Know your world: introduction to geography

Only study guide for **GGH1501**

DEPARTMENT OF GEOGRAPHY

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Introduction

Welcome to this module in geography. You might have had geography as a subject at school and have some idea of what it is about. Geography is not only an academic subject in its own right but is also very strongly multidisciplinary in nature. You can link your geography modules with a variety of subjects offered by the various colleges at Unisa.

People's economic, social and political behaviour (activities) display spatial patterns which we can observe on various scales. The patterns display spatial variation and spatial imbalances. The natural resource base on which humans depend for their existence and wellbeing also displays spatial variation and imbalances.

AIM OF THIS MODULE

Geographers study the spatial patterns of both natural and human phenomena in the world. In this module you are going to be exposed to the spatial patterns of a number of selected human and natural phenomena on a global scale. We will explain how the patterns are formed and what processes help to change the patterns. The spatial patterns are dynamic and change with time. So you are going to learn about the spatial aspects of human and natural phenomena on the earth's surface and how and why these phenomena change over time. We will also examine South Africa's position in terms of these selected patterns and processes on a global scale.

Through this introductory module we want to get you to think spatially and thus geographically. You can then apply your knowledge of and skills in geography critically to the advantage of South Africa and its people. To do this, you have to learn certain skills and master certain basic geographical concepts and processes. This module therefore introduces you to the subject matter, concepts, aids and techniques of the subject called geography.

At the end of this module you should be able to do the following:

- Identify spatial patterns in the distribution of phenomena in the world, explain that all phenomena display spatial patterns and show the spatial relations between phenomena.
- Describe and use basic geographical terms and concepts.
- Read a map and to represent phenomena on a map.
- Describe the spatial variation in the distribution of human activities and natural phenomena and represent them on a world map.
- Explain what processes are responsible for variation over space and time in the world and how these processes work.
- Locate places and phenomena on a world map (i.e. have acquired some global literacy). Throughout the semester you should locate the places and phenomena which we mention in every study unit on a world map in your atlas. In this way

you will learn where places and phenomena are in the world and become more globally literate.

- Locate sections in Bergman and Renwick with the necessary guidance in the study guide.
- Use all of the above skills to show your understanding of the human impact on the environment on a global scale.

STUDY PACKAGE

The study material for this module consists of the following:

the prescribed book which you must buy from one of the official booksellers:

Bergman, EF & Renwick, WH. 2009. *Introduction to geography: people, places and environment.* Upper Saddle River, NJ: Prentice-Hall.

Although we used the 2009 edition of this prescribed book during the revision of the study guide, you will be required to buy the latest edition of this prescribed book. You will get further information in your first tutorial letter. All commentaries will be provided to you on the latest edition. However, if for whatever reason you are using an older edition, please note that, although the chapters and basic content of the various editions are the same, there are differences in the figure numbers and pages and often different case studies are used in the various editions. The use of an older edition should not negatively affect your performance in the module, but it will require more work from you in terms of identifying the relevant study material.

- this study guide
- tutorial letters which you will receive from Unisa during the semester
- an atlas (you can use any atlas which you have at home or which you used in high school; you do not need to buy an expensive atlas, as any high school atlas will be adequate)

THE STRUCTURE OF EACH STUDY UNIT

Every study unit is based on one or more chapters in the prescribed book. The study guide consists of 12 study units. The average Unisa student should spend about seven hours a week per module, and a semester is about 15 weeks long. We trust that you will be able to work through the 12 study units in this study guide in the time available.

Each study unit begins with an introduction and learning outcomes. The study material follows, with activities which are based on the study material and comments on the activities.

INTRODUCTION

In the introduction we briefly explain the content of the study unit. We sometimes explain how the material in the study unit relates to the material in previous study units.

STUDY MATERIAL

Here we indicate the chapter(s) or parts of chapters which you have to study in the prescribed book for the study unit concerned. As the edition of the prescribed book could change during the run of this tutorial letter, we have followed the basic flow of the prescribed book which is the same for all the editions. Please note we have used the 2009 edition of the prescribed book in the revision of this tutorial letter.

LEARNING OUTCOMES

After the list of key terms we give the learning outcomes, which you will be able to achieve if you work through the study unit carefully and methodically. Once you have reached these learning outcomes, you will have completely mastered the material in the study unit. The learning outcomes also give you an overview of the topics in the study unit.

The learning outcomes which we have set for each study unit give you an idea of the knowledge or skills you have to have mastered – in other words, what you have to be able to do – when you have finished studying the study unit. We call the words which tell you what you have to be able to do "action words". Action words are verbs, and if you are able to recognise the action words in the learning outcomes, you will know what you have to be able to do once you have studied the study unit. Here are some examples of action words or verbs which we use in the learning outcomes in each study unit:

Analyse – Break the material up into parts and discuss these parts in their relation to the whole.

Compare – Indicate similarities and/or differences between two or more phenomena, approaches, patterns or processes.

Contrast – Indicate the differences between two approaches, phenomena or patterns.

Criticise – Describe the advantages and disadvantages, good and bad characteristics or possibilities and limitations, with the necessary support for your point of view.

Define – Give a short description of the meaning of a term using other terms.

Describe – Name the characteristics of something. Explain something fully without expressing your own opinion about it.

Discuss – Describe, interpret, argue, debate and come to a conclusion where appropriate.

Distinguish – Name the differences which are characteristic of two or more things or phenomena and show what makes them different from each other.

Draw – Outline, trace, sketch or formulate in graphical form (e.g. a map or graph).

Evaluate – Give an opinion about a phenomenon which is supported by facts and arguments and determine the value of the phenomenon using certain standards or criteria.

Explain – Make something more clear by using illustrations, descriptions, examples and/or comparisons.

Give – Write down names, facts, items and so on. Do not discuss.

Identify – Look for and give the main characteristics.

Illustrate – Give or describe an example.

Indicate – Describe using a logical framework.

Interpret – Try to verify an explanation by reasoning about it. Come to a conclusion.

List – Write down names, places, characteristics, items or facts in a specific order.

Name – Write down names, places, characteristics, items or facts.

Summarise – Write down the key aspects of a given topic.

CONTENT

The study material for each study unit follows the learning outcomes. The content of each study unit is divided into different sections which are separated from each other by numbered headings. Under each heading we discuss different aspects of the material in that section. The length of the discussions depends on the depth in which the topic is discussed in the prescribed book and how difficult the material is. These discussions are not a summary of the material in the prescribed book. Rather they provide additional study material and additional explanations to help you understand the material in the prescribed book better.

Between the different sections of the study material we give you study tasks which refer to sections in Bergman and Renwick; sometimes you might have to access additional sources on the internet or in your local library. Make sure that you do each study task before you go on to the next section of the study material.

ACTIVITIES

In most of the sections there are numbered activities which you have to do. The activities are based on the study material which is dealt with in that specific section and you often also have to use your atlas. To complete the activity successfully, you have to properly understand the material on which it is based.

THE APPENDICES

The following material is included in appendices to this study guide:

- Appendix A
- Appendix B
- Appendix C

HOW TO USE THE STUDY MATERIAL

This study guide is meant to help you work through the prescribed book. You cannot do the work without the prescribed book because most of the study material is in the prescribed book. The study guide is in no way a summary of the material in the prescribed book. If you want to use summaries, you will have to make your own summaries of the prescribed book and the relevant sections in the tutorial letter.

Begin each study unit by reading the introduction. Then skim or quickly read through the study material which is prescribed for the study unit to get some idea of its scope and contents. Next carefully read the learning outcomes so that you know what you have to be able to do after you have finished the study unit. Then systematically study the relevant chapter in the prescribed book before you read and study the discussion and explanations in the study guide. The discussion in the study guide supplements the prescribed book and you should read and study the two together. Be sure to do each study task; do not skip any of the study tasks and complete each study task before you begin the next one.

Once you have mastered the study material in a section, do the activity which relates to that material. You will get the most benefit out of the activities if you try to do them.

We encourage you to keep your atlas and the world map with you all the time you are studying. Use your atlas to find out where all the places, countries and phenomena you are learning about are located. Mark the places on your world map, colour countries in, write in their names and indicate interesting phenomena. As you work through the study material, your world map should show more and more names, symbols and colours. It is your own "global frame of reference" which is going to help you get to know the world as our home.

We hope that the study material and guidelines in this study guide will make you aware of the spatial variation in the world and help you to complete this module successfully and that you will then know the world better.

Study Unit 1
Introduction to and scope of geography

INTRODUCTION

In this study unit we describe the nature, scope and field of study of geography. We explain how geographers see their subject and what issues they study. We also explain certain basic concepts and processes which geographers use.

STUDY MATERIAL

In this study unit you will be studying the largest section of the first chapter in Bergman and Renwick where geography as a discipline is introduced.

Key Terms

- spatial location
- spatial distribution
- spatial variation
- spatial differentiation
- spatial covariation and association
- spatial interaction
- spatial diffusion
- spatial processes
- environmental determinism
- environmental possibilism
- human-environment interaction
- system
- space in time perspective

Learning Outcomes

After you have worked through this study unit you must know what geography is and what is studied in geography. To achieve this you must be able to:

- explain what the field of study of geography is

- describe where geography originated and how it developed in the Western and non-Western world
- name the three perspectives or subject traditions in geography and be able to distinguish briefly between the traditions
- define the following concepts: absolute and relative location, spatial distribution, spatial variation and covariation, spatial differentiation, spatial interaction, friction of distance, distance decay, spatial diffusion, and spatial processes
- explain the composition of the human-environment system
- distinguish between environmental determinism and possibilism in geography
- explain the concept of human-environment interaction
- explain the critical issues for the future and the geographer's unique contribution to resolving these issues

1.1 The World We Live In

Every day you read and hear in the news media about events and conditions in your town, city, province and country. At the beginning of the 21st century problems relating to the population (poverty, population growth), the economy (low growth rate, unemployment), education (illiteracy), health (provision of services, HIV/AIDS), the environment (soil erosion, droughts, air and water pollution) and urbanisation (housing shortages, squatter camps) are not unique to South Africa but occur on a worldwide scale. Geographers with their unique perspective can help to solve these problems in South Africa and in the world.

1.2 The Field of Study and Development of Geography

Study Task

Study the section in Bergman and Renwick that deals with an explanation of the discipline of geography and the development of the discipline.

The word "geography" literally means "a description of the earth". In geography we get to know the world by finding out where things are and why they are there. An appreciation of the diversity and variability of people and places is a central theme in geography. Geography is an anthropocentric science; this means that humans are the central point of reference of geographical studies.

Geography is one of the oldest disciplines and there are geographical writings dating from 200 BC. In the development of the subject the emphasis has been on different features at different times and various analytical methods have been used. Bergman and Renwick distinguish between three different but interactive perspectives or traditions in geography. Although geographers usually give preference to one of the traditions in their daily work, you should note that these traditions do not conflict with one another. They overlap and even supplement one another.

In this module we are not going to concentrate on only one of the traditions; instead we will give you a broad background which includes all three of these traditions.

We therefore need to add to our definitions by saying that geographers do not study all aspects of the environment on earth, but rather that the field of study of the geographer is the earth's surface as the home of humans.

Activity 1.1

1. Formulate your own definition of geography.
2. Name the three traditions or perspectives in geography and briefly distinguish between them.
3. Why is it important for academics to study geography? Why are you studying geography?

According to Bergman and Renwick each of the three traditions uses specific analytical methods. The authors therefore deal with the methods and techniques of each of these traditions under separate headings in the rest of chapter 1. Although we are going to discuss all the concepts in your prescribed book, we now deviate from the discussion of the various concepts used by the three approaches as highlighted in Bergman and Renwick. Instead of providing these geographical concepts under the three analytical methods, we do so independently of these methods. The reason for this is that we believe that no matter which approach the various geographers follow, it is crucial for all geographers to be familiar with the following concepts within a perspective of space in time.

Geographers collect and process a large number of facts every day in their study of the interaction between people and their environment and the spatial patterns which result from this interaction. We can see these facts as individual events which happen or happened at a given place and a given time. Besides the fact that each place is unique, the characteristics of places are constantly subject to change. Change is, after all, the only permanent phenomenon on earth. The facts which geographers study differ from time to time just as they differ from place to place. We can therefore locate geographical facts or information at specific points in space and time. Geographers study phenomena on the earth's surface from a perspective of space in time.

In our discussion so far we have used the words "place" and "space" fairly often. In a geographical context the term "space" indicates extent or area and usually refers to the earth's surface. It does not mean space in the sense of outer space. "Place" indicates a specific position on the earth's surface which has its own identity. Besides these two terms, there are other concepts without which we cannot do geography. The concepts of spatial location, spatial distribution, spatial variation, spatial differentiation, spatial covariation and association, spatial interaction, spatial diffusion and spatial processes are fundamental concepts, or geographical axioms, which geographers use to describe, explain and understand the world.

1.3 Spatial Location

Study Task

Study the section that deals with Location in Bergman and Renwick.

The most important question geographers ask about phenomena and events in the world is "Where?" Different people will answer the question "Where are you?" in different ways. Some will say they are at home, at work or in a library. Others will say they are in Cape Town, Umtata or Polokwane. If you have a global positioning satellite (GPS) device, you might say you are at 31˚36'S and 28˚48'E.

The question "Where?" can be answered in two different ways: in a relative or in an absolute way. Absolute location is expressed in terms of the earth's coordinate system and with the aid of a GPS or a map you can give your location in terms of latitude and longitude. If you say that you are at 31˚36'S and 28˚48'E, you are giving your absolute location. However, what do these coordinates mean? We know that they indicate a location in the southern hemisphere and with the help of a world map we could perhaps establish that it is a location in South Africa. If we describe the place we are talking about as the capital of a former homeland in South Africa on the main route between East London and Durban, more people would probably know what we are talking about. If we go on to explain that it is a city near past President Mandela's birthplace, they would have a better idea. And most of them would know what we mean when we refer to Umtata in the Eastern Cape.

In our example above we have used various descriptions to explain to you where Umtata is situated in terms of other, well-known places. These descriptions indicate relative location. To find or locate a place in space, we need information about direction and distance between points on the earth's surface. Direction is the course from one point of reference to any other point. Distance is the temporal-spatial distance, along the shortest route, between two points in space. We can express distance using absolute measures, like kilometres, and relative measures, like time and cost. For example, a student from Johannesburg lives approximately 60 km (absolute distance) or about an hour's ride by taxi (relative distance) from Unisa (Muckleneuk campus).

Relative location has to do with the spatial relationships between phenomena and places. These relationships are expressed in terms of the accessibility of phenomena and their centrality and isolation with respect to surrounding phenomena. Accessibility refers to the opportunity for contact or interaction from a given location in relationship to other locations. Accessibility implies proximity or closeness, but distance is only one aspect of accessibility. Connectivity is another very important aspect of accessibility because contact and interaction depend on transport and communication channels. Accessibility also depends on economic, cultural and social factors. For example, a health clinic is only accessible if we can get there (distance, transport network and cost), if we can afford the services offered there (economic), if the staff speak a language which we understand (cultural), if we find the services socially and culturally acceptable and if the clinic is open at times at which we can visit it. Accessibility is therefore affected by a number of factors.

Activity 1.2

1. Give a short definition of "spatial location".
2. Give more examples of absolute location and relative location.
3. Think of an example of a place which is located very close to your home in terms of absolute distance but which is very inaccessible to you.

Besides the question "Where?" geographers also ask questions like "What is where?", "How much is there at that time?" and "Why is it where it is?" To answer these questions, geographers need information about the presence or absence of phenomena at more than one place or locality. If all we know is where phenomena are located on the earth's surface, it does not help us to understand what the relationship is between these phenomena. The next step is therefore to establish whether there is a specific organisation in space.

1.4 Spatial Distribution

Study Task

Study the section that deals with distribution in Bergman and Renwick.

The spatial distribution of phenomena refers to the occurrence of phenomena at more than one locality or place on the earth's surface. The distribution of phenomena tends to vary from place to place in terms of pattern and intensity.

Activity 1.3

1. Formulate your own definitions of spatial distribution, density, concentration and pattern.
2. Using the definitions you have formulated in question 1 above, draw a diagram illustrating each of the definitions. **Hint:** Look in Bergman and Renwick for ideas on how to draw these diagrams.

1.5 Spatial Variation

The occurrence of phenomena on the earth's surface tends to vary from place to place. The spatial variation of a phenomenon indicates that the phenomenon does not occur everywhere on the earth's surface or to the same extent everywhere. The occurrence of phenomena, for example population, rainfall or iron ore, tends to vary over the earth's surface. The distribution of phenomena on the earth's surface also tends to vary or differ from place to place. So there is a spatial variation in the distribution of phenomena on earth.

1.6 Spatial Differentiation

Study Task

Study the section that deals with the concept of "region" in Bergman and Renwick.

There are an endless number of unique places or localities on the earth's surface. It is, however, noteworthy that places that are close to one another are more similar than places that are far away from one another. Geographers have always been interested in reducing this endless variation on the earth's surface to a number of spatial units or regions which are easier to handle.

A region can be seen as an area which is uniform as regards certain criteria. It is an area which has a certain internal homogeneity or uniformity which distinguishes it in a specific way from adjacent areas and the region extends as far as this distinction extends. Spatial differentiation or regional demarcation is used in geography to group the complexity of phenomena on the earth's surface into units or regions which are easier to handle.

Activity 1.4

1. What three types of regions do Bergman and Renwick identify?
2. Are regions absolute phenomena on the earth's surface?
3. What criteria can be used to demarcate regions?

1.7 Spatial Covariation and Association

If the spatial distribution patterns of two phenomena are very similar and the two phenomena tend to vary together, we say that there is a spatial covariation between the two phenomena. If the distributions – in time and space – of two phenomena covary, there is possibly a connection or association between them. A good example of spatial covariation is the joint variation in the spatial distribution of the human population and the spatial distribution of rainfall and temperature in the world. People cannot live where the temperature is constantly very low or where it is very dry. As a result the extremely cold and extremely dry areas on earth are sparsely inhabited or uninhabitable. Hence a relationship, or association between the climate of an area and the number of people who live there.

Activity 1.5

Can you think of two spatial distributions which show spatial covariation?

1.8 Spatial Interaction

Study Task

Study the section that deals with "distance" and "distance decay" in Bergman and Renwick.

We have already seen that the distribution of phenomena tends to vary over the earth's surface. Because of this unequal spatial distribution of phenomena we find that, at a specific time, certain areas or regions have a surplus of a specific product. At the same time other areas or regions have a deficit of the same product. In areas with a surplus there is a supply of the product whereas the areas with a deficit have a demand for the product. Where there is a supply and demand relationship between two places, we say that the two places are complementary. This means that two areas have a complementary relationship with each other. If the two areas are complementary, the product can move from the surplus to the deficit area and then we have spatial interaction.

The term "spatial interaction" refers to the movement or flow of phenomena, people, goods, capital or information between different areas in space. This interaction usually takes place along well-defined routes (like roads and railway lines) or within certain zones. Examples of spatial interaction are commuting, commercial transactions, telecommunication, electronic money transactions and distance education. The interaction between places and regions which are separated from one another in space is affected by the distance between the places or regions. Spatial interaction is usually inversely proportional to the distance between two places. This means that the farther away two places are from each other in space, the smaller the interaction between the two places. This phenomenon is known as distance decay.

Spatial interaction is, however, not only influenced by complementarity and distance. Transferability and intervening opportunities also influence the volume of spatial interaction. Transferability has to do with the ease with which something can be transferred and depends on distance decay. Transferability is a function of the cost of the movement (expressed in money and time) and how worthwhile it is to transport the products. All products are not equally transferable, and the same product is not equally transferable between all places. The quality of transport channels and information systems, the level of technological development, historical and cultural association and political factors also influence the extent of transferability between two places. Transferability also changes with time, as new roads are built or new communication technology (such as electronic money transactions) is developed. As a result the spatial organisation of different activities changes constantly.

Although complementarity and transferability are prerequisites for spatial interaction, intervening opportunities often determine the volume and pattern of movement and flow. Intervening opportunities are simply alternative demand or supply areas. The size and relative significance of these intervening opportunities are very important. The rise of an intervening opportunity may reduce and disturb the spatial interaction between two areas.

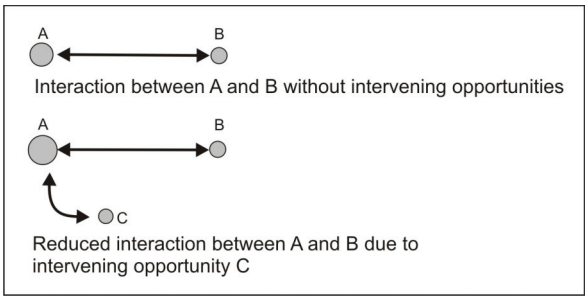


Figure 1.1: The Influence of an Intervening Opportunity on Spatial Interaction

Activity 1.6

1. Make sure that you know what friction of distance, distance decay and model mean and give an example of each.
2. Try to explain the spatial interaction between you and Unisa in terms of the concepts which we have discussed above.

1.9 Spatial Diffusion

Study Task

Study the section that deals with "diffusion" in Bergman and Renwick.

The spatial distribution of phenomena on the earth's surface is not static, but dynamic. In other words, it tends to change in time. Spatial diffusion is one of the processes through which spatial distribution can change.

Spatial diffusion is the spontaneous or deliberate spreading of something from a specific point to other points or places. Bergman and Renwick distinguish three types of diffusion. Contiguous diffusion occurs when there is direct contact between the informed and the uninformed or between carriers and potential adopters. Imagine you are sitting in a class full of students. A student at the front of the class thinks he knows what question is going to be asked in the examination. As an informed person he gives the news to his friend, an uninformed person sitting behind him. The friend then gives the news to another friend sitting next to him. In this way the good news spreads from one student to another until it reaches the students sitting in the back row. At the end of the period the whole class knows what question might be asked in the examination. In this type of diffusion the thing being spread remains at the place of origin while new adopters are added in space over a period of time. In the natural environment we have the example of the invasion of alien plants. You might live in the outer suburbs of a city and plant an exotic (foreign) tree in your garden. The tree has seeds and the seeds spread to neighbouring areas of natural vegetation where more exotic trees then grow. The next season the seeds spread further. The original tree in your garden is still there but every year the exotic trees spread farther and farther into the natural area until the exotic trees have displaced all the natural vegetation within a 10 km area from your house.

In the case of relocation diffusion the phenomenon which is spreading leaves its place of origin (the hearth) and in time establishes itself in another place. An ex-

ample is people who leave the rural areas and move permanently into urban areas. Population migration can therefore be seen as a type of relocation diffusion. In the natural environment we have the example of young elephants that are moved out of the Kruger National Park and are relocated in other national parks in South Africa.

Hierarchical diffusion occurs in a structure which is made up of a succession of ranks or classes. In South Africa we have nine provinces, each with a capital. These capitals differ as regards population size and welfare and we can arrange them hierarchically from, say, Johannesburg, with the greatest population and highest income per capita, to Kimberley and Mafikeng with smaller populations and lower income per capita. With hierarchical diffusion the innovation (e.g. a new fashion) originates in the largest city and then spreads to the other cities in the hierarchy (Cape Town and Durban). Then it spreads to the next rank (Bloemfontein). Thus it moves down the hierarchy until it has spread to every small town. This type of diffusion does not obey the rule of distance. In hierarchical diffusion the welfare or influence of people in specific places is more important than the distance between places.

The diffusion of information or innovation does not always happen without problems. There are various obstacles or barriers which can delay diffusion or reduce the impact of diffusion. These barriers may be physical (mountains, oceans, swamps) or mental (negative attitudes) in nature.

Activity 1.7

1. Name the three types of diffusion and make sure that you know what each of the types involves.
2. Think of more examples of each type of diffusion.
3. Think of possible barriers to diffusion in each of the examples we have mentioned.

1.10 Spatial Processes

A spatial process is a composite, repetitive or sequential action which occurs over a given period of time in a specific way between points and which produces a certain result. Spatial processes can be deterministic or stochastic.

Deterministic processes occur according to some or other immutable (or unchanging) law of nature (such as the laws of gravity and thermodynamics). Spatial processes which occur in the natural environment are mostly deterministic. Examples are condensation, the flowing of a river, wind and erosion.

Spatial process in the human environment are mostly caused and influenced by a combination of accidental or random factors. We call these processes stochastic processes. Population migration is an example of a stochastic process.

We began this study unit by explaining what the field or study of geography is. Now that you are familiar with the basic concepts which geographers use to study the earth as the home of humankind, we are going to return briefly to the field of study of geography.

1.11 The Human-Environment System

Study Task

Study the section that deals with "physical and human systems" in your prescribed book.

The field of study of geography is limited to that part of the earth on which human beings live. This part of the earth is known as the earth's surface. Humans are, however, dwarfed by the size and complexity of the earth. Geographers therefore have to simplify the earth to study, understand and explain how it works. If we model the earth as a system, we can simplify reality to establish how it functions. This system is known as the geosphere or the human-environment system. The human-environment system consists of the human system (anthroposphere or human environment) and the four natural systems (the natural environment).

Human-environment interaction refers to the interdependent relationship between people and their natural and human environment. In instances where this interaction refers only to people's relationship with the natural environment we have to do with environmental determinism and possibilism.

Activity 1.8

1. Define the term "system" and give an example of a system.
2. What is the difference between a system and a model?
3. List the four natural (physical) systems of the earth.
4. What is an ecosystem?
5. Describe the concept of "culture" from a geographical perspective.
6. Explain the difference between a natural landscape and a cultural landscape.
7. Distinguish between "environmental determinism" and "environmental possibilism".

Human-environment interaction in the human-environment system differs from place to place and time to time and gives rise to a series of critical issues in the world.

1.12 Critical Issues for the Future

Study Task

Study the section that deals with "critical issues for the future" at the end of chapter 1 in Bergman and Renwick.

Geographers are interested in the differences and similarities between places and the implication of these differences and similarities for people. Places are unequal in terms of welfare, power, job opportunities, climate, resources and other characteristics, which influence how they develop economically, politically and cultur-

ally. Another focus in geography is the relationship between social change and the natural environment. There is concern about the impact of people on the natural environment and its repercussions for humankind.

Bergman and Renwick identify four interdependent world issues to which we as geographers must give our attention: environmental change on a global scale, global population growth, increasing differences in material wealth in the world, and inequalities in world food production and distribution. Geography as a subject offers unique perspectives for understanding the world we live in better. The multidisciplinary approach of geography enables geographers to pay attention to issues concerning both the natural and the social environment. The global perspective which geographers use today together with applied research in geography enable geographers to understand world problems better and to search for solutions.

Activity 1.9

1. What critical issues for the future do Bergman and Renwick identify?
2. What unique perspectives do geographers offer for understanding the world we live in better?
3. Write two or three paragraphs in answer to the question "What is geography and what do geographers do?"
4. Write a paragraph of about 10 lines on the following:
    a. Describe the field of study of geography and explain why it is a multidisciplinary subject.
    b. Use examples to distinguish between absolute and relative location, and absolute and relative distance.
    c. Explain with the aid of examples what spatial distribution, spatial differentiation and spatial covariation mean.
    d. Explain what contributions geographers can make to global issues like environmental degradation, population growth, the distribution of wealth and food shortages in the world.

IN CONCLUSION

We hope that we have broadened your understanding of the nature of geography in this study unit. We also hope that we have succeeded in encouraging you to think spatially and to expand your knowledge of the world and the unique places in the world – by searching on your world map for every place you hear about but do not yet know where to find.

Study Unit 2
The representation of the earth

INTRODUCTION

In this study unit we concentrate on how the spherically shaped earth is represented using the flat surface of a map, on how the traditional "Where?" questions which geographers ask are answered in both absolute and relative terms, and on how distances and areas can be calculated from maps.

STUDY MATERIAL

In this study unit you will have to revise a large section of chapter 1, and to study chapter 2 of Bergman and Renwick. You will also have to study the appendix in Bergman and Renwick. You will also have to apply the various concepts discussed in study unit 1.

Key Terms

- absolute location
- relative location
- meridian
- geographic grid
- rhumb lines (loxodromes)
- standard time
- local time

Learning Outcomes

After you have worked through this study unit, you should be able to:

- explain what a map is
- draw a graphical representation of the globe together with the imaginary geographical coordinate system
- indicate the absolute location of a phenomenon on a map
- determine the geographical coordinates of phenomena shown on a map
- describe the relative location of a selected place, region or phenomenon
- calculate the time difference between places using their longitude
- use scale information to calculate distances and areas from a map

- convert a ratio scale to a line scale and a line scale to a ratio scale
- distinguish between small-scale and large-scale maps
- choose a map projection which suits the purpose of the map

Study Task

Study the sections in chapters 1 and 2 in Bergman and Renwick that deal with the "shape and dimensions of the earth", the section that describes the "representation of the earth" and the "overview of maps as a means of visually representing geographical data" (spatial data).

2.1 The Representation of the Earth by Means of Maps

In order to study various spatial patterns on the earth, it is necessary to represent the spherical earth on a piece of paper. How can this be done? If we simply draw a circle on a flat surface (e.g. a piece of paper), it would be a representation of the earth. It is a reduction, because in reality the earth is much bigger than the circle we have drawn. It is also a distortion of reality because the earth is not really a flat round disc. In reality the earth has a spherical shape, which can be compared with that of a three-dimensional ball, for example a soccer ball.

One could now draw the continents in, for example Africa or South America, on the circle on the piece of paper. Although we have now drawn a fuller representation of the earth, it is still a generalisation of reality. We have generalised by among other things drawing in only the outline of one continent. There is also not enough space to draw in all the details of what appears on the African continent (e.g. the courses of rivers) on our representation of the continent. The outline of Africa is also a simplification of the actual coastline because the drawing surface is too small to show details like inlets.

Figure 2.1

What we have drawn is therefore a reduced, distorted, generalised and simplified representation of part of the earth on a flat surface. Such a representation is called a map.

Other information can now be included on the map we have drawn. Pretoria, for example, can be represented by a dot in Africa. But where exactly should we put the dot? This brings us to the fact that each place or phenomenon on earth has an exact location which we can plot and describe.

2.2 Plotting and Describing Location

It has already been stated that the shape of the earth is very similar to that of a soccer ball. Suppose you find yourself in a situation in which you have to explain to a blind person exactly where the valve of a soccer ball is located. This would not be an easy task with no point of reference. The same problem would be relevant to finding places on the earth's surface. This problem is solved by using a geographical reference system. How one describes location using a geographical reference system is the next topic of discussion.

