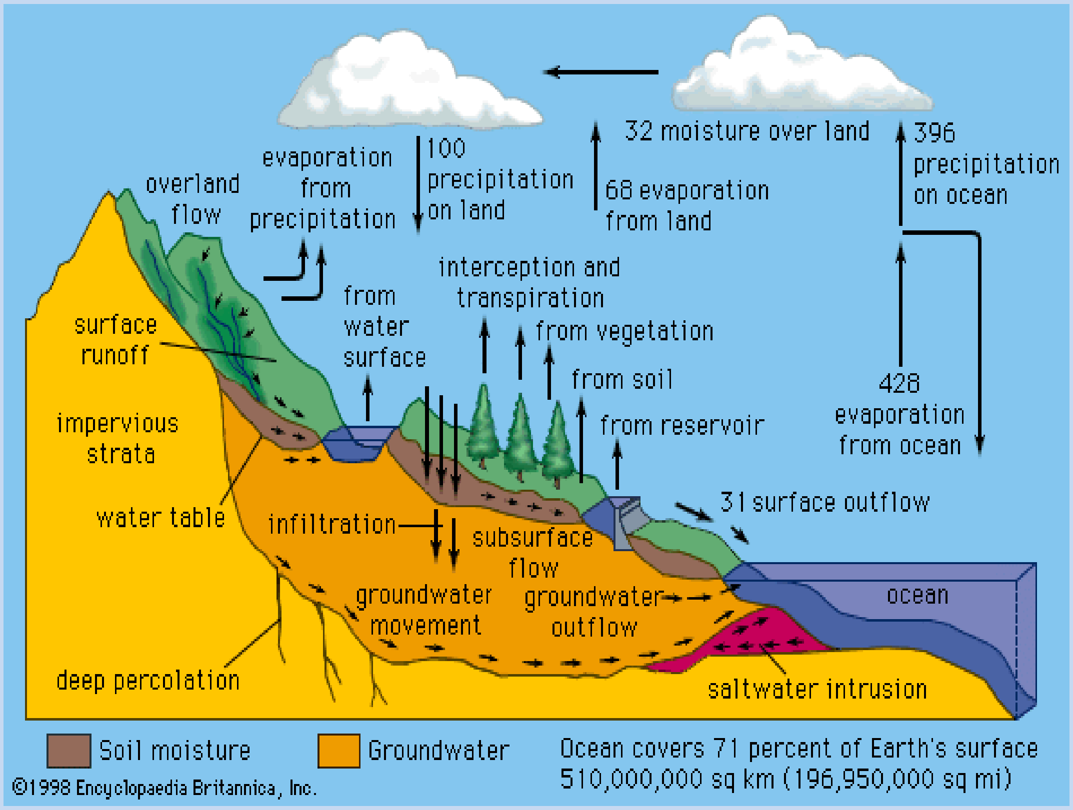
a) Show an understanding of the hydrological cycle.
b) Describe the various components of the hydrological cycle.
c) Discuss the concept of water balance.
d) Describe the nature and form of springs.
e) Evaluate human impact on the hydrological cycle.
f) Examine the role played hydrological processes on land form development.

Introduction

Hydrologyis defined asthescience dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere.There are several important pathways of matter within the earth - atmosphere system, including rock erosion and deposition and various nutrient systems. However, the passage of water, in its vapour, liquid and solid states is unique in that it forms a significant component of nearly all parts of the systems. It thereby plays a major linked role in the study of physical Geography. As shown under climatology the flow of water is intimately linked with the transfer of energy in the system, since large amount of sensible and latent heat are circulated by atmospheric moisture and by ocean waters, and kinetic energy transferred by river and glaciers.

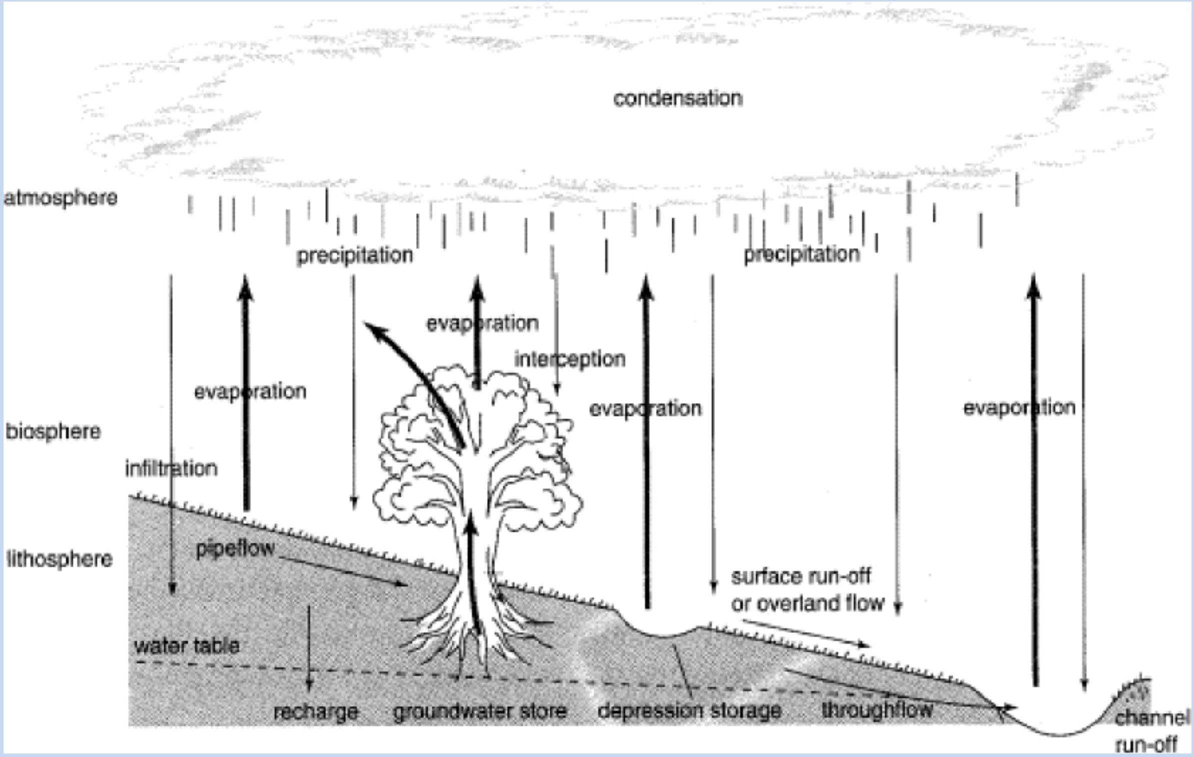
9.2 Hydrological Cycle

It is a model that explains the transfer of water across the globe on a large scale, it explains the role of large water bodies such as oceans being the primary sources of water. Water is then transferred from the ocean to the continental land masses via a number of processes and alternately returns to the ocean. On a localized scale, water bodies such as lakes and rivers form the critical storages necessary for the circulation of water within a drainage basin.



p = precipitation
e = evaporation
pe = percolation
tf = through flow
e.t. = evapotranspiration

Evaporation from the land water bodies and transpiration from plants returns some of the moisture back to the atmospheres to be recycled. In addition to its circulation patterns, the hydrological cycle also embodies a number of reservoirs or storages. Surprisingly large inequalities exist in the global amounts stored. The oceans contain 93% of the totals; glaciers 2% and water constitute 5% of which the vast majority is groundwater storage. Only a fraction therefore is held on or near the surface in the soil, yet this is very small quantity which sustains all life on land. A smaller amount (0,01%) is held in the atmosphere as water vapour.



Inputs, Process, Outputs and Stores and Sub -Stores

The principal input into the cycle is solar radiation from the sun. It provides the energy that enables the transformation of water into different states. Principal water bodies are heated leading to generation of water vapour which rises and cools adiabatically till dew point is reached (condensation). This leads to the creation of precipitation which is another critical input to another system precipitating, in the form of rain or ice.

Processes.

Evaporation Transpiration Condensation
Sublimation
Storages
Atmospheric storage
Ground surface storage
Underground storage
Transfers
Infiltration
Through flow
Percolation
Surface run off
Overland flow
Capillary action
Channel runoff
Interception
Stem flow

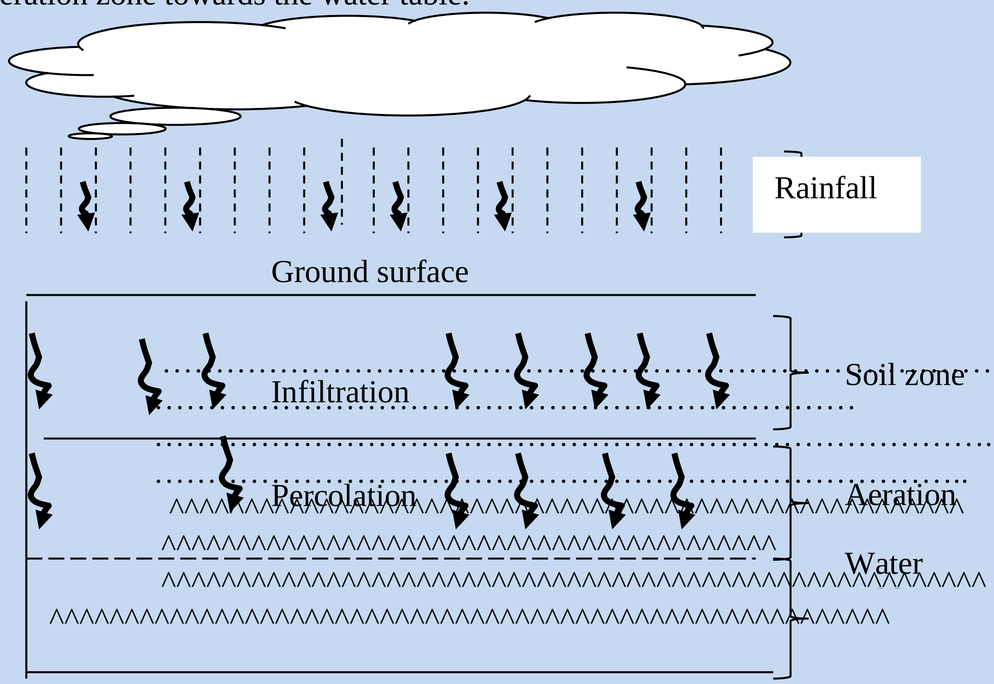
Base flow
Outputs
Evapo-transpiration

Definition of terms

Interception: This is a process when water does not fall directly to the ground because of vegetation. Vegetation prevents rainfall to flow reaching or falling to the ground.
However above certain level or duration of rainfall, the amount that can be held by plant cover is exceeded and the water will reach the ground indirectly either by dripping off the leaves (through fall) or by flowing down the stems and branches (stem flow.
Some of the rain that is intercepted by the vegetation will be evaporated directly back to the atmosphere.
The amount of interception that occurs depends on the character of the vegetation and duration of rainfall.

Infiltration: It is the downward movement of water under the influence of gravitational force into the soil zone.

Percolation: Is the downward movement of water from the base of the soil zone through the aeration zone towards the water table.



Infiltration capacity: The ability of a soil to absorb water into the earth's crust measured in mm/hour.

Infiltration rate: the speed at which water is absorbed from the earth's surface into the soil zone measured in mm/hour.

9.3 Factors affecting infiltration

1. Surface factors –
i) Vegetation
ii) Slope /gradient
iii) Human influence

2. Meteorological factors
i) Rainfall intensity
ii) Rainfall duration
iii) Rainfall type

3. Other factors
i) Raindrop compaction
ii) Type of soil
iii) Biotic factor
iv) Antecedent moisture
v) Frost effect

9.4 Surface factors

Vegetation: There is interception of rain falling to the earth's surface by vegetation- i.e. leaves, branches and stems. As a result, raindrop compaction is reduced as rainfall reaches the earth indirectly as stem flow and through fall. Falling and decaying of leaves provide organic matter, which improves the soil structure, and therefore the infiltration capacity is increased. Water can follow root paths as infiltration.

Gradient or slope: Slopes may be gentle or steep. On steep slopes of the land, runoff is encouraged by the force of gravity therefore water has little chance to infiltrate. On a gentle slope, water infiltrates into the ground more readily.

Human influence: The human impact on infiltration can either be negative or positive. Where impact is negative infiltration capacity is reduced e.g. in urban areas there is tarmac construction by man. Since water will not sink into the ground but flows as runoff into man – made reservoirs, infiltrating is reduced. Where human impact is positive, infiltration capacity is increased and it is evidenced by the improvement of soil structure after application of artificial fertilizer.

9.5

Rainfall intensity: Is the amount / volume in a given area per unit time and is measured in mm/ hour for example, drizzle will cause low rainfall intensity. It affects infiltration in that, if it is too high there will be high surface runoff.

Rainfall duration

This is the measure of time from the starting up to the ending point of rainfall? It affects infiltration by that, if the length of time of the rainfall is short, infiltration capacity is high and infiltration rate will be reduced to zero.

9.6 Type of rainfall

Heavy rainfall e.g. a storm reduces infiltration whilst light rainfall increases infiltration. During heavy rainfall, there is raindrop compaction of the soil particles which reduce water that can infiltrate thus promoting run off.In light rainfall, there is little raindrop compaction thereby increasing amount of infiltration.
Other factors

Antecedent moisture

- Is moisture, which is already in the soil before rainfall? The higher the moisture is, the lower the infiltration capacity and vice versa.

Antecedent moisture is moisture, which is already in the soil before rainfall. The higher the moisture is, the lower the infiltration capacity and vice versa. Initial drier soils tend to have higher infiltration rates than already soaked soils. This is because soil particles, especially clay, tend to become stickier and swell whenever wetted such that the pore spaces may become sealed. Moisture still present in the soil from a previous rain will tend to lower infiltration capacity. Extreme dryness, where the soil surface is compacted, will lower the ability to absorb water.

Initial moisture content %	Infiltration Rate (mm/hr)	
	Good grass cover	Poor weed cover
0-14	18	6
15-23	7	4
24 +	4	3

Frost effect

- Mainly in the temperate regions.

It reduces infiltration by closing the pore space when the ground is covered.

Soil structure and texture:

Application of fertilizer, for example, lime improves the soil structure by increasing the crumbs of the soil thus increasing infiltration capacity. Soil structure is the arrangement of soil particles in the soil profile. Soil texture is the coarseness or fineness of soil.

Biotic factors
This includes the effect of animals and vegetation. Earthworms can enter the soil while carrying humus thereby increasing infiltration. They make holes through which water passes.

Percolation
This is the downward movement of water from the base of the soil zone through the aeration zone towards the water table.

Percolation amount:
This is the volume of water moving downwards from the base of the soil zone through the aeration done towards the water table.

Percolation rate
- The speed at which water moves from the base of the soil zone through the aeration zone towards the water table.

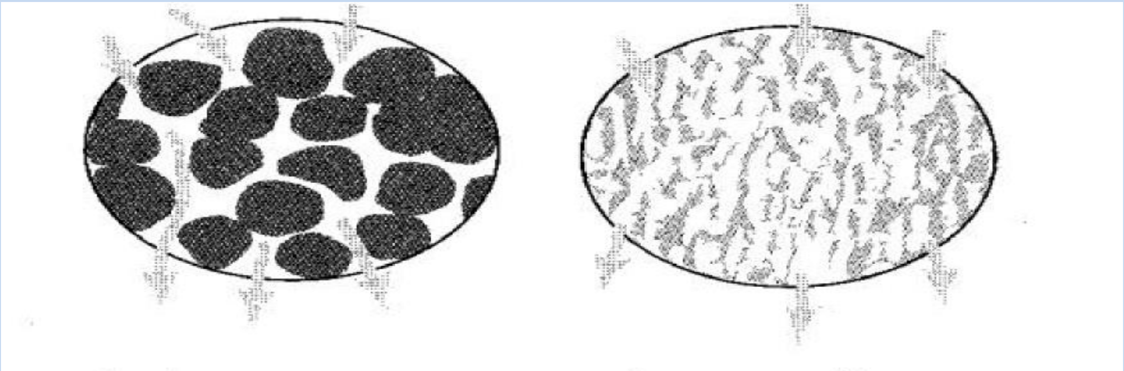
9.7 Factors affecting percolation amount

1.Amount of rainfall.
2.Type of soil.
3.Porosity.
4.Permeability .
5.Infiltration.

Porosity
- Is the amount of pore spaces in a given rock or soil structure? There is a relationship between porosity and percolation. The higher the porosity the higher the amount of percolation.

Permeability
This is the ease with which water can pass through pores within a given soil or rock structure
There is a direct relationship between permeability and the percolation amount.
The higher the permeability, the higher the percolation amount.

Percolation rate - Factors affecting the size of pore spaces: the larger the pore spaces the higher the percolation rate and vice - versa.



Interconnection of pore spaces: - If the pore spaces are not connected and do not lead into each other, they will fill up as percolation continues and thereby reducing percolation and vice-versa.

9.8 Differences between infiltration and percolation

Definition: Infiltration is the downward movement of water in the soil zone due to gravitational force whilst percolation is the downward movement of water from the base of the soil zone through the aeration zone towards the water table.

Location: Infiltration is confined to the soil zone whilst percolation is continued to the aeration zone.

Controlling factors: Factors that control percolation are sub-surface factors whilst infiltration factors are surface ones.

Significance: Infiltration supplies water to the soil zone whilst percolation supplies water to the aeration zone. Infiltration precedes percolation - infiltration comes first before percolation (there is no percolation without infiltration).

Runoff - This is the movement of water either on the ground surface (overland flow) or horizontally within the soil zone (through-flow). Runoff comprises the rain water which leaves the drainage basin by surface routes, either as water running down slopes in the form of sheet wash, hills and rivulets (overland flow) or water concentrated into streams and rivers (channel flow) -R. J. Small. Runoff is initially a direct product of rainfall or melting snow and ice, but may be considerably augmented by spring and seepage flow, which taps soil water and groundwater sources.

Through flow: It is the lateral movement of water after infiltration in the soil
As already indicated above, it is part and parcel of run-off.This is consequent upon the base of the soil zone being impermeable, meaning if the upper layer of the aeration zone is impermeable no percolation will take place therefore course of water will be changed from a vertical to a lateral direction. Where the permeability of the regolith decreases downward,

most commonly at the base of the soil zone, water cannot penetrate into the lower horizon fast enough. Rather it is deflected laterally as through flow.

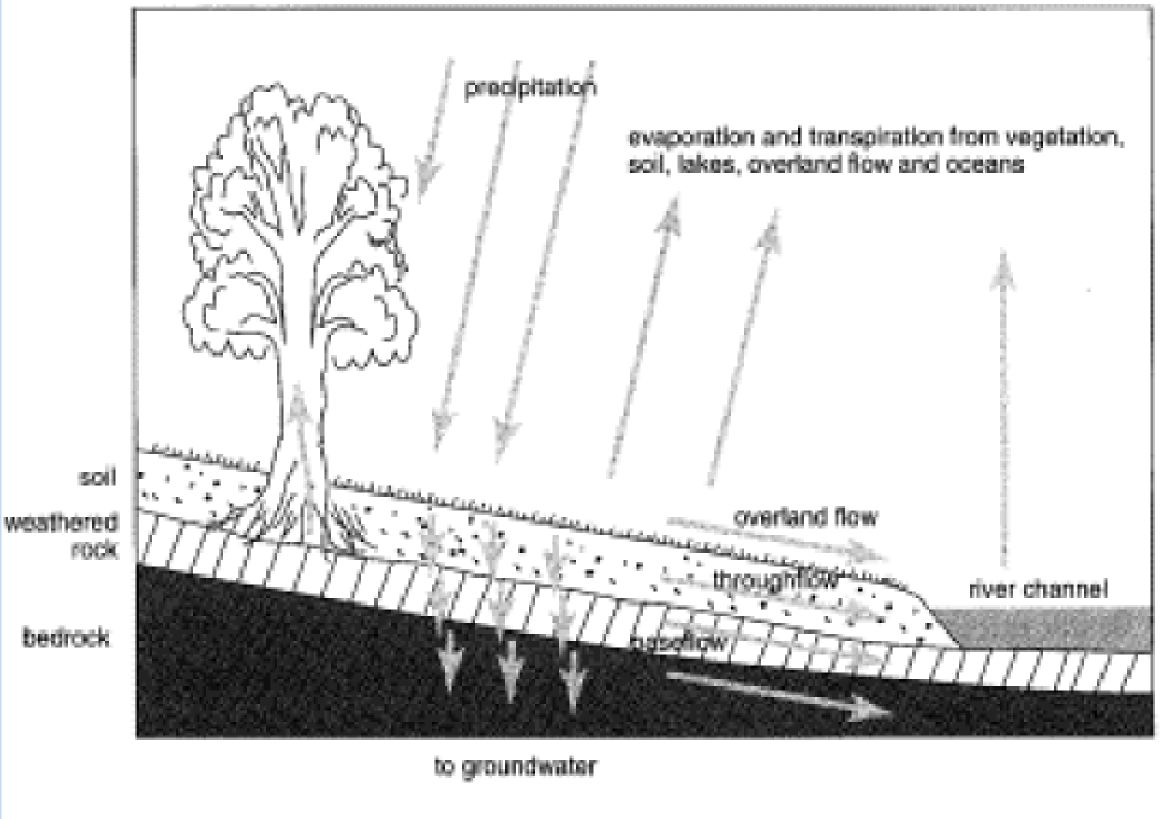


Figure 6.9 *Throughflow and baseflow down the slope*

<u>Surface run-off (overland flow)</u>.

It is a form of flow that exists as sheet or concentrated flow within a given area.

It is generated when the soil has been saturated to fill the capacity, that is, the antecedent moisture will be at 100% and as a result the soil will not have the capacity to absorb more water. This water will then flow on the surface as overland flow. When the soil releases water back to the surface as a result of reaching maximum soil moisture levels saturated over land flow is generated.The Hortonian model of overland flow assets that on the upper part of a slope overland flow generated is in the form of sheet wash. This is because of a very gentle gradient that promotes uniform infiltration into the soil. When the filled capacity has been reached, overland flow is generated. This is a zone where most of the overland flow is generated. At the middle part of the slope overland flow occurs in the form of reel and rivulets due to the gradient of the slope. This region overland flow is generated over a long period of time (the gradient of the slope primarily promotes the generation of surface runoff and the soil is gradually recharged to filled capacity).At the lower part of the slope, overland flow occurs as well defined concentrated flows in rivers. This part of the slope forms a collection zone for all the overland flow generated on all the parts of the slope as well as from the generation of saturation.

Hydrology and landform development summary

The water cycle may produce changes in the land surface from the moment when the precipitation first hits the ground to when it re-enters the sea. The amount of moisture of moisture moving through the soils influences chemical reactions in the soil as well as its structure and profile. It is the weathering sub-system of the drainage basin. Water helps to shape landforms. As water moves between the land, oceans and atmosphere, it causes degradation and aggredation. The importance of it can be seen in the slope and channel sub-system. The drainage basin system is made up of the weathering, slope, channel and network subsystem. Together they form a cascading system , where the output from one is the input of other.

Among the various hydrological processes, precipitation, overland flow and channel flow certainly have greater roles in the formation of landforms.

Precipitation and Weathering

Precipitation is the ultimate source of supply of liquid water and ice which are needed for the weathering of rocks.

1. The physical weathering process of frost action is initiated by the growth of ice in rock cracks.

2. Liquid water found on rock surfaces and topsoil cause chemical weathering in four ways: --

- I Hydrolysis, which is a reaction between a mineral and water
- II Hydration, which is the taking up of the water molecule (H2O) into the rock mineral.
- III Carbonation, which is the reaction between carbonic acid (formed by the combination of carbon dioxide and water) and carbonate minerals * such as calcium carbonate in limestone)
- IV Biological weathering which is indirectly related to but dependent on the supply of rainwater that is needed for the growth of plants and animals.

Overland flow

Overland flow, while derived from precipitation, is the process, which produces changes to slopes. The main ways by which overland flow causes changes to slopes are

1. Landslides occurring along straight glide planes after slopes have become over-saturated with rainwater.

2. Slumps occurring along a curved slip planes.

3. Flow occurring as on clayey slopes by internal deformation.

4. Surface wash by which surface weathered debris is eroded by water running on the slopes.

5. Sheet flow which occurs as a thin continuous layer of water eroding fine and medium sized particles on vegetated slopes receiving high intensity rains

6. raindrop splash which causes a net down slope movement of soil through the impact of raindrops

Channel flow and stream sub-system

Water entering into channels moves towards the outlets of drainage basins .This is because of the force of gravity. The geomorphological outcomes of this movement are the erosion or the removal of weathered debris from the channel   floor, the transportation of weathered debris along with the channel flow towards the lower course, and the deposition of weathered debris at the bottom and along the two sides of the channels.

The next chapter on fluvial processes is a detailed examination of the channel sub system.

Evapo-transpiration

This is a composite or joint term to explain loss of water from water bodies through evaporation and loss of water from plants, principally from leaf stoma process known as transpiration. In other words it is the amount of water returned to the atmosphere by the combined process of evaporation from land surfaces and transpiration from plants .It can either be actual or potential evapo-transpiration.

Actual evapotranspiration

This is the real or the amount of water lost into the atmosphere through the joint process of evapo-transpiration and transpiration. This is the observed true amount of evaporation and transpiration that may lead to a soil moisture deficit if no rainfall where received. In areas of heavy rainfall the actual evapo-transpiration is equal to potential evapo-transpiration i.e. actual evapo-transpiration, potential evapo-transpiration

Potential evapo-transpiration

It can be defined as the maximum amount of water that can be lost into the atmosphere from surface storage assuming that the soil moisture content is always at field capacity. This can only be achieved through a continuous supply of water. It is made available to the area for example, irrigation.

9.9 Factors affecting Evapo-transpiration

Insolation

Size of leaves-types of vegetation

Wind speed

Deforestation

Humidity

Cloud cover

Insolation: It governs activities of plant photosynthesis. An increase in the amount of solar energy speeds up all process that includes circulation of water through root, stem and leaf. Rates of transpiration are greatest during the day and in summer.

Temperature is directly related to intensity and duration of solar radiation. It tends to set up the broad limits to plant growth. It also affects evapo-transpiration.

Wind speed: Removes water vapour transpired from the stoma and therefore tends to encourage high rates of evapo-transpiration.

Humidity: High humidity permits the stoma to open wider and remain open for a longer period. It affects the rate of evapo-transpiration negatively transpiration from the leaf - surface is increased.

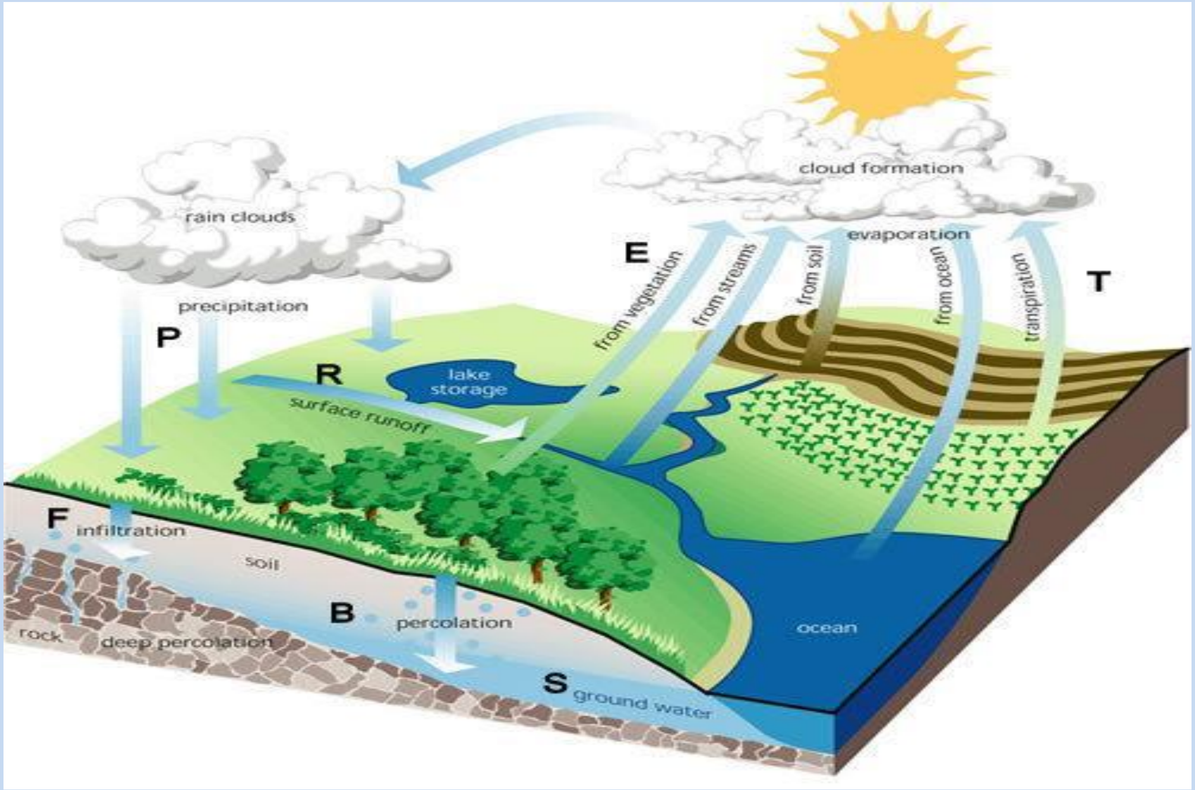
Vegetation types and density ie, how much loss of water and such trees have larger leaves. Other trees have long roots that take a lot of water from the ground. Some trees have small leaves which narrows hence little evapo-transpiration occurs.

Density of vegetation is important because many trees absorb a lot of water from the ground. However, thick vegetation does not allow rapid flow of wind thus reducing evapo-transpiration

The Concept of Water Balance

The concept of water balance is a theoretical assumption that assets that there exists a state of equilibrium between inputs and outputs in a hydrological basin.

It is usually expressed as an equation **P=E+R±S** where P represents inputs in the form of precipitation, E represents outputs in the form of evapo-transpiration, R represents outputs through channel run off and S represents gains and losses within the storage system.



On a global scale there is indeed a state of balance between inputs and outputs i.e. the amount of rainfall received is equal to the amount of water lost through evaporation or runoff. Water balance is determined by the relationship between precipitation and temperature as well as other localized factors. The water balance therefore varies from place to place and from time to time in response to the variations between climatic factors. The humid tropics are characterized by high temperature throughout the year. Those temperatures therefore promote the accuracy of intense precipitation. As a result, more rainfall is received in this region, creating a positive balance throughout the year. This is evidenced by surface storages of water.

The hot deserts are characterized by high temperatures throughout the year and low precipitation. Therefore hot desert regions are zones of perennial water deficits and the little rainfall that is received is quickly evaporated into the atmosphere; the only form of surface storage that may exist would be water emanating from underground storage (oasis that are recharged from other hydrological basins).

The peri-glacial regions are characterized by very low temperatures. This means that the rates of Evapo-transpiration are very low and water that falls into this region is stored as ice, creating a positive balance in the system.

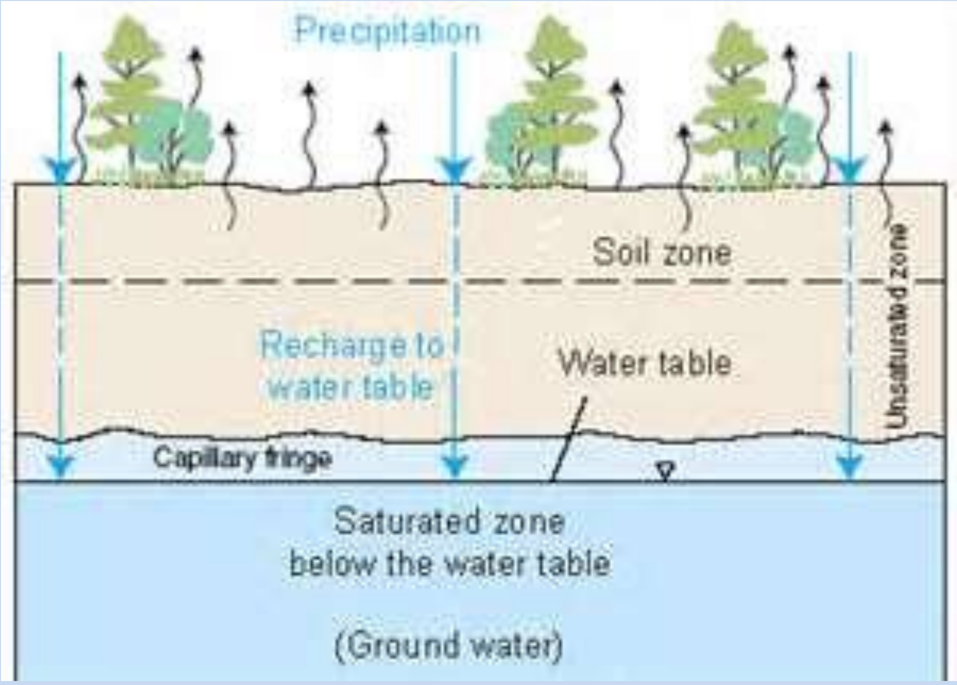
The seasonally humid tropics are characterized by two distinct seasons. During the wet season the amount of precipitation exceeds the rates of actual and potential Evapo-transpiration. As a result there are a lot of surpluses into the system, characterized by increased surface storages as well as the rising level of water table, however during the dry season the rates of evapo-transpiration exceed the amount of precipitation received. This initial leads to the depletion of surface storages and a rise in soil moisture deficit. Seasonal rivers dry up and perennial rivers are changed from underground shortages through the process of base flow recharge.

9.10 Underground water

Underground water forms the zone of underground storage within the system. This storage system is formed as a result of water percolating deep into the ground and through the ground base flow recharge. It is generally referred to as a water table.The nature and height of water table is influenced by a number of factors.

The water table

When the water percolates into the ground it reaches a point where it cannot percolate further but it accumulates in the pores of rocks, creating a zone of underground storage.The depth of this storage increases over a period of time thereby creating a zone of permanent saturation within rocks known as a permanent aquifer.This region is generally referred to as the water table. However, the term water table specifically refers to the upper level of ground water level which marks a break of saturated and unsaturated water strata.



The water table mirrors surface topography, that is, it rises and falls in response to surface relief characteristics. This is because water is stored in rocks, meaning that, if a rock stratum bends downwards the water table does the same.

Forms of the water table

Three distinct forms of the water table have been identified. <u>The Percolation water table</u>: It is a water storage that is created as a result of the natural percolation and accumulation of water underground to form ground water storage.
<u>Seasonal/ intermittent</u>: As the name suggests, this is the water table that develops as a level higher than the percolation water table due to the increased ground storage recharged, thus during the wet season, the level of the water table would be higher only to drop back in the drier months of the year.

<u>Perched water table</u>: This is the zone of underground water storage, that develops above the natural water table as a result of the existence of an impermeable rock layer such as clay or laterite which will impede downward percolation of water and promote the formation of a zone of secondary underground storage. Perched water tables may be a result of duricrust, which may be in the form of laterite. The duricrust are a result of heavy leaching of nitrates, iron or other minerals which gather to form hard rock.

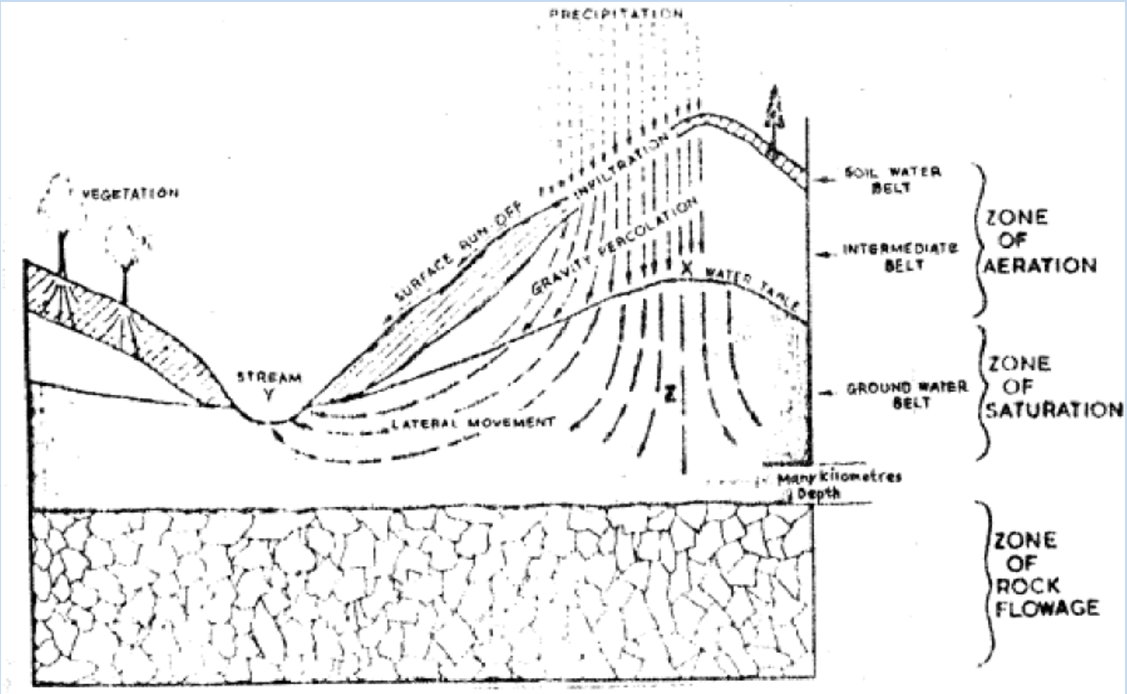
<u>Aquifer:</u>An aquifer is a rock that yields water and allows it to flow freely. Such rocks have a high water storage capacity.

9.11 <u>Types of Aquifers</u>: -

i) Free water or Unconfined Aquifer
This is one in which the water table serves as the upper surface of the zone of saturation. It is also known as a free water aquifer.

ii)A Confined Aquifer
The water yielding or bearing rock will be confined between impermeable layers and it is known as a pressure Acquifer. It occurs where ground water is confined under pressure greater than the atmospheric pressure.

<u>Division of the sub-surface zone</u>
The diagram below shows the division of **the** subsurface zone. This helps in the understanding of underground storage.



9.12 Sources of Ground Water

1.Precipitation: This is the main source of ground water known as meteoric water.

2. Condensation of water vapour from air circulation through pores and interstices. This occurs in very small amounts but still it is a source, which cannot be ignored.

3. Water trapped within rocks during the time of their formation or geological evolution.

This is highly mineralized and salty. It is found in the lower layers of the saturated zone and is called connate water.

9.13 Factors influencing the form and nature of water table

Climatic factors

Amount of rainfall received (intensity and duration)
Temperature
Vegetation
Seasonal variations
Geological factors
Permeability
Rock structure
Topography
Rock type
Other factors

Human activities:- extraction of underground sources
Urbanization

9.14 Springs

They can be defined as a natural out flow of water from an underground storage at a point where the water table meets the surface.The water flows in response to gravity and hydraulic gradient as well as the volume of water within the storage system.The formation of springs is largely attributed to geological structure.

Springs Occur:

(i) At a valley when the water table is above the eroded valley (may dry up when the water table is lower).
(ii) At a point where water seeps into permeable rock e.g. sandstone, limestone or other porous materials but finds a hard underground layer of impervious rock. At this point, water is forced to flow on top and along this layer till it meets the land surface. Such springs may flow at a moderate rate throughout the season.
(iii) Groundwater may percolate deep into the crust where it is heated by hot rock out. This may flow out as a thermal or hot spring sometimes as steam (geysers) which tend to be used as sources of power in New Zealand and California.

It should be noted that it is the natural flow of water from the ground, it may flow out strongly, gush out with great force or just ooze or sip out. In some parts of the world people rely on springs as the source of water supply. Springs are related to nature of rocks (geological structures) and surface relief. They occur at or below the place where the water table meets with the surface.

9.15 Types of springs

Dimple/ simple spring

It occurs when the water table comes in contact with the surface in a gentle undulating terrain

Valley bottom spring

- Formed when a vertical incision by river exposes the water table leading to the formation of a line of springs on the valley sides.

Scarp- foot springs

- Formed at the bottom or foot of scarp slopes as aresult of backward retreat of the slope.

Fault line spring

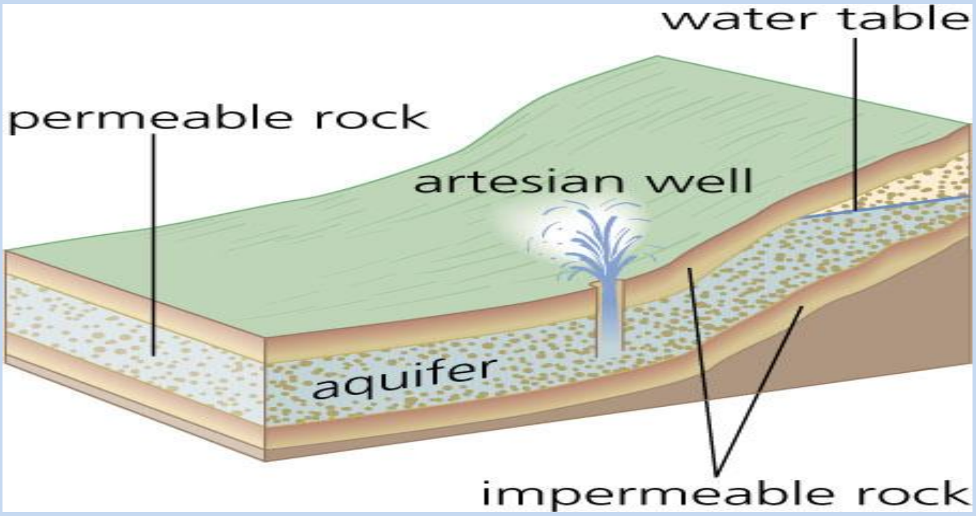
These are springs that develop in faulted regions as a result of tectonic adjustment. When faulting occurs, it may disturb the natural occurrence of the water table leading to the outflow of the water table on the surface.

Vaclusian springs

- Occurs in limestone regions. There are points where rivers that would have disappeared upstream have reappeared back to the surface.

Artesian spring

An artesian basin is a form of water table that is formed due to geological occurrence, it consists of a zone of permeable rock that is overlaying and underlying impermeable rocks. The water table is recharged by precipitation falling on the fringes of the base where the permeable rock is exposed to the surface.Water in this region is under a lot of pressure such that when a well is dug water would flow out naturally forming an artesian spring.



9.16 Factors Controlling Discharge of Springs

1. Level of the water table: The fluctuations of the water table results in either the occurrence or non – occurrence of springs. When there is a rise in the water table it means a high discharge of water resulting in springs and vice – versa.

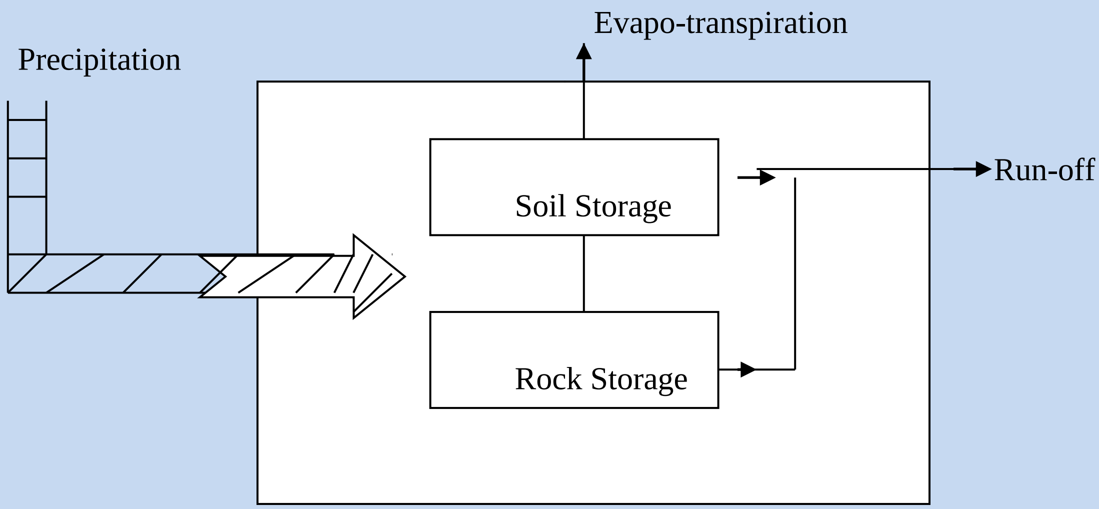
2. Temperature: An increase in temperature will result in a decrease in pressure. Water will be less dense, hence it will escape through joints or faults emerging at the surface.

9.17 Water budget of the hydrological system

The water balance equilibrium.

The concept of water balance can be defined as the state of equilibrium that exists within a hydrological basin.It assumes that there is a balance between precipitation, runoff and Evapo-transpiration, usually expressed through the equation: $\mathbf{P=QR+ E \pm \Delta S}$.Where P=precipitation in various forms; QR= runoff (outputs); E=gains or losses in storage

Water balance or equilibrium only exists as a theoretical concept. Some areas experience more precipitation that exceeds potential Evapo-transpiration. As a result these regions have got a water balance surplus, some regions experience Evapo-transpiration rates that are above the amount of precipitation received within the area. As a result such regions experience water balance deficits. Therefore water balance is influenced by the relationship between precipitation and Evapo-transpiration rates. Thus water balance varies from place to place, and from time to time, in response to the changes in the amount of precipitation received and the rate of Evapo-transpiration.



How water is stored between entering and leaving the drainage basin.

Human impacts on the hydrological cycle

Positive effects	**Negative effects**
Daming	Urbanisation
Paddocking	Industrilisation
Afforestation	Deforestation
Cloud seeding	Mining

Damming:
The construction of water reservoirs e.g. dams affect the natural flow of water and evaporation. Dam constructors encourage evaporation. Infiltration is also encouraged as water has enough time to percolate into the soil, thereby raising the water table.

Afforestation
Planting of more trees encourages the infiltration since as the roots of the trees open up pore spaces and also reduce the rainfall intensity. This gives the soil enough time to take in the coming water there-by raising the water level of the water table and discouraging runoff.

In vegetated areas, there is interception of water on the leaves of trees. When this happens, some of the water is transpired badly into the atmosphere through evaporation. Transpiration is important because it contributes to the water vapour in the atmosphere.

<u>Cultivation</u>
It loosens up the soil structure and allows infiltration to take place thereby raising the level of the water table. Runoff is reduced because water collects in furrows. On a hard and undisturbed ground surface, infiltration is low and runoff is high since it is impossible for water to enter the impermeable hard surface.

<u>Paddocking:</u>
This refers to controlled grazing. Over-grazing in paddocks can cause land and vegetation deformation Stock pathways can develop into streams, and consequently into gullies..

9.18 Examination Type Questions

1. (a)Explain the terms "rainfall intensity" and "inflation capacity."**[6]**
(b)How far can these terms help us to understand the formation of surface runoff on slopes? **[10]**
(c)How may human activities increase and decrease surface runoff on slopes? **[9]**

2. (a) Briefly explain the terms "infiltration", "through flow" and "percolation". **[9]**
(b) Explain the influence on ground water storage of:
(i) Seasonal changes in climate
(ii) rock- type and structure. **[10]**
(c) What role does ground water play in the discharge of rivers? **[6]**

3. (a) Explain briefly what is meant by the term "water balance". (6)
(b) Why does the water balance change from time to time throughout the year in an area you have studied? (12)
c) Explain the main effects of the water balance on the discharge of rivers an area you have studied. (7)

CHAPTER 10

RIVER PROCESSES AND LANDFORM DEVELOPMENT

10.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Describe the main processes of river transportation and erosion.
b) Describe the characteristics of river cross profiles.
c) Discuss the concept of a graded profile.
d) Account for the development of landforms and features resulting from river action.

10.2 Fluvial Geomorphology

It is the study of river processes and their impact in shaping the earth's landscape. A river is a volume of water flowing in a confined channel.

10.3 Types of Rivers

Perennial Rivers. They flow constantly through out the year.

Ephemeral Rivers. These flow in response to seasonal variations and climate i.e. they flow during the wet season.

Intermittent Rivers. These flow after sudden down flow, for only short durations.

Drainage Basins. These refer to an area drained by a river and its tributaries, it is also referred to as the river's catchment area.

Fluvial Processes

The water is in a channelized form when it flows following a route within the earth's surface.

The source of a river may be a spring/ lake/ marsh, but it is generally in an inland region where precipitation is heaviest.

Rivers flow towards lowland or down the slope due to gravitational forces.

The place where the river originates is called its source and where it enters the sea the mouth. The place or crest of mountains from which streams flow down the slope on both sides, is called the watershed or a divide. An upland where a river receives all its water from is a drainage basin or a catchment area. The initial stream that exists as a consequence of the slope is the catchment area.

The point or place where two rivers meet is the confluence. Water flows under gravity seeking the path of least resistance (e.g. a route that maximizes its velocity and minimizes loss of energy through friction).
The three types of flows are:

Laminar flow. Water flows in layers parallel to the bed with water in the bottom maintaining its position for a considerable distance. Usually that occurs when water flows over sediments on the river bed without distributing it.

Turbulent flow. Water flow consists of a series of erratic eddies, both vertical and horizontal with a down stream direction. The river's energy is lost if there is a turbulent flow which causes energy to be used to overcome the friction within water caused by the turbulence, caused by the ;

Roughness of the bed
The energy used to overcome friction on the bed and banks of the channel.
The shape of the channel: more energy used to flow through a flat wide channel and through a narrow deep channel because the wider one has a large surface area and friction is therefore greater.

The channel slope. In the upper part of a river there is more turbulence, roughness and more friction and a steep slope.

Helicoidal flow. Water flows in a cork-screw motion, mostly found in rivers that have uneven beds, especially where there are lots of rapids.
River Erosional Processes
The river erodes its channel through the following processes.

Abrasion/ corrosion
It is the mechanical grinding of the river's traction load against the bank and bed of the river.

Rock fragments are hurled against the sides of the river. It takes place in two ways:

Lateral corrosion
- Sideways erosion which widens the V-shaped valleys.

Vertical corrosion.
- Downward action which deepens the river channel.

Corrosion is most effective during the time of flood because that is when rivers are capable of carrying a lot of load. If there are hallows in the river bed, pebbles are likely to become trapped. Turbulent eddies can swirl pebbles around to form potholes.

Attrition
This is the wear and tear of the transported materials, they roll and collide with one another.

The coarser boulders are broken down into smaller stones, the angular edges are smoothened to form rounded pebbles.
The finer materials are carried further downstream to be deposited.

Corrosion (solution)
This is the chemical/ solvent action of water on soluble/ partly soluble rocks which river comes into contact with.
It is the erosion of rocks that are made up of minerals that dissolve in water e.g. calcium carbonate in limestone is easily dissolved and removed in solution.

Hydraulic Action
This is the force of water itself as it loosens and sweeps away the materials in the river.
Some water splashes against the river banks and cravicies disintegrating the rocks.
Softer rocks are also eroded.

It also picks up the loose fragments from its banks and bed and transports them away.
This is more effective when the river is in flood.

River Transportational Processes
Any energy that remains after the river has overcome friction can be used to transport sediments. The maximum size of material that is capable of transporting at a given time is called its competence. Rivers are more competent when they are in flood and moving at high velocities because that is when they are capable of moving large particles.
A river transports its load through- suspension/ suspended- solution-traction-siltation.

Suspension
This is the transportation of very fine particles of sand, silt, clay and mud which are held up by the turbulence of fast flowing rivers.
The greater the turbulence and velocity are, the larger the quantity and size of particles which can be picked up.

Solution
The transportation of materials dissolved in the water.
The boundary of heavier particles, like pebbles, sand and gravel on the river bed are temporarily lifted up by water and bounced along the bed in a hopping motion.

Traction
The movement of larger and coarser particles (i.e. pebbles, stones, rocks and boulders), which cannot be picked up by water, and hence, their being rolled along the river bed.

Drainage pattern analysis
Rivers flow down hill in response to the forces of gravity, they are said to be cutting down to base level. Different patterns emerge as rivers flow; these are mainly as a result of geological structure.

In areas characterized by uniform base rock that is impermeable such as granite a **dentritic** pattern is likely to develop. River tributaries join the main river at any angle forming a branch like pattern.
In areas characterized by alternating bands of soft and hard rock or well defined joints and faulty lines, a **trellis** drainage pattern is likely to develop.
River tributaries join the main stream at right angles.

Trellis and Paralleldrainage patterns develop in areas that have undergone tectonic re-adjustments. Streams will flow downhill in parallel channels joining each other at right angles. This type of drainage can also occur in areas with alternating bands of hard and soft rock strata in which the softer rocks are easily eroded streams will carve their valleys in the softer band and tributaries will thus flow from the resistant rocks joining at the main river in angular fashion.

Radial drainage pattern develops in areas characterized by the existence of a water body at a high altitude such as volcanic craters. Streams will flow from the top of the crater, downhill in all directions.
In areas characterized by inland depressions, a **centripetal** pattern develops.
Rivers from highland areas will flow towards the low lying areas e.g. Okavango Swamps in Botswana.

Drainage density

It is the average stream length within a unit area. Drainage Density (Dd) is the total length of the drainage channel (L) divided by the drainage area (A)

$$Dd = \frac{\Sigma L}{A}$$

Where Dd = drainage density
ΣL = sum of total stream lengths
A = catchment's basin area

Drainage density is usually expressed as a ratio in km^2

Implications of drainage density

It reflects a complex interaction of factors which control surface run off and thus varies over space and time.
It determines the efficiency with which surface runoff is discharged from an area during individual storms.
Is it drainage density that determines water flows or water flows which determines drainage density?

Obviously, an analysis of drainage density would help you come up with an explanation concerning rock type, vegetation cover, precipitation and topography.

Drainage density is greater on impermeable rock (e.g. granite) than on permeable one (e.g. Limestone). The same applies to the soils. It is greater in clays than in sand soils.

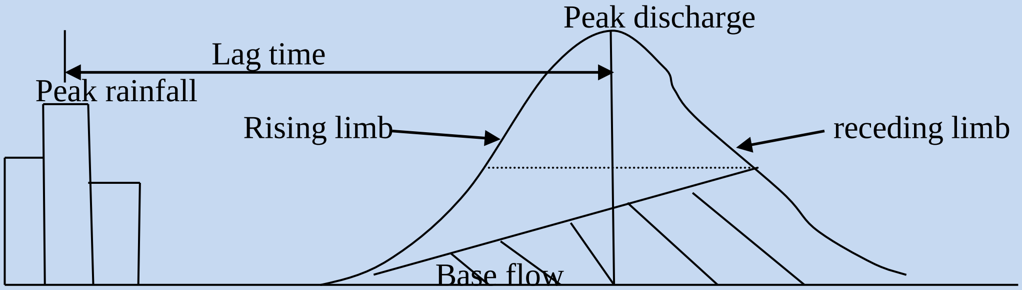
Drainage density is much higher in areas with little vegetation. It decreases with an increase in forest cover. Ironically, deserts and semi- arid regions have the highest drainage density though most of the times the channels are dry.

Drainage densities have seasonal variations. They are greater in the wet season than in the dry season. They also fluctuate with extremes of rainfall e.g. they are greater during the times of floods than during the times of drought.
Drainage density is also greater on steeper slopes than on gentle slopes.

River Discharge
This can be defined as the volume of water flowing through a specified channel within the river channel at a given time measured in mm/sec.
The discharge of rivers varies due to factors outlined below
The discharge of a river can best be explained through the use of a hydrograph called the Storm hydrograph.

The Storm Hydrograph

Diagram showing storm hydrograph



It is a graph that shows the variation in river discharge in response to periods of peak precipitation. In other words, it shows the relationship between peak rainfall period and peak river discharge.

Lag time- it is the period between peak rainfall intensity and peak river discharge.
Bank full stage- it is the point of the maximum carrying capacity of the river.
Over bank stage- it is the point where the river exceeds its carrying capacity.

10.4 Components of the hydrograph

Lag time. It is the time between peak rainfall and peak discharge when the rain starts to fall, there might be a lot of infiltration before runoff commences.
This varies according to the basin characteristics and rainfall intensity.

Time of rise.

- The interval between the beginning of rise and associated peak.

Rising limb. This part of the hydrograph shows an increase in discharge with time as water from different areas within the catchment area is fed into the stream.
It is relatively steep, once runoff commences.

Peak discharge. This is a point reached when water passing a gauging station has reached maximum point (peak point)
The Recession limb/ falling limb: part of the hydrograph that represents water loss in the river.
It is controlled by the amount of water stored in the basin and the way in which it is held in the soil and bed rock.
Gentle when compared to the rising limb cause of the additional water in the form of through which takes longer to reach the river.

Base flow. The amount of sub surface water found in a river before it is stored by springs and seepages. It depends to a larger extent on the contribution from the ground water.

Hydrograph Explanation

Double Peak.

- Happens when a channel receives water supply from the surface and sub surface routes. The first peak discharge would be of quick flow component and the other of delayed flow component. A hydrograph with a very sharp peak results from immediate surface runoff, with little absorption and storage of water in the basin.

Stream ordering

This is a method that is used to classify the nature of streams in a drainage basin, in addition to the use of stream densities in a given basin, streams are classified according to their characteristics. Streams are classified according to their formation.
The initial tributaries in a basin are given the first order classification and the combination of two first order streams leads to the formation of a second order stream. This method of stream ordering is important when you analyze the evolution of drainage patterns from infancy to maturity. A drainage pattern characterized by a lot of first order streams shows that the area is still in the early stages of drainage and landform evolution as propounded by W.M Davis on the other, the mature stage of drainage evolution is characterized by one principal river with very few or no tributaries.

Flood Prediction/ Bifurcation Ratio

Modern day hydrologists have come up with ways of determining the risks of flooding caused by particular drainage basins. There is the use of drainage density analysis where basins with greater stream densities cause a greater flood risk due to increased discharge on the main river.
Lower order streams are characterized by high velocity and confined channels, hence they overflow their banks quite rapidly as compared to higher order streams. A drainage basin with a higher ratio of low order streams is at a higher risk of flooding as compared to a basin with higher order streams.

A flood prediction ratio is obtained through adding the number of streams in one order expressed as ratio to the streams in the next order e.g. if a drainage basin is characterized by four first order streams against one second order stream, the risk of flooding is very high.
N.B: This is very important when analyzing drainage patterns in topographical maps

10.5 Study of River Cross Profiles

It is concerned with the nature of river cross sections at different parts of the river regime. We seek to make an analysis of the processes responsible for carving out their form.

Channel Form

The form of river channels is influenced by a number of processes and factors operating within different parts of the river's long profile.
Three distinct profiles can be identified. These are:
V-shaped profile
U-shaped profile
Open/ rectangular profile.

Upper course
Source region
Steep gradient
High velocity
Low volume of water in channel
Minimum load
Processes
Active River down cutting
Development of V-shaped profile

Middle course
Increase in load
General reduction of gradient
Processes

- Active channel widening due to the increased load.

Development of a U- shaped valley.

Lower course
Volume of water is at its highest.

Processes
Excessive deposition
Development an open/rectangular profile

River long Profile (River Regime)
This refers to the flow of a river from its source to its mouth. It is concerned with the characteristics of the river as it flows from its source to the mouth. Geomorphologists have come up with the term graded profile or concave profile in an attempt to present simplified characteristics of the river regime.

Evolution of drainage

Fluvial geomorphology is concerned with the impact of running water within an environment. It has been noted that drainage and river systems like any processes are undergoing a process of evolution. Drainage undergoes three stages of evolution:

Youthful stage
Mature stage
Old stage

Youthful stage

It is characterized by very high stream density in an area characterized by highlands.
Most streams are characterized by narrow deep sided valleys giving evidence for river down cutting.

Mature stage

It is characterized by a general drop in stream density. There will be a definite stream in the main river, i.e. be able to identify the main river and tributaries.
There is a gradual decline in the nature of our highland with the development of isolated features as a result of river down cutting, weathering and erosion.
These upstanding features give evidence to the fact that the whole area was once an upland.

Old stage

It is characterized by an area with very few or no tributaries, the river will have the characteristics of the lower course.
There is a well defined river valley covering a great horizontal extent.
Isolated uplands are generally few.

FLOODING

Causes:

Natural	Man-made
Changes in climate	Poor farming methods
Global warming	Deforestation, speeding up runoff
Tropical cyclones	Stream bank cultivation and gold panning
Siltation reducing depth and width	

Prone areas

- India and Bangladesh.
- Because the place may be located in a delta region.
- Because the place may be located in low lying areas (coastal areas).

10.6 Examination type questions

1. Show how the discharge of a river may vary from time to time. (25)
2. Account for the formation of waterfalls and rapids. (25)
3. Discuss the relationship between geological structure, drainage density and the development of drainage patterns. (25)
4. Compare and contrast drainage in limestone and granite regions. (6)

b) With the aid of well annotated diagrams describe the development of landforms in granite and limestone regions (12)
c) Critically examine human influence on occurrence of floods in a river basin you have studied (7)

CHAPTER 11

BIOGEOGRAPHY

CHAPTER OBJECTIVES

After studying this chapter students should be able to:
a) Outline factors necessary for soil formation.
b) Describe soil formation processes.
c) Assess the influence of soil type on development of vegetation.
d) Discuss the processes of plant succession and development of plant communities.

SOILS

Definition - The fine - grained product of chemical weathering composed of a mixture of organic materials and mineral particles, dead and living organisms like worms, water hand air. These materials occur in horizons. On average, soils are 3 meters deep, with the exception of brown soils and grey desert soils whose depths can extend up to 6 meters.

Soil characteristics.
(i) Soil texture. -Best illustrated by a soil texture graph which shows percentages of soil composition in terms of e.g. sand, clay and silt (or loam) and determines whether a particular soil is course or fine, highly porous or not.
e.g. a soil composed of 65% sand , 20% silt and 15% clay is sandy loam and one with 33⅓ % of each is a clay.

(ii) **Porosity - P**ore spaces between particles increases or decreases its ability to allow water infiltration larger, numerous, interconnected interstices (pore spaces) increase infiltration and thus soil porosity.

(iii) **Soil moisture-** Water retention by interstices encourages plant growth. However, super saturation as in water-logged clays, may retard growth as plants choke and wilt in too much water with little aeration.

(iv) **Soil colour** –Thiswill depend on soil pedogenesis i.e. its formative origins, particularly noted in soil horizons. Colour sequences in a profile are influenced by climate. Climate type determines amount of vegetation and thus percentage of humus in the soil and its colouring effect. For example, it depends on the luxuriant of vegetation and on the intensity of activity of micro - organism. Thus, for instance middle - latitude soils are black or dark brown in cool, humid areas. Semi - arid steeple lands savannas and deserts; are light brown or grey respectively. Desert soils have very little humus. Climate also influences the chemical weathering of rocks. Thus red and yellow are common colours in soils as a result of traces of iron compounds.