2.2.1 The Geographical Reference System and Absolute Location

Study Task

Study the section on the geographic grid in Bergman and Renwick.

Because the earth – just like a soccer ball – is spherically shaped, we are faced with the same dilemma as described above when we want to describe the location of phenomena on the earth's surface in an "unambiguous" way. To overcome this problem an imaginary geographical reference system – the geographical coordinate system – was designed to make it possible to describe the location of places and phenomena objectively in a universal language. This location is referred to as absolute location.

In Bergman and Renwick reference is made to the north latitude, south latitude, west longitude and east longitude. The first two terms refer to those halves of the earth which lie north and south of the equator respectively. One could also say they are those areas which lie in the northern and the southern hemisphere respectively. The term "west longitude" indicates the western hemisphere or that half (hemisphere) which lies west of the prime meridian (also known as the Greenwich meridian). East longitude therefore refers to a location in the eastern hemisphere or a location east of the prime meridian. Bergman and Renwick illustrate how latitudes are calculated using angular distance; however in figures 2.2 and 2.3 we show you how both latitude and longitude are shown as angular distances.

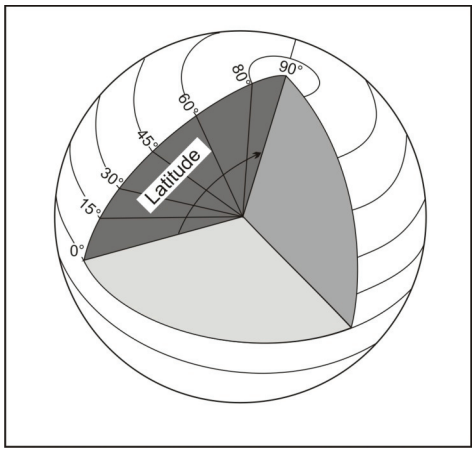


Figure 2.2: Lines of latitude are imaginary circles that extend around the earth, and degrees of latitude are angular distances as measured at the centre of the earth

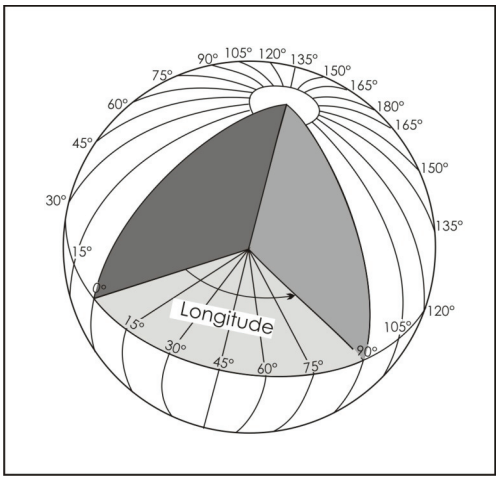


Figure 2.3: Lines of longitude are imaginary lines which connect the North Pole with the South Pole, and degrees of longitude are angular distances as measured at the centre of the earth

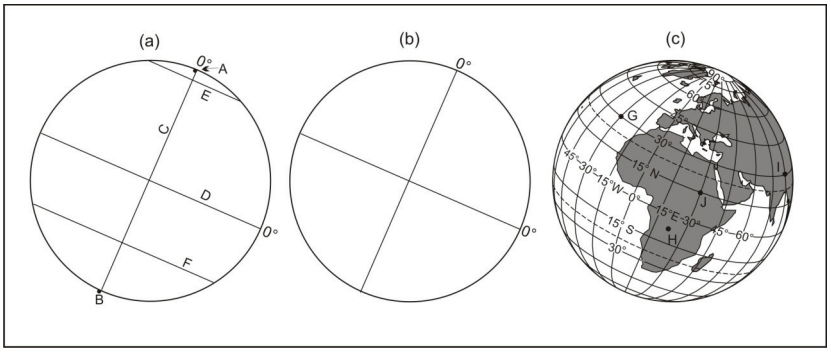


Figure 2.4

Have a look at figure 2.4 in which some geographical references are given and then answer the following questions:

1. Write down the name of the two geographical points of reference which are marked A and B on the map and give their latitude and longitude.
2. Write down two names for the line marked C.
3. What is the latitude of all the places on line D and line E? **Hint:** You will have to use a protractor.
4. How is the line that is marked F related to the location of the African continent? **Hint:** You will have to use a protractor and you will definitely have to consult an atlas to answer this question.
5. Use different colours to indicate the western and eastern hemispheres in figure 2.4(a).
6. Use different colours to indicate the northern and southern hemispheres in figure 2.4(b).
7. What is the absolute location of points G, H, I and J in figure 2.4(c)?

The North Pole, the South Pole, the equator and the Greenwich meridian (the 0˚ line of longitude) are the primary points of a frame of reference which can be used

to describe the location of any place on earth in exact terms. Basically this frame of reference consists of imaginary lines of latitude and longitude which span the earth's surface. A number of characteristics of this imaginary system of lines of latitude and longitude can be listed:

- Lines of latitude and longitude are imaginary lines – they are not actual lines drawn in on the earth.
- Lines of latitude are parallel with one another and are therefore also called parallels.
- The 0˚ line of latitude (also known as the equator) is the longest line of latitude. As we move pole wards (towards the poles) from the equator the lines of latitude become progressively shorter. The 90˚ S and 90˚ N "lines of latitude" actually have no length because they are simply two points, namely the pole points.
- Lines of longitude or meridians converge (meet) at the poles and diverge (move apart) at the equator. In other words, at the poles the distance between any two lines of longitude is minimal (zero) and at the equator it is maximal.
- Lines of latitude and longitude always intersect one another at an angle of 90˚.
- On the spherical surface of the earth lines of longitude look like straight lines when you look at them orthogonally (i.e. from above, as on a map).

Those of you who have used a GPS (global positioning system) will know that this instrument determines geographical coordination with ease. However if you do not use a GPS, how would you go about determining geographical coordinates? The only way is to make use of a map on which the place's location, as well as the lines of latitude and longitude (with their degree values), is shown.

Study the representation of an area in South Africa in figure 2.5. If you look at the coordinates you would be able to establish that the phenomenon indicated as A on the map is located between 20˚ East and 21˚ East (i.e. in the eastern hemisphere) and between 31˚ South and 32˚ South (i.e. in the southern hemisphere), and is thus in South Africa. However, you want to know phenomenon A's exact absolute location or geographical coordinates.

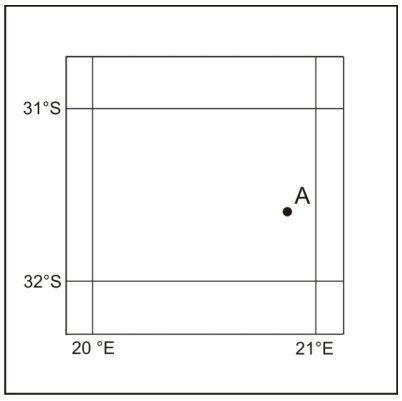


Figure 2.5

Activity 2.1

Follow the reasoning and calculations below which explain how one can determine the longitude of a place. Make sure that you understand the logic underlying every

argument and also check all the measurements and calculations. Remember that there are 60 minutes (indicated as ') in one degree (indicated as °) and that a minute can be divided into 60 seconds (indicated as ").

Calculation of Longitude:

1. The phenomena in figure 2.5 are between 20° and 21° East.
2. On the map the distance between 20° and 21° is 40 mm. Measure it yourself with a ruler. One degree (or 60 minutes) is thus represented by 40 mm.
3. On the map the phenomena are located 35 mm east of the 20° East line of longitude.
4. Because we know that 1° is equal to 60 minutes and that in this instance 60 minutes are equal to 40 mm, we can now apply the following logic in 5.
5. 40 mm on map = 60 minutes; therefore 35 mm on map = 60 x (35 ÷ 40) = 52,5' or 52,5.
6. The decimal portion which we calculated in step 5 means 0,5 of a minute, which is half a minute. Remember that there are 60 seconds in a minute. The 0, 5 therefore actually means 0,5 of 60 seconds.
7. 0,5 x 60 seconds = 30 seconds.
8. The longitude of the phenomena is therefore 20° + 52 minutes + 30 seconds East. We write it as 20°52'30" East. Without indicating "East" we would not know whether the phenomena are in the western or the eastern hemisphere.

Calculation of Latitude

Now calculate the latitude of the phenomena in figure 2.5 yourself.

Activity 2.2

This activity is based on a world map; using an atlas, complete the table by filling in the name of the city. Table 2.1 below gives the geographical coordinates of the 10 cities.

Table 2.1

Latitude	Longitude	City's name
35°15'S	149°08'E	
45°25'N	75°43'W	
40°00'N	32°54'E	
06°27'N	03°28'E	
34°30'S	58°20'W	
10°30'N	66°55'W	
38°52'N	77°00'W	
34°00'N	11°810'W	
55°45'N	37°35'E	
39°55'N	116°26'E	

Table 2.2

Latitude	Longitude	City's name
45˚31'N	73˚34'W	
20˚00'N	100˚00'W	
40˚25'N	03˚45'W	
59˚55'N	30˚25'E	
53˚32'N	09˚59'E	
48˚52'N	02˚20'W	
47˚29'N	19˚05'E	
13˚44'N	100˚30'E	
33˚53'N	151˚10'E	
05˚19'N	04˚01'W	

9. Table 2.2 shows the geographical coordinates of 10 international cities. Plot the cities on the world map in your atlas and write each city's name and the letter which appears in table 2.2 on the map. Complete table 2.2 by writing in the names of the cities.

It is not always practical to explain the location of a place or phenomenon in absolute terms. If someone asked you where the nearest petrol station is and you answered at 26˚12'S; 28˚03'E, they would probably look at you rather strangely! In the next section we look at how geographers can answer "Where?" questions in relative terms.

2.2.2 Relative Location

Study Task

Read the section in Bergman and Renwick on relative location and concentrate on determining what information you would need to explain the relative location of a place to someone else.

Activity 2.3

1. Write down some reasons why it is totally impossible to explain the location of a place indicated as A in figure 2.6 to someone.
2. Now try to explain the relative location of place A to someone, using figure 2.7.

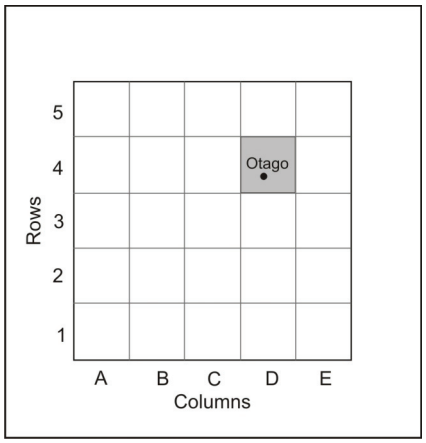


Figure 2.6

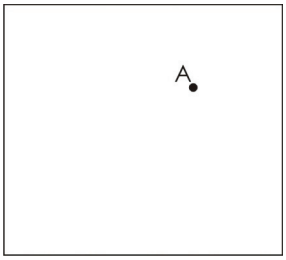


Figure 2.7

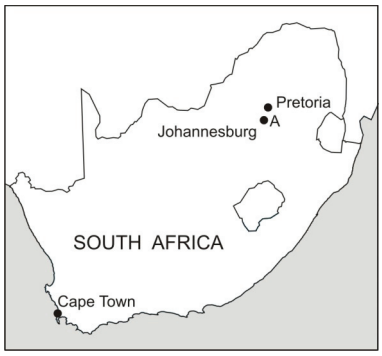


Figure 2.8

Compare your explanation above to our three explanations below. Note that more than one explanation has been deliberately provided. It is highly unlikely that two people would use exactly the same terminology and spatial frame of reference. You must also realise that people's place knowledge differs. Your explanation depends to a large extent on you and your listener's place knowledge. Try to identify what the three explanations have in common:

1. Place A is the South African city of Johannesburg.
2. Place A is the city of Johannesburg which is located about 58 km south of Pretoria.
3. Place A is the city of Johannesburg which is located about 16 hours from Cape Town by motorcar.

The common element in the three explanations is that the location of Johannesburg is described in terms of another place or area (e.g. Pretoria, Cape Town or South Africa), whose location the listener is assumed to know. None of the explanations tell us exactly where Johannesburg is located. Also note that the spatial relationship between Johannesburg and the familiar point of reference is indicated differently. Explanations 2 and 3 use direction, distance and time references.

Bergman and Renwick stress that relative location affects the interaction between places and the accessibility of a specific place. It is important to realise that interaction between places is affected not only by the actual distance between places but that numerous factors play a role in "lengthening" or "shortening" the distance between two places. Do you agree that person A in Cape Town who communicates daily by telephone with colleagues in Chicago and Stockholm is able to bridge distance more easily than person B, who has no money, transport or means of communication, can get a message to a family member in a neighbouring country village? In relative terms Chicago is closer to person A than person B is to the nearby village.

In ending off this discussion of relative location we want to remind you once again that two people will not use the same terminology to describe the relative location of a place or phenomenon. As your geographical knowledge increases, you will be better able to explain the relative locations of places to someone. Why? Because you will know more places which you can use as points of reference. In your study of geography you are going to be introduced to the spatial distribution of different phenomena. It will not help to only read about the distribution of phenomena. You must make sure that you know and can describe the relative location of the phenomena. By the way, we mentioned Cape Town, Chicago and Stockholm in the previous paragraph. Do you know where these cities are and could you describe their relative location to someone?

Activity 2.4

Use an atlas to describe the relative location of the following places, states and phenomena:

1. Antarctica
2. the Indian Ocean
3. the USA
4. Washington DC
5. Indonesia
6. the course of the Nile river

You now have the necessary knowledge to describe the location of places in both absolute and relative terms. You have also had some practise in finding the location of places on a map, if someone describes the location in absolute terms. However, longitude does not only give us an indication of which hemisphere (east or west) a place is located in. Longitude also tells us a lot about time, which has a considerable influence on our everyday life.

2.2.3 The Relationship between Longitude and Time

Study Task

Read the section on time zones in Bergman and Renwick.

Today someone in Cape Town (South Africa) can bridge the relative distance to Chicago (USA). However, the reality is that while the man in Cape Town is in the office during the day, his colleague in Chicago would be sleeping because it would be night-time there. When the man in Cape Town leaves the office late in the afternoon, his colleague in Chicago is only just beginning the working day. Because the earth is spherical and rotates on its own axis, the sun shines for only part of the day on each place on earth. This means that day and night do not occur at the same time on all places on the earth. In order to bridge relative distance, the earth is divided into standard time zones on the basis of longitude.

The term "meridian" (line of longitude) is derived from the Latin word meridianus which means "midday"; this explains the relationship between longitude and time more easily. The name meridianus has to do with the fact that it is midday (12:00) at the same moment at all places which are located on the same line of longitude.

These are the most important things to understand:

- Time zones are standardised in terms of time at the 08 line of longitude (the Greenwich meridian). (Such time is known as GMT [Greenwich Mean Time].)
- The calendar is standardised in terms of the International Date Line (the 180° meridian).
- The world is divided into 24 standard time zones.
- A difference of 15° in longitude is equal to one hour's difference in time.
- You can calculate the time at another place if you know what the standardised time is at the place where you are and you also know your own longitude and the longitude of the other place.
- You have to put your watch forward (make it later) for places which are located east of you and put your watch back (make it earlier) for places which are located west of you.
- You have to subtract one day if you cross the International Date Line from west to east and add one day if you cross the international date line from east to west.

You need to understand the difference between GMT and local time. In terms of local time it is exactly midday (12:00) at a place when the sun reaches its highest point above the horizon of that specific place. We have already said that at all places with the same longitude it is midday at exactly the same moment – their local time is exactly the same. It is self-evident that places with different longitudes cannot possibly have the same local time. The difference in longitude between South Africa's most easterly and most westerly points is about 16°. This gives a time difference of 1 hour and 4 minutes (remember that a difference in longitude of 15° is the equivalent of 1 hour). Imagine the confusion if time was not standardised and sports lovers across South Africa wanted to tune into a soccer final on television which began at 16:00 local time in the FNB stadium in Soweto. All fans living east of Soweto would need to switch on their TV sets after 16:00 local time whereas those living west of Soweto would need to switch on before 16:00.

Figure 1.19 (World time zones) in Bergman and Renwick clearly shows how the world is divided into standardised time zones and that the whole of South Africa

(and also Namibia and Mozambique) uses the same standardised time. The top row of figures in figure 1.19 shows the time in different time zones when it is 12:00 at Greenwich. The minus numbers at the bottom of figure 1.19 indicate the number of hours which the relevant time zones are ahead of GMT. A value of –7, for example, means that when it is 12:00 at the Greenwich meridian, it was 12:00 at places in the –7 time zone 7 hours ago. A value of +7 means that when it is 12:00 at Greenwich, it will be 12:00 at places in zone +7 only 7 hours later. So if it is 12:00 at Greenwich, it is 05:00 at places in zone +7.

Activity 2.5

1. Explain the difference between the concepts of "standard time" and "local time" by referring to Durban and Cape Town.
2. Suppose you work at a travel agency and have made the travel arrangements for a client who has to fly from Tokyo to Los Angeles at 15:00 on 14 January. The flying time between the two cities is 8 hours 30 minutes. Explain to your worried client that she will in fact be in time for her meeting in Los Angeles which is scheduled for 11:00 on 14 January.
3. We suggested earlier that a man in Cape Town would be unpopular should he phone a colleague in Chicago during his office hours. Would it be all right if this man in Cape Town phoned his colleague in Stockholm during lunchtime? Give reasons for your answer.

In the discussion of the representation of the earth by means of maps, the point was made that maps are reduced and distorted representations of reality. In the next section these two characteristics will be examined in more detail.

2.3 Maps: Reduced and Distorted Representations of Reality

This section focuses on

- how map scales can be used to convert reduced distances and areas on a map to actual distances and areas
- projection types which cartographers have developed to reduce the problem of distortion when the round earth is represented on a flat surface

2.3.1 Map Scales, Distances and Areas

Study Task

Study the discussion of scales in Bergman and Renwick.

As South Africa uses the metric scale, it is necessary to provide you with the metric version of the version in Bergman and Renwick that makes use of the references to a scale of 1:62 500 with 1:50 000 because this is the map scale on which South Africa's official topographical map series is based. To convert the figures in miles in the prescribed book to kilometres (km) you would need to multiply by 0,625.

Because the concept of scale and particularly its use in practice are reasonably difficult, you should work through the examples step by step with us and do all the activities. Make sure that you understand every step.

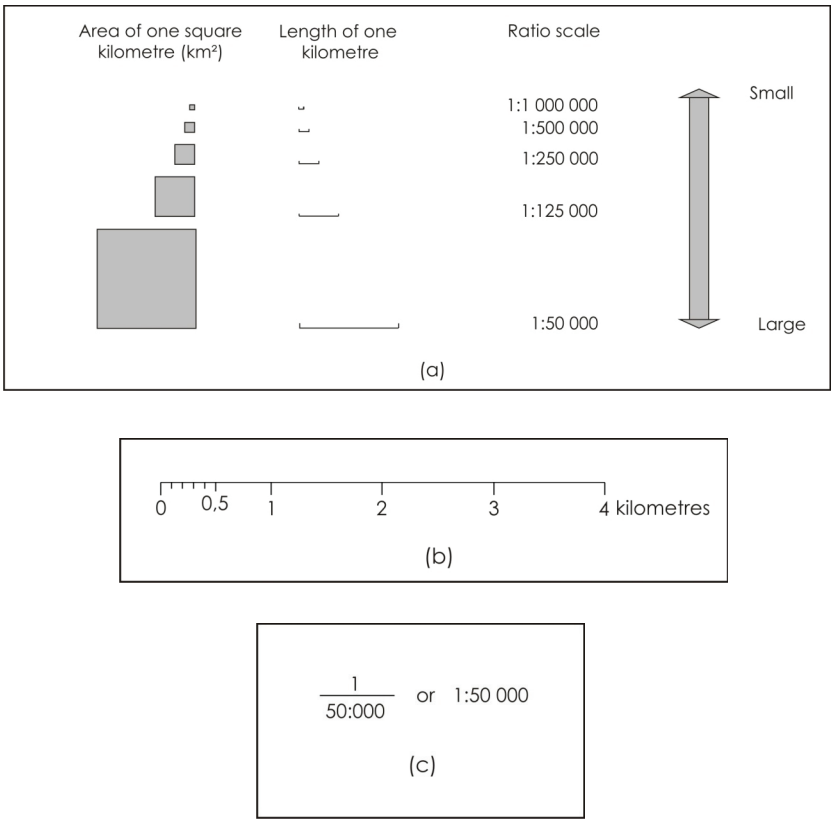


Figure 2.9

The representation in figure 2.9 shows that a small-scale map portrays a large part of the earth's surface. A large-scale map shows a smaller part of reality in much more detail. Figure 2.9(b) is a line scale. Figure 2.9(c) shows fractional (ratio) scales (Bergman & Renwick 1999:29).

Make sure that you understand the concepts of large and small scale and also the relationship between different scale levels and the amount of detail a map can show. The bottom figure in a fraction is the denominator. The greater the denominator, the smaller the map scale used to represent reality. You know, of course, that half (1/2) an apple gives you more to eat than quarter (1/4) of an apple. A map scale of 1:50 000 is therefore bigger and gives more detail than a scale of 1:250 000.

Also note that a fractional or ratio scale is neutral as regards the unit of measurement. In other words, a fractional scale of 1:50 000 means that 1 unit of measurement on the map is equal to 50 000 of the same units of measurement in reality. The unit of measurement can be mm, cm or whatever you choose to measure with. On a map with a scale of 1:50 000, 1 centimetre therefore represents 50 000 cm in reality, and 1 millimetre represents 50 000 mm.

To be able to calculate distances and areas, you have to be able to convert one metric unit to another metric unit. Suppose someone asks you how far the closest hospital is from your house and you use a 1:125 000 map to work out the answer. If what you measure on your map (16 cm) shows that the distance between your

house and the hospital is 400 000 cm, that is not the answer you would give. The answer is 4 km.

You could memorise the following rhyme to help you do conversions:

King	Henry (of)	Denmark	makes	delicious	caramel	meringues
Kilometre	Hektometre	Dekametre	Metre	Decimetre	Centimetre	Millimetre
Km	Hm	Dm	m	dm	cm	Mm

Suppose you now have to convert 4 000,5 mm to metres:

1. Write the metric units alongside one another:

Km	Hm	Dm	M	Dm	Cm	Mm

2. Put the decimal comma after the mm and write one figure under each unit.

Km	Hm	Dm	M	dm	cm	Mm
			4	0	0	0,5

3. Move the comma to after the "m" for metre:

Km	Hm	Dm	M	dm	cm	Mm
			4,	0	0	05

4. The answer is 4,0005 m. When converting areas from one metric unit to another, you must however remember that an area is two-dimensional – it has length and breadth. Instead of one figure under each metric unit, you now have to write down two figures.

Suppose you have to convert 732 006 429,8 cm^2 to hectares (Hm^2). One hectare (ha) is an area of 100 m x 6 100 m that is 1 Hm^2.

1. Write the metric units alongside one another:

Km^2	Hm^2	Dm^2	m^2	dm^2	cm^2	mm^2

2. Put the decimal comma after "cm^2" and write two figures under each unit:

Km^2	Hm^2	Dm^2	m^2	dm^2	cm^2	mm^2
	07	32	00	64	29,	80

3. Move the comma to after the "Hm^2":

Km^2	Hm^2	Dm^2	m^2	dm^2	cm^2	mm^2
	07,	32	00	64	29	80

4. The answer is 7,320064298 hectares (ha), or 7,3 ha (rounded off).

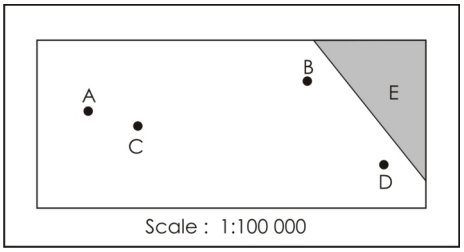


Figure 2.10

Activity 2.6

Calculate the distance (in km) between the two places indicated as A and B in figure 2.10.

Comment:

1. Map scale = 1:100 000.
2. Map distance between A and B (as measured with a ruler) = 40 mm.
3. Actual distance = map distance x scale.

   = 40 mm x 100 000.

   = 4 000 000 mm.

   = 4 km.

Activity 2.7

Consult figure 2.10 and calculate the actual distance between places C and D.

Activity 2.8

Calculate the total area of the area represented in figure 2.10.

1. Map scale = 1:100 000.
2. Calculate length.

   70 mm on map x scale

   = 70 mm x 100 000.

   = 7 000 000 mm.

   = 7 km.

3. Calculate breadth.

   30 mm on map x scale

   = 30 mm x 100 000.

   = 3 000 000 mm.

   = 3 km.

4. Area = length x breadth.

   = 7 km x 3 km.

   = 21 km^2.

Activity 2.9

Calculate the area of the wheat field marked E in figure 2.10.

Comment:

In contrast to activity 2.9 we now have a triangle rather than a rectangle. Look carefully at the shape of the triangle.

The lengths which you have been measuring on maps up to now have all been straight lines. You could simply put a ruler on the line and read the distance. Human phenomena often have straight, regular shapes. Natural phenomena, by contrast, mostly have irregular outlines. You cannot measure the length of the Nile or Amazon River with a ruler. So what do you do?

Set the two points of a pair of dividers at a certain distance, for example 0,5 cm. Now "travel" the whole length of the line with the dividers and count each "step" (see figure 2.10). A total of 47 "steps" of 0,5 cm gives a total length of 23,5 cm. Now compare this length with the line scale of the map.

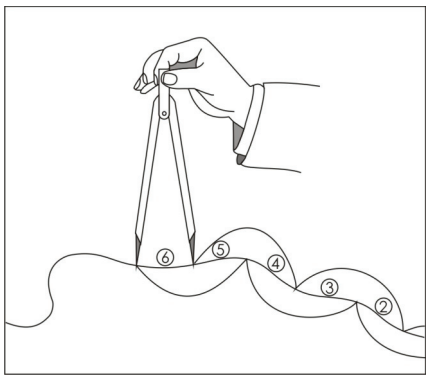


Figure 2.11: Measuring curvilinear distances on a map

Activity 2.10

You have a map with a scale of 1:25 000. Provide both a line scale and a word scale for the map.

Comment:

1. 1 cm on the map = 25 000 cm in reality.
2. 25 000 cm = 250 m.
3. Draw a line scale with cm lengths. Each centimetre (cm) on the line scale represents a distance of 250 m (or 0,25 km or a quarter of a km). Take note of the "m" which appears alongside the right-hand value of the line scale (fig 2.11). The "m" indicates that the distances on the line scale are measured in metre units. Without such an indication a line scale is useless.

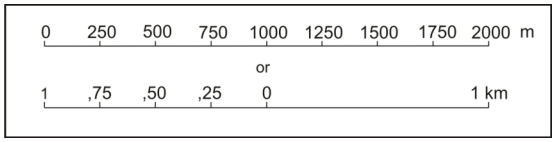


Figure 2.12

4. Word scale: 1 cm on the map represents 250 m in reality.

Activity 2.11

You have a map with a scale of 1:50 000. Provide both a line scale and a word scale for the map.

Activity 2.12

Express the line scale in figure 2.12 as a ratio scale.

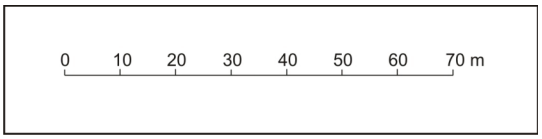


Figure 2.13

1. According to the line scale 10 mm on the map represents 10 m in reality.
2. 10 m is the same as 10 000 mm.
3. 10 mm on the map is therefore equal to 10 000 mm in reality.
4. A distance of 1 mm on the map is therefore equal to 10 000 divided by 10 = 1 000.
5. Ratio scale is 1:1 000.

Activity 2.13

1. Express the line scale in figure 2.13 as a ratio scale.

In concluding the discussion of map scales it should be emphasised that you must make sure of the scale of a map before you can interpret the map. You must be able to form an idea of how far apart places are from one another and how large the areas are that are depicted. The next activity intends to show you how essential it is to take scale into account when interpreting maps.

Activity 2.14

The following two maps (figs 2.14(a) and (b)) show the distribution of towns with more or less the same population size and composition and also the location of a clinic which serves the towns. Note, however, that the scale of the two maps differs considerably. Briefly discuss the desirability of building another hospital and/or clinic(s) to serve the towns.

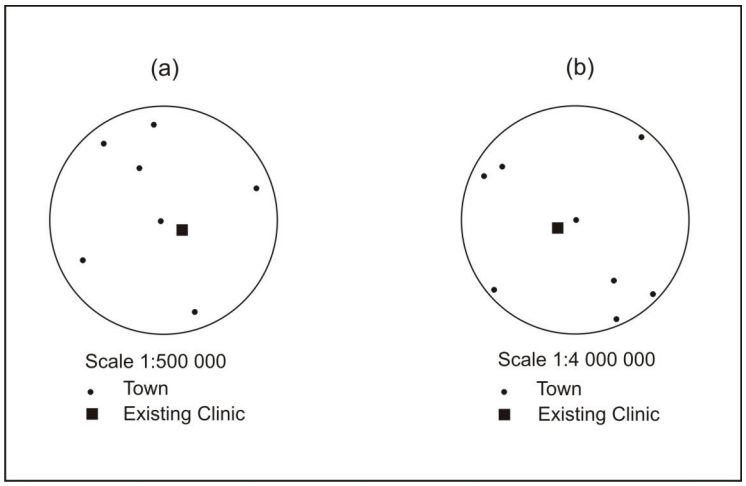


Figure 2.14

You have done a number of activities in which you have had to use scale to convert the reduced distances and areas which appear on maps to actual distances and areas. We hope that you have now well and truly mastered the concept of scale. In the next section we turn our attention to broad map projection categories, which were developed to reduce the distortion of the round earth when it is represented on a flat surface.

2.3.2 Map Projections

Study Task

Study the section on map projections in Bergman and Renwick (remember to include the appendix in the prescribed book as part of your studies).