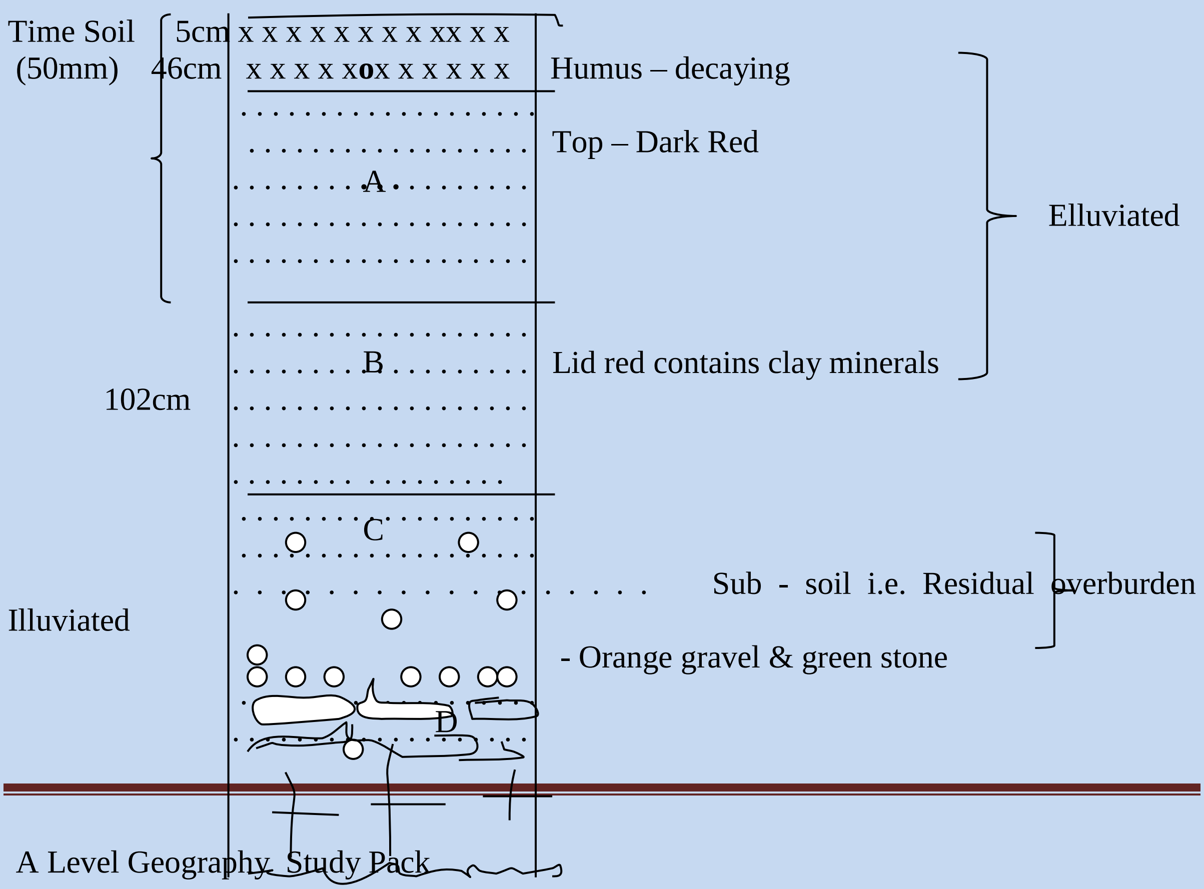
(v) **<u>Soil pH</u> -** particularly important to farmers as this influences a farmer's decision in improving the soil quality for his particular activity. For example, highly acidic soils (pH less than 5,5) require strong liming to neutralise except for acid - tolerant crops, and are common in cultivated soils of humid climates, whereas, strongly alkaline soils, common in semi - humid and arid climates require no liming. Examples of acidic soils are grey-brown podzols and Tundra soils while the latter are chestnut and brown soils to black alkali soils.

<u>Soil composition</u>

Soil is a dynamic body in which many complex chemicals, physical and biological activities are taking place. Thus, soil is forever changing and developing.

A true soil is composed of both mineral and organic particles whereas the underlying, material may be wholly mineral matter (see diagram below).

An ideal soil profile



Bedrock or parent rock

Soil substances exist in 3 stages, viz solid liquid and gas. All these three are important for plant growth

<u>Solid</u> -comprises both the organic and inorganic components.
(i) Inorganic particles from rock weathering give soil its weight and volume. The fragments range from grave and sand to colloidal particles too fine for the naked eye to see.

(ii) **<u>Organic solids</u>** consist of both living and decaying plant and animal material in the form of plant roots, fungi, bacteria, worms, insects and rodents. Colloidal particles of organic material also exist.

(ii) **<u>Liquid</u> - T**his is a complex chemical soil solution derived from the existence of water in soil to enable chemical reaction to take place in order to support life.

(iii) **<u>Gases</u> -** exist in pore spaces in the form of atmospheric gases as well as gases released by biological and chemical activity in the soil.

NB. Not all soils have clearly defined horizons layers and mature soils like podzol soils exhibit clearly defined horizons from the humus layer down to the parent rock while such horizons are totally absent in immature alluvial soils.

<u>Soil forming processes</u>

1. <u>Humification</u> – This refers tothe decay of and integration of humus into the soil including the chemical secretions of earthworms, soil bacteria and other micro-organisms in this humus incorporation.

2. <u>Leaching</u>-in high precipitation area where it exceeds evaporation e.g. in tropical rain where it exceeds evaporation e.g. in tropical rain forests calcium and mineral bases are dissolved and removed vertically downward through the soil from one horizon to another especially from the topsoil to the sub soil. It results in soil fertility.

3. <u>Weathering</u> -deep chemical weathering along rock joints in situ is responsible for the soil and mineral particles of the soil.

4. <u>Eluviation</u> - this is the washing down of minerals or organic matter through the soil by percolating water.

5. <u>Illuviation</u> -this is the decomposition of humus minerals and other materials leached and eluviated from A horizon into the B horizon.

NB. Processes 3- 5 are known as translocation processes i.e. the movement of solids and dissolved substances in the soil in areas where precipitation exceeds evaporation.

6. Decalcification- the translocation downwards of calcium minerals in the soil by infiltration.

7. Desilication - the translocation of silica from the upper soil horizons particularly in rainforest areas where lotosoils are common.
8. Acidification - Slow humus in corporation into the soil in Savannah and desert areas influence the development of highly acidic soils. The pH value of soils is divided into three (3) categories:

a) Highly acidic pH value is less than 4.
b) Mildly acidic or neutral pH is between 4 -7.
c) Alkaline soils are above pH7.

9. Calcification - in low rainfall area bases, calcium and magnesium ions remain in the soil. They are not leached out. Calcium carbonate is also brought upward by capillary water films and precipitated (deposited as a residence after evaporation of the water in dry periods) in B-horizon as nodules, slabs and dense strong layers. The process is characterised by grasslands such as the Savannah and semi–deserts, since they use the base and restore them to the soil surface.

Factors influencing soil formation
These can be grouped into passive and active soil forming factors. Jenny's formular for soil forming factors can also be used (**S=fg c, p, v, r, t)** where
S = soil characteristics
F = function of
C = Climate
p = Parent material
V = Vegetation
R = relief
T = time

(a)Passive soil formers.
- Parent material -the key determinant of soil texture and the main source of mineral particles. So the types are directly related to nature and weathered material found in the area. Thus, the following soil types have been established 75% of soils derived from granite are sandy e.g. in Seke and Matopo Communal areas of Zimbabwe.

(b) 50 % of soils from basalt are clay e.g. in the South East Lowveld of Zimbabwe.

(c)On a local scale, reddish clays are derived from banded ironstone e.g. in Mazowe and Belvedere (Harare).

Landform or relief

2a (i) Steep slopes promote rapid surface runoff and removal of weathered material (erosion) resulting in thinner soils.
(ii) Flat slopes develop thick clays (dense clay pans), since weathered material accumulates. Such clays are highly leached, poorly drained and dark coloured.
(iii) Gentle slopes with good drainage but slow erosion produce ideal soil profiles.

(b) **Aspect**-in middle latitudes, south -facing slopes exposed to the warming and drying effects of the sun, have different vegetation and soils from the cold moist north- facing slopes.

Time-a mature soil profile can only develop when all soil-forming processes have acted on the parent rock. This is in equilibrium with many processes and forces acting on it. Young soils are those that have developed from recently deposited river alluvium or glacial till. Characteristics of soil horizons are absent or poorly developed.

4. Active soil formers
Climate - very important influence on soil formation in terms of the effects of variable rainfall, evaporation ratios from place to place and from time to time, e.g. when rainfall exceeds evaporation, more leaching and eluviations of minerals occur and translocation of materials is initiated, leading to laterization and formation of lactosolsior podzolisation.
When evaporation exceeds rainfall, calcification and capillary are removed leading to formation of chernozem soils.

Classic examples of climatic impact on soil formation

Pedocals	Pedalfers
Associated with dry climates e.g. western USA parts where annual rainfall is less than 600mm and moisture deficiency is common.	Associated with humid climates e.g. Equatorial Rainforests where annual rainfall of 2000mm exceeds evaporation.
Calcification, dominant leaching and alluviation virtually absent	Decalcification leaching eluviation and deposition (illuviation) of iron oxides and aluminium into the soil are common.

Temperatures also affect soil formation. Chemical weathering is doubled by a higher temperature but reduced by cold and ceases when water is frozen. Thus, tropical soils have deep chemically weathered soil profiles while frozen tundra soils are composed of coarse gravels and mechanically broken minerals.

Bacterial activity thrives in warmer or humid tropics. They consume all dead plants on the ground surface. Humus is totally incorporated into the soil whereas a reduced dense layer of decomposing vegetation covers the ground under forest. Thus, raw humus is preserved at the soil surface rather than incorporated.

Winds may increase evaporation at soil surfaces and erode surface topsoil in arid regions lacking plant cover. Wind blown dust (loess) may accumulate and provide the parent material of a soil.

NB. Wind action is of minor importance.

Biological activity - Aeroflot (trees, shrubs and herbs) and micro flora (bacteria and fungi) greatly influences soil development.
Plants maintain soil fertility by bringing the bases (calcium, magnesium, potassium) from lower levels of the soil to the surface through their plant stems and leaves as these decompose. Dead plants provide humus, which gives a dark brown or black colour to the soil, and help retain mineral ions in the soil. Organic acids form during humification aid in the decomposition of parent material minerals. Leached potassium, calcium and magnesium ions are replaced by hydrogen ions in the acid solution, thus, soils of cold humid climates are denied in bases and consequently of low fertility for cropping. Application of nitrogen-rich fertilizers solves this problem.

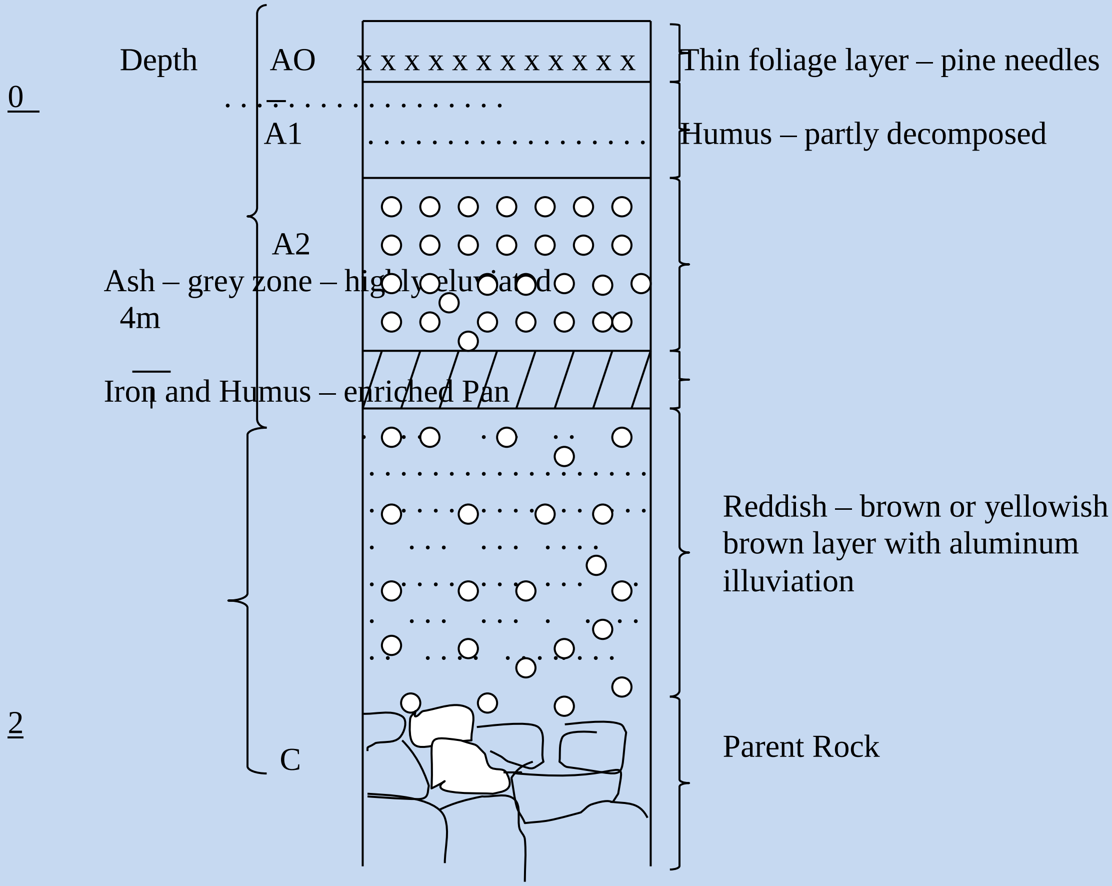
Bacteria consume humus in the humid tropics. The humus is rapidly oxidised and incorporated into the soils leading to low humus, high proportions of bases and low silica. In cold climates bacteria growth is slow hence significant humus layers become part of a mature soil profile. Locally, such under-composed organic matter forms peat. Bacteria and algae assist in nitrogen fixation i.e. converting atmospheric (gaseous) nitrogen into a chemical form that can be used by plants. An example is the bacteria Rhizobium present in leguminous plants.

Earthworms burrow and change the texture of the soil as well as its chemical composition through enzyme secretions, ants and termites living large quantities of soil from lower horizons to the surface. Burrowing squirrels, moles and field mice disturb and rearrange the soil.

Soil types and soil profiles

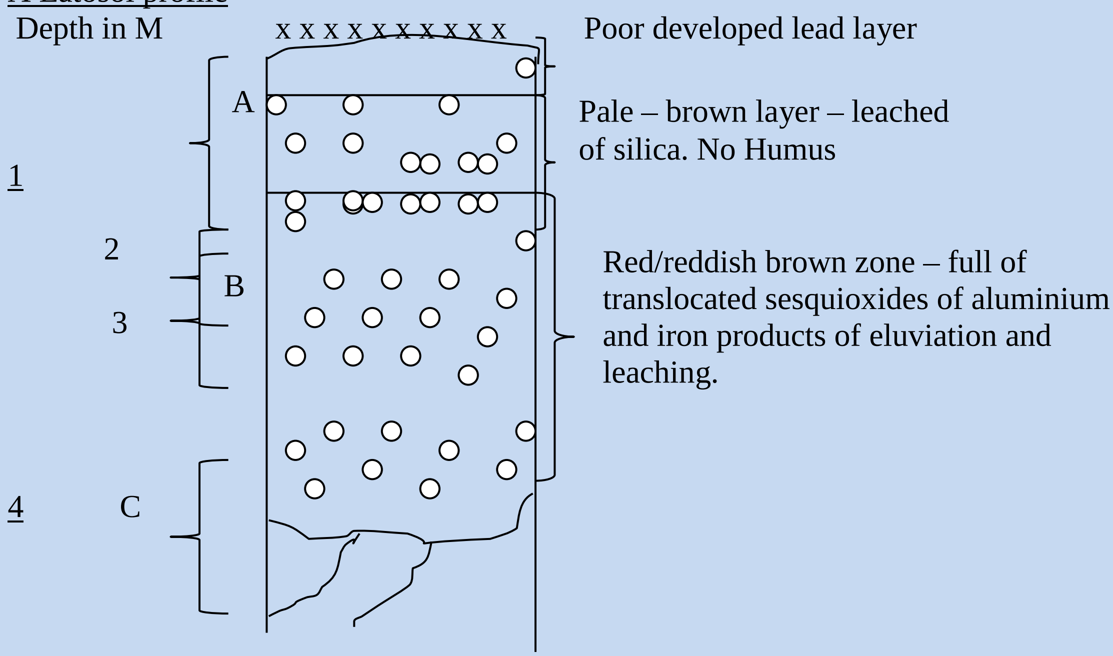
Soils can be classified into 3 categories;
Zonal soils ; mature and well-developed under conditions of good soil drainage and prolonged action of climate and vegetation. Widespread of the 3 groups and exhibit defined soil profiles. Examples are podsolic soils, lotosoils Chernozems, Prairie soils, brown soils and Tundra soils (see Illustration overleaf).

A PODSOL PROFILE



Formation-it is mainly attributed to podsolisation process mainly in coniferous forest belts (temperature climatic areas) where the rain supports this vegetation. Little bacterial activity promotes leaching and eluviations and slow humus incorporation. Abundant leaf litter produces humid acids which translocations iron oxides from A horizon and deposits them in B horizon. The A horizon is rich in silica.

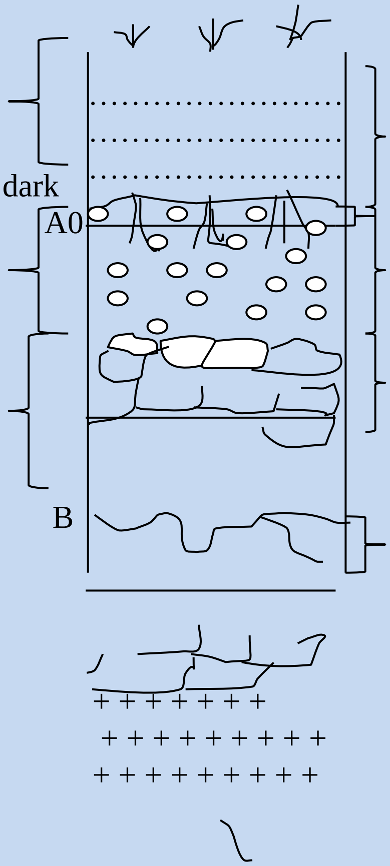
A Latosol profile



Formation

These are formed mainly by laterisation i.e. heavy leaching of minerals (silica due to high rainfall and temperatures in humid tropical regions. Leaching results in a characteristic yellow colour. In southern Uganda, dry spells influence development of a hard, iron - rich lateritic crust as high as 10m.

A CHERNOZEM PROFILE



Formation

Chernozems or black earth is typical in semi-arid climates.

Humus layer is crumb-like. Downward percolation of colloids and bases from horizon A horizon contains alleviated accumulations of bases and mineral colloids.

Lower B Horizon is rich in calcium carbonate precipitated here by capillary action. Chernozems develop in parent material rich in calcium carbonate.

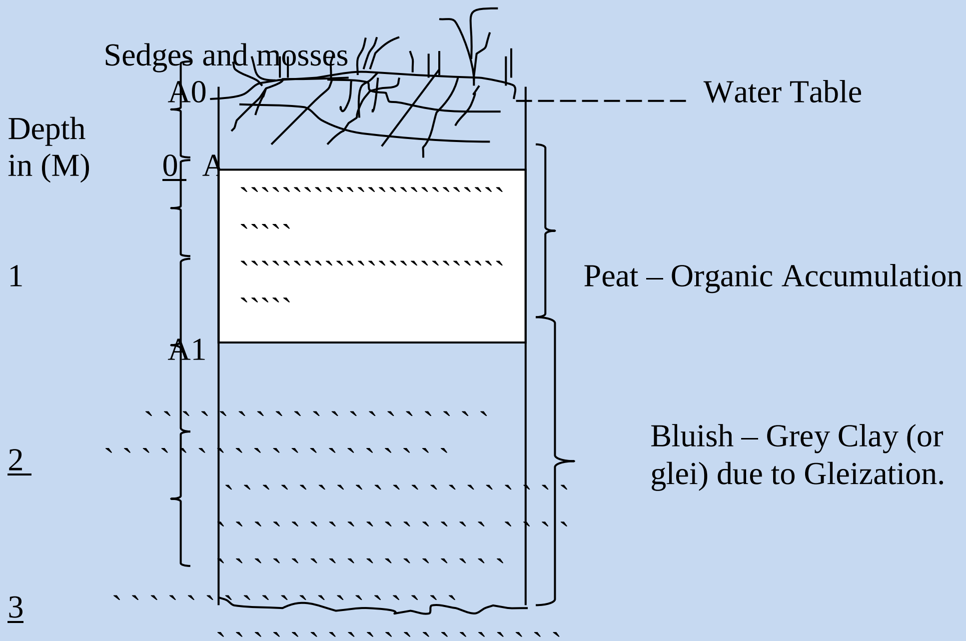
Occur quite extensively in the Ukraine Region surrounding the black Sea and continue to the heart of Asia.

Azonal Soils

These have undergone very little pedogenic development. They lack a defined soil profile and have been little affected by leaching, eluviations and illuviation. Slopes are too steep to allow profile development. Examples include thin strong mountain soils (lithosoils), Freshly deposited alluvial material and sand dunes (regosoils).

Intra zonal soils

Bog soil Profile



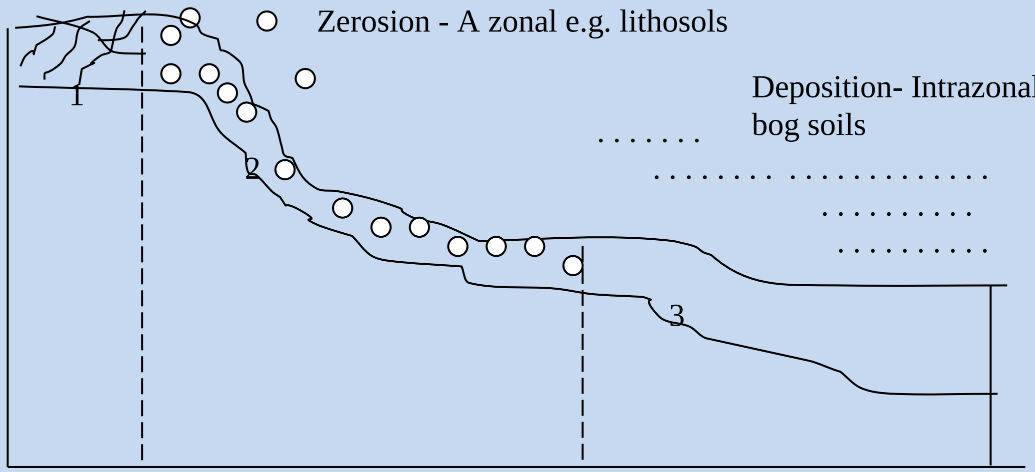
Formation – in cold , moist climate characterised by poorly drained but not saline environments. Low temperatures permit heavy accumulation of organic matter to form a surface layer of peat. A glei horizon develops below this layer, which is a thick layer of compact, sticky, structure, less clay of bluish-grey colour. The glei Horizon generally lies within the zone of ground water saturation. Thus the iron is partially oxidised to give this zone a bluish - grey colour.

Intra - zonal soils - formed under description of local conditions very poor drainage for example in marshes / swamps, flood - plain or in playa lake basins of deserts, or on limestone. They display closer links to parent material than neither climate nor vegetation. Thus limestone has a dominant influence. Water- logged areas give rise to general poor soils.

Soil Catena

Definition - this is a horizontal profile of the soil, which is influenced by changing topography from a mountain top to the lowland.

Illustration of the soil Catena



Upper mountain reaches: regolith accumulates in situ on the summit but gravity enables good drainage.

Rectilinear slope allows transportation of soil by erosion
Soil depth is thin and freely drained. Valley area - deposition of soil dominant depth is thicker thus usually poorly drained or water logged (e.g. vleis and dambo areas in Zimbabwe)

Associated soil types

Zonal soils e.g. Plano soils on flat up levels.
Azonal soils e.g. Liyhosols.
Intra-zonal soils e.g. log soils which are hydomophic soils of swamps and marshals

Soil fertility

Natural factors
This refers to the physical composition of the soil, including its texture, drainage, structure, depth and other materials in it such as pebbles, and also its aeration. The Presence of humus, which is natural manure, improves the structure and moisture retention of a soil.
Humification

- The efficiency and ease with which organic matter is decomposed and incorporated into the soil.

Chemical content presence of bases such as calcium, potash and nitrogen promotes plant growth.

Soil pH value i.e. whether it is acidic neutral or alkaline influences plant type to grow and nutrients to add.

Human factors
In a bid to reclaim marginal soils in extensive agricultural activities; man has improved soil fertility through the following processes.

Uses of chemical fertiliser's e.g. nitrogen and, potassium to increase mineral levels, in leached soils. Also they assist in developing loamy sands, thus increasing water retention.

Liming of acidic soils to grow acid intolerant crops.
Use of organic fertilizers - improves soil structure and quality without the negative environmental impacts of salinisation and eutrophication of water bodies caused by excessive chemical fertilizer additions.
Ploughing - particularly using drought animals works the soil well without destroying its long -term infiltration capacity, compared to the tractor which develops a plough pan which improves infiltration and results in lowered soil moisture levels.
Re-grassing and forestation on mountain slopes improves humus levels, introducing micro flora and thus improved soil structure and texture. Water retention is also improved. Terracing has a similar effect on improved soil profiles on mountain slopes, given time.

Soil erosion Processes	**cause**	**Effect**	**Solution**
1. Rain-drop splash effect	The force of large rain drops onto bare surfaces (naturally occurring in arid lands or man - induced in humid land)	(a) The impact of the raindrop causes a geyser - like splash in which soil particles are lifted and dropped into new position (splash erosion) (b) On a sloping surface splash erosion shift the soil down hill. (c) Soil pores are then clogged(sealed) by shifted particles reducing infiltrationand fertilisation. (d) Where the soil particles have been	Forestation to break the fall of the large raindrops (although drops from leaves has caused the same effect underneath the canopies) Re-grassing dissipates energy of overland flow by friction with grass stems. Forested slopes provide numerous check dams in the form of leaves, twigs roots and fallen tree trunks that cushion the soil from overland flow.

		shifted subsequent raindrops harden and compact the fine silt, increasing sheet erosion.	
2. Sheet erosion	a) When a plot of ground is first cleared of forest then ploughed for cultivation infiltration is initially increased. b) Rain drop splash then breaks down the soil aggregates and seals soil pores. c) Large areas of gently sloping land is then flooded after a heavy down pour particularly in maize fields and base surfaces due to deforestation and burning grass as well as the trampling effect of dense populations and overstocking.	a) Fertile topsoil is washed away over the whole piece of land. A common process in communal areas of Buhera,Mhondoro Ngezi, Mutema Manyame,Mutoko, Zimuto, Kezi and Ntabazinduna. b) "Dust devils" are experienced in the dry windy season of August, September and early October when whirlwinds blow off a lot of dust. These strong winds are quite destructive on dry exposed or loosened field soils trampled by cattle as they feed on crop residue (crop waste)	Afforestation. Later cropping or mulching tobacco and maize fields with groundnuts or cowpeas. Legislation against igniting bush fires with associated stiff penalties. Winter cropping to maintain a ground cover in the windy dry season. Terracing by growing pineapples in strips across hillsides. Adding organic fertilizers like manure and humus and even chemical fertilizers to the soil improves its water retention capacity by creating a porous crumb structure, which promotes infiltration and thus minimises erosion.
3. Rill Erosion	Freshly ploughed gently sloping fields	Raindrops splash effect cause soil particles to be gradually washed along narrow fair by steep channels from ploughing or runoff.	Harrowing after ploughing to level field and destroy the vulnerable plough furrows.
4. Gully Erosion	a) Bare surfaces b) Over cultivated fields. c) Monoculture. d) Down slope cultivation. e) Marginal soils already vulnerable to erosion due to their weak structure.	a) Storms rainfall of high intensity or heavy down pour impact the soil and fail to infiltrate. b) When the fast flow is trapped and confined to a small area, it cuts deep grooves and ditches which start off narrow then gradually lengthen and deepen.	a) Resultant badlands topography may be difficult to reclaim but quick action may be in the form of: 1. Gully stopping or plugging where stones are placed at intervals along the length of Gully to allow sediment build up and stop head ward erosion of gully. 2. Growing guava trees, which

		c) Widespread in communal lands of Buhera, Murewa save Valley and Mhondoro	can be easily dispersed by goats.

In summary, stressed marginal communal areas experiencing population pressure on land and overstocking need urgent government and community action to arrest loss of the valuable thin topsoil to erosion.
Legislation by government on land carrying capacities helps in restocking, particularly when Arex officers educate their ward farmers. Government policy of resettlement and local reform, helps redistribute populations from stressed communal areas. Well planned grazing paddocks make it possible for grass and trees to recover from heavy grazing by browsers and grazers. Animals like goats, sheep and donkeys graze to the root of grasses. Establishing heavy fines for burning grass and starting forest fires as ell as educating farmers on good farming and soil management techniques .Introducing laws against stream bank cultivation and educating people to cultivate beyond the 30m mark from the river bank to stop siltation of dams and rivers. Initiation of soil conservation movements at VIDCO, WADCO levels and establishing conservation committees has been successfully done in Mhondoro-Ngezi .Deforestation, burning grass and stream bank cultivation have been minimised. Such programmes must involve the villagers themselves rather than use a top-down approach.

The conservation committee has recorded another success in the Chikomba District where people have responded well to the visits. The district was suffering serious siltation due to over cutting of trees and disastrous stream bank cultivation. Today many people in Chikomba District are involved in REAFFORESTATION programmes where council has established 3 gum tree plantations at Manyame, Mupatsi and Sadza.

These trees are being harvested and sold as poles and firewood to the locals at reduced prices, effectively reducing cutting indigenous trees for fuel. Local farmers buy the seedlings at highly subsidised prices and these seedlings are freely open to the schools.

Desertification

Desertification is a process whereby the productive potential of arid and semi-arid land is reduced by the activities of humans. It is a serious and growing problem in many regions of the world including: sub-Saharan Africa, the Middle East, western Asia, northern Mexico and south-eastern South America, western United States, prairies of Canada, and eastern Australia. Scientists estimate that 60,000 square kilometres of new desert are now annually created world-wide.

Desertification occurs when the natural vegetation cover is reduced in its cover and the topsoil becomes susceptible to erosion. The removal of the vegetation and topsoil then initiates a number of other problems including:

1. Increase in surface runoff and stream discharge.
2. Reduction of water infiltration and groundwater recharge.

3. Development of erosion gullies and sand dunes.
4. Change in the surface microclimate that enhances aridity.
5. Drying up of wells and springs.
6. Reduction in seed germination of native plants.

The effects of desertification can be reversed in many cases. Reversal begins by halting the activities that created desertification. In many parts of the world, overgrazing and deforestation are the primary factors causing this form of soil degradation. Two other remedies for repairing the effects of desertification are the re-vegetation of the soil surface and the planting of windbreaks.

Reduced rainfall - either related to short- term seasonal drought, mid-term cyclic changes from wet to dry (5-7 year droughts) Zimbabwe, for example, or long term.
Continuing trends towards climatic desiccation, results in severe droughts, particularly in Africa. These periodic droughts have greatly reduced vegetation and water-tables leading to reduced rainfall.

Desert margins have fragile **sandy soils** often termed agriculturally marginal soils, which are vulnerable to wind, and water erosion. Reduced biomass naturally leads to rapid erosion resulting in diminished infiltration rates and lower water tables. Again, desertification sets is due to reduced evapo-transpiration and severe aridity.

El-nino effects -significantly interferes with the hydrological cycle with serious reduction in rainfall effectiveness (i.e. amount of rainfall entering the soil and becoming available for plant growth). In Southern Africa both droughts and floods from such El-nino have the effects of reducing the biomass, increased gully erosion and thus increased extension of deserts.

Human causes
Given the vulnerable natural conditions of the Sahel and Savanna areas the following human activities highly accelerate, and in some instances initiate, desertification.

(i)**Rapid population growth -** In the Sahel regions, encouraged by the wet period of the 1940s and 1950s has impacted negatively on the climatic fluctuations of deserts margins. The population pressure has meant massive deforestation to open lands for settlement and wood, fuel. Grazing and cultivation lead to interfered hydrological cycle and existence and the extension of deserts margins.

(ii) **Overgrazing -**due to reduced pasture by increased populations has exposed marginal sandy soils to rapid wind and gully erosion, rending such areas prone to crop failure, and fuel extension of desert badlands.

(iii) **Man - induced droughts -** from deforestation and the destruction of the ozone layer by increased carbon dioxide emissions, into the atmosphere due to carbonisation have particularly caused and reduced annual rainfall and increased aridity in the Sahel.

(iv) Areas of the Sahel and grasslands, and associated pastures are increasingly being replaced by bare, arid surfaces, shifting sands and extending volume systems due to extensions of cultivated lands.

Sustainable management of the Sahel

Background: Increased populations in the Sahel means increased demands for food, fuel settlement, and grazing. Such pressure on land resources, accelerates gulley erosion, interferes with basin and global hydrological systems and hence extension of deserts

Population migrations to escape impending starvation flee the Sahel areas and only increased the risk of desert margin extensions.

Attempts to Reduce Desertification

Since desertification is a natural phenomenon, only accelerated by man's activities, man should initiate activities to reduce desertification.

Cause	Measures	Evaluation
Rapid population growth placing pressure on land resources	Population education in natural populations. Availability and affordability of contraceptives. Practicing good agro-ecological methods such as zero tillage on fragile sandy soils.	Zimbabwe Family Planning programmes and campaigns highly successful in urban areas, particularly.
Overgrazing	Paddocking Destocking land, observe land carrying capacities Culling of great herbivores like elephants to maintain ecological balances and resettlement.	Commercial ranching in Zimbabwe successfully practising paddocking. Unmonitored pastoral nomadism placing Sahel at risk South Africa and Zimbabwe successfully managing their Savanna grassland ecosystem through legislated elephant culling.
Deforestation	Afforestation in the form of woodlots forestry and reintroducing grasslands.	Zimbabwe National Tree planting Day on 1st Saturday of December a success each year involving schools and village communities. However, veld fires particularly ignited by hunters and pastrolists are retrogressive.
Gully erosion	Gully reclamation by e.g. gully	Successful gully stopping

	plugging Afforestation growing grass for thatching as a form of re-grassing Destocking Resettlement education on fossil Conservation -legislation against stream bank cultivation 30m off bank allowance	and growing guava trees by animal dispersal in Zimunya communal lands. Resettlement has successfully reduced pressure on communal villages
Marginal sandy soils	Liming Adding humus and manure to improve water holding capacity by creating a crumby porous structure	Farmers find it cheaper and faster to add chemicals fertilizers, which have improved yields through improved retention but have negative environmental effects of entrophication and increased salinisation of Savanna soil.
Soil erosion caused by incorrect cultivation e.g. down slope	Terracing on slopes to retrain water and stop soil erosion by runoff. Forestry on slopes Afforestation Resettlement Education on soil conservation methods	Successful in communal and commercial farming in the Eastern Border Highlands (terracing) Education hampered by high extension farmer to farmer ratio.
Destruction of the ozone layer	Anti - pollution laws and campaigns Carbon tax Legislation on height of chimneys Ozone - friendly aerosols Pollution - free fuel substitutes e.g. HEP, unleaded fuels Catalytic converters in motor - engines and chemical producing plants	Measures have been introduced in both MEDCS and LEDCS with limited success in LEDCS who are just industrializing, are under pressure to solve high unemployment levels and are yet to benefit from large - scale industrial growth. Moreover over it is expensive for them with abundant fossil fuel resources to switch to cleaner sources unlike counterparts who, after realizing the cost of massive industrialization and urbanisation, are reaping the economic benefits while LEDCS are paying the costs of ozone - layer destruction

Examination Type Questions

1. (a) What are the main factors that influence soil formation? **[10]**
(b)Discuss the physical processes of soil erosion and suggest methods by which soil may be reduced. **[15]**
2(a) Explain briefly the terms "soil profile" and "soil texture". **[7]**
(b) Describe and explain the changes in soil characteristics that are expected along a hill slope in seasonally humid tropics. [11]
(c)How may soil slope profiles and texture be influenced by human activities? [**7]**

CHAPTER 12

Desert processes and landform development

12.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Describe the physical nature of arid environments.

b).Outline the main processes operating in desert regions.

c) Describe the main landforms found in desert regions

d).Assess ways of plant and animal adaptations in arid environments.

e) Define desertification and outline its causes

Introduction

Arid andsemi arid environments are characterized by high temperature variations, usually exceedingly high temperatures during the day and freezing temperatures during the night. There is a high moisture deficit due to very low rainfall totals. As such there is very little vegetation cover. Areas that meet the above description are generally referred to as hot desert.

12.2 Deserts

Deserts are generally hot areas and occur primarily due to natural influences that would be present in a particular area.

12.3 Natural Causes

Geographical Location: Desert located on the western sides of continents between Latitude 150-300. This is mainly due to Cold Oceanic currents emanating from the poles, such as the cold Benguela current,responsible for the existence of the Kalahari and Namib deserts. These oceanic currents bring with them cold and dry winds that leads to the formation of mist or fog.

Rain shadow effect

Some deserts have been formed due to the rain shadow effect caused by mountain chains. Thus rain falls on the windward side of the mountain and when winds blow over the ran shadow area, they are not dry. This characteristic will influence the vegetation and climatic characteristic of such regions.

12.4 Desert processes And Landform development

Two dominant processes operate in desert regions. These are, “action of running water” and “wind”.

Action of running water

Running water plays a less significant role in desert processes of the present day. However the impact of water has carried much of desert landscape and it is believed that water action has played a great part in the development of present day desert landforms. Present day landforms can largely be attributed to the action of water going past pluvial periods. An examination of parts of the Sahara and other deserts in the Middle East gives us sufficient evidence that present day landscape mirrors effects of past pluvial processes. However, running water still plays a significant role in the development of desert landscape.

Wind Action in Hot Desert

Wind processes play a very significant role in the development and modification of desert landforms.

Wind erosion

Wind transportation

Wind deposition

4.Sustainable management of the Sahel

BACKGROUND

Increased populations in the Sahel means increased demands for food, fuel, settlement, and grazing. Such pressure on land resources accelerates gulley erosion, interferes with basin and global hydrological systems and hence the extension of deserts. Migration or population immigrations to escape impending starvation from the Sahel areas only increase the risk of desert margin extensions.

Adaptation of Plants and Animals to the desert environment

Desert environment are generally known to be harsh and uninhabitable. However, a study of desert regions has proved that such an assumption is wrong. It has been discovered that a range of flora and fauna have adapted to desert environment.

12.5 Desertification

Desertification can be defined as a process by which areas that did not exhibit desert characteristics begin to be encroached by desert-like conditions. This is due to both natural and human induced factors.

12.6 Factors influencing desertification

(a) Natural Causes

(i)**Climatic Changes:** Increasing global temperature accompanied by low levels of evaporation ratio from reduced water bodies and forests have resulted in progressive drying out of the Savanna areas (semi-arid) which naturally bound desert margins. This increased aridity means extension of desert margins to incorporate Savanna lands.

(ii)**Highly unreliable and seasonal rainfall** such as this occurs in the semi arid (Savanna) regions and desert margins globally have compounded increased dryness of these areas leading to extensions of desert margins. The conditions lead to reduced soil moisture and evapotranspiration with related reduction in biomass-a vicious cycle of related events in desertification.

(iii)**Reduced Rainfall** (either related to short- term seasonal drought, mid- term cyclic changes from wet to dry (5-7 year drought in Zimbabwe for example) or long- term continuing trends towards climatic desiccation (about every 200 years), results in severe droughts, particularly in Africa. These periodic droughts have greatly reduced vegetation and water-tables leading to reduced rainfall.

(iv) **Fragile sandy soils**(often termed agriculturally marginal soils) which are vulnerable to wind and water erosion. Reduced biomass naturally leads to rapid erosion resulting in diminished infiltration rates and lower water tables. Again, desertification sets in due to resulting reduced evapotranspiration and severe aridity.

(v)**El Nino Effects** significantly interfere with the hydrological cycle with serious reduction in rainfall effectiveness (i.e. amount of rainfall entering the soil and becoming available for plant growth). In Southern Africa both droughts and floods from such El Nino effects have effects of reducing the biomass, increased galley erosion and thus increased extension of deserts.

12.7 HUMAN CAUSES

Given the vulnerable natural conditions of the Sahel and Savanna areas, the following human activities highly accelerate, and in some instances initiate, desertification.

(i)**Rapid Population Growth** in Sahel regions encouraged by the wet period of the 1940s and 1950s has impacted negatively on the climatic fluctuations of desert margins. The population pressure has meant massive deforestation to open lands for settlement, fuel, grazing and cultivation, leading to interfered hydrological cycle (droughts) and extension of desert margins.

(ii)**Overgrazing** due to reduced pasture by increased populations has exposed marginal sandy soils to rapid wind and gulley erosion, reducing such areas prone to crop failure, famine and extension to desert badlands.
(iii)**Man-Induced Droughts** from deforestation and the destruction of the ozone layer by increased carbon dioxide emission into the atmosphere due to carbonisation, have particularly caused reduced annual rainfall and increased aridity in the Sahel.

(iv)Areas of sands and grasslands, and associated pasture, are increasingly being replaced by bare, arid surfaces, shifting sands and extending climatic systems due to extensions of cultivated lands.

(v)The current inter-glacial period is ending. A climatic change is expected to recur, climatic changes have been known to occur (as evidenced by past wet climatic remnants in deserts).
However, the Sahara has remained largely arid except for a brief humid period at the end of the last glacial period. The negative impact of man's activities initiating droughts and accelerating the fragility of soils is likely to promote extension of desert margins that redress desertification.

12.8 Examination type questions

1) With the aid of a fully annotated diagram describe and explain landforms found in the Piedmont zone. (15)
b) To what extent has running water contributed to present day desert landscape? (10)
3) Critically examine the role of wind action in the development and modification of desert landscape. (15)
b) Critically, examine the role of wind action in shaping present day desert and landscape. (10)
4) Describe the climatic causes of desertification (12)
b) With reference to examples examine attempts to reduce the negative impact of desertification on agricultural productivity (13)

CHAPTER 13

HAZARDOUS ENVIRONMENTS

13.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Describe different forms of hazards.
b) Outline global areas at high risks of hazards.
c) Evaluate the impact of hazards.
d) Outline measures to minimize impact of hazards.

Definition

A hazard can be defined as natural or human induced events, which are perceived as threats to life and property. They include hazards related to such environments as climate, fluvial processes, tectonic process, geo-morphological and human interference with the natural environment.

13.2 Factors influencing the nature of hazard (Disaster)

Its cause - natural / human ii) controllable / uncontrollable
Its effects: i.e. impact on physical and human environments where hazards has hit; as well as regional and global implications; short or long term hazards and effects, scale / magnitude.

Risk perception and levels of response: These may magnify or limit the level of damage and are influenced by:

The Level of understanding of the type and nature of hazard. Whether a hazard is known/unknown, common/ rare and thus whether response will be immediate /delayed
Degree of damage/ impact in terms of distribution of death i.e. spread over time/ concentrated to just the incident, widespread or localised in the area hit.
Location: urban /rural level of poverty; warning time/ production early warning systems; accessible/ inaccessible level of preparedness i.e. vulnerability and possible future prevention or avoidance

13.3 Types of hazardous environments

Hazards due to tectonic environments

The main geological tectonic hazards are volcanoes, earthquakes and tsunamis. Thus they are mainly connected to plate boundaries or areas of major plate activity such as subduction zones of the 3 plate boundaries conservative margins, constructive margins and destructive margins - the last is the most disaster prone. Hence, the circum pacific ring of five (apathy named for the majority of earth-quarter foci and active volcanoes is, globally, the most vulnerable).

<u>Table below summarises nature of hazards associated with tectonic movements</u>.

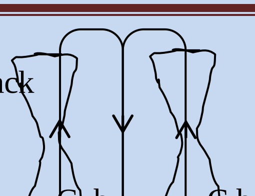
Tectonic activity	Location	Occurrence	Impact	Response/control
Earthquakeinduced tidal waves – tsunamis Earthquakes due to folding Faulting Destruction of earth's crust Tremors from volcanic eruptions There are slump quakes dueto collapse of hollow parts of the crust whose effects are minimal VOLCANOES Particularly nature of evaporation. Local people affected. Vulnerable land form elements fields, nature of nature of slope) Associatederuption gases	Coastal margins facing plate convergence/ Subduction zones. Areas affected in recent years are: - south tosouth eastern coastsof Indonesia (2004) Northern coastof Australia Japan Island Coasts (worst in 1703)East Costs of China (2004) Pacific Ocean Islands most frequently The circum-pacific Belt - which stretches from New Zealand traces the liners of New Caledonia, Java Islands then arcs to the Philippines Island to	Atsunami is a seismic sea/ tidal wave, which is a secondary effect of an earthquake.The series of waves is generated in the ocean near the epicentre by a sudden movement of the sea floorWaves travel over ocean in widening circles. Imperceptible due to deep-sea water. Coast line sea level slowly rises over a period of 10 - 15 minutes Wind - driven waves on topof the increased water level cause the tidal waves to attack inland places normally beyond the reach of waves (up to 10m altitude).These tidal waves are	Widespread destruction of property and deaths by drowning Low -lying coastal areas are submerged Coastal flooding in genera l. Water– borne disease outbreaks Gas and electrical chemicals fires Collapse of sewage, sewers and clean water supplies and related problems of hygiene Most hazardous quakes occur in the shallow zone of crust (0 - 70Km deep) a quake whose magnitude on the Richter Scale	Response Air rescue evacuations setting up trauma centres etc (see earthquake) constructing homes far inland Building homes on tall stilts Control Same as earthquake Response Emergency evaluation before or after. Erecting traumas centres Recording deaths missing and alive. Providing material and food, clothing medical drugs, tents Psychological services (in the long run) Air and surface rescue internally or from external help. Resettlement /or

	include Japan and take on the Alentian Island Alaska, down the San Andreas fault to follow the Western Coast of South America (Peru and Nazca and South American plates collide. The Alpine Himalayan zone of convergence Indonesian up to Malaysia Also found in the earthquake belts.	huge and powerful and come suddenly without prior warning Ann EG is a vibration caused by the sudden release of energy in the mantle. The P - waves and S - waves then transmit this energy through rock and water. The series of tremors are highest in and near the epicentre becoming weaker with increased distance away from the focus. Function in crustal rocks triggers earthquakes as found on the Benioff zone where the oceanic rock melts on subduction and is destroyed in the mantle Structure of the earthquake Epicentre (Greatest shock & Damage	reads 5.0 is 10 x that which is 4.0 and thus its intensity is worse felt. Worst known is the Good Friday Earthquake of March 27, 1994 whose epicentre was 120Km from Alaska Damage is from secondary effects Collapsed buildings particularly brick concrete blocks Mudslides on coastal areas Deaths due to collapsed high – rise buildings, particularly in densely populated urban centres Dam bursts flooding. Electrical fires Disease outbreak Shock, trauma, distress and death related to collapse of communication lines – rail, road, phone Localised damage to vegetation and foothill or mountain side settlements	reconstruction. Control Earth quake prediction or establish early warning systems (although they cause panic and associated damage and loss) Construct wooden houses. Construct apartment blocks which conform with EQ –0 resistant standards (Japan) Set up vigilant ambulance, fire, air and surface rescue + early mornings. Evacuate people and set up rescue drills. Build at low density. While localised, volcanic soils and rocks attract dense farming and mining communities on mountainsides and foot of mountains, hence highly vulnerable. Control is limited as early warnings can cause panic and widespread damaged and loss from this panic. Early evacuation to minimise panic and loss Education Using cheap materials to construct houses

		Focus 1. Volcanic eruption, which extrudes basic lava, caused widespread damages. The lava contains 45 – 52% silica, is very fluid and highly mobile and thus able to flow long distances before solidifying. The hot river of molten rock can flow up to speeds of 60Km/ hr on fairly steep gradients 2. Cluster bombs can burn like napalm, though damage is more localized and confined and mountainside. 3. Ash and cinder in other eruptions can be blown by strong winds and affect weather patterns abroad	capable of building whole cities and villages Rivers become choked. Creation of natural dams. Flooding in valleys due to sudden increased snowmelt. Pre - eruption Initial eruption tremors may trigger avalanches from show field causing pre – eruption damage. Increased levels of sulphur fumes causing air and causing air and environmental pollutants (faces of buildings) Associated rain storms from increased condensation cause midlands Respiratory diseases/ complications from empted gases	Low - density settlements Effective early warning systems Establish refuge/ trauma centres Reconstruction assistance.

13.4 Summary of climatic hazards

Climate hazard	Location	Occurrence	Impact	Response /control
HURRICANES These are tropical cyclones	Occur between 80-150 N & S of Equator and Troposphere in late	Structure of a hurricane	A slow moving hurricane storm is most devastating	Mostly felt in LEDCs due to lack of sea



(depression cell) also known as typhoons.	summer and autumn when Inter-Tropical Discontinuity is at its greatest distance from the equator	Cirrus canopy Deep cumulus outer band of Cumulonimbus Cirrus cloud Wind directions S small -scale storm disturbances which develop over oceans at 8^0 - 15^0 N & S of Equator An easterly wave of low pressure depends and intensifies, growing into a deep, circular low pressure cells. High sea – surface T^0 C of $20^{0\ +}$ C warm the air at low level creating instability predisposed towards formation of a storm The storm moves westward through the trade wind belt Structure	as it causes extra damage to crops, livestock, buildings, roads, strong winds also cause damage to property. Storm causes floods and landslides Coastal flooding magnified by rise in tides due to storm High population density areas difficult to evacuate. Damage to slip freights and sea activities. Insurances take too long to compensate deaths Loss of tourism exports due to damaged ports/ bays.	deepness emergency evacuation system. Higher death tollsteam MEDCs Control Forecasting and predictions help prevent major disasters in MEDCs Maintaining disaster centres and emergency services In LEDCs and communicating warnings is difficult and evacuation is limited.

		Diameter: 650Km larger in western pacific * Central air pressure very low (below 900mb) Considerable vertical cloud development with cumulonimbus top reaching 12 000 m. heat and moisture from low levels drawn into warm core of the dense cumulonimbus the eye (inner most part of the hurricane) has diameter of 30 – 50 km. Calm with clear skies or broken cloud descending air. Eye surrounded by solid wall of cumulonimbus at edge, clouds dispersed.		
Drought	Common Where Sub-Tropical High Pressure Cells Increase And Persist e.g. Extension of Zones High Pressure (Mid-Atlantic) To The East And South Is Linked To Sahel droughts Sub -Saharan countries particularly bordering the humid savanna (dry savanna). Marginal areas where	A period with insufficient precipitation to maintain meaningful soil moisture levels able to sustain plant life and human activity. Such inadequate precipitation compounded by high T^0C effect high evapotranspiration,	Effect is delayed and indirect Famine resulting from crop failure due to lack of H_20 Extensive soil degradation	Areas prone to periodic droughts like Zimbabwe need to reduce its impact (famine) by. Cloud seeding Intensive irrigation systems. Good food storages/ soils for grain. Provide

	small moisture variations which are prolonged develop into drought are most vulnerable e.g. Zimbabwe	rates cannot maintain stream flow levels or even replenish ground H_2O (long term). Irregularities in summer monsoons of maritime tropical air, which brings rains in Asia. Changes in ocean currents/ upwellings produce cooler ocean surface T^0C causing fog instead of rain e.g. Benguela current and Namib desert Displacement of mid - latitude depressions by the development of persistent blocking high pressure areas Seininose bring erratic rains causing drought or floods		incentives to farmers to grow food crops for food self-sufficiency. Develop skills in food preservation. Establish early detection systems in their meteorological departments.
EL Nino Southern Oscillation (ENSO) EI NINO Change in normal H_20 circulation in the Pacific Ocean Southern Oscillation associated with change in atmospheric circulation in the region		ENSOs disrupt the ocean atmosphere system in the tropical Pacific with intense worldwide effects. During El- Nino, the easterly trade winds weaken and may reverse over the whole Pacific region (see diagrams below) a)Normal Equatorial conditions	The eastwards displacements of atmospheric heat source overlying the world's warmest water result in large scale changes in global atmospheric circulations Flooding in the immediate region e.g. Permanent Drought and fires	Early warning systems as detected by the buoys in the Pacific. Also satellite agency measuring ocean surface T^0Cs and showing cloud movement help in these predictions.

		b) EL Nino conditions ENSOs events occur on average of every 5 years .Gap ranges between 2 and 10 years A network of buoys measure T^0C, currents and winds in the tropical pacific to observe conditions. Predictions of up to a year before Nino hits can be made.	in Indonesia and Australia. Peruvians warned when it begins to rain on the Atacana desert with sea levels rising by 30cm and T^0C of sea surface by 6^0 to 8^0C. Further afield on continents prone to droughts and flooding in open areas.	
TORNADOES Also known as whirlies or willies	Occur most frequently in NW Europe and the Midwest USA plains The "tornado alley" in USA covers the states of Oklahoma, Indiana, lowa and Kansas. Occurrence in USA recorded at 750 per year with 100 deaths per year on average	Mostly in spring. They are smart, short- lived and extremely violent storms Consist of a funnel or rapidly spiralling air reaching down from a base of a cumulonimbus cloud Wind spread from 150-200 and sometimes 400 Km / hour due to low pressure at	The strong funnel winds are highly hazardous to life, vegetation and property. Blown debris also effects great damage on impact as roof tops, cans, whole trees uprooted, wooden houses can be blown for several kms effecting damage on the way.	Early detection and warning Good alert system via media, TV, radio. Sirens where tornado is likely. Education Boarding windows taking shelter in closets or cellar underground cannot be controlled

		centre of funnel. Funnel is 600 m or less and moves across the country at 30 - 70 Km / hour Can travel distances of a few kilometres to up to several km. Path or pattern of movement unpredictable and effect great damage. Formation: Intense frontal activity at the edge of the front with extreme instability, results in thunderstorms		

Task / assignment

(a) Tropical storms or hurricanes develop under certain climatic conditions. Give a reason account for the distribution of areas most frequently at risk from hurricanes. (b)What are the effects of a hurricane on coastal areas?

(c) To what extent are the effects of hurricanes similar to and different from Environmental hazards caused by tectonic activity?

(d) Show how and to what extent such environmental hazards can be successfully predicted

Hazardous environments resulting from mass movements

Nature of movement: Rock fall

Cause

Occur on steepest slopes of 70^0 - 90^0 which greatly exceed angle of friction

Also occurs when the internal strength of rock is overcome by force of gravity due to

Ice shattering or Thermal disintegration and exfoliation

Movement is triggered by:

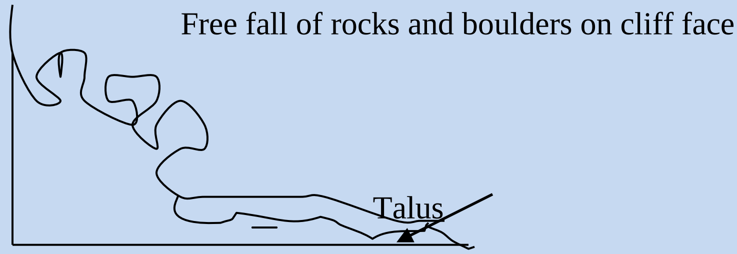
Earth tremors;

Rumbling truck noises which cause disturbances in rocks

Snowmelt may release pore pressure in scree supporting boulders triggering their fall.

Excavations

Description of hazard and examples



Frost - shattered screen or exfoliation slabs move down slope by a combination of falling, rolling and bouncing.Movement is sudden and quick.

Material comes to ‘rest’ where the slope angle is too low to allow further movement i.e. where the gradient of the slope is less than the angle of friction. Rock falls are common in mountainous parts and motorists are particularly vulnerable as well as mountainside cabins and foothill settlements.

<u>Examples</u>: Reported incidents of rock falls in Boterekwa in Shurugwi triggered by long haulage trucks to and from the chromite mines

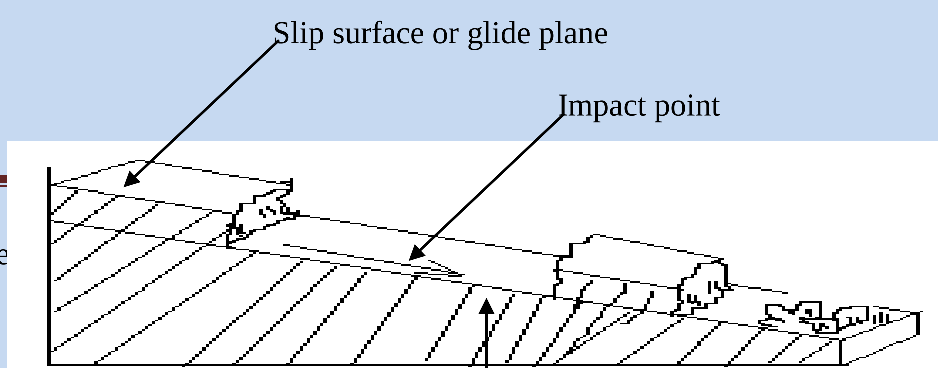
<u>Risk control / or management</u>
Steeply inclined slopes at most risk are reinforced using ductile fencing material as an embankment to “catch” rolling rocks and protect mountain side passes (roads). Danger warning signs to motorists. Legislation against foothill settlements and regulating truck movements on mountain sides most at risk.

13.5 Nature of mass movement –
<u>Rock slides and land slides</u>

<u>Causes</u>
Steep slopes of between 50^o - 55^o
Unstable slopes consisting of bedding and joint planes particularly of weak clays and limestones prone to saturation and forming slide planes (weak rocks) Incessant heavy rains for a week or more.

<u>Example</u>
A debris avalanche triggered by an earthquake killed 10 000 people in the town of Yungay (1970) in the Rio Santa Valley in the Peruvian Andes Mountains. The 1966 catastrophic mudslide killed 116 school children playing at a village school in Aberfan (UK) in South Wales) when coal waste saturated with water collapsed onto the village and school yard

Description of hazard and example



Movement is intermittent and localised. Weak layers of clay, sandstone or limestone soak up rain water and develop into a slip - off plane. Hard rocks and unconsolidated material slide down an inclined plane intact until it reaches the bottom of the plane where it breaks up upon impact.

Examples of landslides and rocks slides

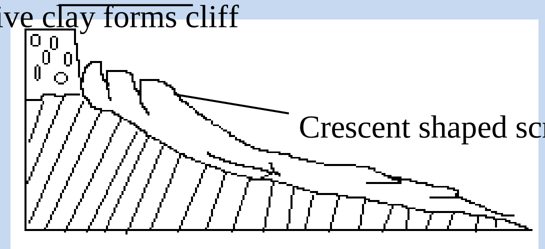
The Nyanga North lands slide on Choga Mountain in the Nyangani Range (1989) which was caused by heavy torrential rains. Gardens and dams were destroyed at the foothill.
In 1963 a massive rock side slid into a dam creating waves rising 50m above original lake levels causing an overspill and a flash flood that swept 2 000 people in the village of Langarone in Italy

Nature of mass movement–
Mud flow

Cause

Occur in areas with sparse vegetation cover and subject to torrential rains.
Rapid, less viscous and occur on slopes of low gradient e.g. 6^0 - 10^0
The exposed regolith becomes saturated, exceeds its liquid limit and becomes a viscous river.
Particularly catastrophic are the hot lava mudflows from volcanic eruptions

Description of hazard & example



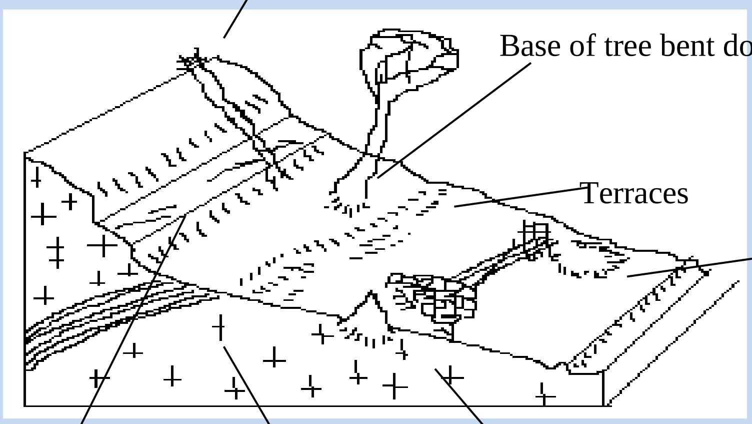
Mudflows in desert wadis are responsible for the development. Particularly vulnerable are foothill settlements that suffer sudden burial by a sea of mud, which occurs without warning. Riverine settlements downstream are also vulnerable after a dam wall burst which releases sediment material as a river of mud

Nature of mass movement:<u>Soil creep</u>

<u>Cause</u>
Alternate wetting and drying of clays may cause regolith to expand and contract respectively. Heating and cooling alternately causes particles to change their volume.
Expansion causes the surface of the slope to heave at right angles to original surface and particles are lifted along expansion path. On contraction and due to gravity particles move downwards. Particles may expand linearly parallel to the slope. On expansion the smaller fragments are pushed aside, leaving a space around the longer fragments that then slide to the lower end of the slope is steeper than the angle of friction. The expansion parallel to the slope pushes down the slope and adds to the slide component of gravity, thus promoting movement of material lying near its angle of friction.

Description of hazard and example

Effects of soil creep



Beds of shale, ends of beds turned down slope “curvature”

Occurs on gentle slopes of about 6^0

Tilted pylons and telegraph poles result from their being sited on inadequate foundations which do not reach down as far as the solid bedrock or stable part of regolith
Downward movement of regolith may cause tension gashes in roads with poor foundations when the outside road moves faster down slope than the inner edge.
The curvature of exposed ends of well – bedded rock indicates effect of creep on unweathered bedrock as well as true regolith.

Nature of mass movement: Slump

Cause

- Occurs on weak rocks.

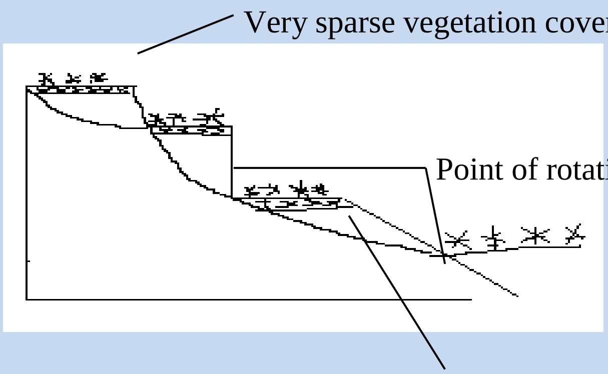
Have a rotational movement along a curved slip plane.
Common on 18^{0+} slopes. Weak rock, once saturated, provides an ideal slip plane triggering slump.

Description of hazardous environments and examples

- Multiple rotational slumps of massive rock over underlying weak clays or limestones.

Heavy rain and gales may saturate chalky boulder clay overlying soft clay. The slump may then be triggered by the foot of cliff causing slumping of the unsupported boulder – clay.
Terracettes have been observed on chalky coastal margins of Norfolk and on well-traversed goat and overlaying weak rocks.
Slumps may affect coastal highways and big hotel investments on coasts risking loss of tourism particularly on small islands heavily dependent on it.

Effects of Slump



Difficult to control.
Study of headland or cliff rock before infrastructural development might avert disaster and loss of life and livelihood.

Nature of mass movement: Avalanche

Cause

Rapid, intermittent movement on steep snow covered slopes.
Movement triggered off by:
Earth tremors
Gunshot report
Scream or shout
Rumbling of trucks
Disturbances of delicately perched rocks and boulders

Description of hazards and example

- A high mountain phenomenon. Rolling rocks or boulders collect ice, growing in size as they fall down slope. This may trigger an avalanche of ice in addition to the initial fall of boulders.