Map projections are based on complicated mathematical applications which are designed to represent the geometry of the round earth on a flat surface such as a piece of paper. Your level of knowledge about projections must, however, be such that you will

- not interpret a map incorrectly or base invalid measurements on it
- be able to choose the right type of projection when you have to indicate phenomena on a map yourself

In the discussion of the geographical reference system you were introduced to the imaginary grid of lines of longitude and latitude which encircle the spherical surface of the earth and you were also given a list of characteristics. Because correctly

visualising this grid is so important to being able to evaluate projection types, it is essential that you familiarise yourself with this imaginary grid of lines of longitude and latitude. If necessary, you should revise it in section 2.2.1 before you continue.

2.3.2.1 Equidistance

In reality there is no such thing as a map that is perfectly true to scale. Remember that the earth is shaped like a ball. In order to represent the earth on a flat surface, certain sections of the earth will have distorted scale.

On small-scale maps you cannot measure the distance between any two places with a ruler and calculate the actual distance on the basis of the scale because the distortion is too great. The reality is that even on a map which does preserve scale, the scale is only correct between certain points and along certain lines of longitude and latitude. Those lines of longitude and latitude along which the scale is in fact correct are known as standard lines of longitude and standard lines of latitude or lines of null distortion. Unfortunately many maps fail to indicate to the user where the lines of null distortion are. You should therefore regard all calculated values on maps with a scale smaller than, say, 1:1 000 000 with suspicion if you are not convinced that they are true to scale or equidistant.

You are probably thinking that if a map does have a scale, we could use the scale to calculate distances and areas of phenomena. In the case of large-scale maps, for example 1:50 000 and 1:100 000 and even scales like 1:250 000, the argument would be correct – the scale distortion which is present is so minimal that we can ignore it.

2.3.2.2 Conformality

A map projection which preserves the shape of phenomena is conformal. Another important characteristic of shape-preserving or conformal projections is that they represent angles and therefore also direction correctly.

2.3.2.3 Equivalence

Projections which preserve area or equal-area projections are especially suitable for visually representing the spatial distribution of phenomena and particularly the density of distributions (e.g. population densities). Because geographers are so intensely interested in representing and studying spatial distributions, equal-area projections are the class of projection which geographers use the most.

The Goode homolosinal equal-area projection which is used in your prescribed book is highly suitable for indicating the distribution of phenomena on landmasses. Most of the distortion occurs in the ocean areas. However, because the phenomena which are mapped are not present in oceans, the effect of the distortion of distances, shape and direction over oceans is not serious. Bear in mind that the projection is interrupted over oceans. The interruption creates the impression that the landmasses are closer together than they really are.

2.3.2.4 Azimuthality

You should know at this point that all the lines of longitude on the spherical globe are straight lines which run from north to south, that lines of latitude are straight

lines which run from east to west and that lines of latitude and longitude cross one another perpendicularly (at an angle of 90˚). It is these characteristics which we have to look at to determine whether or not a projection preserves direction.

Distance and direction are two key elements on which navigation depend. The shortest distance between two points on a flat surface is a straight line. Because the earth is a sphere, and therefore three-dimensional, it is however impossible to connect, say, Cape Town and Moscow with a straight line. What then is the shortest distance between two places on the globe? We find the answer in the concept of a great circle.

A great circle is an imaginary circle on the earth's surface which divides the globe into two halves of exactly the same size. The surface of a great circle therefore always goes through the centre of the earth. Each line of longitude, together with its antimeridian (its continuation on the "other side" of the earth, for example the 20˚ East and the 160˚ West line of longitude), is therefore a great circle.

Two questions now arise: "How is a great circle route shown on a map?" and "How do we navigate to follow the great circle route?" Study figures 2.15(a) and (b). The thick line on figure 2.15(a) is a great circle which runs through places A and B. The line AB is therefore the shortest distance between places A and B. Figure 2.15(b) is simply an enlargement of the great circle route between places A and B. Make sure that you understand the following deductions which are based on the figures:

- The shortest distance between points A and B is via the great circle route which appears as the thick solid line on the maps.
- The compass direction of B from A is expressed as the clockwise angle which is formed by the intersection of the arc of the circle route and the line of longitude (meridian) which runs through the origin (in this case A). In this instance the angle is +137˚.
- Now suppose that you have moved along the great circle route to points A1, A2 and later point B. The angle formed by these points between the arc of the great circle and the relevant line of longitude is definitely not the same size as the angle at point A. They are +110˚ and +99˚ respectively (measure the angles with a protractor to convince yourself). The deduction which we have to make is that the great circle route crosses different lines of longitude at different angles. What is the implication of this? The compass direction changes and a navigator would have to constantly change his or her route direction to stay on track. Constantly changing direction like this is undoubtedly very impractical.

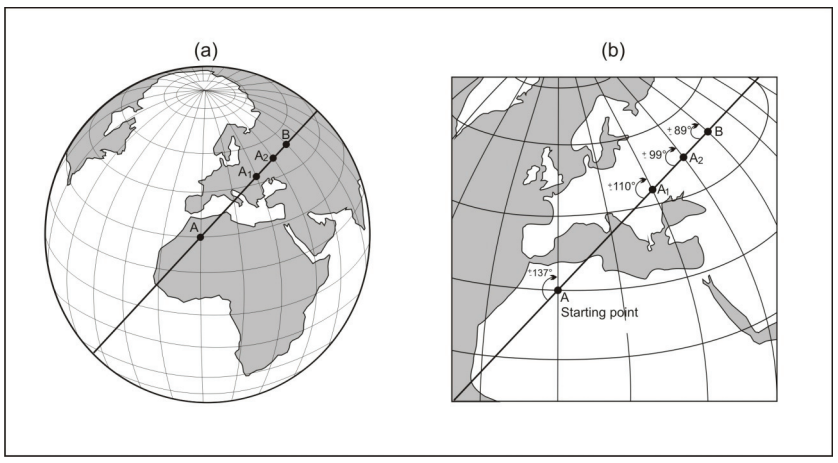


Figure 2.15

The "rhumb lines" are also known as loxodromes. The main characteristic of a loxodrome is that it correctly shows compass direction because it intersects all lines of longitude at the same angle.

Activity 2.15

Figure 2.16(a) is a gnomonic projection and shows the shortest route (the great circle route) which you as a pilot have to follow to fly from Tokyo to New Orleans. The gnomonic projection is, however, not suitable for determining compass direction. Figure 2.16(b) shows the same two cities on a Mercator projection which is suitable for measuring compass direction. Draw in the great circle route on figure 2.16(b) in and show how you would generalise the great circle route for navigation purposes in order to stay on track more easily. **Hint:** You might have problems drawing in the route. To help you, we have placed a dot at each point in figure 2.16(a) where the great circle crosses a line of latitude or longitude. You can plot the great circle route in figure 2.16(b) by simply showing all the dots in figure 2.16(a) in their correct position in figure 2.16(b). Because latitude and longitude values appear on both maps, you should be able to do it. You find the great circle route between Tokyo and New Orleans by simply joining up the dots which you plotted on figure 2.16(b).

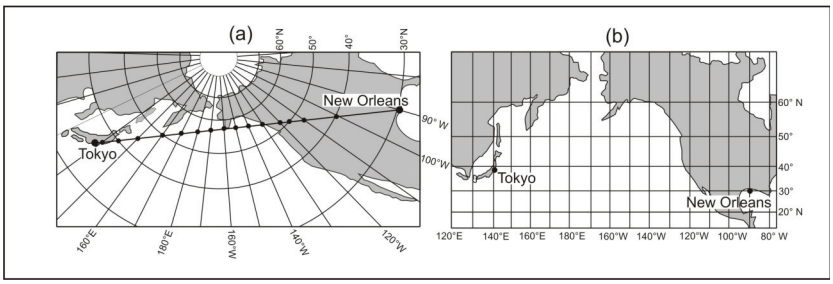


Figure 2.16

To conclude the discussion on projections we should note that there is no one correct projection and that one projection is not necessarily better than another. Different projections were developed for different purposes. The choice of a projection is therefore determined by the spatial message or story you want to convey by means of a map. In fact, a projection is often chosen that does not meet any of the requirements of preserving area, shape, direction or scale. Such a projection is the Robinson projection which is discussed in appendix I in Bergman and Renwick.

Although the Robinson projection (used by the National Geographic Society for mapping on a worldwide scale) is not an equal-area (equivalent) projection, it can be used for showing spatial distributions. As stated in this study unit, the projection does not meet any of the requirements of preserving area, shape, direction or scale. However, the projection manages to minimise the effect of the four possible forms of distortion reasonably well and it is also called a compromise projection. It creates a "correct impression" of the world, but there is not one point which is not distorted. Between 45° S and 45° N the distortion is very small. Outside these lines of latitude the distortion increases rapidly in the direction of the poles.

Activity 2.16

Complete table 2.3 by indicating which classes of projection and which specific projection you would choose for the different purposes we give. By projection class we mean equivalent, conformal, azimuthal or equidistant. You need not fill in the shaded cells.

Table 2.3

Purpose of map	Projection class	Projection name
To show global population density by means of dots		
To show the shortest route between New York and London as a straight line		
To show the world's dominant wind directions		
To serve as a general reference map of the area between 20° S and 20° N		
To emphasise the extent of global deforestation		
To compare the surface areas of continents		
To show the loxodrome between Johannesburg and Moscow as a straight line		
To show the flow pattern of ocean currents		
To serve as a political map for a lecture on the different outlines of countries of the world		
To calculate the distances between places on the equator		

Activity 2.17

1. Make a simple sketch in which you show the four references which (in your opinion) are the most important points of reference in the geographical reference system.
2. What is the importance of the geographical coordinates 21˚26'N; 39˚49'E and 41˚54'N; 12˚27'E to people of certain faiths? **Hint:** You will have to use an atlas.
3. Represent a scale of 1:5 000 graphically by drawing a line scale.
4. Use an atlas to calculate the distance between Tripoli and Benin. Also say where Timbuktu is located in both absolute and relative terms.
5. Suppose a South African athlete qualifies for the final of the 10 000 m race at an athletics meeting in the Australian city of Brisbane. At what time should we in South Africa switch on our television sets if we want to watch the race, which begins at 19:00 Australian time?

6. Complete table 2.4 below by indicating which class of projection and which specific projection you would choose for the given purposes. By projection class we mean equivalent conformal, azimuthal or equidistant.

Table 2.4

Purpose of map	Projection class	Projection name
To show the distribution of cattle in the world		
To show the main sea routes for the transport of crude oil		
To serve as a general reference map for the area between 35° S and 35° N		
To compare the size of the catchment area of rivers		
To show the great circle route between Cape Town and New York as a straight line		
To calculate the distances between places situated between 5° N and 5° S from a world map		
To indicate the location of Pretoria		

2.4 Contemporary Technology Used to Draw Maps

Study Task

Study the sections "Geographic information technology", "GIS: a type of database software" and "Integration of information technologies" in Bergman and Renwick.

Until very recently, maps were hand drawn using ink pens and specialised equipment. Nowadays maps are composed by computers. Information contained on the maps used to be collected by optical surveys, visual inspection and/or aerial photographs. Now we obtain location and land use information via global positioning systems (GPS) and satellite imagery, although we still use the conventional technologies of the 20th century. An added advantage of contemporary technology is the use of the geographic information system (GIS). The introduction of the GIS basically saves the geographer many hours of time, as this technology makes use of computers to assemble rapidly collected digital data, which it then analyses together with other information to produce simple, complex and specialised maps.

Although you need to be aware of the various technologies used to draw maps, you need not go into any of these technologies in detail for this module. Should you choose to continue your studies in geography, you will learn more about the use of GPS, GIS and satellite technologies.

IN CONCLUSION

You have now learnt a whole lot about the representation of the earth, location and the characteristics and use of maps. You should now be aware that although maps represent reality in a reduced and distorted form, they are extremely useful for conveying spatial information.

Study Unit 3

Maps and map use

INTRODUCTION

In this study unit we deal with the general characteristics of maps, how specific types of maps are created and how we analyse and interpret maps.

STUDY MATERIAL

No particular section in Bergman and Renwick must be studied for this study unit. However, you should page through the prescribed book to identify the variety of maps and symbols described in this section. The application of the various maps will also become clearer if you page through Bergman and Renwick.

Key Terms

- soline
- choropleth and dot density maps
- contour lines
- bearing

Learning Outcomes

Once you have worked through this study unit you will be able read maps and be able to create maps yourself. You will also be able to use a map to gain a better understanding of both the spatial processes which occur around us daily and the spatial distributions and patterns which arise from these processes. You will know that you are able to do this when you can

- read map symbols
- create a map legend
- read and describe direction
- represent data spatially
- draw isoline, choropleth and dot density maps
- represent quantitative information (i.e. numerical information) in a visually effective way on maps

- derive the dimension of height from contour lines and also describe it qualitatively and quantitatively
- draw contour lines associated with certain landforms and identify such landforms on a contour map
- draw drainage lines and basins on a topographic map

3.1 The Value of Maps

A map is unique in the sense that it depicts spatial data (any data on objects or phenomena whose location and distribution we know) in the correct relation to one another. A map is a spatial information system which gives us the answers to many questions about the area which is shown in the map: the distance between places and phenomena, the location of a phenomenon and the location of different types of phenomena relative to one another, the area of phenomena, and the distribution patterns of variables.

For a map to be useful and effective, you have to understand the message which the cartographer or map maker wants to communicate to you as the map user. It is not possible to show all the details of the world, your country or your town all on the same map. The detail would be overwhelming, and you would not be able to read the map at all. Instead of creating a single map from which you would have to read, say, the natural resources, air pressure patterns, rainfall patterns, vegetation types, soil types, air pollution levels, traffic systems, economic strength and population growth of the countries of the world, the cartographer creates topic-specific maps. In other words, the cartographer creates a separate map for each of the phenomena we have mentioned above, because mapping them all together would lead to total confusion.

The phenomena which the cartographer chooses to put on a map are largely determined by the purpose of the map. No information appears on a map which does not help the reader to understand the subject of the map. Suppose you had to create a world map which shows possible reasons for shipping disasters on the coasts of continents. You would not show rivers, railway lines and roads on such a map! Rather you would map the distribution of phenomena like lighthouses, ocean currents, coral reefs, ocean depths and storm wind belts. In other words, you would only map the essential details.

In the sections which follow we are going to give you many guidelines and hints to help you achieve the learning outcomes for this study unit, but always remember that the simpler a map is the quicker and easier it is to understand. You only have to take a look at any map in Bergman and Renwick to see how "simple" maps are easy to understand. Sometimes the subject and purpose of a map are much more complex and you have to study the map intensively before you can make any sense of the spatial distributions and understand what the spatial relationships are. After you look at a variety of maps in Bergman and Renwick, you will note that the more phenomena that are mapped, the more difficult it is to interpret the map. Please be reassured that if we ask you to study a map, it does not mean that you have to be able to redraw the map. Rather see a map as a tool which you use to identify,

describe and explain spatial distributions and spatial relationships more easily (i.e. those explained in study unit 1).

3.2 Types of Maps

Maps are task-specific, and there are different types of maps. It is completely impossible to expose you to every possible type of map within the limited length of this study unit. Maps can, however, be divided into several broad categories (ie classified) on the basis of some of their characteristics and next we look at three of these categories, namely classifications based on

- scale
- function
- the nature of the phenomenon which is mapped

3.2.1 Classification on the Basis of Scale

In study unit 2 you were introduced to the terms "small-scale maps" and "large-scale maps". You should also know by now that the smaller the map scale, the less detail can be shown on the map and the greater the degree of generalisation. The cartographer therefore has to be stricter in selecting the phenomena which he or she wants to map. The terms "small-scale", "medium-scale" and "large-scale" are relative and there is no agreement on the quantitative limits between the three scale groups. There is some agreement that maps with scales of 1:25 000 and even 1:50 000 can be classified as large-scale maps and maps with scales of 1:500 000 and smaller (e.g. 1:1 000 000) can be called small-scale maps.

Activity 3.1

A map with a scale of 1:50 000 is considered a large-scale map. But is the scale large enough to show details like the outline of houses in your suburb or town? Give reasons for your answer. Hint: Have a look at the extract from the 1:50 000 map in appendix A of this tutorial letter 501.

Activity 3.1 was included to show you how subjective the classification of a map on the basis of scale can be. Even though we consider a 1:50 000 map a large-scale map, the scale is still too small to show details like the shapes and sizes of houses. A building with exterior measurements of 12,5 m x 6,10 m has to be drawn as a box of 0,25 mm x 60,1 mm on a 1:50 000 map. Because this is completely impossible, small buildings like houses do not appear on 1:50 000 maps.

3.2.2 Classification on the Basis of Function

The purpose of some maps is to show the location of a wide variety of phenomena such as cities, towns, coastlines, landscape shapes, rivers, roads and railway lines. Maps with this type of function are called topographic maps or general reference maps. The name "topographic" comes from the Greek words topos and graphos

which mean "place" and "describe" respectively. A topographic map is therefore a "drawing which describes a place". A characteristic of this map type is that it tries to give the map user an idea of the three-dimensional shape of the landscape. By three-dimensional shape we mean the height above sea level at which phenomena are situated.

One can distinguish between large-scale and small-scale topographic maps. Large-scale topographic maps are based on very accurate surveys and are therefore the most comprehensive and accurate maps which can be made of any country. Because it is a long and expensive process which requires advanced technical equipment, knowledge and skills, the task is usually undertaken by government institutions. In South Africa the Chief Directorate of Surveys and Land Information produces the 1:50 000 topographic map series (a total of nearly 2 000 map sheets).

Examples of small-scale topographic maps are the maps of states, countries and continents which we find in atlases. They show the same type of phenomena as large-scale general reference maps, but since they represent larger parts of the earth and therefore have to be a lot more reduced and generalised, they cannot be as detailed and as accurate. A second group of maps which we can distinguish on the basis of function are thematic maps. As we will be looking at thematic maps in more detail later on, all we will say here is that thematic maps usually concentrate on the distribution of a single phenomenon or variable or the relationship between a pair of phenomena or variables. Page through Bergman and Renwick and look for thematic world maps, such as the maps on literacy, religion and agricultural production to mention a few.

3.2.3 Classification on the Basis of the Phenomenon which is Mapped

Because of the wide variety of geographical phenomena and the numerous uses which maps have the possible number of object-oriented or topic-specific map types is enormous. Some examples are cadastral maps (maps which show administrative boundaries like the boundaries of properties, magisterial districts and farms), political maps, soil maps, geological maps, climatic maps, population maps, and economic maps. Elsewhere in this module we will use these types, and also others, as examples of how we can use maps to expose and analyse spatial distributions.

3.3 The Characteristics of a Good Map

The chances that two journalists or commentators who have to write (or tell) the same story will use exactly the same words in exactly the same order are virtually nil. The chances are just as slim that two people who get the same instructions to draw a map will draw identical maps. Even if the maps look different, all maps should, however, have certain common characteristics which make it as easy as possible for the map user to understand the map's spatial message. The characteristics are

- the correct indication of the location of the phenomena
- a clear description of the purpose of the map

- a clear distinction between the essential information and the background information
- an indication of the map scale
- an indication of reference systems
- an indication of direction
- a clear explanation of the symbols which appear on the map

In the next section all of these characteristics are dealt with one by one.

3.3.1 Correct Indication of the Location of Phenomena

Maps show phenomena as though we were observing them from a position directly above the phenomenon (as seen in plan or orthogonally). Briefly distance, direction and proportion, and also the arrangement of phenomena in relation to one another, are distorted by any perspective other than a perspective in plan. Your ability to read maps will depend greatly on how successfully you can form a realistic picture in your mind of what appears in plan on a map. The secret to mastering this is to practise, practise and practise some more. Figure 3.1 gives you an idea of how different phenomena are indicated in plan and side view on a map.

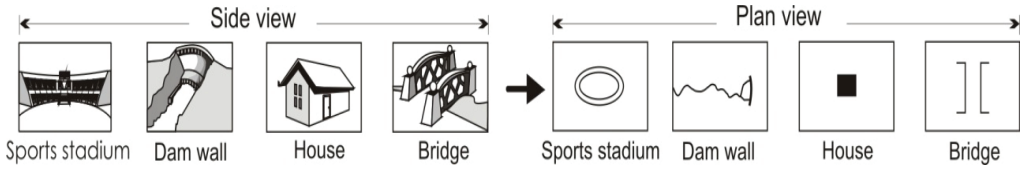


Figure 3.1

3.3.2 Clear Description of Purpose

Take a random look at any five maps in your prescribed book. Each map has a caption or title which briefly indicates what the phenomenon is that is mapped. The caption to a map therefore describes the map's purpose; without the caption you would not automatically know what the maps are depicting.

3.3.3 Emphasis on Essential Information

Cartographers should always try to make a clear distinction between a map's figure and ground. In short this means that whatever the cartographer wants to emphasise (the essential information) should stand out clearly. It is not quite as simple as we will put it now, but the essential information can be emphasised by indicating it in a brighter colour than colour used for the background information – the essential information should catch your attention immediately. Other ways of doing this are to use bolder lines, larger letters or larger symbols to distinguish the figure from the ground.

3.3.4 Necessity of Map Scales

Maps enable the user to form an idea of the proportions of the phenomena which appear on the map. In other words, it must be possible to use the map to say whether a phenomenon is bigger, smaller, taller, shorter, closer, farther, higher or lower than another phenomenon. Sometimes it is obvious that a phenomenon is bigger than another phenomenon, but it might also be necessary to use the map scale to calculate the exact proportions. Without a map scale it is impossible to calculate exact proportions. We discussed how you go about calculating areas and distances in depth in study unit 2 and therefore will not repeat it here.

Some of the maps in Bergman and Renwick have no scales. Why is this? Remember that we explained in study unit 2 that a map should not be used for purposes which are totally in conflict with the map's original purpose. You cannot, for example, use a conformal map to calculate distances or areas. By not giving the scale, the cartographer ensures that you will not use the map for the wrong purpose.

3.3.5 Indication of Reference Systems

You learnt about the geographical reference system and how it is used to indicate the absolute location of phenomena in study unit 2. When you have to draw a map, you should obviously also give geographical references (latitude and longitude) on your map. In your prescribed book many maps indicate the lines of latitude and longitude by continuous white lines. Sometimes these lines are not continuous and the positions of the lines of latitude and longitude are only indicated by short lines in the margins. Note that you cannot indicate only the position of the lines. You have to write in the values of the lines (e.g. 34˚) and also indicate which hemisphere you are referring to by using abbreviations such as N, S, E and W.

We have already discussed the use of the alphanumeric reference system (which is often found in atlases) in study unit 2 and will therefore not repeat it here.

3.3.6 Indication of Direction

All maps should give an indication of direction so that the map user can determine the location of places in relation to or relative to one another. North is the main reference point which is used on maps and in most cases north is at the top of the page. If direction is not indicated, you can assume that north is at the top of the page. Direction can be indicated on a map in different ways:

- The most common way of indicating direction is to use lines of latitude and longitude which show where east and west and north and south respectively are located.
- A direction indicator or an arrow (can you identify such indicators on the maps in Bergman and Renwick?) can be used on a map to show true north. Please note that North is not necessarily on the top of the map. A point of reference can also be true south rather than true north.

We referred to true north a couple of times in the paragraph above. Why did we not just say "north"? The reason for this is tied up in the two concepts of geographic

north and magnetic north. Geographic north, or true north, is located at the North Pole – that point where the lines of longitude in the northern hemisphere converge.

When a compass is used to describe direction, one refers to magnetic direction and magnetic north. Geophysicists have determined that the magnetic north and south poles do not correspond with the geographic north and south poles and that the magnetic poles actually change position or shift around continuously. The practical implication is that when we put a magnetic compass on a direction-preserving map (an azimuthal projection) which is correctly oriented, the compass needle will not point in the same direction as the lines of longitude on the map. This is because the compass needle is attracted to magnetic north. The angular deviation between the compass needle (which indicates magnetic north) and the line of longitude (which indicate true or geographic north) is known as the magnetic declination or magnetic deviation. In South Africa magnetic north is always west of true north.

The fact that the magnetic north pole is continuously shifting means that the magnetic declination varies from place to place and from time to time. A further complicating factor is that the declination is not constant from year to year. Institutions which are involved in the production of large-scale topographic maps simplify the problem by providing information about the extent and nature of the magnetic declination in the margins of topographic maps. Let's look at the topographic map which appears in appendix A. The angle diagram in the bottom left-hand corner shows the magnetic declination. There is also a note that indicates the magnetic declination (based on measurements during a year).

How do we use the general direction indicators on a map to describe precisely how places are located in relation to one another? First we are going to look at how we can describe direction in absolute terms by means of full circle bearing. Then we discuss how we use a compass rose to explain or describe direction in relative terms.

Full circle bearing (also known simply as "bearing") is the system most commonly used today for specifying direction exactly. Again we have to distinguish between true bearing and magnetic bearing.

Activity 3.2

In question 1 (which is based on figure 3.2(a)) we give you a worked out example which you should go through step by step. Then go on and complete question 2 of this activity on your own.

1. In what direction, relative to point A, is point B located? We could also have formulated the question as follows: What is the forward bearing on B from A?

   Because we do not have the magnetic deviation, we can only calculate true bearing. Note: The constructions which we refer to in the next steps are shown in figure 3.2(b).

   a. Construct a true north-south line which runs through point A – the northern tip of this line represents zero direction.

   b. Draw a line which joins points A and B.

   c. Place a protractor on the sketch in such a way that the base line is exactly on the north-south line and 0° is in the direction of true north.

d. Read, clockwise from the zero line, the angle which is formed between the north-south line and the line which joins points A and B. The angle is 50°.

e. B's direction from A is therefore 50°. We can also say that the forward bearing on B from A is 50°.

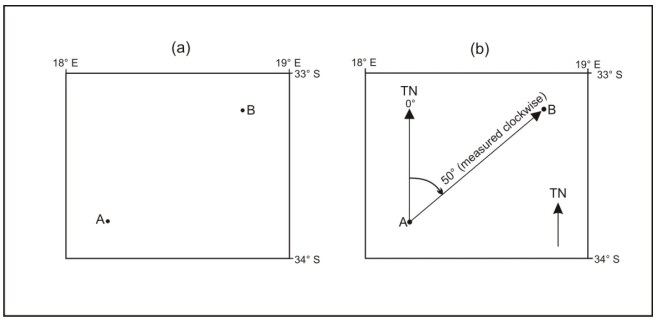


Figure 3.2

2. Use figure 3.3 to determine in what direction D is situated relative to point C.
3. Use figure 3.3 to determine the magnetic forward bearing on E from C.

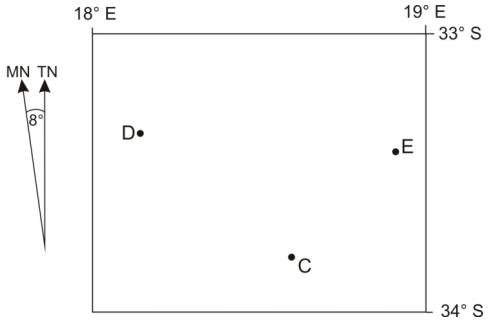


Figure 3.3

It is not always necessary to specify direction in exact terms using full circle bearing. A visitor to Namaqualand during Spring would probably be satisfied if you told him that he would find the prettiest flowers about 12 km northeast of Springbok. The compass rose in figure 3.4 shows some direction indicators which you can use to describe the direction of one place in relation to another place.

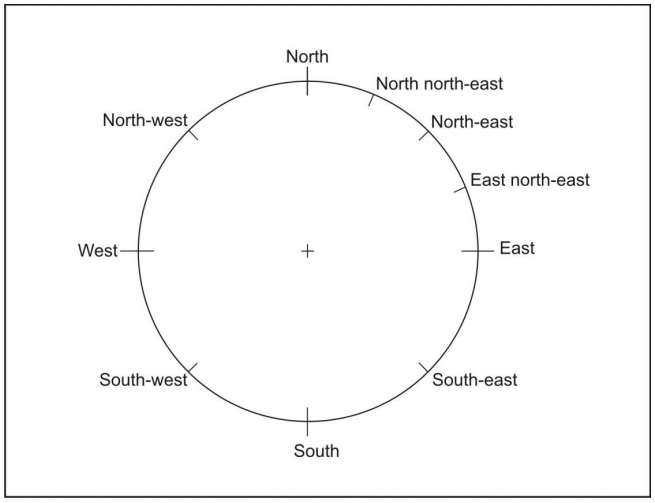


Figure 3.4

3.3.7 Description of the Meaning of Map Symbols

In order to use maps more efficiently in making spatial distributions, patterns and relationships clearer to yourself and others in your working and living environment, you need some insight into the principles on which the design of symbols on maps is based. You will find these useful not only when you have to draw a map yourself but also when you have to interpret other people's maps.

Through a map the cartographer is basically "telling" us where different phenomena are located. The language which the cartographer uses to convey his or her message does not consist of words like our everyday language does, but of a series of symbols which we call map language. If we do not understand the map language, we also cannot understand the map. It is therefore essential that the cartographer should briefly explain the meaning of each symbol which is used on the map. This is done by means of a legend or key. It is usually a clearly framed part of the text in which the meaning of each symbol is described briefly. To be able to interpret the information which appears on the map you have to use the legend. As you become more experienced at interpreting maps, you will also understand the map language better and will be able to "read between the lines" as it were without having to study the legend constantly.

The symbols which are used on maps may appear strange and absurd to you at first. However there are similarities between the nature of the actual phenomena and the type of symbols used to represent the phenomena. We can classify what occurs in reality in terms of dimensions, namely points (e.g. a church), lines (e.g. a river) and areas (e.g. a plantation). On a map we therefore use points, lines and areas to symbolise different phenomena which look like points, lines and areas. Point phenomena have no dimension, but line and area phenomena are one-dimensional and two-dimensional respectively.

Table 3.1

Point Phenomena	**Line Phenomena**	**Area Phenomena**
Church	National road	Cultivated land
School	Secondary road	Plantation
Post office	Footpath	Dam
Spot height	Perennial river	Shallow pan
Bridge	Non perennial river	Unused land
Caravan park	District boundary	Orchard
Airport	Railway line	Urban land
Small town		
Large town		
Copper mine		
Zinc mine		
Lead mine		

You now know that all symbols on a map are only points, lines or areas. By using this knowledge, you can now make your own map (see figure 3.5). Table 3.1 summarises all the phenomena which are indicated on the map (figure 3.5).