An earthquake triggered off the 1970 shower debris avalanche that wiped out the town of Yungay and several smaller villages.

- Risk control or management.
- Placing warning signs on risk slopes.
- Legislation avalanche triggering human activities.
- Educating skiers and mountain villagers.

Man- induced mass movements

Man's activities may trigger off mass movements ranging in nature from mudflow and earth to rock and slump.

These activities include,

- Piling up soil heaps and rock into unstable accumulations that falls spontaneously
- Removal of support by undermining natural masses of soil, overburden and rock.
- Spoil heaps produced by strip mining of coal are unstable and a constant threat to the lower slope and valley below. When saturated by heavy rains and melting shows, the spoil generates earth-flows and mudflows that descend upon houses, roads and forest.

Example / case study
Earth quake experienced in Palos Verdes in Los Angeles, California.

Description: The large and small earth flows are a result of water infiltration from cesspools and from irrigation water applied to lawns and gardens.

A discharge of 30 000 gallons on water from 150 homes is believed to have saturated the shales which become plastic when water is added weakening them sufficiently to cause the upper earth flow to slump with backward rotation of the down – sinking mass.

13.6 Sustainable management in hazardous Environments

Human interference with natural slopes by mining, road and settlement construction, deforestation, impeding drainage (dam construction e.g.) has tended to increase some otherwise rare mass movements. This has hence, increased incidents of catastrophes related to mass movements, floods, earthquakes and volcanic hazards.

The magnitude of a catastrophe is again related to the economic nature of the affected place and, consequently, their level of preparedness. Densely populated coastal fishing villages of India and China may be adversely affected by a tsunami or earthquake while the San Andreas tear fault may harm a few scores of people caught on a busy highway. Apartment blocks in Japan are now designed with internal stress absorbers to avert the adverse impacts of earthquakes, a frequent hazard in these archipelago islands found on destructive plate margins

Monitoring systems have been largely successful in averting many catastrophes except in a few incidents where human error, ignorance, negligence have cost lives (e.g. the recent tsunami disaster in South East Asia).

13.7 Examination Type Question

1. (a)Explain briefly the term "mass movement" **[6]**
(b)In what ways may different kinds of mass movement on slopes be classified? [**9]**
c) Explain how different kinds of mass movement affect the physical and social geography of the places in which they occur.
ii) Assess the measures taken in alleviating some of these effects. **[10]**
2.a) Describe and explain the distribution of areas most at risk from tropical storms. **[9]** 3. Show how the effects of tropical storms are:
(i) Similar to, and
(ii) Different from those of earthquakes and volcanic activity. **[16]**

4. (a) What is a "Natural Hazard"? **[6]**
(b) Which parts of the world are most at risk from natural hazards? Explain why (12)

(c) With reference to any **THREE** natural hazardous events chosen from the list below, explain to what extent these may be predicted and/or prevented. **[7]**

Earthquakes and Volcanoes.
Landslides and avalanches.
Willy Willies.
Floods.
Droughts.

CHAPTER 14

PRACTICAL MAP WORK SKILLS

14.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Analyse topographical maps.
b) Draw annotated sketch and relief section.
c) Describe and explain drainage and relief features.
d) Carry out in practical field work activities.

Introduction

Geography is the study of the spatial distribution of natural phenomena. Physical geography is concerned with the study of the natural environment as it affects man. The primary interest is in the visible environment, and particularly in the explanation of its spatial aspects.

14.2 Practical work

The current syllabus calls for the use of a variety of techniques and relevant skills. This includes the use of large-scale topographical maps in the study and interpretation of relief, landforms and drainage patterns. This should be coupled with the drawing of sketch maps and sketch profiles.

In physical geography, the following techniques of paramount importance:

- Field sketching, observation and recording
- Measurement of landforms (slope angles and profiles)
- Studying of river channels
- Measurement of all types of sediments e.g. particle size, roundness, angularity etc
- Hydrological techniques – measurement of stream velocity, river discharge, drainage density, index of sinuosity, etc.

- Soil studies – infiltration rates of different soils, soil acidity and alkalinity, soil profiles,

All this must be coupled with the use of graphs, hydrographs, histograms, and cumulative frequency graphs. Practical work is also characterised by the use of large-scale topographic maps focusing on the study and interpretation of relief, landforms and drainage patterns. You will also be required to draw sketch maps and sketch profiles.

N.B: - Practical work comes from the relevant physical geography topics and hence should not be learnt as a topic on its own.

14.3 Map work

Sketch map

As the name suggests, a sketch map is not detailed but shows the essential features of the map. It focuses on the physical features such as drainage landforms and also holds up to half of all the marks on the question. It is quite an easy task if one knows exactly what one is doing.

A good sketch map must always show the following things among others: -

Uplands and lowlands
Major drainage features
Some annotations within to further explain what is being shown
Direction of flow of the rivers
Major guidelines that form the boundary of the map being shown
Direction
Title

It is difficult to define or determine upland and lowlands on a map. Most people don't do well not because they are ignorant but because they fail to provide the distinction of upland from lowland. Using what we call a dividing contour line makes such a distinction. Choose one contour line that you think practically divide lowlands from highlands. If you choose too high a value from the range of values on the map contour lines, you may end up having very small highlands and very large sections of low lands. If the value is very low, then much of the map will be made up of highlands and a small section of lowlands.

14.4 Fieldwork relating to features of the river channel

River channel processes that can be measured include the following: -

- Channel width
- Channel depth
- Wetted perimeter
- Channel discharge
- Sediment load
- Particle size
- Meander wave length, amplitude & index of sinuosity

- Radius of curvature.

14.5 Methodology

Make field measurements at selected points of observation preferably systematically e.g. every 100 metres downstream

For some of the aspects, measurement can actually be done on the 1:50000 topographic map and the results compared with those from fieldwork

Random sampling could be employed to choose the grid squares on which to do the fieldwork.

Mathematical indices like the index of sinuosity or channel efficiency must also be calculated.

Fieldwork relating to features of the river valley:

- Flood plain width
- Slope measurements
- Gradient as you go downstream
- Sizes of pebbles as you go downstream
- Changes in rock type

Methodology

Divide the map into grid squares

Renumber the grid squares

Use random tables to choose squares to be sampled

Use ruler, tape, clinometer etc to make your measurements

Tabulate your data

Draw conclusions

Repeat the procedure every 100m or 500m down-stream and compare the data.

Problems likely to be faced:

In your fieldwork you are likely to face a number of problems and these could include the following:

Measurements such as discharge can be affected by time and unnoticed rain input upstream.

The existence of some of the features shown on the map may be dependent with seasons. A river that seems to have meanders in dry season may not reveal such meanders in summer.

The geographer may find it difficult to distinguish braids from meanders.

Results are also dependent on the time of the day, and the type of instruments employed.

NB:A Map may give false information about the area to be sampled.

The area may be very steep, dry or may have a physical obstacle like a very deep pool making it dangerous to measure pool depth and the wetted perimeter.

Do's & Don'ts

Be as accurate as possible in your measurements.

Be as reasonable as possible in choosing the practical sites. If an obstruction is encountered, take the measurements as near as possible to the original site.

Repeat the measurements several times over and then calculate the mean results before making any conclusions.
Use the most recent topographical maps.

Several aspects relating to slopes can be measured on the field. Most of these measurements also relate slope steepness. Measurements that can be made include:

- Slope height and slope length
- Mean and maximum slope angles
- Using the measurements to divide the slope into Convex, rectilinear and concave
- Expressing each sequence as a percentage of the total slope.

14.6 Selecting the points on which to make the measurements

Sampling techniques have to be employed (see the human geography practical for the techniques)
If the fieldwork calls for a comparison of two areas, use stratified random sampling. In such a situation, the population must have equal samples of each rock type - 50%
Use a topographic map to demarcate the fieldwork area on the map.
Identify the sampling points or areas using random numbers (can make use of random tables)
Decide on whether to use point, line or quadrant sampling. Random numbers can be used to decide on the sampling line or points if the squares are numbered.

You are required to make a geo-morphological study of a small river (up to 2km in your local area.

(a) What features of the river **channel** would you measure in the field, and how would you make your measurements? **[13]**

(b) What features of the river **valley** would you measure in the field, and how would you make your measurements? **[12]**

(a) **<u>4. EITHER</u>**

The table below shows downstream changes in channel slope, channel width, discharge and mean diameter of bed particles at eight points (A- H) along a river.

	Distance downstream (km)	Channel slope (0)	Channel width (m)	Discharge (m^3) / sec)	Mean Diameter of bed particles (mm)
A	2	4.8	2	1	410
B	5	3.2	3	2	270
C	11	2.1	4	3	95
D	42	1.9	7	24	14
E	83	0.9	21	60	3.6
F	150	0.4	43	135	0.8
G	260	0.2	75	290	0.5

H	480	0.1	110	540	0.4

(a)How does the data help to explain the form of the river long profile?
(b)What factors (other than those in the table) help to determine the form of river long profiles?

<u>OR</u>

You are required to study the channel of a small river (approximately 25km in length), with a view to demonstrating downstream changes in channel dimensions and shape, in relation to downstream changes in river velocity and discharge.

Describe the programme of measurements you would undertake in the field. **[7]**
Explain ways in which you would analyse your field data, in order to show possible relationships between channel dimensions and shape and river velocity and discharge. **[11]**
What problems might you expert to encounter in both your field study and the analysis of data? **[7]**
You are required to make a comparative field study of slope steepness in two adjacent areas of contrasting rock-type.
What measurements of slope steepness would you make in the field? **[7]**
How would you select the points at which to make your measurements?
How would you use your data to demonstrate any differences in slope steepness between the two areas? **[7]**

CHAPTER 15

Population distribution and density

15.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a)Define population distribution and density.
b)Examine factors affecting density and distribution.
c) Assess the changing nature of population density and distribution patterns on a regional and global scale.
d) Compare and contrast population distribution patterns in the developing and developed countries.

15.2 Population distribution and density

The term refers to the spacing of the individuals of a population within a given area. In the analysis of population patterns, it is often necessary to determine whether the population is concentrated around a central city or clustered in a particular district, or whether it tends towards uniformly even distribution or is merely randomly scattered over the area in question.

Geographers have developed various statistical techniques or borrowed techniques from other disciplines in order to clarify, measure, describe and compare population distributions. For example, a measure known as mean distance between nearest of neighbour, originally devised for the analysis of plant distributions is now widely used in the study of population patterns. This provides an index value for any distribution on a scale ranging from the hypothetical extremes of total concentration to perfectly even distribution.

The mapping of population distributions is usually done by means of dot distribution maps or by the use of proportional circles or spheres, or by a combination of these techniques.

15.3 Factors influencing population distribution and density

Patterns of population distribution in almost every part of the world are influenced to some degree by environmental conditions, but various historical economic and social factors must also be taken into account in seeking an explanation.

From a superficial examination of the distribution of the world population, it is tempting to conclude that physical influences alone, such as climate and terrain (relief), exert a dominant and controlling influence on population numbers and distribution. However, this type of interpretation in which patterns of settlement and economic activity are to be determined by environmental factors alone, does not stand up to close examination.

It is a view known as geographical determinism which found favour with many geographers during the early years of the 20 century. For example, Unworthy Huntington and others even went so far as to describe climate as "the mainspring of civilization the impulse for migrations and determinant of the energy and character of nations".

It is now realized that man is capable of modifying and controlling his environment to a considerable degree and is not a passive and powerless creature totally constrained and dominated by his surroundings. His environment offers various possibilities and operations which may not be fully explored. According to this view point, which is referred to as geographical possibility, man is the dominant element in the man /environment relationship.

In the context of population analysis, reference should be made to both physical and human factors.

<u>**Physical influences**</u>: On patterns of population distribution

- Latitude.
- Relief.
- Seasonal variation in temperature and precipitation
- Availability of water supply.
- Soil quality
- The geographical distribution of mineral resources

<u>Human influence</u>

- The type of economy practiced in an area.
- The degree of urbanization and industrialization.
- The level of technological development.
- The role of government in the fields of economic and physical planning
- The age and duration of settlement in a given area.

<u>Population distribution and density at continental level- Africa South of the Sahara</u>

<u>Why Africa has low population totals</u>

Africa is one of the relatively sparely populated continents. In the early 1930s its crude population density was eleven people per km^2. This figure is below half of the world's average, in Africa, arable density is very low. The following are some of the many reasons that account for the relatively low density of population in Africa.

The presence of the Sahara desert in the north and the Kalahari and Namibian deserts in the South and South West. The Equatorial zone has luxuriant vegetation, infertile, soils, diseases and inaccessible.
Province of pests and disease - malaria, yellow, fever .sleeping, sickness, and small pox - these have decimated people of Africa. The Plant and animal diseases -rinderpest, foot and mouth, viruses of fungi, nagana. Much of Africa has not experienced evolution of peasant civilization that was based on irrigation like in Asia. The Nile is the only out standing exception (historical factor) Constant inter tribal warfare led to high mortality e.g. the Ndebele wars with neighboring states .Slave trade as many millions of Bantu and Sudanese regions (the middle veld of Nigeria were shipped to the Americas or Islamic countries. Most of these slaves were in the reproductive age groups (Nyika region of Tanzania) STD s and STIs has reduced population fertility in many parts of the countries. European colonial conquest caused losses on African population e.g. Uganda Kenya and Zimbabwe.

The distribution of population in Africa is a function of a combination of different factors: relief, climate, soils, vegetation, disease and human influences. The factors combine to decide whether one lives in a particular area or not.

The following is an outline summary of such factors and reference is made to detailed studies or examples.

<u>Physical Influence:</u>
<u>Relief</u>:
It has three main effects on population density and distribution. Extreme high regions, Ruwenzori, upper slopes of high mountains like Cameroon Mt Kenya and Mt Kilimanjaro - all too steep, vegetation and soils almost non -existent, snow and ice prevent any permanent settlement by man. Some remote areas with relatively high relief may be taken as refuges by man although they don't live there permanently e.g. some traders such as the Fulani chose remote higher plant - the Futa Jalon and Bamenda Highlands to avoid tsetse fly ,the Wanderobo people still occupy the higher parts of the Aberdares of Kenya, Lesotho (Sotho) people retreated into the Maluti Mountains to avoid clashes with the other Bantu (Nguni) in South Africa.

<u>Climate</u>:
It has a very important influence on the overall pattern of population distribution in Africa. Rainfall amount and reliability exerts a tremendous influence. Areas with less than 380 mm per year support few crops unless rain is concentrated in a short season and area.
Rainfall of 508mm or more is useless if evaporation rates are high. Large expanses of the Sahara, the Kalahari desert, the semi-desert regions of Somalia, the Nyika regions isolated pockets of dense population excess wherever water is plentiful – the desert, the regions where rainfall is caused by increased elevation (up-drafts) the Hoggar in the Sahara, the Kilimanjolo region, the Marsabit region of Kenya, the Futa Jalon plateau.

<u>Soils.</u>

These may affect settlement over a wide region or may exert some great influences in small areas -swampy soils have high densities of population e.g. along the coast of Siera Leone, the Gambia and Liberia.

15.4 Population density for countries outside Africa

Most densely populated
Hong Kong (4000) -abnormal in a very small country
Singapore (35 00) -very highly urbanized with no significant agriculture

2 (i) Australia -2
(ii). UK -229 (immigrants from South Europe and North Africa)

3. Common Market Countries
   i). France
   ii). Italy
   iii). Denmark
   iv). Ireland: More densely populated than UK immigrants from other parts of the world looking for employment.
4. Germany - Belgium - Luxemburg and the Netherlands more densely populated (340) -due to urbanization. Important agriculture -to do with efficient management and a high level mechanization -exploit less than 4%. In U K-many people employed in tertiary and secondary activities
5. India -175, Pakistan 83, Indonesia 84 (much territory is mountainous and forest, these are populous countries.
   Japan -factory industries developed on a large scale population density is controlled greatly by the quality and excess of agricultural land and size of farm holdings.
6. Bangladesh - (refer to David Waugh) -50-76% of population is rural
   -peasant farmers with holdings less than 2 hectares
   - Family could not be supported by such small farms -so Bangladesh has very high population density.
7. India has smaller overall density than Bangladesh because about 45% is forest, mountainous, desert with out agricultural value

Comment on population density
Average density is practically meaningless. It fails to indicate the simplest fact that many parts of a country e.g. (Canada and Australia) are inhabitable or at least habitable only under extreme difficulty.

An example is Japan-the average density for Japan according to 1980 estimate was 295/km. But in actual fact about 16% of Japan's area is habitable, the rest, about 84% in inhabitable because of altitude, climate or infertility of soil and so is almost devoid of any economic usefulness -hence the density of population works at 2000 per km2. Thus we must be aware of accepting the average density at face value.

15.5 Population distribution in Zimbabwe (case study)

Introduction

Information on population size and growth is essential for development planning. Equally important is information on population distribution. Population distribution varies between urban and rural areas and within urban areas among the cities and towns of different sizes.

Within rural areas some places are more densely settled than others. The national average of population conceals areas of high and low population density, population size and density in all provinces from 1969.

Inter - Provincial Variation:

The table below shows the percentage distribution of population and of areas among provinces.

Province	Population %	Size of province %
a. Midlands	14,47	15,09
b. Masvingo	13,67	11,34
c. Manicaland	14,57	8,93
d. Mash Central	7,47	6,98
e. Mash East	19,82	6,38
f. Mash West	11,38	15,47
g. Mat North	11,73	18,82
h.. Mat South	1,89	

Population Distribution among Local Authorities

The majority of people reside in district councils that consist of communal lands and small scale commercial farming areas. Next to the largest group are those who live in urban areas managed by municipalities.

There is no rural population in commercial farms, service towns and resettlement, lands. A small residual of less than half percent (1/2%) of population is found within national parks, forest land and similar areas.

The table below shows population, area and population density by administrative units in 1982.

Unit	Population1982	%	Area km 2	Population km
Zimbabwe	7546 071	100	390 759	19,3
Rural Councils	1571 349	20,82	167 442	9,4
Municipalities	1673 057	22,17	19 21	870,9
District Councils	4278 900	56,68	169 556	25,2
Other areas	24 765	0,33	51 840	0,6

A. The uneven distribution is evident from the table. The belt of higher density of population coincides with the agrarian and industrial tracts of the eastern and central parts of the country.

B. Factors contributing to high concentration in these areas are:
a. The development of agriculture and its economic infrastructure.
b. The development of industrial centres.
c. The consequential service sector. The zone contains most of the large urban centres like Harare, Chitungwiza, Marondera, Mutare and Masvingo
C. Even if the overall density of the rural population is around 15 people per km², large numbers are found in tracts of land where terrain is level, rainfall is adequate, and irrigation facilities are available.
And consequently, farming is either well developed or has a potential for development.
D. The map shows that a large part of the country is sparsely populated with about 56% of the land area with a density of less than 10 people per km^2. With the exception of three game areas (Danda and Tuli Safari areas, UmfurudziPark and Wild life area) no extensive part of Zimbabwe is unhabitable.
The low population densities in most of the forest and commercial farming areas can be attributed largely to the prevailing use of land.
E. Division of the country on the basis of population density reveals these categories:
a. Low (under 20 people /km^2)
b. Medium (20-39 people /km^2)
c. High (40 or more people/km^2)

Low population Density
Cover tracts of land especially the western and southern parts of the country. It also extends towards these eastern and north eastern areas where agriculture potential is low. It mainly includes game reserves and forest areas, such as the Kariba Park. Low population density extends outward, hence, National Parks, Safari areas and wildlife, together about 13 % of the total area, with only 0, 26 of the country population. In these areas and those reserved for mining, cultivation and settlement are negligible.

Medium Population Density!

- Mostly surrounding, flanking and connecting heavy density areas. The areas tend to be associated with nominal roads. One area extends to the west and north of Harare. The second one link the Gutu, Mutare, Bikita peoples and Zaka district council. These areas show a fairly even scatter of population.

High Population Density:
These are in three general regions. Each includes small nodes with higher densities. These regions are the north east near Harare, the south east and south-west near Bulawayo.
The areas extend fairly across the country along most of the roads and railway lines, with strong concentrations around the south and east of Harare in the district councils of Goromonzi, Murewa and Kubatana. Small concentrations occur in Chiweshe and Chaminuka district councils and those of Rudhaka and Harare.

The distribution is essentially peripheral to the major urban centres which dominate these areas. The national axis of the rail and road lines being pioneer development zone is characterized by relatively large scale commercial farming and industrial concerns.

The flanks of this farming and industrial zone attracted many rural people most of whom were seeking wage employment on the commercial farms and nearby towns. In this way population density has built up along the line of roads and railways during the previous decades.

The eastern region of the country from Chitepo district council in the north to Gazaland district council in the south is agriculturally developed and has Mutare as a gravitating urban centre. Roads radiating from Mutare north and south wards along these roads and a pattern of heavy concentration of population density is observed. This area has fertile land which supports commercial farming and is associated with heavy rural population density.

To the South-west of Mutare several areas support 400 or more, people per km^2. The main areas of population concentration in this zone fall in Zaka and Bikita. People in district councils have population concentrated near roads and river banks. An off shoot of this belt with a relatively higher population concentration extends towards Gutu district council towards Masvingo and Nyaningwe district councils in the west.

<u>Conclusion</u>

There are some economic causes of population concentration. Areas of high population density tend to have a comparatively well developed economy dependant upon commercial farming and industry and their associated urban centre. Population concentration also reflect historical influences e.g. the higher densities of communal administrative and service centre such as regional growth points are attracting more people

The pattern of rural population density is influenced by the following factors , sparsely populated game reserves, national parks and wild life areas mountains and hilly tracts which stand in marked contrast to the agriculturally developed areas in the centre –east and south east where rural population strings along valleys where pockets of cultivable land and water for irrigation are available. Rural population density express a wide range of pattern from highly disposed to count rated.

15.6 Examination type questions

1) With reference to examples examine the view that population density and distribution is largely a result of economic opportunity? [25]
2) To what extent can population distribution be attributed to climatic considerations? (25)
3) With references to examples account for low population densities in the developing countries as compared to the developed countries. (25)

CHAPTER 16

Demographic characteristics

16.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Define critical population terms.
b) Outline main factors affecting demographic characteristic.
c) Assess reasons for variation between demographic characteristics of developing and developed countries.
d) Construct, interpret and analyse age,sex, andstructure.

Introduction

Demography is defined as the study of population characteristics .This enables one to be in a position to explain different aspects of the population. In this regard this chapter is dedicated towards explaining critical demographic concepts and models.

Crude population density This can be defined as a measure of the average number of individuals per unit area. For instance, the U K has an average population density of 230 persons per km²; such a finger is of limited value, for there are of course, wide variations on either side of that mean figure.

As a measure, crude population density is most useful when used in studies of small area units such as parishes, census enumeration districts or city wards. It can however be modified in various ways to improve its value.

16.2 Definition of demographic terms

Fertility: The occurrence of live births in a defined population. Fertility is determined by fecundity.

<u>Fecundity</u>: Biological capacity for reproduction.

- **<u>Mortality:</u>** The occurrence of death in a defined population.

- **<u>Infant mortality</u>**: The number of deaths of infants under the age of one year.

- **<u>Maternal mortality</u>**: The number of deaths of expecting mothers in a defined population (of females)

-Mortality, the second of the components of population change differs from fertility in that it tends to be more stable and predictable and less prone to short –term fluctuation.

-As with fertility, there are a number of measures which can be used to express mortality.
-The most widely used index is that of crude mortality rate or crude death rate.

- Mortality Rate factor (Socio-economic factor)
- Level of health awareness especially among women.
- The level of hygiene in homes.
- The level of nutrition within the population.
- Education attainment of women.
- Types of residence -both rural and urban.

-Beliefs including traditional and modern religion and the level of technology.
-Mortality varies with age, sex, regions, ethnic, groups and race.

Birth and Death Rates:
Crude Birth Rate: - It is a measure of fertility.
C.B.R. - Number of live births per year per 1000 of the population

<u>No of births x 1000</u>
Total population

Crude birth rate has the advantage of being easy to calculate, but it does not take into account the effect of age structure on birth rates.

<u>Birth Rates</u>: In developed countries (below20%)

- In developing countries (up to 50% or more) e.g. Germany 9, 7%, Japan 17, 2%, Togo 50, 6%, Zimbabwe 36, 0%, Kenya 40%.

A reason for these figures is that fertility declines in developed countries where living standards are high and is high in developing countries where technology is least advanced.

<u>Factors determining births rates</u>.
<u>Demographic structure.</u>

This is the character of population's age and sex composition. Areas with a high percentage of children and the aged have low birth rates. Areas with many adults- high birth rate e.g. new towns with high immigrant numbers. A low birth rate may be due to the fact that numbers of one sex exceed that of the other sex.

Education:

- Advance level of education,-smaller average age, family size - knowledge of birth control social awareness.

Religion:

Muslims and Roman Catholics encourage large families to safeguard the continuance of their religion. Countries with such religions have high birth rates e.g. Latin America, Algeria (49%) and Morocco 47% in 1989.

Social customs.

The concept of marriage is different among different social and cultural groups. In some places polygamy is practiced so this increase birth rate. In Hindu society the -average age for girls to marry is 16. In Panama, Honduras and Bolivia- Legal marriage age is 12 for females and 14 for males (Zimbabwe 18).

Diet and Health

Poorest and unnourished people have highest birth rates. Perhaps there is a correlation between diet and sexual appetite (according to sociologists). High birth rates in these areas lead to continued poverty which maintains malnutrition and a vicious circle of poverty.

Politics

War limits population growth. The world wars resulted in losses of about 60 million lives. Wars reduce population for one generation only and demographic recovery comes soon with an increase in birth rate. During war men folk are fighting and the number of births falls naturally. After the war troops return and births rates rise suddenly. Most European countries experienced fertility bulge in the year 1918, 1920and 1946-49.

Value of children

Children are valuable. They provide continuation of the human species. Children are sources of happiness. They are potential means of support and security, once parents are no longer able to provide for themselves. Traditional agricultural societies believe that there is much work done by hand-so a large family is important.

Marriage

Is nearly universal among women and the majority of married women are under 20. All women are at reproductive risk during their fertility years. Fertility is higher among women who are rural ,poorly educated with poorly educated spouses ,illiterate ,not employed out side the home and lower among those who are urban .,better educated ,literate and employed outside home.

Custom which prohibits cohabitation of couples until the baby is weaned. This reduces birth rate e.g. in most West African countries.

Labour migration involve males so reduce birth rate.
Large families symbolises prestige and social standing. In some African countries the need for numerical superiority over minority groups led to increase in birth rates and this still continues.
Misconceptions - A belief that greater numbers of people would be able to resolve any problems created by higher population densities

Death Rate:
Crude Death Rate: - This is the ratio between number of deaths in a single simple year and the total population per 1000.

$$\text{i.e.}\quad \frac{\text{No of deaths per year} \times 1000}{\text{Total population}}$$

It is a measure of mortality. It is lowest (5%) in less economically developed countries.
Countries with low birth rate have low death rate and vice-versa. Examples are, India 15%, Malawi and Ethiopia 25%. Some countries with limited technology have low mortality rates probably because they have been subjects to the influence of major western countries e.g. Fiji 4%, Singapore 5%, Puerto Rico 6, 5%.

Factors Affecting Death Rate
Demographic structure.
Areas with large proportion of aged people have high death rates e.g. Britain retirement resorts of the South coast. Some wealthy advanced nations may have a higher death rate than less advanced and developing nations because the population of less developing countries shows young age structures.

Medicine:
Better medical services and supplies give result to lower death rate. Ratio of doctors to patients within a given area is important. More Economical Developed Countries (M E.D.Cs) have more doctors to patients ratio.

3 Social class;
Higher death rates are associated with poorest sections of society or population than rich ones because the less privileged live in low standard housing and sanitary conditions, no balanced diet, no adequate medical treatment

4. Occupation
Some occupations are more dangerous than others e.g. coal miners are vulnerable to a high accident risk or respiratory diseases (Hwange Disaster, 472 people died in 1972). Some occupations lead to mental strain e.g. jobs of high level responsibility.

5. Place of residence.

There are higher death rates in urban areas than in the country side because of crowded conditions, high traffic densities, atmospheric pollution, and nervous strain

<u>6. Reduction of killer diseases</u>
Small pox, malaria, dysentry - sanitation problems.

7. According to Africa Economic Development News published by the International Press Institute, an African baby is 10 times more likely to die before her first birth day than a European or American baby. An average European or American can expect to live at least 20 years, more than an average African.
Reasons; - In developing countries every year 4,5 million infants under 5 years die of diarrhea.

More than 4 million die due to infected lungs.

2 million die from malaria each year.

16.3 Reasons for low Rate of population Growth in the More Economically Developed countries

<u>High rate of urbanization</u>:
People who live in towns are faced with higher living costs especially in renting accommodation and food buying. Their earnings cannot support many children at high standard of living and at the same time be able to let them get better services and expensive consumer goods.

<u>Education.</u>
People learn more about the world and alternative living styles. They find it possible to plan ahead in checking the size of their family.
Large families are regarded as an excessive drain on the resources of the land.
Low birth rate.
Industrialization

Population Policies for different countries:

<u>**Population policies**</u> are made an integral part of overall development policies.
Some governments have a policy to increase fertility e.g. Argentina, Bolivia, Iraq and Israel, Cambodia, Guinea, Libya (with a population density of one person per km^2).
Some governments have a policy to decrease fertility e.g. in Latin America, Barbados, Jamaica, Honduras, Mexico, Trinidad and Tobago. In Asia-Bangladesh, India, China., Fiji, Iran, Jordan, Korean, Republic,Phillipies, Sri Lanka, Vietnam, Thailand. In Africa-Botswana, Egypt, Lesotho, Mauritius, Swaziland, Seychelles, South Africa, Tunisia, Uganda, Zimbabwe.

Other governments have a policy of maintaining fertility at present levels e.g. Asia-Cyprus, DPR Korea, Kuwait, Mongolia, Saudi Arabia, United Arab Emirates, and in Africa-Ivory Coast and Mozambique.

The Madagascar policy to alter fertility rates by letting each family decide upon their family size includes:

a.) Provision of /or withdrawing contraceptive advice and facilities.
b) Legal measures like making abortion illegal and raising the age of marriage.
c) Socio - economic measures designed to encourage /discourage large families.

Singapore has systems of incentives and disincentives that actively discourage large families (population density 3500)

- Liberalization of abortion and sterilization demand.
- Abolition of paid maternity leave for delivering the 3rd and subsequent children.
- No priority is given to large families in allocation of government housing.
- Low priority in the choice of primary school to children of the 4th birth and higher. (But at present may be due to increased out migration, Singapore encourages high fertility).

Bolivia which seeks to increase fertility levels has chosen family planning clinics and provides no support for access to contraception and has made abortion illegal.

<u>Zimbabwe's policy</u>:
-Making teenage marriage illegal.
-Making marriage age at 18 years.
-Encouraging family planning and child spacing although making abortion illegal.
-Laws relating to taxation, housing and child care facilities could also have positive impacts of the regulation of family size.
-Provision of maternity leave with pay for working women influences family sizes by allowing a maximum of 3. Such periods are given in a civil service career and only given every 24 months.

Japan has successfully encouraged people to have smaller families and for more than 20 years the birth rate has been much low. In 1950 the population of Japan had large base with high birth rate. In 1975 the pyramid resembled that of the UK.

Sri- Lanka - Delaying marriage.
-Encouraging female employment.
-Stimulating social mobility.

Some 3rd world countries want high rates of emigration e.g. Republic of Korea, Algeria, Pakistan, Turkey.

Others want high rates of immigration e.g. Saudi Arabia, Israel, Argentina, South Africa, Bolivia, Gabon, Equatorial Guinea, Ecuador.

Some 3rd World (less Economical developed countries) countries have policies to:
a) Promote or facilitate temporary emigration of manpower or profitable employment in the newly developing oil rich states
b) Promote repatriation of this skilled manpower residing abroad

16.4 POPULATION COMPOSITION:

<u>Age -sex distributions</u> are useful indicators of man power. They provide crude measures of the dependency load, consumption needs and social requirement in the present or near future. Age and sex are two of the basic characteristics of population. They are important in relation to other population variables such as mortality, fertility and migration.

<u>Age structure</u>: The number of people in a total population found in each age group. It is important because:

Age determines one's personal characteristic –what one thinks, does and needs
Determines one's primary, social and economic importance in society.
It is related to other demo graphic characteristics such as birth rate, death rate, migration and marriage.
Reflects demographic and socio –economic history of a population over a period of time.

There are 3 age groups normally recognized in a population group
-Under 16 –children
-16 to 64 –adults.
-65+ Aged.

<u>Factors affecting age structure of a population:</u>

Birth Rate
- High-large proportion of young people.
- Low –small proportion of young people.

ii.) Mortality - Reduction of death rate-population old because people live longer.
-May result in making population younger (if it is high)

iii.) Migration -Has impact on population of districts and cities.
-Is age selective?
-Involves a large proportion of young people.
-Areas that experiences an out-migration has fewer young people
-Areas with a large amount of in -migration may show an excess of young adults.

iv.) Catastrophies e.g. wars- many young adults who are combatant may die in war
- There is usually a sharp decline in birth rate during war.

v.) Changes in population growth leads to changes in age structure.
-Falling growth rate –ageing population.
- Rising growth- youthful population.

16.5 Sex structure:

This is the expression of male –female proportion in population. It is expressed as a sex ratio.

Sex Ratio – The number of males per 100 females.

$$\frac{\text{No of males x 100}}{\text{No of females}}$$

- 100—males =females in a population
- >100—males > females
- <100—males < females

Factors Affecting Sex Ratio.

Death rate differences between sexes – mortality in every age group is biased against males.
Net migration rate – more males migrate than females.
Wars –refer to life expectance here.

Age –sex Pyramids.

The presentation of data on population structure can be done through the use of age –sex pyramids – which illustrate age-sex structures of a population. They provide information about social attributes of populations. Two bar graphs are placed back to back. The vertical line represents zero population and age groups. Numbers of people in each age group by sex is indicated by horizontal bars –males on the left and females on the right.

Shape of Pyramids.

The shape varies according to country, community and time. It reflects social and economic character of a country, its state of advancement, nature of society and prospects for the future.

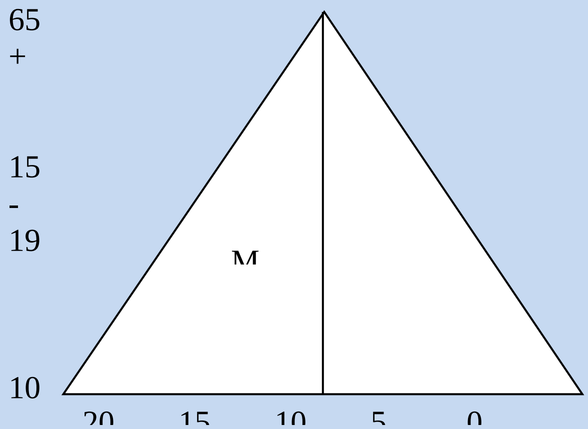
It may indicate some aspects of the country's demographic history –incidence of wars plagues, natural disasters etc. The – middle – age - group (adults) is important because it consists of a working population that is supports children and the aged or retired.

Few adults imply that the country finds it difficult to be economically viable. This becomes a problem where age structure is either very progressive or very regressive.

16.6 Types of age – Sex Pyramids.

Progressive Age structure.
Regressive Age structure.

Inter mediate Age structure.Progressive Age structure (Triangular shape



)

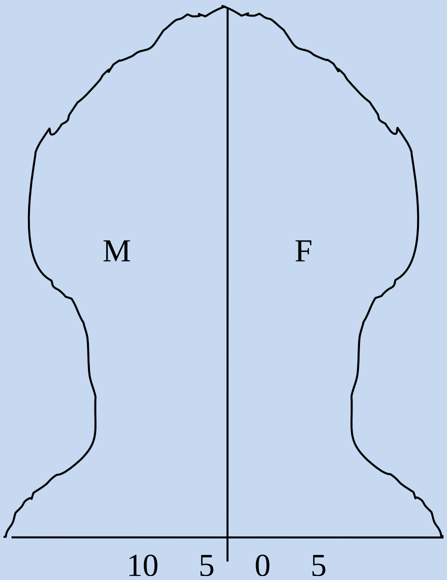
Wide base (pattern of less industrialized economies.
High birth Rate.
Narrow top
Population is young (children 45-55%)
Few old people.
Gold Growing population.
Common in developing countries where social, cultural and religions and economic conditions lead to high fertility and poor living conditions, bad diet and little medical care leads to high levels of mortality.

Implications

Public services are needed e.g. recreation halls and stadiums.
Education and health centre (schools, colleges, hospitals and patient –doctor ratio
Strain of country's resources e.g. forests, land pressure.
Employment creation needed.
Heavy burden on worker sector.
Heavy dependency ratio or load.
As young people become older and move up the pyramid, the potential for population growth increases.
Low median age
Low expectancy.
Involves a proportionately bigger investment in and depreciation of human capital.
But this may mean high proportion of new entrants in labor force –who can be more easily framed and adapted to the changing needs of the economy.
Examples of countries:
Kenya, Brazil and Zimbabwe.

Regressive Age structure

- Common in developed countries e.g. UK and other West European countries with a high standard of living, education, social awareness, good medical facilities



Varying pattern
Countries passing through stages of development
May have had progressive structure in the past
In future have regressive structure

Concepts of Economically Active Population and Dependency Ratio

16.7 Economically Active Population

Population that is engaged in gainful employment, which is adult population, is an economically active population with the working population that includes men and women who are normally employed. Activity rate of a population refers to the proportion which is economically active.

This excludes children below work age and retired people, students, housewives, inmates of institutions, people living from rents, dividends, pensions, the aged and those who live by private means. All these belong to an inactive population.

The following are factors that determine population that is economically active.
i.) Size of total population in a country -Large proportion.
-Small size relatively less numbers of active population.

Age structure of a population--- Young rapidly growing population of developing countries- active population tends to be small and there is heavy youth dependency. In developing countries activity rate is about 20%due to the percentage of children.

Advancing ageing at the apex –creates a state of heavy old age dependency. Activity rate is high 50% because the number of young people is low and at present female employment is common e.g. in Europe.

iii) In the developing world e.g. in Africa, the size is low because of the tradition of non-employment of women (social factor) e.g. in Muslim societies women have sheltered existence.

iv) Wars –people of working age die in wars –especially men.

v) Migrations - decrease or increase in size of working population e.g. the Rand in SA. Copper belt of Zambia.

vi) Economic changes-closure of industries in a country e.g. many factories closed in Zimbabwe in 1984 -5 and from 1999 to date thus causing unemployment.

vii) Urban-rural ratio. Activity rates of women, children and old people living in African communities differ from those of towns. They are higher in the country.

viii) Longer education and improvements in social conditions have diminished the activity of children in the towns especially in Britain.

ix) Level of income affects activity rates.

x) Health state of population influences activity rates. Physical disability is higher in poverty stricken, economically backward countries than in highly developed countries.

Dependency Ratio:

-The proportion of population that is in the non-productive age.
It is a statistic measure of the role of age composition on product activity. This assumes that people between 20 and 64 years are the productive segment of the population whereas those under 20 and above 64 years are the dependent segment of the population.

$$\text{Dependency Ratio: } \frac{\text{- Population under 20 + population above 65}}{\text{Population between 20 -64 years.}} \text{x100}$$

The purpose of the dependency ratio is to measure the number of dependents that each 100 people in the productive years must support. Some nations have high dependency ratios because of a large number of elderly whereas other nations of large number of children.
Dependency ratios are high in developing (i.e. less Economically Developed) countries due to their relatively high fertility levels- Large population proportions are under 15 years of age e.g. in Ghana, where 47% of population is under 15 and 4 % of population is above 64. There are 104 persons in the working ages in the highly industrialized countries such as Japan where 24% of the population is the dependent ages for each 100 people in the working age. World patterns of age structure reveal the following features.

Youngest populations are found in Less Economically Developed Countries (LEDCs) or nations of Africa, Asia and Latin America.

Tanzania - 2% of population -over 64, 47 %, under15.
In 1980 the countries that had highest proportions of persons under 15 were Libya 49%, Mali 49% , Algeria 48%, SWAZILAND 48%, Nicaragua 48% Zimbabwe 48%, Syria 48%.
Europe is the world's most elderly continent –with 12% of its population aged 65 and over. Germany 15% Sweden 15% , France14% Austria 15% , Norway 14% , UK 14%, Belgium14%, Denmark 13%, Luxembourg 13%

Comparison of Dependency Ratios.

*World average dependency ratio=72
*Average for More Economically Developed countries (MEDC=55)
*Average for Less Economically Developed countries (MEDC=79)

Africa alone	89 (highest)	China 63
Zimbabwe-108	Japan 48	Germany 56
Morocco-103	Poland 49	Italy 56
Ghana-102	Hungary49	Netherlands 57
Botswana101	Russia 54	Singapore 58
Syria 89	U.S.A. 55	Britain 60
	Canada55	France60

***NB*:** Countries with lowest dependant ratios are communist countries like Cuba and China; The western nations, U.S.A, Canada, Germany, Italy, Netherlands, U.K, France, Austria; The Islands of Jamaica, Hong Kong and Singapore, reason being needed to reduce population growth and family size. China is taking drastic measures to curb population growth e.g. the one child per couple policy.

16.8 Examination type questions

1 .a) Define the terms fertility ratio and total fertility ratios. (6)
b). Account for the variation of fertility ratios between developed and developing countries. (12)
c) Critically examine attempts to reduce rapid population growth in the LEDCs (7)
2. With reference from regions you have studied. Outline attempts by LEDCs to reduce infant mortality in the last 30 years. (15)
3. To what extent has the education of women led to the decline in global population growth rates? (25)

CHAPTER 17

Population and resources

17.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Define, over, optimum and under population.
b) Critically examine population resource relationships.
c) Evaluate with reference to examples the applicability of population resource relationships.

Introduction

The well being of a population of any country depends on the appropriate utilization or availability of resources. Some regions are richly endowed with abundant natural resources yet the quality of life is very low. On the other hand, in some other areas, the quality of life may be very high yet the country in not endowed with a lot of resources. Our conclusion is that population and resources play a critical role in maintaining a steady balance of demographic characteristics. This section gives a critical evaluation of the population and resource equilibrium in response to the theoretical concepts of over, optimum and under population

The ability of an area or country to absorb a large number of people depends; on the following factors;
1] Size of country.
2] Resource endowment.
3] Prevailing technology.
4] Social structure.
5] Stage of economic development.
6] The needs, traditions and aspirations of individuals.

<u>There are two groups of resources.</u>
1] <u>Renewable resources</u>.
These include the biological phenomena, farming, fisheries, forestry resources and solar energy that can be tapped through batteries to produce electricity and power from wind and water.

2] <u>Non renewableResources</u>.
These include fossil fuel for example, coal and natural gas and metallic minerals. The main characteristic of these resources is that they are finite.

There are 3[three] important concepts were are concerned with, that is the relationship between population and resources. These are overpopulation, optimum, and under population.

<u>Overpopulation</u>
It occurs where and when there is an excess population in relation to the available resources and skills. It exists where there is too great a population in a given area, region or country for the actual or potential resources to support it and results from an increase in population or where the decline in the country's resources.

It occurs when resource development fails to keep pace with population growth. It does not only entail high density. Northern Brazil, with a population density of less than 2 people per square kilometer, is well known for its poverty, hunger and is a good example of an overpopulated area. If population is greater than a point at which a country has achieved a density of population which, with the given resources and skills, produces the greatest economic welfare [maximum income per head], there will be overpopulation.

In an overpopulated area, the standard of living is lower than it would be when the optimum prevailed.

The following are indicators/symptoms of overpopulation
[a] Low capital incomes, population in a country are a measure of the country's wealth
[b] Low living standards or welfare levels and trends.
[c] High levels of unemployment and underemployment

[d] Well marked outward migration
[e] High population density [though not always]
[f] Hunger and famine
[g] Malnutrion
[h] Illiteracy

The following are examples of overpopulated areas
1] The Sahel region of West Africa
2] Southern England
3] Bangladesh
4] Brazil -as evidenced by the existence of epidemic, famine, diseases and poverty
5] **Some rural areas of Zimbabwe** --Chivi, Mazvihwa, Jerera, Gutu, Mberengwa- as evidenced by pressure on land, shortage of timber in many areas, vanishing of forests due to search for firewood, rural to urban migration in many rural districts.
6**]Kenya** The working population is about 4million but only 17% are employed in urban areas or large scale farms; many young people flock to towns especially Nairobi.
7) **THE ISLANDS OF BARBADOS** – population density is about 500 people per square kilometer. People depend on agriculture for their livelihood, all cultivable land is used: unemployment is severe and population pressure is relieved by emigration.
8) **EGYPT:** This is an example of an over populated area or country. It has an area of one million per km^2 but the habitable area is about 3600 km^2 i.e. 3 % of the total area .Population of about 44 million is concentrated on the Nile Delta, along the Nile river and the Fuyun. Beyond the delta, Mediterranean Coast is sparsely populated. The Western desert has sedentary groups living at oases. Apart from the oil well settlements, the Sinai provides a home for scattered groups. The 44 million people are increasing at a rate of about 3% per year, one of the greatest in the world. The rate of population growth is the result of the reduction of a very high death rate in modern times. Life expectancy is still fairly low by western standards (males 51, females 53).
More than 40% of population is below 15 years of age. The crude birth rate is very high, 34,9% per 100. A large proportion of the population is too young to do productive work. Settled areas are very densely populated and population pressure is by far the greatest problem facing the country.

In 1930, Egypt was the most advanced country in Africa but the economy failed to take off because the country has been constantly faced with problems of trying to maintain basic food supplies in line with increasing population.
Despite significant improvements in farming practice and despite major development projects per head per capita has not risen and periodically has fallen.
Egypt may therefore be said to be overpopulated. Egypt's total cultivable land is only 2 ½ million hectares. Efforts have been made to increase the area of cultivable land e.g., the building of the Aswan High Dam.

The introduction of year round irrigation allowed the growing of more than one crop a year so that the cropped area has grown faster than the cultivable land/area. Irrigation, intensive farming methods, use of modern fertilizers and pesticides have made yields in Egypt amongst the highest in the world but income per head hardly changed between 1913 and by

1952 output per head fell. So the law of diminishing returns may be said to have operated. Even major modern projects have failed to change the basic pattern. Competition of the High Dam at Aswan in the 1960, has added 1 million hectares of cultivable land to the farmlands of Egypt but this merely produced additional food and income to maintain the pre-existing standard of living because the population had grown so rapidly.

17.2 Difficulties in measuring over population

Overpopulation may be a relative term used subjectively. Over population should be considered in terms of the stage of development of a given country. It does not take into account factors such as culture, racial character, level of technology and differing expectations. What one may consider to be over crowded and poor in some other regions may be accepted as normal in other regions. A resource that may be considered not important in one place may be of great value in another place. In developing countries food is a major criterion for over population. In developed countries (i.e. less Economically developed countries and more Economical Developed countries).

Different societies and cultural groups have different needs, traditions and aspirations -so there are no simple indices of over population. Defining over population using the rate of growth of population is difficult.

An area may have a rapid growth of population, but if there are enough resources, technology and skills to exploit and utilize these resources there will be no over - population. Trends in average income may be low but if a given society has low expectations and aspirations there may be no over – population.

The extent of unemployment may depend on availability of jobs, determined by the level of industrialization. Resources may be available but there may be no skills due to lack of education. This may also be affected by deficient technology and some social economic obstacles to development.

In Europe and the U.S.A there is no over - population because they can feed their people. Many thousands in the UK are not employed but these people can be well fed and the U.K cannot be said to be over populated. In industrialized countries over population is not necessarily determined by unemployment e.g. before the World War II, unemployment in America was due to economic factors and not an increase in population. France was a centre of attraction for many foreigners but some industries suffered from unemployment problems due to the economic system that was un- favorable to export not an excessive population growth.

17.3 OVER POPULATION AND POPULATION DENSITY

A densely populated area is not necessarily over populated. There are many examples to illustrate this point. Density of population relates people to their resources and standards of living that they enjoy in a particular area.

The standard of living per capita income is not merely a function of the number of people in an area. It is also the result of the character of the economy, the technology level and skills of the people, the capital and resources available and economic and political factors out side the control of the inhabitants themselves.

Some countries can feed poor and wealthy sparsely population areas at both local and world scales. Holland has intensive farming that is based on high technology and high capital investment. This produces high yields that can be sold to wealthy industrial regions and cities. Thus high density of population does not therefore mean that land is over populated. Since farming there is now less than labour intensive and a decrease in rural population could reduce yields and farm in come. This contrasts London or Los Angeles with Calcutta or other Asian cities. In the Netherlands there is acute shortage of agricultural land, the population density is about 340 people per km² but there is no over population. Density does not take into account fertility of soil or social conditions under which people live.

Physiological density: Population density / km^2 of cultivable soil may be used but it does not take into account out side sources of food.

Agricultural density: The number of people living by agriculture on the areas concerned. This is just an approximation because cultivated area may contain belts of land of different value or quality. Again this system of cultivation may not be intensive to produce high yields

What to consider in over population:
The standard of living – i.e. the whole economic system even in qualitative terms together with a degree of civilization e.g. income minus rates and taxes, may make an area not to be overpopulated.

Quantitative notion of food consumed by people
High living standards in Sweden, France Belgium are distinguished from Poland and Romania with low standards of living. There are therefore some advanced countries in which consumption is ample because their population increase is little and their methods of production are intensive and complicated. There are also countries in which population total and the backward state of their technique lower the standard of living.
Material life: A country feels effects of over population when people realize that their standard of living is low and conceive of the hope of improving it by some means. That is why migrations begin with special cases where there is plainly, visible and perceptible difference in the standard of living in two adjacent countries.

17.4 REMEDIES OF OVER POPULATION

Bring un-used areas under cultivation e.g.
U.S.A
Australia
Canada
Africa
Argentina
Eastern
Asia

Establishment of industrial centres or industrialization of country districts that are too rural. This was done in Germany, Italy and Japan to absorb many immigrants. But industrialization may provoke a further increase in population that may destroy the margin of well being accruing to the masses owing to the increase in agriculture when people leave tilling of soil e.g. France and Japan.

Changing crops and yields everywhere e.g. Introduce hybrid species

Establishment of active and good relations with the rest of the world. Over population becomes clean and perceptible when international trade is slackened by political events. Freedom of markets is important to a country

OPTIMUM POPULATION

This is the situation or point at which a country has achieved a density of population which, with the given resources and skills produces the greatest economic welfare (the maximum in come per head). It occurs where the population size of a given country area allows maximum utilization of resources. It implies that man achieves maximum out put per head and highest possible living standards.

Optimum population is in fact a theoretical concept or situation. Theoretically, here it implies that there is no optimum population for every country. Optimum population is essentially dynamic. Any figure of optimum population is calculated on the basis of a country's existing technology.

The balance between population and resources is not necessarily constant. Any increase in resources, for example, improvement in soil fertility, new mineral finds the realization by a country of power potential or stock of capital will permit or require an increased labour supply. So the level of optimum population will be raised e.g. Manyuchi irrigation project in Masvingo province, oil in the Mozambique coast, coal in Gokwe in Zimbabwe and oil drilling in the Zambezi Basin. Optimum population can only be maintained if the exploitation of some resources or development of the forms of employment keeps at the same place with the increase in population.

The following may be a useful equation for optimum population:

$$\text{Level of living} = \frac{\text{Natural resources x Technique (Technical skills)}}{\text{Population}}$$

The country's resources e.g. mineral resources, soils, forests etc are more or less given, but their availability and value can be increased by improvement in technique.

Difficulties in finding examples of optimum population

Optimum population cannot be measured. It is a useful theoretical concept against which to measure the relationship of people and resources in different countries to gauge whether they are seriously under or overpopulated, but no calculation of optimum population size can be made.

The condition of optimum population must be the result of the operation and interaction of a great variety of factors. Each of the factors is dynamic and subject to change e.g.
The size of the markets
The value of resources.
Food prices.
The area of cultivatable land
Exchange rates

So if an optimum figure were calculated, it would be for a one point in time and subject to rapid change. It is also impossible to establish what is optimum productivity for a particular industry, area or country. So we are not able to access what population size would do to produce the greatest economic welfare.

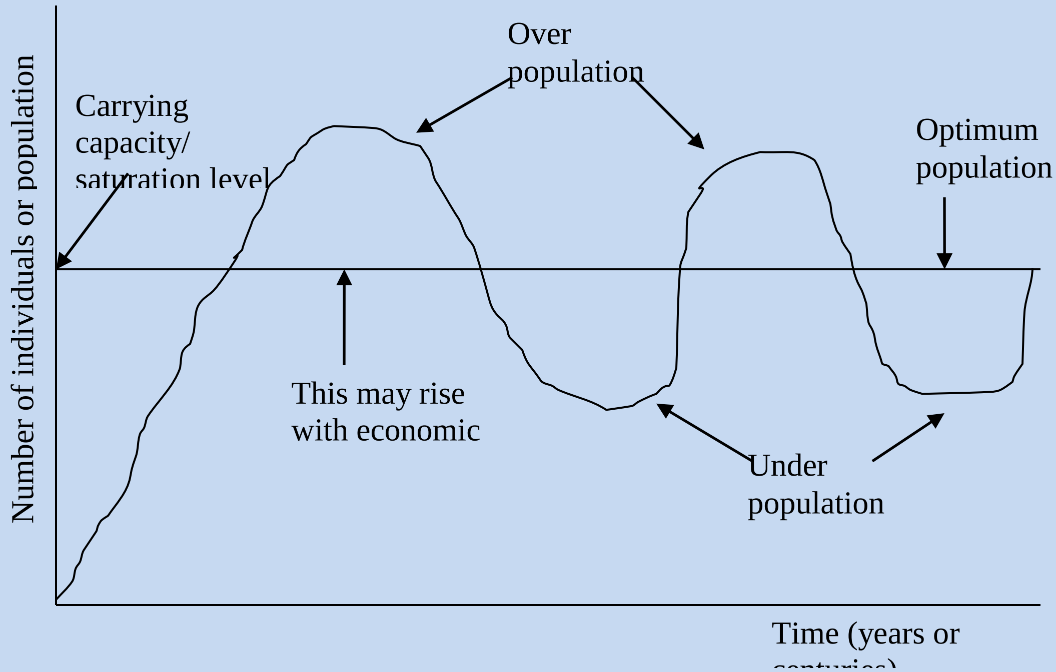
Under population:
If population is less than a point at which a country has achieved a density of population which with the given resources and skills produces the greatest welfare then there is under population. It refers to a population that is too small to make full use of the resources that are available to it. A higher population could be maintained by available resources without any reduction in living standards. These may be regions at low levels of civilization like the Amazon Basin or regions which man has not yet developed like the Canadian Prairies, Brazil with 14 people per square kilometre, the Democratic Republic of Congo etc. Liberia could be said to be under- populated because mining development is held back by limited supply of labour.

However, low sparsely populated areas are not necessarily under populated e.g.

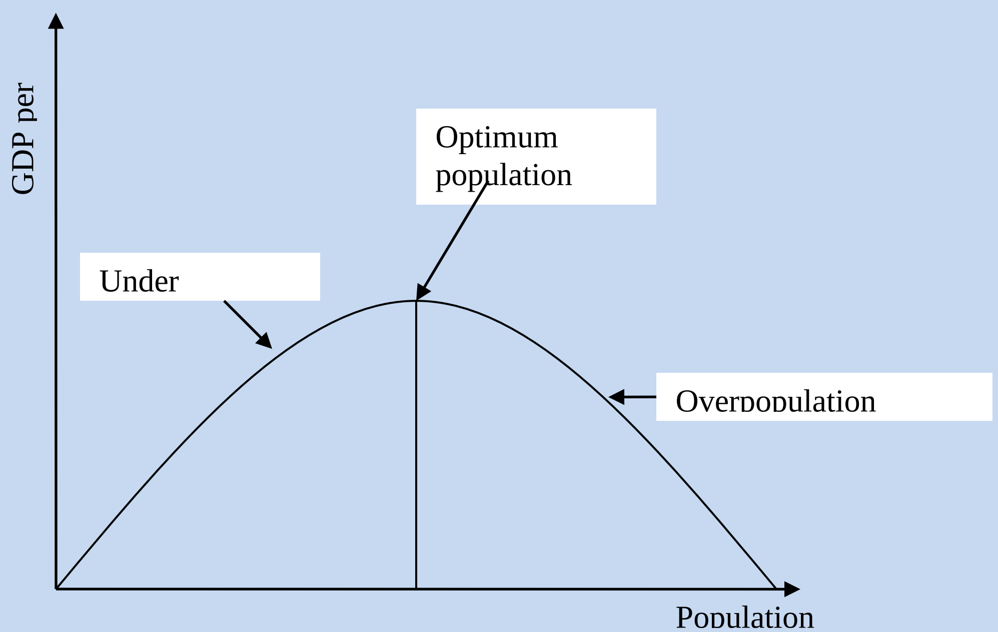
Agricultural development and settlement in the interior of Australia has been limited by lack of people and South West Australia could not be said to be under populated.
Although the Sahel is sparsely populated it can no longer carry the numbers it has. The diagrams below can be used to illustrate the three concepts that relate population and resources

Fig. 1

A

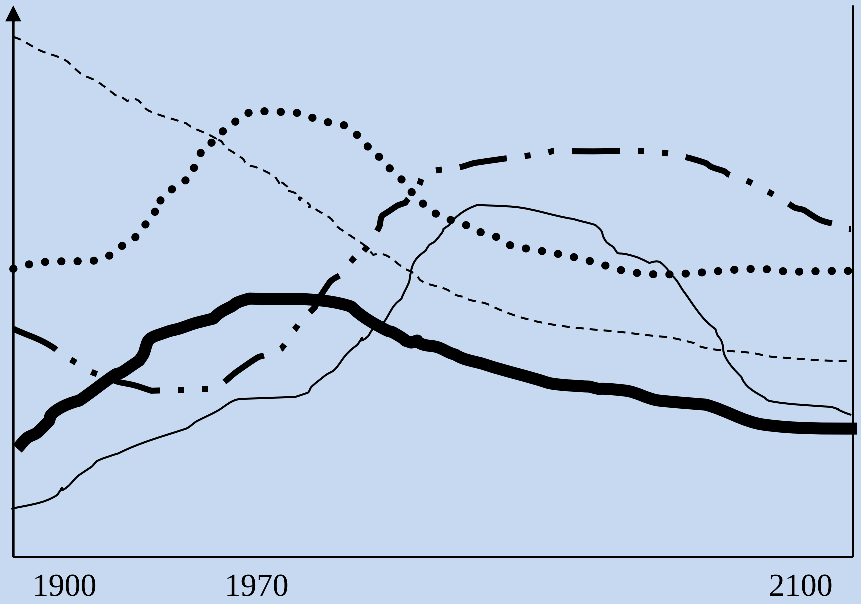


B



This may rise or fall with economic progress and technological advancement.
The model of limits to growth: (Standard world model)

Fig. 2



KEY

Pollution

Population

Resources

Food production

Industrial production

Research Based on MIT (Massachussetts Institute of Technology) by 30 scientists in 1968.

The model assumes that there is no change in physical, economic and social relationship that has essentials in the system; the predicted trends are as follows:

Continued increase in population and industrial production due to expansion of industries in industrialized countries and industrialization of the less Economical Developed countries.

<u>The diminishing resources.</u>
Increase in pollution associated with industrialization and population growth.
Food, industrial output all grow at exponential rates and then decline rapidly. This decline is due to rapidly diminishing resources basis. This especially affected industrial output due to

increasing scarcity and cost of basic raw materials. Food production is affected as farms need machinery and fertilizer produced by industries.

Decline in industry is also due to pollution of water bodies that are used to supply water to industries.
Because of the inertia in the global system both pollution and population continue to increase after industrial and food production decline.
Eventually a population crash is experienced due to a combination of decreased food supplies that result in malnutrition, starvation and deterioration of medical services. This occurs as a result of population pressure on medical services

17.5 Examination type questions

1) With reference to appropriate examples critically examine the view that population resource relationshipsare largely dependent on levels of economic development (25).
2.a) What factors can lead to a region being overpopulated? (12)
b). Outline with reference to examples measures that can be put in place to reverse effects of over population. (13)
3. Discuss Thomas Malthus' population growth theory in relation to population resource relationships. (25)

CHAPTER 18

The concept of demographic transition

18.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Examine past and present population growth trends on a global scale.
b) Define population change.
c) Discuss population change with reference to the Demographic Transition Model.
d) Evaluate the applicability of the model in the present day.

18.2 The concept of Demographic Transition

Population of an area changes with time and is never constant. This change is due to changes in births or deaths over time or due to movement of people in or out of the area i.e. immigration and emigration. The change in population over time called, Demographic Transition, has nothing to do with emigration or immigration.
Change occurs as an area undergoes technological, social and economic changes. Changes involve transition from high birth and death rates to low birth and death rates with a middle stage in which the decline in the death rate is followed by a decline in birth rate.
Rate of natural increase is relatively low in the first and final stages but considerable higher in the middle stages. A decline in mortality is attributed to rising standards of living and

medical improvements while decline in fertility is partly a response to a decline in mortality and party a result of a variety of social and economic changes like changes in family structure, organization of labor, educational opportunities and status of women. These changes favour the trends towards families.
The Demographic transition Theory is based on pattern of population changes that occurred in Europe in about 1700 to the present day. It is based on historical changes in population.

18.3 Demographic Transition in Europe:

Until late 18th century, birth rate and death rate fluctuated. After the industrial Revolution, death rate fell gradually. After 50 (fifty) 70 years, birth rate fell too. A brief post World War II rise in birth Rate (baby boom) followed by a drop in natural increase.
There are 4 main stages in the Demographic transition:

STAGE I

High fluctuating stage that is typical of pre-industrial society. It is also referred to as a primitive demographic regime. Fertility and mortality rates are at high levels –where we have both high death and birth rates. There is a natural increase in population. There are at the same time fluctuations - (+ve) and (-ve) changes.
It is typical of countries that have low levels of economic development, low expectation of life, which lack both birth and death control.
It occurred in Britain until the early 18th century. It is at present common in tropical Africa and South East Asia where birth and death rates exceed 30/1000 (3%).

STAGE II

- An early expanding stage or youthful demographic regime. It has a sharp decline in mortality rate and fertility remains high. That means there is a rapid natural increase in population and also there is an ageing population.

In Britain this occurred in about 1870. In fact many countries are at this stage or have acquired these characteristics suddenly (thus high fertility and rapidly declining mortality). An abrupt decline in mortality without accompanying decrease in birth rate produces high natural increase in population e.g. Kuwait 36, 2/1000, Kenya 36, 5/1000, Libya 34, 2/1000, Mexico 33,4/1000, Zimbabwe 36,5/1000 as well as Brazil and India.

STAGE III

-Is called a late expanding demographic regime. It has medium fertility rate at about 2% (20/1000) and there is low mortality at about 10/1000 (1%). Population growth is less rapid than in the previous stage.

Examples that are selected: Spain with fertility rate of 8,3/1000 (0,83 %) Yugoslavia (0,85%) Portugal 0,7, Russia 0,83%, New Zealand 0,87% Australia 0,86% Canada 0,87%.

STAGE IV

-A low fluctuating stage and is typical of industrialization societies.
Both birth and death rates are low and moderate and natural population growth is very slow or there may be a decline in numbers.

This may be called mature demographic regime. Many North West European countries are at this stage. These countries have very low birth rates of about 12/1000 (1, 2%) and have low mortality rates some of what are less than 1/1000 and the natural increase. UK 0,4/1000 , Sweden 0,1/1000 . We have some countries which have excess of deaths over births e.g. Germany fertility rate is -2,1/1000 (-021%)and Australia -0,8/1000(-0,08%)

18.4 Comment on Demographic Transition:

The demographic transition model was a response to diminishing death rates and it marked a change to a consumer oriented society, people started to look for material advantages in life, making wise choices between having large families or land living in luxury with small families

It occurred in most western European countries and it occurred a little earlier in France and Sweden and later in Southern European. Outside Europe, it occurred in North America, Australia, and New Zealand and recently in Japan. Russia is in the process of adjusting its birth rate to the diminished death rate (late expanding stage). Most developing countries are reaching a stage which the UK passed through more than a century ago.

Not all countries will follow the trend of the demographic transition-so the demographic transition is not a simple one to be applied to all countries at countries at the same time. African countries and Asia as well as Latin America have different values, cultural and historical backgrounds and will perhaps undergo different population growth trends – That means different countries may develop their own unique stage characteristics.

Countries with political and social planning policies may omit one stage e g in India the introduction of family planning will result in reduction on length of the early expanding stage 4. In Western countries the transition from the balance of high death rates and high birth rates to one first and second centuries and it was a gradual process which occurred simultaneously with gradual improvement of economic and social conditions and high income per capita. Also, a substantial volume of emigration in some instances relieved population pressure at home. In Asia and most developing countries, the recent decline in mortality has been the out come of advances in medicine and control of epidemics rather than major improvements in social and economic conditions and there has been a significant rise in per capital income from which one could expect a positive (+ve) correlation of the increasing levels of living and declining fertility observed in Western countries.

The present rate of population growth in Africa is about twice as high as that in industrial Europe in the 19th century. An excessively rapid growth of population imposes a heavy strain on developing countries and calls for large investment, new means of production and in social and economic infrastructures and trends in order to aggravate the existing scarcity of capital to developing projects.
9.) Difficulty is increased by the predominance in most African countries of subsistence agriculture, lack of financing facilities and out model economic structure technology.

<u>Relevance for developing countries of the Demographic Transition</u>

In less Economical Developed countries, fertility decline is not a reaction to mortality decline and social economic development as the stimulant for both declines.
Birth rate decline after a long time after social-economic development has reached a point of literacy, infant survival, industrialization and urbanization. It is only after these that many individual couples will perceive small families to be an advantage. Modern contraceptives are not necessary for decline of fertility. In Europe it occurred long before the discovery of pills and sterilization.

Development is believed to be the best contraceptive (according to a resolution of population conference in Bucharest, 1974) Decline in European birth rate occurred against the background of modernization and falling mortality. In the developing countries, there are many deviations from the pattern followed by the classified D.T Theory so a shift in fertility in less developed countries would /might also occur differently.

Research show that large families were not necessarily desired in the pre-transition Europe- yet this is a reason given for persistence of high fertility in developing countries. Neglect, abuse and resulting high rates of infant and child mortality may have been one way of adjusting to high fertility in developed countries. But in some developing countries, birth rate decline have bee associated with economic and social progress before organized family planning got under way e.g. in Singapore, Taiwan, Costa Rica, Hong Kong and South Korea. Also a significant decline has occurred in relatively backward socio - economic settings where political bureaucratic and community resources and women power have been fully mobilized behind family planning e g China and Indonesia.

Mexico's birth rate remained 40% in the mid -1970s despite rapid economic growth and transition and heavy emphasis on education. The D, T in today's developing world is and will be different from that of Europe. In developing countries birth rates were high in the 1940s- about 40% between 1950 and1955at the beginning of their D.T and still are high in Africa today due to early and universal marriage .

By contrast, the average in Western Europe in the 18th century was 30-35%. Mortality decline which took a century or more in Western Europe occurred fast in developing countries in about 15 years from the late 1940s to early 1960s. The result was population growth rates of 2 or 3 times what they were in Western Europe.
With high fertility, coupled with rapid declines in mortality 45 -50% of developing countries, populations are composed of children under15 (fifteen) in contrast with 25% in developing regions. So population would continue to grow for a long time.
The number of young people coming into the ages of fertility in developing countries is so much larger than the numbers of older ages, that even if couples' average
children were to replace themselves, total births would continue to out strip death rates. This would take a century or more in countries with very high population growth.

<u>Less Economically Developed countries and D.T</u>
As a whole, fertility is declining in developing countries though it is difficult to get reliable data to verify this. In some countries decline is faster than in Europe. Decline is most marked in Asia and Latin America. Sub Saharan Africa shows no fertility decline. Fertility

transition has now started for much of the developing world e g Asian countries such as China, Indonesia, South Korea, Philippines and Thailand. In Asia, delayed marriage accounted for the decline and is a major cause to date for reduced fertility among married women especially those over 18.

18.5 Consequences of Rapid Population Growth: (revisited)

Introduction.

Effects of rapid population growth are evident across the spectrum of animal, human and plant life. In the developing world, population is still growing at high rates that could double in 20 years. These countries are hard pressed to supply their populations with decent living conditions .In countries like these which have under gone DT; the problems are different in order of magnitude.

Economic level

Improved living conditions required population growth to be below economic growth. Developing countries income per capita and levels of living is low. Rapid population growth diverts resources that may be available for investment in development. About 70% of the population in developing countries is focusing on improvement of the agricultural sector but fertility is highest in these agricultural nations.

The result is out-migration or more people on land. Pressure on land leads to further subdivision of family holdings (land fragmentation) and perpetuation of poverty.

In developing countries, family size is highest among the poor. Resources spread among many dependents- so there are no chances for investment beyond sheer survival e.g. education which may help families out of poverty.

18.6 Employment.

Unemployment was a major problem in the developed world in the 1970s due to recurring recessions associated with soaring energy prices e g 1971-72 oil shock after World War II baby boom. Developing countries problems are worsening. Some people work few hours in a day or days in a year. Income is inadequate to meet basic needs. Job shortage has resulted in migration to developed countries. According to the World Bank, industrialized countries of North and West Europe have over 6 million workers from North Africa and less developed countries of South Europe such as Yugoslavia and Portugal.

Urbanization.

It was predicted that by the year 2000, half of the world's population would be living in (urbanization) towns and cities. In industrialized countries of North and Western Europe, (urban areas) took many decades permitting a gradual emergence of economic, social and political institutions to deal with the problems of transformation.

The process in developing countries is occurring far more rapidly. Against a back ground of higher population growth, lower incomes and fewer opportunities. Many are for international migration.

Rapid population growth leads to pressure on public service and food shortage.

18.7 Minerals and energy:

Per capita consumption is high. Even the slow rate of population growth in the country may have as deleterious a long range effect in the world's available resources as the much higher growth of an equivalent population in low-consumption developing countries.

Environment:

Growing pressure of population on the global environment -i e Earth vegetation cover (cropland) forest and grassland , fisheries , water sources and atmosphere have under gone increased rate of depletion and pollution . The problem world wide is evident in:

Destruction of vegetation -the source of food and oxygen.

- Leveling off of the world's animals and fish catch. Since 1970, despite stepped up efforts, due largely to over fishing and pollution of spawning beds
- Over crowding and impairment of national parks, wildlife reserves, beaches and other natural recreational areas.
- Destruction of animal and plant wild life essential to a healthy ecosystem by farming, timbering .transport, pesticides and fertilizer poisoning and hunting.
- Increases in illness such as employee stroke, parasitic infections, heart diseases, cancers caused in part by the introduction of new chemicals into the ecosystem by air and water pollution.
- Water shortage due to massive water requirements of modern agriculture , mining industry and consumer living ,depletion of underground water supplies, pollution of lakes and rivers, exhaustion of promising water catchments and irrigation sites and increasing acidity in rain.
- Damaging rainfall and temperature pattern change brought on by increasing carbon-dioxide in the atmosphere from the burning of wood and fossil fuels, dust from urban and agricultural activity and thermal effects of waste heat and economic activity.

18.8 Examination type questions

1. Discuss the concept of the demographic transition in relation to present day population growth trends. [25]

2: To what extent can the concept of the demographic transition be used to explain present day population growth trends? [25]

CHAPTER 19

POPULATION MOVEMENT- MIGRATION

19.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Define migration.
b) Outline factors affecting migration.
c) Examine Ravenstains Rules of migration.
d) Assess characteristics of migrants.

19.2 Migration:

Definition: Migration includes all movements of man whether for few kilometers to the nearest town or thousands of kilometers to a new country or continent. Migratory movement can be by choice for economic reasons or compulsory as in slavery wars and persecution. It involves going to a new place to live, stay there for a certain period of time and return or not return.

<u>Process of migration:</u>

It may be within the country or across the boundaries. It is selective – i.e. some elements of the population are more migratory than others. The major population characteristics that influence processes of migration are sex, age, marital status, and occupation and education attainment.

Young unmarried people are the most mobile ones. People with low skills are also involved in the migration. In Africa (40-50), years of age of people are more mobile than others. These can easily adapt to a new condition and have recently entered the labour force and so they can change jobs more easily.

In developed countries young single adults are most mobile. Here even the married ones are very mobile. There is dominance of males or females in migration. E.g. in the 19 century European young girls had to move to towns to work as domestic servants. In the frontier towns of America; male dominate the movement.

In Africa the males are dominant especially in mining towns. Unskilled workers are less migratory than the skilled and the semi-skilled and the professional people are most mobile. Apart from the age and sex the other factors that determine who migrates are e.g. a person may regard him self a misfit in the society and decides to migrate.
The misfits find themselves incapable of normal society and they are compelled to move to urban areas. Individuals who seek a different environment in which to explore the potentially of their own personality and capabilities tend to move.

19.3 Types of migration:

These can be classified according to distance traveled and the nature of movements.

<u>Migration</u>

Internal | International

Temporary | Permanent | Temporary | Permanent

Seasonal Periodic

Seasonal Daily

Periodic

Developing to
Developed world

19.4 Regional migration

This involves no international frontier movement within one country. It is usually a result of increasing population problems in one region. Movement is biased to new lands that are open for development. In the UK there have been movements southwards, in the USA many people moved westward and also most of Southern and northward to the industrial north east of USA. There are also movements westwards across the Appalachian Mountains into the Central places - across the Rocky Mountains to the Pacific coast lands of California, Washington and Oregon.

Effects of the Regional; Migrations:

- The buildings of new towns-continental railways.
- Establishment of the modified farming methods to suit climatic changes.
- Introduction of farming types e.g. growing of wheat, maize and the grazing of animals. Development of new lands in Russia and this led to the movements into the European Forest zone. There were movements southwards into irrigated semi-arid lands of Russia.

19.5 Urban decentralization

- Results from the movement of people from urban areas (centers). This is indicated by:

- Newcomers who live on the outskirts of the cities where land is cheaper.

Town dwellers move out from the overcrowded of the inner zones modern cities to the outskirts where there are fewer people.
It is normally called suburbanization:
People are normally pushed out of the city centers by town clearance, congestion, building of shops, and establishment of offices.

Some suburbanization in the UK are government, planned and controlled in order to avoid a congestion e.g. Movement of people from Central London to Hemel Hemstand, Liverpool-Skelmersdal, Runcord -Leyland; Glasgow -East Kilbride Cumbernaub.

<u>Migration of retired people</u>

- Movement into a peaceful environment. In the UK retired people move to the coastal resorts. These are found in Devon, Cornwall, Kent, Sussex, Norfolk, and Suffolk. In the USA many retired people migrate to Florida and California. They move to the areas of favorable climate and lively scenery.

In France retired people move back to their place of birth but some move to Coted Azur which is an international centre for wealthy retired from the whole of Europe.

19.6 Seasonal Migration

-Occurs in the developing countries. It may involve mountainous areas as well as agricultural areas in developed areas e.g. Pastoral normadism-movement in search of new and good pastures for animals e.g. The Fulani and their horned beasts (Nigeria) e.g. Movement southwards in the Savanna are as during summer and northwards to the desert margin in cooler seasons.

<u>Effects</u>

- Separation of family groups-family breakdown. It leads to overgrazing e.g. the Fulani. Total reliance of animals for food e.g. Fulani (Nigeria).

19.7 Transhumance

- A form of migration in the mountainous areas of Europe and Northern America. It is mainly concerned with movements of animals. In spring men and their livestock move from valley bottoms to the mountain slopes in search of grass. In summer they move back to the valley bottoms- common in the European Alps (Switzerland).

<u>Indonesia‘s trans- migration project</u>

3-4 million of people from densely populated islands were moved to some of its 15 000 less populated areas. To reduce population pressure and create agricultural jobs in **<u>Sri-Lanka the</u>** international agencies including CIDA and the World Bank financed the Mahawell Hydro-electric project that helped to relocate 10% of Sri- Lanka’ s population.

- The plan to resettle half a million of **<u>Ethiopians</u>** from Northern Highlands. This resulted in the clearing and robbing the country of precious fuel and grazing areas (effect).

- Movement of people into resettlement areas of **<u>Zimbabwe</u>**

19.8 Rural- urban Migration

-Movement of people from rural areas to urban areas commonly done in Zimbabwe.

<u>Causes:</u>

-Towns offer better opportunities for employment than rural areas.

-Overpopulation in many rural areas.

-A decline in amount of employment in rural areas due to increased mechanization e.g. Puerto Rico.
-Superior amenities in towns e.g. electricity piped water and modern sanitation.
-Hopes for better medical and educational facilities as well as entertainment.
-Land fragmentation in rural areas through multiple inheritance, or of the farming structure is such that primo genitive causes the young sons to be displaced by elder sons becomes tough and they migrate to towns.

Other people are encouraged to move to towns by friends returning from town.
Sense of deprivation-arises in the rural areas where people feel that they might live in urban areas or where they think the standards of living are higher than what they are accustomed to. The rural residents tend to want more than what the city has. Such people view it with interest that the wider the Freedom from the restraints in the rural areas.

<u>Civil disturbance in the countryside.</u> Any lack of security in the rural areas has the consequence of pushing whatever the population can move into rural areas and this influences the people to migrate as well as to make necessary steps.

<u>NB</u>: Consider the following:
Pull Factors - Urban areas as an attracting center.
Push Factors - Repel potential migration

<u>Effects</u>:
(i) For the receiving area
For the sending area
Social Effects
Economic factors

19.9 Effects of Rural-Urban Migration.

- Housing problems-Problems in sanitation, electricity and other amenities.

Development of shanty towns for squatter settlement on the out skirts of Singapore, Lusaka, and Harare etc.

- Unemployment in the urban areas, imbalance of population in the rural areas because the villagers are left with old people, women and very young children. Destruction of the economic systems of the rural areas because male workers are no longer available. The money which is sent back from the cities helps to put up the prices in the rural areas.

- Increase in the family debts the migrants borrow money for the journey and this cause social problems.

The individual ties within the family are sometimes broken-security of family is weakened. The responsibility of the father is loosened. The wife and children are left with relatives to look after them and the father rarely visits home.

Cities are faced with financial burdens, problems of shanty towns on the periphery. The poor conditions of the migrant communities may lead to social and political problems, especially towns which have mutually high proportions of young people.

Rural to Rural

- Development of new areas for agriculture e.g. in Zimbabwe and other developing countries decline in fertility in rural areas.

- Growth of population in one part of rural areas. Existing agricultural activities will be sufficient to support the population e.g. government sponsored resettlement schemes found in many parts of Zimbabwe e.g. Tongogara -Shurugwi. In Indonesia the settlement of farmers.

- The Gezira scheme settlement in inland Niger. The Delta Scheme of Mali, Movement of people from Lake Volta to better lands. Movement associated with the Kainji project (Nigeria).

Urban tourban

- From small urban centers to large urban centers e.g. from Gweru to Harare. Movement from urban to rural involves the retired people.

19.10 CASE STUDY OF INTERNAL MIGRATION IN BRAZIL

Direction of movement: NE to RIO and to SE and that constitutes inter-regional migration from Rio to Brazilia and it constitutes the movement of the civil servants- inter -urban migration. Movement from the rural winter lands to Brazilia-rural-urban migration.

- Movement from the central area Rio to suburbs inter-urban migration.

2. Types

There is cyclical movement - migration of workers to the cocoa area plantations of Sertao region

Shifting agricultural in the Amazon

Phased movement - short distance movement to local towns and then to major town

Resettlements - movement from industrial cities like Sao Paulo to some resettlements areas

3. Push Factors

Drought and famine in the rural areas.

Decrease in soil fertility in coffee plantations.

Natural disasters eg. Frost in coffee regions.

Change of use eg extensive cattle rearing replacing intensive arable farming.

Overpopulation in the NE part of Brazil.

Debts to money lenders.

Landlessness in areas such as Matto Grosso or areas around the Rio Valley.

Lack of employment in NE Brazil.

Low standards of living.

PUSH FACTORS

Government action such as establishment of urban areas e.g. Brazilia and this attracts people (one of the fast expanding cities in the third world)

Better transportation: e.g. new highways in the centre and north of Brazil - greater social status associates with living in large urban centres such as Rio de Janeiro. High wages in industries.

Availability of land in the Amazon - attracts shifting cultivation

Employment opportunities in Brazilia. Kinship links family members of friends who have moved to towns.

Better housing and social facilities e.g. in the Rio de Janeiro.

Consequences:

Similar to those of any developing country, shanty towns, overcrowding, congestion, social problems continued, unemployment frustration, high crime rates because of destitution.

19.11 INTERNATIONAL MIGRATION (EXTERNAL)

-Crossing of international boundaries is also called external migration.

Examples:

Compulsory movement such as movement of Jews from Germany in the time of Hitler trans-oceanic exodus of Europeans and the Atlantic slave trade when millions of slaves from Africa were forced to migrate

Effects:

Redistribution of the world's population

Slaves occupied the sparsely inhabited America

Development of Sugar plantations in the West Indies

Development of some West African territories (countries)

Small farmers who were already in the West Indies could not compete with slave owners and plantations owners, so were forced to sell their farms to plantation owners then they moved to North America.

Spread of European diseases which affected the Arawak and the Caribbean Indians.

Examples: Voluntary Inter - continental migration started in the1820s and they consisted of movements from densely populated NW Europe and the movement from poor and oppressed parts of South and East Europe between 1840 and 1930. In this period about 50 million Europeans migrated to different parts of the world. The destinations were North America, Australia, New Zealand, Latin America, Asia, Southern Africa (1820 Settlers).

Effects:

Redistribution of population

Opening up of new lands

Economic development in the new lands

Release of population pressure

Establishment of new markets for manufactured goods
Opening for capital investments

Movement from underdeveloped world to developing countries
Main Reasons:
The widening technology and economic quality between some people of the developed world and the developing world
Rapid ratio of population growth in the developing world.

Effects:

The unskilled and educated members of the population left developing world especially between 1961 and 1970 about 53616 scientists' engineers and physicists from the developing world emigrated to USA. So there was a great deal of brain drain.

After abolition of the slave Trade and Slavery

Some slaves returned to their countries and this created labour shortages in the plantation and created a situation of wired labour in population to work under indentured labour system i.e. recruited for a specific number of years to work in the plantations from China, India, Lebanon and Syria.

European Settlement in tropical Africa

Occurred during the period- government officials, missionaries miners and prospectors were immigrants and the destinations were in East Africa, Kenya and Tanzania

In Kenya they occupied the Kenyan Highlands which came to the white Highlands in Tanzania. The Germans occupied the Usumbara Highlands European settlements were established on slopes of Mount Kilimanjaro and MountMeru.

In Zimbabwe they occupied mining areas, high and other cooler and fertile land.

In Zambia they occupied mining areas of the Copperbelt. In Malawi they occupied the Shire Highlands. Designs or accidents e.g. America is full of examples of European architectural and also place names of the world may reflect past migrants.

- Flow of capital which leads to economic expansion in areas of net-migration and economic concentration in areas of net emigration.

Results of inter-migrants workers are important to the economy of several African countries especially Botswana, Malawi, Mozambique and Burkina Faso where we have migrant remittances which are sent to the country

Absence of large numbers of able - bodied for part of the year has adverse effects on the economy of the home lands. This is important in some parts of Tropical Africa where their labour is needed.

Increase of population of receiving areas

Migrants may be responsible for disease, eg, in many parts of tropical Africa, movement of pilgrims, nomadic pastoralists and emigrants workers made control of malaria difficult.

<u>Family breakdown</u>
Resettlement of new skills taught to workers can defer back to home country (a positive effect)

Housing development on the estates and establishment of many camps

19.12 Examination type question

1. Briefly explain the terms migration and circulation **[6]**
With reference to an example in LEDCs, outline urban problems resulting from in - migration. (12)
To what extent have the problems been successfully solved? **[6]**

2.Critically examine the laws of migration with reference to an area you have studied. (12)
b). Outline the social and economic consequences of migration in a named source and destination region. (13)
4) Define the term multi racial society (6)
b) With reference to a named region outline the effects of multiracial societies (12)
c) Examine attempts made at redressing the effects you identified in (b) above (7)

CHAPTER 20

<u>SETTLEMENT STUDIES</u>

20.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:
a) Outline the characteristics of urban and rural settlements.
b) Assess factors that influence development of settlements and settlement patterns.
c) Discuss the concept of primacy.
d) Outline problems associated with the inner city.

<u>Introduction</u>

The study of geography is primarily concerned with the interaction of man with the environment. One important aspect of this interaction is the ability to shelter himself from the harsh effects of the environment. Settlement studies are concerned with the nature of human habitation. We are going to make an evaluation ofthe possible reasons why different communities adopt different settlement styles and the impact of such settlement dynamics on the immediate environment

Rural and Urban Settlements

1) Rural Settlement in both developed and developing countries.

a) **Types of Rural Settlements**

1) Isolated dwellings: Typical of the developed world eg Britain. There are farm dwellings lying themselves in the midst of country side.

Examples:

- Isolated and Trans - Peniune farmsteads. These are found in Britain.

Crafts: In the highlands of Scotland -there are (cottages) small areas worked by tenant farmers and they consist of cottages and cultivated land for oats, potatoes and rough grazing.
Livestock farms of the Peninues.
Prairies wheat farms of Canada.
The Esterncias of the Argentinean Pampos- isolated dwellings in cattle ranching areas.

These isolated settlements are many kilometers apart. They are self-sufficient and they are a result of economic needs instead of social preference.

2)**Hamlets**: A group of houses. Many have a church or an inn. They are developed around farms or manors. In Britain hamlets are associated with livestock rearing in hilly areas. They may have small post offices to offer some services. In Britain hamlets are common in Wales and Scotland.

3) Small Villages
A small village is a settlement with some social features and service centres. Many have religious centres, small post offices and some times a general store, a bank, village hall and primary and or secondary schools.

4) Large Villages
A large village has large numbers of services and it has a greater variety of social and economic functions than a small village where you can have a butchery, grocery, more than one bank, hospital, school etc.

Conditions That Influence the Choice of Settlement Sites (Sitting factors)
1) The initial reasons for the establishment of settlements were man's primary need for shelter and his inclination to live in communities with fellow men.

2) Decision of where settlement should be built is /was usually arrived at after the consideration of a number of factors.
3) It is rare that a single factor can influence the choice of a particular site.

1. Reliable water supply
This leads to wet point sites -access or accessibility to stream water, spring or wells.
Water is needed for drinking, gardening and watering of domestic animals: As a result we have settlements near oases, boreholes, lakes or wells and dams.

2. Dry land sites
May be away from marshy or water-logged areas and some of such settlements may be away from places subjected to seasonal flooding, on hilltop or knolls, on gravel terraces along valley sides, above flood plains on the interfluves.

3. Aspect or shelter
That is against bad weather -need for sun-shine-exposed spots. Avoided sites gives rise to settlements in valleys, rain shadow areas or lee-sides of ridges.

4. Easily defended sites
Such as hills or valley sides e g offshore islands, land with a meander

5. Access to agricultural land i.e settlements being near level land for agriculture, well-watered land that can support a farming people on sites on fertile soil areas and rich pastures.

6. River crossing points: near shallow or narrow sector of a river for easy crossing. points.

7. Trade: Gives rise to settlements near or en route i.e. on road, junctions, and bridges, along lines of communication such as along track roads, railways, canals and navigable rivers.

8. Service opportunities: Near schools townships etc.

9. Relief and gradient: On fluvial fans, on ridges and sometimes on flat land for easy building and expansion.

Rural Settlement Patterns

1. Loosely knit or fragmented
Scattered, irregular villages over a large area are too loose to be regarded as isolated or dispersed. They are further apart and show no relationship (thus no nucleus). This normally results from gradual decrease of woodlands and individual squatting of people who build their homes where-ever space is found and normally there is no community spirit and no consented plan

2. **Clustered or nucleated**:

Dwellings are close to one another and we have a well defined division between settlements and country side. Dwellings normally focus upon a route centre. Their shapes are determined by a pattern of communication, at road junctions farming star or T shapes. The pattern may also result from the need for trading links or necessity of defense. It may be due to the system of agriculture eg where there is a consented farming effort of a tribal group or community e.g. Old Kwamo near Kumasi in Ghana.

3.**Linear pattern / Line**:

May be elongated in shape or appearance. It may develop for reasons of trade i.e. where a settlement is aligned along the road, river, or a canal. It may also be for reason of physical limitation eg settlement lying along the narrow valley floors or linear along ridges. It may be several kilometers long and there may be correlation between linear patterns and strip farming where each village may have a back field eg in Zimbabwe

Example

i) Igbo compounds grouped along tracks in Eastern Nigeria.

ii) Spring line settlement in some places and in the Ankole country in South West Ghana.

4Dispersed:

May be close to a loosely knit settlement pattern. Family residents are isolated between and sometimes settlements are surrounded by fields. They are characteristic of agricultural areas. Settlement units are small in size, normally with single family residents.

Examples:

i) Dispersed rural compounds in densely populated areas near Banku in N.E Ghana.

ii) Dispersed fishing settlements along the ocean shore and beside the coastal lagoon in Ghana, Togo, Benin and Nigeria.

Factor favoring nucleation /clustering /compaction

1. The tendency of people to live close to one another known as gregariousness of human beings i.e. need for social contact.
2. Settlements with non-agricultural activity e g where there is forestry.
3. Where villages need to defend themselves against enemies in times of unsettled political and social conditions (strategic).
4. Low land areas with rich soils.
5 Communities with strong family clannish or tribal ties.
6. Need to provide and obtain service facilities.
7. Intensive agriculture as opposed to extensive agriculture.
8. Water supplies shortage of surface water supplies may lead to concentration of settlement around springs and wells/oases in deserts.
9. Rugged terrain -concentration of settlement tends to occur in the valley bottoms of patches of low lands.
10. Limitation of site e g in valleys with steep sides as in the French and Swiss Alps in Europe and in South Wales and the Rhine Gorge, on islands, on hill tops eg, hilltop villages of Italy, oases in deserts.

Factors favoring dispersion /dispersed settlements

1) Ruggedness of land -difficulties of tillage in rough upland may result in the dispersion of farmsteads which concentrate on livestock rearing.
2) Diffusion of resources i.e. when resources are found every where such as arable land, water, natural sites with good exposure.
3) Regions of dissection and abundant slopes especially steep slopes may have scattered fragments of cultivable land (this is about fertile soils).
4) Socio-economic factors are as follows-
a) Change from communal to private land tenure.
b) Break of nucleus families.
c) Improved transportation.
d) Rise of commercial agriculture leads to establishment of extensive farming and ranching.
e) Establishment of pastoral farming.
f) Social influences such as customs of inheritance whereby land is shared by sons of a land owner or where a parcel of land is given as dowry. This is likely to lead to fragmentation of land and the dispersion of settlement.
g) Introduction of the enclosure system in Europe- This is about fencing a land by individuals into separate farms so that each farmer encloses his piece of land.
h) Over population-some people would look for separate land.

Functions of Rural Settlements

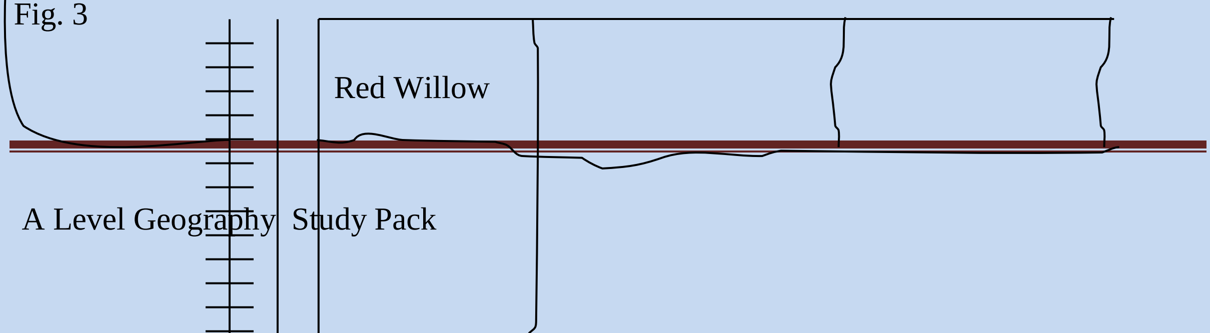
1) Farming-subsistence e g in all communal areas of Zimbabwe and resettlement areas.
2) Forestry -e.g. near Mvuma in Zimbabwe
3) Fishery -fishing centre found along coastal area of Central Africa as well as in land centres.
4) Trade and service centre -large stores, growth points.
5) Mining -e.g. Renco, Sandawana etc. in Zimbabwe

Examples of rural settlements in thedeveloped world

1. North America Prairies (Canada) and U S Mid West are based on commercialized forms of extensive farming and the pattern is essentially dispersed and based on the single isolated farmhouse. There‘s a closer pattern in the damp east where there's more cultivation than in the west where ranching predominates. In the western irrigated areas the pattern is also closed.
In parts of the high plains approaching the foot of the Rocky mountains, soil erosion has been wide spread and many farms have been abandoned. The great part of the Prairies region was surveyed before settlers came in.

Most of the villages are service centres located mainly at cross road. These may have a school, church, shop, bank and warehouses

Fig. 3



Key

Main Road
Local Road
Railway
Farmstead or Other Building

Additional notes - Dispersed settlement in parts of Alberta,
areas of commercial agriculture based on cultivation or stock rearing,
Along major roads and railways, service centres such as Red Willion have grown up to serve the scattered farming populations.

Problems of distinguishing rural and urban settlements What criterion /criteria is /are used? When is a rural settlement is actually called urban?

Classification

1) Size of settlement
2) Administration status
3) Function of settlement
4) Importance of trade and population.

In general, a town is a compact settlement larger than a village and smaller than a city .It is engaged chiefly in non-agricultural occupations. There is no universally agreed definition of a town in terms of population size to distinguish it from a city or village. A town is essentially an urban settlement with a business centre that serve its own population and others who live outside its boundaries.

Size of population (as a factor)-

Some settlements may have a population of up to 5000 without possessing attributes of a town. Some market towns may support about 2000 people and enjoy urban status. However population densities differ from one town to another and from one part of the town to another. These populations are almost always higher in towns than in villages. Houses and other buildings are also very close to one another and they are very much more than in rural areas. Towns also possess a well marked community organization ie are self -governing.

(b)<u>Functions</u>:
Functional contrasts between towns and villages are not always distinct. Villages may have non- agricultural workers and people who are not rural in their mode of life eg shopkeepers, teachers, clergymen, postmaster, garage workers eg in Russia there are what are called **agrovilles** being regarded as towns (i.e. agricultural villages). They have several thousands of people with a high proportion.

In South Europe, many towns have some agricultural elements. During the middle Ages in Western Europe, farming was an important occupation of town people.

Most distinctive urban functions include manufacturing, retail and wholesale trade, professional and office work which play a very small part in villages. Towns have 2/3 of people following non- agricultural related occupations. There is also a variety of shops which may sell durable items such as furniture. They may have banks, residential hostels and offices.

In a town, man-made scenes predominate over natural scenes. The town's people follow a way of life that is foreign to those in villages. People in towns live in some social and economic independence enjoying common administration, cultural and social amenities. A number of splendid (specialized) services and activities are found in towns but these are normally absent in rural areas.

(c)<u>Trade</u>:
The growth of business, trade and exchange are the most important factors in an urban development. Although some towns emerge as defensive and administrative, the great majority of them emerged as trade centres.

<u>Rural problems particularly in the developed countries</u>
1. Depopulation is the result partly of improved agricultural technology which reduces the demand for farm workers and partly of natural decline of population as old people who will be dominating rural population rise whilst birth rates are falling due to the outmigration of young adults. Country districts generally offer fewer employment opportunities than the towns and few social, cultural and educational facilities. This may help agricultural improvements to take place but can also lead to social and political differences.

<u>2. Decline of country occupations</u>
New technology, changing demands and mass production are causing the disappearance of many rural craft men such as blacksmiths wheel-wrights and saddle makers. This not only aggravates the poor employment situation but also leads to destruction of village life.

3. Poor social conditions

Many parts of the country-side are fairly inaccessible with poor road and rail networks and inadequate public transport. Also, many cottages are small and over crowded and they are normally tied to farm employment and there's lack of adequate water supplies, electricity and other related services.

4. Village urbanization

Improved transport and living standards have led many town workers to seek homes in the country side. This can transform farming villages into commuter settlements. The new comers are often wealthy upper or middle class families and professional workers who can afford to buy cottages at prices far higher than those within the reach of the country people. The resulting rise in property values causes an increase in the rate of outmigration by the original villagers. This change in population has a serious effect on the essential character and community spirit of many rural people.

5. Second homes:

Urbanization of the country side is further encouraged by the increasingly common phenomenon of weekend or holiday accommodation. The town dwellers buy homes for temporary use, caravan houses, boats, converted cottages and even in some places purpose-built villas.

Areas of particular natural beauty such as mountains and coastlines are especially vulnerable to this sort of development and are suffering in consequence with inflated property prices, traffic congestion on narrow roads and greater stress on social facilities. The urbanites seek unspoiled communities for their rural retreats but their very presence destroy their quality

6. Tourism

Leisure and recreational facilities at present represent the most serious danger of urban encroachment into the country side. The periodic invasion of tourists brings with it traffic congestion, litter and pollution, conflict between farmers and visitors, ugly camping, caravan sites and the intrusion of petrol stations, cafes, gift shops and other such incongruous features.

Rural- urban interaction

Towns are related to country sides around them –much of the sustenance of a town comes from the people around it. The urban areas provide goods and services. Rural areas supply the urban settlements with workers, shoppers and people who visit it for educational, health and recreational, cultural and social services. Towns act as colleting and marketing as well as service centres for the rural areas. Rural areas which are involved in rural marketing of products are called spheres of influence or urban fields or hinter lands.

The urban sphere of influence is the whole area- rural and urban i.e. is influenced by a central town. Urban centre provide employment to the rural people and then rural -urban commuting.

How the rural and urban areas interact-

Urban areas are not islands, it they interact with rural areas in many ways.

(1) Communities Interaction

Rural areas provide workers and these workers work in the shops and industries of the urban area. There is commuting interaction.

(2) **Trading interaction** - rural areas may provide shoppers and urban areas provide items that are to be bought.

(3) **Social interaction** -rural dwellers may constantly visit the urban areas for recreation and cultural activities. Urban dwellers may also go to rural areas for sight seeing or picnics

(4) **Economic interaction** -agricultural interaction -rural area provides forming products consumed in the urban areas.

(5) **Industrial interaction** –as exemplified by Gweru with the Zimbabwe Alloys- minerals are not mined in Gweru but from rural areas and then processed again for making of furniture etc.

The concept sphere of influence:

The urban sphere of the influence is the whole area-rural and urban that is influenced by a central town. The other terms are urban fields or hunter lands.

Shape and size of sphere of influence –is determined by many factors like:

a) Relief features -may create an elongated sphere or field of influence along valleys, rivers and coast lines.

b) **Circular shape**- shows that the urban settlement interacts with its hinter land in all directions.

c) **Elongated along** -lines of communication determined by road or railway.

SIZE OF SPHERE OF INFLUENCE

Some urban spheres are small and others are large depending on the strength of functional needs with the surrounding area. The size is determined by the urban facilities that are offered, employment structure, population density of regions and size of towns - although towns of equal size do not necessarily serve areas of equal size e.g. People in rural Beitbridge who know that there’s Harare, but not knowing Zvishavane.

Industrial and mining towns have very few shopping facilities so they tend to have smaller sizes of urban influence than the mixed functioning towns. Centres of communication or administration capitals like Harare and Bulawayo have large urban fields. Population density -if population density is low, there will be a low field and if it is high, the urban field will be low.

Closeness to towns

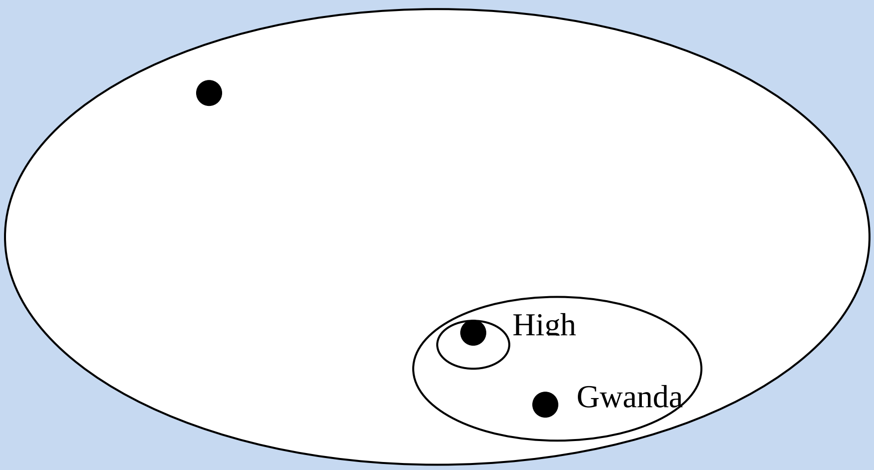
Towns that are widely spaced have large urban fields and vice versa. Towns within a conurbation or limited sphere of influence normally compete with one another in the sphere of influence will be small.

Distance from a town - Towns' urban influence decreases with distance. Functional linkage is strong within the immediate environments and weak in few districts.

Primary and secondary urban fields

Primary - these are concerned with low order goods and services such as bread, milk etc, so that it is normally smaller than secondary one that means they occur frequently.

Secondary are concerned with higher order linkages-we have infrequent movement e g furniture but they cover wide areas. Each settlement has its own urban influence such that there is a hierarchy of urban fields. Fields of largest settlements encompass those smaller ones which in turn encompass those of yet smaller settlements.



Measuring or delimiting the urban sphere influence.

There is no single method that can be used. Certain key services provided by a settlement are normally selected for measurement in an attempt to determine the settlement's sphere of influence.

These may include:

1. The area served by a large departmental store or wholesale department.
2. The local newspapers and their circulation areas i.e, from which villages news items are included considering personal columns and information from publishers about the circulation areas.
3 Catchment areas of secondary schools, perhaps in towns, also with boarding schools in rural areas e g Manama in Gwanda as having authorities encouraging who people from local towns to attend a particular school.
4. Frequency and routes of local bus service. This gives evidence of size and strength of town.

5. Area serviced by a town's cattle market.
6. Hospitals and clinics.
7. Entertainment catchments area- different people visiting an area for entertainment- membership of various clubs.
8. Church catchments area.

Conclusion on these methods /concluding Remark

It is possible to take all those and plot the market area of each and then generalize to form a single market area each or sphere of influence. More often it may be the more convenient one which one regards as the most valid indicator measure for a particular settlement.

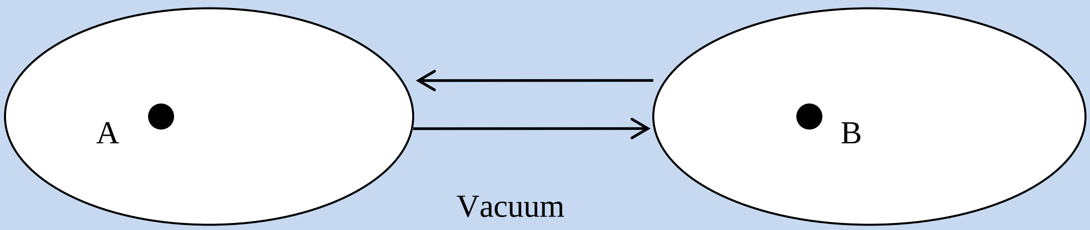
Problems likely to be met in a sphere of influence

There is no town with one urban field because a town offers a variety of goods and services. Some goods have a small market e.g Bulawayo - we do not have to go to Bulawayo to buy drinks or beer but we go to buy furniture, T.V radios, sofas etc. These are higher order goods.

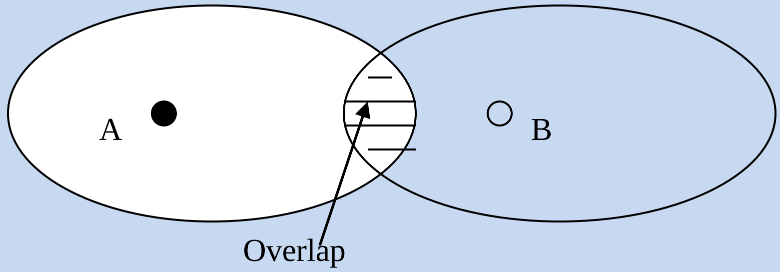
Departmental stores, hospitals and banks have different spheres of influence from these of administration centres.

Around each urban centre there may be a variety of urban fields of different shapes and sizes. Each one is a zone of influence of different urban function or facility.

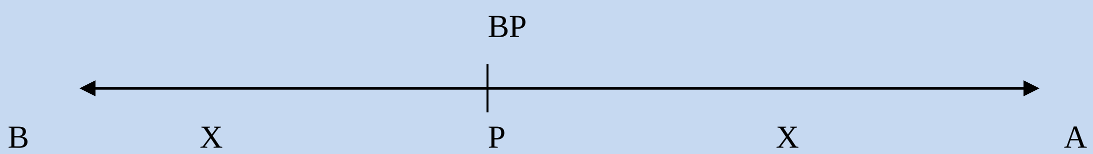
Urban fields between towns may fail to meet and there will be a vacuum in which the inhabitants are not served by either town.



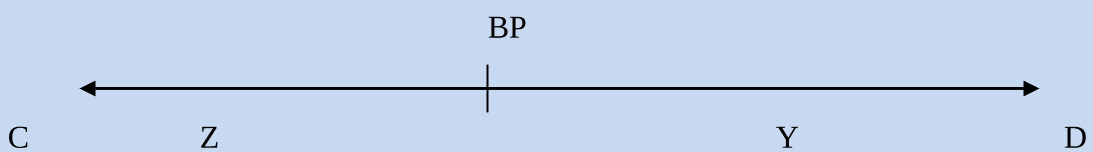
Two urban fields may over lap so that some people will use the towns equally and there towns compete for customers equally.



The solution to this problem is provided by what is called the Breaking Point Theory. This enables a single demarcation to be established between two settlements. The Breaking point between the settlements divides the people who use one town from those using another. If two towns are of equal size, the Breaking point will be way between them.



If they are not of equal size the large one will have a greater attraction than a small one (the Breaking point will be near the smaller one).



$$\left\{ \begin{array}{c} Y > Z \\ D < C \end{array} \right\}$$

<u>The Breaking Point Formula</u>

Distance of breaking point from A- Distance between A and B

1 + V   A (B)
P (A)

Where PA – Population of town A and P B = Population of town B.

Adjustment of Urban sphere of influence (It's dynamic, not static)

1. Economic, ecological and social conditions may lead to adjustment of the size of sphere of influence.
2. Development in transport, urban facilities and even in human behaviour.
3. Greater use of motor cars widens the sphere of influence.
4. Opening of new motor ways.
5. Deterioration of public transport which narrows an urban sphere of influence.
6. Newly opened shopping centres attract people from further afield than old ones.
7. Closing of popular large departmental stores

Shapes and size of urban fields differ with time and place and each one is unique at that moment.

Examination type questions

1) With reference to a named region outline the physical and social considerations that have contributed to its settlement dynamics (12)
b) How valid is the claim that economic considerations play a large part in the siting of a particular settlement? (13)

2. a) What do you understand by the terms (CBD) and (Commuter Zone)? **[6]**
b) With reference to an example studied, explain how urban renewal is being carried out **[12]**
c) Assess the success of attempts to affect urban renewal in the example cited in b above [7]

3) With reference to examples examine the factors influencing the development and modification of settlement patterns. (25)

CHAPTER 21

The Central Place Theory

21.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) State the main assumptions of the theory.
b) Assess the main principles of the theory.
c) Critically examine the applicability of the theory with reference to selected case studies.
d) Examine the concept of rank and size in .relation to urban settlements.

Introduction:

The Theory deals with distribution and spacing of settlement - (By Walter Christaller).It attempts to give reasons for the existence of different types of settlements. It is important to note that this is a theory based on particular assumptions and field observation. In this chapter, we shall make an attempt to critically evaluate the theory taking into account its basis and applicability in the present day settlement dynamics.

Settlement patterns are irregular and uneven due to the following factors.

Relief features.
Climate.
Availability of resources.
Communication factors.
Trade patterns.
Historical evolution and culture.

Although there is an uneven distribution, there is sometimes a regular pattern in spacing of urban settlements. The regularity of patterns is explained by the Central Place Theory.

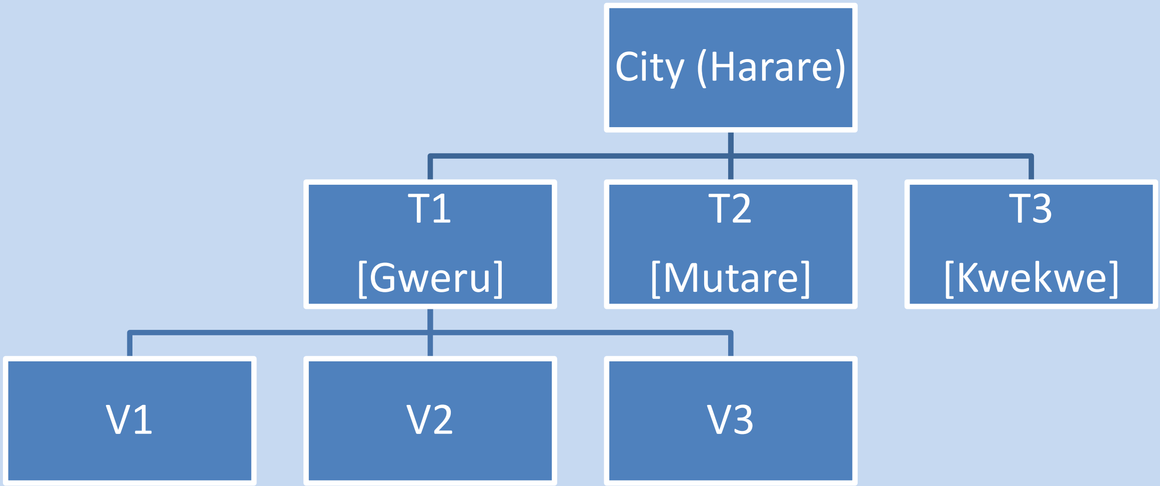
Settlements serve as service centres in a hierarchy. They provide places where buying and selling occurs and where exchange of ideas occurs and where services are offered e.g. retail and cultural services. A central place is a settlement which provides goods and services for the population in the settlement and the settlements within its sphere of influence. This central place should be a well located place which is accessible from all points.

This means there should be modality meaning there should be routes that converge and public transport should be provided. The importance of the centrality of a central place is determined by its functional complexity to the number of different central functions and the number of functional units of each of these central functions.

There may be more than one function in one establishment. Central places differ in size and function. Large places have many central functions and have many functions -normally they provide higher order central functions (or goods) which are less frequently bought e.g. furniture. Small place have few central functions and have limited number of functional units. Central functions in small places are low order goods and these occur frequently e.g., Harare is a higher order centre and Mabasa growth point is a low order centre.

As settlements increase in size, the distance separating them also increases

Fig. 4



.
The central place theory is applicable to settlements of a particular type i.e. those providing retail goods and services e.g. banking, milk, and news papers. It is a limited theory. The development of some settlements may have to do with some factors such as the occurrence of a particular resource e g, coal at Hwange, chrome at Shurugwi and asbestos at Zvishavane.

The Central Place Theory

This was put forward by a German, Walter Christaller, in 1933. His work or views were based on the work he did in Southern Germany. He was the first person to find out that there is a pattern in terms of order, size and urban functioning and spacing of settlements.

Founding assumption

There is an isotropic or homogeneous land surface with topography, soil, climate, resources and population.

There is an equal case of movement of people in all directions. That means transport costs are proportional to distance and there is only one mode of transport –a horse drawn cart.

Central places (settlements) on the plain provide goods, services and administration functions to their hinterlands. That means these settlements or central places depend entirely on their hinterland area or sphere of influence.

Consumers want to minimize the distance they travel. Thus they buy goods and obtain services from the nearest central place or service centre.

Those who supply goods and services are economic men (these are the owners of the shops) who want to maximize profit by locating their functions on the plain. Since consumers are rational, they want to minimize distance travelled to the suppliers, they locate their functions as far apart as possible to maximize the market areas.

No one on the plain /surface is further from the function than he is prepared to travel to obtain services or goods. Some central places offer more functions than others, i.e. there are some higher order centre and lower order centre.

The higher order centres provide functions which are not offered by lower order centres. These higher order centres also provide lower order functions provided by lower order centres.
All consumers have the same income and the same demands. **NB.** The assumptions are far away from reality and they distort reality. Given these assumptions the task is to investigate

a) The number of central places required to satisfy consumer demands.
b) The size of the trade areas (that is of areas serviced by central places).
c) The most efficient spacing of central places.

The investigation in the Central Place Theory reveals the following principles:
There are some principles which may be true in the real world. These principles are based on the fact that the central places depend upon a regular market which also has to travel some distance in order to obtain and buy goods they need. The two principles are:

1. The threshold of a commodity- refers to population required.
2 The range of a commodity –refers to distance.

<u>The Threshold of a commodity</u>
The threshold refers to the minimum number of customers required to support a central place. It is only when this population is available that services or a function can be provided and different thresholds like different goods and services, have markets of different size. Hence some functions occur more frequently than others eg, a population that supports ten general dealers may support only one departmental store.

When population increases low order central functions (low threshold) or cheaper goods increase in number. Low threshold functions therefore occur more frequently than higher ones eg, many groceries, many bakeries and basic food shops. And these require small centres such as village shops and small towns.

All consumers are expected to visit the nearest centre for goods and services. This means that the threshold may be shown on a map as a size of a market area that contains the minimum population necessary to enable the function provided. The supplier tries to have a larger market than the threshold population, in order to maximize profit. The large market is governed by range of goods i.e., minimum distance customers can afford to travel. Expensive goods are infrequently bought and need people from long distances i.e. they require large settlements because they offer more goods

<u>Range of a good</u>: It is the maximum distance people are willing to travel in order to obtain goods and services. It is the distance in all directions from a distribution point i.e., central place to be served.

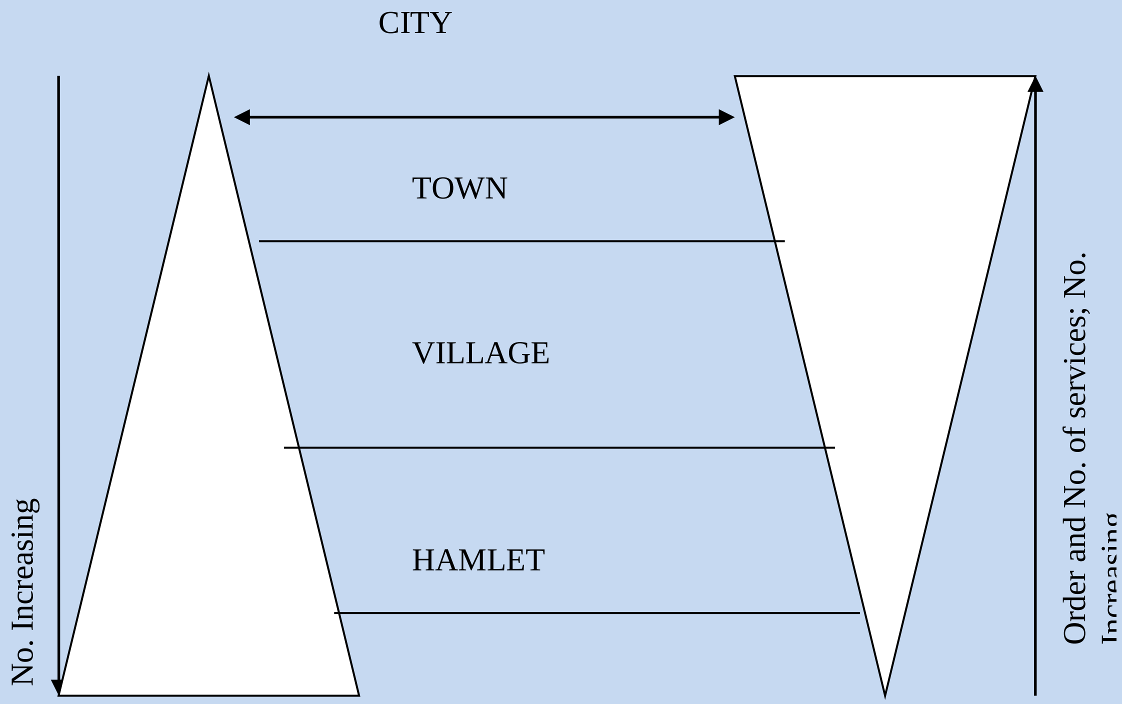
<u>Comments in the Theory</u>
According to the Central Place Theory,
1) There is a hierarchy of settlements and services from smallest to greatest. Hamlets provide goods with the shortest range. Villages provide all goods of a greater range. Towns

provide goods found in the villages plus another range of goods not found in small settlements. Large cities provide goods of highest order.

2) Settlements of equal size will provide similar services and will be equidistant or equally spaced. Village stores serve small areas around them. Towns serve large areas and attract people from distant areas. The city may be used by the whole region i.e., city and town.
3) The number of services increase with settlement size and there are more towns, than there are cities and more village than towns. Small settlements are often numerous but have the fewest services while largest settlements have most services but occur infrequently.

<u>Summary by diagram / illustration</u>

Settlements ranked according to size. See diagram



4) Services offered by urban areas are good measures of sizes of towns' e g, in Zimbabwe if we order towns according to functional size it will be Harare, Bulawayo, Gweru, Mutare, Kwekwe, Kadoma, Masvingo to growth points and then smallest village.
5) Most village shops offer very small amounts of goods and services.
6) Shopping centres are found in areas where their customers can easily reach them.
7) Everywere customers try to reduce distance traveled to purchase goods and obtain services. Consumers shop at a hierarchy of centre for different types of goods and services.

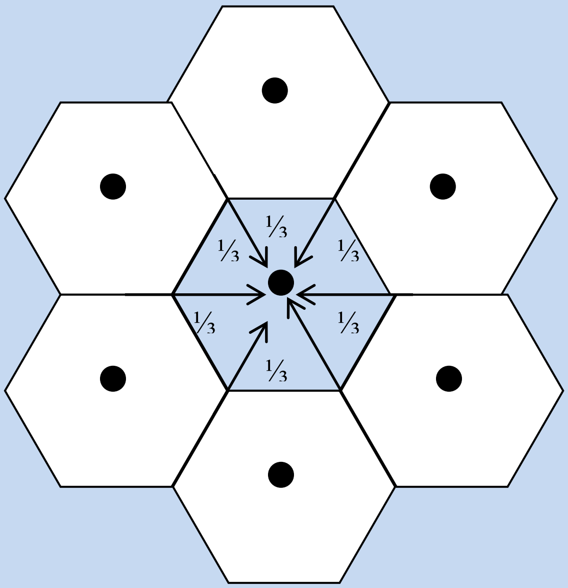
<u>The K- Principle:</u>
According to Christaller, there is a relationship between settlements and market areas of different orders on the one hand, and settlement patterns on the other hand. There is also a fixed relationship between central places. This fixed relationship is what Christaller referred

to as “K” and this is the constant ratio of settlement and market areas of one order to that of the next order.

The 3 principles that would be served by settlement networks of central places each with a “K” value are:
i) Functions of marketing
ii) Functions of transport
iii) Function of administration.

The K-value is the number of lower order centres. There is a market principle that minimizes distance travelled by all consumers to obtain services and goods. This is served by a net- work in which low order centres are lying in the boundary of market areas of next higher order centres.

Each high centre is surrounded by 6 centres of the next order. Each of these is shared between other places of similar order. Each higher order market is made up of 3 lower order market areas (that is its own market and 1/3 of each of the 6). People in any lower centre can choose between higher order centres all high order goods.



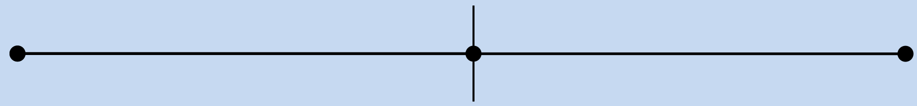
K = 3 network
E.g. 1 + ⅓ of the 6 centers
= 1 + 2
= 3

According to Christaller each lower order centre is mid point between 3 higher order centres. This gives a rise to a uniform pattern in which centres are distributed in the form of the triangular pattern. K =:3 develops where lower order settlements are as close to the higher order as possible because people want to minimize distance

For K =3 network, 1st order (highest) area countries the equivalent of 3 second order areas (has 3 catchment areas. Its equidistant to a 9 3rd areas (catchments areas of 3rd order) also 27 4th order areas, equivalent to 81 5th order areas etc.

Order	No of market areas in order to market.
1	1
2	3
3	9
4	27
5	81
6	243
7	729
etc	Etc

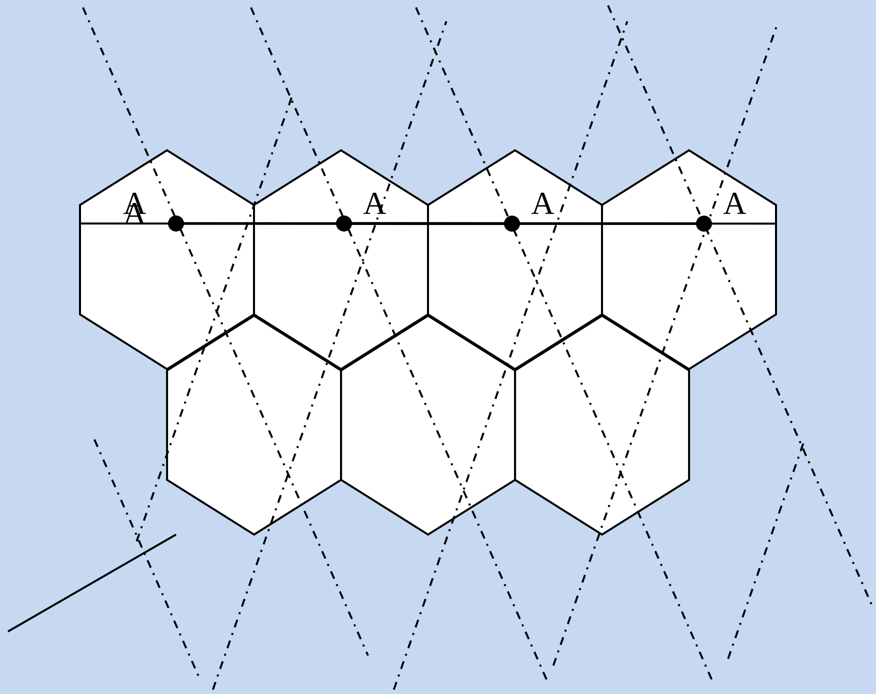
Transport (centre) K =4: For purposes of transport each place is located in the middle of a straight line which connects 2 adjacent places of next order.



This enables direct transport routes between 2 places of similar order passing through places of next lower order at their boundary. Each central place is surrounded by 6 places of the next lower order.

Each of these is shared by only one other central place of similar order i.e. each market area is made up of 4 lower order areas ie itself plus half the market areas of 6 surrounding areas 1+(1/2of 6)= 1+(1/2x6)=4.

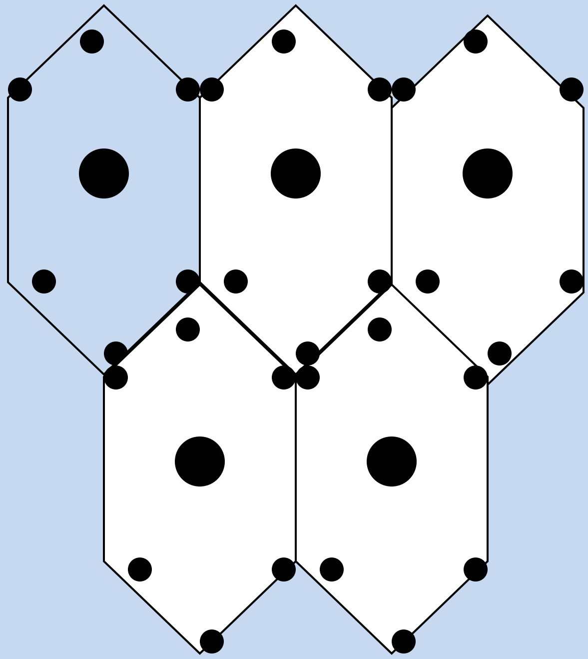
Four K =4 first order centre contains equivalent of 16 3rd order centre, 64 4th order centre 256 5th order centre etc.



ie Order ___________________ 1 2 3 4 5 6
Market area (K=4)____________ 1 4 16 65 256 1024

Administrative Principle K =7 net work.

For the purpose of administration, there will be a k =7 settlement network. Market areas are arranged in such a way that lower order central places lie completely within the market of the nearest higher order centre. In this case there are no divided allegiances, (that means no place is shared by higher order centre). In this way, administration will be carried out efficiently. A higher order market area contains 6 market areas of the next lowest order ie its own plus centre =7.