Figure 3.5

Activity 3.3

Turn to a map in appendix A. Draw a frame around the rectangular section which has geographical coordinates at its top left and bottom right corners respectively. Make a list of all the phenomena which are indicated in the rectangular section by means of symbols and alongside each name indicate (in brackets) whether the phenomenon is a point, line or area. Use the abbreviations P, L and A for points, lines and areas respectively.

All symbols on a map are only points, lines or areas. You will however note in this study unit that all the point symbols look exactly alike and all the line symbols and all the area symbols look exactly alike. We cannot distinguish between them at all. Luckily there is a solution to our dilemma and this is what we are going to discuss next.

There are four basic characteristics of a map symbol which make it possible for us to distinguish between different symbols which represent different phenomena on the same map. The four characteristics are colour, shape, size and orientations, Please refer to the legend that appears in appendix A while reading the following:

1. **Colour**. You can now quite easily distinguish the secondary road, river and district boundary in appendix A because they are drawn in red, blue and grey (grey is a lighter shade of black) on the map.
2. **Shape**. We can now also distinguish between the church, the school and the post office because their symbols look different. The same applies to the perennial river (a solid blue line) and a small stream (a blue dashed line). Some symbols are very similar to the phenomenon which they represent (e.g. the

symbol for a caravan park). Other symbols (e.g. the symbols for a school and a post office) do not look very much like the phenomenon which they represent.

Symbols are divided into two groups, namely iconic symbols and abstract symbols, on the basis of the visual similarity between the symbol and the phenomenon itself. Iconic symbols (e.g. the symbol for the caravan park) look much more like the phenomenon which they represent than is the case with abstract symbols (e.g. the symbol for the school). If you make a map for people who do not have much experience in reading maps, you should use more iconic symbols than abstract symbols.

3. **Size**. Because small towns and large towns are still towns, their symbols look the same. However, by changing the size of the symbol, we can distinguish between small towns and large towns.
4. **Orientation**. Note that the symbols which are used for the three types of mine all look the same in the sense that all three symbols are black semicircles which are exactly the same size. However, by changing their orientation we can distinguish between the three types of mine.

We can use the four characteristics of a map symbol in any combination in order to distinguish between phenomena. Have a look at the area symbols for farm lands, plantations and orchards, for example. All three phenomena are indicated by the same colour (green), but differently shaped symbols are added to help us distinguish between them. You also have to learn to read between the lines. The fact that farm lands, plantations and orchards are all the same colour green is an indication that the three phenomena are related – all three have to do with vegetation.

In topographic maps it has become standard usage to indicate certain groups of phenomena by certain colours. You will understand this last statement better when you have done activity 3.4.

Activity 3.4

Study the legend for the two 1:50 000 topographic maps which appear in appendix A of your tutorial letter. Complete table 3.2 by writing in three examples of each of the types of phenomena. Also indicate the colour in which the individual phenomena appear on the map. What conclusion do you reach?

Table 3.2

Examples of cultural or human phenomena	Examples of vegetation-related phenomena	Examples of water-related phenomena	Examples of landscape-related phenomena
Colour(s):	Colours(s):	Colour(s):	Colour(s):

To finish off this discussion of map symbols, we want to share a few deductions which we can make on the basis of the legend and topographic map in appendix A with you:

- Most of the symbols which appear on the map merely show where a specific phenomenon occurs and what type of phenomenon it is.
- Some symbols not only give us an indication of where we find what type of phenomenon but also tell us more about the size or importance of the phenomenon. By simply looking at the symbols for towns, we can see that one town is bigger than another. Many of the symbols which appear on the maps in your prescribed book are actually based on specific measurements.
- In the legend the phenomena are arranged in such a way that related types of phenomena are grouped together. This makes it easier for map users to interpret the map.
- Certain phenomena are indicated in specific colours.

In the discussion of map language we have not highlighted the symbols which are used to represent the three-dimensional landscape. Because we consider it very important that you should develop the ability to deduce the shape of the landscape from maps, we have devoted a whole section to it later in this study unit.

3.4 Representation of Height above Sea Level

To start off this section in which we discuss heights and the representation of heights, we want to immediately focus your attention on two terms, namely "relief" and "topography", which people often use incorrectly when talking about the landscape. Do you remember in section 3.3.2 we indicated that topographic maps show a wide variety of features such as cities, towns, coastlines, and the shape of the landscape, rivers, roads and railway lines? All these features together constitute the topography of the landscape. The mistake which people sometimes make is to interpret the word "topography" very narrowly and to associate it only with variations in the height of the landscape.

We are actually getting ahead of ourselves a bit, but you also need to know that the heights on a topographic map are always relative to sea level. We are actually getting ahead of ourselves a bit, but you also need to know that the heights on a topographic map are always relative to sea level. The height symbol (e.g. a spot height) on a topographic map shows the height in meters (m) above the average sea level. The word "relief" comes from the Latin word relevare which means "to raise up". Relief has to do with the difference in height between places (not between the place and sea level) and we use it when we are referring to the third dimension (i.e. the mountains, hills, plains and valleys) of the landscape. We can look at the landscape and say that the mountain to the west rises about 300 m above the valley. We only know that the mountain is 300 m higher than the valley, but we have no idea how high (or perhaps how low) the mountain is in comparison with other mountains in our region, our country or the world.

Throughout the centuries cartographers have shown a lively interest in ways of representing the height dimension of the landscape not only accurately but also

realistically on maps. The four landscape representations which we deal with next, namely hill shading, hypsometric colours, spot heights and contour lines, are the ones which are used most commonly in atlases and topographic map series.

3.4.1 Hill Shading

In Bergman and Renwick there are many maps in which shading is added as a grey background to give the reader an idea of the relief of the landscape. One of the best examples is the relief map which appears in the inside cover of Bergman and Renwick. Other examples can be found in figures 1.4, 2.6, 6.29, 6.30 and 7.16.

Activity 3.5

What is the purpose of adding shading as background to so many of the maps in Bergman and Renwick?

3.4.2 Hypsometric Colours

In addition to hill shading, some maps in Bergman and Renwick (in particular the world map representing the earth's topography on the inside cover) show the technique of using hypsometric colours to indicate relief. Basically the technique involves using different colours to indicate different height categories. The term "layer tinting" is a very good description of what the technique entails. Along with the essential legend the hyposometric colouring shows us at a single glance what parts of the earth's surface are the highest above sea level – in this case it is the purple Himalayas in Asia which form the boundary between China and Nepal and the high Andes range on the west coast of South America. Also note that the colour of adjoining height categories are not contrasting, but rather shades of the same colour or colours which do not contrast very sharply with each other. It has also become standard usage to colour the lowest lying area green. Page through an atlas and have a look at the different hypsometric colour schemes which are used to indicate different height categories on a topographic map.

There are two criticisms of the use of hypsometric colours. In the first place some people claim that hypsometric colours create the illusion that the landscape is layered. Secondly the critics say that many map users associate the use of green for the lowest lying areas with lush vegetation cover. However, if you read the legend, you should not make this type of incorrect deduction. Hypsometric colours are not very effective in representing the three-dimensional landscape realistically.

3.4.3 Spot Heights

In section 3.3.2 we indicated that large-scale topographic maps are based on accurate surveys. The measurement of the height above sea level of prominent landmarks is one of the measurements we referred to. The indications of such measurements of height on a map are called spot heights. Turn to appendix A and see what the symbol for a spot height looks like in the combined legend for the acompanying

maps. You will see that it is a small dot with a height value alongside. Note that a trigonometric beacon (find it in the legend too), which is indicated by a small open triangle, is also a spot height. The value which appears below (or sometimes on the left-hand side of) the triangle is the height of the beacon above sea level. The value on the right-hand side is the number of the beacon.

Activity 3.6

1. Turn to appendix A. Use the map to determine how high above sea level the highest point is.
2. Explain what you understand by the term "relief" by referring to features found on the map.

3.4.4 Contour Lines

We are going to use activities to give you practise in drawing contour lines and deriving the three-dimensional shape of the landscape from contour lines.

For now we will not concentrate on the theory that contours are based on, but will start with a practical illustration of how we can create a contour map:

- **Step 1**. Take a large square glass dish which stands completely level and pack clay (or a very clayey soil) into the dish so that it forms a pile in the middle of the dish (see figure 3.6(a)). Press the clay together so that it forms a steep "mountain" and make a groove all the way down the pile of soil, from top to bottom, as shown in the figure. Your pile of clay now represents a mountain or hill, and the groove is a valley which has been eroded by rainwater running down the hill.
- **Step 2**. Take a ruler and measure a number of vertical intervals of equal length along the side of the dish to show its depth (see figure 3.6(b)). You can use any unit of length; it depends on how deep the dish is. We used 5 cm vertical intervals.
- **Step 3**. Fill the dish with water until the water is 5 cm deep in the dish and make a number of marks around the pile of soil at the exact level of the water. The more marks you make, the more accurate your end result will be. Once you have made the marks, you can use a tin of spray paint to join the marks with a line. All the marks on this line are 5 cm above the bottom of the dish. Why did we say that the more marks you make, the more accurate the result will be? Remember that a line is actually just a whole lot of points (or marks) which are so close together that you cannot distinguish between the individual points. The closer together you make the marks, the more the marks will look like a line. When you join the points by means of a line, you are actually estimating the position of those extra points which are needed to make a continuous line of points.
- **Step 4**. Now fill the dish with more water until the water reaches the 10 cm mark. Mark the water level again with a lot of marks and join them with a line of spray paint. We trust that you will agree that each point (or mark) on this second line is 10 cm higher than the bottom of the dish. Secondly each point on the 10 cm line is also precisely 5 cm higher than any point on the 5 cm line. Repeat this procedure by pouring another 5 cm of water into the dish each time (see figures 3.6(c)–(e)). Keep on until the tip of the "mountain" sticking out of the water is less than 5 cm high.

- **Step 5**. Pour the water out of the dish without disturbing the pile of clay (see figure 3.6(f)), and go and stand next to the dish so that you are looking at the pile of soil from the top. What do you see? The lines which you made when you increased the water level by exactly 5 cm each time look like those in figure 3.6(g). Where the groove or indentation occurs on the side of the pile of soil, the lines are also indented. As in figures 3.6(b) to (e), all the lines in figure 3.6(g) are also closed lines, in other words the starting point and end point of each line join each other. What do these similarities mean? Let us use the innermost line in figure 3.6(g) as an example. The significance of the innermost line is that it represents all those points which are exactly 20 cm higher than the bottom of the dish. In other words, it represents the marks which we made when the water level in the dish was 20 cm high. In the same way we can say that the line which is marked with a "5" in figure 3.6(g) represents all those marks which we made when the water level in the dish was 5 cm high. What we did when we drew figure 3.6(g) was to copy the pattern of each line, as we saw it from above (orthogonally or in plan), exactly onto a piece of paper (a map). We call the individual lines on the piece of paper contour lines and figure 3.6(g) as a whole a contour map. In other words we use contour lines to represent height, which is a three-dimensional concept, on a flat surface. When you look at a contour map you have to teach yourself not to see the landscape as you see it each day when you drive past in a motorcar or walk past in the veld, but as you would see it if you were looking down on every mountain, hill or valley.

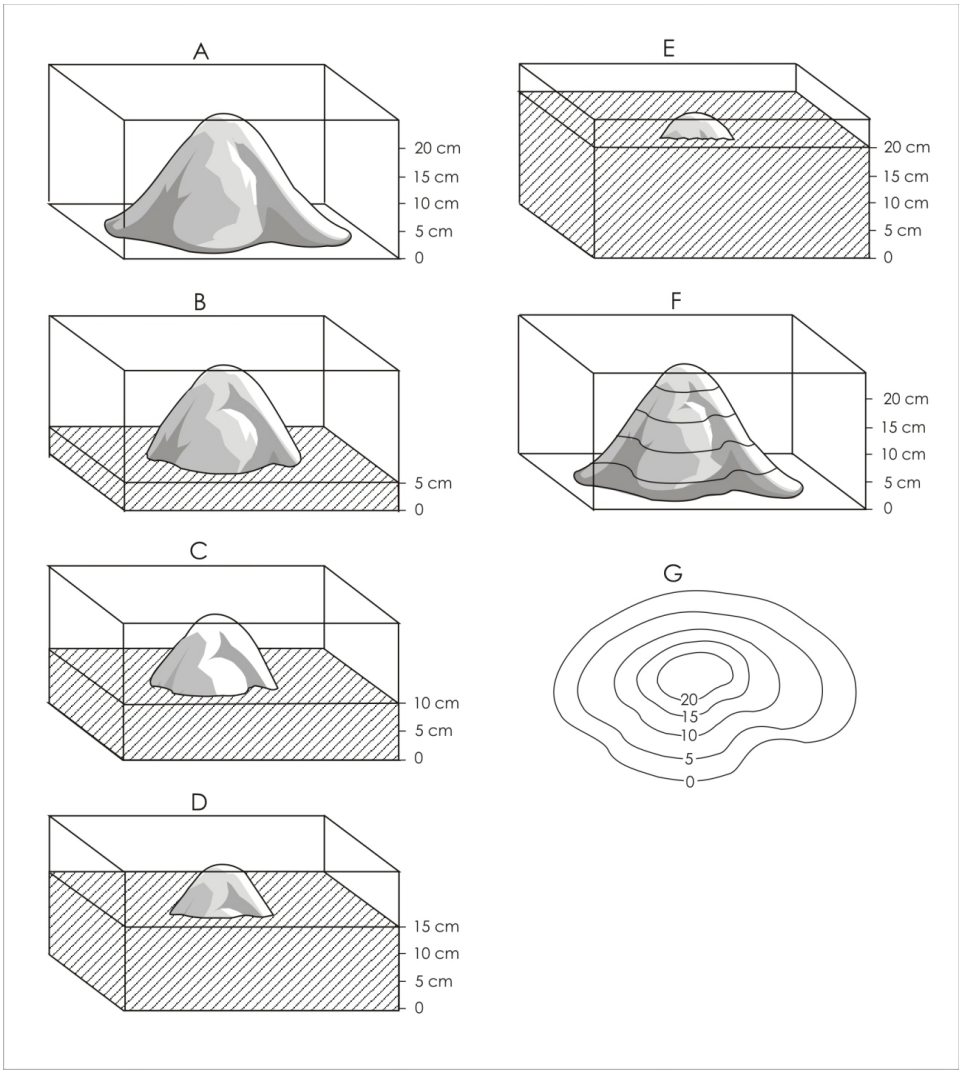


Figure 3.6: The principle according to which contour lines are plotted on a map

To end off we can now describe a contour line and a contour map as follows. A contour line is a line which joins points of the same height above a base level – these lines are also known as isolines, isarithms or isometric lines. In the case of our "mountain", the base level was obviously the bottom of the dish. On a contour map of an actual landscape the average sea level forms the base level. A contour map is the orthogonal representation (as if you were looking at something from directly above it) of evenly spaced contour lines on a flat surface like a map. By "evenly spaced" we mean that the height difference between any two adjoining contour maps should be the same everywhere on the map. Let's go back to our example of the "mountain" in the dish. The difference in height between adjoining levels was 5 cm each time. We could not have drawn a usable contour map if the difference between water levels had been 5 cm, 8 cm, 10 cm and 17 cm respectively.

3.4.4.1 Drawing a Contour Map

In the previous section you learnt how to draw a contour map from the pile of clay in a dish. In reality it is, of course, impossible to flood the landscape with water so that we can draw a contour map. So how do we go about drawing contour lines? Think a little about what a contour line is. Contour lines give us information about how high points are above a base level (sea level). To draw a contour map we therefore need the location of a whole lot of points on the earth's surface whose height has been measured very accurately. When we join the points with the same height above sea level, we have drawn a contour map.

It sounds quite easy, but where do we get the information about the point's location and height above sea level? We are in the fortunate position today that large portions of the world (including South Africa) have been properly surveyed. This means that the country has a network of trigonometric beacons whose location and height above sea level have been accurately determined by surveyors. In South Africa this is the function of the Chief Directorate of Surveys and Land Information in Mowbray, Cape Town. Of course we can draw contour lines automatically by computer today – but, to help you understand, it is essential that you can draw a contour map yourself on the basis of the information which the computer package requires to draw it automatically. This is exactly what we are going to do next.

Suppose you have the geographical coordinates and height above sea level of a number of trigonometric beacons (see table 3.2). You have to use this information to compile a contour map with contour intervals of 50 m. Note that 10 trigonometric beacons are too few to draw a relatively accurate contour map – we will explain the reason for this statement to you later on. However, we did not want to compile a table which covers page after page and requires a whole lot of repetitive work from you. In figure 3.6, which is going to serve as the basis of our contour map, we have therefore already given the location and height values of additional trigonometric beacons so that we can create an accurate map. All we have to do is to add the information in table 3.

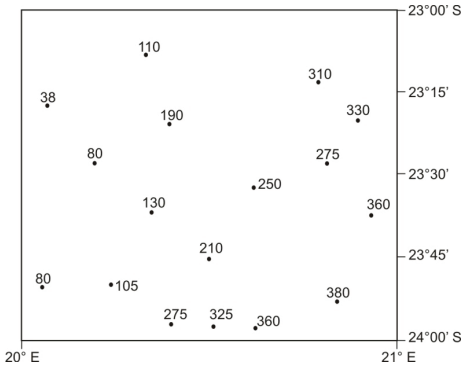


Figure 3.7

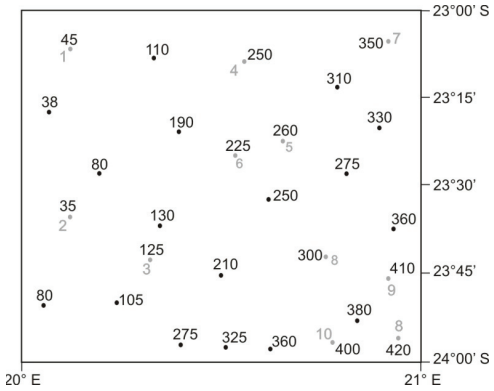


Figure 3.8

Table 3.3

Beacon number	Location		Height above sea level (metres)
	Latitude	Longitude	
1	22°7'	20°7'	45
2	22°4'	20°8'	35
3	22°43'	20°19'	125
4	22°9'	20°33'	250
5	22°23'	20°39'	260
6	22°25'	20°32'	225
7	22°5'	20°55'	350
8	22°42'	20°45'	300
9	22°46'	20°55'	410
10	22°11'	20°46'	400

1. In figure 3.8 the location and the number of the 10 additional trigonometric beacons which appear in table 3.3 are added in blue to those in figure 3.7. The beacons' height above sea level is given in black.

2. We have now entered the information from the table on the map and we can go on to the next step, which is drawing contour lines. Remember, however, that we specified that the map must have a 50 m contour interval or vertical interval. What does this mean? Easy! The height difference between adjoining contour lines must never be more or less than 50 m. In other words, the height levels which we have to show must increase in increments of 50 m. Since the minimum and maximum height values on the map are 35 m and 420 m respectively, we have to draw the 50 m, 100 m, 150 m, 200 m, 250 m, 300 m, 350 m and 400 m contour lines to make provision for all the height values on the map.
3. The process by which we determine and draw in the position of each line is known as interpolation. (Interpolation means that we estimate the value of a point on the basis of surrounding points whose values we know.) Let's begin with the highest contour line. The 400 m contour line joins all the points which are 400 m above sea level, and it separates all those points whose height value is lower than 400 m from those points whose height value is higher than 400 m. In the case of points whose height value is exactly the same as that of the contour line the interpolation is relatively simple – the 400 m contour line must run through all points which are situated exactly 400 m above sea level. The question is: What happens between the points? Let's illustrate this using figure 3.9 in which a 5 m contour line has to be drawn in.

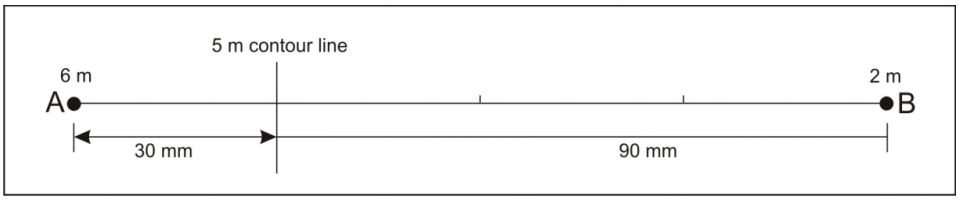


Figure 3.9

4. You should agree that we have to draw the 5 m contour line somewhere between points A and B.
5. Since the difference between the height value of point A (6 m) and the value of the contour line (5 m) is smaller than the difference between the height value of point B (2 m) and that of the contour line, we have to draw the contour line closer to point A than to point B. Point A (6 m) is only 1 m higher than any point on the 5 m contour line, whereas point B (2 m) is 3 m lower than any point on the 5 m contour line.
6. The question is: Where exactly between A and B must we draw the contour line? Point A differs by 1 unit (6 m – 5 m) and point B differs by 3 units (5 m – 2 m) from the value of the contour line. The joint deviation of points A and B from the contour line is therefore 4 units. We can now simply divide the distance between points A and B into four units of equal length. Since line AB is exactly 120 mm long, we need 4 units of 30 mm each. We can now draw in the exact position of the 5 m contour line easily and accurately. It is 30 mm from point A and 90 mm from point B.

Please don't worry! We will not expect you to calculate the position of each point on a contour line mathematically (do you remember that a line is in fact simply a se-

ries of points which have been plotted very closely together?). You must, however, be able to estimate the position of the contour lines reasonably accurately.

Figure 3.10 shows step by step how we draw in the individual contour lines. Put differently, it shows how we interpolate between the height values which appear in figure 3.8. Figure 3.10(a) shows the 400 m contour line. This line separates all points which are lower than 400 m and higher than 400 m above sea level from one another. In figure 3.10(b) we have added the 350 m contour line. The completed map on which we have drawn in all the contour lines appears in figure 3.10(c). Our advice to you is always to begin with the highest contour value. Also note that we always write in the contour value on the corresponding contour line and that we do so in a very specific manner. Contour values can be written in parallel to the contour lines on a map, but the contour value (the figure which you write in on the map) must always be oriented in such a way that it points in the direction of the increase in height. This means that you sometimes have to write in contour values upside down on a map. Also note that you put the value on the "higher" side of the contour line. Thus by simply taking note of how contour values are entered on a map, you can deduce where the high-lying and low-lying ground is.

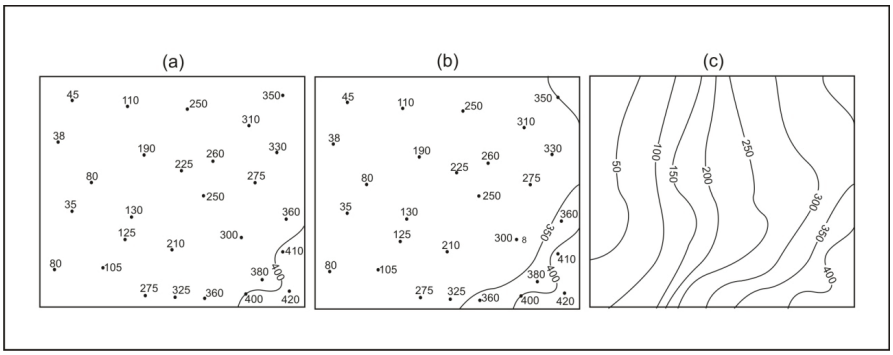


Figure 3.10

It is definitely not necessary to write in the height value of each contour line on an actual map. Always ask the following question when you are drawing a contour map: Am I providing sufficient height information for the person reading my map to be able to deduce the contour values relatively easily?

Before we give you the opportunity to read/complete a contour map by means of interpolation, we need to summarise some "contour rules" and also test whether you are now able to use a contour map to make simple deductions about height. Let's first look at these five principles of contour lines:

1. Contour lines never cross one another.
2. A contour line is always a closed line which either joins itself again or is drawn to the edge of the map on the assumption that it continues on the adjoining map.
3. Contour lines must always be given height values, or otherwise the height of every fourth or fifth contour line must be indicated so that the map user can easily read the values of the lines in-between.
4. The correct way to indicate the height values of contour lines is to write them either in the middle of the line (e.g. 400) or on the "higher" side of the line. The

contour values should be written in such a way that the map user reads them in the direction of the increase in height.

5. The vertical difference in height between adjoining contour lines must always be the same everywhere on the map.

Activity 3.7

All the questions below are based on figure 3.11.

1. Colour in the whole area between 500 m and 750 m above sea level in light brown.
2. Indicate the highest point on the map with the symbol H.
3. Indicate the lowest point on the map with the symbol L.
4. Estimate how high points A, B, C and D are above sea level.
5. How far is point X from point Y?
6. How many metres higher is point E than point F?
7. Why would it take more effort to walk from point G to point E than from point F to point E?
8. Do you agree with the statement that a contour map is based on accurate measurements of height at definite points (data points), but that the height values between the data points are based on informed estimations? Give reasons for your answer.

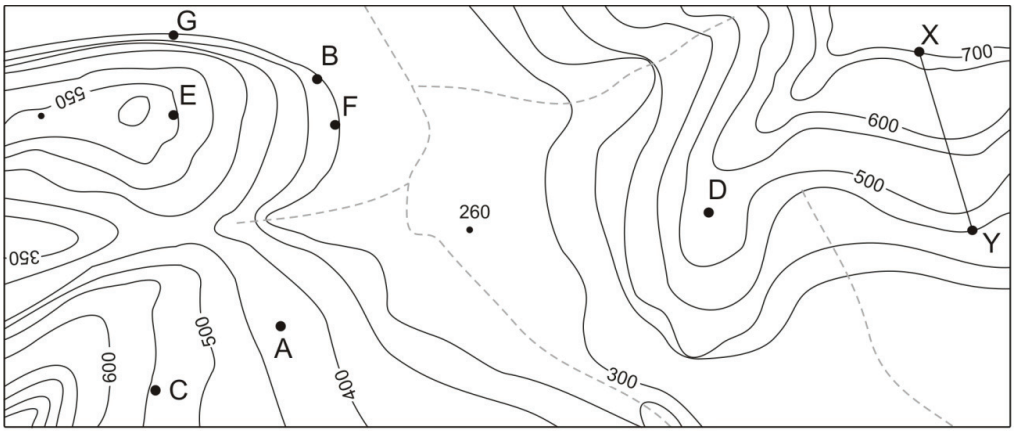


Figure 3.11

In activity 3.7, you had to calculate distance with a specific purpose in mind (see question 5). You had to measure the distance between point X and point Y with a ruler and then take the scale into account. Never make the mistake of trying to measure the difference in height (see question 6) between two places with a ruler. We calculate the difference in height between two points by inferring the height of each point from the contour lines and then subtracting the one value from the other value. Remember, contour lines give us information about the vertical dimension. We measure the map distance (a horizontal dimension) between two places with a ruler, of course. By taking the scale into account, we are able to convert the map distance (the ruler distance) into actual distance. We did this in study unit 2.

Now you get the opportunity to draw a contour map yourself.

Activity 3.8

Draw in contour lines of which the contour interval is 50 m, in figure 3.12. You must base the contour lines on the position and height values of the 30 spot heights which appear in the figure. Use the left-hand map (figure 3.12(a)) to practise on and then copy the final contour lines (and contour values) in neatly on the right-hand map (figure 3.12(b)). Note that your lowest contour line must be the 350 m contour line.

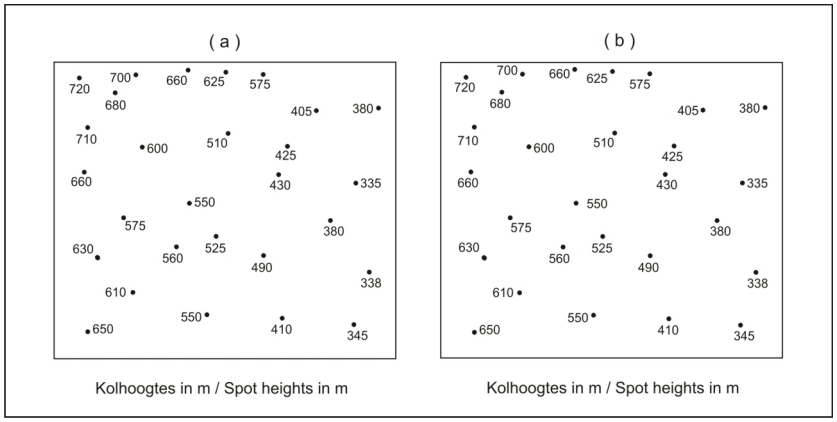


Figure 3.12

To conclude the discussion of how to draw contour lines, we need to point out that isolines (a contour line is one type of isoline) have a far wider application than representation of height above sea level. We can distinguish between two types of isolines: isometric lines and isopleths.

Isometric lines (Greek metron = measure) join values which occur at specific places and which have been accurately measured. Examples of such isolines are isohypses (otherwise known as contour lines – lines of equal height above sea level), isotherms (lines of equal temperature), isobars (lines of equal air pressure) and isohyets (lines of equal rainfall).

The following examples all appear in Bergman and Renwick. Figure 2.6 (global temperatures) is based on measurements of temperature at weather stations and the isolines or isometric lines of equal temperature are known as isotherms. Figure 2.23 shows lines of equal air pressure, namely isobars. The method of representation in figure 2.30 differs slightly from that in figures 2.6 and 2.23, but in essence it is also based on interpolation. In the case of figure 2.30 the isolines of equal precipitation are not given isoline values. The surfaces between the isolines are instead coloured in and the map has a legend which indicates exactly what intensity of precipitation is associated with a specific colour. By studying the legend, we are quickly able to establish that the map actually consists of isolines which represent precipitation values of 25 cm, 50 cm, 100 cm, 150 cm (not 105 as indicated by error in Bergman and Renwick!) and 200 cm. The principle of allocating colours to categories is exactly the same as that of the hypsometric colours which we discussed earlier.

Isopleths (Greek plethos = amount) differ from isometric lines in the sense that the values associated with them are not measured at points but are values which have to

do with spatial units such as census districts, provinces or countries. A good example is a country's census information. We know that people do not all come together in one place to be counted. However, this is the assumption that the cartographer makes when he or she is compiling, say, a population density map. For mapping purposes, the cartographer chooses a point in each census district and makes the assumption that all the people in the different census districts live at that point. Then he or she interpolates between these points on the basis of the quantitative value (whether number of people, cattle or perhaps motorcars) which is associated with the point. The technique of isopleth mapping is illustrated in figure 3.13.