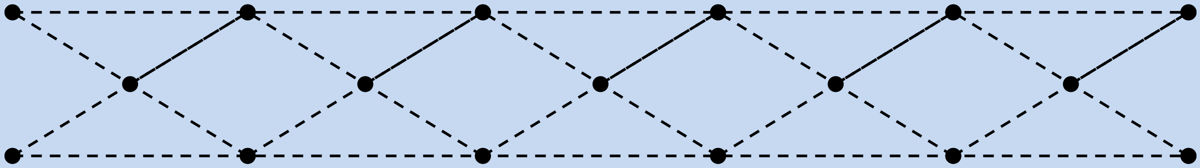


Order	Market (k=7)
1	1
2	7
3	49
4	343
5	2401

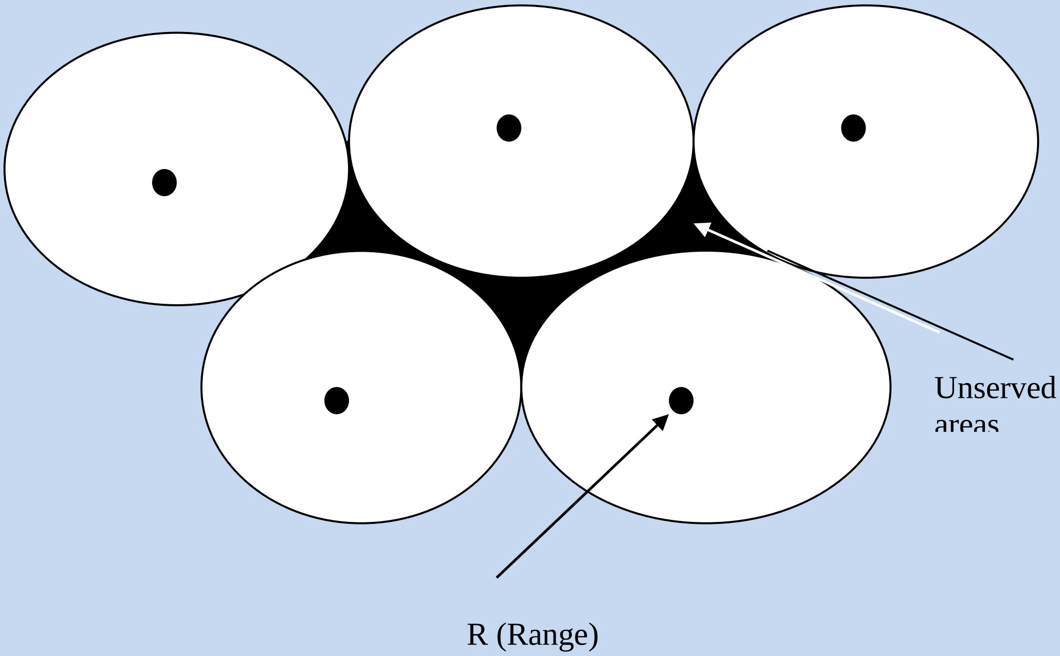
Spartial distribution of central places

Suppliers therefore maximize market areas to gain profit. They will therefore be spread across the plains in an evenly spaced lattice pattern.

Fig. 5



If the maximum range of function provided is to be shown, a pattern of circles develops.



The spaces that remain between the circles represent people, who are not served, Consumers minimize distance to be traveled. Therefore centres develop close together with developing zones.

Over lapping areas are bisected and thus give a hexagonal pattern of service areas developed by Walter Christaller.

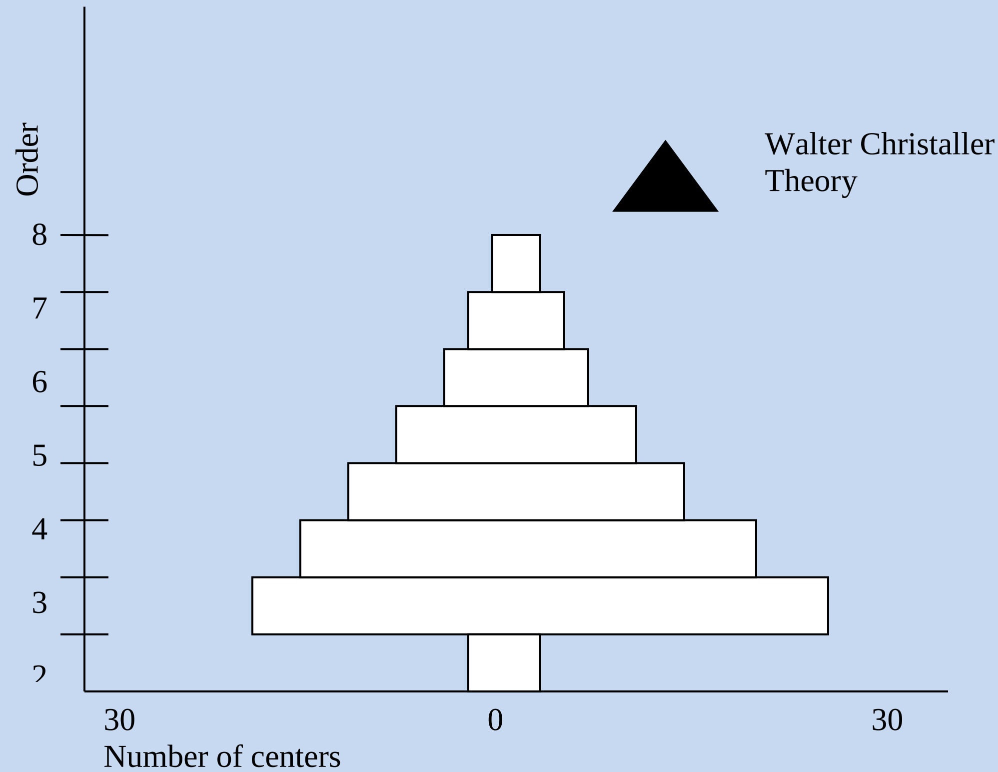
<u>Application of the Central Place Theory to Zimbabwe</u>

According to Professor R.A Health (University of Zimbabwe), the centre can be grouped according to functional complexities and a number of functional units if they are to be ordered in a hierarchy.

<u>Urban areas</u>

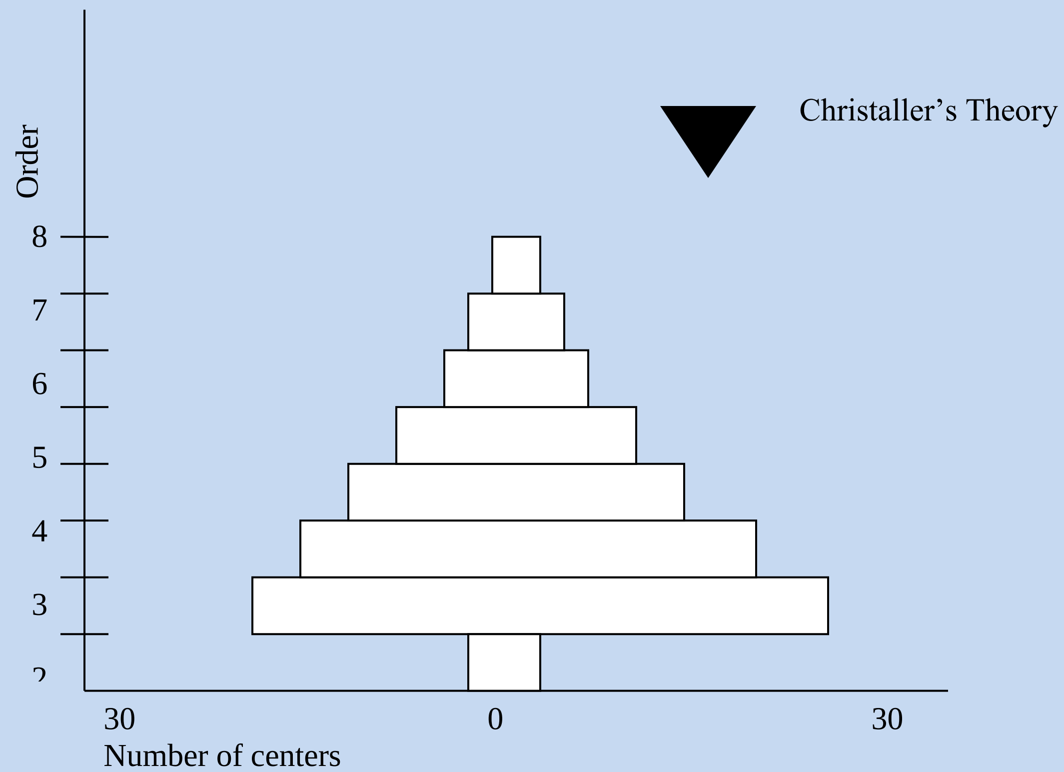
If the urban areas are to be ordered, the hierarchy will be found to be unbalanced. There will be two large centres at the highest order. These are Harare and Bulawayo which are the dominant centres in all economic activities of the country.

The middle order places are poorly developed and the lowest order places are almost non-existent. This lack of middle order places makes Harare and Bulawayo primate cities (though of late Harare has increasingly grown at the expense of Bulawayo).



<u>Rural Areas</u>

Rural areas have central places that serve the rural population. Many of these places lie in the lowest order of the hierarchy. There is a very limited number of centre at the highest order. This again shows an unbalanced hierarchy.



Combination of rural and urban centres

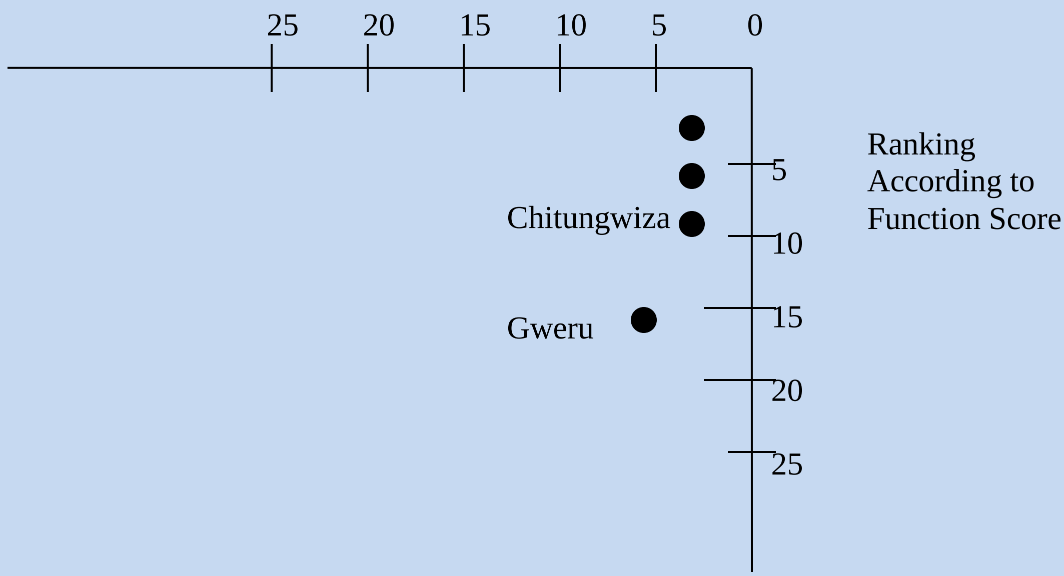
It may give a balanced hierarchy in which Christaller's theory may be applied. Higher order centres offer functions with more functional units than the lower order centres.

Lower order centres are closely spaced and serve small trade areas and rural population, than higher order centres. All places in the same order of hierarchy possess similar functions showing that there is a hierarchy of central places in Zimbabwe, although not as regular as suggested by Christaller.

Relationship between functional, complexity and population size of central places

Ranking of centres according to population can be compared with the ranking according to function. This ranking shows correlation although there may be some deviations.

Ranking According To Size (Population)



<u>Deviations”</u>
Centres that serve large or prosperous rural areas have greater numbers of central functions and higher functional ranking in relation with their population ranking. This shows that such benefit is from the rural service functions and not from their own population.

<u>Examples</u>*:* are Gutu – rises 16 places in rank, Chiredzi 14 places. These are time- central places that save threshold of population with a rural component described by Christaller.

Centres with the element of mining, industries and other special economic activities have less comprehensive range of functions under-serviced in relation to their population ranking.

<u>Examples</u>
Mashava falls 28 places rank, Mutorashanga and Triangle 20 places. These are not true central places described by Christaller. They have limited service centres and have little effect in the surrounding area. (This theory is difficult to apply to mining, industrial and other related centre)

<u>Shape of the service market</u>
According to Walter Christaller the shape must be hexagonal. Zimbabwean central place shapes are not hexagonal because there is no uniform population density –no isotropic plain. The shapes are at times truncated by political boundaries and physical features or relief, roughly circular market areas due to service in all directions.

<u>Evaluation of Christaller’s Central Place Theory:</u>

<u>A) Limitations /weaknesses of the Theory</u>

1) It is a limited one, applying only to places with retail goods and services mainly to tertiary services

It does not take into account the fact that an urban area has a wide range of functions and that there are specialized centres such as tourist mining and industrial centres.

2) Christaller expected the consumer to be rational human beings who would purchase from the nearest places yet human beings buying decisions are not usually so simple.

3) The Christaller landscape was set in the 1930s. This makes his theory static, it did not take into account the changes which would take place in society and the economy e g, increasing consumer mobility .,urban sprawl e t c.

4) The emergence of suburban shopping centres leads to a decline or death of towns, emergence of hyper markets and governments increase concern over location of service activities. A major problem in the central place Theory's assigning of importance to a service centre of the role it plays in serving its own local population.

5) The idea of an isotropic plain is a weakness. We cannot have featureless plains with equal buying desires, mobility in all directions, evenly populated; one mode of transport does not match into reality (isotropic plain as an idea is utopia!)

6) It is rare to find regular ordering of settlements, even hexagonal patterns.

B)**TheValue of the theory**

1) The concept of a threshold population and range of a good seem to be valid. The size of service areas seems to be a function of population density and buying the power of population. If there is a range of thresholds, there will be a range of central places to accommodate, than there will be a hierarchy. The idea of a hierarchy is how ever, hard to determine or explore.

2) It is common that distances between places of a given order are regular-although this does not occur with the regularity suggested by Christaller.

3) Without Christaller, we would be left with a catalogue of settlement descriptions rather than a logical framework against which to test reality.

Rank size rule

This is not a theory but a rule used to describe the size, distribution of towns and cities in a country or a given region especially regular relationships between the larger number of smaller towns, fewer major towns and very few large cities.

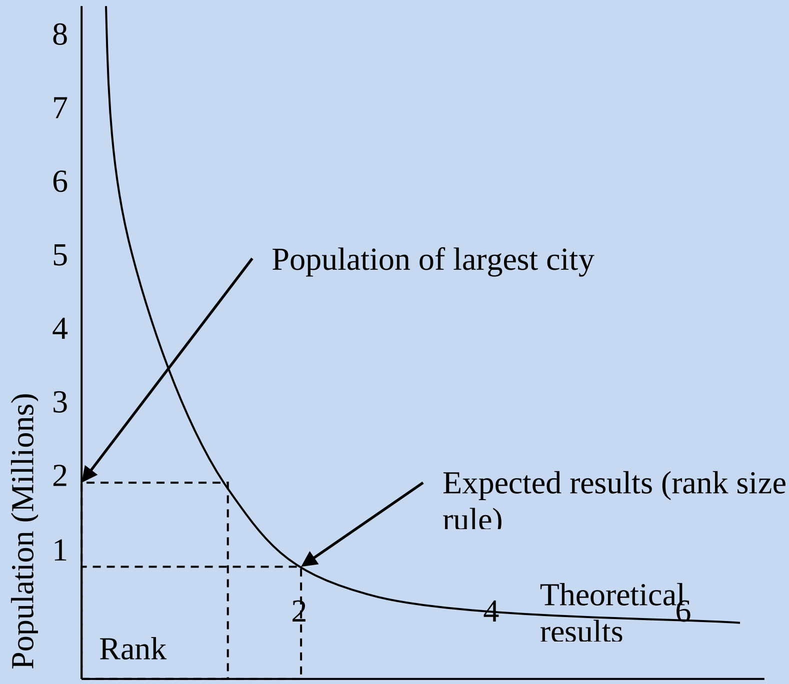
It was introduced by G. K. Zipft in 1949. It states that if all urban settlements are ranked in order of descending population size from largest to lowest, population of the town will be 1/n the size of the largest city ie the primate city. N is the rank order position.

The population of the 2nd secondary largest town will be ½ the population of the primate city. From this the population sizes of cities can be arranged in series 1, ½, etc. It can also be expressed in the formula,

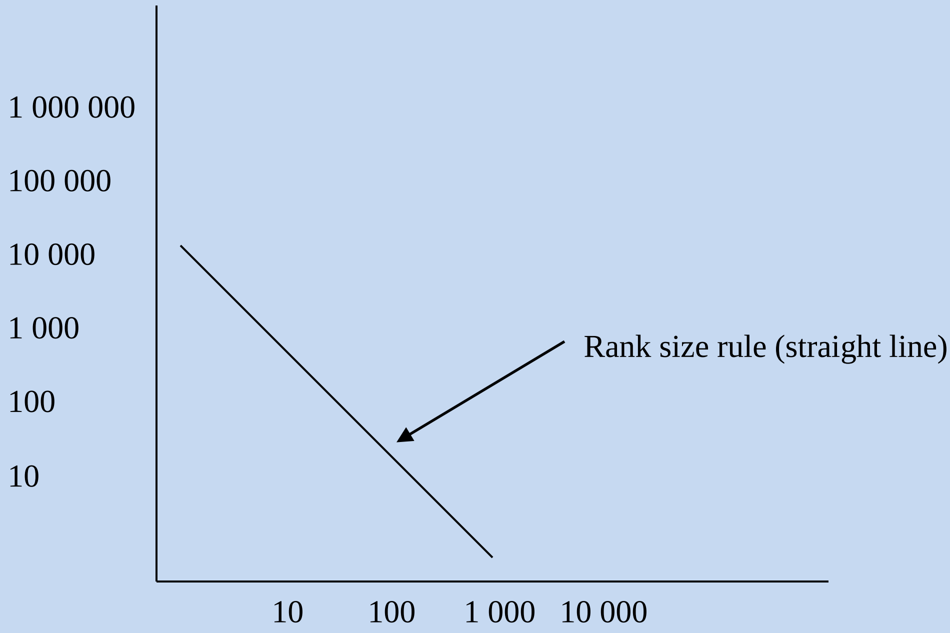
Pn=p/n where Pn- population of the nth town

P-population of the largest town
n- rank position of n (town)

If the rank numbers are plotted against the population sizes for each respective town on a graph, the curve resulting takes the form of an inverted J. See graph below.



When a Logarithmic scale is used for both axis on the graph, the curve is converted to a straight line. The curves can be compared for various countries if they are plotted according to the actual population. They rarely fit closely to the curve of the expected population. This suggests that the rank size rule is rarely accurate. The nature of the resultant misfit can be used as an instructive descriptive tool.

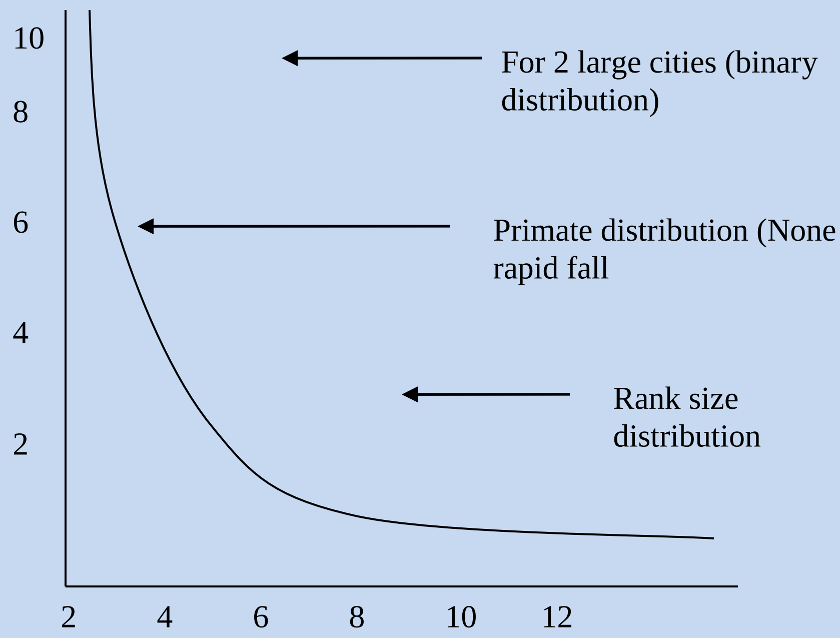


<u>Examples:</u>

1) A more rapid fall off than expected in the 1st few ranks is illustrative of a primate distribution where the country's urban pattern is dominated by:

a) Very disproportionately large cities.

b) If 2 large cities dominate a country this is known as binary distribution, quaternary if they are 4.



No case can result in the smooth curve because not even one country conforms to the rank size rule. The application of the rank size has resulted in the following relationship:

a) Countries that display a close relationship to the ideal rank size relationship are U.S.A, Switzerland, Sweden.

Illustrations using U. S. A statistics of 1980

City	Actual population(1000s)	Rank size population
1 New York	7867	?
2. Chicago	3366	3933
3. Los Angeles	2816	2622
4 Philadelphia	1948	1573
5 Detroit	1511	1311
6 Houston	1252	1123
7 Baltmore	905	983
8 Dallas	844	874
9 Washington	746	786

These relationships were found for countries larger than average with a long history of urban growth and countries which are economically complex (developed) and in federal system of government which prevents dominance by one large primate city where all the economic and political powers are concentrated.

b) <u>Countries that display a primate relationship</u>
These are the countries with a high rank city which is disproportionately larger than the second. These are countries that are smaller than average and in a short history of urban growth.

Very often the primate city was used as a collecting and distributing point of the colonial empires rather than the servicing to the full of their respective regional economies.

<u>Examples</u>
-Santiago in Chile, Lagos in Nigeria, Harare in Zimbabwe, Nairobi in Kenya etc.

c) Those countries that display a no-primate relationship (more or less binary distribution). In these countries cities tend to complement rather than compete with each other.

City	**Actual Population (1000's)**	**Rank size Population**
1. Sao Paulo	5241	?
2. Rio de Janeiro	4310	2620
3. Belo Horizonte	1126	1747
4. Relief	1070	1310
5. Salvador	1018	1048

The Concept of primate cities

A primate city is the largest city in a county or region. It is the centre of political affairs, trade, economic, social and cultural activities.

According to the Rank size Rule; the primate city should be twice the size of the second largest city. However, the ratio can be above the one which is stated by the rank size rule i.e. 2:1 e g a ratio of 17:1 for Uruguay in South America, Montevideo being the largest city and Paysend as its second

The law of primacy states that once a city is larger than any other in its country this fact gives it impetus to growth that cannot be possessed by any other city and it draws away from them all the industrial character and size

In addition, the primate city assumes an exaggerated importance in the country. The presence of early industrial growth enhances attractive powers of that city and it becomes cheaper to supply the infrastructural needs of the new industries eg Dakar has more than 16% of Senegal's population, accounts for 80% of workers in manufacturing industry and 70% of the country's commercial workers.
.
Workers are found in the following:
1) Finest wares

2) Rarest articles.
3) Greatest talents.
4 Most skilled workers.
5) Many young and ambitions people flow there in search of fame and fortune.

Factors explaining the degree of primacy

a) Small territorial extent
b) Relatively high population density.
c) Low per capita incomes.
d) A high degree of dependence upon agricultural exports.
e) High rates of population growth.
f) Former colonial centre of a country.

All these are attributing factors typical of developing countries where many primate cities are common. This situation is less clear in wealthier, more economically self –sufficient countries with slow rate of population growth.

Half the countries in the developed world display primacy whereas in the developing world more than half or almost all countries display primacy. Urban primacy dominates African cities.

The degree of primacy varies. It is 14% in South Africa, 100 % in Lesotho, 100% in Djibouti and Seychelles. Primacy in these countries is due to rapid population growth and the fact that 1/3 of the urban population live in such cities and the remaining 2/3 shared among smaller cities.

There is a higher proportion of rural urban migration. The following cities have population from 30-65%- Aerazu, Nairobi, Dakar, Cairo, Luanda, Addis Ababa etc.

The Urban Population

1. The Urban population is distinct from rural populations in density, composition, mobility, growth rates and occupations.

The demographic characteristics vary from town to town. Although sharing the overall characteristics, urban populations are unique in each urban area e g, for Harare and Bulawayo.

2. Population diversity is higher in towns than in countryside although differences occur between towns. Population density tends to be higher in old towns than in new towns and also higher in towns; of developing countries (less economically developing than in those of developed (more economically developed) countries.

The highest urban density in the world is in Hong Kong with more than 300 000 people /km^2, Calcutta (India) 75 000 people /km^2 and cities in Western Europe.

Paris has one of the highest, 35 000 people/km^2 and with in Britain the medieval towns and towns built during the 19^{th} century have densities of up to about 75 000 people whilst the new towns have about 12 000 people /km^2. Dormitory and resort towns tend to have fairly low densities.

3. Inside the cities densities vary spatially. In Western cities they decrease out wards from the city centre as poor people tend to live in more central places than do the rich non-Western cities people tend to live in the centre at low density whilst the poor people at peripheries at high densities resulting in the development of charity towns or squatter settlements.
4. An Urban population is heterogeneous in composition while the rural are homogeneous. People in an urban population, work in various places and come from diverse, social, ethnic, linguistic, religious and cultural groups.

These variations may enrich artistic life but they pose serious problems of adaptation .integration and assimilation (problems of rural societies). It is partly due to the demographic mixture that large towns are often marked by high levels of violence, crime and general discontent.

5. Age and sex composition leads to further differences between urban and rural areas within individual towns with the exceptions of tourist resorts. Urban areas in the developed world have higher proportion of young adults than rural ones. This is due to rural –urban migration which involves people between ages 15-35 years, that is, those people with the greatest energy and ambition to migrate to military bases and naval towns, mining towns and areas dominated by heavy industry have more population and in towns of South Coast of England women outnumber men by about 3:2 because the area is a retirement resort which can accommodate a high proportion of elderly people and females live longer than males on average.

6. The Age –sex proportion varies spatially within cities. Near the centre where houses are normally divided into flats, there is a high percentage of young single population especially woman whilst in the periphery, the percentage of young couples increase.

As people grow older and as they have children they move out wards from the centre, as an out come of age and sex, spatial differences. There are also differences in population growth rate in urban districts. Some areas have a rapid increase in population and others have rapid decline. The former may have a higher proportion of young adults and the latter a high proportion of old adults. The different growth rate may sometimes be identified between urban and rural populations.

7. Fertility rates are generally lower and mortality rates generally higher in urban areas. Compared with the country side , towns may have small to average house sizes and more social diversions and a high degree of education , and a great deal of birth control. But they also have over crowding and worse sanitary conditions and this may explain why mortality rates are generally high in towns.

8. There is natural segregation of different social racial groups e g most European cities have Jewish sectors. This is an example of spatial segregation of races. There are blank areas in British and American cities.

Types of urban settlements

1) Town

This is a large settlement with a variety of services. It has greater competition among similar functions than a larger village. It can have a chain of stores and factories e.g. OK, T.M, Meikles, Edgars etc. There are general shops that specialize in similar goods and also some education institutions, places of amusement and normally the population may be above 1000 although this is not a universal measure.

2) City

It is normally larger than a town, has considerable diversity of functions and has a U types of occupations and sometimes many types of factories and industries. There is a greater number of economic functions than in a town. A city may have major financial institutions and regional administration offices.

3) Conurbation

This is an area of urban development. Normally it results from the merging of originally separated towns and cities e.g, Tokyo, Ruhr, and NE American board.

4) Megalopolis

This is an area in which large towns or cities have merged into a vast urban zone eg North East of U.S.A.

Factors that have led to the growth of urban areas

1. Agriculture

Improvements such as farm mechanization have relieved farm labourers to work in industries. Increases in food supply sustained a large non- agricultural population.

2) Industrialization

Dependence on raw material and power supplies led to clustering of factories in relatively few areas of towns accounting for urban growth. The resulting agglomerations created external economies of scale. Industries and multiplied greatly. Large scale output required large amounts of labour and as output rose, labour requirements also rose.

3) Market potential

Development of light industries led to the increase in market rented locations. Towns provided large ready markets for consumers and attracted new industries which brought new labour supplies which in turn increased the size of the potential market.

4) Increased service Activities

Tertiary and industries grew, due to increased trade, high standard of living and need for greater economic and social organization.

5) Transport improvement

This led to better communication and better expansion of towns along major routes. This also created population mobility and people were able to move easily from rural to urban settlement.

6) Social and cultural Attractions

Towns if they play old or cultural functions, may act as magnets to their surrounding areas and many people enjoy being near the centre of towns

7) Increased Education

People become knowledgeable and ambitious and find out that towns offer opportunities and have hopes for success there

8) Natural population growth

Though some towns expand through immigration many of them are naturally self-sustained and birth rate is high in towns.

Urban Population increase in Africa

1. Population increases hence need for more services.
2 Economic employment opportunities give rise to mining towns.
3. Increase in transport led to urban dispersal and development of satellite towns which in turn led to the establishment of and services, there by attracting more people.
4. Rural –urban migration.
5. Export trade led to the development of port towns.
6. Encouragement of industrial development by newly developing governments.
7. Development of settled agriculture and improved technology which led to sustained high yields.

Reasons for sustained growth of African Towns:

Once towns are established, they continue to grow. This can be attributed to the following**:**

Rural-urban migration.

Accessibility by all forms of transport.

Development of industries and continued supply of raw material from local and other sources

Flow of goods and information to and from urban centres

Continued performance of the original functions successfully e g mining towns

Kadoma-(agricultural towns)
Natural population increase
Industrial multipliers effect and commercial development (agglomeration)- Increased attraction of more and more industries
Functional specialization
Continued existence of satellite towns and opportunities.

Functional zones of urban centre:
Factors –two groups of factors can be analyzed
1. Centripetal factors
2. Centrifugal factors
Centripetal factors tend to attract functions towards the centre of the town.
Centrifugal factors tend to repel /push functions away from the centre.

1**. Centripetal factors**

a) Site attractions eg water fronts or route convergences.
b) Functional magnetism- this leads one function to attract another for the sake of convenience of management and patrons /customers, cinema, theatre, clothing shop and warehouses.
c) Functional prestige -functions located at the centre for prestige e g, offices of administration, lawyers, travel agencies, doctors.
d) Human, nature- desire to be at the centre of things.
e) Inertia-leads people to cling to sites which are no longer suitable for residence.
f) Civil pride in having administration buildings at the centre.
g) Ability to pay high rents or rates which decrease from the centre to the periphery.

2. Centrifugal factors
a) Open character of land away from the crowded centre and availability of more space for horizontal expansion and for car parking.
b) Frustrating congestion of traffic, noise and sometimes pollution.
c) Lower cost of land and water, rent, changes of outer urban zones.
d) Growing obsolescence (no longer used property in the central place).
e) Human desire to live and work in more healthier and congenial environment.
f) Improvement in transport or influence of motor transport.

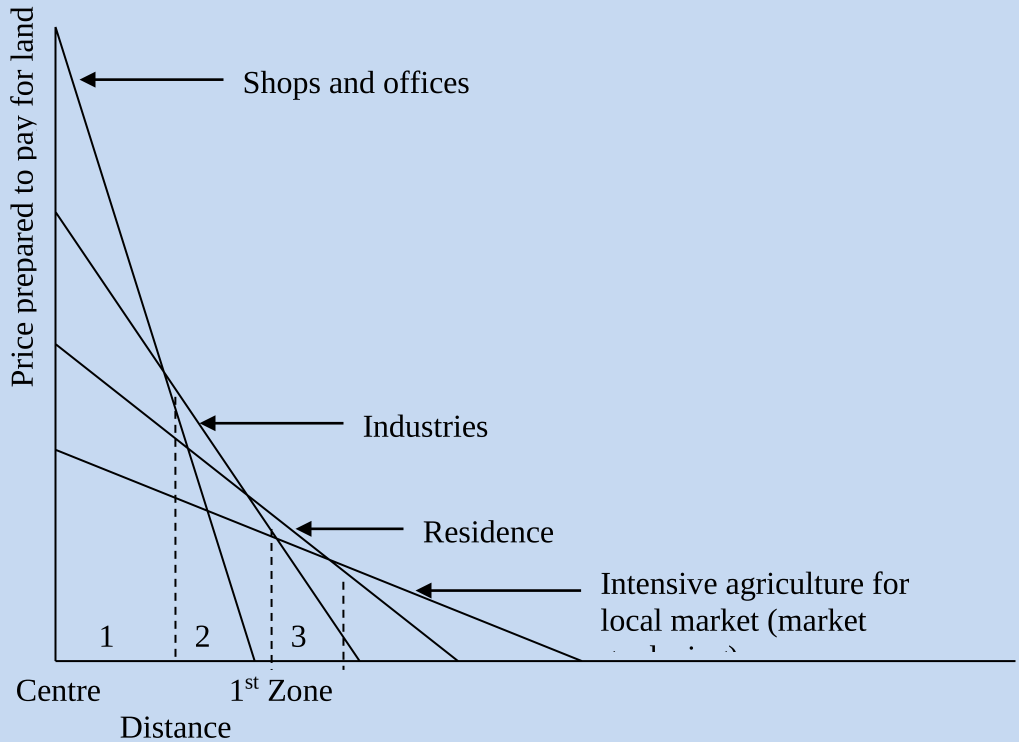
3. Other Factors

Physical factors
a) High class houses are in the periphery, away from the city centre and industries.
b) Economic activities e g industries may be located near railway lines, roads, canals or dock sides for ports.

Bid Rent Theory

This is a theory that tries to explain the location of functions within a town or city in terms of economic factors. The basic assumptions in this theory is that the relative efficiencies of using land in different ways in particular locations, is measured by rent paying ability which is the Bid Rent.

Competition for different locations within a city by different functions produces the most efficient pattern of land uses.



Explanation

1. Rent gradient, that is the degree of steepness of the rent curve is steepest for shops and offices. Shops and offices require central locations with the greatest accessibility to the whole population of a city, to maximize profit. They outbid most other land users near the city centre, but this ability declines rapidly away from the city centre.
2. Industries would benefit from central locations but cannot afford the absolute centrality of shops and offices and so their bid rent is lower at the city centre but it declines less steeply away from it.
3. Residences cannot compete with retail industrial users and so the rent curve is less steep.
4. Intensive agriculture is out-bided by all urban users and has the least rent curve. It occupies the margins of the urban areas.

Comments

The urban land market is seen as a land value surface. The market centre is the point of highest site value and there, land values reach a grand peak at the city centre and decline away from the city centre.

Secondary points land values are near or at major traffic intersections. High values also occur along major traffic arteries. As rent declines with distance, the value of land falls and the use changes. See diagram above.

Examples of Urban functional zones and their characteristics

1. Central Business District (CBD) - It is known by various names eg Down Town Districts in U S A, Urban Core and Central Areas. It is the very heart of the urban system and is the city's structure. It is a 20TH century phenomenon.

Transport technology makes people reach the shops and offices quickly. Construction technology led to establishment of multi-storey buildings.

The CBD contains the following specializations

a. Main commercial or shopping: streets, banks and offices, departmental stores, specialized shops, (jeweler's shops), public buildings (halls) post offices, tall buildings.

b. Its outer limits contain less intensive forms of land use e g lower average height buildings, motor cars, dealers and garages, storage buildings in workshops and low grade restaurants and small shops.

It provides commercial enterprises with important linkages with other businesses and the public.

Shops benefit from cumulative attraction if their potential customers are concentrating on a limited area.

Similar retail outlets that are confined to a specialized area attract more customers than isolated ones.

Customers make comparison either by inspecting the prices and quality of similar goods provided in the CBD.

<u>DELIMITATION OF THE CBD</u>

The building height approach:- the height declines as one moves away from the central zone – so building heights can be used for delimitation.

Contracts of Traffic and Pedestrian flows – this can be made at selected points along the streets which lead into a city. Pedestrian flow is normally high at the centre and decreases with distance from the centre. Figures that are obtained can be interpreted to delimit the CBD.

The Pattern of Residential Population - there are very few residential trade functions within the CBD.

Land Property Value- can be called <u>rent index.</u> Normally land values or rates are high at the peak, land value intersection and they decline from this point.

The reliable values are obtained from the municipal authorities and these can be used to demarcate the CBD.

The rate index is obtained using the following formular:

Rate Index Gross Ratable Value - m^2

Grand Floor Space m^2

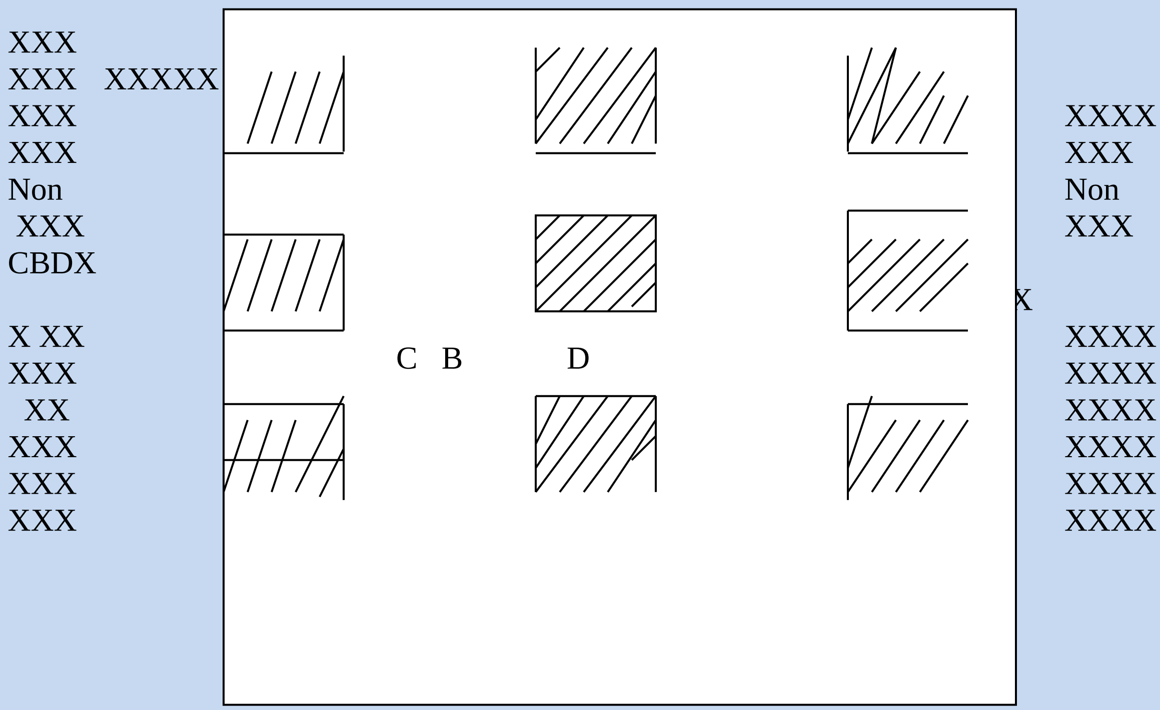
Residence perception of the CBD – normally unreliable.

- Interview local people about the CBD boundaries, it's unreliable

Mapping CBD and non – CBD areas using a base map:

CBD functions are those which serve the whole city e.g. highly specialized stores, departmental shops, insurance headquarters and whole distribution.

Non-CBD functions serve part of the city. Normally the CBD ends at the break of concentration of CBD functions with non-CBD functions. They are mapped and then shaded differently so that the CBD stands out clearly. This method assumes that you already know CBD functions and non- CBD and you are given a base map.



Land use Studies- using base maps. In this case you move around the city trying to contrast your findings within the land- (use models of Burgess, Hoyt, Harns and Ullman.)

Identify the restricted parking zone and metres citing of parking zones and metres indicate limits of the CBD because the local authorities don't erect parking metres in areas that are less busy so that all parking metres are concentrated where competition for parking and business is high and this is in the CBD.

PROBLEMS ASSOCIATED WITH DELIMITING THE CBD
The edge of the CBD is a zone rather than a boundary.
Sometimes it becomes difficult to find evaluation data from the local authorities.
The CBD is not a static element. The boundaries of the CBD are bound to change or shift following the change in economic conditions increasing or decreasing.

The Residential Areas and Land Use
The residential areas are the largest land users in all cities. There are very few prestigious dwellings in the CBD such as flats. We may have residential areas just outside the CBD. In large towns where we have residential areas close to the CBD, these may be Multi-family residents or slums.
Suburbs were a product of the 20th century and they developed for the following:
Increase in urban growth
Families that become smaller and smaller
Poor housing in the inner zone e.g. in Britain we have a garden city where a family enjoys living in a large detached house with a garden attached to it.
High land value of inner zones
Desire for low density houses
Development in transport and communication
Development of dormitory towns
Spread of motor car ownership and establishment of suburban bus services
The needs for privacy- suburbs have low density and there is high proportion of open spaces around individual housing units.
High density areas for the poor while low density areas are of Bourgeoisie classes e.g. in colonial era (Park 1954)

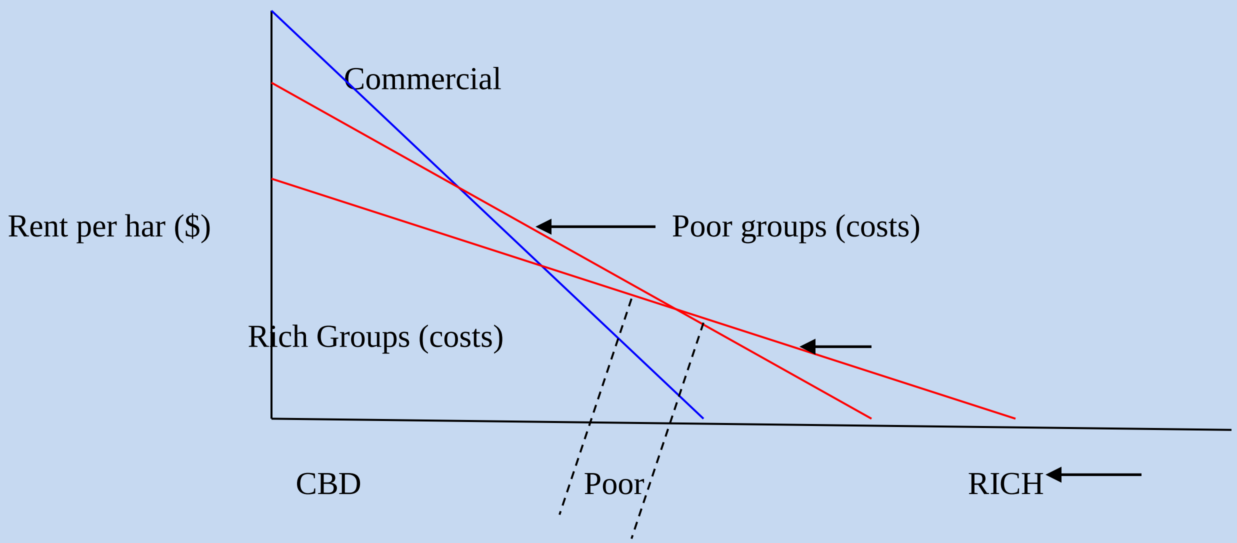
Adjustments or changes which are likely to occur
1. Like other land uses, the residential areas are subject to changes from time to time due to:
Changes in socio- economic conditions.
Influx of upper class people which may lead to upgrading of upper classes e.g. in Britain this is called gentrification.
Dwellings, suburbs divided into lower income people and in Britain this is called filtering down.

2. Wealth and poverty in relation to residential locations:
We assume that the users of land for residence have a single centered city whose centre of employment is essentially the CBD
When people in town choose a house i.e. a place of residence, they consider accessibility to the working place in the city.
Whatever decisions are made, they depend on the money and time they afford to use on overcoming relative distance.

SITUATION 1
-Residential land use and cost of community to work
-Budget of family is divided among living costs, housing costs, transport costs and for an individual

-Some people are rich and others are poor. The poor people remain with little money for commuting after the deductions have been done on housing and living expansions. Thus they are forced to live close to places of work. Their bid rent curves are expected to be low.

If they can afford to live on high rent they do so if they consume less space. Rich families on the other hand have a lot of money and they need not have sites that are close to places of work. They can still afford to stay some distance away from the employment places which is the CBD.

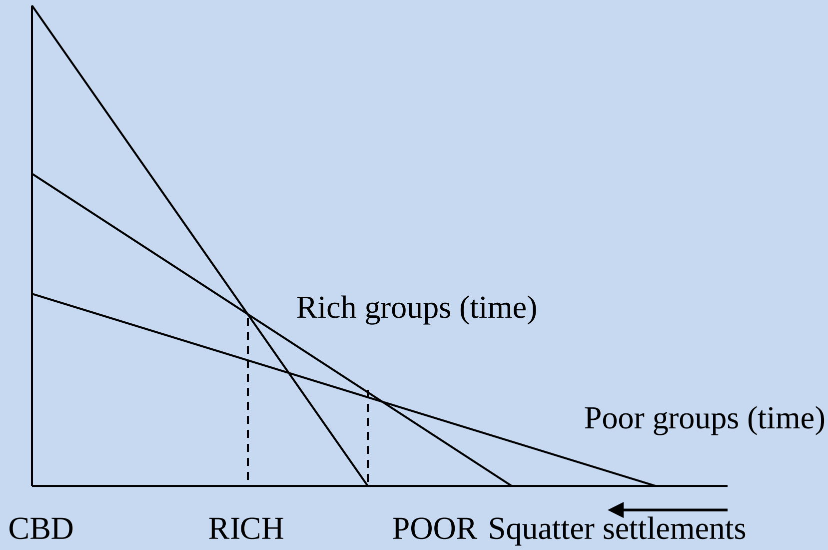


SITUATION 2

The impact on the time cost on residential location decisions in time that one spreads on community is the time that could be devoted to earning some money. Distance becomes critical for the rich ones because they make more money.

As a result, the rich families will have steep rent curves and live near the city centre and on the other hand the poor with shallow bid rent curves stay away from the city centre.

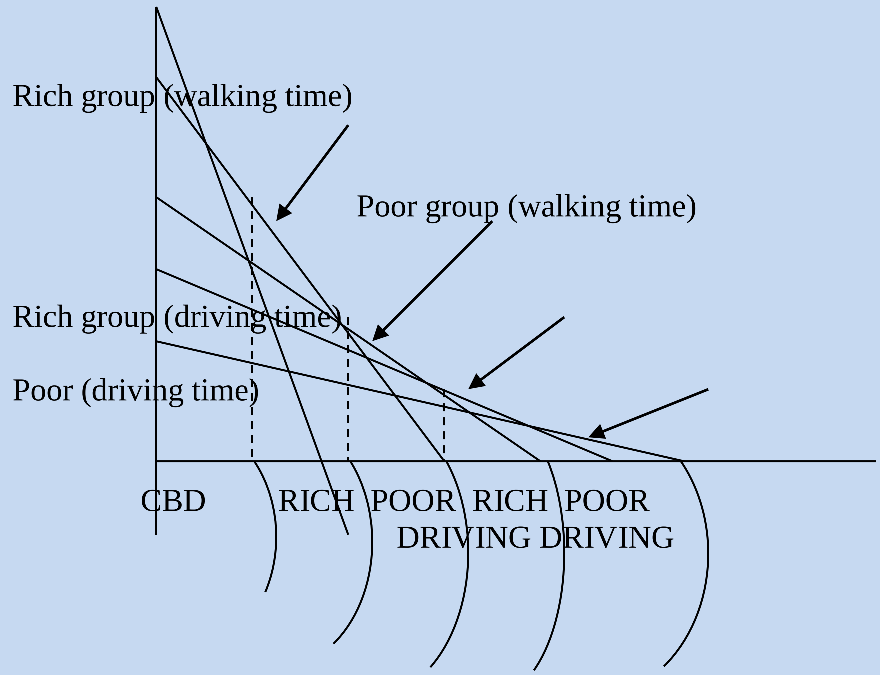
This land use pattern is typical of many developing country cities. The poor people live in the peripheral squatter settlements and shanty towns and the rich in affluent / opulent city residences.



SITUATION THREE

It is based on traveling time criterion. The two patterns mentioned so far show the situation when a single mode of transport to work is used.

In reality there may be two modes of transport in walking or driving. This means that the cost of traveling time for the rich and the poor differs. It will not be the same. The steep bid rent will be steeper for the rich who drive to work followed by the poor walking to the places of work, then the rich driving to the place of work.



<u>CONCLUDING REMARKS</u> Costs, time and mode of transport to work have an important influence in residential location. However, other divisions to accessibility such as nearness to services are to be considered. They also influence the bid rent i.e. location of residential location.

Reasons for growth of million cities:

It is difficult to be precise or sure about the reasons but some of the following conditions have helped to give rise to the million cities.

In many regions the growth in industrialization has promoted the migration of the excess rural labor force into the towns. In some countries such as Japan, shortage of arable land has compelled people to seek alternative employment in the towns. In some areas the mechanism of agriculture has led to rural unemployment and the peasantry has been compelled to seek work in towns. As people become more educated, they desire "better jobs" and the opportunities are practically confined to the urban areas. The social amenities and attractions of town life have led to a marked drift in many areas into the large urban centre.

Problems associated with million cities

No community spinet that permeates smaller urban centre therefore populations are less stable. Traffic congestion is a serious endemic. Parking problems are over whelming journey between residences and working place is uncomfortably long. During the rush hours this is distracting and in some cases detrimental to mental health.

The country side is increasingly drained of its younger and more active people due to migration exerted by every large city, over crowding and the development of shanty towns. Unemployment becomes wide spread.

Advantages

- A wide variety of employment opportunities in commerce, administration, transport and manufacturing. Their citizens are able if they wish, to change from one job to another without moving houses.

Future of million cities:

They are growing in number; growing in size, consume more and more agricultural land. Population growth rates will remain higher than for the world as a whole.

New Towns:

A new town is an urban settlement that is planned. It is a town that has not grown naturally out of the village as a result of expansion or planning.

Reasons for establishment of new Towns

It is deliberately planned to provide employment and accommodation to relieve the pressure of congestion of urban areas e.g. over spill towns of Britain ,new towns around London to promote /provide attractive living places in coal fields areas e g Pepperell and Calinbram.

- To stimulate the general economic growth of an area which was suffering from depopulation, e.g. new towns in Wales.

Political factors

Brasilia, Canberra, Islamabad, New ports eg Tawas; to house new mining communities-Stephenville and migration to gorse.

- For strategic and commercial purposes, e g new towns of former society Asia
- To provide shopping facilities.
- To provide recreational space for their in habitants

Examples

British new towns-built after the war to accommodate over spill population from large towns. They were carefully planned. Milton Keynes-in building Hanishire communities and also for people from Buckinghamshire and land. Planned to be a city with many centres. To be only large new town this will have grid pattern of road. Within the grid will be a mixture of land uses. About 130000 jobs in industries are planned to be distributed amongst several industrial estates. Good roads and rail lines attract companies. New towns of Malaysia - Retailing Jaya to accommodate over-spill population from Kualar Lumpur. To provide employment on its industrial estate.

Zimbabwe-Chitungwiza: overspill population from Harare “Some industries are being established there. Many schools were established for children.

The Zimbabwean growth point is an idea of hiving new towns which are planned before being established

Advantages of New Towns

Absorb population and relieve population pressures.

Provide up –to- date factories.
Have room for industrial expansion.
Have room for extensive works, car parks and growing volume of reliable well housed labor.

Rapid access to major roads and railways.
Most have light industries that provide jobs for both men and women.
Better housing and healthier environment than in old cities.
Act as growth points and stimulate development of regions into which there has been little immigration
Last but not least, dispersion of industries leads to uniform distribution of the country's population and wealth with the inclusion of standards of living.

Disadvantages
Provision of social amenities and shopping facilities lags too far behind supply of houses and industries.
Rent is high.
Lack of variety in housing and in social classes.
Those from large cities feel lack of home lives and death of meeting places. They miss the activity of older towns. The new surroundings with time will develop community High loyalties and social migration and their complaints dwindle.

URBAN POPULATIONS
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6. Age - sex proportion vary spatially within cities, near the center where houses are normally divided into flats. There is a high percentage of young single population specially women whilst in the periphery, the percentage of young of couples increase.

As people grow old and as they have children they move outwards from city centres. As an outcome of age and sex, spatial differences there are also differences in population growth rate in urban districts. Some areas have rapid increases in population and others have rapid decline. The former may have a higher, a high proportion of old adults. The different growth rates may sometime be identified between urban and rural population.

7. Fertility rates are generally lower and mortality rates generally higher in urban areas. Compared with the country side, towns may have smaller to average house sizes and more social diversions and high degree of education, hence a great deal of birth control. But they also have great overcrowding and worse sanitary conditions and this may explain why mortality rates are generally high in towns.

8. There is natural segregation of different social and racial groups e.g, most European cities have Jewish sectors. This is an example of spartial segregation of races. There are black areas in British and American cities.

ETHNIC SEGREGATION

Different ethnic groups have separate residences e.g. in the USA, large cities like Chicago have a mixed population - Black belt of Chicago, China town in Chicago, Little Italy in the same Chicago, Little Wales in the same city.

We also have what are called Jewish ghettos. In South Africa we have in Cape Town residential areas for coloureds, Asians and Indians in Durban. In Britain we have Pakistan areas in London and also West Africa residential areas and also for Indians.

In Zimbabwe's Gweru we have Nashville associated with coloureds, in Harare- Arcadia again for coloureds, Bulawayo - Thorngroove again for coloureds.

INDUSTRIES IN CITIES

Industries close to the CBD

These are normally small units of industries that consume little power and are interplaced with other land uses.

These are industries that need access to skilled labour from the whole urban areas or industries depending on heavily specialized services that are found in the CBD. They may be industries that distribute products to retailer in the CBD or to consumers over the whole urban area. They may be a relic of industries that feel secure or avoid severe competition in suburban areas.

They occupy low grade sites in derelict areas. They may have advantages of occupying the CBD.

Examples included:
Industries which manufacture instruments, that produce equipment, manufacturing fashion, clothing and also publishing and newspaper industries etc. Industries close to railways, waterways or roads are industries which use a lot of raw materials.

Examples are:
Those which have to do with milling, sugar refining and saw mills, motor assembling, oil refining which require extensive sites normally available at the periphery of the CBD.

Industries that produce a lot of noise, industrial fumes e.g. metal smelting, industries that produce or manufacture pulp and paper and cement industries. These are located close to bulk transport facilities but away from residential areas e.g. power industries which need a lot of fuel.
Industries found in suburbs. These are a result of:

- Growth of road transport for movement of raw materials and products.

Need to move away from the congested areas of the inner cities
Cheaper sites
Labour availability in the suburban areas

Such industries are well ordered and planned and are provided with storage materials and are located close to city roads leading out of the city centre.

In some cases the whole district workshops and supportive services may be developed to create an industrial estate. Products of suburban industries are varied e.g. consumer goods for local urban market, food stuffs, furniture, clothing, and electrical goods – the list is long.

Secondary shops suburban shops:- these are the shops in suburban areas. They create some retail centres which are called secondary shopping centres. They occur because people in suburbs no longer want to travel to the CBD for day to day shopping. They are normally lower order centres and have their own market areas and they provide cheaper convenient goods needed by customers every day.

HYPER MARKETS
These are well planned out of town shopping centres. They sell a wide range of goods. They also provide large variety of services. They may be gigantic complex shopping

centres serving more than 250 000 people. In some areas, they are called regional shopping centres.

Reasons for Emergence of Hyper markets:
To serve mobile and highly affluent people
High level of car ownership
To serve those who travel/ drive to town to purchase bulky goods
To change people's traditional shopping patterns by attracting customers who may make some relatively infrequent visits to purchase bulk items normally bought locally on a weekly basis
To relieve congestion in overcrowded suburban shopping districts
They are pleasant and easy shopping centres where all services are located in a single planned centre
Goods adjacent parking facilities
The traders meet lower rentals than in city centres

The Hyper-markets are sometimes opposed for:
Some people believed that it is more convenient to travel to city centre.
These Hyper markets are not used by the poor or elderly people with no means and ability to make bulk purchases and to travel long distances
Large areas for parking tend to destroy neighbour shopping allegiances and community spirit
Hyper markets may cause a decline in shopping facilities in the inner city.

OPEN SPACES
The open spaces break up the inner city zones. They may be in form of private land, private gardens, recreational parks, play fields, school play grounds, and patches of woodland and farm lands.

RURAL URBAN FRINGE
The rural – urban fringe is beyond the main built up areas of large cities and they may contain some new shopping structures, dormitory towns and villages, modern factories. It may also have small play fields, golf courses, airports, sewage works, hospitals, farm lands for market gardening and milk production.

These rural - urban fringes market the intervention of the transition zone between farms and cities.

According to these two urban geographers, even if concentric pattern exists, reality shows more complex situation than Burgess and Hoyt theories.

City growth from a central core may be complicated by the existence of several subsidiary centres. Each subsidiary centre acts as a growth point as well as a nucleus for a developing region. Around the nuclei, land uses that are related or linked to functions may cluster. This results in a circular urban structure.

Places which may act as nuclei are airports, industrial complexes/ districts, hearts of towns, and university campuses. Land use functions cluster in these because of common siting requirements or mutual economic benefits e.g. industries seek places near transport termini.

Residential areas may cluster around shopping centres, estate agents and solicitors may cluster along routes.

Comments:
The theory is complex
It is more accurate than the previous ones
It is flexible in that it can be applied in both developed and developing world cities.

APPLICATION OF STRUCTURE THEORIES
The theories do not match with reality. They however, serve as guidelines for the understanding of landscape patterns in urban areas.

A study of a particular town shows that some of these models may be true for some regular patterns that exist and they may also be used to explain why there may be some irregularities. Some towns have elements of these models though to some variable extent in various combinations.

In general, small towns, particularly those of flat land show concentric models, medium sized towns show nuclei pattern and other large towns may also show all aspects of the three models.

URBAN PROBLEMS
Extensive growth or urban sprawl!
Here physical growth is important. This is the excessive size in population and geographical extent or the outward growth of town. The economic base of a city becomes inadequate to cope with problems created by the excessive size.

It is a world wide problem although it is severe in developed countries. It is accelerated by the growing use of private motor cars e.g. in Russia, Britain and Australia.

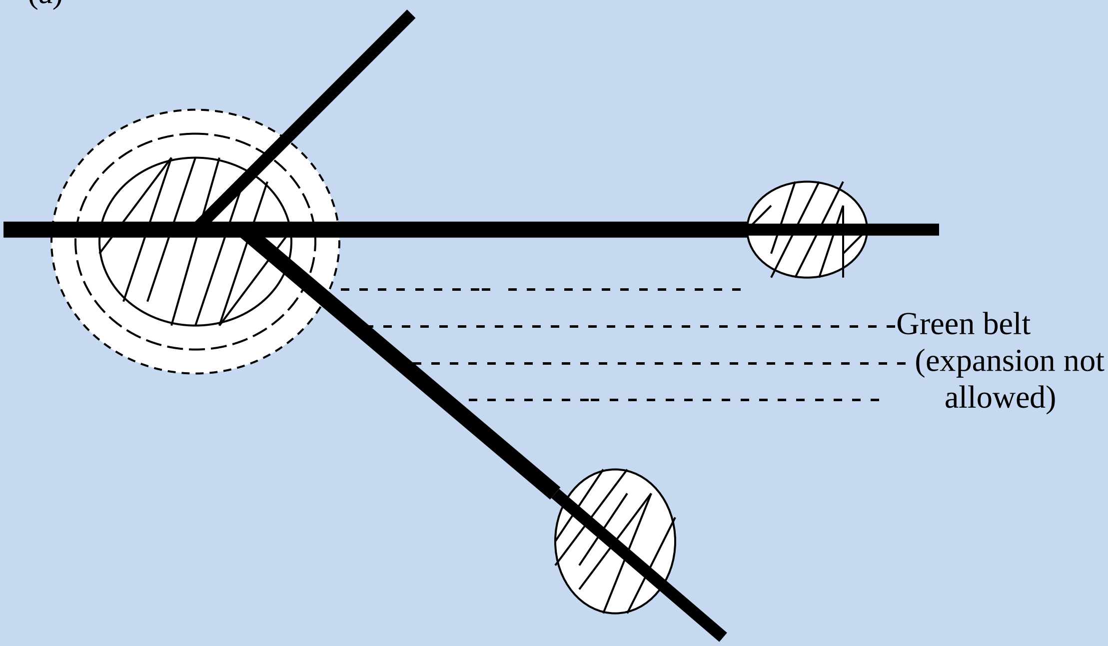
The expanding urban area consumes agricultural land e.g. in Japan the area covered by towns and cities amounts to 1/5 (one fifth) of the country’s cultivable area and in England and Wales the proportion of urban land doubled between 1900 and 1960 to occupy 11% of total area and this leads to loss of economic agricultural land.

Upward expansion is detrimental to urban living adding local eddies, shadows and social problems.

To limit urban sprawl Britain introduced:
“high building schemes”
Preservation of green belts around large cities

Planning of new towns that are designed to house overspill population eg Chitungwiza for Harare.

(a)



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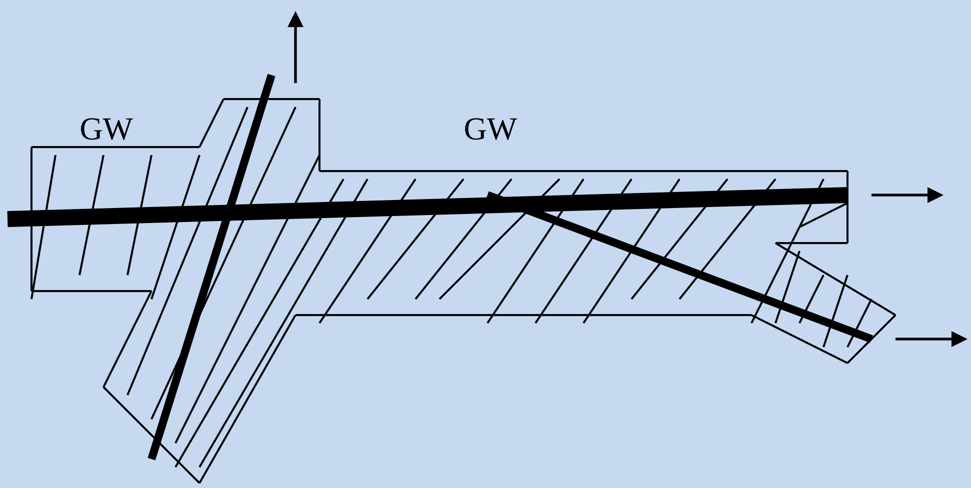


GW- Green Wedge (sector – no expansion)

- Arrow shows direction of expansion

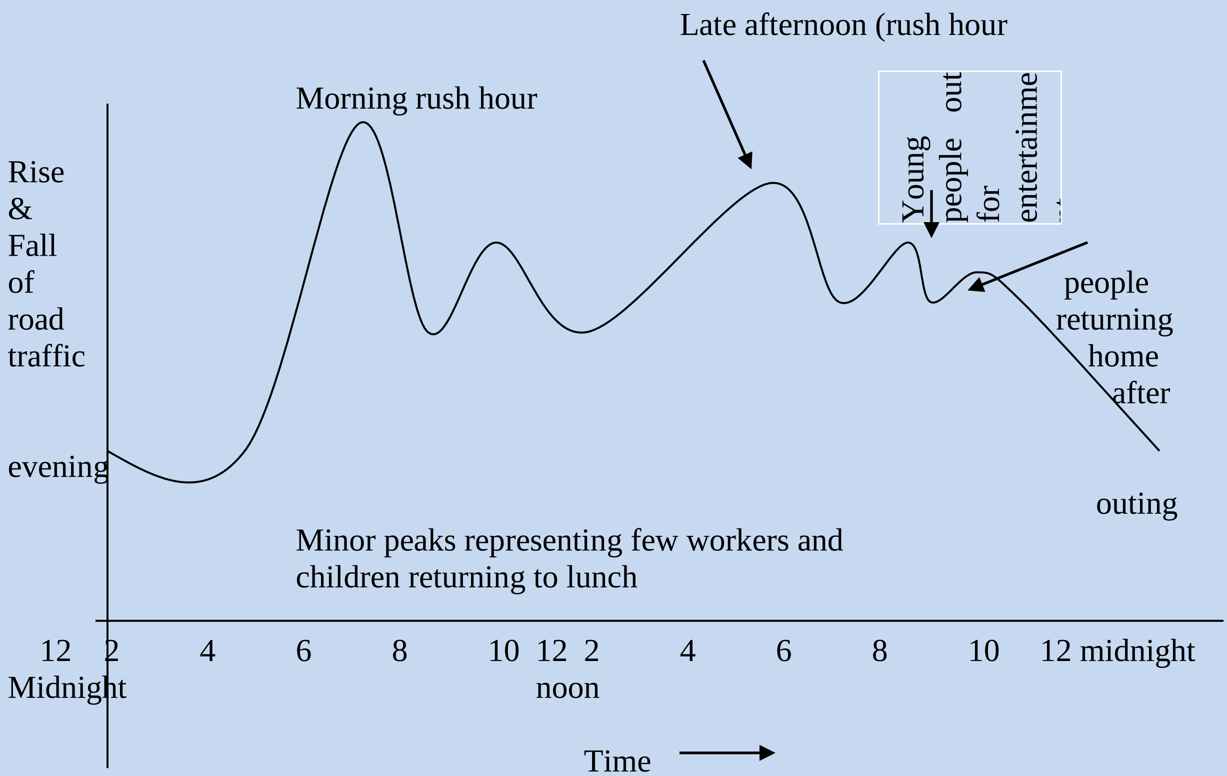
<u>Problem of lengthening of journey to work</u>

The journey to work lengthens as cities increase in area. Expansion train ways, suburban railways, motor bus routes and post war rise in number of cars on urban roads made it possible for people to live further and further from their places of work or even live in rural areas while working in town.

The Growth of numbers of people employed in offices and shops also multiplies the number of commuters who move to and from places of work everyday. This results in the rush hour becoming a problem for both people and transport.

As a result, many people waste time and money on travel and become fatigued and even frustrated. Transport authorities keep in reserve large amounts of capital equipment and pay only partially productive labour to the public at peak hours and convergence of people on city centres creates traffic problems and in some towns it is becoming too difficult for people to reach places of work even in their own cars.

Day's travel – peak in England:



Overcrowding is the effect of excessive population sprawl:

Many people occupy a small area. It is a worldwide problem although it's acute in developed countries.

<u>Shortage of some basic urban services:</u>
Housing shortage – It is often a poor person who suffers most in this case as he or she cannot afford buying at higher costs. This is a result of too many people in urban areas.

In free market or non – communist countries poor people suffer most because land rents rise quickly and the majority cannot afford them. The problem is even found in affluent cities. It is a very serious problem as it leads to shantytowns. It is most common in communist countries because government gives priority to industries and armaments. So the capital pumped in house is inadequate to meet rate of increasing demand every time.

Squatter and slum settlements:

Slum refers to older houses deteriorating or decaying because they are under serviced and dilapidated.

They are at valuable land adjacent to the CBD. But in the Less Economically developed countries (developing), they may be found through out the city. These are depressed areas that are socially and economically linked to city centres and development, hence, lots of crimes in these areas. They are also health hazards and they are centres of socio – economic problems, overcrowding and high birth and death rate.

Slums are acute in 3rd world countries and they are mobile in USA referred to as (ghettos)

Shortage of Human needs

-The Shortage of piped water, sewage systems, no reliable electricity supply, no adequate garbage disposal system.

-Inadequate recreational system and facilities due to too many people sharing little facilities, common in third world countries.

Traffic Congestion

It is a result of the automobile society which creates problems of movement of people and goods in cities. It is a problem of overcrowding and low need facilities and poor planning.

Unemployment and underemployment

In the third world countries about half of the population is under 25 years and this creates strains in job markets. This results in self – employment especially in urban areas eg hawking, opening up of food stands, street begging due to few jobs and too many people. People end up getting jobs below their capabilities and this creates widespread underemployment.

It becomes very difficult for urban authorities to create job opportunities. It is a wide spread problem, though common in third world countries. It is often the poor and the unskilled people who are mainly unemployed.

In the USA, teenagers, women and racial minorities and unskilled people face the problem of unemployment. In the third world, it is the young who also face unemployment.

Environmental degradation:

This is caused by pollution of air and water by the noxious factory fumes such as carbon dioxide and monoxide and sulphur monoxide – vehicle exhausts which produce carbon dioxide especially in industrial countries. This constant production of fumes of Caborndioxide may lead to high incidence of fog.

Uglification of landscapes

-Through lack of planning and urban sprawl and vandalism
-It is a problem in both developed and developing countries.

Urban Decay:

The industrial and residential buildings in towns may be obsolete and decay due to age and others because they were poorly built. The central urban centres are the most dilapidated being characterized by twilight zones, zones in which there are slums, poor social services and high crime rates.

Administrative organization:
Problems of how to expand health care, water supply, sanitation, transportation, electricity and other services to the inhabitants of fragmented suburbs. Problems of how to organize spatially new administration structures and how to prevent continued expansion and how to implement urban plans effectively and problems associated with declining in the central city.
-Governing or administration whose population area extends and quality of services are unknown.

PROBLEMS IN UBARN GROWTH IN SUB – SAHARA AFRICA

Primate citiesUrban primacy dominates African cities. This is due to dramatic growth in population. Capital cities dominate the other cities.

Site and situationThe growth of many African cities was not accompanied by careful planning. For some of these, the situation is more important than the site.
Most African cities were founded by colonial powers and were to be trans-shipment centers for efficient handling of raw material exports.

It was never in the colonial powers to establish functional towns that could be in the interest of indigenous population, so site and situation as well as internal space organization were not important. The result was that site suffered from a limited area of expansion and development e.g. Lagos, Dakar, Mannovia, Durban, Cape Town, FreeTown, Nairobi whose expansion is limited by mountains and hillsides.

Rural urban migration: About the 60% of third world urban growth is due to rural - urban migration. It is a crucial problem that affects African cities. Cities become centers of power and investment especially after the period of colonization. They do not offer employment, they offer few services and they are a liability to development rather than asserts because of a disproportionately large amount of the economic development needed to sustain stability.

Functional concentration: This applies to primate cities which are much larger than other cities and they may monopolize urban functions.

The bulk of secondary, tertiary and quaternary industries are located in primate cities. All important functions are contained in those cities e.g. Government International Affairs, transport, industries, educational affairs etc.

The primate city is very essential; it controls the whole set of functions of the country and its prosperity and growth are derived from the transfer of resources. This transfer of resources is not reciprocated by a reserve flow in terms of development, service and diffusion of technology. It is the core of economic activity.

The outlying areas are made to suffer from sacrificing their power and resources in order to maintain the centralized powers of the primate city.

International characteristics There is a form of development desperation in African cities. We have an existence of poor population that is subservient to the more privileged social classes. Two enclaves in an African city exist:-
One is composed of elite with strong functional linkages to international systems
The other is composed of the poor who maintain socio – economic affirmed in the countryside.

The elite class is spatially domain in representing highly modernized work. Modern social services, residential environment complete with tarred roads, telephones, financial institutions, indoor running water and other luxuries and the poor segment lives in shanty areas.

POSSIBLE SOLUTIONS TO PROBLEMS IN CITIES IN AFRICA

Solutions on current problems associated with rapid urbanization in Africa under present socio- economic structures should be accompanied by policies that have a great impact that goes beyond city confines.

One of the most important factors that prevent growth and integration of African economy is the division of the country into economically and politically weak islands or pockets that hope to develop in visible nations.

The flow of spatial- economic gravitates towards the primate city.

The following are possible solutions or policies that must be adopted to reduce urban problems or that may direct rate of development from the city.

Internal regional development policy

This would improve flow of development, investments and infrastructure.

Development policies - growth points could be established in the countryside eg in Zimbabwe

Establishment of satellite towns

Rural service centres which can be identified from the existing system of central place. These service centers should receive a large share of development than before.

Selection of a hierarchy of central places and providing them with services. This should be done to improve the rural economy and development in order to increase efficiency in delivery of central services to the rural areas.

The primate city should share some of the services and stop monopolizing. These services and activities should therefore be accessible to smaller centers.

Improvement of transport and social structure in order to exhibit the tendency towards rural development in order to achieve this road and activity between lower order centres should be improved.

Providing some urban functions in rural areas will make sure that there is a reduction of centripetal urban functions e.g. education, health and recreational activities in order to enhance decentralization – rural development geared on agriculture and productive potential and natural resources may do a lot to redress rural – urban disparity as well as reversing the current trade and resource transfer relations which always favour large primate cities and other urban areas of a country.

Making smaller urban centres acquire competitive conditions of adjusted income and amenities so that they can attract people to their own territories.

Making smaller urban areas and rural areas more attractive to work and live so that most trade people would not prefer to live in large towns.

This helps to reduce centripetal forces towards large cities.

SQUATTER SETTLEMENTS AND SHANTY TOWNS

These are shanty towns or pathetic shelters built with whatever material is available or the shift dwellings. They are known by many different names in different countries e.g. favelors- Rio de Janeiro, bistus - India, gaurbivilles, bidoveilles-Algeria, squatter camps / settlements – Zimbabwe and Zambia.

LOCATION:

They are normally found or located on the periphery of cities or land that is not economically used, for example, derelict land in the city.

They are also found on the urban fringes just beyond the legal limits of the city. Although most of them may occupy municipal land and locations away from places of employment e.g. Rio de Janeiro, they occupy hillsides, around Rio de Janeiro. They are found amid marshes and valleys around Bolivia.

REASONS FOR THEGROWTH OF SHANTY SETTLEMENTS:

- Rapid immigration of working population from remote, undeveloped countryside.
- Rapid urban growth

The failure of urban authorities to provide adequate accommodation for migrants
Large numbers of poor people in large cities of the developing world.
In some cases they may be houses between villages and towns or extension of village conditions where existence to relatives and friends is possible while town life may be difficult and while labour is short supply, but eventually becomes a permanent place as lack of employment removes all the hope and aspirations.

- Unemployment and housing shortage as well as lack of permanent buildings, roads, piped water, electricity and other resources.

New areas are created by their own inhabitants to protect themselves and mobilize their minimum resources.

- The poverty of the people who are not able to enter fully in the urban society.

Refugees may also construct some shelters close to urban centers or people born in urban areas who fail to adjust themselves to city life.
They are there to occupy land not sort after for other uses.

Characteristics of squatter settlements

They are erected without official permission and are unauthorized camps occupying land which does not belong to squatters.
Building materials are tin, card board straws, wood, flattened petrol tins, sacks, etc
There is an uncontrollable construction and there is minimum sanitation standards – that is open latrines and bush latrines and open drains.
There is high incidence of disease and there are breeding areas for flies.
There is extreme poverty and discomfort.
There are sectors of the city which are not fully integrated socially and economically into development process.
There are no essential services of urban environments such as sewage, piped water, lighting and shops.
They are poorly provided with transport and they are the poorest in urban society.
They are not controlled by city authorities or bureaucracy.
These camps contain the most recent city's inhabitants.
They are symptoms of both rapid urban growth and ineffectiveness of policies of economic development.

Problems caused by squatter sites
Disregarding of hygiene frequently leads to sickness and disease.
They present financial burdens for the existing city dwellers if services such as piped water, sewage, sanitation, refuse collection and lighting were to be provided.
They are associated with high mortality rates.
The governments are very much concerned about the impression their countries give to visitors who see these squatter camps.
They occupy land which could be used for other purposes eg industrial

They are associated with socio-economic problems such as delinquency crime, prostitution and violence.

Possible solutions to squatter problems:

Provide better services such as water, electricity and drains to squatters.
Set up small scale industries in rural areas to reduce rural - urban migration
Build large blocks of flats and disjoin squatter settlements.
Provide grants and training for farmers.
Employ the police, army to clear squatters by force eg Operation Murambatsvina in Zimbabwe
Encourage industry that employs a lot of people in towns so that they are highly paid and in turn they can afford buying up-to-date houses of their own and be able to maintain them.
Encourage self help groups to build better houses in towns.
Introduce rural land reform encouraging peasants to own and run small farms.

Examination type Questions

1. Define the terms range and threshold and explain why they are important concepts in Central Place Theory. **[8]**
2. The interaction between a central place and its surrounding sphere of influence is a fundamental part of Central Place Theory. Describe and explain the nature of this interaction and how it alters as size and importance of the central place increases. [10]
3. With reference to any **ONE** area you have studied, briefly describe and explain its hierarchy of settlement. **[7]**

4 (a) what do you understand by the terms:
   i) primate city,
   ii) Rank – size rule
   iii) Binary distribution of settlement? **[9]**

(b) With reference to any one rapidly expanding city in a developing country: Outline the factors that have encouraged this rapid growth, and

(c) Assess the social and economic effects of this rapid growth. **[16]**

CHAPTER 22

AGRICULTURE

22.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:
a) Outline factors contributing to world agricultural systems.
b) Critically examine the factors that have led to a global increase in food production.
c) Assess relationship between population growth and food supply.
d) Define green revolution and its impact on the agricultural sector.

Introduction

Agriculture is a primary industry concerned with food production. It developed out of the need by man to have a steady supply of food to meet the demands of a rising population. Historically, early man lived off his environment he ate or hunted what the immediate environment supplied. A rapid rise in population forced mankind to adopt a more settled lifestyle and that marked the origins of early agriculture. Man domesticated wild animals and began to till the land. Agriculture can be defined as the practice of growing crops and rearing animals as humanity continuously attempts to maintain a balance between population growth and food supply .In this chapter we shall make an evaluation of the practice of agriculture in the present day paying particular attention to past and present day development in the practice of Agriculture

22.2 Factors affecting agricultural land use patterns:

The physical factors do not by themselves determine what a farmer grows and practices. They set limits within which a farmer operates. A farmer must reconcile his needs with the physical conditions of his land and the opportunities that are offered by the market.

22.3 Physical Factors

1. Climate and its fluctuation
2. Soil conditions
3. Relief
4. Location with regard to markets and transport means

Climate is the principal aspect of the physical environment that affects agriculture. The soil characteristics are largely the products of present and past climates and vegetation that have flourished in them. The effects of relief results in climatic variations. Every country required certain climatic conditions from its environment for it to survive more severe conditions if it is to produce naturally.

a) **Precipitation**: Rain is an essential element in agriculture and water from the soil and underground water are important for plants.

Underground water collects from rainfall or from rivers and streams. It is essential for animals. Wells provide water for both livestock and human consumption. Plants get water from the soil through the root system, so water must be available in the soil in large quantities. Too little water causes plants to whither (wilting too) and too much water causes water logging or disease and death of plants.

Precipitation should be higher than evapotranspiration or infiltration capacity should be above evapotranspiration for plants to survive. Rainfall may have destructive effects e.g. example soil erosion and if it is in the form of snow, it may cause death of some animals/ or plants.

Temperature: The germination of seeds and growth of plants require suitable- temperatures and plants require optimum temperature for them to grow. Very low temperature may result in slow growth. Frost may kill crops. Frost free- days or periods are very important for photosynthesis to take place.

Wind:

Wind causes soil erosion. It is directly related to evapotranspiration. It may also have destructive effects on crops so that we may have killing winds for examples the Nustral of France, Sirroco winds of the Sahara and the Chinook of the Rocky mountains.

II. Soil Conditions: Soil is a medium of germinating seeds and growing plants. In agriculture it is therefore important to maintain soil fertility. Crops remove nutrients from the soil and with time this lead to low returns. The important elements that are needed by plants are nitrogen, potassium, sulphur, magnesium and iron. In addition to these some trace elements are also important.

The proportion of vital elements that are in the soil vary from place to place due to;-

i) Different climatic conditions which affect the rate of weathering.
ii) Different rock composition from which soil comes.
iii) Soluble minerals that may be leached and carried to streams/ sea.

The important soil properties for plant growth are: alkalinity and acidity, texture and structure.

22.4 Soil Texture:

This is the result of the nature of the parent rock. It includes fine particles of clay. Silt, coarse sand textures determine porosity and water holding capacity of soil and also the infiltration rate of water. Clay soils are poorly drained. They remain water logged and may be difficult in ploughing. Wheat may favour clay soil but in most areas clay is left under grass to support dairy farming. Every crop type has a range of soil types which are best for it.

Soil Structure: This is the vertical arrangement of soil constituencies. The process of leaching which dissolves and carries soluble constituents results in the formation of podsols in cool damp regions and laterites in the tropical areas. Such soils are of low fertility because leaching removes nutrients. Soluble material can be drawn by capillary movement towards the surface resulting in the Russian Steppes and Prairies of Canada and these are fertile soils.

In mid- latitudes there are soils rich in humus.

Soil Acidity and Alkalinity: depends on the nature of the parent rock, moisture, climate and soil chemistry - expressed in the Ph value.

Neutral soils - Ph 7, lower than 7 shows acidic soils and above 7 alkaline. Acidity and alkalinity vary within a short distance. Some crops grow well in acid soils and others in alkaline soils.

B) Human Factors

a) Land Tenure: who owns the land, why? With what effects and is there any scarcity of tenure?

Factors which determine type of tenure:

i) The type of economy prevailing in a given area or region whether there are cash crops or only crops for consumption.
ii) The pressure of people on the land - population size.
iii)Type of political system - individual ownership, collective farming or land belonging to the state.
iv) The type of tools and machines.
v) History of the area - linked to the political system.

Types of Tenure.

a) Communal Tenure: No private ownership of land. Land is owned by a group of people i.e. family or the whole ethnic group. The land is allocated to a member of the ethnic group according to their needs.

Every member has the right to cultivate a piece of land and the right to possession. They have full knowledge of tenure- every person knows that he or she has the right to use the land.

There is no eviction or dispossession of land (security). The land is also for grazing, hunting or farming. Farming is entirely for subsistence purpose and normally communal tenure occurs where land is abundant and population is sparse. Communal tenure was strong before the coming of the European settlers -(in ethnic village).

Disadvantages of Communal Tenure:

Land cannot be sold, so there is little chance of improving its value and little incentive to invest on it when plots of land are re-allocated at intervals and the occupier has no incentive to improve the holding.

Soil mining can be encouraged in this way. The need to conserve the soil or land is not recognized because no individual regards himself responsible for the land. Where there is no property rights on land, it cannot be used as security to get credit since the plots are distributed amongst the members of the ethnic group according to needs.

It is impossible for an individual to establish a large holding on which advanced farming methods can be invariably accompanied by a high degree of fragmentation especially where there are too many people.
Nearly all the grazing land in Africa is communally grazed. As there are no restrictions upon the number of animals per square metre, overgrazing over wide areas while the communal grazing remain. There is no chance of improving the quality of livestock or any incentive for an individual harder to dig wells for water which would be used by all people.

Communal tenure deters individual initiatives and is a major obstacle to agricultural development, for example, in East Africa, pastoral areas of Masai of Kenya and Tanzania, the Turkoma, the Kwamajong and, North West Kenya and North East Uganda, mixed farming areas of the Ukoniboni in Kenya.

Consequences: an individual takes as much land as he likes without any incentive to conserve or to improve it. Efforts to improve land benefits the whole community not the individual. Where the land is used for cultivation, continued cropping causes furrows, and the destruction of soil structure, and depletion of fertility. Where grazing is the main activity they overstock - thus causing overgrazing.

Where different herds mix freely, disease is very difficult to control by one man. There is uncontrollable mating so that selective breeding is impossible. The overall effect is the impediment of agricultural and overall economic growth.

b) Free- hold/ individual tenure:
Here the farmer has the right to cultivate the way he likes and it is a system applicable both to subsistence and commercial farming. It can have problems of fragmentation through inheritance and sub- dividing but can also contribute to efficiency in land use. The farmer has the degree of choice of production plans.

Advantages:
i) It allows free and flexibility decision on farm products.
ii) It provides greatest incentive, effort in farming, conservation and improvement of land.
iii) Where a farmer has little capital, it becomes possible for credit making (security for obtaining credit and loans).

Disadvantages:
i) Capital may be too limiting for a big agricultural development.

ii) A farmer may borrow too much and experience repayment problems that may lead to short maximization of plans instead of optimum farm plans.
iii) Management problems may impede agricultural progress although agricultural extension advisory services maybe provided.

Examples:
i) Rural areas of Zimbabwe, resettlement areas.
ii) Highland areas of central provinces of Kenya and Kigezi in Uganda.

c). Collective or Co-operative Tenure:
It involves collective arrangement of land under government control or other boards, for examples, the Ujamaa villages in Tanzania, a group of farms in Uganda and co-operation farms and ranches in Kenya as well as collectivization in former soviet Russia.

Effects
Where there is suitable co-operative spirit and good management, good economic results may be achieved, for example, Mwea irrigation settlement scheme of Kenya. Co-operative Schemes in Zimbabwe where there is lack of management of co-operatives and lack of co-operative production, co-operatives may not succeed.

(d).Size of Holdings:
Small Holdings determined by the presence of how many people are on the land and sizes are very small in communal areas, for example, in Zimbabwe where there are subsistence practices. The sizes are also small in India, China, and Greece. In Belgium and Denmark the holdings are very small but heavily capitalized and heavily used. There is no full employment of families if the land is too small. In Canada and Argentina, the sizes are very large. If the sizes are very large and, if they are very small, there is no field employment and the output becomes unequated to human effort and low standard of living results.

The output becomes too small in relation to human efforts and this leads to low standards of living. Techniques may be of high standard but may intensify under-employment because labour will be cut down.

Migration into industries or into another country may result for example in rural areas of Zimbabwe. Small size results in fragmentation of land in scraps that are scattered all over the field. This results in wastefulness of land and time. Land is also divided among heirs (sons) as it happens in Zimbabwe.

A farmer with a fragmented land has no access to commercial markets and it becomes difficult to get the future demand of the crops. It is also difficult to use mechanical equipment on small farmlands, for example, in Southern France. The lands are small for farmers and are fragmented. Yields are low and time is wasted each day in traveling to and from the fields. Fields do not allow the use of machinery. These fields are usually associated with monoculture.

Large Holdings:
These, as already mentioned, are common in large farms, for example, the Prairies of Canada, the Cornbelt in the USA and the Pampas of Argentina. There may be thousands of hectares. Large scale farms or large holdings are highly capitalized and owned by farmers who use modified farming practices to take advantage of shifts in demands and fluctuations of the world economy.

Markets:
Subsistence farmers do not need reliable markets because they consume most of their products whereas a commercial farmer produces for markets only. In Zimbabwe we have the Agricultural Marketing Authority. Its task is to market and control the prices of agricultural products and there are boards which buy and sell produce internally, for example,

i)The Grain Marketing Board (G.M.B.) – for marketing wheat, maize, sorghum and soya beans. All farmers sell their produce to the G.M.B. – i.e both communal and commercial farmers. "Attractive" prices at the GMB encourage more production.
ii)The Cold Storage Company (CSC) buys cattle from communal and commercial farms. Prices are "encouraging."
iii) Dairiboard Zimbabwe Limited used to have exclusive rights (monopoly) to buy and distribute milk into urban areas. The producer prices are normally fixed by the government.
e).Rural Development Policies (as a factor) i.e. Government Policy - they are towards rural development and are necessary for the following:

i)To upgrade the living standards in rural areas and farming production.
ii) About 40% of Zimbabwe's land masses that contain the country's majority population has been badly neglected for political reasons.
iii) To resettle the thousands of families and educate them in farming techniques.
iv) To establish revolutions in land conservation and animal grazing.
v) To check on rural - urban migration.

22.5 MAIN AGRICULTURAL REGIONS OF ZIMBABWE

REGION I
It occupies 58 350km^2 and is about 15% of the country. It has very high rainfall- above 1 000mm per year and the temperatures are low, about 15^{0}C. Evaporation is therefore reduced. Crops are fruits, coffee, potatoes and tea. There is also extensive beef and dairy farming found on the Eastern Highlands. Soils are well drained. There are gentle slopes which prevent logging and there is abundant labour.

REGION II
It covers 72 748km^2 and is about 18, 7% of the country. Rainfall is between 700 – 1 000mm. It has a warm climate in summer. Temperatures are between 18^{0}C -22^{0}C and has cool winters 15^{0}C - 18^{0}C.

There is intensive farming of tobacco, maize, cotton, wheat, marketing and gardening. Also, beef fattening and dairying near towns/ places close to urban areas. Soils are deep and well drained, very rich soils on gold bearing rocks and there are also sandy loan soils which favour crops like tobacco and deep clay soils which favour cotton. There are heavy application of fertilizers and also capital is available- very close to urban markets which are quite large.

Arable land may be more than 30ha. Beef production accommodates more land.

REGION III

67 680 km^2 and is about 17, 4% and receives moderate rainfall from about 550 -700mm and high temperatures about 25^{0}C and there are dry spells - certain very hot periods. Drought resistant crops are grown like cotton, soya beans, sorghum and beef rearing-extensive and breeding.

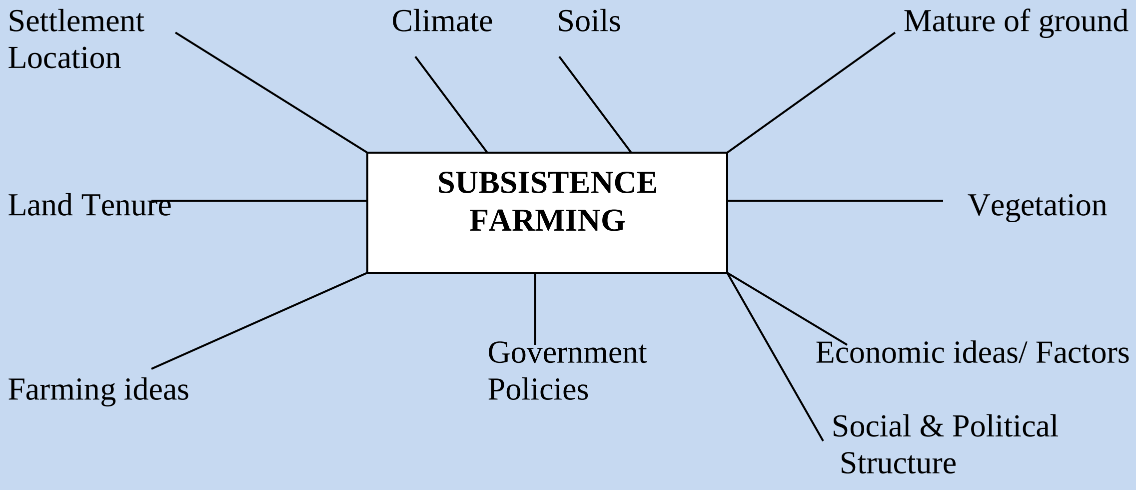
REGION IV

This region has very low rainfall between 450-600mm and there is seasonal drought. Temperatures are above 25^{0}C. Drought- resistant crops and semi- extensive controlled grazing and irrigation is practiced.

REGION V

Very low rainfall - less 500mm and is very hot. Temperatures may reach 30^{0}C. It includes the lowveld (South Eastern) - extensive cattle ranching and irrigated pastures.

Landuse in Rural areas -Zimbabwe (factors).



22.6 Transition from subsistence to commercial agriculture.

Features of subsistence agriculture that necessitate transition:

Output and consumption are identical because they tend to produce for local consumption.
Inputs and production are low.

Use of simple tools (primitive methods)
Minimum capital investment.
Land and labor are the main production factors.
The law of diminishing returns operates on shrinking land parcels due to frequent fragmentation.
Technological limitation.
Rigid social institutes for example, keeping of many cattle not taking into consideration land capacity and quality but only prestige for example, African peasants.
Poor communication methods.
Subsistence agriculture is very risky and very uncertain because it depends on uncertainties of nature.
Average output is low and poor peasants and their children face starvation.

<u>Preconditions for Transition:</u>
Large groups of a non- agricultural family both at home and away for the farmer to supply. At present about two thirds of African population are engaged in agriculture so that there are very few people to whom farmers may supply hence the low market – less productivity.
Improvement in marketing organization-selling and sending to market may be done.
Improvements of communication.
Increasing efficiency in productivity.

<u>Problems associated with Transition:</u>
Land is regarded as a resource to be exploited quickly in order to get a quick return. Because of this soil or land is mined instead of cultivation.
Because there is no peasant commitment to the land, the farmer mixes occupations for example as a school teacher, trader or an artisan so that full productivity of land is never reached because it is not given or worked on full time basis.
Emphasis on leisure by most African farmers which inhibits the growth of their incomes. Each farmer divides his time between farming or engaging in social activities for example initiation ceremonies, councilling, etc.

This may be due to the fact that women are responsible for growing food crops which don't need to be marketed hence men devote most of their time in public affairs.

Development of local markets for each cash crop is discouraged and restricted to small urban centres where residents are encouraged to grow their own food stuffs.
Specialisation is prevented or hindered (both in cash crop and food stuff production) hence overall production is held down. Women tend to farm as widows or whose husbands are staying for long periods in town and that means work is not fully done for maximum returns.
Lack of capital.
Lack of adequate knowledge.
The farmer usually resists new methods of production - this reveals the importance of his attachments, so low production.
Small scattered holdings.

There is little incentive for improvement for higher yields because land may be periodically cultivated or worked under shifting cultivation.
Extended family productivity discourages production for the market because harvests are widely distributed among family members leaving nothing to be marketed hence subsistence continues.
Rural indebtedness

Stages in transition:

Stage 1
This involves a move from subsistence to diversify or mixed farming. The staple crop no longer dominates the output due to cash crops like vegetables, tea and coffee growth together with single animal husbandry.
There may be no period of total unemployment. New crops are to be grown in dry season to take advantage of idle land and family labor.
In areas of shortage of labor at peak season labor serving devices can be used.
Use of better seeds, fertilizer and simple irrigation.
Growing of cash crops to sell and raise family standards or to invest.
Diversified farming can minimize impact of staple crop failure and provides security of income that was previously unavailable.
Success of transition depends on some factors e.g. Farmer's ability in raising. production, social and commercial institutional conditions under which the farmer works whether or not secures reasonable and reliable access to credit for fertilizers, crop information ,marketing facilities etc and whether or not he feels secure that his family and himself will benefit from the improvements that are made.

Stage 2 - From diversified to specialization (modern commercial)

This is the final stage in a mixed market economy and the more advanced stage in farming. It is accompanied by general raising of standards of living and technical progress as well as extension of national and international markets.

The basic objectives being pure commercial profits and maximum production per unit area, maximum production may result from irrigation, use of fertilizers, pesticides and use of hybrid seeds. Production is purely for the market.
At this stage the concepts as variable cost saving, investment rates of return, maximum production and market prices become important.

Emphasis in resource utilization is no longer on water ,land and labour as in subsistence and mixed farming, instead capital, research plays a characteristic, sophisticated labor serving harvesters to air-borne spraying techniques, allow the working on a large field-.

Emphasis on cultivation of one particular crop e.g fruits, vegetables, corn hence specialization of labor techniques of production. There is reliance on economies of scale to maximize profit and to reduce unit costs.

The distinguishing characteristics of these farming stages.

Characteristics	Subsistence	Mixed	Specialization
1 Composition of out put.	Staple food and auxiliary crops	Diversified	Dominant cash crop and auxiliary crop
2 Purpose of production	Domestic supply	Domestic market	Market only
3 Income	Low	medium	High
4 Income security	Lo w	High	Medium prices fluctuate
5 Rotation of income	High	Approximately 1\2	Low
6 Farmers profession and know how	none	Very diversified	Specialized
7 Dependence on a supporting system	none	Partial dependent	Full dependence.

22.7 Farming systems in Tropical Areas

Small scale mixed commercial crop and ranching
Dairying.
Collective farming.
Irrigation system

Farming system: Case studies:
Cocoa in Ghana:
Cocoa cultivation; unlike tea or coffee, thrives in a tropical low land environment. Plant is propagated from seeds and grows best in forest conditions.

It is thus an ideal crop for small holds but is grown on Estates in some parts of Africa and Latin America. Primitive means are often used by small holders and trees are planted close to each other -3 meters apart and there is no pruning.

Occasional weeding and manuring do help to improve the quality of the bean and lengthen the life span of the tree. However 2 crops are harvested in a year

Processing

Cocoa pod is split open with a sharp knife and beans are scooped by hands. Then they are allowed to ferment for a week to remove the unpleasant bitter taste of the fresh beans and stop seeds from germinating.

Sweating process liquifies the unwanted soft pulp which drains off. The fermented beans are washed and cleaned and then dried in the sun. After drying they are packed and exported as there are no chocolate making factories in cocoa producing countries. On arrival they are cleaned and roasted to produce cocoa rubs. Then they are ground by expensive mills into powder.

In Ghana, cocoa production rose rapidly from less than 45 080 km to 420 000kg in 1967 but had dropped back to 310 000kg in 1977 due to the predominance of the old trees, lack of disease control, bad farming management and lack of government incentives to improve production.

Fixed prices are low and the drive towards food sufficiency makes maize a more valuable crops Cocoa is the country's greatest foreign currency earner, accounting for over 60% of exports and is cultivated on 1,2 million ha (3million acres)of land . Cultivation began in coastal districts but now cocoa is grown as much as 720 km inland, sent by rail or road to the exporting ports.

The greatest concentration is in the Cocoa Triangle is formed by towns of Accra, Kumasi and Takoradi. Before the reconstruction of the harbor at Takoradi, ships had to anchor about 2km or more and be loaded by surf boats, but the deep water encouraged at Takoradi has eased the shipment of cocoa as well as other exports. Cocoa is shipped to all ports of the world.

The chief importing cities include:-
London, New York e t c. Some processing of cocoa is also at Tokoradi

<u>Commodity prices</u>
Prices for most of the commodities like tea, cocoa, rubber, minerals, bananas, and sugar are the most unstable of the leading commodities. The effect of such price fluctuations on the economies of the producer countries are very severe.

Ghana, for example, is the world's leading cocoa producer and cocoa makes up over 1-2%per year the export earnings from the crops. As a result of the uncertainty over financial resources, and the government is unable to carry out plans for the crops diversification or rationalization of the cocoa industry and has been hampered in its long term plans for industrialization and economic development.

Geographic requirements of cocoa.
1.<u>Climate:</u>
Equatorial environment with high temperatures and heavy well distributed rainfall is best of 2030 -35555mm is ideal but cocoa will grow in areas with 1220 of rainfall and on a short dry season.

It is sensitive to prolonged droughts and will not grow well in regions with low relative humidity

Shade:
Direct sunlight –though not too much heat

Effect of strong winds:
These may blow off unripe pods.

Low- land Location:

- Will not grow where mean annual temperatures are less than 23^{o}C. An increase in altitude lowers average temperatures and it is therefore on the plains on the lower foothills of West Africa and Tropical Africa.

Soil:
Loamy soils rich in iron and potassium are ideal but light clays are suitable

22.8 PLANTATION AGRICULTURE

This is the specialized commercial cultivation of cash crops on plantations or estates. It is a very distinctive type of tropical agriculture found in Asia, Africa, tropical and sub –tropical Africa.

The rise of European industries increased demand for tea, cocoa and sugar. Fibred, vegetable oils and rudder became essential. Population agriculture is one of the different ways in which advanced countries of the world have influenced the agriculture of developing countries.

Characteristic features:
Estate farming-plantation crops are usually raised on large estates of more than 40ha each. Success of such crops has often encouraged other farmers to grow them so that small holdings exist side by side with large estates.

i)In some parts of West Africa small holding are more important than estates. Small holding in Malaysia now exceeds that of estates. Seeds are first grown in nursery seedbeds and then transplanted in rows, well spaced regularly weeded on estates.

Foreign ownership and local labour-most of the largest estates are owned by Europeans. Most Malaysian rubber estates were originally in the lands of British companies with head offices in London, managed and supervised by Englishmen.

ii)Locally, Britain established large tea gardens in India. The French have established coffee plantations in West Africa. The Dutch once monopolized the sugar-cane plantations in Indonesia. Farming in plantations is scientifically managed. Work in estates is executed, with specialized skill and wherever possible, the application of machinery and fertilizers aims at high yields, high quality production and large output most of which is exported. The final product has to be carefully processed and standardized to meet world demand and speculation. Competition in such primary products is very keen. Estates are better able to reach required standards than individual small holdings.

It is estimated that yield of rubber from estates is twice that of small holdings.

Heavy capital outlay-: to initiate and to maintain a tropical plantation, large sums of money are required as many plantations are located in previously underdeveloped or sparsely populated areas, far from urban centre. A minimum network of communication by road and rail has first to be developed either with or without government assistance-expensive in tropical conditions (costs high).

Oil palm demands a close network of internal estate roads or rail lines to bring palm oil fruits to the nearest palm oil processing factory. Many plantation crops take several years to mature (rubber 6 years, cocoa 5, oil palm 3 years) and during the long gestation period these crops yield no income. In addition new restocking and replanting at the end of the productive life of the tree or shrubs is an expensive operation (clearing of old trees ,the preparation of land and finally planting) When technical and administration staff have to come from overseas, this creates various expenses- provision of comfortable living quarters for them and other benefits.

Problems of plantation Agriculture commercial farming in the tropics face a number of other difficulties.

Climatic hazards-crops like rubber, cocoa and palm oil need constantly high temperatures, high relative humidity and heavy rainfall but unfortunately are least sited to human activities. Heat and humidity scup human energy and reduce amount of work people can do. Local winds like the harmtan, hurricanes and typhoons can cause great damage to plantation crop. In sub-tropical areas excessive rainfall or an extended drought can reduce output or damage trees.

Coffee production:

iii)Presence of disease and insect pests:

The tropics with their hot humid conditions encourage growth of insects and bacteria and also spread of disease. Plantations can suffer from uncontrollable outbreaks of plant diseases e g coffee blight.

Labor force is prone to virus diseases such as fevers and this will reduce productivity.

iv)Difficulties of clearing and maintenance:

The hot, wet tropical climates encourage the growth of wide variety of vegetation. A dense vegetation cover is difficult to clear to make way for plantations and sound communication network. It is even more expensive to prevent forest shrubs and trees encroaching on such clearings. Large sums of money are needed annually for repair of estate roads and rail.

v) Rapid deterioration of tropical soils:

Heavy rainfall-down movement of soil nutrients-leaching proceeds rapid and magnesium, potassium and calcium are removed. The red lateritic soils are thus rather infertile. Large qualities of manure of fertilizers have to be used to maintain soil fertility. The first harvests from newly cleared virgin lands in tropics are abundant in humus. Subsequent harvests deteriorate because of leaching when forests are removed. In some cases, careless exploitation of tropical soil leads to soil erosion due to heavy rainfall. In a number of estates weeding between rubber trees is no longer done to avoid soil erosion.

Small holders; Grow crops for export and subsidies to food production. No large labor force - do not attain high standards of farming in large plantation-usually poor quality products

Slow to adopt new methods of farming where the crop is to be processed soon after picking or where there should be large amounts of produce there may be problems.
Problems can be overcome by grouping farming or co-operatives. Some small holders are subsistence farmers who produce the cash crop incidentally.

Areas specializing in plantation Agriculture in the tropics

1. Asia	Area	Crop
	Sri Lanka	Tea, rubber, coconuts.
	Malaysia	Rubber, coconuts, tea.
	Indonesia	Palm oil coffee, rubber, tobacco, tea.
2. Africa	East Africa	Sisal, sugar cane, tea, coffee, coconuts
	Zimbabwe	Tea, sugar cane tobacco, citrus fruits
	Malawi	tea
	West Africa	Rubber in Liberia oil palm, sugar cane in Guinea.

Advantages of plantation agriculture:
Methods of production are more scientific and efficient.
Plantation is run by a large company with large financial reserves. So processing machinery and control are vast and these are efficiently run on the market.
There is intensive use of fertilizers, herbicides and pesticides a strict control of plant growth, breeding of improved varieties and use of special fertilizers are easier because of operation of large company.
Labourers are transported for great distances in various aspects of plantation work, conditions and acquire special skills.
Plantation has the advantage in production of crops like palm oil, sisal and sugar cane. These need a great deal of processing before they are sold since they have large scale operations they use modern factory methods in processing yields.

Better quality which brings a high price. Harvesting of the produce is carried out quickly cheaply and efficiently with economic transport to processing centre.
Specialization of labour.
Regular supplies of produce are guaranteed by the plantation system. This often justifies the creation of processing factories on the spot rather than exporting the bulky raw materials over long distances.
There is no wastage - waste is used as fertilizer or as fuel e g in sugar cane.

Disadvantages of plantation Agriculture:
Concentration on production of one crop makes plantation vulnerable to fluctuation of world market eg in 1960 production of synthetic fibres in East Africa was in a large area. A single crop is grown in a large area. This increases the risk of spread of disease e g the spread of Pananna disease in the Caribbean coastal low lands in Central America which led to abandoning of banana plantations of United Fruit Company.
Many Tropical plantations are owned by foreign companies or individual.
Most of the profits are consumed out side the country.
Often the labourers mostly young men leave their village and the cultivation of subsistence crops to the women and old folk, although some plantations provide housing for families.

22.9 Pastoral Nomadic agricultural system

This is the simplest form subsistence farming. It arises mainly from climate. When cultivation of fodder crops is made impossible by the dry seasons, nomadic make sensible use of land which would not be used by arable farmers.

Areas where it is practiced
Northern, Nigeria-(West Africa) - Fulani (Western Sudan)

Kenya, Tanzania (East Africa - Masai).
In these areas the nomads rely on subsistence farming based on herds. Milk from cattle, sheep and goats provides food. Meat is rarely eaten. Animals are killed on ceremonial occasions.

Hides and skins are also used. Livestock are rarely sold. They are the nomads' capital. Many cattle are also kept regardless of conditions of quality or growing areas. Cattle are also kept for prestige - so they have a social value.

Large herds are kept in case some die-so others have to survive. There is no pasture improvement. Nomads rely on natural vegetation for livestock's fodder. Nomads have been in decline in numbers for the following reasons:-

Their lands are being taken over by commercial ranching.
Arrival of automobile and the aeroplane
They are becoming sedentary (settled) and growing crops as well as keeping animals.
Modernization of the world

Those who remain nomads are restrained in their movements by the availability of water supplies and pastures. Southern North Africa nomads follow the swing of precipitation north and south.

22.10 Commercial Ranching

This is not an indigenous system to Zimbabwe or Africa etc. It was imported from Europe and then modified to suit tropical conditions. Livestock rearing is carried out in the following tropical areas:- South America, Australia, Tanzania, Kenya, Zambia, Zimbabwe, parts of central America, Botswana and West Indies.

Ranching in tropical areas is mainly concerned with beef production although in some parts of Africa there are cattle ranches for dairying. Ranching involves use of natural pastures and supplementary feeding (in the form of manufactured stock feeds). It is practiced where there is little rainfall and where rainfall distribution is seasonal and very variable e.g for Matabeleland in Zimbabwe.

The carrying capacity of the area for dairying is usually low-hence an efficient ranch is very large. Ranching is best use of the poor vegetation and soil in low population densities of ranching areas and low labour input per hectare. There are low capital inputs though the initial outlay is high

Returns per hectare are low and vulnerable to climatic and price fluctuations. Both cattle and sheep now rely on hired labor season after season.

<u>Problems:</u>
Fear of stock loses in drought so that the larger the herd the greater the chance of survival.

22.11 Overstocking and over grazing:

- Dependence on one product and the resultant vulnerability in times of poor prices. Ranching is highly specialized with one product-beef or wool.

Seasonal shortages of pasture-During the season, cattle lose weight and may die in a bad year. Natural pastures are usually poor in quantity

- Poor communications-because a rancher depends on marketing his cattle or other products. Some ranches are geographically remote hence cattle have to be transported long distances to the market

Production is for export markets- there must be adequate facilities e g –deep freezers for the meat.

<u>Case study:</u>
North parts of Western Australia, Northern territory and Queensland. The areas are Savanna land. Rainfall is highly seasonal. Grass grows rapidly during wet season.

In the dry season there is shortage of pastures and drinking water.
<u>Problems:</u>

- Shortage of water and pastures in dry season.
- In each dry season most cattle stations lose 10% of their stock.

Disease and insect pests.
Cattle ranching areas are poorly served by roads and railways - so cattle are driven long distances on the hoof to the nearest rail or road
Cattle lose weight during the long drives that take some weeks due to shortage of water.
This part of Australia is sparsely populated hence it is often difficult to have sufficient labor.

Mixed Farming in North Western Europe and North America (Commercial Agriculture) Features:

Highly commercialized it has become both a way of life and business. The farmer raises crops and livestock primarily for sale.
Increase of tractors and other forms of agricultural machinery are major production cost of the farmer.

Artificial fertilizers are purchased in large quantities.
Application of fertilizers per hectare of available land is high North Western Europe than anywhere else except Japan. The farmer is involved with manufacturing industry in the purchase of inputs. He also sells the produces as raw materials rather than as a finished product.

Sugar cane is grown under contract to sugar refineries. Potatoes are sold to distillers. Vegetables are grown under contract to freezing plants. Agricultural labour is declining just as rural population due to widening gap between farmer and urban incomes and growth of industrial employment.

Farms in mixed farming areas in NW Europe and N. USA are owned by families and operated by family labour force. Size of fields vary. The Corn Belt is up to 100 ha. I n Europe sizes are smaller -10-15ha in Germany especially the Western part. Some farms are small to benefit from economies of scale and to provide acceptable standards of living Fragmentation presents some problems but in England and Denmark there are consolidated plots. Farms produce both crops and livestock and the enterprises are irrigated.

Land use Patterns:
Cultivated area is normally under grass. Grass may be permanent –some grasses are sown for 2 to 3 years and then crops again.

In cooler maritime areas-grows is 3/4 of the area. In better farmed areas grass is treated with care.
Cereals occupy much of the tilled land-leading grain varies with climate and soil. In the Corn Belt of North USA the main cereal is the Soya beans. In Europe wheat is the main cereal in dry regions and on loose soils. On poor marines soils of North Germany and in shortened growing seasons of Scandinovia there is rice, barley.

Second major category of crop- roots e g turnips, marigold fodder crops, potatoes and sugar beet potatoes to feed pigs and cattle and in Germany sold to distillers.

Intensity of land use diminishes with increase in the effective distance from towns and cost of transport to the town marked increase.
The more intensive dairy farming, vegetables and fruit growing area near towns are underglass houses (green houses)
Dairy farming is also important in most areas.

Advantages of the system

A number of crops are grown. The farmer is protected against the risk of poor prices and diseases.Labor requirements are spread through out the year especially where both autumn and spring sown crops are grown. It helps to maintain soil fertility if rotation is practiced .Temporary grasses provide grazing or hay and restore nitrogen content of the soil. A variety of the resources provide income to all people, and are not likely to suffer from low prices of animals and crops.

Disadvantages:

Has a variety of environment, economic and social requirements that the limited areas of the world and limited numbers of people to fulfill.
If an operation of mixed farming should raise a variety of crops the farmer should live in an environment favorable to all these activities

Every crop in the system has requirements soil, climate of growing season which are slightly different from those of other crops.
The environment must fit all crops. This is a factor that limits the practice of this system to wide areas of the world.
Farm must be near the market for its products and the markets which must absorb all of them are limited.

Transport must be easily available and cheap.
Cultural factors a high intelligence and knowledge of wide variety of agricultural techniques are required to operate such a farm.
High diversity of knowledge and skill is required.

22.12 The Green Revolution:

Definition: It is the development of extremely high-yielding grain crops that all major increases in food production particularly in sub-tropical areas. This increase in agricultural productivity –has occurred since the 1960s. It was essentially result of the introduction of high yielding varieties of wheat and rice. The increase in agricultural productivity was due to research and plant breeding which resulted in production of higher yields and in some cases doubling the yield and enabling double cropping.

Use of fertilizers was also made efficient. The overall aim of this increase in agricultural productivity was meant to benefit the third world countries. It depends on new seeds, fertilizers, pesticides, herbicides produced and controlled by multi- national corporations.

How it was carried out and its progress
Scientists in Mexico began to develop rust resistant

Dwarf wheat in 1953. This doubled Mexico's per acre production. The decade that followed, after a major drought in India in 1965, Mexican dwarf wheat was widely planted in the northern part of India. The results were dramatic in terms of wheat yield especially in areas such as Punjab.

Rice development followed a similar course though more slowly than wheat. The Los Banes Research Institute in Philippines was set up in 1962 backed by Ford and Rockeffer Foundation to develop varieties of improved rise (1R).

In 1965 the GR flourished. Its harvest from 60 trial tonnes of seed produced an astonishing six fold increase of rice under field conditions. From these successful beginnings of varieties of 1R with better resistance to disease, better taste and better appearance after cooking, were developed.

The varieties produced good results where ever they were planted in humid tropics. About 10% of India's paddy land (rice field) is at the moment planted with 1 R varieties. The Philippians that were once a major rice importer is now self -sufficient in rice production.

Problems of the Green Revolution:
The green Revolution has been a blessing in that new seed was introduced.
Gives 2 or 4 times the yield of indigenous grains.
Has a shortened growing season.
Has a wider tolerance of climate variations

22.13 NEGATIVE EFFECTS OF THE GREEN REVOLUTION

The yield is dependent on high application of fertilizer and insecticides plus in the case of rice, copious irrigation. It therefore means that innovation has been most rapid in the most prosperous areas and among the most prosperous farmers. It follows that the inter regional and social gaps have widened.
There is an urgent need for more widespread adoption of the new varieties in poor sectors of the community but the fertilizer and water they need are still beyond the financial reach of many of the agricultural peasant of South East Asia.
Traditional marketing patterns have been upset. Countries like Thailand and Burma and major exporters of rice have found their traditional markets disappearing. Japan which normally used to be a great importer of rice has now bulging elevators and now looks for export areas.

- Lack of many genetic engineers in some countries eg Thailand.
- Competition from Western agricultural products in the international market. For example, Thailand scientists fear that if Western genetic engineering produces diseases resistant crops that are superior in quality and yield the competition will be unbeatable.

Depends on large scale one crop farming which is ecologically unstable due to its susceptibility pestilence: fatal epidemic disease.

Depends on controlled water supplies that have been instrumental in increasing the independence of human disease like malaria and shistomiasis
It is restricted to wheat, rice and corn which are low grade protein foods.

Higher return on capital investment in such input is realized by mechanizing farm operations by buying more land. This results in labour displacement and agricultural unemployment, increased landlessness, rural-urban migration and increased malnutrition for those that are unemployed who are not able to buy food that is produced by the Green Revolution.

In Pakistan, hybrid maize, produced by the GR is processed into sweetener for soft drinks for the urban middle and upper income groups.
The GR does not increase the ability of the poor to buy food- it reduces it
The GR has helped to create a landscape of longer and longer commercial farms along side fewer and smaller peasant.

Attempts to improve agriculture in the Less Economically Developed countries

The most important solution to the problem of hunger is to raise agricultural output and productivity within the developing countries. This will stimulate in turn general economic growth and bring those areas nearer to the level of living now enjoyed in developed countries. Agricultural output may be increased in two ways

i) By increasing the land under production
ii) By intensifying agriculture (specialization)

Increasing the areas under agriculture
It seems that the possibilities expand the world agricultural land are fairly low and any increase will be at the expense of growing land. In the developing countries the best farming lands are already utilized with the exception of South Africa and South East Asia.

It is estimated that further expansion of arable land will bring into cultivation land giving lower production than that of already cultivated.

Possibilities of intensifying agricultural production:

At the present moment a small proportion of land is intensely cultivated so that hectares of land are failing to yield maximum full potential. Ways to increase:

22.14 Control of soil Erosion:

The main methods of overcoming erosion are out lined below
To control surface runoff, Plant trees that can act as wind breakers.
To maintain soil fertility by adding manure and vegetable compost.

To enrich the soil naturally by way of crop rotation with legumes such as clover, beans playing an important part. These are practiced in more economically developed. countries (MEDCs) or developed countries and can help less economically developed countries (LEDCs) or developing countries if this is practiced.

22.15 Plant and animal husbandry:

By means of hybridization –new species of plants with greatly improved yields have been involved. Using hybrid U S A has doubled food production in the last 30 years.

The Food and Agricultural Organization of the UN is trying to spread the use of planting hybrid seeds in developing countries. In Japan, 70% of rice is sown with hybrid seeds but it is an exception. The breeding of high quality animals has mainly developed in developed countries. In Africa the quality animals has mainly developed in developed countries. In Africa the governments are trying to increase meat protein in their diets. Selective breeding has been shown to treble milk yield and double meat production.

3. <u>Use of fertilizers</u>:

In the 19th century the fertility of the soil was maintained by farm yard manure and leguminous growing. This century has seen the introduction of fertilizers which increase fertility rather than maintaining it. Increase in crop yields in the last 30 years has contributed to fertilizer use. The developed world use 79% of the chemicals in field as fertilizers. The developing countries would benefit from using fertilizer but they are too expensive to buy. They lack the advantage of promoting home industries. As a result any chemical fertilizers used are mainly on export crops rather than local supply crops.

4.**<u>Use of pesticides</u>:**

The problem of pests and diseases tends to increase as farming becomes intensive and specialized. Farms in North America and Russia use chemical pesticides, and it has been calculated that if these pesticides are used, the increase in yields will be half times more in developing countries.

Most of these chemicals are sprayed from air craft. These insecticides are mainly neurotics eg DDT which paralyses and kills an insect by attacking its central nervous system. These insecticides efficiently kill insects eg mosquitoes, tsetse etc.

DDT, though banned in some countries, has played a vital role in the destruction of plagues of locusts in parts of South West Asia and North Africa. FAO, estimates that the application of modern anti- locust methods would increase total output of crops by over 15%.

The disease control in animals is also important. In Tropical areas, cattle are very prone to nagana or trypanomiasis caused by tsetse lies

Other animal infections include tick-borne, foot and mouth, anthrax etc. Animals in certain countries are frequently sprayed and injected. Because of disease cattle are reduced in large numbers. Some countries which have tried to eliminate disease and improve their pastures are North coast USA, Jamaica, Brazil, Botswana, Malawi, Zimbabwe e t c.

5. **Mechanization**:
The use of machinery plays an important role because farm operations can be carried on much quicker. In China the use of rice plant machinery makes the growing of the two rice crops much easier and this increases yields. The need to increase tools and machinery is universal throughout the developing countries which have the main tool as a plough.

In India between 1960 and 1967 certain areas were chosen and machinery was introduced along with hybrid seeds, fertilizers, farm planning advice and education. Yield increased from 76 000 to 528 000 tonnes. Even simple forms of machinery into developing countries will have an impact on agricultural production.

22.16 Land Tenure and Management:

In many developing countries, agricultural holdings are too small to introduce machinery let alone to increase productivity. Many farmers do not own farms to cultivation so they have no incentive to increase productivity. In monsoon Asia and Latin America, a system of tenancy/ Latifundia land tenure is widespread.

The land owner provides the land, building equipment and seed while the worker provides the labor in return for a fixed share of the produce. Laborers have only an indirect control over their earnings so the great problem involved is lack of security.

A tenant will not spend on improvement if he is in constant fear of eviction. Another type of tenancy is called share Cropping. In this case, there is no fixed rent and the tenant cultivates the land and gives shares of sometimes 50% of the agricultural produce. This system gives the tenant more security because no cash is involved and he is protected against harvest fluctuations.

In developed countries, farms are much larger in size mainly due to land consolidation. In Western Europe many farms were small because of the origin from communal open systems which were divided into strip or have been split into small units by inheritance. Land consolidation has resulted in farm holdings being large enough to be managed efficiently to give possibilities of intensive production.

Until attempts to consolidate land in developing countries are made, there seems to be no future in increasing agricultural productivity because farm units are just too small to be economically viable. Irrigation methods also increase productivity.

22.17 Examination Type Questions

1. (a) Define the term ‘intensive farming’ and give one example of such type of farming. **[5]**

b) Describe and explain how intensive farming in LEDC varies from that in MEDCS. **[8]**

2) With reference to examples of intensive farming you have studied:

i) Describe the environmental problems resulting from the farming methods used (15)

ii) Discuss the measures taken to solve or reduce these problems. (10)

3. Low agricultural productivity per hectare remains characteristic of some areas within developing countries**.**

(a) Outline the physical factors that can contribute to low agricultural productivity.**[7]**(b) With detailed reference from **ONE** country you have studied, describe attempts to raise food output by making agricultural production more intensive. **[8]**

(c) Assess the consequences of the attempts described in (b) for the rural environments and communities involved. **[10]**

CHAPTER 23

AGRICULTURAL

LAND USE THEORIES

23.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Outline the main assumption of Vonthunian Isolated State theory.
b) Discuss the principles of the theory.
c) Demonstrate a working knowledge of the agricultural landscape model.
d) Critically examine the applicability of the theory in the present day.

23.2 Introduction of elementary Agricultural Location Theory by Von Thunen

Von Thunen wanted to put forward a method of analysis that would be applied to any given situation in method and space. He stated that his findings were not and are still not universal. What he claimed to be important was the method that he used to obtain those results and that is why his theory is regarded as a method of analysis which can be applied to different situations -although not all the time.

His aim was to find the factors/or laws that govern prices of agricultural products at the market and the laws by which variations in prices of these products can be translated into patterns of land use.
Von Thunen owned a farm near Rostock-Germany. He came up with evidence in his work.

His ideas:
The distribution of crops which of course determines land use depends on the competition between farm crops and the system for the use of a given land i.e. in a given piece of land, there will be competition among crops for which crop is going to where.

On a given plot of land the crop that gives high returns, income is given first preference. It will occupy the land. Less competing crops will be relegated or reserved to less fertile land. Von Thunen was concerned with returns or profits per unit area after expenses have been deducted.

Profit = revenue – expenses – i.e. how much does a farmer get per ha.

Idea of Economic Rent:
Suppose there is a town which needs wheat. The wheat can be obtained by cultivating the best quality land near the town.

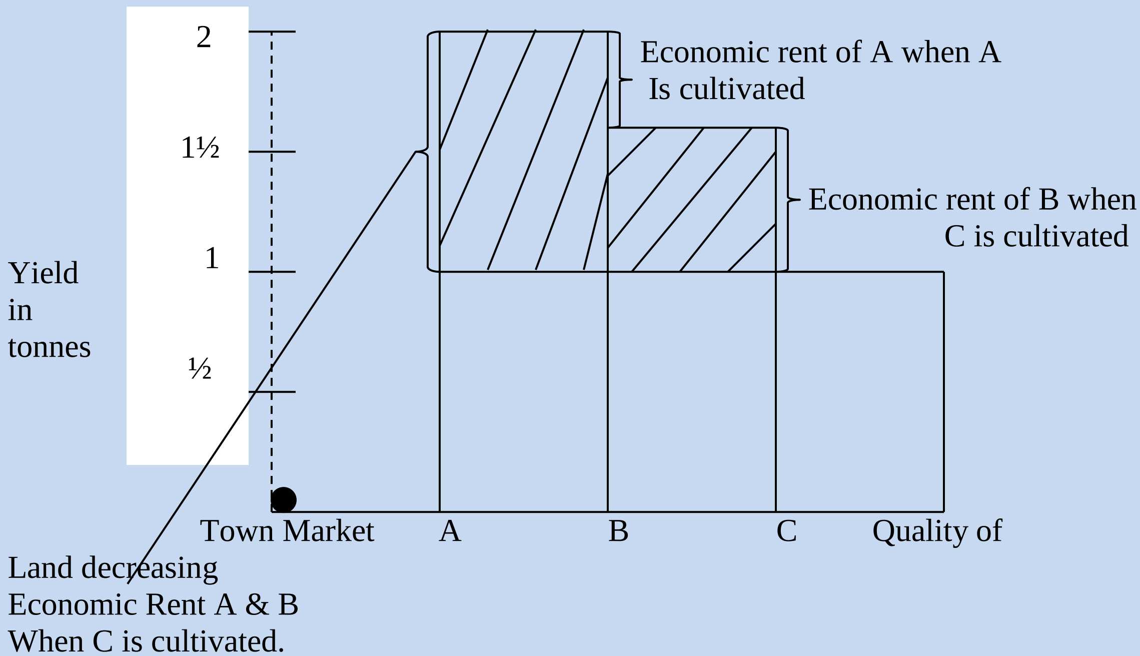
The best quality land is farm A. The yield is two tones per hectare per year on this land. As the town's population increases more wheat will be needed but all the best quality land is used up. If this happens, they will then resort to low quality land - farm B.

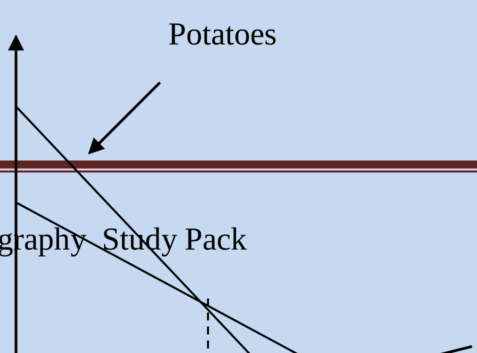
Suppose the yield in the farm B is one and a half tones per hectare per year. The cost of production for both farms may be the same in terms of seeds, labour, although yields differ. That means farm A will produce half a ton in a hectare of better soil and none on the poor soil.

Economic rent is therefore the surplus that can be obtained from using better soils above the return that would be obtained by applying the same resources – production costs to the poor land i.e. the land at the margin of economic cultivation.

If population grows, the land in B will be used and that means the next poorer soil will be used - i.e. Farm C. The yields are one ton per hectare per year. If the same inputs are applied on all three farms, A will have 1 tonne above C. It will therefore have an economic rent of half a ton provided C is cultivated.

It is this economic rent which shows the competition for land use and it also provides the means whereby this competition is resolved to provide patterns of land use.





Wheat

Distance from the

O Potatoes A Wheat B market

Market

Potatoes are grown between O & A and wheat between A and B. If the same sequence of crops is found in all directions about the market, the in–belt of potato cultivation and out belt of wheat are produced.

Potatoes are more bulky per hectare than wheat - so the transport cost/ha will be more than that of wheat. Where a product is highly perishable, gain is achieved if the production is reduced (constant transport cost).

Perishable goods yield an economic rent that decreases as distance from the market increases, so they tend to be near the markets. Products that need inputs of manure etc are found near the market and the most extensive further away.

<u>Exceptions -</u>
When production is large/ha even for small inputs of low value, that product may be very close to the market. The low value will be overweighed by large production. Large quantities of inputs yield a small bulk of valuable products. It can be away from the market, for example, butter.

23.3 The Isolated State theory:

In light of the above argument Von Thunen conceived the idea of a state which has:

i) No trade connections with other areas.
ii) Which is surrounded by cultivated land?
iii) Uniformly fertile soil.
iv) A single city at the centre acting as a market and which provide the agricultural area with supplies (seeds, fertilizer).
v) All other inhabitants being rural.
vi) No lines of improved communication.
vii) Farmers who acted rationally to maximize profits (economic men).
ix) All goods transported by horse – drawn carts.
x) With uniform cost (increase with distance).

Then he calculated the economic rent for each type of land use at various distances from the market. He came out with concentric circles forming land use patterns.

1. Horticulture and Dairying
2. Sylviculture (forestry)
3. Intensive Arable Rotation
4. Arable land with long fallow (7 years rotation: 3 years, dairying – 3 years; arable; 1 year fallow).
5. Three fold arable (1 fallow, 1 arable, 1 pasture)
6. Ranching

NB: (2) Forestry: Wood was the major source of fuel i.e. he introduced variables that distorted this pattern.

a)A navigable river (passing through the market).
b)Presence of a small town with its own productions.

<u>Other variables which can distort the pattern:</u>

a)	Soil fertility	b) relief	c) climate
d)	Government taxes	e) Government subsidies (supplies)	

23.4 Economic Rent Equation:

R (1 – M) = Y (a – n) (P (a – n) → -d (1 – n) t] – C

R - Economic rent in relation to distance 1 tonne
Y- Yields/ha of crop (a-n)
P- Market price of crop (a – n)
d- Distance to market (km)
t- Transport Cost
c- Cost of inputs

<u>Comments on the Theory</u>:

1. Von Thunen's theory was more relevant to the period in which he wrote it than it is today.
2. The assumption of a single city without any contact with other urban areas does not exist now.
3. At present there are always a number of urban centres interacting with one another and this complicates zones of production.
4. Other factors which affect Von Thunen's concentric rings are new technological changes such as refrigerators.
5. Improvements in transportation have increased the radius of the land's production zone. However, the concentric zones may still be recognized on a continental scale in some areas.
6. Forestry in the second zone and other types of production away – the fact is that by Von Thunen's time timber was a major source of fuel and a necessity for building and it had

high transport costs. By that time timber produced a high economic rent. Therefore when he wrote, the theory was logical. Since then technical changes have been introduced and forestry does not need to be near the market.