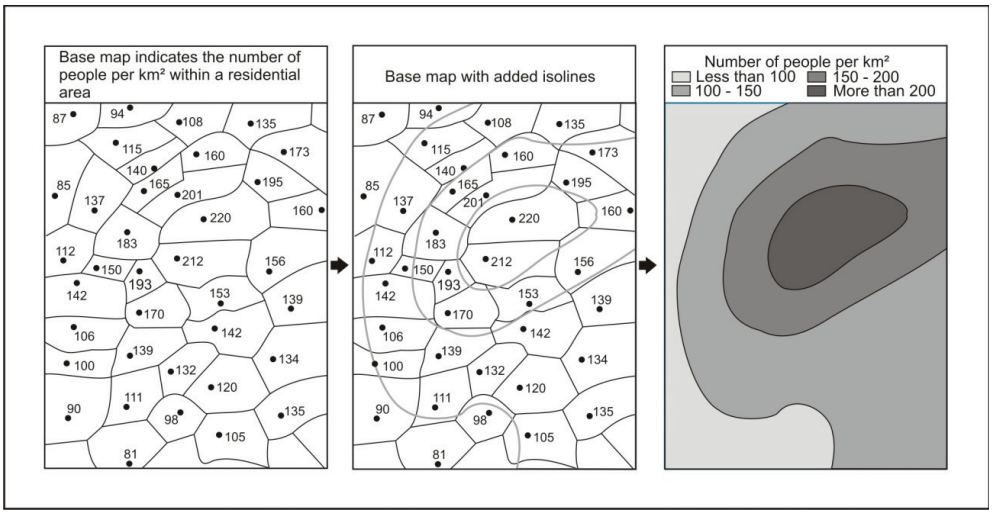


Figure 3.13

3.4.4.2 Contour Maps as a Representation of the Landscape

After our experiment with the "mountain" in the glass dish, we said that with the aid of a contour map you have to learn to look at the landscape from a position above the landscape. By looking at the contour map you must be able to form a three-dimensional representation of the landscape in your mind. At that stage this might have sounded very difficult. It is a skill that will take you some time to master, but fortunately we have a few useful guidelines to share with you.

A skilled map user can easily deduce the shape and specific characteristics of the landscape from the distance between contour lines and also the shape and patterns of the contour lines. We are first going to concentrate on what the distance between contour lines tells us about the steepness of the terrain. Next we discuss two criteria (gradient and slope) which we use to describe steepness in absolute terms. Thirdly we focus on how we can express steepness in relative terms. We then complete the section with a discussion of the relationship between contour patterns and landscape forms.

3.4.4.3 The Distance between Contour Lines

You have doubtlessly already noticed that the contour lines which we have drawn are sometimes close together and sometimes far apart from each other. Why is this? Let's explain using the following example (while reading the next section, refer to figure 3.14).

For each of three different hikes you have to draw a contour map with contour intervals of 20 m on a scale of 1:10 000. Each hike is exactly 300 m long. The height above sea level of the starting point of all three hikes is the same (by chance), namely 100 m above sea level. The only difference is that the end points of routes 1, 2 and 3 respectively are 60 m, 200 m and 300 m higher than the starting points. Next we explain our reasoning step by step and how we go about drawing the maps:

1. A scale of 1:10 000 means that we have to draw each of the three 300 m hikes as 30 mm lines on the maps (see figure 3.14(a)).
2. If the end point of route 1 is 60 m higher than the starting point (100 m above sea level), then the end point of route 1 is 160 m above sea level. In the same way we can reason that the end points of routes 2 and 3 are 300 m (100 + 200) and 400 m (100 + 300) above sea level respectively.
3. Because we have to use a contour interval of 20 m and the starting and end points of route 1 are 100 m and 160 m above sea level respectively, we have to draw in four contour lines for route 1. These are the 100 m, 120 m, 140 m and 160 m contour lines. If we space the contour lines evenly (in other words it is equally steep along the route), the map will look like that in figure 3.15. If we use the same contour interval, namely 20 m, for hikes 2 and 3, we will need 11 and 16 contour lines respectively.
4. From figure 3.14 we can make the deduction that the greater the height difference between places which are a constant distance from each other, the more contour lines we have to draw in on the map and the closer together we have to space the contours.

The horizontal distance between the contour lines on the three maps differs because the three hikes are not equally steep. Have you ever tried to define steepness? Before we explain steepness to you in theoretical terms, we give you an example which we hope will lead you to discover exactly what "steep" means for yourself.

Study figure 3.15. Gloria lives within walking distance of her two best friends, Patricia and Veronica. She has to walk 500 m and 1 000 m respectively to go and visit Patricia and Veronica. Gloria is equally fond of her two friends, but she visits Veronica more often than she visits Patricia. When Patricia pointed out to Gloria how "unfair" this was, Gloria's answer was that it is much more physically exhausting to walk the 500 m to Patricia's house than it is to walk 1 km to Veronica's house.

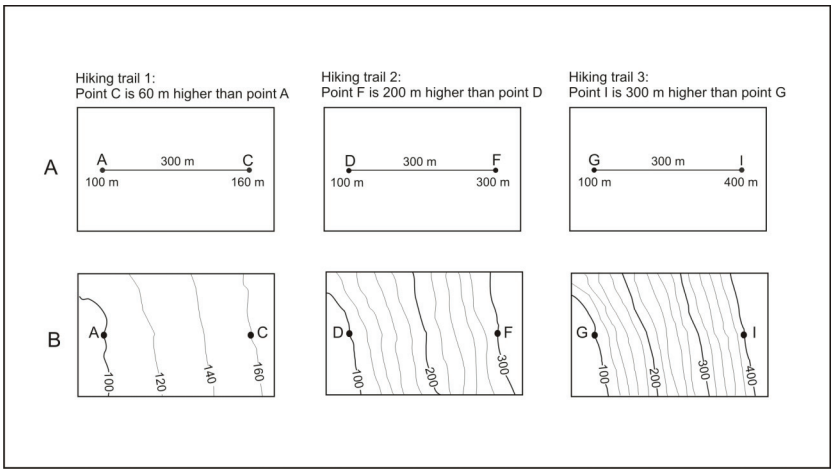


Figure 3.14

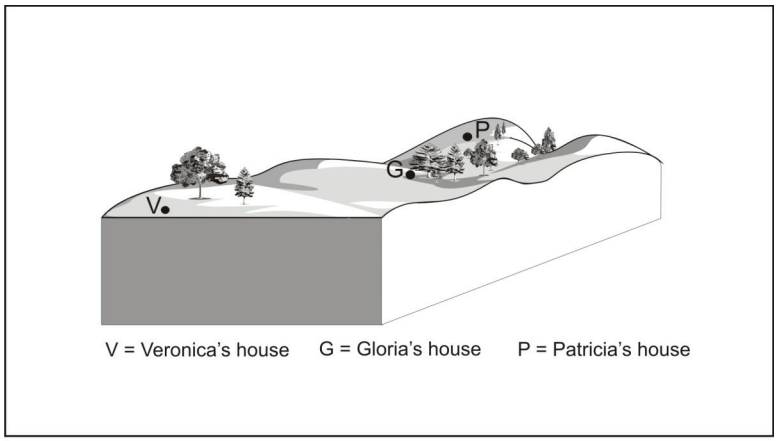


Figure 3.15

Activity 3.9

Let's also think about a drive through a flat landscape and a steep mountain pass. Why do we say that the mountain pass is steep or that the path to Patricia's house is steeper than the path to Veronica's house? We find the answer in the relationship between the distance which we have to cover in a vertical plane (the vertical interval, or VI) and a horizontal plane (the horizontal equivalent, or HE) to move from one point to another. In a level landscape we move far in a horizontal plane but hardly move in a vertical plane. The horizontal equivalent (HE) which we cover is great, but the difference in height between our starting and end point is very small. In a steep mountain pass the opposite is true: for every short distance which we move horizontally, we also have to move considerably in the vertical plane.

The next part of our discussion is based on figure 3.16. The triangles in the figure are side views of the three hikes whose contour maps appear in figure 3.14. For your convenience we have repeated the three contour maps in figure 3.16. Compare each side view with its contour map.

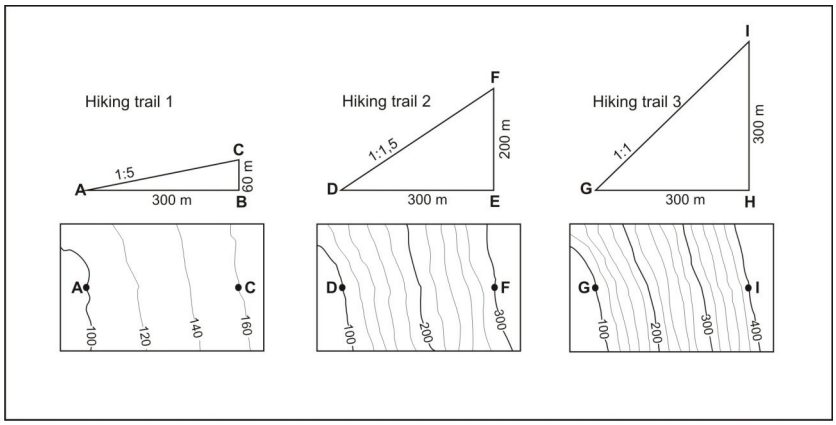


Figure 3.16

Do you now believe what we said earlier, namely that the reason why the contour lines on the three maps are differently spaced is that the steepness of the three routes is different? You should be able to see that route 1 is the least steep and that route 3 is the steepest. Descriptions like "least steep" and "steepest" are, however,

relative. Sometimes it is necessary to be more precise in our description of steepness so that other people know exactly what we mean. We therefore need a criterion to express steepness as an objective quantitative value. Two such criteria are gradient and slope. We first deal with gradient, which is based on the following formula:

Gradient = Vertical Interval ÷ Horizontal Equivalent.

We can now substitute the values which appear in figure 3.16.

Gradient of route 1:

Vertical Interval ÷ Horizontal Equivalent = 60 ÷ 300 = 1 ÷ 5.

We can also write the answer as 1:5. What does this mean? For every unit of measurement in a vertical plane, the horizontal plane is 5 times as long. Check our last statement by measuring the distance between AB and BC in figure 3.16. Also note that the smaller the ratio between the difference in height (VI) and the horizontal distance between two places (HE), the steeper the terrain is. In other words, a road with a gradient of 1:14 is less steep than a road with a gradient of 1:3.

Activity 3.10

1. Use the values in figure 3.16 to calculate the gradients of routes 2 and 3.
2. Measure the distances between D and E and also between E and F and explain what the relationship is between these distances and the gradient that you have calculated for route 2.
3. Arrange the gradients of 1:4, 1:0,6, 1:7 and 1:2 in order of increasing steepness.

Earlier we referred to slope as a second criterion which we can use to describe how level or steep a terrain is. Again we use the three hiking routes (see figure 3.17) to make the difference between slope and gradient clear and to show you one method of calculating slope. In contrast to gradient, which is a ratio, slope is the angle which is formed between the base line and the hypotenuse of a right-angled triangle. If we apply this to route 1, the slope is the angle of 11˚ which is formed by the two lines which extend from A (the starting point of the route) to B and C respectively (angle CAB). Use your protractor to check whether the two angular or slope values (34˚ and 45˚) which we have written in for routes 2 and 3 are correct.

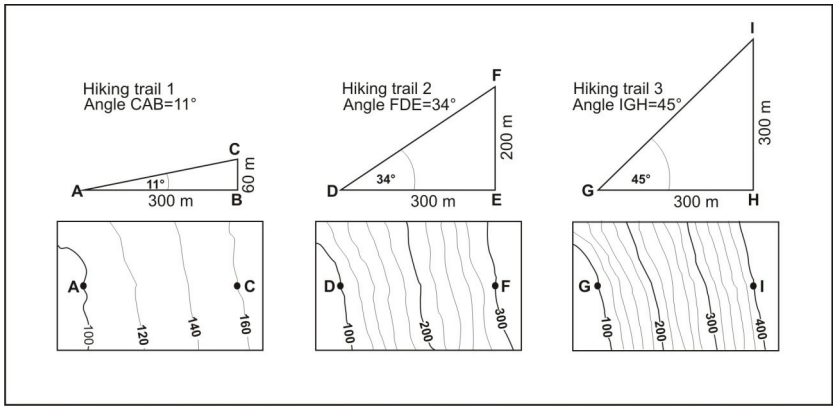


Figure 3.17

Activity 3.11

Calculate the slope of the two footpaths which run from Gloria's houses to Veronica's and Patricia's houses respectively. Use the information below. **Hint:** Draw yourself triangular diagrams to scale like those in figure 3.17.

- The distances between Gloria's house to Patricia's and Veronica's houses are 1 km and 2 km respectively.
- Gloria's house is 420 m above sea level. Patricia's house is 120 m higher than Gloria's house. Veronica's house is 380 m above sea level.

To conclude this discussion on "distance between contours" as an indication of steepness, we look at ways of describing steepness, or slope, in relative terms and also at how the contours which are associated with these descriptions appear. Figure 3.18 shows three hillsides (i.e. a slope or a flank of a hill) which we can describe as gentle, moderate and steep. Note that the three maps have the same scale and that the vertical interval (contour interval) on all three maps is exactly the same, namely 20 m. Also note how the horizontal distance between contour lines becomes smaller as the hillsides become steeper. Have you noticed that on each of the three maps the contour lines are evenly spaced? The reason for this is that each of the hillsides is uniform. The slope of the hillsides therefore remains constant from the bottom to the top. Note: If you measured the distance between the evenly spaced contour lines with a ruler, you would find small differences. This is because it is impossible to measure such detailed sketches which are based on very fine measurements with a ruler.

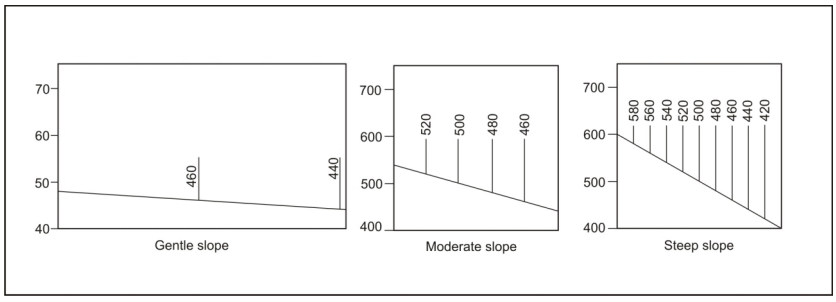


Figure 3.18

3.4.4.4 The Patterns of Contour Lines

Contour patterns are an indication of the shape of the landscape. Where the distance between the contour lines is an indication of the gradient, the pattern which the contour lines form on the map is an indication of the appearance of the landscape and its elements, namely the landforms. In reality it is difficult to separate the slope and the appearance of a landform. You should be able to see from figures 3.14 to 3.18 that it is the slope of a landform which gives it a certain appearance. Similarly it is the landform's unique appearance which gives the contour lines on a map a certain pattern.

The fact that valleys, hills and mountains have different slopes at different places means that contour line patterns on topographic maps are sometimes very irregular and may look very muddled to someone who does not have much experience in reading these maps. But for someone who has learnt how to make certain distinc-

tions, the way the landscape actually appears falls into place like the pieces of a jigsaw puzzle. The most basic distinction is that between the different V shapes that contour lines make – Vs which vary from two legs which are "stretched" so far apart that they nearly form a straight line (and therefore an ordinary uphill or downhill) to a V which is so "bent closed" that it almost looks like a hairpin. Figure 3.19 explains this concept. Note that in each of the figures we use the word "or". The reason for this is that the contour pattern of a narrow valley and a knife-edged spur, a valley and a mountain spur, a wide valley and a hill, and a gradual uphill and a gradual downhill respectively look the same. Without the height values (contour values) we cannot distinguish between these landforms.

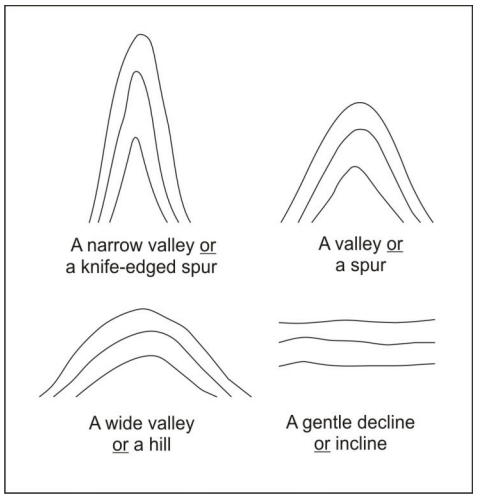


Figure 3.19

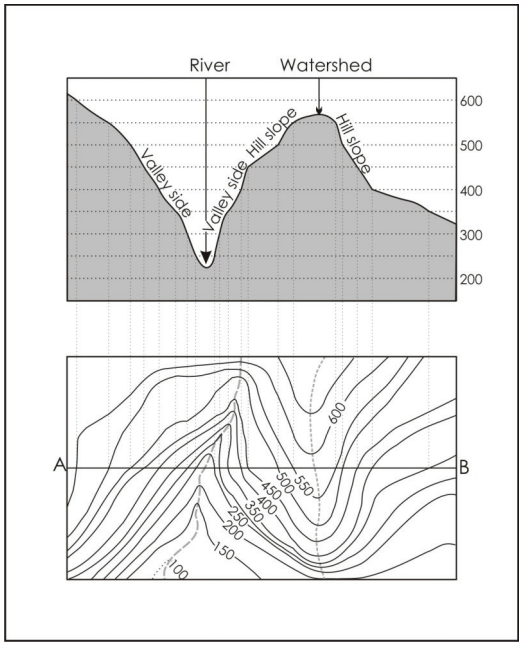


Figure 3.20

The direction in which the height values of the contour lines increase gives us an indication of whether the slope is a descending slope (e.g. a river valley) or an ascending slope (e.g. a hill or a mountain). It is therefore important that contour lines on a map should have contour values. Because figure 3.19 does not have contour values, we cannot distinguish between the landforms. When we are interpreting

any contour map, it is the direction in which the height increases together with the type of V in which the lines are arranged which give us an indication of the type of relief feature we have on the map.

The importance of the direction of the increase in height is illustrated in figure 3.20. In this figure the river valley and the spur look very similar and it is difficult to distinguish between them unless we look at the contour values. Here is a very important rule:

- In the case of a river valley the points of the Vs point in the direction of the increase in height and the successive Vs form the channel or the riverbed in which the water flows from the top of the valley to the bottom of the valley.
- In the case of a spur the Vs point in the direction of the decrease in height.

In figure 3.20 the dotted line through the successive Vs represents the crest or ridge of a hill and is simultaneously the watershed – because rain which falls on the eastern side of this line flows down the eastern side of the hill, while rain which falls on its western side flows down the western side. In the case of the river valley in figure 3.20 the broken line represents the river.

Next we look at how the contour representation of different landforms appears. Because contour lines on all maps are drawn according to the same principles, the contour patterns which are used to represent well-known landforms on topographic maps look more or less the same. We say "more or less" because obviously one hill never looks exactly like another hill and one landscape never looks like another landscape.

a. A river valley

The contour lines are always arranged in a V shape and in such a way that the points of the Vs point in the direction of the higher contour values (see figures 3.21 and 3.22). The contour lines are usually close together along the flanks or sides of the valley and more closely spaced the higher the V shapes "climb". In the case of larger rivers the slopes of the tributaries are steeper than the slope at which the mainstream flows. Note also the small streams in figure 3.21 which flow into the mainstream.

Figure 3.21: A river valley in the foothills of the Natal Drakensberg

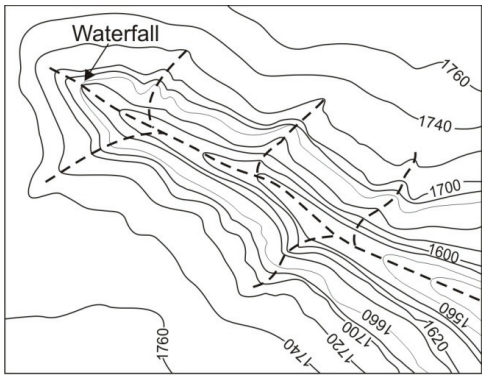


Figure 3.22: Contour map representing a river valley, with small tributary streams on either side draining into the main stream flowing along the bottom of the valley

b. A mountain spur or ridge

A spur (see figs 3.23 and 3.24) is a mountain ridge which juts out from a central mountain range or a range of high hills at an elevation lower than that of the major watershed. In a mountainous or hilly area such a spur often thrusts out like a giant tongue of land between two river valleys or meanders. Spurs often have convex slopes (they are steeper at the bottom than at the top) and their "noses" are characterised by U-shaped rather than V-shaped contour lines. On contour maps they are separated from one another by the V-shaped contour lines of river valleys.

Figure 3.23: Mountain spurs with convex slopes separated from one another by deep valleys

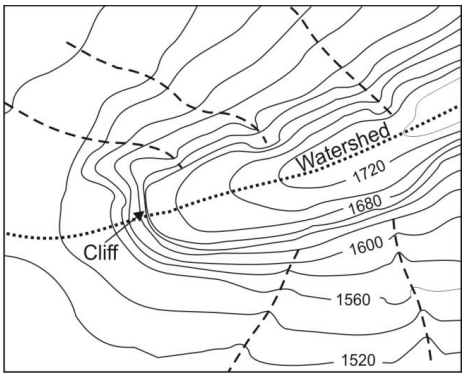


Figure 3.24: Contour map representing a mountain spur, with some of the streams along the slopes of the spur draining towards the north and others draining towards the south (because the crest line forms a watershed)

c. A watershed

A watershed forms the boundary between the drainage areas of two adjacent watercourses. Figure 3.24 shows the watershed, drawn in all the way along the ridge of the spur with a dotted line, and how rainwater which falls on the southern side of the flank drains away in a southerly direction, while rain which falls on the northern flanks drains away to the north. Watersheds are not indicated by definite lines on contour maps, but are easy enough to draw in along the ridge of a chain of mountains or high hills. Just as a drainage basin is defined for each small intermittent or non-perennial stream or rivulet in the landscape by means of watersheds, so each large river system in the world (e.g. the Amazon and the Nile) also has a drainage basin which is bordered by watersheds.

d. A Koppie

Koppies are represented by more or less circular contour lines (see figures 3.27 and 3.28). In the case of a butte (pointed hill or spitskoppie) (as in figures 3.25 and 3.27) the contour circles get smaller and smaller and eventually end in a point or peak. Buttes usually have a uniformly steep slope. Mesas or table mountains (see figs 3.26 and 3.28) also have circular contour lines. Because the crest of the hill is flat, the highest or the second highest contour line has a greater circumference than that of a butte. Koppies are not always steep and regular like the typical butte and mesa in figures 3.27 and 3.28. They may be a variety of shapes.

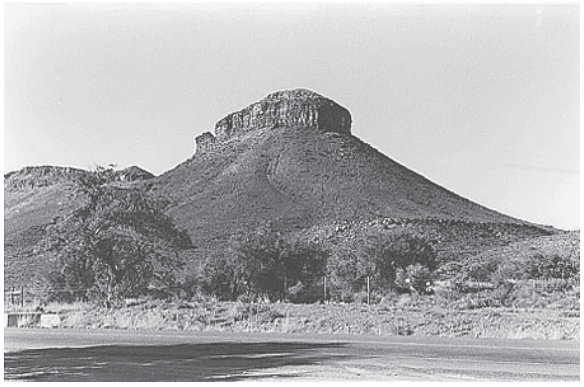


Figure 3.25: One of the Three Sisters situated next to the N1 northwest of Beaufort-West

Figure 3.26: A table mountain in the Karoo

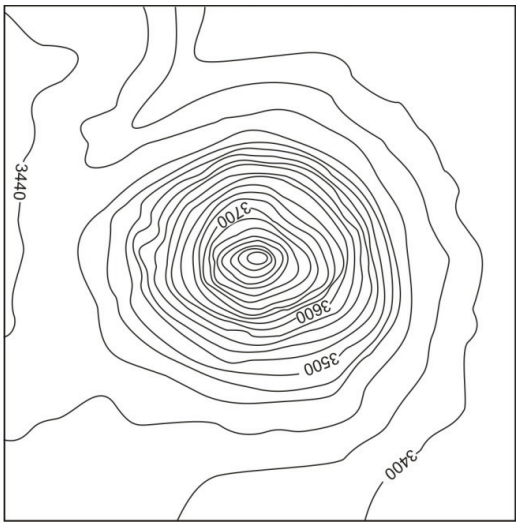


Figure 3.27: Contour map representing a butte

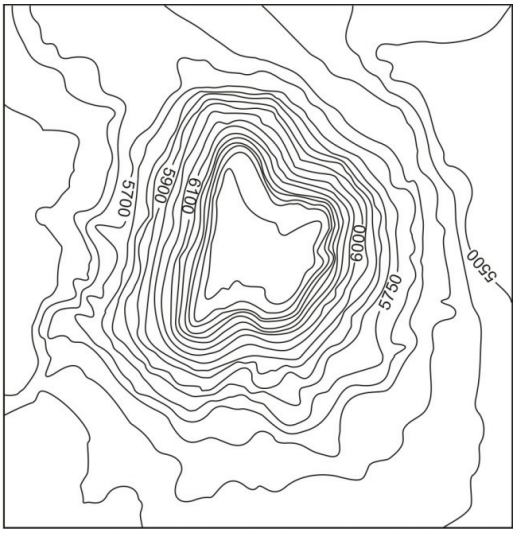


Figure 3.28: Contour map representing a table mountain (mesa)

Koppies are not always steep and regular like the typical butte and mesa in figures 3.27 and 3.28. They may be a variety of shapes.

e. A cliff

We recognise cliffs on contour maps by the fact that two or more successive contour lines touch each other. If the cliff is on the nose of a spur, it is the points of two successive Vs which touch each other (see fig 3.24). Where two or more contour lines touch each other in a river valley and form a cliff, we obviously have a waterfall (see fig 3.22).

f. An escarpment

An escarpment separates a low-lying area from a high-lying area. From the lower-lying landscape the escarpment looks like an uninterrupted mountain wall (see fig 3.29), and on a contour map (fig 3.30) we can distinguish it from an ordinary mountain range because the closely spaced contour lines appear on one flank only.

Behind the escarpment there is a plateau and there is no decrease in elevation as in the case of a mountain range.

Figure 3.29: The Great Escarpment rising as an impressive mountain wall in the northern Drakensberg

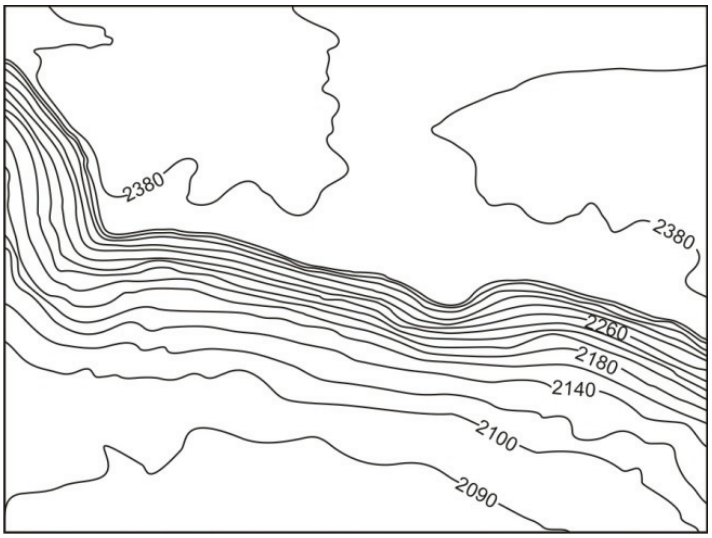


Figure 3.30: Contour representation of an escarpment

g. A plain and a plateau

Both types of landscape show relatively little variation in relief – they are therefore extensive flattish landscapes. Because there are few height differences, a contour map of such an area firstly has few contour lines and the contour lines are secondly spaced far apart and reasonably parallel to one another. The biggest difference between a plain and a plateau is that a plain is lower than a plateau. Figure 3.29 is a striking illustration of this. In the foreground we have the plain. Behind the "mountain wall" we see another level area, which is called the plateau. In figure 3.30 the area above 2 360 m is the plateau. In the same figure you can see that the area at the bottom of the escarpment gradually becomes a plain (the contour lines are spaced farther and farther apart).

h. A poort

A poort (see figures 3.31 and 3.32) is formed where a river carves itself a course as it crosses a mountain or a chain of hills. In most cases the poort is at more or less the same height above sea level as the surrounding plain. We can easily recognise a poort on a contour map because there are no V-shaped contour lines in the area between the spurs.

i A neck

A neck (see figures 3.31 and 3.32) occurs in a chain of mountains or hills and is a low-lying ridge between two high peaks or spurs. Unlike a poort, a neck is situated at a higher elevation than the surrounding landscape and forms part of the watershed. We can easily distinguish it from a poort on a contour map (see figure 3.32) because the V-shaped contour lines which increase in altitude jut inwards like "tongues" between the two spurs. In fact two sets of Vs point towards each other on either side of the neck. We have indicated the location of the most prominent neck by means of a dot in figure 3.32.

Figure 3.31: Hartbeespoort in which the Hartbeespoort Dam was constructed

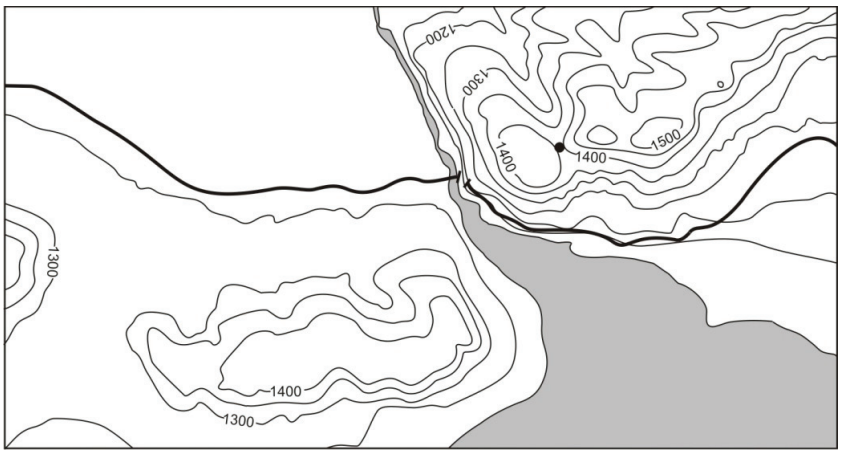


Figure 3.32: Poorts and necks in the Magaliesberg range

Activity 3.12

1. In pencil indicate where you find contour patterns which are examples of a neck (N), a spur (S), a plain (PL), a cliff (C), a valley (VA), a poort (P), a koppie

(K) and a watershed (W) in figure 3.33. Simply write the abbreviations which appear in brackets alongside the names of the landforms on the map. Note that you have to indicate the location of point, line and area phenomena.