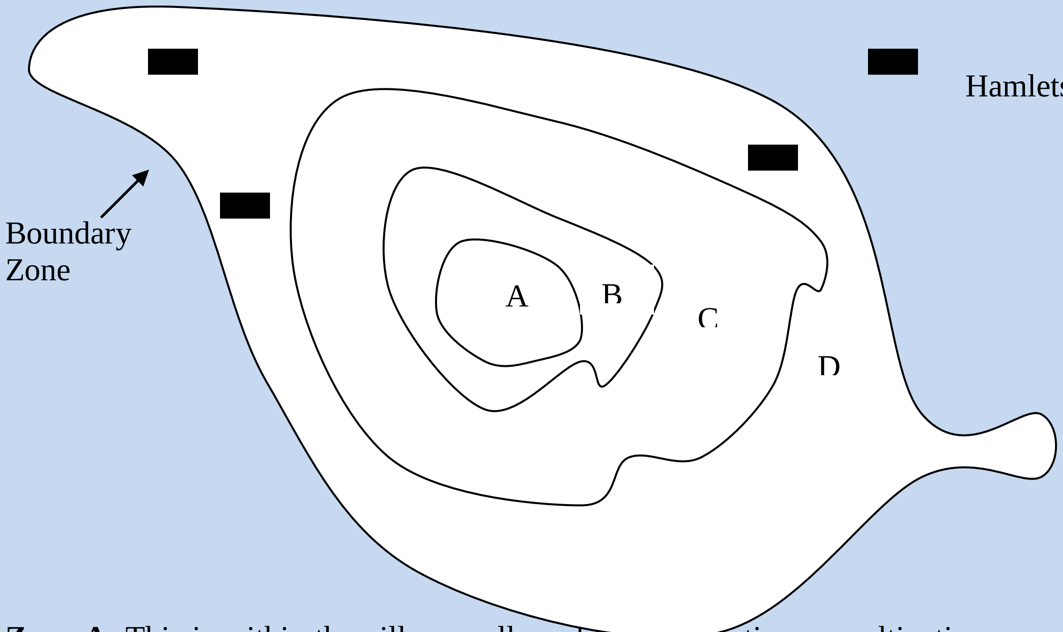
7. Soil is not uniform or constant in fertility. Production costs vary and it can be noted that variability of soil fertility has a long effect on the location of products and even on annual production.
8. He relaxed the assumption that transport cost was proportional to distance by introducing a navigable river which reduces transport costs.
9. He also considered the effects of mountain barriers and transport costs of moving goods so that distance was also economic.
10. He abandoned the fact that there is a single city by introducing a subsidiary city with its own production zones.

Other factors as to the modification of his theory, are trade restrictions, government subsidies and taxes. All these affect the prices of products and have an effect on location of production zones.

23.5 Application of Von Thunen's Theory

Case Study:

Land use around Soba in Northern Nigeria (In Africa)



Zone A: This is within the village walls and there is continuous cultivation associated with heavy manuring. Crops grown are tobacco, Guinea corn, sugar cane and pepper.

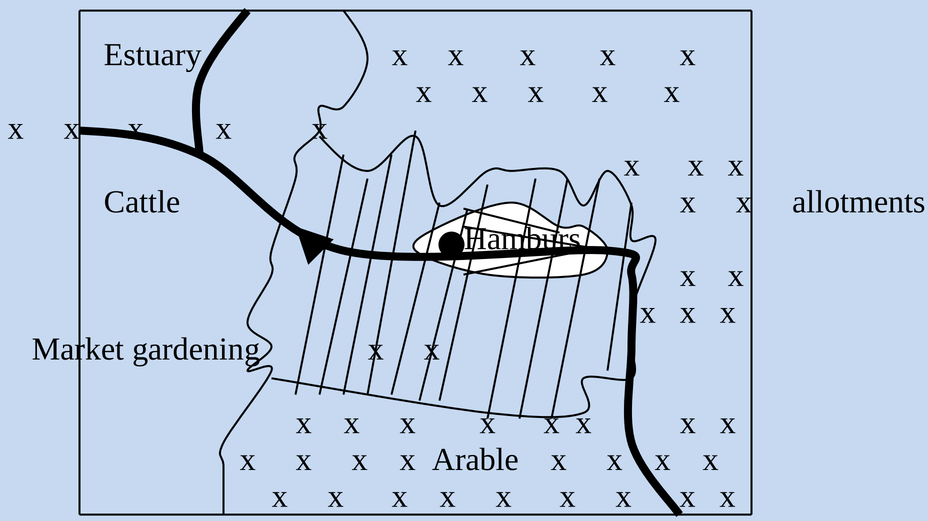
Zone B: It is the most cultivated and is about 1km wide and is intensely manured. Crops are Guinea corn, tobacco and groundnuts.

Zone C: It is half a kilometer wide and there is a rotation system with 3 – 4 years of cultivation and then 5 years fallow.

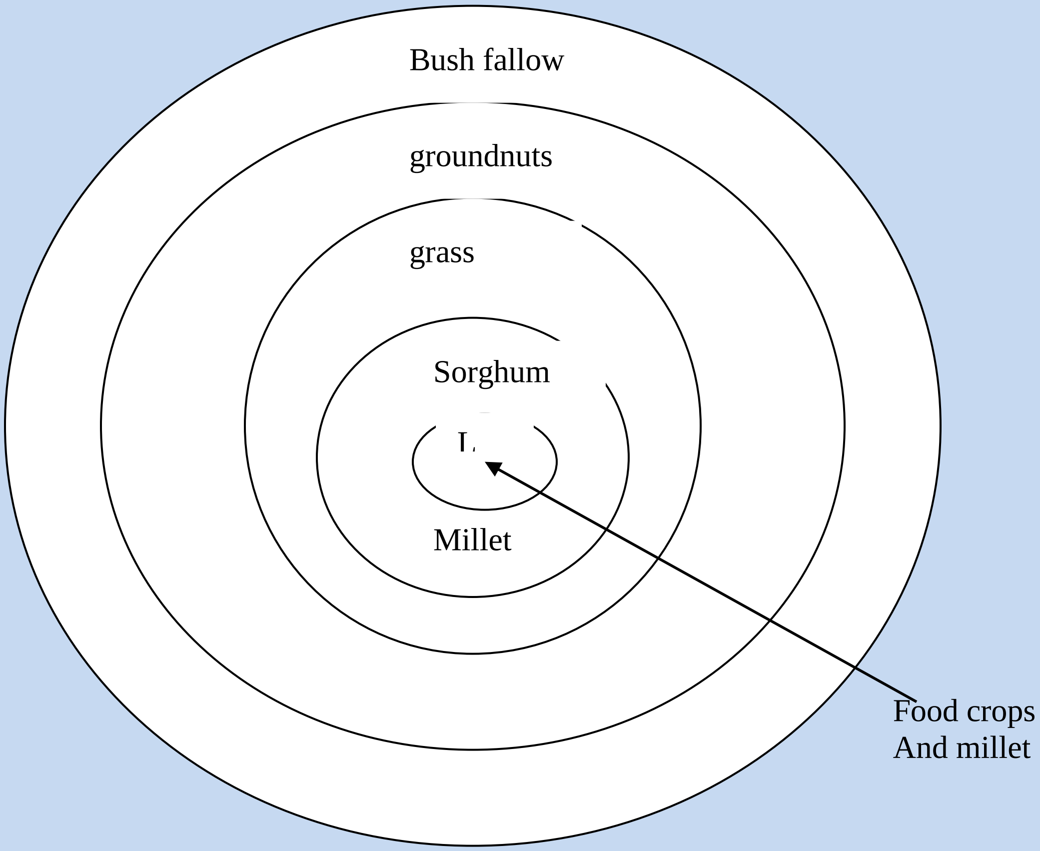
Zone D: It is remotest and bush dominated here. There is some concentration of small concentrated cultivated zone around the villages.

2.Land use around Hamburs in Northern Germany – there are some ring patterns formed determined by transport costs to the market. Rings may result from the different degree of attention that different crops need.

<u>Allotments</u>: Small owned piece of land in towns for personal use (rented).



. Land use around the town of Medina near Doukik in Gambia.



<u>Land use in South Africa (Around Durban)</u>

<u>Concentric Zones in Natal</u>

The study of land use around Durban was done by N. Hurwitz in 1957 and he closely followed Von Thunen's theory and found that concentric zones were determined by distance and transport factors.

He found that close to the market, there is a zone of bulky perishable (goods) products of low value like fruits and vegetables. The second zone contains less perishable and less bulky goods such as potatoes, wheat and milk production.

The third zone contains less perishable products of high value such as butter, poultry and eggs. In the fourth zone, there are arable and animal lands as well as some food crops. The inter zone is specifically for livestock rearing.

23.6 Examination type questions.

1, Outline the main principles of the isolated state theory (6).

2. To what extent can the isolated state theory be used to explain present day agricultural land use patterns? (12)

3. With reference to Von Thunen's ideas explain the concept of bid-rent in relation to agricultural land use.

4) The major weakness of the agricultural land use theory was the failure by its architect to foresee the influence of technological innovation .Discuss the validity of this statement in relation to agricultural land use in a region you have studied (25)

CHAPTER 24

AGRICULTURAL LAND REFORM

24.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Discuss the reasons for land reform.
b) Critically evaluate the implementation of Land reform policies in identified regions.
c) Critically assess the relative success of land reform policies in increasing agricultural productivity.

Introduction

Land reform is a systematic method of changing land use patterns within a particular area. It is largely dependant on government policies and governments all over the world have carried out land reform programmes for a number of reasons.

Reason for land reform

The following are some of the reasons of carrying out land reform
To increase agricultural productivity
To reduce population pressure on traditional agricultural areas
To redress historical land ownership imbalances
To open up new areas for agricultural production

Rural Development Policies

Most governments in the least economically developed countries have undertaken land reform programmes in order to upgrade the living standards in rural areas and to increase farming production. They also aim to resettle thousands of families and educate them in farming techniques and establish revolutions in land conservation and animal grazing, as well as to put a check on rural-urban migration.

How Development is carried out:

i) AREX advisors, advise farmers about the best agricultural production and control methods
ii) Bringing together small pockets of land under the system of co-operatives for increased production.
iii) Formation of rural growth points that may create cottage and secondary industries throughout the country
.iv)Create industries that are related directly to the most important sectors and job generating in agriculture.
v) Establishment of resettlement schemes and teaching of correct application of fertilizers.
vi) Introduction of modern grazing techniques. (paddocking).
vii) Importation of up to date machinery needed in crop production.
viii) Provision of trading facilities and advisory services to rural or communal farmers.

ix) Expansion of irrigation facilities in some rural areas both on collective and individual farms.

<u>Comments</u>

The State or government may intervene in agricultural affairs, for example, Collectivization in Russia, i.e. in order to sustain the farmers' prosperity so that they remain prosperous and productive.

Farmers are urged to produce food crops cheaply, to supply the industrial people. The government may intervene for security and self – sufficiency reasons and in some cases may aid agriculture in order to create jobs. The government may try to protect local farmers against foreign competition, for example, after World War II France protected her agriculture by intensifying modernization and re- equipping further and in southern France the government encouraged the joining of scattered units called remembrement. The process is known as land consolidation.

Resettlement in Zimbabwe since independence

The government policy was to acquire land for resettlement in order to relieve population pressure in some parts of the country, while at the same time maintaining production.

Large amounts of money from international funders have enabled the government to buy land in Commercial Farming areas that were unused so that people could be resettled.

Resettlement policies are aimed at:
i) Providing relief of population on overpopulated regions in the country.
ii) Extending and improving the productivity in the peasant farming community.
iii) Improving the standards of living in the largest and poorer communities of Zimbabwe.
iv) Helping those who suffered during the war to have land on which to earn a living.
v) To promote the landless peasants with land to earn a living.
vi) To use fully the land which might have been lying follow or unused.

Historical Background:

The Land Apportionment Act of 1969 left nearly 60% of the total population occupying less than half the land area in the country. The legislation resulted in serious problems of land pressure, rural urban migration and lowering of crop yields

See Table

AREA	Type of farming	AREA	Percentage
African	Largely Subsistence	18,2	46,6
European	Largely Commercial	18,2	46,6
NationalLand	None but used for other purposes for game parks	2,6	6,8

The Africans were mostly left to occupy marginal or unsuitable areas for cultivation. In contrast, some 5 500 commercial farmers producing cash crops mainly for export, occupied large areas of land far much better in terms of fertility, with low population densities.

The same commercial sector brought in a vast revenue, employed approximately 300 000 workers in 1979, produced large crop surpluses for export and managed the land efficiently.

<u>Implications</u>
That meant some way had to be found to integrate these two systems for the benefit of the total population but without endangering the economy of Zimbabwe.

Communal agriculture was/ or is to be made more efficient and the desire of individual farmers for sufficient land must be made while, at the same time, the commercial base of the country's agriculture must be protected.

The government had studied these problems and believed that a programme of intensive resettlement and co-operate development was the best solution.

<u>Organization of the Resettlement Programmes</u>

In the early phases of resettlement programmes, large sections of land rather than small scattered areas, were chosen by a Land Selection Committee on the basis of soils, water supply and general suitability.

The government purchased the land and then passed the responsibility to the, then Ministry of Lands and Water Development for the general organization and financing of the schemes. The Department of Rural Development prepared settlement reports, planned the layout of the schemes, cleared and ploughed land, constructed schools, clinics, and roads in selected settlements and controlled squatters.

The Agricultural and Rural Development Authority (ARDA) acted and still acts as the government's agent in establishing and operating state farms. Its activities include the following:

As a parastatal ARDA is to run many of Zimbabwe's estates producing a wide variety of crops In addition, ARDA assists in the preparation of land near its estates for communal farmers, gives advice and helps to run co-operatives.

Settlers were chosen on the basis of having no land or little land to support their families or because of poverty or unemployment. The settler farmer was to be aged between 20 and 55 years and had to give up rights to the communal area.

Once chosen, the settler was permitted to reside and farm in the new settlement.
Three types of farms (models) were designed as well as ranching schemes.

1. MODEL A

These are settlements of nucleated villages. Each family is allotted a residential plot and an arable holding of 5ha (0,5 to 2ha on irrigated land) less than two kilometers from the village.

In addition each farmer has the right to share communal grazing land, livestock numbers depending on the area quality of the grazing land. The village will house 20 to 50 families and have a borehole water supply. A settlement section will contain 15 such villages, housing 500 families with four schools, six dip tanks and a service centre.

2.MODEL B

These are situated in areas where there is already a developed infrastructure (roads, water, dip tanks etc) and will support 50 to 200 people in a co-operative. The houses, livestock and machinery are held co-operatively and a co-operative committee runs the settlement.

They produce subsistence crops until they are well established, then cash cropping is introduced.

3. MODEL C

These are a mixture of individual and co-operative holdings but farming will be specialized, for example dairying, beef cattle, pigs, or maize. An already established central estate will provide advice, loan machinery and allow the use of its processing plant for tea or coffee crops.

4. MODEL D:

This is an experimental ranching scheme (a pilot scheme at Doddieburn -Munyoli). Each family has a small irrigated garden and a one hectare of dryland arable plot near the village plus 20 livestock units (goats and cattle). There is a small area for domestic stock and the use of wider ranges for communal grazing. Co-operative irrigation schemes and game management may be introduced. Most, especially Model A Schemes, are on the edges of the zone of high population pressure stretching from Mt Darwin – Pfura, past Mashonaland East, through Manicaland into Masvingo and as far West as Matabeleland North and South. See map:

<u>Evaluation of resettlement progress 1980-1983</u>

	1980-81	1981-82	1982-83
Land (ha) bought and developed	438 000	706 000	1 657 000
Settled families	1 100	10 000	21 000
Number of Schemes	6	66	176
Roads build (km)	-	1 000	5 000
Cattle dips	-	15	146
Classrooms built	-	90	464
Clinics built	-	-	7
Boreholes		100	464
Costs	$12 000	$1 356 000	1 683 793

More than 80 per cent of the resettlement schemes are in undeveloped and generally poor Natural Regions III, IV and V and there have been many difficulties including lack of water during drought years, security problems and resistance by some local people. These are mostly marginal (unreliable) for crops.

Available data shows that quite a number of the Model A and B Schemes have been growing cash crops for some time and 6 000 ha were planted with cotton and tobacco.
Examples:

i)Batsiranayi Co-operative in Shamva -established an irrigation scheme for tobacco, cotton and vegetables, also runs a poultry farm and beef herd.
ii)Kuenda Co-operative in Mt Darwin concentrating on coffee.
iii)Tanhi Co- operative in Nyanga concentrating on fruit.
iv)Shandisayi Pfungwa Co- operative near Marondera -wheat.

In good rainy seasons, yields have been fairly high, for example, four tonnes per hectare of maize at Mufurudzi in Shamva while some schemes have produced 1,9 tonnes of cotton per hectare, higher than commercial rates.

<u>Case Study: Mufurudzi resettlement scheme:</u>
This is a good example of a well-established scheme.
Mufurudzi resettlement scheme is situated between Shamva and Mt Darwin and was established in October 1980. It covers 55 000 hectares formally occupied by 19 commercial farms. Today it supports 556 people living in 19 villages of the Model A type. In addition, there is a Model B co-operative (the Simba Youth Co-op) which has 28 members who farm 200 hectares growing cotton as well as cash crops.

The settlers were drawn from all parts of Zimbabwe (and beyond) and about $1,1 million has been used in establishing the scheme. See tables.

<u>Mufurudzi Resettlement Scheme</u>

ORIGIN	**NO. OF FAMILIES**
Local communal lands (Bushu, Madziwa, Chiweshe	220
Local landless	206
Commercial farms	54
Refugees and foreigners	48
Urban area	28
Purchase areas	10

Use of Funds

USE	**% COST**
Land	39,9
Schools	28,5
Water Supply	6,9
Staff Accommodation	7,0
Cattle Dips	2,2
Service Centre	4,9
Roads	5,0

Planning, layout and land preparation: Part of the money has been used to ensure a high degree of mechanical aid, for example ox - drawn implements such as ploughs (410).

NB: At Independence, the government of Zimbabwe was promised a grant by the former colonial power, Britain. The money was to be used on purchasing farms on a willing buyer, willing seller basis from the white commercial farmers. Very little of the promised money was released in the agreed ten year period.

After the lapse of the period, the government repossessed the land and redistributed it to the landless peasants and other people interested in farming. This was the fast- track land reform programme which came full swing in the year 2 000. Two farm Models were put in place-i.e. A_1 Model and A_2 Model.

Examination type questions

1) Under what circumstances can an area experience land reform? Your answer should make reference to specific case studies. (12)
2)Critically examine land reform policy in Zimbabwe during the period 1999-2005.(25)
3) With reference to examples discuss the advantages and disadvantages of land fragmentation and land consolidation. (12)

CHAPTER 25

MANUFACTURING INDUSTRY

25.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Examine factors affecting location of Industry.
b) Account for the changing nature of Industrial location.
c) Show working knowledge of the theories of industrial location.
d) Discuss the concept of agglomeration, economies of scale and cumulative causation.
e) Account for Industrial decline in the developed countries, and growth in the Newly Industrialized Countries.

<u>Introduction</u>

Manufacturing industry can be defined as the processing of raw materials into semi finished or finished products.The manufacturing industry is classified under secondary industry which is mainly concerned with value addition. It is important to note that industry is generally classified according to the nature of activities. Thus we can classify industry into four broad categories, that is, primary industry (which is concerned with the extraction or primary production of raw materials from the earth), Secondary industry which is concerned with processing of raw materials, tertiary industry mainly concerned with provision of services and quaternary industry concerned with information technology. In this chapter we shall make an evaluation of the main aspects of manufacturing industry taking into account latest local,regional and international scales.

<u>Factors affecting location of industry</u>

Factors that influence location of an industrial activity are inter-related. No single factor may dictate the industrial location. However, among many factors one or two may be predominant. In some cases, factors that were strong at the beginning of industrial location are at present becoming less important as location factors.

1. **<u>Raw material oriented industry</u>**

   In early periods of manufacturing, raw materials were important due to transport problems and even today. There are industries in which raw materials play an important role. Most industries are concerned with processing of raw materials. The location of industry is therefore to some extent governed by location of raw materials and the cost of obtaining them.

   The degree of attraction of industry to the raw materials depends on their nature.

   Perishable goods or raw materials attract industry, for example, fruit and vegetable canning, fish canning.
   The ability of raw materials to lose a lot of weight in processing for example processing

of sugar cane and sugar beet, pulp and paper, processing of butter and cheese.
The value of raw material-high value raw materials can bear the cost of transportation.
The industry may be far away from the location of raw materials.

Examples of raw materials oriented industries: Sugar Cane Processing.

The initial processing of sugar cane is carried out at Triangle and Chiredzi in Zimbabwe. The reason is that sugar cane is bulky. There is a great loss of weight when sugar cane is processed. Processing is carried out near the plantation to avoid the problem of transporting of waste materials.

Fish canning and refrigerating plants are located at the fishing ports of Durban and Walvis Bay. These ports are close to the fishing grounds of the Indian Ocean and West Coast of Southern Africa respectively. Fish are perishable, so their processing is carried out near areas where they are caught.

Pulp and paper mills: Pulp is obtained from cellulose from wood tissues of trees. Reduction of tissues to pulp involves loss of great weight. Chemical pulp has eight loss of 46%. The industry should therefore be raw material oriented. The cost of timber and water can be off-set by those of transporting timber. It is therefore cheaper to move pulp than wood because of lower bulk. Canada's saw mills and pulp mills are located in the Coniferous forest belt in British Columbia, Quebec and Toronto. The pulp and paper mills of Zimbabwe are located in the Eastern Highlands near Mutare where there are large plantations of pine trees.

The pulp and paper mills of Norway, Sweden and Russia have similar locations.

d) Some materials that are bulky and heavy, are concentrated and sometimes smelted in producing areas. They are exported in the form of concentrates, ingots or refined metal.

Copper smelting is done at the Copper belt in Zambia. Processing of gold in Ghana is done at the mine. Bauxite is converted to aluminum at the mine in Guinea. Oil refineries occur near oil fields usually.

e) Where secondary industries rely on other industries such industries are located near companies that make raw materials. Heavy engineering works locate close to steel suppliers. Petro- chemicals industries are found near refineries that provide raw materials for example Port Harcourt in Nigeria.

The following are reasons why raw materials are becoming much less important as a location factor.

a) Transport has developed and special handling facilities have become available. Movement of raw material has become easier. Roads and railways are no longer poor and transport means are faster and moderate. The pull of raw materials was reduced in many ways or industries. However, improvement of transport has not abolished the importance of raw materials.

It has reduced its relative importance, for example, pencil making occurred in the past due to availability of graphite and timber. Today pencils are made in many towns because only small quantities of raw materials are required and these are easily transported.

b) As industry has become more complex, fewer and fewer firms are raw material based for example in the USA about 80% of manufacturing started with semi- processed or even finished products.

c) Technology has intensified the use of materials so that there is less waste in manufacture and materials themselves are being improved at the source to enable them to be transported more cheaply.

d) As other factors like markets and labour supply have gained in importance, raw materials have declined relatively.

e) Many modern industries require a wide range of raw materials that may not be at hand. The location is therefore dependent on transport that can assemble all required raw materials. Cost of transporting the most bulky or heavy raw materials is very decisive in industrial location.
Industries in Europe, West America and Japan depend on imports from all over the world. As a result, ports make ideal industrial sites where raw materials can be assembled cheaply and goods can be re- exported after processing.

f) Where there is small amount of raw materials, light in weight or high value raw materials, transport costs are low and raw material location is not necessary.

Market Oriented Industries: -

Industries produce goods that are consumed by people. Markets are important because industries that produce goods that have high transport costs. If it costs more to transport products to the consumer than to carry the raw materials to the factory, it becomes economic to locate the industry close to the consumers. Where the products increase in weight, bulk or fragility on processing the products will find it economic to locate near the market.

The following are examples of market oriented industries

a) Production of perishable products such as food staffs, bread, cakes, cooked meat, dairy products. Market location ensures ready disposal of fresh products. Dairy Board industries obtain supplies from near at hand. For this reason large towns are surrounded by dairy farms.

b) Specialized industries – those processing textile machinery are normally found close to important personal contact between producers and consumer (Cloth factory). Automobile component industries are located near factories. Tea in Mid - West USA is near automobile making centres – baking industries that produce boxes and printed material for specific goods and fashion industries like jewellery, shoes, paper making, printing and publishing – agricultural machinery industries in market towns in rural areas.

c) Industries that add water to their products like breweries and soft drink manufacturers or those whose products increase in weight and perishability such as baking industry.

d)Production of fragile goods – that break easily and need to be near consumers. This reduces loss through damage, for example, bottled drinks, glass ware, porcelain.

Those located at market unless they can stand high transport cost and have high insurance costs.

e) Goods that are bulky and of low value – need high transport costs e.g. brick making, cheap furniture. These make better profits if located near markets.

f) Labour intensive industries – light industries for electrical goods, toy making and carpentry should be located where it is easy to recruit cheap and abundant labour.

g) Industries needing small quantities of raw materials – these can be quickly and cheaply transported for example light engineering electrical goods, plastics.

h) Manufacture of furniture is associated with large towns: - Liverpool Manchester, Paris, Lisbon, Oslo and Stockholm. During processing, furniture increases in bulk many times as much as timber from which it is made.

Some urban centres in Western Europe, West America, Japan and Africa are largest consumers of largest manufactured goods and pools of labour because of large population. These form good locations for industries (large markets) but a large population doesn't always provide a large market.

Some places of large population have low buying power. They do not afford to buy goods. This is why Third World countries have few industries although they are densely populated. Industries are based on demand plus ability to pay for goods produced. Markets are therefore not just numbers but the earning capacity of people and their willing to spend.

3. <u>Transport Costs</u>

Types of transport to carry raw materials and finished products determine the costs. Bulky and low value commodities are moved cheaply by water. Highly perishable goods are moved quickly by road, rail or air transport that are expensive in terms of industrial location. The best location is therefore one that minimize the costs of both procurement and distribution.

<u>For this reason we are to have three situations</u>

If the product is more expensive to transport than the raw material production is likely to be close to the market, for example, cement manufacture.

If the product is much lighter or less bulky than the raw materials used, the industry will usually be attracted to the source for example <u>copper smelting.</u>

If the industry uses several raw materials and serves a wide range of markets, transport costs will not control location directly, for example, British Car Manufacturing Industry that is located in the Midlands where industry draws assembly parts from a wide area and its nodal position makes for each. These situations are shown on diagrams.

Location may therefore be anywhere along the line from R. to M.

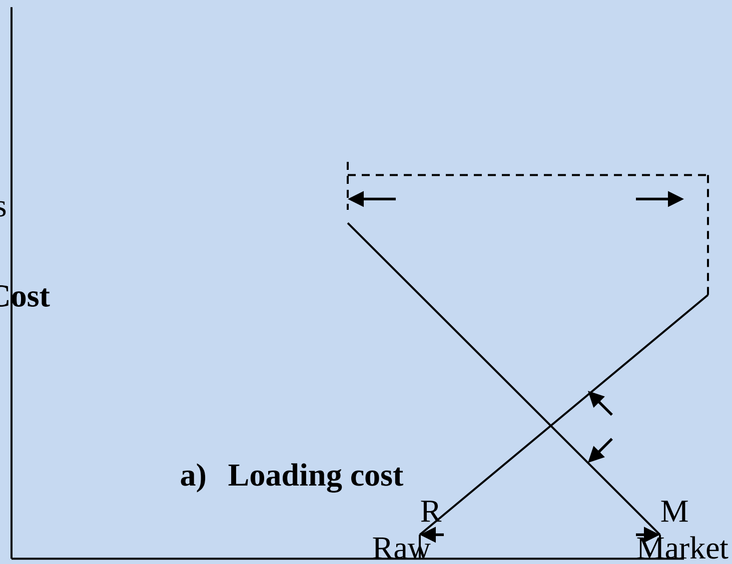
Total Cost

Unloading costs

25.1.1 Cost

Fig 1

Transport cost



In all cases factors such as labour power etc are fixed and so are not important or are required.

Situation 1

The loading costs are the same at the raw material source and at the market. Delivery costs naturally increase with distance so that total transport costs are shown by a dashed line. Transport costs are least at either market or raw materials.

Situation 2

In this situation there is change in weight. This obviously affects transport costs. Transport of raw materials and of manufactured products is not the same. Suppose transport costs of raw materials are more than those of finished products. The line representing the total cost will not be horizontal as in situation 1(see fig 2). Transport costs will be lower from R when transport costs are higher for the finished products. The industry will be located at R.

Situation 2

25.1.2 TOTAL COST

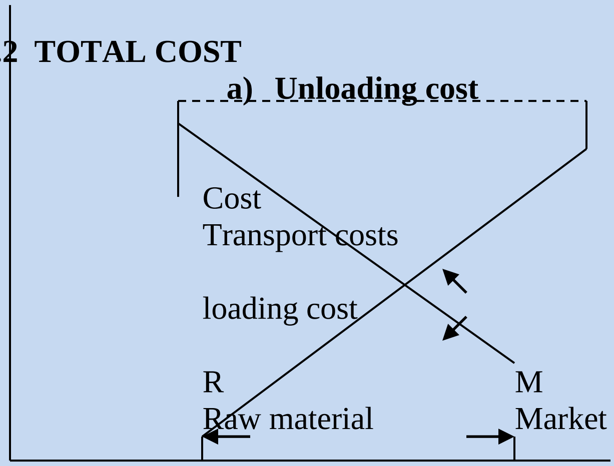
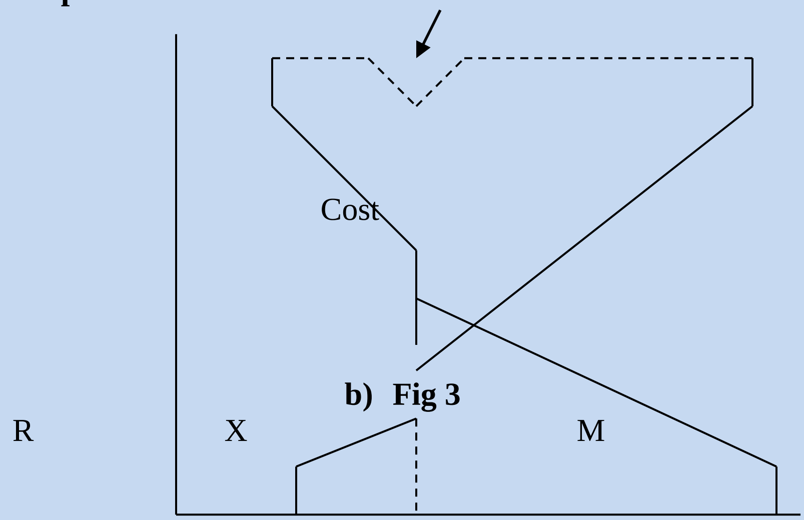


Fig 2

<u>Situation 3</u>
There may be 2 means of transport (sea and land) Costs of unloading at port are likely to be high. In this all 3 points will have least cost location. The industry may be located anywhere between R and M or at X.

Break of bulk point



b) Fig 3

The importance of a market location is perhaps due to the general practice of charging higher transport costs on finished products than on raw materials.

<u>Modern Industries require</u>
Continuity of raw materials
Raw materials from various sources
Quick dispatching of manufactured goods to different places.

All these require good transport facilities. For this reason transport plays an important role in the location of an industry. Efficiency of transport determines the fuel costs of transport and the price of the finished product. When transport network is efficient like in USA and Europe competition between various means of transport brings down transport costs.

<u>Fragile goods, perishable food stuffs and many goods of high value are costly due to higher insurance coverage,</u> need for specialized trucks or wagons, for example, refrigeration trucks and possibility of breakage, deterioration in transit. Industries manufacturing such items tend to be close to the markets.
Transport costs of raw material is sometimes more important than that of finished products. The reason may be that finished products have higher value and can stand higher value and can stand higher charges for example where large quantities of steel products are required for the engineering industry. The industry may locate close to a steel making industry in order to reduce transport costs. The product is heavy but the great value means that transport costs represent a small percentage of total costs.

Some industries need a small quantity of easily and cheaply transported goods. These industries may locate close to labour sources or markets because transport costs for raw materials are low, for example, the assembly of electrical goods or apparatus.

In the third World countries communication is not well developed. The transport costs therefore lead to an increase in the cost of finished products. In this case transport costs become one of the main deciding factors in industrial location. The mode of transport used to carry goods and raw materials is also important in industrial location.
Rivers such as St Lawrence, Yangtze, Rhine and Ganges, have led to location of industries along their respective areas. Ports such as New York, Rotterdam, Hamburg and London are important industrial centres of the world. Mobility of road transport has given rise to the decentralization of some industries.

Trans-shipment points such as ports, influence industrial location because they have advantages over transport costs. The use of containers that can be carried by ship, lorries and railways can make transport to inland areas cheaper and quicker. This helps to stop decline of some inland centres that have industries.

Transport for workers to places of work is also important. Availability of bus and passenger train services the likelihood of congestion and storms between industrial sites or residential areas are also important factors in industrial location. But a location where transfer costs are at their lowest is not necessarily the best location. There are other important location factors such as - energy sources, labour supplies, economies of scale and government policy.

4. **Labour Supplies:**

Labour is not a powerful factor influencing industrial location on its own but availability or a pool of cheap and relatively unskilled labour is important in industrialial location.

The importance of labour varies with industries. There are industries that have labour which scores high in the total costs. Examples are jewellery, clothing, textiles and shoe industries. The following are industries that need small labour supplies, – petrol refining, motor vehicle, meat packing and flour milling.

Industries that require a lot of labour are usually near the markets with ready supply of labour although that is not always the case. Those are some industries that are limited to particular locations by labour. These need a lot of skill. These locate where the industry was. First located for example pottery, high class furniture and ladies, tailoring. Some industries require highly skilled labour for example precision industry like watch making, electronics, electrical engineering and craft manufacturing.

These industries are found in advanced countries with professional training and traditional skills. Areas that have few or no skilled labour are very mobile so these may not strictly govern industrial location. Industries that require large labour force may draw towards densely settled areas. In developed countries where many are educated, the problem of shortage of unskilled labour is solved by automation. Government policies attract industries to areas where there is a pre- existing labour force experiencing unemployment.

5. **Fuel and Power**

The main sources of energy are coal, HEP, nuclear power and gas. Industries grow on coalfields for coke used in blast furnace for example, Ruhr, Lancashire, Yorkshire, Pennsylvania, Appalachian and Great Lakes Region of USA.

At present natural gas and petroleum and, electricity are playing an important part in industrial location and development of modern industry. Electricity has helped to force industry from domination of fuel supply location. Electricity has been a great influence to labour supply and market. It is very important in industries such as electronics, electro- chemical production electrolytic smelting and refining of aluminum and other metals.

Petroleum and natural gas are less important factors on industrial location because they can be transported by pipeline and tankers to industrial sites. For this reason there are few industrial districts on oil fields except where other factors have weight, for example, in Pennsylvania and Mid - West manufacturing Belt and Texas.

In Pennsylvania oil replaced coal as a fuel in a location that was originally a coal field oriented. The Texas presence of chemicals such as sulphur and salt means that the area is ideal for location of chemical industries and petro-chemicals. In other areas petroleum cannot attract industry because it occurs in deserts especially in the Third World countries.

Industrial locations like exporting - importing ports which handle oil have been influenced by availability of oil and gas.

6. **Government Policies**

Government policy affects industrial location both directly and indirectly. Government may encourage or discourage industries in given areas. Government intervenes for the following reasons: -

To assist national industries against foreign competition.
To avoid heavy and continuous unemployment.
To develop strategical important industries.
To provide jobs for example Mezzogiorno in Southern Italy.
To diversify the industrial structure of regions that are over dependent on a limited range of activities for example Venezuela which reduced over-dependence.
To reduce large sums of money spent on importation of manufactured goods.
To pressure green belt around towns.
Presence of national parks.
To open up undeveloped parts of a country, for example, northern territory if Australia.
To revive depressed areas, for example, old industrial areas of Northern England, mining valleys of South Wales.

Examples

Textile industry, shoe making, cement, steel rolling in Nigeria are meant to be import substitutions.
In Ghana steel rolling mills – diversification.

Industries located in capital cities for prestige, for example, most West African countries except Nigeria.
The idea of growth points in Zimbabwe – decentralization of industries and reduce unemployment.
In Russia, for military reasons and to populate empty land, disperse industries hence industries are decentralized around Moscow, Doubas, Nizki, - Tagil, Mazzgnitogorsk region and Leningrad – (now Petersburg again).

How it is done?
Offering cheap land.
Reducing local rates, income tax import tax
Offering low interest loans.
Free industrial planning especially the advanced stage to control industrial location.
Assistance in buying machinery
Improving transport facilities
Introduction of tariffs and import duties.
Restriction due to noise, smoke or size of buildings.

7. **Economies of Scale**

This refers to economies of growth resulting from the expansion of the scale of productive capacity of a firm or industry leading to increase in its output and decreases in its costs of production per unit of output.

Large plants have advantages over smaller ones. The advantages are due to: -

i) Large supply of materials that ensures steady flow of output.
ii) Easy even out of any imbalances between processes.
iii) Obtaining of materials, energy and services in bulk.
iv) No dispersed location pattern found in small plants but concentration at major areas.

There are two types of economies of scale: -
A) Internal B) External

A **Internal Economies of Scale**

These are advantages of large scale production that can be achieved by an industry. They arise from the actual processes of production and organization of process.

Types of internal Economies Scale -

1) **Technical-** arise where there is large scale production. This occurs when production is broken into different parts or separate tasks.

a) Many will be fully employed on full time basis

Take a clothing factory: Worker A - cuts cloth Worker - B takes various arts together, worker C - makes button holes, worker B - sews buttons on.

Advantages

i) Division of labour, specialization.
ii) Maximum use of machinery.
iii) Maximization of labour.
iv) Technical help in linkages.
v) Specialised plants are located on one site by serving a particular purpose.

b) Car Assembly had moving assembly line, car design, buying components, making engine, gear box etc – Assembly body – up to servicing finished cars.

NB: to obtain these economies of scale, geographical location of the industry is important for example in the USA, industry is concentrated in the Detroit region and in the UK – Oxford, Luton and Lancashire.

c) Iron and Steel Industry of Zisco:

Advantages

It is least coast location – By bringing all the materials together, processing them at once there is reduction of transport and production costs. The final product goes straight to the consumer. The factory can work day and night and there are no hold ups waiting for supplies or parts to arrive.

d) **Integrated pulp and paper mills**
Have economic advantages due to a large scale production. Large mills that use equipment in full benefit from lower unity electricity costs than smaller plants – cheaper transport on large loads and lower unit labour etc.

2. Managerial Economies:

These are important when production increases. Organisers spend time organizing work – low workers to routine. Export administrators are in charge of sales transport. There could be accountants, marketing managers, advertising experts, salesperson and production engineers. All these people devote their attention to a small part of the company's work and there will be increase in productivity.

3. **Social Economies**

They attract customers. These involve, say sponsorship of football competions – involve recreational facilities, pension, bonus etc. Workers are made to feel that they are an integral part of the firm. They develop loyalty to the firm.

b)**External Economies of Scale**
These have to do with industrial agglomeration. Plants in the same industries but performing different operations may locate in a cluster. There is therefore a concentration of linked industries in an area. This results in mutual benefit.

The external economies of scale are the original location factors for industrial concentration. They are responsible for continued growth of an industry.

Advantages
Common services such as marketing organizations can be set up.
Roads and social amenities can be jointly provided.
Technical schools can be provided.
Industry can be located where markets exist.

Examples The motor car industry is served by a host of small firms that provide components maintain services and other industries.

8. Industrial Inertia

Coal is at present not the only fuel source. In some areas, other industrial requirements are lacking or the raw materials are exhausted.

However some traditional areas especially those based on coalfields, are all still in their original location. Failure of industries to move from one area to another when locational advantages and disadvantages change, is called industrial inertia.

Industrial inertia may be due to the following

Area with a tradition of industrial employment. The area with traditional concentration on a particular industry. In such areas a large body of skilled and experienced workers will be built up.
Area that has acquired good transportation network of roads railways, canals etc.
Mainly new areas meet transport problems.
The traditional or original areas good communication means that even if fuel supplies or raw materials are not available, they can be easily brought by road and railway for example Zisco's Redcliff.
Cost of equipping and building a factory is high.

New buildings are expensive to put up.

Existing sites therefore may continue to be occupied long after the original advantages have gone. Industries can move away when disadvantages completely outweigh advantages.

f) Long established industries have labour and transportation advantages and local market in form of other factories that are in need of finished goods. New type of industry, for example, electronics which have no link with traditional factors.

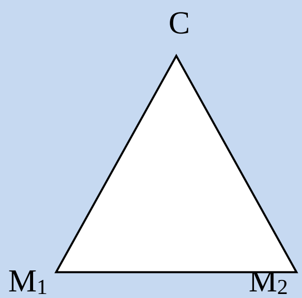
Alfred Weber's Theory of Industrial Location

Raw material Index (M_1)

Terms used in Weber's Theory

According to Weber industries would be raw material oriented or market oriented depending on the raw material index of an industry (M_1). This is defined as the proportion of weight of localized raw materials used to the weight of the finished product.
Hence M1 = weight of localized raw material/ weight of finished product. Thus in M1 > 1 the industry will be raw material oriented. If M1 < 1 the industry will be market oriented.
If M = 1 the industry will be either at the raw material or at market or intermediate.

a) Transport Costs: Weber used a location  (triangle)



C Consumer (market)

M_1 Raw Material 1

M_2 Raw Material 2

All places in the triangle () are equally accessible by transport. If one were to minimize transport costs where will be P (product)?

Least transport cost location is a point at which the total ton/km involved in getting raw materials to a place of production and the finished production to market is at a minimum.

Each corner of the triangle  exerts a pull on point measured by weight to be transported from or at that corner. If M_1> 1 the weight loss in production process so industry will be at raw material. If M_1< 1 the industry will be market oriented. If M = 1 the industrial will be either at raw material or market intermediate stage.
This means PM1 = PM2 = PC.

Labour Costs

Weber demonstrated that optimum location of an industry might be pulled away from the least cost transport in favour of a location with a pool of cheap labour or advantages of agglomeration. According to Weber, if the ratio of the industry's labour costs to the weight of the material inputs plus product output is high then a pool of cheap labour will attract the industry to the location that is different from the one based on least transport provided the savings from cheap labour are greater than the extra cost of transport of finished product.

Labour cost - high (then labour cost > raw materials production, so labour attracts

Raw material + production cost industry)

To measure the importance of labour, Weber used the labour cost index.

Index of labour cost - average cost of labour that is required to produce unit weight of output. If it is high the industry is diverted from the least cost location.

c) Agglomeration and deglomeration

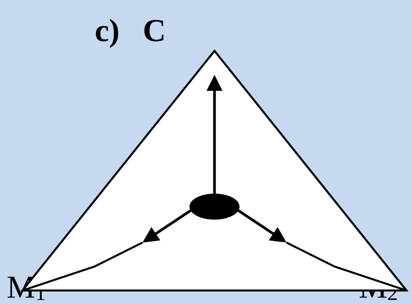
Weber pointed out that the least transport cost location could be diverted if savings in costs could be achieved through spatial association of industry. This coming together of industries is called agglomeration.

Agglomeration provides the following benefits
i) Reduction of time taken to visit linked industries.
ii) Less cost of producing items.
iii) Provision of pool of skilled labour.
iv) Co- operation between plants - sharing specialized equipment.
v) Sharing benefits - for example social services for workers.
vi) Transporting finished products in large quantities at low costs.
vii) Importing raw materials in large quantities at low costs.
viii) Greater division of labour.
ix) Large scale purchasing and marketing.

However it can be possible for a nucleus to grow too big for its own production. When this happens we have deglomeration.
i) This occurs due to congestion that may occur.
ii)Rising of land prices if two many roads are joined.
iii) Increases in clearing costs due to pollution of firms.
iv) Congestion that results in transport delays.

Examples to illustrate Weber's model- Application

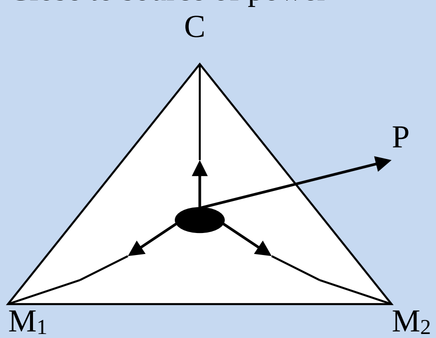
a) Weberian triangle (△) illustrating pulp and paper mill location in Pacific Nw of USA.



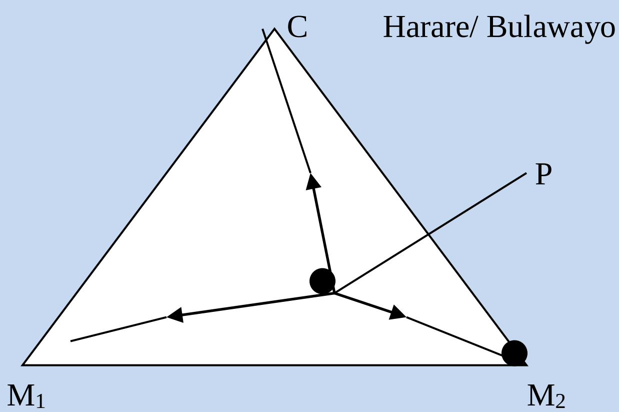
C	-	USA manufacturing belt is large market
M_1	-	Wood, water, hydro – electric power in Pacific NW
M_2	-	Chemicals from US GulfCoast
P	-	Industry is close to M_1

b) Weberian location triangle (△) illustratingaluminum smelting industry in Western Canada.

C - Markets are USA and Europe
M_1 - bauxite from Jamaica
M_2 - power (HEP) from Kitmat Scheme in W. Canada
P - Close to source of power



Iron and steel at ZISCO Zimbabwe.



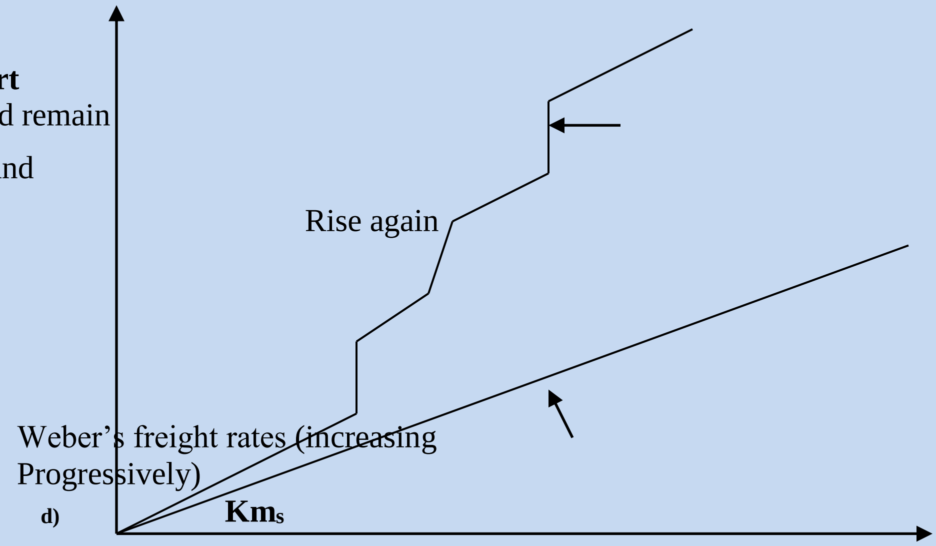
C - Markets for example Harare, Bulawayo etc
M_1 - Coal from Hwange
M_2 - Redcliff (Iron ore and limestone)
P - Industry at Redcliff

NB: Examples are numerous.The student is encouraged to carryout individual case study assessment of local and regional industries.

<u>Criticism of Weber's Model</u>

Assumptions do not fit reality.
Weber said transport cost increases proportionately with distance and weight. In reality freight rates are stepped instead of increasing progressively.

Real freight rates (transport
Cost reach a certain point and remain
Constant for some distance and
Transport
Cost



Weber assumed some means of transport but transport means differ with places.
There is variation in transport networks and topography. Movement is never equally easy over all forms of surface. Topography may affect transport costs.
Weber pointed that there is perfect competition. This is not realistic. Perfect competition assumes that demand is constant over the earth. The real fact is that with increased transport costs from plant demand most logically decline and transport costs push up the price of the product.
Weber pointed out that demand came from 1 point (market) and all transactions were occurring at this point. He also mentioned that production is at one point. In reality demand is spread over a wide area.

Garry - USA Iron and Steel Industry
Site Factors
Garry is near Chicago, so management can conveniently transact business with Chicago Offices. Garry is positioned in such a way that it is not affected by prices and land taxes that are characteristics of metropolitan centres.

i) **Markets -**the markets are offered by movement of population which resulted in increase in Mid West markets for Iron and Steel. Large demands for structural steel for agriculture, automobile and other manufacturing industries at Chicago and Detroit.
ii) **Labour** – The area around the government lakes of USA is densely populated. The town of Garry is very close to Chicago.
iii) Raw materials - Iron ore brought by Lake Steamers from mines around the western bend or Lake Superior. Coal for fuel and raw material is railed from Southern Illinois or by road and water from Pennyslvannia. Limestone from 300 miles away at Northern end of MichiganPeninsula.

Examination type questions
1 (a) Define the term "informal sector" as applied to manufacturing and briefly outline its characteristic features. [6]

(b)Describe the role the informal sector in the industrial economy of any one country you have studied and outline the problem this sector is facing in that country. [12]

(c)Explain why manufacturing has grown much more rapidly in some developing countries than in others. [7]

2. (a) Briefly explain the terms:

i) Export processing zones (EPZ)

ii) Invisible export [6]

(b) With reference to More Economically Developed Countries, discuss the changes that have occurred in the ownership and operation of industries over the last thirty years. [12]

(c) To what extent have less Economically Developed Countries managed to increase their exports while at the same time protecting their own industries? [7]

CHAPTER 26

TOURISM AND RECREATION

26.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Account for the rise in intention tourism after World War II.
b) Assess the reason for growth/decline of tourism on one region studied.
c) Show a working knowledge of the concept of the multiplier effect on tourist and national development.
d) Examine the impact of tourism in an area under study.

Tourism

Tourism is the temporary "stay away from home" of not less than twenty-four hours that is undertaken by an individual or a group of people while visiting a place of interest. Tourism involves an element of travel.

Types of Tourism

Tourism can be classified into different types depending on the number of people involved, the destination, and the environment under which it is carried out.

Three types are easily distinguished and these include: -
Mass Tourism
Individual Mass Tourism
Eco-tourism

Mass Tourism

It is organized tourism or simply packaged tours. The whole product is sold as a complete package with all the essential things pre-planned, guided and fixed. Such tourism involves many players such as tour operators, airlines, and hotel groups. Mass Tourism products are sold under popular brand names meant to attract travellers. These names vary with regions and tour operators. Zimbabwe used to have "Flame Lily Tours" that used to be marked by the National airliner, or the current "Sun Holidays marketed by the Zim-Sun group of hotels. Mass tourism is highly seasonal and is characterized by high spending. Mass tourist frequents popular resorts like the Victoria Falls.

Individual Mass Tourism

This one involves individual tourists organizing and controlling their own travelling. The initial bookings and travel arrangements are made through a travel agent just as is the case with Mass tourism. But, the tourist is at the destination; he/she takes control of his or her own travelling as well as time management. Such tourists are known as Individual mass tourists. Such tourists avoid popular destinations, preferring to discover new areas, on their own that are not yet spoilt. Since they are interested in discovering new areas, these types of tourists are also referred to as explorers. This type of tourism is associated with low spending.

Eco-Tourism

It is nature-based tourism whose objective is direct enjoyment of an unspoiled environment. It involves visiting the natural environment but making sure that the ecosystem balance is not upset in the process.

Eco-tourism has also been termed 'alternative tourism' since it is seen as an alternative to mass tourism. It is based on the concept of sustainable development. Sustainable development aims at protecting the environment as it recognizes the interdependence between the environment and economic issues.
It is associated with low spending and low commercialisation.

Factors influencing the development of Tourism

Tourism development is a product of three factors and these are demand, supply and facilitating factors. Demand for a tourist product is experienced in the source area, i.e. where tourists originate from. Satisfying this demand will depend on ability of the destination to supply the product. However, supply and demand only interact where there are accessibility or facilitating factors. Accessibility can be physical, social or political. The table below summarizes the factors.

Demand Factors (Source area)	Supply Factors (Destination area/ Resort)	Facilitating factors
Increases disposable income Shorter working week Increased paid holidays Early retirement Increased knowledge about world regions Interest in travelling	Availability of areas of scenic beauty Abundant wild life Cultural heritage Well developed infrastructure Government policy e.g. Zimbabwe's Look East Policy	Advertising Media reports A competitive exchange rate Well developed infrastructure e.g. road, railway and air network Improvements in transport Political stability

This table is not exhaustive. The applicability of all these factors is country specific, that is, it depends with the country chosen

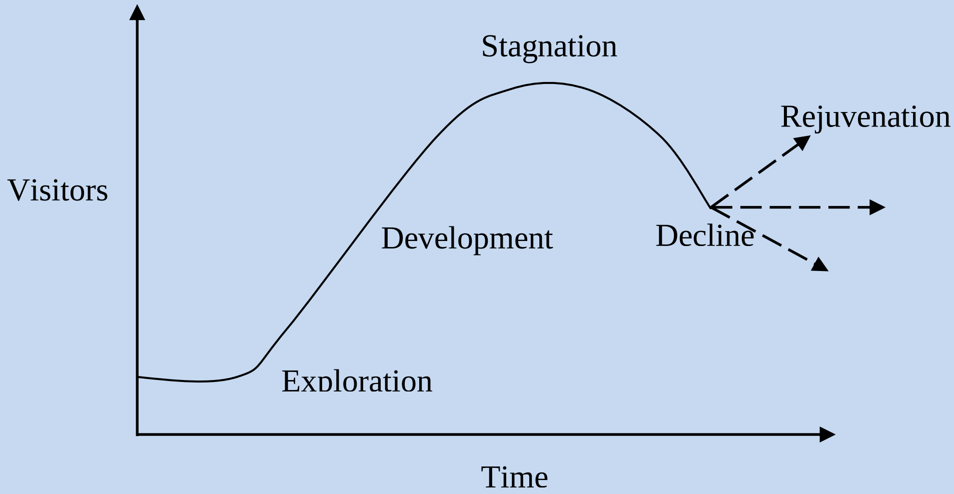
Tourism as a product

Tourism is regarded as a product and hence it also undergoes stages in its development. A simplified Butler product life cycle model best depicts these stages as shown below.

From exploration, tourism develops and reaches a period of stagnation and thereafter it starts to decline. Once the stage of declination has been reached, there is need to rejuvenate it otherwise it may not recover.

Exploration

This stage is characterized by the existence of a few tourists who move out on their own discovering those areas that are not yet known or not yet spoiled. Such tourists are explorers and their main aim is to enjoy nature in seclusion. At this stage, tourism really approximates eco-tourism. Remember, eco-tourism is based on the sustainable use of the environment.



Development

The early stages of development are characterized by an increase in the number of visitors. Explorers are fast replaced by individual mass tourists. Later on as a tourist resort becomes more popular, tour operators take over, hotels and airlines get involved and thus the age of mass tourism sets in. However, at some point, the resort reaches its carrying capacity, that is the maximum number of tourists it can service at any given point is reached. But due to increased demand, it may get overstretched in terms of its social, environmental and economic capabilities. Once this happens, it means the resort has reached the stage of stagnation. It cannot develop further.

Decline

Overcrowding, pollution, crime and so forth lead to the decline in the number of visitors. Besides the overstretching of the existing facilities, tourism also declines due to a number of reasons. These reasons vary from one country to another. Some common examples are given below.

- Crime and violence.
- Emergence of new tourist attractions or alternative packages.
- A rise in the cost of the tourist package.
- Negative media reports.
- Political instability.
- Natural disasters.

- Congestion and overuse of facilities.
- Terrorist attacks.
- Disease outbreaks.

Rejuvenation

This is an attempt to make an area whose tourist significance has dropped regain its status and attract more tourists. Unless rejuvenation takes place, a tourist attraction or the tourism industry may die completely. Rejuvenation is possible through

- Increased advertising.
- Improving security.
- Devaluation of the local currency.
- Improving the infrastructure.
- Re-branding the existing tourism product.
- Adding new attractions to the list.

Economic Impact of Tourism

It leads to the development of Transport and communication

A lot of employment is created in hotels, airlines, crafts and the other industries linked to tourism e.g. bakeries, dry cleaning, banking, farming etc

It generates much-needed foreign exchange for use by other sectors. In Zimbabwe, Tourism was the major foreign currency earner in 1999 bringing in over US $200 billion.

Taxation from tourism also generates revenue for the government.

However, tourism has a negative impact on the economy. Some of the negative aspects of the industry are shown below

Much of the foreign currency generated is used to import more luxury goods for tourists than improving lives of residents

A few large multi-national companies may dominate the economy and benefit at the expense of other companies.

The employment created tends to be seasonal

Multinational corporations that have interests in tourism also repatriate a lot of profit to their countries of origin and hence a lot of foreign currency leaks away from the system

Prices of basic commodities can be artificially high as a result of the presence of lots of tourists. Victoria Falls is a good example where basic foodstuffs are beyond reach of low-income earners.

Socio-economic impact of tourism

The social impact of tourism can also be divided into positive and negative effects. The table that follows clearly illustrates this.

Positive	**Negative**
Peripheral areas can also be developed	Promotes prostitution
It fosters the social integration of different races, tribes, classes and cultures.	Promotes the spread of deadly diseases like bird flu, ebola and mad cow disease
Enables exchange of ideas between people of different environments.	Drug trafficking is also associated with tourism.
Helps societies to preserve their cultural heritage which otherwise could have been discarded.	Can promote cultural imperialism as local people copy foreign cultures and discard theirs.
Helps local authorities and central government to enact environmental laws and fund environmental programmes etc	Culture is commercialised and hence loses its traditional values.
	Local people get irritated by foreigners who invade their privacy.
	The environment is polluted. Disturbs animal habitats and breeding patterns.
	A lot of agricultural land is lost to roads, hotel construction etc

Tourism and the other sectors of the economy

Tourism creates all sorts of linkages with the rest of the economy. These linkages include backward, forward, horizontal and vertical linkages. In some countries like South Africa and Kenya, tourism is a major foreign currency earner. In the CaribbeanIslands, France and Spain, it is one of the dominant industries. However, in any country where tourism is established, it is an important industry through the linkages it develops with the other sectors of the economy. It is virtually linked to agriculture, mining, fishing, construction and other service industries. Some of the linkages are detailed below.

It creates employment in hotels, airlines, national parks, banks, the construction industry, farms and the food processing industries.

Agricultural production is stimulated, as more food, beef, pork and flowers have to be produced for both the local population as well as for the tourists. This has a down stream effect on the agriculture related industries such as fertilizer production, baking, production of agricultural machinery etc. Tourists like local food because it is usually tastier and free from genetic engineering while for hotels using local food is cheaper for them. Tourism also results in the growth of the informal sector particularly those who produce curios.

It should be noted that the linkages are not always positive. Once tourism declines, the market for some of the goods disappears. Thus employment is lost and some of the industries close shop. Hotel occupancy declines and overall earnings in foreign currency also dwindle. A case in point is Zimbabwe where the importance of tourism has dropped to its lowest since 2002.

Recreation

This is defined as those activities that people engage in during their **leisure** time. Such activities can be ‘active’ e.g. sport or can be ‘passive’ e.g. watching a movie. In short, recreation refers to those activities that an individual can get for free and hence recreation is not work.

Recreation does not involve overnight stay!

Leisure

Is the time, outside the normal working hours that an individual may choose to undertake in personally satisfying activities. Leisure refers to free time in which recreation activities are carried out.

Demand for recreation

The demand for recreation is mostly associated more with urban dwellers than rural people. Also, the demand for recreation is just as high in LEDCs as it is in MEDCs. This is a result of the high rate of urbanization that has taken place in the LEDCs of late and hence the need to escape from city problems. Reasons for an upsurge in the demand for recreation include the following;

Urbanites often stressed up and therefore need to refresh periodically. The stress is caused by the compact nature of the city which brings together a lot of people with diverse backgrounds, interests and behaviours into close contact for a long period of time, transport and housing problems, pollution (water, air, noise) problems, etc all drive people to seek recreation.

In LEDCs, the young make a large percentage of the urban population. Either these young people are not employed or are of school going age. Thus recreation is essential to avert problems associated with idleness. In MEDCs, there is a large number of the elderly due to improved medical facilities and easy access to the medical facilities. This has led to a remarkable increase in the demand of recreational facilities.

For those in the working class, in the MEDCs, the improvement of working conditions has also meant an increased need for recreation. Many people are now better paid than before and hence they have more disposable income. Conditions at places of work have improved and the working week is now shorter, thereby making available plenty of time for recreation.

In some professions and trades, recreation is part of the employment package. Traditionally, in banks and in the financial services sector, Wednesday afternoon is reserved for sporting and recreation, so that bankers can mingle with other executives from different institutions, play golf whilst talking business. This has in itself cultivated a culture of recreation among sizable number or a class of people within urban areas.

Examples of Recreational facilities

Activity	Facility
Sporting, Physical	Stadiums/stadia Swimming pools/ water whirls Gymnasiums Race courses Motor racing
Arts and entertainment	Theatres Art galleries Museums/ libraries Historical sites
Camping, Aesthetics	Camping sites Parks Nature tracks Botanical gardens
Food, drink, accommodation	Hotels

Most of these facilities, if not all are available in the major cities. In Zimbabwe, Harare and Bulawayo have most of these facilities e.g. Harare houses Ewanrig Botanical Garden, Borrowdale Race Course, National Sports Stadium, Rufaro Stadium, Donny Brooke Motor Racing Course, Epworth Balancing rocks, Lion and Cheetah Park, Reps Theatre etc. Bulawayo has Matopos nearby, Chipangali Wildlife Orphanage, Ascot Race Course, Babourfields and White City Stadiums, Art Gallery etc.

Problems associated with recreation

Recreation has its own problems that centre on the conflict between urban dwellers and their rural counterparts. The following are examples of such conflicts.

Urban dwellers have different moral values from those in the rural areas and thus the way they portray themselves can be seen as being inappropriate. Rural people accuse urban dwellers of polluting their culture.

Recreational activities conflict with seasonal activities in the rural areas. While rural people are busy preparing their fields during the summer season, urban dwellers may want to engage in bird watching and nature tracks. Rural dwellers will regard them as interfering with their planting activities. Such conflicts are common in the Domboshawa area near Harare and Matopos near Bulawayo.