2. Indicate whether you agree with the last sentence of the next paragraph and then give reasons for your point of view.
3. We have put a question mark at the spot height which indicates that the specific point is 1 321 m above sea level. You will note that two streams flow into each other west of the spot height. Northwest of this confluence (on the map it is a distance of 5 mm) another stream is shown. The cartographer made a mistake by not joining the northwestern stream with the other two streams.
4. The point which is 1 228 m (find the spot height) above sea level is at the confluence of two streams. We have not, however, drawn in the upper courses of the two streams on the map. Draw in the missing streams (the upper courses) on the map with a blue crayon.
5. Draw in the catchment area of the stream which we have indicated with a thicker blue line on the map.
6. Now indicate the common catchment area of the streams which you had to draw in on the map in question 3.
7. Write in an "H" and an "L" at those two points on the map which is the highest and lowest above sea level respectively.

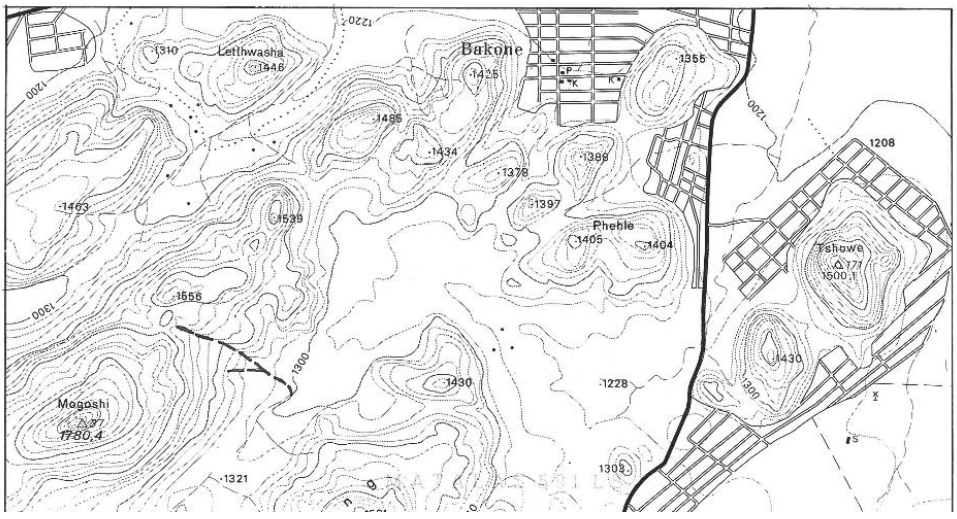


Figure 3.33

3.5 THE REPRESENTATION OF NUMERICAL DATA ON MAPS

3.5.1 Choropleth Maps

A technique which is commonly used to represent statistical data in particular is choropleth mapping. Bergman and Renwick has many examples of this technique. Have a look at figures 5-7, 5-10 and 5-11. We are going to use figure 5.17 in Bergman and Renwick as the basis of our discussion.

The subject of the map appears as a title in the legend box. From the title we deduce that the map shows the spatial distribution of the life expectancy at birth for the year 2006. The title also tells us that the figures in the legend are "years". Five categories appear in the legend. The darkest colour shows very clearly the countries

where people could expect to live for over 75 years, while the lightest colour indicates the countries that have a low life expectancy of less than 50 years.

We now know what the map represents, but how was it drawn? Unlike contour lines which are based on precise measurements which are made with instruments at specific points, the type of data we are dealing with here are completely different. The data are also not related to a specific point but to surfaces, which in this case are countries – the spatial unit is a country. The "instruments" used to collect the data were the individual censuses conducted in the different countries to count their populations among other things. Using statistics provided by each country, the average life expectancy of the population in the various countries was calculated. We call this type of figure an index and the individual values are called index values. You will find other examples of indexes in the various population maps in the chapter on world population in Bergman and Renwick.

Activity 3.13

The data in table 3.4 give the number of years it will take for the African states in Southern Africa to double their 2008 populations if each state's population growth rate remains constant. Use the map in figure 3.34 as the basis for a choropleth representation of the data in table 3.4. Use the following categories to put the countries into groups and also colour in the groups differently:

- less than 25
- 25–29, 9
- 30–34, 9
- 35–39, 9
- 40 and more

Remember to draw a legend and to give the map a title.

Table 3.4 Number of years it will take Southern African states to double their 2008 populations if each state's growth rate remains constant (*World Population Bureau data sheet* 2008)

State	Years	State	Years
Algeria	29	Comoros	
Egypt	34	Libya	
Libya	19	Sao Tome and Principe	
Morocco	35	Togo	
Sudan	33	Congo(DR)	
Tunisia	36	Madagascar	
Western Sahara	24	Niger	
Benin	21	Benin	
Burika-Faso	23	Swaziland	
Cape Verde	36	Angola	
Côte d'Ivoire	27	Somalia	22
Gambia	28	Liberia	22
Ghana	24	Mali	23

State	Years	State	Years
Guinea	29	Nigeria	23
Guinea-Bissau	34	Burkina-Faso	23
Liberia	22	Tanzania	23
Mali	23	Eritrea	24
Mauritania	27	Ghana	24
Niger	21	Western Sahara	24
Nigeria	23	Uganda	24
Senegal	26	Ethiopia	25
Sierra Leonne	36	Cameroon	25
Togo	20	Malawi	25
Burundi	26	Burundi	26
Comoros	19	Senegal	26
Djibouti	30	Zimbabwe	26
Eritrea	24	Mozambique	26
Ethiopia	25	Lesotho	27
Kenya	27	Kenya	27
Madagascar	21	Mauritania	27
Malawi	25	Equatorial Guinea	27
Mauritius	60	Botswana	27
Mozambique	26	Côte d'Ivoire	27
Reunion	43	Namibia	27
Rwanda	36	Gambia	28
Seychelles	50	Central African Republic	28
Somalia	22	Chad	28
Tanzania	23	Algeria	29
Uganda	24	Guinea	29
Zambia	33	Congo	30
Zimbabwe	26	Djibouti	30
Angola	22	Sudan	33
Cameroon	25	Zambia	33
Central-African Republic	28	Guinea-Bissau	34
Chad	28	Egypt	34
Congo	30	Morocco	35
Equatorial Guinea	27	Gabon	35
Gabon	35	Sierra Leone	36
Sao Tome and Principe	20	Tunisia	36
Congo (DR) (Zaïre)	21	Rwanda	36
Botswana	27	Cape Verde	36
Lesotho	27	Reunion	43
Namibia	27	South Africa	46
South Africa	46	Seychelles	50
Swaziland	22	Mauritius	60

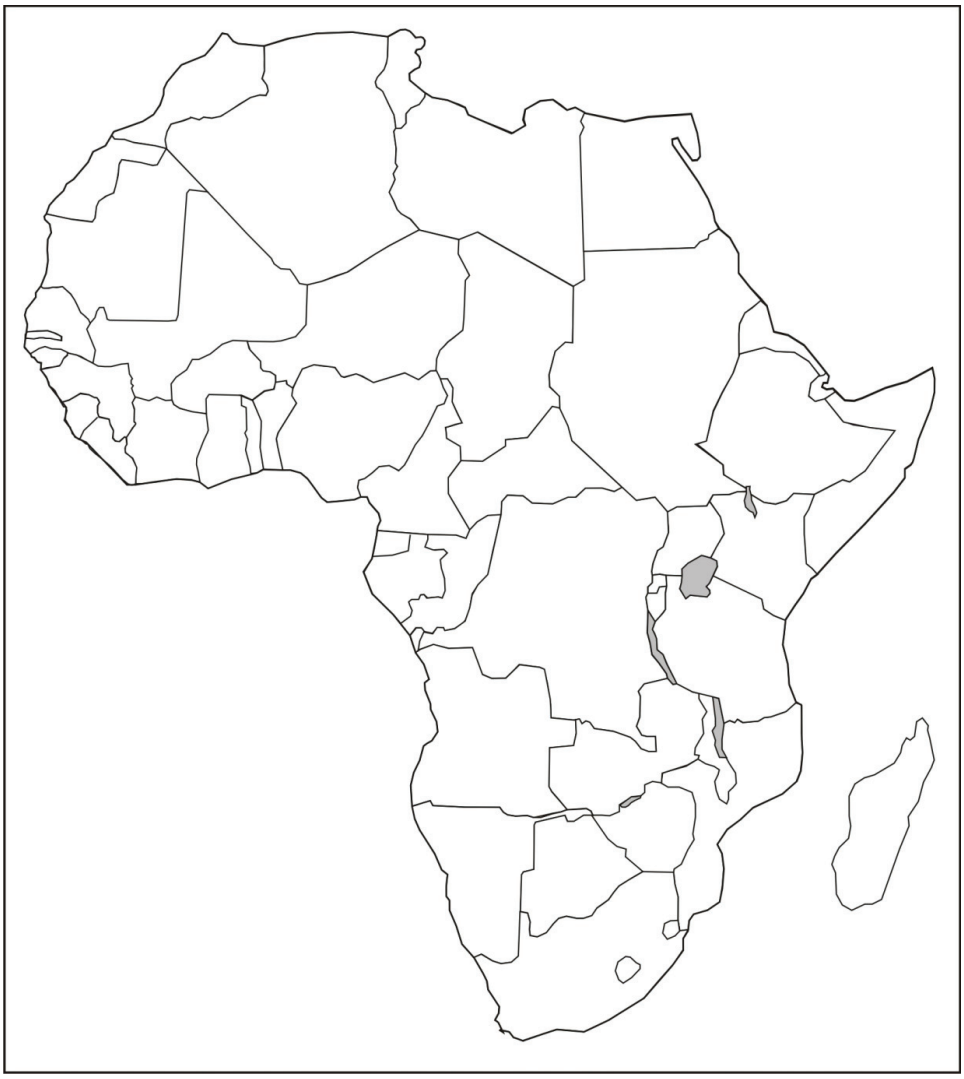


Figure 3.34

3.5.2 Other Graphical Techniques for Representing Numerical Data

There is an enormous variety of techniques for conveying quantitative information to the map user and for showing how numerical data vary spatially.

Dot density maps are an effective technique for spatially representing data which are based on counts. Examples are the number of people, schools, cattle or libraries in a province, country or even the world. A dot density world map can be found on the back inside cover of Bergman and Renwick. The technique is based on the principle that a dot represents a specific number of individuals of the phenomenon in question. In the case of the world map in your prescribed book each dot represents 100 000 people. Note that the dots are not simply distributed evenly within each country's borders. The western parts of South Africa are the most sparsely or thinly populated and therefore the cartographer quite correctly put fewer dots in the western parts of South Africa. The advantage of this technique is that the map gives an indication not only of how many people live in a country but also where in the country the people live (even if it is very generalised). We therefore get an idea of the spatial variation of the phenomenon which is mapped. Compare the

dot density technique with the choropleth technique which is used in figure 5-7 of Bergman and Renwick. Each country has only one colour, which in fact hides the fact that there is variation in the spatial distribution of population growth rates in each country.

The data which are mapped determine to a large extent what value is attached to a dot. It does not help to choose a value that is so small that you cannot fit all the dots into the spatial units or a value that is so big that some spatial units have no dots at all. You might sometimes have to experiment with different values before you decide on the most suitable dot value. In calculating the number of dots you cannot avoid working with decimal numbers. Always round off to the nearest whole number – 14,4 becomes 14 dots and 14,5 becomes 15 dots. Never forget to create a legend which shows what the value of a dot is – without a legend the map is absolutely useless.

Activity 3.14

Use figure 3.35 as your base map for drawing a dot density map of the population distribution in the area. The dot scale is 1:5. Since you are very familiar with the area, you know that there are about 500 people living in the area. You know that there are no people living 350 m above sea level and that 70% of the population live in the town. The squatter area is home to 10% of the people. The other 20% are evenly distributed over the surrounding rural area.

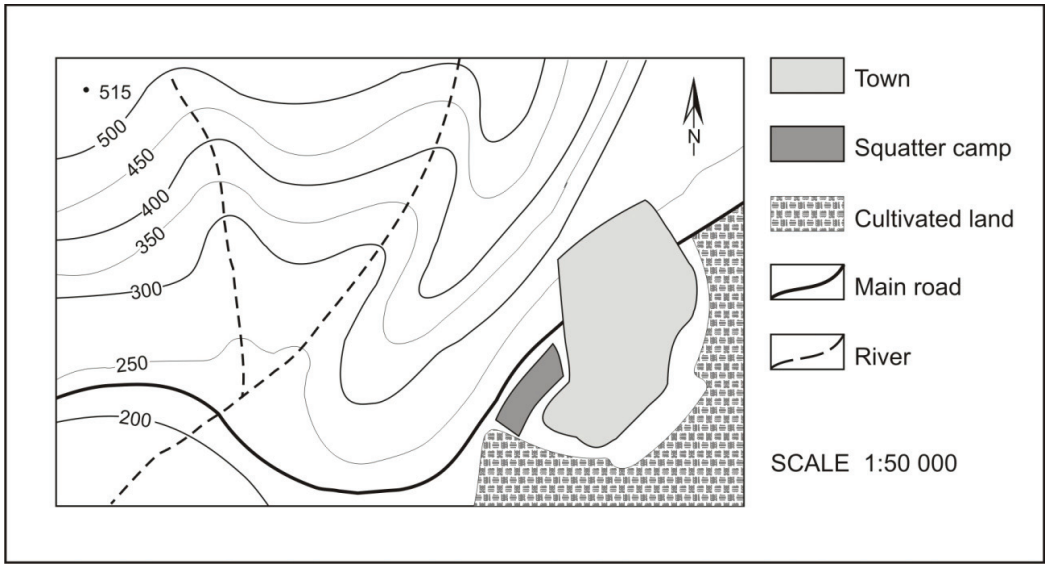


Figure 3.35

3.6 Examples of and Practise in the use of Maps

3.6.1 Political Maps

Instead of telling you how political maps are interpreted, we are going to let you make some discoveries of your own in activity 3.15. The questions are based on two maps in Bergman and Renwick: figure 1-6 and figure 11-1.

Activity 3.15

1. Why do you think that figure 1-6 has no legend?
2. Draw a legend for figure 1-6 in the blank space on the bottom right-hand side of the map.
3. Is there a reason why South Africa and Brazil are coloured yellow in both figure 1-6 and figure 11-1?
4. Describe the location of Indonesia.
5. What is the capital city of the South American state of Uruguay?
6. In both maps there are smaller maps with a double frame around them. What are these smaller maps and why was it necessary to draw these smaller maps? What is the relationship between the scale of the smaller maps and the main map?
7. Which countries in Africa do not have direct access to the sea?
8. Which three countries in Africa were the first to gain independence?
9. What information in figure 1-6 tells us that the map is relatively recent (not obsolete)?
10. Discuss the location of Alaska relative to Russia.
11. Suppose you were the cartographer and had to indicate in figure 1-6 all the states which have become independent since 1975. How would you add this additional information to the map without making it illegible?

3.6.2 Thematic Maps

By means of the next activity we are going to give you practise in using different thematic maps in combination to identify spatial patterns of similarities or exceptions.

Activity 3.16

Take a look at how the variables, which are shown in figures 12-6, 12-8, 5-7 and 5-10 in Bergman and Renwick, are spatially distributed over the African continent. We also studied these maps and came to the following conclusion:

- In Africa there is a similarity between the four different distribution patterns because the four variables covary spatially. **Hint:** Look at the bigger patterns rather than concentrating on individual countries.

3.6.3 Topographic Maps

Activity 3.17

1. A dam wall has been built in the poort shown in figure 3.36. The engineers designed the dam wall in such a way that the water can dam up to point A, which is 95 m above sea level. Use the information on the map to indicate the area which will be flooded when the dam is 100% full.

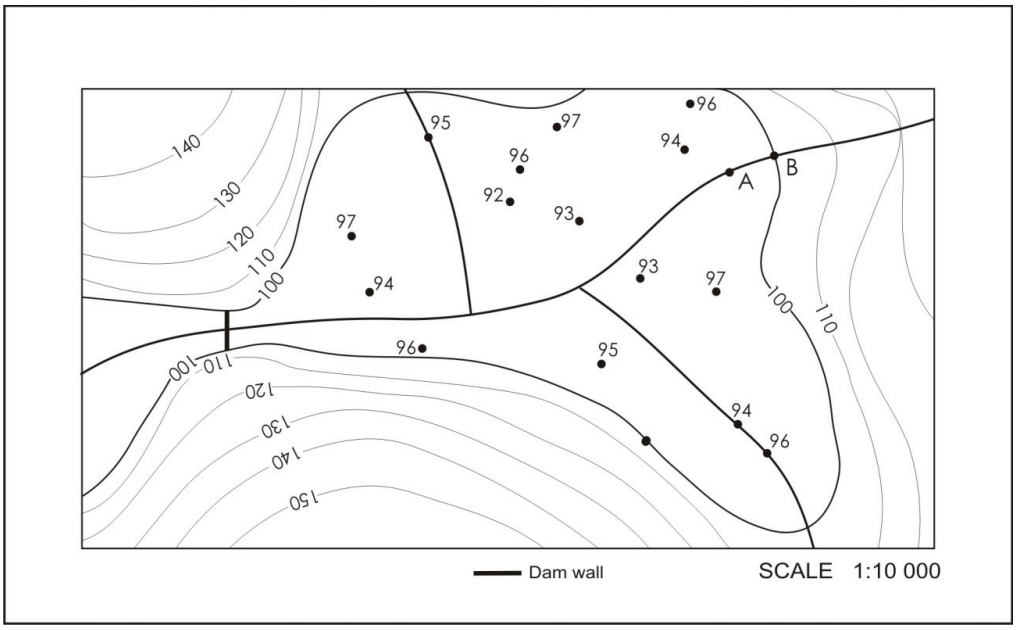


Figure 3.36

Use figure 3.36 as your base map on which to indicate the following phenomena:

2. The area which is between 120 m and 140 m above sea level. Colour the area in lightly.
3. Any hiking route from B to the waterfall along which the gradient does not become steeper than 1:10 at any point. Note that the map scale is 1:10 000.

Activity 3.18

1. Study the continent of South America which is shown on the front inside cover of Bergman and Renwick. In addition to the relief of the continent the map also shows the main rivers. Indicate in pencil the area which is the catchment area for all the water which eventually flows into the sea at the mouth of the Amazon River.
2. Compare the size of the Republic of South Africa and the size of the catchment area of the Amazon River. **Hint:** Have a look at the outline of South Africa in figure 1-66 in Bergman and Renwick and draw it in lightly on figure 5-7. The two maps are on the same scale and also have the same projection.

IN CONCLUSION

You should now have the necessary map-reading skills and in the next study units you should be able to make maximum use of them when the authors of your prescribed book use world maps to help you get to know the world we live in (and more specifically the spatial distribution of global phenomena) better.

Study Unit 4
Global patterns of temperature, air circulation and precipitation

INTRODUCTION

Temperature, air circulation and precipitation all have some kind of effect on all phenomena on earth. It is therefore important at this stage of your studies that you should learn about them in more depth. Not only natural phenomena like soil, vegetation, animals, rivers and landforms are affected by temperature, air circulation and precipitation, but also all aspects of people's lives: for example their clothing, where they live and work, agriculture, tourism and health.

In this study unit you will be learning more about temperature, air circulation and precipitation. You will learn that these phenomena vary both in space and over time, and that these variations follow specific patterns. We also introduce you to the reasons for these variations and the connection which exists between temperature, air circulation and precipitation.

STUDY MATERIAL

You will find the prescribed study material for this study unit in chapter 2 on energy and weather of Bergman and Renwick.

Key Terms

- weather
- climate
- temperature
- precipitation
- latent heat
- intertropical convergence zone
- pressure gradient

Learning Outcomes

After you have worked through this study unit, you should be familiar with and understand the world maps for temperature, air circulation and precipitation; you should also be able to use these maps.

To understand and use these maps meaningfully, you should be able to

- explain what the terms "weather" and "climate" mean
- explain why the amount of solar energy received on the earth's surface varies spatiotemporally
- name and explain the variables which influence temperature on a global scale
- name the main characteristics of the global temperature map
- explain how air circulation comes about on a global scale
- name the global zones of air pressure and air circulation and explain what type of weather conditions each zone has
- explain how precipitation comes about
- name three types of precipitation
- name the main characteristics of the global precipitation map

4.1 Weather and Climate

Before we look at the world's temperature, air circulation and precipitation patterns, it is important to make sure what we mean by the terms "weather" and "climate", how weather conditions come about, why weather conditions vary (over both space and time) and what the consequences of this variation are.

Study Task

Study the introduction to chapter 2 to just before "Energy and weather" in Bergman and Renwick. Make sure that you understand the difference between the terms "weather" and "climate".

Activity 4.1

Briefly explain how the environment in which humans live is affected by both day-to-day and place-to-place variations in weather conditions.

In activity 4.1 we focused your attention on the variation over space and time in weather conditions and how these variations affect people. We do this to make you aware of geography's focus on weather conditions. In geography we do not look at all aspects of the weather, and we are certainly not trying to make you a weather forecaster.

The rest of this study unit concentrates on three important elements of climate: temperature, air circulation and precipitation.

4.2 Temperature

The temperature conditions on earth depend largely on the amount of heat energy which is present in the atmosphere. This energy derives both directly and indirectly from the sun. In this section of study unit 4 you are going to learn more about the

variables which determine how much solar energy is received by the earth, why this amount varies not only over space but also over time, and how these differences give rise to and maintain weather and climatic processes. First we look very briefly at the role of the sun as a source of energy.

4.2.1 The Sun as a Source of Energy

Study Task

Study the introductory paragraphs of "Energy and weather" in Bergman and Renwick. It is important that you make notes on the following:

- how the sun produces and radiates energy
- how the earth receives this energy
- the role which this energy plays in the atmosphere

4.2.2 Variations in the Amount of Solar Energy Received

The amount of solar energy received by any place on earth is determined by the following things, among others:

- intensity of the solar energy
- length of the daylight period
- time of year
- absolute location of the place on earth

In the study task which follows we cover each of these things in more depth.

Study Task

Study the section "Incoming solar radiation" (except the last two paragraphs) in Bergman and Renwick. In this study task you should make sure you understand the following:

- how the angle at which the sun's rays strike the earth's surface affects the intensity of the energy which is received
- how this angle varies daily and seasonally at any place on earth
- how this angle varies seasonally and spatially across the earth
- how the length of the daylight period affects the amount of solar energy which is received
- how the length of day varies seasonally at any place on earth
- how the length of day varies seasonally and spatially across the earth

Also make sure that you can give the reasons why

- the amount of solar energy received by any part of the earth varies during the course of a year
- there are spatial variations in the amount of solar energy received across the earth (i.e. why certain areas receive more solar energy than others)

Activity 4.2

Answer the following questions.

1. Give the date(s) on which each of the following positions on earth receives the most solar energy:
   - equator
   - Tropic of Capricorn
   - North Pole
   - Antarctic Circle
   - South Pole
   - Tropic of Cancer
2. Arrange the following cities from the one which has the shortest day on 21 December to the one which has the longest day (use an atlas to check the location of the cities): Los Angeles, Moscow, Rio de Janeiro, Dakar, Nairobi and Sydney.
3. Where would you go and when would you go there if you wanted to experience a day that lasts 24 hours?
4. On what date(s) are day and night the same lengths for the whole of South Africa?
5. During what time of the year does the South Pole experience complete darkness?

4.2.3 Solar Energy and the Global Temperature Pattern

The amount of solar energy which is available in different parts of the world at different times of the year obviously affects temperature conditions in the world. In the study task which follows, our focus therefore shifts to the global temperature pattern.

Study Task

Study the following in Bergman and Renwick:

- figure 2-6(a), the temperature map for January
- figure 2-6(b), the temperature map for July

You should note the following in these figures:

- the general west-east trend of the isotherms

- where high and where low temperatures occur
- how the situation changes from January to July

At this point it is important that you are able to explain your observations about the global temperature pattern in terms of the variations in the amount of solar energy which is received.

Activity 4.3

Answer the following questions about figure 2-6 in Bergman and Renwick:

1. Where and when does the highest average temperature occur in the southern hemisphere?
2. Where and when does the lowest average temperature occur in the northern hemisphere?
3. Why does the highest temperature not always occur at the equator?
4. You are a member of an Antarctic research team. At what time of the year would you not need your warm clothing?

Apart from the amount of solar energy which the earth receives, temperature is affected by the differences in the ability of land and water to absorb and store solar energy. The water masses of the world (which cover about 75% of the earth's surface) can be seen as massive stores of heat energy which therefore significantly affect temperature conditions right across the world. This is dealt with in more detail in the study task which follows.

Study Task

Study the section "Storage of heat in land and water" in Bergman and Renwick. Also have another look at figures representing the global temperatures during January and July in Bergman and Renwick.

You need to note the following:

- the differences in the reaction of different materials to heating by solar energy
- the different reactions of land and water to heating by solar energy
- the impact of this phenomenon on temperature conditions, specifically the moderating effect of large water masses as compared with the extreme conditions which are characteristic of large landmasses

You should now know that the earth receives solar energy, and that this energy is stored by both land and water. Some parts of the earth receive more solar energy than other parts. Because the earth is constantly heated by solar energy, you might wonder why it does not get hotter and hotter on earth, especially in those places which receive large amounts of solar energy. In the next section you will discover how the earth gets rid of the heat energy which it receives from the sun.

4.2.4 Heat Transfer Between the Atmosphere and the Earth

There are different forms of heat transfer between the atmosphere and earth. In the next study task you will be looking specifically at the processes of radiation and latent heat transfer.

Study Task

Study the section "Heat transfer between the atmosphere and earth" in Bergman and Renwick.

In terms of radiation, note the following:

- that solar energy has a much shorter wavelength than the energy radiated by the earth
- how the atmosphere is heated much more by the energy radiated by the earth than by energy from the sun
- what the greenhouse effect is, and how the heating of the atmosphere is explained by this effect

Concerning "latent heat transfer", note the following as you study the relevant section in Bergman and Renwick:

- the distinction between latent and sensible heat
- what latent heat and latent heat exchange are
- the heat exchanges involved in freezing, the evaporation of water, the condensation of water vapour and the melting of ice

Activity 4.4

Answer the following questions.

1. What would happen to the temperatures on earth if there were not something like the greenhouse effect?
2. Name the greenhouse gases.
3. What would happen to temperatures on earth if the concentrations of greenhouse gases increased?
4. Through what process does the heat of a campfire reach the people sitting around it?

By now you should know that the earth transfers heat energy to the atmosphere and that this heats the atmosphere. You also know that some parts of the earth receive a lot more solar energy than other parts receive. Some parts of the earth therefore have a lot more heat energy than other parts to transfer to the atmosphere. Land and water masses also transfer different amounts of energy to the atmosphere. The combined effect of these variations is that the atmosphere is not evenly heated all over. We study how this uneven heating leads to the movement (or circulation) of air in the next section.

4.2.5 Heat Exchange and Air Circulation

The uneven heating of the atmosphere gives rise to density differences in the atmosphere which cause air to move. In the next study task we explain this process in more detail using a simple example.

Study Task

Study the section "Heat exchange and atmospheric circulation" in Bergman and Renwick.

You need to note the following:

- why air rises when it is heated
- what convection is – how it comes about and what the results of it are
- the explanation of the connection between heat exchange and air circulation
- what is meant by advection

At this point you should realise that uneven heating of the atmosphere gives rise to air circulation. The following section concentrates on the air circulation patterns which are created on a worldwide scale because of the uneven heating of the atmosphere.

4.3 Air Circulation Patterns

4.3.1 Air Pressure

Since air circulation is the result of differences in air pressure, you must understand exactly what is meant by the term "air pressure".

Study Task

Study the introductory paragraph to the section "Circulation patterns" in Bergman and Renwick.

While studying this section you need to note the following:

- the definition of air pressure
- the variation in air pressure at different levels in the atmosphere
- what sea level air pressure is, and why scientists use it as a standard
- how air pressure is measured and in what units it is measured

4.3.2 Air Pressure and Wind

Differences in air pressure give rise to the circulation or movement of air (also known as wind), because air tends to move from high pressure to low pressure areas. If the earth did not rotate, this movement would take place in a straight line. But because the earth does rotate, the movement of air follows an indirect, curved path.

Study Task

Study the section "Pressure and winds" and figure 2-20 (Coriolis effect) and figure 2-21 (Wind movement with Coriolis effect) – in Bergman and Renwick.

Note the following:

- how the difference in air pressure between a warmer island and the cooler surrounding ocean can cause the movement of air
- what the term "pressure gradient" means
- the atmospheric conditions where the air pressure is low at the earth's surface
- the atmospheric conditions where the air pressure is high at the earth's surface
- what the term "Coriolis effect" means
- the impact of the Coriolis effect on the movement of air in different parts of the world and on the movement of air between high and low pressure areas

Activity 4.5

Study figure 4.1 carefully and explain what would happen to a rocket that is fired from the South Pole at a target (X) on the equator if the rocket takes exactly two hours to cover the distance between the South Pole and the equator. **Hint:**

- You must refer to the Coriolis effect in your explanation.
- In this activity you must remember that the earth rotates from west to east on its axis and in the process moves through 15° per hour.

You now know that certain rules underlie the circulation of air. This means that air circulation in different parts of the world has specific characteristics and thus significantly affects the weather and climate of any area on earth. Next we look at the air pressure and air circulation zones of the world.

4.3.3 Air Pressure and Air Circulation Zones of the World

Beginning at the equator we can identify four zones of air pressure in each of the northern and southern hemispheres. These are the intertropical convergence zone, the subtropical high pressure zone, a zone of low pressure between the 55th and 65th degree of latitude and the polar high pressure zone. The presence of these zones in certain parts of the world is largely responsible for the formation of recognisable patterns in world air circulation. In the study task which follows we look at each of these zones in more depth.

Study Task

Study the section "Global atmospheric circulation" in Bergman and Renwick.

Please note the following as you complete this study task:

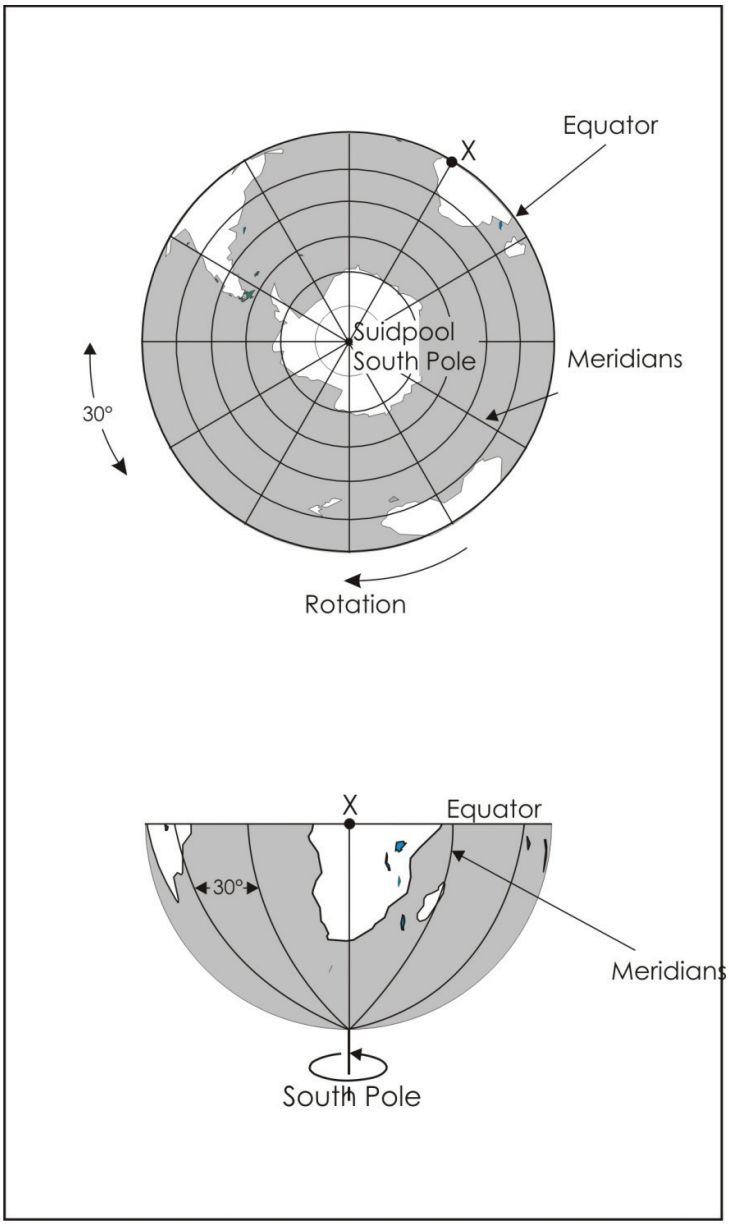


Figure 4.1: The trajectory of a rocket fired from the South Pole at a target (X) on the equator

- You must know what the dominant circulation conditions are in each of the four zones and how the circulation of air occurs between the zones.
- It is important to realise that these zones do not each function on their own, but that they are interconnected because air flows from one zone to another.
- You must understand that it is the flow of air between these four zones that moves the surplus heat at the equator to the poles and thus ensures a balance in the world's climatic system.

Activity 4.6

Label and complete the cross-section (fig 4.2) of atmospheric circulation between the equator and the poles. You have to indicate the direction in which the air moves, where high pressure and low pressure conditions occur, and what the names of the different zones are.

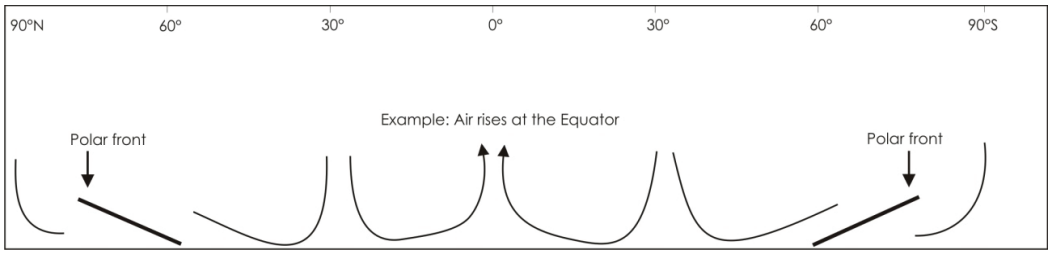


Figure 4.2: Cross-section of atmospheric circulation between the equator and the poles

Answer the following questions in the spaces given:

1. In what air pressure zone(s) are the Namib, Sahara and Australian deserts located?
2. Explain why a balloon which takes off at the equator and floats in the air currents will not reach the North or South Pole. Where will it descend?
3. Why does air rise in the zone between the 55th and 65th degree of latitude?
4. Give the names of two cities in South America, in Africa and in Oceania which are located in the intertropical convergence zone.

Activity 4.7

Draw in the intertropical convergence zone, subtropical high pressure zones and polar fronts on the world map in appendix A. **Hint:** Refer to figure 2-22 of Bergman and Renwick.

You now know that we can distinguish four air pressure zones in each of the northern and southern hemispheres and that the circulation of air between these zones displays certain characteristics. You also know that this system of air circulation is largely convection-driven; in other words it originates and is maintained as a result of the difference in heating intensity between the equator and the poles. In the next section you are going to learn how this simple pattern of four air pressure zones in each hemisphere is affected by the different reactions of land and water to heating and also how the pattern varies seasonally.

4.3.4 The World Map of Air Pressure Cells and Air Circulation

You learnt in sections 4.2.5, 4.3.1 and 4.3.2 that differences in the intensity of heating give rise to differences in air pressure. You are now going to apply what you have learnt to determine how the different reactions of land and water to heating cause the uniform air pressure zones to break into separate cells of air pressure over land and water. You are also going to learn about another application – that the seasonal north-south shift of isotherms (as a result of the seasonal north-south shift of the position at which the sun's rays strike the earth perpendicularly) gives rise to a corresponding seasonal north-south shift of the air pressure and air circulation pattern.

In the study task which follows you will therefore be looking at the global distribution pattern of air pressure and wind and also at how this pattern varies seasonally. Because the circulation of the oceans is so closely linked with that of the atmosphere, you also have to know the global distribution pattern of the major ocean currents.

Study Task

Study the section "Seasonal variations in global circulation" in Bergman and Renwick.

Note that:

- the air pressure and circulation zones are not homogeneous, but manifest in separate cells
- the air circulation zones migrate north-south as the seasons change
- the wind direction changes completely as high pressure conditions over continents during winter are replaced by low pressure conditions during summer

Study Task

Study the section "Ocean circulation patterns" in Bergman and Renwick. The last paragraph of this section is particularly important, as well as the world maps showing the major warm and cold ocean currents. These are important to note because the warm and cold ocean currents significantly affect the weather and climate of the adjoining regions of land.

You now know that there are certain regularities in the global air circulation pattern and that we can distinguish four zones of air pressure in each of the northern and southern hemispheres. The following section focuses on precipitation and the effect which this regularity in air circulation has on the precipitation pattern.

4.4 Precipitation

The amount and type of precipitation which can be expected in any area on earth very much depend on the location of the area with respect to the global air pressure zones. In these zones the air tends either to rise or to sink. In this section you will learn about the connection between rising air and precipitation and finally see what the global precipitation pattern looks like.

Because people depend on water to survive, it is extremely important to be aware of precipitation patterns.

Study Task

Study the section "Precipitation" – you need to page back in Bergman and Renwick.

4.4.1 The Formation of Precipitation

Air has to rise for precipitation to form. We are now going to look at exactly what happens when air rises and why precipitation is specifically associated with the rising (ascent) of air but not with the sinking (descent) of air.

Study Task

Study the section "Condensation" in Bergman and Renwick. Note the following:

- that precipitation is part of the energy flow to and from the earth
- the meaning of the terms "saturation vapour pressure" and "relative humidity"
- what happens to the relative humidity when air cools
- under what conditions condensation occurs
- the role of rising air in cooling and condensation

We cannot overemphasise how essential the rising of air is to condensation and precipitation. In the atmosphere the cooling of air which is necessary for condensation to take place and for clouds to form is brought about mainly by the rising of air.

Air rises where the surface air pressure is low. Parts of the world which are characterised by low air pressure are therefore high precipitation areas. The opposite is true in areas where the surface pressure is often high – because the sinking air which occurs there is compressed and subject to increases in temperature, so that clouds do not form easily.

Air pressure and rising air are, however, not the only factors which cause precipitation to form. The temperature of the air is also important. Cold air has a far lower capacity to carry water vapour than warm air. Precipitation should therefore vary with latitude, with the highest values in the hot equatorial areas and a general decrease in the direction of the poles.

Finally distance from the sea also plays a role. Areas deep in the interior do not usually get much precipitation, simply because the air contains little moisture by the time it eventually reaches these areas.

4.4.2 Types of Precipitation

Different types of precipitation can be distinguished on the basis of how air rises. Three important types of precipitation which can thus be distinguished are convection, orographic and frontal precipitation. We look at these three types of precipitation in more detail in the next study task.

Study Task

Study the section "Causes of precipitation" in Bergman and Renwick.

Note: The detailed material on adiabatic cooling and the distinction between warm and cold fronts in Bergman and Renwick does not form part of this study task.

Take specific note of the following:

- the basic mechanism of rising air in convection, orographic and frontal precipitation respectively
- those parts of the world and/or times of the year where and/or when each of these three types of precipitation occurs

Activity 4.8

Go back to activity 4.6 and indicate the following information on the cross-section of the world's atmospheric circulation:

- where it should rain
- where it should be dry

The previous activity gave you a rough idea of the global precipitation pattern. Now you are going to study the spatial pattern of precipitation in the world in detail.

4.4.3 The World Precipitation Map

To a large extent the world map of precipitation distribution is related to the pattern of global air circulation, with wet conditions around the equator and in the zone from the 40th to the 60th degree of latitude (both zones where air rising should be a common phenomenon), and drier conditions in the subtropics and the polar regions (where sinking air should be a common phenomenon). However, in reality there are many deviations from this generalised pattern.

Study Task

Study figure 2-30 (Average annual precipitation worldwide) in Bergman and Renwick.

Take specific note of the following:

- the largely zonal distribution pattern of precipitation, which corresponds with what we would expect given the world's air circulation patterns
- the numerous exceptions to the expected pattern, for example the dry conditions over Central Asia and the wet conditions on the eastern side of Southern Africa

Activity 4.9

Look at figure 2-30 in Bergman and Renwick and give concise explanations for

- the drier than expected conditions over Central Asia
- the wetter than expected conditions on the eastern side of Southern Africa

As regards the drier than expected conditions over Central Asia, your answer should focus on the effect which high mountain ranges and a location deep in the interior can have on precipitation.

As regards the wetter than expected conditions on the eastern side of Southern Africa, your answer should focus on the effect which sea water and the air pressure conditions in the atmosphere above it can have on precipitation over the adjoining landmasses.

Activity 4.10

Answer the following questions (each answer should be no more than half a page long):

1. Explain the effect of the angle at which the sun's rays strike the earth's surface on the intensity of the solar energy which is eventually absorbed by the earth's surface.
2. Briefly explain why the temperature in Southeast Asia in January drops to levels of –24 ˚C, while it is warmer than 0 ˚C in adjacent parts of the Indian Ocean and even reaches 24 ˚C.
3. Explain why there are high pressure conditions in North America in January but low pressure conditions in July.
4. Explain why there are relatively dry conditions in the western interior of the USA and Canada in spite of the location of these countries in the relatively wet zone between 40˚ and 60˚ N.
5. Describe the temperature and precipitation conditions in the area where you live. Try to explain them in terms of the solar energy which is received and the prevailing air pressure and air circulation conditions.

IN CONCLUSION

Now that you have worked through this study unit you should have a good understanding of the spatial variation and covariation in the major climatic variables across the world, namely temperature, air circulation and precipitation.

In this study unit we have looked at the patterns of temperature, air circulation and precipitation individually; in the next study unit our focus shifts to the climates of the world, with climate being the average weather conditions over time.

Study Unit 5
Climate regions of the world

INTRODUCTION

Although we can get a good deal of information from an analysis of the temperature, air circulation and precipitation patterns of the world, this information does not really give us an overall picture of climatic conditions in different parts of the world. Classifying climate under certain general types can be very useful for helping us to overcome this problem. In this study unit you are going to learn about different climatic types and about how we use them to divide the world into climate regions. You will learn about the main characteristics of each climate region and why they have these characteristics.

Key Terms

- weather
- climate
- global warming
- precipitation
- climograph
- evapotranspiration
- insolation

STUDY MATERIAL

You will find the study material for this study unit in the last section of the chapter on weather and climate in Bergman and Renwick.

Learning Outcomes

After you have worked through this study unit, you should be familiar with and understand the world map of climatic regions and also be able to use it. You will also have a broad understanding of climate change and global warming.

To understand and use the world map of climatic regions meaningfully, you have to be able to

- explain why it is necessary to classify the climates of the world

- name the variables which are used in classifying climates
- explain how we go about classifying climates
- draw a climograph using the necessary temperature and precipitation data
- explain how the world is divided into climate regions by means of the Köppen system
- list the main characteristics of each of the world's main climate regions, and explain the reasons for these characteristics

To understand the concept of climate change and global warming, you have to be able to:

- explain how climate change has taken place within geological time
- provide possible reasons for climate change
- explain the concept of global warming, and how it affects the climatic regions of the world

You already know that we can see "climate" as a summary of the weather conditions over a number of years. It is not, however, as easy to describe the climate of an area as it may seem. We are therefore first going to look at the phenomenon known as climate in detail.

5.1 Climate

In the study task that follows we introduce you to climate as a phenomenon and also explain how climate influences people's lives.

Study Task

Study the section "Climate" in Bergman and Renwick.

Activity 5.1

Answer the following questions.

1. Why is it difficult to describe the climate of an area?
2. What happens to climate over long periods?
3. Give three examples of the effect of climate on people.

Two variables which play a determining role in the climate of any area are temperature and precipitation. We now look at each of these variables separately.

5.1.1 Temperature

You learnt in study unit 4 that temperature is generally higher in the tropics and decreases as we move towards the poles. We also explained in study unit 4 how this

pattern is affected by the different reactions of land and water masses to heating. In the next study task you learn about the influence of another two variables, namely topography and humidity, on temperature.

Study Task

Study the section "Air temperature" in Bergman and Renwick.

Note the following:

- how temperature is measured
- how the daily average temperature is determined
- the decrease in temperature with an increase in height above sea level
- the reasons for this decrease in temperature
- that mountainous areas are usually cooler than the surrounding lowlands
- the effect which intense solar heating and dry air have on temperature in deserts
- the relatively small seasonal variation in temperature in coastal areas

5.1.2 Precipitation

We have already discussed the global precipitation pattern in study unit 4. You learnt about the relationship between precipitation and air circulation and also about the different types of precipitation. Although the average precipitation figures which the global precipitation pattern is based on tell us a good deal about the climate of an area, other aspects of precipitation are also important. Examples include the intensity, regularity and reliability of precipitation.

Study Task

Study the section "Precipitation" up to "Water availability" in Bergman and Renwick.

Note the following:

- how the amount of precipitation is measured
- the type of precipitation which occurs in the tropics and in the midlatitudes respectively
- the effect of light rain as compared with that of sudden storms
- that some parts of the world receive the same amount of precipitation virtually throughout the year, while other parts of the world have definite wet and dry seasons
- the disadvantage of precipitation which occurs during a short time of the year only
- the variation in precipitation and the predictability of this variation

- the large year-to-year variation in precipitation in many of the tropical and sub-tropical parts of the world
- the impact of variations in precipitation on human activities

You now know that temperature and precipitation are two important climatic variables, and that they influence people and the environment in various ways. You are also aware that these variables vary both in space and over time across the earth's surface. In the next section you will see how we use these variables to classify climate.

5.2 The Classification of Climate

We begin this section with a brief discussion on the usefulness of climate classification.

Study Task

Study the first paragraph of the section "Classifying climate" in Bergman and Renwick.

Although the value of climate classification should now be clear to you, you must remember that it has shortcomings as well. An example of such a shortcoming is the loss of detail when we try to identify general climatic characteristics for areas. The data which climate classifications are based on are also often inadequate and inaccurate. When using the results of climate classifications, it is important to bear shortcomings like these in mind.

Most systems for classifying climate use information about temperature and precipitation to determine the effect of temperature on the availability of water for plants.

Study Task

Study the section "Water availability" in Bergman and Renwick.

Note the following:

- how precipitation is used in climate classification systems
- the fraction of the total amount of precipitation which is absorbed by plants
- what happens to water which is absorbed by plants
- what transpiration is
- what is meant by potential evapotranspiration (POTET)
- the difference in POTET between areas in the tropics, midlatitudes and poles
- the use of POTET to distinguish between humid (wet) and arid (dry climates)

An example of a climate classification system which uses the availability of water to vegetation as departure point is the one which was developed in 1918 by the German geographer Wladimir Köppen.

Study Task

Study the section "Classifying climate" and figure 2-31 in Bergman and Renwick. Also study the introductory paragraphs of the section "Earth's climate regions" in Bergman and Renwick. Appendix II at the end of Bergman and Renwick is also applicable here.

Important: Although you must know how the main climate types are divided into subtypes and what each subtype is called, you do not have to memorise the letter codes for the subtypes! You must, however, memorise the letters for the main climate types.

Note the following:

- the five main climate types, the letters used to indicate each type, and how these letters were chosen
- that each main climate type is divided into subtypes, as shown in table 2-1 and appendix II
- that the boundaries between the climate regions were not chosen arbitrarily, but are based on the distribution of plants and their water needs
- the use of the letter H for the climate in mountainous areas, and the reason why mountainous areas are an exception

As regards table 2-1, figure 2-31 and appendix II in Bergman and Renwick, it is important to note the general patterns. Try to relate the map of climate regions to what you know about the world's temperature, air circulation and precipitation patterns, as explained in the introductory paragraph to the section "Earth's climate regions" in Bergman and Renwick.

Here you should first think about the general decrease in temperature from the equator towards the poles. Also bear in mind the variables which upset this general pattern in places: the different reactions of land and water to heating, height above sea level and ocean currents. Then think about how temperature differences on earth give rise to air circulation, and the air pressure and air circulation zones which we can distinguish on earth as a result. Also consider the relationship between the global air pressure/air circulation zones and the global precipitation pattern. Then there are also those variables which cause deviations, namely distance from the sea, high mountain ranges and the capacity of air to carry water vapour.

With this background it should not be difficult for you to understand why

- low latitude climates (A climates) are warm and humid
- so many of the dry climates (B climates) occur in the subtropics
- climates in the midlatitudes are mostly humid, and are divided into colder climates (closer to the poles) and hotter climates (closer to the equator)
- polar climates are cold
- mountain climates have a unique character

Activity 5.2

Use figure 2-31 in Bergman and Renwick, together with any atlas you have access to, to determine the type of climate of each of the following places. Give both the letters and a description of the main climate type and the subtype in each instance.

Example:

Cape Town: Main type: humid subtropical climate (C): Subtype: Mediterranean climate (Cs)

Now do the same for the following places:

Jakarta (Indonesia)

N'Djamena (Chad)

San Francisco (USA)

5.3 The Graphical Representation of Climate Variables

In the previous section you saw that precipitation and temperature are the two climate variables which we use to distinguish, classify and describe climate types. However, describing temperature and precipitation conditions in words is unsatisfactory because we have to use too many words and easily lose the overall picture. Fortunately there is another way of describing climate data, namely representing them graphically.

In the classification and/or description of the climate of an area we often use climographs. A climograph shows both the monthly average temperature and precipitation for a place, and it is therefore easy to contrast these two variables visually. In this section we are going to teach you how to draw and also how to interpret a climograph.

Bergman and Renwick make use of several climographs to depict the different climate types. In this section we are going to limit our discussion to figure 2-32 in Bergman and Renwick. We are going to examine in detail the climograph for Singapore (find this tiny country in Oceania in your atlas) which is given in this figure. For convenience's sake we have reproduced the climograph in figure 5.1.

At the bottom of the graph (we call it the horizontal or x-axis) the months of the year are given in sequence. On the left-hand side of the graph temperature is given. The figures in brackets indicate temperature in degrees Fahrenheit, while those which are not in brackets indicate temperature in degrees Celsius. On the right-hand side of the graph precipitation in millimetres is indicated. We call the left-hand and right-hand sides of the graph the vertical or y-axes. The temperature and precipitation figures are indicated on a suitable scale on the vertical axes. The scale which is chosen depends on the figures which have to be represented on the graph. In this case each block on the left-hand y-axis represents 108 ˚C and each block on the right-hand y-axis represents 50 mm. This scale is used for all the climographs in Bergman and Renwick. The reason for this standardisation is that it makes it possible for us to directly compare the climographs for different places.

The temperature in Singapore over a year is indicated by the line graph in the top part of the graph. We can read the average temperature for each month of the year from this graph. Let's take January as an example. Follow the vertical line which runs through the letter J (for January) on the left on the x-axis. To make it quite clear, this procedure is shown in figure 5.1. At the point where the vertical line

crosses the temperature graph, we read the temperature on the y-axis on the left-hand side. It is clear at a glance that the average temperature for January is between 20 and 30 ˚C. But we would like to determine the temperature more accurately. To do so we have to divide the part of the y-axis between 20 and 30 ˚C into 10 equal parts, each of which represents 1 ˚C (see fig 5.1). Depending on the level of accuracy required, it can also be divided into, say, five equal parts, each of which represents 2 ˚C. In this way we can read the average temperature for January more accurately as 26 ˚C.

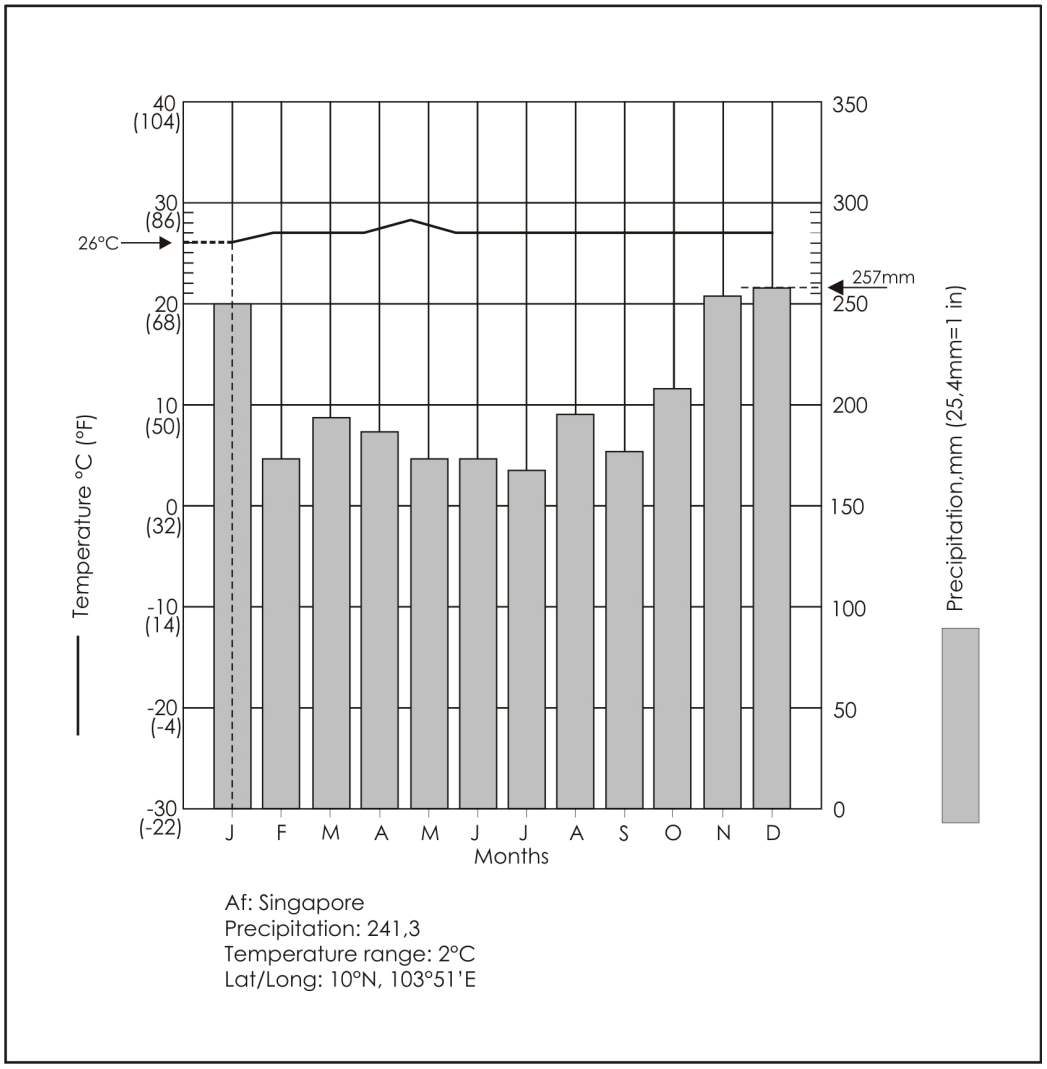


Figure 5.1: Climograph for Singapore, taken from Bergman and Renwick (1999:71) figure 2-33

The precipitation received in Singapore in the course of a year is indicated by the bar graph in the bottom part of the graph. The average precipitation in every month is represented by a separate bar and we can therefore easily read it off the graph. Let's take December as an example. Find the top of the bar representing precipitation in December. Now draw a horizontal line from the top of this bar to the right-hand y-axis (see fig 5.1). We read the average precipitation in December at the point where this line crosses the y-axis. It is clear at a glance that the average precipitation in December is just over 250 mm. To get a more accurate reading, we have to divide the area on the y-axis between 250 and 300 mm into smaller parts. If we divide this part of the y-axis into 10 equal parts, we get parts which each represent

5 mm, because 50 mm – 10 = 5 mm (see fig 5.1). In this way we can read the average precipitation for December more accurately as being 257 mm.

Representing temperature and precipitation on a single graph has various advantages. The main advantage is that we get an overall picture of the seasonality of both precipitation and temperature at a single glance and can make comparisons in this regard. We can see whether precipitation is concentrated in a certain period of the year or whether it is spread evenly over the year. At the same time we can also evaluate the effect of temperature on precipitation. A situation in which the dry season coincides with the hot season can result in extreme aridity. In a situation in which the wet season and the hot season coincide, the effectiveness of the precipitation may largely be cancelled out by the effect of evaporation.

Let's now draw a climograph ourselves. We are going to use the precipitation and temperature data for Darwin in Australia (see table 5.1). By the way, do you agree that Darwin has a seasonal, humid tropical climate (Aw)?

Table 5.1 Precipitation and temperature data for Darwin (Hidore & Oliver 1993:281, table 14.4)

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temp °C	28,2	27,9	28,3	28,2	26,8	25,4	25,1	25,8	27,7	29,1	29,2	28,7
Prec (mm)	341	338	274	121	9	1	2	5	17	66	156	233

We are now going to explain step by step how to compile a climograph from the precipitation and temperature data for Darwin.

- ***Step 1***. Analyse the data:

  Determine the highest and the lowest temperature: highest 29,2 °C; lowest 25,1 °C.

  Determine the difference between the highest and the lowest temperature:

  29,2 – 25,1 = 4,1 °C.

  This means that the left-hand y-axis must make provision for a variation of 4,1 °C, and must definitely include values from 25,1 to 29,2 °C.

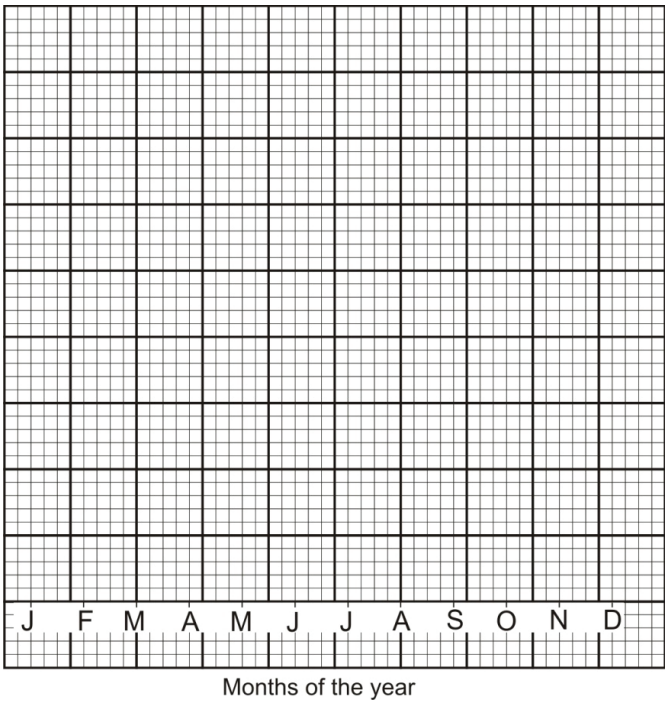
  Determine the highest and the lowest precipitation: highest 341 mm; lowest 1 mm.

  Determine the difference between the highest and the lowest precipitation:

  341 – 1 = 340 mm.