Some local people view recreational sites as sacred places while outsiders may be interested in a place because of its geographical value. This is true of Domboshawa, which now falls under the authority of the Department of National Parks and Wildlife. Local residents regard the recreational activities being carried out there as denigration of their ancestral shrines. The same is true for places like Matopos and Njelele outside Bulawayo.

Whilst rural dwellers are after expanding their agricultural land, which is their livelihood, Urban dwellers often resist such moves fearing that it would interfere with their recreational activities. Unfortunately, laws and bylaws are made in urban areas and thus the rural people are always disadvantaged in this regard.

TASK: Define the terms Individual Mass Tourism and International Tourism
With references to MEDCs, discuss the characteristics of Mass Tourism

Assess the extent to which individual tourism is similar to eco-tourism

Mass tourism is offered under conditions of mass production. It involves the movement of a large number of people

It is highly seasonal. In MEDCs, have distinct cold and warm seasons and each season has its own packages. A winter package could involve skiing in mountainous areas like the Alps in Switzerland while a summer package would include a holiday in the beaches of the Mediterranean

There are a few players who dominate certain markets and tourism products e.g. Thomas Cook or Disney World.

Mass tourism operators are always coming up with new tourist destinations and packages while constantly scratching off those that are no longer profitable. Thus there is always an element of research and design

Examination Type Questions

1. (a) What factors have led to a considerable increase in the amount of international tourism in recent years? **[15]**

(b) For any one country you have studied, show how international tourism has had a multiplier effect on the economic activities of the country. **[10]**

2. Discuss the ways in which the development of a tourist industry may be based on:

(a) The natural landscapes, **[15]**

(b) A heritage from the past. **[10]**

CHAPTER 27

MINING

27.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

A) Examine factors influencing nature and type of mining.
b) Assess the role of mining in national development.
c) Evaluate effects of mining.
d) Outline reasons for the use of different sources of fuel and power on a Global Scale.
e) Examine the energy policy of one developing and one developed country.

27.2 MINING

Mining can be defined as the extraction of mineral ore from the lithosphere. However, mining goes on to encompass all activities that are involved in the mining process from the initial mineral ore extraction through to the processes or refining of the mineral. Mining can be influenced by a number of factors which are discussed below.

a)Nature of ore body and mode of occurrence

i) Sedimentary or bedded ores which lie close to the surface can be worked by open cast or tunnels that can be driven into the side of the shaft. This is an economic way of extracting minerals.
ii) Lodes and veins need complex arrangement of shafts and galleries.
iii) Placed deposits are worked by pumping or dredging of mineral-bearing sands and gravels.

b)<u>Amount of waste in minerals</u>

i) Some metal ores have a lot of (waste). Copper contains below 1% metallic copper.
ii) Ore that contains 6% copper is regarded as very rich.
iii) Where there is a lot of waste material the processing is called ore dressing.

This involves crushing the ore and separating the valuable mineral from the gauge by gravitation, floatation or chemical processes. Thus the improvements in the methods of pre dressing have made profitable the working of low grade ores that were previously regarded as uneconomic.

c) <u>Depth of deposits</u>

<u>Open cast mining is cheaper than shaft mining. Shaft mining involves</u>

i) Sinking shafts.
ii) Cutting of shafts.
iii) Installing of winding gear.
iv) Pumping equipment.
v) Underground railways.
vi) Cost of Ventilation.

d) <u>Quality of Ore/ Grade of Ore:</u> -

If minerals are of the same quality and are to be extracted in the same manner, those that are close to the market are mined first.

If low grade ores are close to the market they can be mined. Distant ores should be of high quality in order to bear costs of transportation. For example, there are high costs of mining in the harsh environments of Sweden Lupland. There is also a great distant i.e. between this area and the iron and steel production centres of Western Europe. But the Swedish mines at Kinema and Gallivane are able to produce iron at a high price in these markets. This is explained by the exceptionally high quality of the ore that contains 55-70% iron.

e) Size of Reserves:

This is important due to the high level of capital investment in mining operations. The size of reserves may out weigh other factors. Large size reserves enable large scale methods of extraction and result in economies of scale.

f) Demand:

It is important for continued working. Demand constantly changes due to technological developments. Increased demand of copper in recent years has been due to increase in electricity industry. Increasing demand of bauxite has been due to a rise in the craft industry. Some metals were replaced by plastics and others by synthetic materials. This caused demand to fall. Changing demand affects prices and also determines the profitability and profit margin of mining enterprises.

g) Capital:

Opening a new mine involves high level of capital investment in prospecting, surveying, installation of mining gear, pumping equipment, ore dressing plant and transport systems. Large ore bodies are worked before small ones. For example, the coal deposits in the lowveld of Zimbabwe.

h) Labour Supply:

The wage bill for the workforce is part of production costs. Availability of suitably skilled and qualified workers is important. Mining can be carried out in remote areas with some physical hardships, for example, high latitudes, deserts and mountainous areas, for example, Mauritanian (Iron Desert) and the Bolvia (Mountain). Arctic Canada, GreatAustralianDesert and High Andes.

In these areas, the local population is sparse and trained for highly technological and specialized work needed in modern mining activity. It becomes necessary to attract qualified staff and operations into remote and unattractive areas by inducements such as high wages and the, provision of social and recreational facilities. Sometimes it becomes necessary to construct planned settlement or company towns such as Schefferwile in Quebec, Canada.

i) Transport:

This links mines with markets. Road transport is not very suitable for large volumes of heavy and bulky materials. Railways have to be constructed. The mining operations can be delayed if a railway is not constructed, for example, Katanga in Zaire, Kanema in Arctic Sweden, Broken Hill in Australia, all waited for railways to be constructed.

The railways in Zimbabwe and Zambia can be explained largely in terms of mineral distribution and the need to link rail with coastal trans- shipment points.

j) <u>Technology</u>

Profitability of ore deposits should be continuously assessed in light of changes and improvements in technology of mining, ore dressing and metal smelting. Improved methods of steel-making and development for alloy steels has stimulated demand for metals like chromium, nickel, cobalt and tungsten. There has also been development of furnaces that allow increasing use of scrap iron and steel production. The reliance on scrap metal is a conservation measure of some importance and tends to stabilize ore prices.

NB: When there is scarcity, ore prices rise and also prices of scrap rise. This provides incentive for collection of scrap metal which in turn prevent prices rising to very high levels.

27.3 Effects of Mining on Landscapes:

i) Permanent marks and scraps of mining.
ii) Rapid growth of associated settlements.
iii) Rapid decline of settlement resulting in the emergence of ghost towns, for example, mining districts in Rocky Mountains of USA.
iv) Production of distinctive landscape features such as disused shafts – addits or quarries, surface subsidence in many areas, dumps and spoil heaps of waste material, vegetation destroyed by air and water pollution, derelict mining gear and ore processing machinery.
v) Slag waste, for example, South Wales.
vi) Disused grand pits.
vii) Cornwall spoil heaps.
viii) Smelting and concentration of non- ferrous ores can damage the environment – sulphides giving of sulphur oxide from sulphuric acid that is poisonous to plant and wildlife.
ix) Sifting of fields by mud carried after rain, for example, former Buchwa Mine N & S of mountain side – (now a ghost mine).
x) Scree mining destroys vegetation, for example, Buchwa Mine.

27.4 Mining and its impact on the national economy

i) Monetary contributions to the national economy, for example, in Zimbabwe from 1890 – 1965 mining alone accounted for $1 223 million.
ii) Development of settlements around the mines. These settlements determine the pattern of road and rail transportation. Houses and trading stores were established at mines, for example, Shurugwi, Hwange etc.

iii) Development of settlements around mines led to commercial farming around farms, for example, farms around Lonely and Mutapa mines north of Bulawayo are still flourishing.
iv) Examples, of settlement to be sited are Chegutu, Kwekwe etc which survived after closure of mines.
v) The main railways from Harare to Bulawayo was initially laid through mining areas. Other branch lines to mining centres are Banket, Shamva, Shurugwi and Zvishavane.
vi) Employment opportunities - when Buchwa Mine was operational, it employed more than 600 people in mining alone.
vii) Housing of heavy manufacturing industries based on minerals as in Zisco iron and steel, Zimbabwe alloys.
viii) Development of other sectors of the economy, for examples, commercial trading, agriculture etc.

27.5 Case Study of Buchwa Mine – Iron Ore

The case study is based on iron ore production at Buchwa mine before it scaled down operations

Iron ore production in a period of 3 years:

1985	-	891 857 tonnes
1984	-	75 895 tonnes
1983	-	723 819 tonnes

NB: Although Buchwa Mining Company is still operational, it relocated to Redcliff near Kwekwe after the closure of mining operations at Buchwa Mine in Mberengwa. This resulted in the company laying off many workers.
The closure of the mine resulted from rising operational costs which failed to correspond with profits as the ore grade became poorer and poorer – so what is important here is to use the data on Buchwa as a guide to the study of mines which are still operational in the country. The main concepts must be noted.

Role of Buchwa in the National Economy:
It was the sole supplier of iron ore to Zisco. Today focus is on Ripple – Cliff near Zisco. Zisco is the only steel works in the country. The products of Zisco are exported in order to earn foreign currency and some are used at Lancashire steel in Kwekwe for making fence wire etc which in turn is exported as well.

Effects of Mining on the Physical Environment
a) Changing nature of landscape
   i) Mine dumps
   ii) Vegetation destruction
   iii) Pollution of vegetation with dust – due to building of mining settlements and mining operations – there is an impact on the environment. Measures that were taken to arrest these problems include the following:

Silt barriers

When rain falls, it erodes the waste materials which will have been dumped on the N and S sides of the mountain. To combat this, a number of silt barriers were constructed. These stop the silt which destroyed the people's fields but allow water to pass through.

Rehabilitation of Vegetation

As a result of scree mining operations, some vegetation was destroyed. Trees were therefore planted in these areas to restore the nature of the landscape. The residential areas and nearby schools planted trees for aesthetics.

27.6 Promoting workers and providing incentives

i) Shopping trip to Masvingo with company transport.
ii) Free medical health care.
iii) Subsidized housing with free electricity and water.
iv) Recreational facilities
v) Free transport for school children.
vi) Adult literacy classes.
v) Incentives comprising production bonus, annual bonus and promotion.

Staffing and Welfare

At the time of closure, the company employed 600 people including in this figure apprentices and fluctuating numbers of casual employees.

The casual employees were drawn from the surrounding community. The mine also engaged the local youth in small contractual jobs like cutting firewood and geological exploration work.

Pollution of the environment has been of great concern to the mine. Management in consultation with the National Resource Board, have instituted a programme of building dams across streams that are in the area.

Unlike most mines Buchwa did not have its own school. Children and dependents of the mine employees attended the nearby MahindiPrimary School and ZvomukondeSecondary School. The mine had "adopted" these schools and provided them with material help and other services like transport and housing.

Since independence, Buchwa had played an important role through consultation and participation of the local population, transport for school competitions and other honourable jobs like transport of grain to local G.M.B. centres. Inter - schools competition have been generally held at Buchwa because it is central and there are facilities, for example, medical facilities provided for emergences and needy cases.

Even with the very limited financial resources, the company had tried to make Buchwa a comfortable second home for all the employees.

Details on functional different departments within the mine

There are five (5) departments

i) **Mining Departments**: These are responsible for the mining operations - i.e. drilling blasting etc and also the pit equipment under this department.

ii) **Mining Services**: comprise planning, surveying and geology and provides essential services to the mining departments.
iii) **Plant and services**: cater for the plant processes i.e. primary crushing, transporting, secondary crushing, sizing and loading into trains. Also electricity, water, communication and transport fall under this department.
iv) **Personnel:** deals with industrial relations. Company record of employees, recruiting, training, staffing and welfare.
v) **Administration**: deals with the financial aspect of the company and is responsible for ordering any items required.

NB: Though Buchwa Mine is now not fully operational, the company relocated to Redcliff to continue with some of these functions.

27.7 Problems faced by mining as a whole:

1. Lack of foreign currency.
2. Social problems
3. Transport problems
4. Failure to retain skilled labour.
5. Industrial relations.

Copper Mining - Democratic Republic of Congo and Zambia:
Mining of cobalt, copper and other minerals in the Copper Belt of Katanga DRC and of Zambia brought its impact - i.e. the development of concentrating and refining plants, industries serving the mines such as the manufacture of explosives and other industrial development.
Mines provide employment opportunities, good wages by national standards and have led to the growth of towns and of road and rail links which serve both the mine and the population.

a) Zambia:
Production did not begin until the southern railway reached Kaber in 1909. Development was retarded by disease, inaccessibility and technical ignorance. The Copper Belt accounts for 10% of total (copper) world production.It also has 25% of the world's proved copper reserves. In 1970 Zambia received ₤366, 6 million and 1974 ₤654 million from copper. The Zambian economy is completely dominated by mining, copper industry being the largest customer of railways and the greatest consumer of power.

The Copper Belt has a population exceeding one million. Each of the major mines' townships has developed with shopping centres and industrial zones. The largest is Kitwe (250 000) near Nkana Mine, a commercial and industrial centre with electrolytic copper refineries. Ndola (600) lying north of Bwana Mlambwa Mine closed in 1931) and is the main function for the Copper Belt and Shaba. It has copper, cobalt and sugar refineries and its regional airports that serve Zambia.

Various other minerals are extracted in the Zambian Copper Belt - Cobalt (Chibuluma and Nkana) and gold and silver are removed during processing. Zinc, Magnesium and others are mined in the Kabwe District. Copper by and large, accounts for 97% of Zambia's export value. Dependence one commodity makes Zambia to be at the mercy of price fluctuations for copper. Look at the table below.

Year	Price on the world market
1970	₤425
1972	₤400
1973	₤900
1974	₤600
1975	₤513
1977	₤650

Such fluctuations mean that the government is not able to plan very far, since it is unsafe for the revenue it can attract from the mining companies.

b) <u>Shaba DRC</u>:

Katanga was linked to the outside world when the Broken Hill line reached Lubumbashi, and Elizabethville in September 1910. Competition with other outlet routes resulted in Union Miniere becoming the world's largest producer of copper and cobalt in the early 1930's.

The Shaba Katanga belt is a concentration of deep and open cast mining, refineries, concentration of plants and HEP Station. Deposits lie close to the surface and there are open cast mines in Kolwezi and Muso Kamato.

One which contains 6 -8% is at Shifun plant near Likasi and Linei refinery at Kolwezi. The belt produces 410 000 tones annually. Besides copper, other mineral deposits include cobalt, radium and uranium (at Chinolo), tin, zinc, coal and iron ore. Copper represents 30% of total export. The chief city of Shaba province is Lubumbashi with Likasi a secondary regional centre.

<u>Problems</u>

The copper belt has been faced by two major problems. The great fuel needs for copper refining processes and the need for commercial outlets for the refined copper.
The Shaba belt used to use poor coal from Luena but after exhaustion it railed imports from Hwange, Zimbabwe –. Several HEP Stations were built, for example, at the Marinel on the Lualaba and at Mwadingoshi on the Lufira that is, before the Kariba project. Today it fulfills the Copper belt's major power requirements.
Construction of outlets for refined copper from the landlocked Copper Belt illustrates how political considerations over ride economic ones. The biggest single problem for landlocked Copper belt is transport. Roads through the DRC, the Benguela railway through Angola, roads in Zambia and the Tazara railway to Dar- es Salaam on the Tanzanian coast as well as the railway through Zimbabwe and South Africa all link the Copper Belt with the Sea.
Civil war which was in Angola had effectively closed the Benguela, the road network in the DRC had been allowed to decay since independence so that the whole section of the country was now inaccessible and exports could not go through that way.
The Tazara railway is in need of effective repair. Locomotives have broken down. It takes three weeks or more for one to reach Dar es Salaam where further delays occur since the ports are extremely inefficient. Zambia at one time stopped to use the Zimbabwe- SA route

because of political instability. Delay and difficulty of exporting reduced income so that mines have not been able to under- take another exploitation.
Transport problems have been increased by civil wars in Angola and pre- independence Zimbabwe, by insurgency in Katanga and growing violence in the Zambian Copper Belt. Zambia also had bad relations with South Africa due to activities of MNR bandits in Mozambique. Political insecurity had kept away expatriates vital to the smooth operation of mines. Both the DRC and Zambia now have only half the number of expartriate personnel they need and this together with shortage of cash, is leading to inefficient production and a decline in output. Decline in earnings is even making it difficult to maintain the transport network.

27.8 Iron ore effects on African economies

Mauritania: First exploited in about 1960, it has become the backbone of the economy. Before it was discovered and worked, the largely desert area had a traditional agricultural society with livestock rearing nomads in the north, and more settled agriculture in the eastern and southern districts.

Railways were a major engineering fit and opened up the northern part of the country. Shipment of iron ore and agricultural produce was lucrative. Mining attracted population movement from the desert north, and gave rise to new settlements with shops, cinemas and schools.
These attracted nomads to settle in the area. The relative importance of the north and south of the country was completely reserved. Long-term effects may not all be beneficial especially when reserves run low and mines no longer can be run. The importance of mining may blind administrators to the needs of agriculture which is more difficult to develop but which in the long run could be more valuable.

Conclusion:
Liberia, Swaziland, Mauritania and Angola are all exporters of iron ore to the industrialized nations of Western Europe and North America. They have no iron and steel industries of their own.

27.9 Impact of copper mining in Zambia

The copper belt is one of the most urbanised and industrialised regions in Southern Africa. Six of Zambia's towns started as mining centres and the Zambian railway network was constructed to transport minerals from the copper belt.

The railway line attracted commercial agriculture along the areas it passed through.
Mining necessitated the development and expansion of the electricity grid in Zambia. The HEP stations at Mlungushi, Kafue and Kariba north bank were meant to serve the copper belt.

Copper mining has also led to the opening up of new factories producing cement, cars and explosives. The coalfields and their associated industries at Maambe and Nkondambwe were also opened due to the demand of coal products in the Copper belt.

Copper generates 90% of Zambia's foreign currency and 55% of government's earnings through taxation. Most of all, the people employed in Zambia worked in copper related industries.

However, copper mining has brought its own fair share of negative impacts on the Zambian economy. Economic benefits have spread out thinly and unevenly such that the copper belt has become developed whist the rural hinterland remains underdeveloped. As more men migrated to the copper mines, a large population also migrated to the urban areas as many people started to shun rural life. Food production also decreased due to neglect. There were a lot of leakages as well as a lot of royalties paid to the parent companies.

Zambia also became over reliant on Copper, a situation that is unhealthy particularly during periods of depression. The copper belt is 1200km from the nearest port and this increases the market value of copper by one third, making it more expensive. Furthermore, copper is now competing with substitutes such as fibre optic, thus decreasing its marketability.

27.10 Examination Type Questions

1. With reference to examples critically examine the role of geological structures in influencing the nature of mining operations. (12)

2a) Evaluate the impact of mining on the national economy (12)

b) Why is it not advantageous for a country or region to rely on the mining of one mineral? Your answer should make reference to examples studied. (13)

3. Critically examine the environmental impact of mining activities in one mining area you have studied. (25)

CHAPTER 28

REGIONAL DEVELOPMENT AND ECONOMIC PLANNING

28.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Define the concept of a region.
b) Critically examine development and underdevelopment in relation to regional inequalities.
c) Examine the concept of the core and periphery in relation to regional development.

d) Assess the relative impact of global economic system in bringing about global and regional disparities.

Introduction

Regional development and economic planning is primarily concerned with the evaluation of the equitable distribution of the world resources. It seeks to explain why some areas are more developed than others and in general it makes an assessment of the relationship between developed and developing regions in terms of resource utilisation and economic planning

What is a region?

There are many definitions of a region. A region is an area with uniform physical, economic, social and cultural characteristics. In other words it depends on a variable that one is looking at, but, any of the following can be employed.

Political boundaries; e.g. each province or country can be viewed as a region. Examples of political regions are Mashonaland East or Matabeleland North, Zimbabwe or Zambia, SADC, EU etc.
Vegetation; Savanna, Rainforest, Desert.
Climatic patterns.
Soils.
Physical landforms e.g. river basin, plain, highland etc.
Level of Economic Development; More Economically Developed Countries (MEDCs), Less Economically Developed Countries (LEDCs). The level of economic development is measured by the use of various indicators such as the level of health care, literacy level, Gross National Product, Gross Domestic Product, per capita income as well as the levels of energy production or energy consumption.

Human and economic geography is always interested in looking at regional development from an economic point of view.

Core -periphery concept

For various reasons, regions do not develop at the same pace. Some develop faster than others. This in turn brings about regional imbalances or regional inequalities. Regional imbalances and inequalities will be analysed later.

As of now, let us turn on to some important concepts pertaining to regional development, the core and periphery, then explore their relationship.

The Core region

This is the most developed region or the most prosperous region. A core usually develops around the capital city, an industrial town, port or mining town. In most cases, the core is the most economically active region that captures most of the local and foreign investment. This results in highest standards of living. In Zimbabwe, the core region include those areas in and around Harare and Bulawayo. In South Africa, the core is made up of the area formerly known as the PWV area now known as the Gauteng province.

The Periphery

This is a region of low economic activity. It also refers to a region that is actually declining. Thus low education levels, low per capita income, poor health services; poor infrastructure and low energy consumption among others characterize the periphery. The term also denotes a disadvantaged area in terms of government funding and corporate support.

The terms **core** and **periphery** can also be regarded as relative, depending on the scale at which they are used. If one takes Zimbabwe as a region, then Harare and Bulawayo could be regarded as part of the core whilst the surrounding rural areas would be the periphery. If one were to take Southern Africa as a region, then South Africa's Gauteng province would be regarded as the regional core and the rest of Southern Africa, Harare and Bulawayo included, as the periphery. On a larger scale, MEDCs such as UK, France and the rest of the European Union, USA and Japan are the core whilst the rest of the LEDCs are the periphery. However, there is always a relationship between the core and the periphery measured in terms of the flows of the materials, people and finance

The Core - Periphery relationship

The core and the periphery are related. It is the comparison between two or more regions, in terms of services, skills and economic activities, that brings about inequalities and hence the existence of the terms core and periphery. The relationship of the core and the periphery is clearly understood if one analyses the flow of people, raw materials, finished goods as well as capital. There are flows to and from the core, as well as to and from the periphery.

The core - periphery relationship always benefits the core whilst disadvantaging the periphery. However, the benefits and disadvantages vary from time to time and the relationship is dynamic and not static. An analysis of the Zimbabwe – UK relationship confirms this. During the colonial era up to the early days of our independence, skilled people used to flock from the UK to Zimbabwe. Some came to settle in the country while others took up employment as expatriate workers particularly in the fields of education, health and engineering. These days, the same class of skilled personnel is flowing from

Zimbabwe to the UK, yet in terms of economic development; Zimbabwe remains the periphery of the UK.

Regional imbalances

The gap or the difference between the developed and less developed areas is the one referred to as regional imbalances or regional inequalities. The imbalances are a result of or a function of several factors that are economic, political and social in nature. Several theories have been advanced to explain the regional imbalances. These include the Core- Periphery model by Hirschman, Friedman and Mydal, as well as the Growth Pole Theory by Perroux. In both theories there are certain concepts that are crucial and these are explained below.

Cummulative Causation

This is the process through which a region develops faster than other regions because of its ability to attract skilled labour, innovations and investment resulting in better services and infrastructure. The growth is likely to attract even more investment creating sustained development inertia. Such a region develops into a core region.

Initial development attracts even more development. More people are attracted into the region. This creates a demand for housing, social services like schools hospitals, banks, shops etc. The result is continuous growth and expansion of services, investment and employment.

Spread effects

These are forces that enable development to diffuse from the core region (rich region) to the periphery, thereby stimulating development in the periphery. In other words, Spread effects help the core and the periphery to merge in terms of developmental levels.

-Spread effects spread the development to the backward regions.

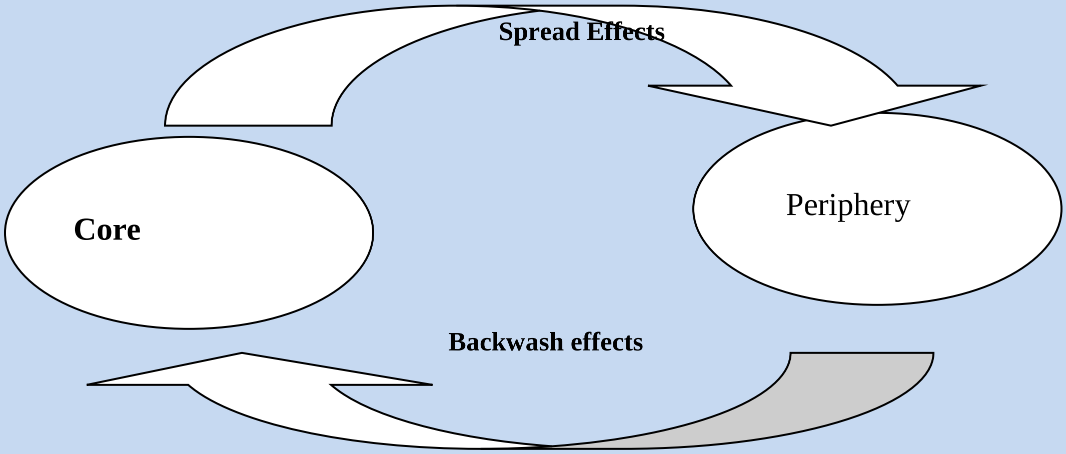
-They decrease the gap between the core and the periphery

Backwash effects

These are the processes or forces that help concentrate resources into the core region. They siphon resources or wealth from the periphery into the core (developed) region. A good example is the attraction of skilled labour, capital, raw materials etc from rural areas to the cities of Harare and Bulawayo on a national scale and from LEDCs to MEDCs on the international scale, e.g. from Zimbabwe to the UK.

-Backwash effects increase the gap between the core and the periphery.

A good example of the relationship between spread effects and backwash effects is shown in the illustration below



It is important to note that both spread effects and backwash effects operate concurrently in any region. However, development is determined by the strength of one of the two forces. If spread effects are stronger or dominant, than the backwash effects, then the region is more likely to experience positive development. If backwash forces are the dominant forces, then development is most likely to be negative.

Other forms of Periphery

Besides the Core, Friedman divided the Periphery into different categories. These are
Upward Transition Zone
Downward Transition Zone
Resource Frontier Region
Special Problem Region

Upward Transition Zone

This is a fast growing region made up of many smaller urban centres. Although there is increased economic growth and high population growth, the rate of urbanization is low. The Midlands region of Zimbabwe could be a possible example.

Downward Transition Zone

This refers to an urban area with a decaying economy, or a mining region that has lost its primary resource. There are several examples from Zimbabwe and these include Kamativi (tin mine) in Matabeleland North, Mhangura (copper mine) in Mashonaland Central as well as Empress (nickel mine) in Kadoma.

Downward transition Zone can also be used to refer to any rural area whose economic development is stagnant.

Resource Frontier Region

These are isolated regions known for, and developing due to, the availability of some resource such as a mineral or a crop. Such regions have a potential of becoming a core region although they are located in remote areas. Good examples are Victoria Falls -a tourist resort, Hwange - for its coal resource and Chiredzi - for its sugar crop.

Special Problem Region

These are areas that need a special strategy to develop and usually are located along the national boundaries. Examples from Zimbabwe would include Binga, Plumtree, Beitbridge and Mudzi.

Causes of Regional Imbalances

Regional inequalities are a result of many factors that may include the following

Different regions have different resource endowments that create or may not create the required initial advantages

Regional development depends on how far the residents of the region are involved in developmental issues, or how economically active they are. It needs local initiative. In some regions, there is more human initiative than in others.

Political factors and decisions can channel more resources into some regions than into others. Regional political stability is also a factor.

Multiplier effect - cumulative causation already discussed

Historical factors - some regions or cities have a colonial history - either they were entry ports e.g. Cape Town, Windhoek or were capital cities e.g. Harare and Pretoria.

Location and accessibility - some regions grow because of lack of barriers, while others are drawn back by natural catastrophes like earthquakes, and tsunamis etc.

Growth-Point Theory

Perroux (1955) defined the growth-point as a set of economic elements that are concentrated in geographic space and within which certain linkages are found. It is an application related to the diffusion theory in which development is seen to diffuse from an area of concentration to an area of low concentration. This has led to the use of the theory in many developing counties including Zimbabwe. Growth points are not peculiar to Zimbabwe as they would seem but have been used the whole world over in countries like Russia and South Africa, and most of South America.

Growth-point Development Steps

- Identification of growth centres that have some raw material base.
- Setting up of propulsive industries
- Setting of the processes of cumulative causation, agglomeration and economies of scale.
- Spread effects to the surrounding areas.

Propulsive Industries are leading industries that generate sufficient economic growth, create strong linkages with other sectors and bring about products for both national and international markets.

Importance of the Growth-Point Theory

The growth pole theory is an important development tool in that it provides a very efficient way of developing problem areas. Starting development on specific areas, like growth points, costs less than attempting to develop vast areas. Downward transition regions and problem areas could easily be developed and their problems solved by spread effects from growth points.

Growth-points policy in Zimbabwe

Zimbabwe has two classes of growth-points, these are growth points and district service centres. Growth points were introduced in 1978. Centres with a resource base were chosen although some without were included. Those that had a resource base include Sanyati, Gokwe, Jotsholo, Murehwa, Murambinda, Ngwizi and Gutu Mupandawana. Later on 55 district service centres were established though some of the growth points acted as District Service Centres as well.

Problems Faced

Most industries are foreign owned and thus it is difficult to attract them to growth points since decisions are made abroad.

Growth points often lack the threshold population needed to sustain a meaningful market.

Some growth points lack any raw material endowment and thus cannot attract any propulsive industries into the area.

There is a general lack of entrepreneurial skills necessary for employment creation

Provision of infrastructure at growth points should have been paired with skills training

District councils and the government have taken time to provide the necessary infrastructure- e.g. water and electricity.

Task:

With reference to examples, explain the terms Core Region, Periphery and Resource Frontier Region

(b)To what extent can the relationship between LEDCs and MEDCs be termed a Core – Periphery relationship?

SUMMARY

Core region

It is the most prosperous or economically developed region of a country e.g. Harare

It can include towns, ports and industrial regions

It is characterized by highest standards of living, existence of skilled personnel, hi-tech industries, financial firms and high industrial growth

Periphery

This is a region or regions of low development for example Zambezi Valley in Zimbabwe. It also includes most of the rural areas.Low standards of living, poor infrastructure, low or no government funding also characterizes it.

Resource Frontier Region

An area where resources are being exploited e.g. Hwange or where resources have been discovered e.g. Sengwa coal fields or Lupane (methane gas)

It also includes areas of scenic beauty e.g. Victoria Falls.

The resource frontier region is part of the periphery.

Task;

Compare the flow of materials, skills and capital etc. between the two and assess the extent to which it mirrors the core-periphery relationship.

Examination Type Questions

The concept of core-periphery provides the basis for a study of regional inequalities of income and welfare on both a national and continental scale. With reference to EITHER **ONE** country or group of countries,

1a) State the criteria that would help you to identify the core and the periphery; **[**7]

b) Describe the social and economic conditions that exist in the periphery; [10]

c) Discuss the effectiveness of the policies that have been introduced to reduce the inequalities between the core and the periphery. [8]

2) Discuss the origin and nature of economic imbalances in a region you have studied. [12]

b) Evaluate attempts that have been made to address economic imbalances at a

(i) Global scale.

ii) Regional scale. (25)

3) Discuss the origin of underdevelopment in the third world [13]

b) To what extent can the west be held accountable for lack of development in the third world? [12]

CHAPTER 29

ENVIRONMENTAL MANAGEMENT

29.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Outline causes of environmental degradation.
b) Identify forms of environment degradation.
c) Evaluate attempts made at protecting the natural environment.
d) Outline the main cause and forms of pollution in urban areas.
e) Assess the Environmental policy of one developed and one developing region studied.

Introduction

Environmental management is primarily concerned with the attempt to effectively utilise the world's natural resources. The sustainable utilisation of resources has been necessitated by the rapid destruction and pollution of the environment in recent years due to population expansion and development. In other words humanity has been focussing on his own sustenance at the expense of the environment. Only upon the realisation that the environment is the foundation of his survival, he has over the years been ignoring the call to maintain a healthy environment to a stage where his survival has been threatened Only then has mankind taken a more positive approach to the conservation and management of the environment

Environmental degradation

Environmental degradation is the reduction of the capacity of the environment to meet social and ecological objectives, and needs. Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards. Some examples are: land degradation, deforestation, desertification, wild land fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion.

The term also refers to: -
pollution disturbance, resource depletion, lost bio-diversity and other kinds of environmental damage. It usually refers to damage occurring accidentally or intentionally as a result of human activities (see also anthropogenic), but can also be caused by natural disasters or stressors.

Decline in the productive or regenerative capacity of an ecosystem

Man-made negative alteration of the ecosystem has widespread or long lasting consequences. Usually these involve mass killing of animals and plant systems, and frequently can include mass killing of human beings, or severe disruption of human life requiring mass migration.

AIR POLLUTION

Air pollution is the accumulation in the atmosphere of substances that, in sufficient concentrations, endanger human health or produce other measured effects on living matter and other materials. Among the major sources of pollution are power and heat generation, the burning of solid wastes, industrial processes, and, especially, transportation. The six major types of pollutants are carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide, and photochemical oxidants.

Examples of Air Pollution

Noise Pollution

Noise pollution or unwanted sounds that are carried through the air, have an irritating and detrimental effect on humans and other animals. Careful planning of streets and buildings in towns and better control over noisy vehicles may add to the control of noise pollution.

The key to clean air, is to reduce reliance on private motor vehicles by encouraging people to use public transport, car pool and to ride bicycles. Vehicles should also be well maintained to limit the pollutants they release.

<u>Possible solutions under consideration include:</u>

A larger, safer and more reliable public transport system
Improved town planning to include higher density living, careful citing of industry and use of buffer zones, continued monitoring and control of emissions and air quality.

Acid rain is a significant air pollution problem that affects rural, suburban and urban areas that are down-wind of major industrial areas. Acid rain is caused when sulphur and nitrogen pollution from industrial smokestacks is combined with moisture in the atmosphere. The resulting rain is acidic which destroys natural ecosystems and buildings.

Global warming is taking place now and affects everyone. As pollution gathers in the earth's atmosphere, it traps heat and causes average temperatures to rise. It is hard to predict exactly how climate change will affect a particular area. Here are a few likely results (according to the Union of Concerned Scientists):

- A rise in sea level between 9-88cm leading to more coastal erosion, flooding during storms and permanent inundation.

- Severe stress on many forests, wetlands, alpine regions, and other natural ecosystems

- Greater threats to human health as mosquitoes and other disease-carrying insects and rodents spread diseases over larger geographical regions.

- Disruption of agriculture in some parts of the world due to increased temperature, water stress and sea-level rise in low-lying areas such as Bangladesh or the Mississippi River delta.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Carbon monoxide (CO) is a colourless, odourless gas that is produced by the incomplete burning of carbon-based fuels including petrol, diesel, and wood. It is also produced from the combustion of natural and synthetic products such as cigarettes. It lowers the amount of oxygen that enters our blood. It can slow our reflexes and make us confused and sleepy.

Carbon dioxide (CO_2) is the principal greenhouse gas emitted as a result of human activities such as the burning of coal, oil, and natural gases.

Chlorofluorocarbons (CFC's)are gases that are released mainly from air sprays, air-conditioning systems and refrigeration. When released into the air, CFCs rise to the stratosphere, where they come in contact with few other gases, which lead to a reduction of the ozone layer that protects the earth from the harmful ultraviolet rays of the sun.

Leadis present in petrol, diesel, lead batteries, paints, hair dye products, etc. Lead affects children in particular. It can cause nervous system damage and digestive problems and, in some cases, cancer.
Ozone occurs naturally in the upper layers of the atmosphere. This important gas shields the earth from the harmful ultraviolet rays of the sun. However, at the ground level, it is a pollutant with highly toxic effects. Vehicles and industries are the major source of ground-level ozone emissions. Ozone makes our eyes itch, burn, and water. It lowers our resistance to colds and pneumonia.

Nitrogen oxide (NO)causes smog and acid rain. It is produced from burning fuels including petrol, diesel, and coal. Nitrogen oxides can make children susceptible to respiratory diseases in winters.

Suspended particulate matter (SPM)consists of solids in the air in the form of smoke, dust, and vapour that can remain suspended for extended periods and is also the main source of haze, which reduces visibility. The finer of these particles, when breathed in can lodge in our lungs and cause lung damage and respiratory problems.

Sulphur dioxide (SO_2)is a gas produced from burning coal, mainly in thermal power plants. Some industrial processes, such as production of paper and smelting of metals, produce sulphur dioxide. It is a major contributor to smog and acid rain. Sulphur dioxide can lead to lung diseases.

Water pollution

Water pollution is the introduction into fresh or ocean waters of chemical, physical, or biological material that degrades the quality of the water and affects the organisms living in it. This process ranges from simple addition of dissolved or suspended solids to discharge of the most insidious and persistent toxic pollutants (such as pesticides, heavy metals, and non-degradable, bio-accumulative, chemical compounds).

Examples of Water Pollution include
Industrial air effluent
Water is discharged from after having been used in production processes. This waste water may contain acids, alkalis, salts, poisons, oils and in some cases harmful bacteria.
Mining and Agricultural Wastes
Mines, especially gold and coal mines, are responsible for large quantities of acid water.
Agricultural pesticides, fertilisers and herbicides may wash into rivers and stagnant water bodies.

- Sewage disposal and domestic wastes. Sewage as well as domestic and farm wastes are often allowed to pollute rivers and dams.

Types of water pollution

Microbiological
Disease-causing (pathogenic) micro-organisms, like bacteria, viruses and protozoa can cause swimmers to get sick. Fish and shellfish can become contaminated and people who eat them can become ill. Some serious diseases like polio and cholera are waterborne.

Chemical
A whole variety of chemicals from industries, - metallic and solvents, and even chemicals which are formed from the break-down of natural wastes, (ammonia, for instance), are poisonous to fish and other aquatic life. Pesticides used in agriculture and around the home insecticides for controlling insects and herbicides for controlling weeds are another type of toxic chemical. Some of these can accumulate in fish and shellfish and poison people, animals, and birds that eat them. Materials like detergents and oils float and spoil the appearance of a water body, as well as being toxic. Many chemical pollutants have unpleasant odours. The Niagra River, between the US and Canada, even caught fire at one time because of flammable chemical wastes discharged into the water.

Oxygen-depleting Substances
Many wastes are biodegradable, that is, they can be broken down and used as food by micro organisms like bacteria. We tend to think of biodegradable wastes as being preferable to non-biodegradable ones, because they will be broken down and will not remain in the environment for very long times. Too much biodegradable material, though, can cause the serious problem of oxygen depletion in receiving waters.

Like fish, aerobic bacteria that live in water use oxygen gas which is *dissolved* in the water, when they consume their "food". (The oxygen in the compound H_2O, (water), is chemically bound, and is not available for respiration(breathing)). But, oxygen is not very soluble in water. Even when the water is saturated with dissolved oxygen, it contains only about 1/25 the concentration that is present in air. So if there is too much "food" in the water, the bacteria that are consuming it can easily use up all of the dissolved oxygen, leaving none for the fish, which will die of suffocation.

Once the oxygen is gone (depleted), other bacteria, that do not need dissolved oxygen take over. But while aerobic micro organisms (those which use dissolved oxygen) convert the nitrogen, sulphur, and carbon compounds that are present in the waste water into odourless and relatively harmless, oxygenated forms like nitrates, sulphates and carbonates, these anaerobicmicro organisms produce toxic and smelly ammonia, amines, and sulphides, and flammable methane (swamp gas). Add in the dead fish, and you see why we do not want large amounts of biodegradable materials entering lakes and streams.

Nutrients

The elements phosphorus and nitrogen are necessary for plant growth, and are plentiful in untreated wastewater. Added to lakes and streams, they cause nuisance growth of aquatic weeds, as well as "blooms" of algae, which are microscopic plants. This can cause several problems. Weeds can make a lake unsuitable for swimming and boating. Algae and weeds die and become biodegradable material, which can cause the problems mentioned above (and below). If the water is used as a drinking water source, algae can clog filters and impart unpleasant tastes and odours to the finished water.

Suspended matter

Some pollutants are dissolvedin wastewater, meaning that the individual molecules or ions (electrically charged atoms or molecules) of the substance are mixed directly in between the molecules of water. Other pollutants, referred to as particulate matter, consist of much larger but still very small particles, which are just suspended in the water. Although they may be kept in suspension by turbulence, once in the receiving water, they will eventually settle out and form silt or mud at the bottom. These sediments can decrease the depth of the body of water. If there is a lot of biodegradable organic material in the sediment, it will become anaerobic and contribute to problems mentioned above. Toxic materials can also accumulate in the sediment and affect the organisms, which live there and can build up in fish that feed on them, and so be passed up the food chain, causing problems all along the way. Also, some of the particulate matter may be greased or be coated with grease, which is lighter than water, and float to the top, creating an aesthetic nuisance.

Effects of water pollution

Task:

With reference to examples, discuss how water may become polluted?
The effect of pollution is always severe whether immediately or over a long period.
Pollution can cause problems with the taste, odour and colour in water.
Many of the chemicals that enter the water with runoff and seepage are, even in minute amounts, toxic to human health and can alter ecosystems by destroying fish, wildlife and plants.

Effects of pollution are not necessarily immediate; they may take years to appear. Pollution may make water unsuitable for drinking, recreation, agriculture and industry. It eventually also diminishes the aesthetic quality of lakes and rivers. Even more seriously, when contaminated water destroys aquatic life and reduces its reproductive abilities, it eventually menaces human health. Nobody escapes the effects of water pollution.

Another effect of water pollution is the acceleration of the Eutrophicationprocesses of waters.Eutrophication is the aging of a lake by biological enrichment of its water. In a young lake the water is cold and clear, supporting little life. With time, streams draining into the lake introduce nutrients such as nitrogen and phosphorus, which encourage the growth of aquatic organisms. As the lake's fertility increases, plant and animal life burgeons, and organic remains begin to be deposited on the lake bottom.

The majority of people now live in cities. Suburbs that contain many acres of hard surfaces characterize these urban environments. Natural vegetation such as forests and fields slow down rain-water, allowing it to soak into the surface. In contrast, streets, roofs, parking lots and manicured lawns, all provide hard, impervious, surfaces that prohibit rain from soaking into the ground. Since the excess rainwater cannot soak into the ground, it accumulates and rushes into storm sewers and waterways.

There is a common misconception that water travelling into storm sewers ends up treated at the local wastewater treatment plant. Because of this misunderstanding, many citizens use storm drains and ditches as places of disposing of all kinds of pollutants.Thus, storm drains carry large amount of pollution away from urbanized areas mixed with the excess storm water.
Street litter, fertilizers, pesticides, herbicides, pet and yard waste, motor oil, anti-freeze, household hazardous wastes, and paint are just a few of the pollutants that find their way into storm drains. This water travels from storm drains into local streams, ponds, rivers and lakes.

Because storm drains can be a major source of pollution to our waterways, it is important to keep polluting materials out of them.
Following is an overview of the problem, and some suggestions on how you can help keep storm drains clean.

Hazardous waste
Hazardous waste is any discarded substance that is fatal to humans or other organisms at low quantities.

- Toxic to humans or other organisms.
- Ignitable at low temperatures
- Corrosive, explosive or highly chemically reactive

Most hazardous waste is generated from metal processing, mining, chemical production, or the refining of petroleum. A number of techniques have been used to try to dispose of this type of toxic waste.

These techniques include:

- Incineration
- Storage in lagoons and pits

- Detoxification, recycled, or recovered injection into deep wells or salt caverns
- Chemically and physically treating the waste to create more benign substances
- Storage in specially designed landfills.
- Recycling.
- Deep well injection into porous rock formations
- Storage of waste underground in caves and abandoned salt mines
- Disposal of wastes in normal sanitary landfill sites

Land Pollution

Land pollution is the degradation of the earth's land surface through misuse of the soil by poor agricultural practices, mineral exploitation, industrial waste dumping, and indiscriminate disposal of urban wastes. It includes visible waste and litter as well as pollution of the soil itself.

Examples of Land Pollution

Soil pollution is mainly due to chemicals in herbicides (weed killers) and pesticides (poisons which kill insects and other invertebrate pests). Litter is waste material dumped in public places such as streets, parks, and picnic areas, at bus stops and near shops etc.

Waste Disposal

The accumulation of waste threatens the health of people in residential areas. Most of the waste decays and, attracts household pests and turns urban areas into unsightly, dirty and unhealthy places to live in.

Control Measures could include the following

Anti-litter campaigns can educate people against littering;
Organic waste can be dumped in places far from residential areas;
Inorganic materials such as metals, glass and plastic, but also some paper, can be reclaimed and recycled.

Task:

Evaluate attempts that have been made to solve problems associated with industrial waste in a MEDC you have studied.

Examination type questions

1.a) Outline the economics and social conditions which may lead to accelerated soil erosion. [12]

(b) What types of agricultural system are most likely to suffer from the problem you have identified in (a)? [7]

(c) Illustrate how the effects of soil erosion are often found outside the immediate area in which it occurs. [6]

2(a) Describe and account for the various forms of pollution which occur in urban environments; [18]

(b) Explain why it is difficult to resolve the problem of pollution in urban environments. [7]

3. With reference to specific examples from both the developing and developed countries describe and explain attempts that have been made to reduce the prevalence of environmental degradation in urban and rural communities? [25]

CHAPTER 30

Collection, presentation, analysis and interpretation of geographical data

30.1 CHAPTER OBJECTIVES

After studying this chapter students should be able to:

a) Outline ways of carrying out a survey.
b) Show understanding of sampling techniques and their limitations.
c) Critically examine methods of Data presentation.

Introduction

Human geography involves a lot of reference to information presented in graphical form. It is prudent for a student of Geography to be able to analyze the given diagram appropriately. To do this, the student should be in a position to explain how the particular diagram was drawn as well as how the information used in the drawing of the diagram was collected from the field.

30.2 DATA COLLECTION

This is a process of identifying and obtaining raw data from the field in order to meet the needs of a specific investigation.

30.3 Sampling techniques

What is a sample?

A sample can be defined as a representation of the total population that is selected to meet the particular study. This sample should exhibit characteristics of the total population i.e. it should be representative.

Sample selection depends on a number of factors and, these include:

Purpose of survey
Time available for the survey
Human resources
Financial resources
Material resources

Population

In statistics, population refers to all items from which a sample is drawn. It is also referred to as the *sampling frame*. The term is used for all objects being studied be it buildings, people, vehicles and so forth.

When do we use sampling?

When the population is very small, it is possible to study every item. Actually for a small population (items or objects less than 100), it is recommended that you study all of them, as sampling would not produce very reliable results. However, there are times when the sampling frame is very large, such that it is impossible to study every item. That's when sampling can be employed. It means from the whole population, you have to choose a subset whose properties are similar to those of the population. Always choose a bigger sample because:

It closely approximates the population

When interviewing people for example, a considerable number will not respond. Thus there is often a difference between the chosen sample and the achieved sample, hence the need to initially have a very large sample.

30.4 Sampling techniques and methods

There is a difference between sampling techniques and sampling methods. The two should not be confused.

Sampling Methods

Point sampling: individual points are chosen and sampled.

Line sampling: items or objects are sampled along lines drawn on a map

Quadrant (area) sampling: sampling takes place within squares or quadrants drawn on a map.

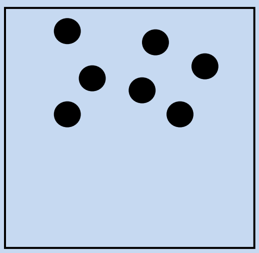
Sampling Techniques

Four techniques are commonly used and these are:

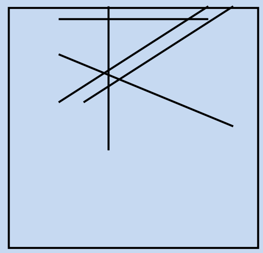
i) Random sampling
ii) Systematic sampling
iii) Stratified sampling
iv) Stratified random sampling

30.5 Random Sampling

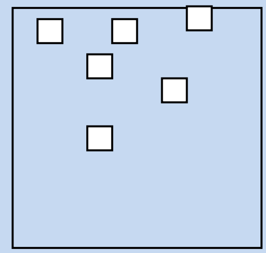
This is sampling whereby each item or object in a population or sampling frame has an equal chance of being selected as part of the sample. In other words, in random sampling there is no bias. Random number tables can be employed to select the items. Random sampling can be applied to any sampling method and thus we end up with random point sampling, random line sampling and Random Quadrant sampling.



Random Point Sampling



Random Line Sampling



Random Quadrant Sampling

<u>Advantages of Random sampling</u>

1. Every item has a chance of being selected
2. It can give a representative sample of the population concerned if the population is not very small

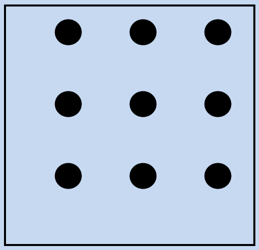
<u>Disadvantages of Random sampling</u>

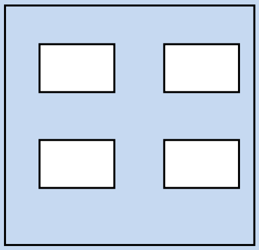
1. It may not work in some surveys where the total population is not known e.g. a shopping survey.
2. It is not practical enough in some instances e.g. one cannot first number the shoppers then select them.

30.6 Systematic sampling

Items or objects are picked at some regular intervals e.g. every 5th house in the street, or every 10th shopper or every 3rd grid line on the map. However, random numbers should determine the starting point.

Systematic sampling can also be point, line and quadrant as shown below





<u>Advantages of systematic sampling</u>

1. It allows for a complete cover of the population since the clustering that may occur in random is avoided.
2. There is no need to make a pre survey
3. Good for studying patterned items.

Disadvantages of systematic sampling

1. It is only useful when sampling from a map when some system can be developed. Otherwise it is not a good method if one is sampling from a list or directory since the distribution may not actually be physically systematic.
2. When sampling houses, every 5^{th} house may be a corner house hence this does not give a complete picture of the characteristics of the other types of houses within a street.

However all depends much on whether one uses point, line or quadrant sampling methods.

30.7 Stratified Sampling

The population is divided into groups or classes (strata), depending on one or more characteristics. Each group or class is known as the stratum and all groups as strata.
Samples are then chosen from each group.

If say you are sampling a population of 50 000 people, of which 60% of them are black, 30% are white and 10% are coloureds, it means if you were to draw up a sample of 1000 people, then 60% of the sample must be black i.e. 60% of 1000 = 600. 30% must be white = 300 and the remaining 10% must be coloured, that is 100.

Advantages
1. Helpful in studying a population made up of different groups.
2. It enables comparison of different groups to take place.
3. Each stratum or group of items is adequately covered.

Disadvantages
A lot of information on the composition of the population is needed before sampling can take place.

Planning for survey
A survey consists of three stages:
- Pre- survey (purpose of survey, time available, area of operation,accommodation, background, financial and human resources).
- Survey
- Post-survey

30.8 Data Collection instruments

Task:
You are required to carry out a research to examine the impact of HIV and AIDS in a named rural area. Show how you will undertake this research (pre-survey: methods, instruments).

Instruments
Questionnaire/ instrument document.

Tally sheets
Data Collection

30.9 Methods of data collection

Field observation
It can be used, to see the number of people who push trolleys at T.M.
Population Count
It can be used, for example, whencounting the number of people in the library.

Interviews
A questionnaire is a document that solicits for public opinions on a particular subject. This is done through giving the public questions that will bring out a particular response from the respondents.

These questions are derived from assumptions made during the pre-survey.
When raw data has been collected from the field, it has to be processed and graphically presented. This makes it easy to give descriptions and illustrate research findings. For example, we cannot present a data collection, traffic count, tally sheet in its raw form to illustrate the flow of traffic along a particular route.
Presentation of data in graphical form simplifies research findings and governs a visual impact on our research.

Surveys
Surveys are done practically in the field and it all depends on what one wants to find out. They can be questionnaires based or interviews. As already pointed out, they can be on rural and urban land use, plotting spheres of influence, traffic counts and so forth. However, there are certain steps that one should take to make meaningful surveys.

These include the following: -
1. One has to make sure he/she has obtained permission prior to undertaking any survey.
2. Obtain the background information where possible. This includes obtaining a map or a plan of a town if your survey needs one.
3. Before the actual survey, there is need of a pre-survey to check whether the interview guide or the questionnaire is well structured and it really works
4. Decide whether the survey you want to do demands that you do the job alone or you need help from friends. If help is needed, then you should come up with meaningful groups to carry out the actual survey.
5. Carry out the survey as you have planned or set out to do.
6. All the data obtained should be recorded on an information sheet, questionnaire, map, plan, field notebook etc
7. Analyse the results and making sense and comments out of it.

Note that in a survey, one should be able to articulate two things, planning the survey and actually carrying it out.

Problems
Each survey has its own problems. The most common problems associated with surveys include those of: -

1. Language if it is interview based
2. Accessibility if there is an element of observation
3. Purposeful lying by respondents on questionnaire based interviews
4. Non co-operation from some sections of the population
5. You may not enter certain prohibited areas.

30.10 Data presentation, analysis of interpretation

Flow Diagrams

Flow diagrams are used to illustrate the various types of movement from place to place, since at times geographical data frequently relates to items which are either moving or are being moved.

Items in motion may occur in several forms: -
-Quantities passing through a series of checkpoints where counts are made or rates of flow are measured e.g. vehicle or pedestrian flow
-Quantities passing along a given route in a particular time e.g. bus service
-Quantities passing through known points of origin or destination e.g. passengers, through the route is not specified.

In short, flow diagrams illustrate the movement of flows of vehicles along roads, pedestrian movement along roads and pavements, international migrations etc.

The variation of quantity that occurs must be represented on a linear basis!

Features of a flow diagram
A flow-line diagram must be able to show two things:

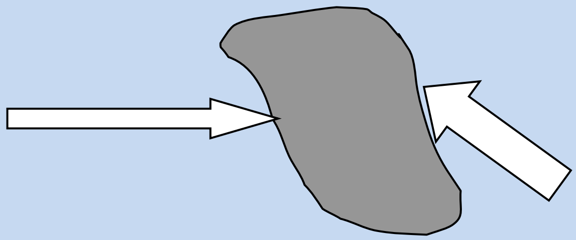
- The pattern of movement
- The quantity of flow along each route.

30.11 Types of flow diagrams

Basically, there are two types, the flow-line map and the Desire line map

Flow- line Map

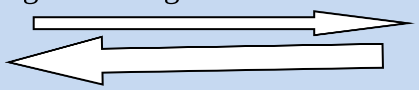
A flow line is a line of variable width drawn to represent the quantity of flow passing a given route. The route is indicated by the course which the line follows.



<u>Steps in the construction of a flow line map</u>

1. Construct a map of the route network marking on it the different check points and the known quantities of traffic passing through such points.
2. On the map, mark the total count of traffic recorded at each count point.
3. Decide upon a suitable scale of line width.
4. Mark the line widths on the map. This should be done for each point or route section. The route line should always be at the centre.
5. Draw in the flow lines. If the quantity of flow is uniform, then the width will also be uniform.

Show the direction of flow. Distinguish between traffic moving in different directions along the same route by using arrows e.g.



<u>Advantages of Flow-line maps</u>

1. They can easily show a route hierarchy.
2. They can help to identify points where there is a problem of movement e.g. traffic congestion.

<u>Disadvantages of Flow-line maps</u>

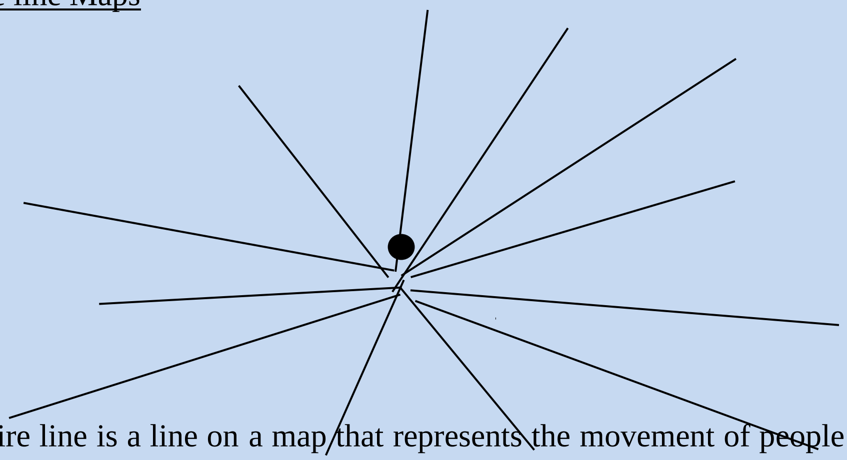
1. The choice of scale can be difficult if the volumes involved are big
2. Direct proportionality is lost if the scale is calculated using the square root of numbers, e.g. If 100 cars are represented by a line width of 1 cm

$\sqrt{100} = 10$ represented by 1 cm

$\therefore$ 25 vehicles $\sqrt{25} = 5$ represented by 0.5 cm

The means one has to constantly look at the scale - which is time consuming.

Desire line Maps



A desire line is a line on a map that represents the movement of people from their homes to certain destinations such as schools, work places, shopping centres and places for entertainment. A desire line represents one journey. They are drawn as straight line between the point of origin and the destination. It takes no account of either the actual route followed or the transport used.

What are desire lines used for?

One should note that the desire line map represents the movement between two points rather than along a route network.

It is used to represent the movement of a dispersed population to and from a focal point e.g. a shopping centre or school.

It is an indication of the sphere of influence of a point. It is a practical method of delimiting the hinterlands or market areas of growth points or service centres.

30.12 Method of construction

1. Identify a suitable reason why people would travel to a particular shopping centre.
2. Conduct a sample questionnaire based survey to discover the pattern of shopping trips to the shopping centre
3. Plot each trip as a desire line to build a finished map.

Advantages of desire lines

1. They help to outline the sphere of influence or the catchment's area of a service centre.
2. They give an instant impression or picture about attraction to particular centre.
3. The reason for each journey can be justified.

Disadvantages of desire line maps

Since the map is based on a single journey survey, the map's outlook varies from day to day.

Details needed to construct desire line maps i.e. origins and destinations of each individual journey, are of a qualitative nature. They cannot be observed and counted like traffic flows. You have to believe the person you are interviewing.

30.13 Choropleth maps

A Choropleth map is also known as the density-shading map and is used to show, for example, the variation of population density over an area.

Constructing a Choropleth map

Transform the raw data into classes.

A total of 6 classes are ideal

Assign a shade to each class

Shade or colour in the respective boundaries

Provide the necessary key.

Provide the title.

Value of the Choropleth technique

It is the most ideal for showing spatial distribution of data

- Gives a good visual impression.

It is easy to interpret.

Limitations of the Choropleth technique

Distribution of phenomena is not linked to administrative boundaries in the real world

In reality, phenomena vary even within boundaries. It does not reveal this.

Averaging and classifying data reduces the accuracy of the data

Along the boundaries, changes are gradual not abrupt as shown by the map.

30.14 GRAPHS

Data can also be presented as graphs and among them are bar graphs, histograms, pie charts etc. Graphs reduce the complexity of data, making it manageable to understand. They also clearly bring out the similarities and differences in data. We will briefly look at the steps followed to construct each of them.

General steps in the construction of Graphs

Collect raw data and arrange it the way it occurs. (Raw data is unprocessed data and that does not show any numerical pattern.

Re-arrange the data in either ascending or descending order.

Construct a frequency table to further reduce the complexity of data or to summarize the data.

Use the values and frequencies to construct the graph.

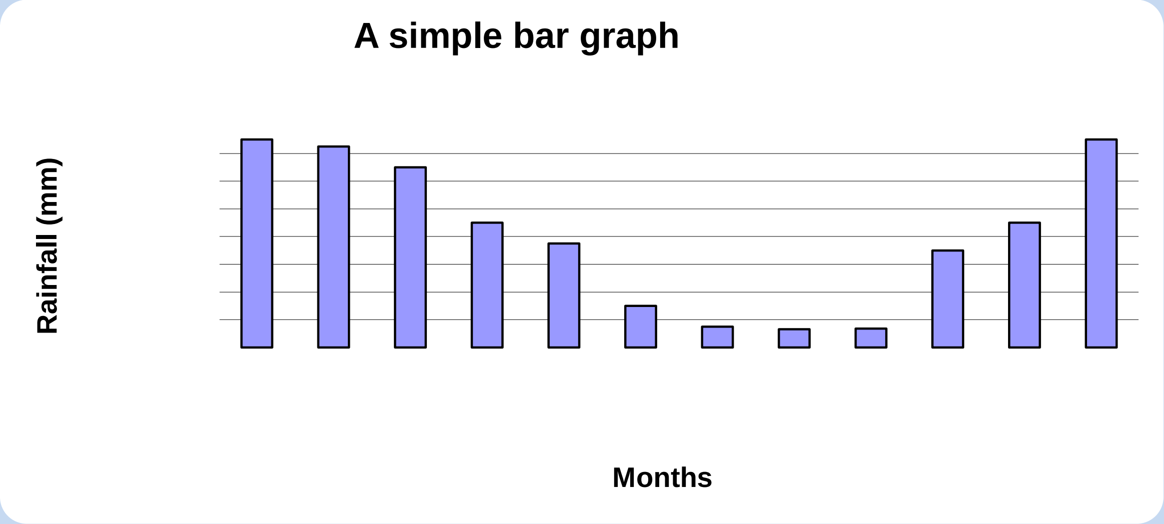
Bar Graph

It is sometimes called a bar chart. It is used to represent a variety of pictorial variables such as population, imports and exports. The variables should vary numerically.

Draw the axis

Decide what you want to put on each of the axes
Choose a suitable scale that will objectively portray the data
Plot the bars - make sure the bars are of the same width.
Shade or colour the bars
Make sure the bars are labelled
Choose a suitable title for your graph

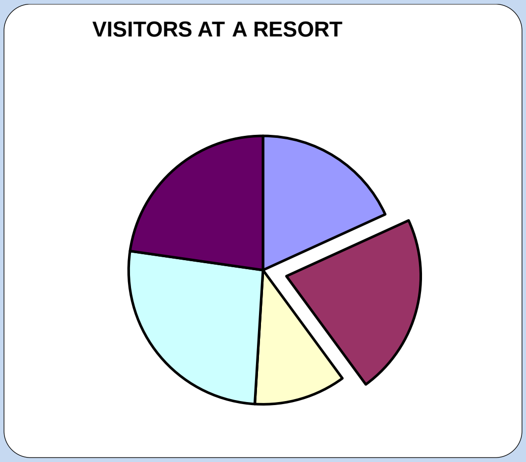
The following is a simple bar graph



30.15 Types of graphs.

Compound/cumulative bar graph
Divergent graphs
Vertically divergent graph
Horizontally divergent graph
Side by side bar graph
Line graphs

Pie Chart



Method of construction

Convert the various percentages in degrees. Remember a circle has 360 degrees
Draw the circle
Measure the angles
Plot the sectors. Always start vertically when drawing you first sector.
Assign different shades or colours.
Provide an appropriate key.
Give it a fitting title.

30.16 Examination Type Questions

You are required to conduct a survey to investigate the quality of life in different suburbs of a town you know very well.

a) Describe how you would plan and carry out the survey in the field. (8)
b) What kind of information would you collect in the field. (4)
c) Outline the problems you would most likely encounter in the collection of the required data. (7)
d) Describe how you would present the data collected in the form of a diagram. (6)