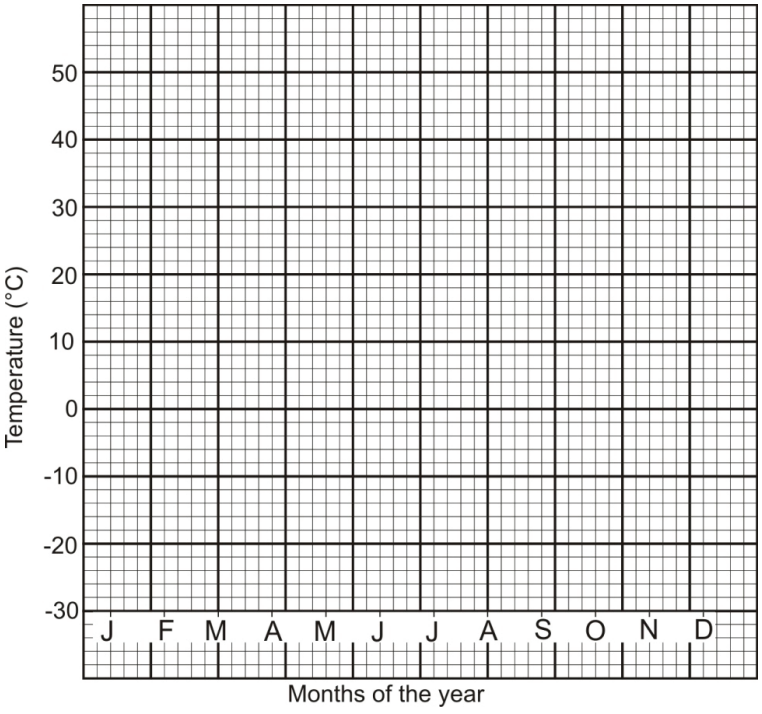
  This means that the right-hand y-axis must make provision for a variation of 340 mm, and must definitely include values from 1 to 341 mm.

- ***Step 2***. Draw a horizontal line close to the bottom of the graph paper and mark off the months of the year at equal distances along this line. Directly below write "Months of the year".



Graph 1

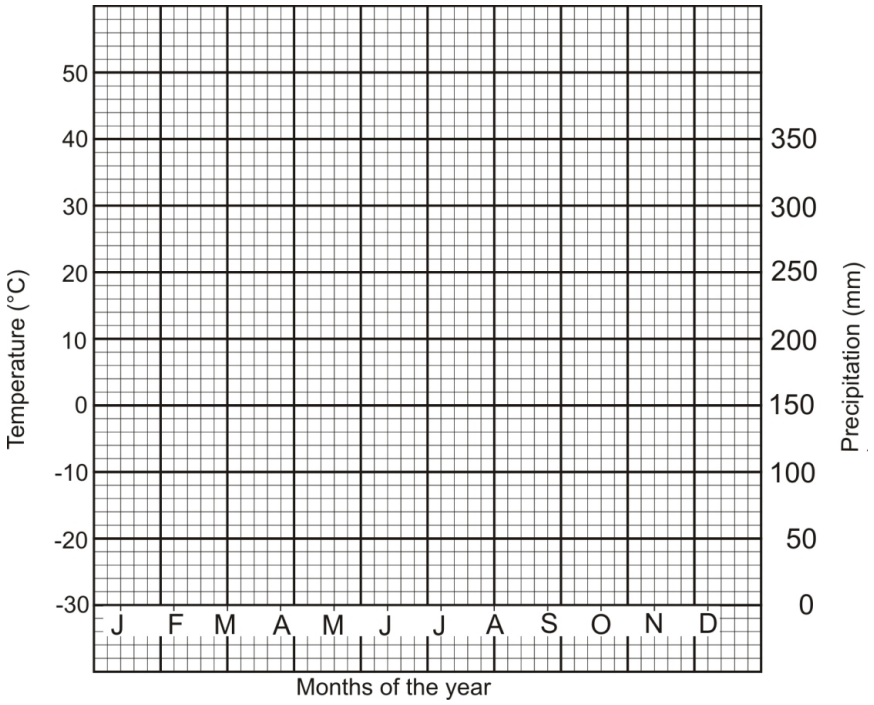
- ***Step 3***. Draw the left-hand y-axis on the left-hand side of the horizontal line which you drew in step 2 and divided into months. Using a suitable scale, mark off the temperature along this axis. We have used the same scale as is used in Bergman and Renwick, namely one large block or 1 cm on the graph paper to represent 108 ˚C. Then divide each one of these 1 cm blocks on the graph paper into five smaller blocks, which thus represent 2 ˚C each. We have marked off the left-hand y-axis from –30 ˚C to 40 ˚C. Write "Temperature (˚C)" along the left-hand y-axis.



Graph 2

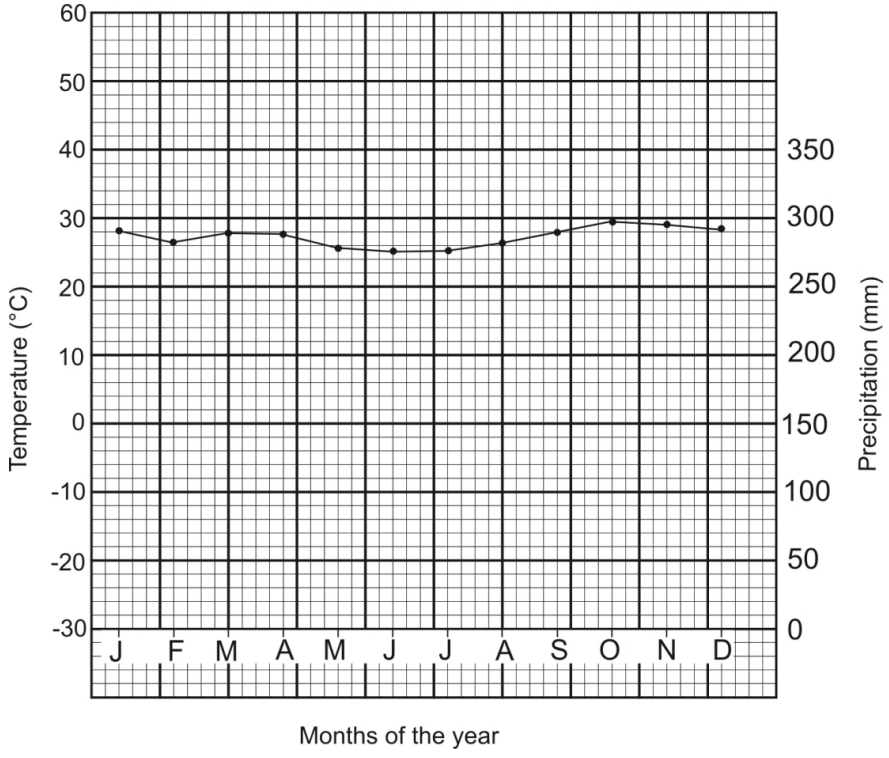
- ***Step 4.*** Now repeat step 3 to draw in and mark off the right-hand y-axis. We use the same scale as is used in your prescribed book; in other words one large block

represents 50 mm and each of the smaller divisions represents 10 mm. Write "Precipitation (mm)" along the right-hand y-axis.



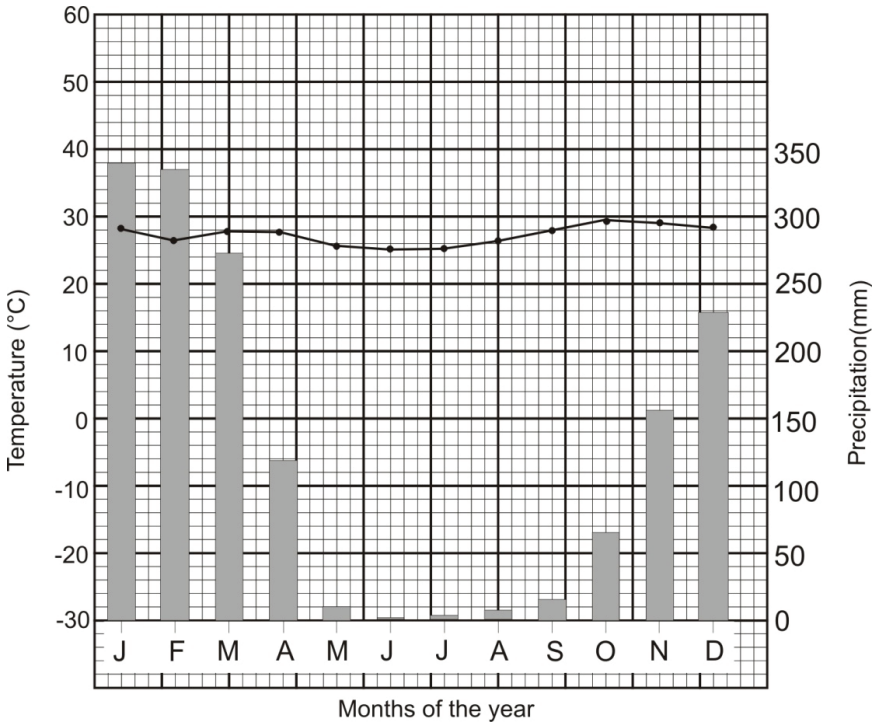
Graph 3

- ***Step 5***. Now use dots to plot the temperature for each month on the graph paper. To determine the position of the dots on the graph paper, you have to first find the temperature for the relevant month, say January, on the left-hand y-axis and then make a dot to the right of it – exactly opposite January on the horizontal axis. Once you have plotted the dots for each month on the graph paper, you join them in calendar order with a solid line.



Graph 4

- ***Step 6***. Now you have to add the precipitation data to the graph. We do this by means of a bar graph. A bar graph is actually simply a line graph which we draw in a different way. Up to a point we therefore go about representing the precipitation data in a similar way to the temperature data. Instead of determining the dots which have to be joined by a line, we see the dots as the tops of bars of equal width, which all stand on the horizontal axis. We leave equal spaces between the bars, and finally we colour in the bars.



Graph 5

Our climograph is finished. Now we can interpret it.

The seasonality of the precipitation in Darwin is striking: from May to September there is virtually no precipitation. By contrast, the annual variation in temperature is not nearly as striking. The difference between the hottest month (October) and the coldest month (July) is only 4,1 ˚C. At 12˚26'S Darwin is situated between the intertropical convergence zone and the subtropical high-pressure cells. The wet conditions in Darwin in the summer and the dry conditions in the winter coincide with the seasonal north-south shift of air pressure and air circulation systems. The temperature pattern is regulated by a combination of the intensity of the incoming solar radiation (insolation) and the effect of the succession of wet and dry seasons. The temperature therefore rises in the spring because of the greater intensity of solar radiation which is received, but then falls in the summer months as a result of the effect of cloudiness and cooling by evaporation.

Now that you know how we draw and interpret a climograph, you are ready to study the climate regions of the world according to Köppen's system in detail.

5.4 The Climate Regions of the World

In this section we look at the main characteristics of the different climate regions in the world. Our points of departure for this discussion are table 2-1, figure 2-31 and appendix II in Bergman and Renwick. We explain the typical conditions in each climate region using the climographs given in Bergman and Renwick.

5.4.1 Humid, Low Latitude, Tropical Climates (A)

This climate type is divided into two subtypes. Humid tropical climates (Af and Am) occur mostly between 10˚ north and south of the equator and are warm and humid throughout the year. By contrast, seasonally humid tropical climates have a definite wet and dry season.

Study Task

Study the section "Humid low-latitude tropical climates" in Bergman and Renwick.

Take particular note of the role which the intertropical convergence zones play in this climate region.

Activity 5.3

Answer the following questions.

1. What type of storms can be expected in the Amazon forest? At what time of day do these storms occur?
2. How should the difference between day and night temperatures in Gabon compare with the difference between the temperature in the hottest and the coldest months of the year?
3. The annual precipitation figure for places with a humid tropical climate often exceeds ... mm.
4. To what can the seasonal nature of precipitation over the Indian subcontinent be ascribed?
5. Provide the following information from the climograph for Managua, Nicaragua (fig 2-34) in Bergman and Renwick:
   - hottest month:
   - temperature:
   - wettest month:
   - precipitation:
   - difference in temperature between hottest and coldest month: difference in precipitation between wettest and driest month:

5.4.2 Dry Climates (B)

More than 35% of the earth's surface is characterised by dry climates. Dry climates are generally found in the zones directly south and north of the humid low latitude tropical climates. They also occur in other parts of the world, for instance as a result of the rainshadow effect of high mountains and where the interior of large continents lies far from the sea (the main source of moisture in the air). Dry climates are divided into two subtypes: desert climates (BW) and semiarid climates (BS).

Study Task

Study the section "Dry climates" in Bergman and Renwick.

Take particular note of the following:

- where these climates occur
- the distinction between hot and cooler dry climates
- the role which the subtropical high-pressure cells and cold ocean currents play in desert climates
- where semiarid climates occur, and how they differ from desert climates

Activity 5.4

Answer the following questions.

1. How big a portion of the world's population lives in areas which are characterised by dry climates?
2. Which deserts exist because air descends over the oceans on the eastern side of high-pressure cells?
3. To what can the semiarid climate in large parts of western interior of the USA be ascribed?
4. Name three world cities which are situated in areas with a semiarid climate.
5. Study figure 2-36 in Bergman and Renwick. How do the water requirements of vegetation in the vicinity of Cairo compare with the amount of water which is available? **Hint:** Look at the typical POTET value for areas with BW climates.

5.4.3 Warm Midlatitude Climates (C)

The midlatitudes are situated between the subtropical high-pressure zone and the low-pressure zone between the 55th and the 65th degree of latitude. This area has definite hot and cold seasons because the amount of insolation received varies in the course of a year. Warm subtropical climates occur on the equator side of the midlatitudes and are divided into humid subtropical climates (Cfa and Cw), marine west coast climates (Cfb and Cfc) and Mediterranean climates (Cs).

Study Task

Study the section "Warm midlatitude climates" in Bergman and Renwick.

First note the occurrence of definite hot and cold seasons in the midlatitudes, and also how precipitation in the midlatitudes is affected by the polar front.

Also note the following for each of the humid subtropical climates, the marine west coast climates and the Mediterranean climates:

- where they occur
- the precipitation and temperature characteristics
- the mechanisms responsible for precipitation
- the implications of the climate for people and the environment

Activity 5.5

Fill in the missing words:

1. The relatively small annual variation in temperature in areas with a marine west coast climate can be attributed to the moderating effect of the ..... .
2. In the subtropics it is the ..... which brings in moist air from the oceans to the eastern margins of continents.
3. The eastern part of the interior of South Africa has a ..... climate.
4. Mediterranean climates are characterised by ..... summers and ..... winters. In South Africa this climate is found in the ..... .
5. In Mediterranean climates farmers have great problems with ..... because there is little precipitation in the summer, when POTET is highest.
6. In marine west coast climates the occurrence of ..... contributes to the relatively high precipitation which is received.

5.4.4 Cold Midlatitude Climates (D)

The cold midlatitude climates occur on the poleward side of the midlatitudes. These climates are characterised by lower temperatures and greater seasonal contrasts than the warm midlatitude climates. There are two subtypes: humid continental climates (Dfa, Dwa, Dfb and Dwb) and subarctic climates (Dfc, Dwc, Dfd and Dwd).

Study Task

Study the section "Cold midlatitude climates" in Bergman and Renwick.

As regards humid continental climates, you must know where they occur, why they have this name, the form of precipitation and when it occurs, and finally how and why temperature varies in the course of a year.

As regards subarctic climates, you must know how they differ from humid continental climates, what the temperature and precipitation conditions are, and finally how people and the environment are affected by the climate.

Activity 5.6

Answer the following questions.

1. Why are humid continental climates characterised by large seasonal variations in temperature?
2. Why do we find hardly any D climates in the southern hemisphere?
3. What type of forests occurs in subarctic climates?
4. How low do winter temperatures fall in subarctic climates?
5. Why is it not really possible to practise farming on a continuous basis in subarctic climates?
6. Why is vegetation found in subarctic climate regions despite the low annual average precipitation?

5.4.5 Polar Climates (E)

As the name of this climate type indicates, polar climates occur exclusively at and in the direct vicinity of the North Pole and the South Pole. They are characterised by exceptionally low temperatures and extreme seasonal variation. Polar climates are divided into two subtypes: tundra climates (ET) and ice-cap climates (EF).

Study Task

Study the section "Polar climates" in Bergman and Renwick.

To start off, note the main reasons for the specific characteristics of this climate type. In particular, note that polar climates are identified purely on the basis of temperature.

It is, of course, also important to know where each of the polar climate types occurs and what the main temperature and precipitation characteristics of each type are.

As regards tundra climates, you must also know

- what permafrost is
- how much water is available
- what type of vegetation occurs

Activity 5.7

Say whether the following statements are true or false:

1. Polar climates occur only in the northern hemisphere.
2. No solar energy is received in polar climate regions.

3. Permafrost, or permanently frozen ground, is a common phenomenon in tundra climate regions.
4. The name "tundra climate" comes from the type of vegetation which occurs in this climate region.
5. Ice-cap climates occur in the southern hemisphere only.
6. Ice-cap climates are characterised by an average annual precipitation of about 500 mm, mostly in the form of snow.

5.5 Climate Change

Study Task

Study the section "Climate change" in Bergman and Renwick.

Note the following:

- climate change over geological time
- the astronomical and geological hypotheses of climate change
- human causes of climate change
- definition of global warming
- consequences of global warming

Activity 5.8

1. Briefly explain why the greater part of Africa north of the equator has a semi-arid to a desert climate. (Length of answer: about half an A4 page.)
2. Explain the implications of the humid tropical and seasonally humid tropical climates which occur over the greater part of Brazil for the natural vegetation. (Length of answer: about half an A4 page.)
3. Explain the implications of the subarctic and tundra climates in the north of Canada for human activities. (Length of answer: about half an A4 page.)

IN CONCLUSION

In this study unit you have expanded your knowledge of temperature and precipitation, and seen how these climate variables are used in Köppen's system for classifying the world's climates. You have also learnt about the five main categories into which we divide the world's climates on the basis of this classification. You have seen that there are certain patterns in the occurrence of climates across the world. In the next study unit you will be using your knowledge of the climates of the world to explain the global distribution pattern of both natural phenomena (e.g. soils and plants) and human phenomena (e.g. population numbers and economic activities).

Study Unit 6
Landforms of the world

INTRODUCTION

This study unit deals with the surface of the earth. Our approach is to view the earth's surface as an interface that receives energy not only from the sun and atmosphere, but also from the earth itself. These forms of energy impact on the earth's surface, shaping it in many ways; think, for example, of mountains and valleys.

The earth's outer surface consists of land and water. This study unit focuses on the land surface, in other words that part of the earth's surface that is not covered by water. We look at the main landforms: how they are created and where they occur.

Our interest is not only in the shape of the land surface, but also in what is happening below the surface. We therefore not only look at the structures that underlie and shape the earth's surface, but at the resources (minerals and fossil fuels) that are found below the earth's surface as well.

STUDY MATERIAL

You will find the prescribed study material for this study unit in the chapter "Landforms" in Bergman and Renwick.

Key Terms

- plate tectonics
- earthquakes
- volcanoes
- shield volcanoes
- rocks
- minerals
- weathering
- erosion
- endogenic and exogenic processes
- fault

- drainage density
- run-off
- deltas
- alluvial fan
- graded stream
- fossil fuels

Learning Outcomes

After you have worked through this study unit you should understand how landforms are created and be familiar with the spatial variation of landforms on the earth's surface. You should also be able to locate the main landforms on the world map.

Having mastered the specific requirements of this study unit, you should be able to

- explain the role of plate tectonics in creating landforms
- describe the spatial distribution of earthquakes and volcanoes across the globe
- name the nine continental shields
- distinguish between rocks and minerals
- explain how rocks and mineral deposits are formed
- name the three main types of rocks and explain how each is formed
- distinguish between weathering and erosion
- explain how weathering and erosion contribute to the creation of landforms
- show that you are familiar with the world map of the main landforms and can distinguish between first-order, second-order and third-order landforms

6.1 The Study of Landforms

The study of landforms and the processes by which they are created is known as geomorphology. Geographers are, however, interested not only in landforms as such, but also in the interaction between landforms and people. We explain this view and others relating to the study of landforms in more detail in the study task below. This study task also introduces some of the terms used in the study of landforms.

Study Task

Study the introduction to the chapter "Landforms" in Bergman and Renwick.

Pay special attention to the following:

- the meaning of the following terms: lithosphere, landforms, endogenic processes and exogenic processes

- the relative stability and constancy of the lithosphere compared with the other spheres of the earth
- the slow and protracted process largely responsible for shaping the land surface and creating landforms
- the sudden changes which sometimes occur in the earth's surface
- the drastic implications for people of sudden changes in the earth's surface
- the impact of human activities on both the earth's surface and the lithosphere

Now that you are familiar with the geographer's perspective on the study of landforms, and have become acquainted with some of the relevant terms, you are ready to explore the landforms of the world.

We start in the next section by looking at the theory of plate tectonics, which offers a possible explanation for the global pattern of continents and oceans, and some of the major mountain ranges as well as phenomena such as earthquakes and volcanoes.

6.2 The Earth's Moving Crust

For a long time, people believed that the oceans and continents had been where they are now since the beginning of the world. This has been contradicted by the widely accepted theory of plate tectonics.

6.2.1 The Theory of Plate Tectonics

Study Task

Study the two introductory paragraphs of "Plate tectonics" and the introductory paragraph of "Earth's moving crust" in Bergman and Renwick.

Pay attention to the premises of Wegener's early theory of a supercontinent, the reasons why this theory was rejected, and how it was eventually replaced by the theory of plate tectonics.

You must be familiar with the various elements of the theory of plate tectonics, especially those relating to continental drift and how this gives rise to phenomena such as oceanic ridges and ocean floor trenches as well as some mountain ranges.

You should also be able to distinguish between the different plates of the earth's crust and you should know why these plates move. It is especially important to pay attention to the movement of the plates in relation to one another. Also make sure that you know what happens along the margins of these plates, where the plates either push together or move apart.

Activity 6.1

Answer the following questions:

1. To what can we attribute the creation of the Andes Mountains?

2. Name three plates of the earth's crust that are found in the southern hemisphere and also indicate where each of these plates is located.
3. What happens to the crustal plates at the Mid-Atlantic Ridge?
4. What is the mantle, what does it consists of and why do convection currents occur in the material of the mantle?

You now know that the crust of the earth consists of a number of plates which move in relation to one another. You have also seen how such motion leads to the formation of mid-oceanic ridges and trenches as well as some mountain ranges. This motion is also accompanied by earthquakes and volcanic eruptions.

6.2.2 Earthquakes and Volcanic Eruptions

Earthquakes occur every day somewhere in the world, usually in the vicinity of the boundaries between the earth's crustal plates. They may also occur elsewhere, for example as a result of faults in the earth's crust or as a result of mining activities. Volcanic eruptions are not as common as earthquakes, but generally follow the same distribution pattern as earthquakes.

Study Task

Study the sections "Earthquakes", "Volcanoes" and "Shield volcanoes" in Bergman and Renwick.

- Pay attention to the following concerning earthquakes:
  - the spatial distribution of earthquakes across the globe
  - the meanings of the epicentre and the focus of an earthquake
  - how the intensity (magnitude) of earthquakes is measured
  - factors that determine the amount of damage caused by an earthquake

- Concentrate on the following information relating to volcanic eruptions:
  - what happens during a volcanic eruption and why it happens
  - what a shield volcano is and give an example of a shield volcano
  - what a composite cone volcano is and give an example of a composite cone volcano
  - the most violent volcanic eruption of the 20th century

At this stage you know that the earth's crust consists of moving plates and that earthquake and volcanic eruptions occur mostly along the boundaries between these plates. We now need to take a closer look at the exact nature of the movement at the boundaries between crustal plates, and also at how plate movements help to shape the earth's crust.

6.2.3 Movement Along Plate Margins

Four different types of movement are possible along the boundaries between crustal plates. Plates may move towards each other, away from each other, past each other, or vertically in relation to each other.

Study Task

Study the section "Types of boundaries between plates" in Bergman and Renwick.

Pay special attention to the specific effect that each of the four types of movement at the margins of plates has on the earth's crust, and the landforms associated with each type of movement.

You should also know where the different types of movements commonly occur on the globe.

You also need to be familiar with the following terms: divergent plate margins, convergent plate margins, transform plate margins, seafloor spreading and isostatic compensation.

You now know that, although the earth's crust may appear to be solid and unchanging, it really consists of a number of plates that continue to move very slowly. The current positions of the continents are the direct result of this motion. You have also learnt about the specific types of movement at the margins of plates, and that phenomena such as earthquakes and volcanoes occur mainly in the vicinity of the plate margins. We now look at the material that makes up the earth's crust, as well as the role that this plays in the creation of landforms.

6.3 Materials of the Earth's Crust and Landforms

The earth's crust is made up of minerals. Although there are more than 2 600 different known types of minerals, only 15 of these account for approximately 99% of the mass of the earth's crust. A mineral is a compound of elements with a constant chemical composition and distinct physical properties, such as crystalline form. Individually or together, minerals form the rock of which the earth's crust consists. In this section you will learn more about minerals and rocks, as well as the relationship between rocks and landforms.

6.3.1 Minerals and Rocks

Based on the way in which they are created, the rocks that make up the earth's crust may be divided into three main types: igneous, sedimentary and metamorphic rocks. The occurrence of these types of rock varies across the globe. Each type of rock also has a unique mineral composition. Together, igneous and metamorphic rock covers some 25% of the exposed land surface, the remaining 75% of the exposed area being covered by sedimentary rock. Because all landforms are built up of rock, it is essential to examine their properties and origins in more detail.

Study Task

Study the section "Rock formation" up to the section "Stress on rocks" in Bergman and Renwick.

Note the following:

- the different ways in which the three types of rock are formed
- the examples of each type of rock (and, where appropriate, the places where each may be found)
- the role of minerals in the diversity of rocks
- the nature of "sial" and "sima", and where they occur
- what a continental shield is and where the nine continental shields are located
- the importance of the continental shields as source areas for mineral resources

Now that you know more about the rocks that make up the earth's crust, we can take a brief look at the role of rocks in the creation of landforms.

6.3.2 Rocks and Landforms

In this section we look at the role of the inherent stress in rocks in the creation of landforms. We also look at the differences between the resistance of different rocks to external processes, and how this affects the creation of landforms.

Study Task

Study the sections "Stress on rocks" and "Rocks and landforms" in Bergman and Renwick.

Pay special attention to the following:

- the contribution of the variation in the structures and rocks of the earth's crust to the geographic variability of the earth's surface
- how the stress in the rocks of the earth's crust lead to faulting
- what happens to rocks when faulting occurs
- the difference between a normal and a reversed fault, and how rocks are affected by such vertical faults
- that stress does not necessarily cause only faulting, but may also cause folding (i.e. bending) of the earth's crust
- how rocks are affected by horizontal faults
- what structural landforms are and how they are created
- the relationship between the soil types of an area and the minerals that are present

Activity 6.2

1. What caused the creation of the Himalayas?
2. How were the ridges and valleys of the Central Appalachian Mountains in the USA created?
3. What happens in time to that part of the earth's crust that has been pushed up due to faulting?
4. What is happening to rocks along the San Andreas Fault in California?
5. Which world city is located on the San Andreas Fault?
6. Which type of fault is responsible for rocks being broken apart in the Great Rift Valley in East Africa?
7. Name two examples of mountain ranges where folding of the earth's crust may be observed.

So far we have concentrated on the endogenic or internal earth processes which explain not only why the continents are in their present positions, but also how, why and where phenomena such as faults, earthquakes and volcanic eruptions occur. These processes start with the heat released by radioactive substances deep inside the earth. As a result of these processes, the earth's surface is built up, new land surfaces are created (e.g. volcanic islands such as Réunion and Hawaii) and mountains are formed. We have also looked at the materials that make up the earth's crust and the relationship between such materials and landforms.

However, the earth's surface is not affected by endogenic processes only. A second group of processes, known as exogenic processes, also affect the earth's surface. In contrast with endogenic processes which build up the surface of the earth, exogenic processes break it down. In the next section we consider exogenic processes and the landforms that they create in more detail.

6.4 Exogenic Processes

Exogenic processes, also called gradation processes, derive their energy from the sun and the effect of the earth's gravity. Such gradation or gradual breaking down of the earth's surface takes place in two steps. Firstly, rock is broken into smaller pieces as a result of weathering. The weathered material is then moved from one place to another as a result of gravity and the action of wind, water or ice.

6.4.1 Weathering

Weathering is the first step in the gradation of the earth's surface. Without weathering there is nothing for the wind, water or ice, together with the effect of gravity, to move.

Study Task

Study the section "Weathering" in Bergman and Renwick.

Pay special attention to the following:

- when weathering begins
- the main causes of weathering
- the nature of chemical weathering, how it takes place and where it occurs
- the nature of oxidation
- how decomposition of calcium carbonate takes place
- what a karst landscape is and where it is found
- what mechanical weathering is, how it takes place and where it occurs

You have now seen how mechanical and chemical weathering combine to break down rock. In the next section we look at how the weathered material is transported from one place to another.

6.4.2 Movement of Weathered Material

The simplest way in which weathered material starts moving is down the slopes of hills or mountain by force of gravity. This may take place either through mass movement or through the flow of water across the surface.

Mass movement takes place when weathered material, stone, boulders, soil and gravel slide, roll or tumble down the sides of hills or mountains by force of gravity. Surface flow takes place when water runs down the slopes of hills or mountains by force of gravity, carrying with it particles of rock, weathered material, soil and gravel. This process is also known as surface erosion.

Weathered material may be carried farther afield by consolidated flows of water in a river. In dry areas, weathered material may also be carried from one place to another by the wind.

The oceans and moving ice masses (glaciers) may also cause erosion, but unfortunately the role of oceans and ice falls outside the scope of this tutorial letter.

Study Task

Study the introductory paragraphs of the section "Moving weathered material" and the sections "Mass movement" and "Surface erosion" in Bergman and Renwick.

Pay special attention to the following:

- that the steeper the slope of a hill or mountain, the more rapid the movement of weathered material
- that weathered material also moves down gentle hill and mountain slopes
- the different types of mass movement, under which conditions each type occurs, and the consequences of each
- that rain initiates surface erosion
- how surface erosion takes place

- that small channels or rills initially created by the flow of water gradually develop into larger channels (called erosion gullies or dongas) and may eventually become permanent watercourses
- the effect of vegetation on surface erosion
- the effect of human activity on surface erosion

The weathered material that has moved downhill along the slopes of hills and mountains as a result of mass movement and surface flows is carried farther by the run-off of water in rivers.

Rivers serve two important functions. Firstly they are responsible for removing water from the surface of the land by carrying it to the sea. Run-off to the sea takes place by force of gravity. This process allows the build-up of energy which rivers need for the second function, which is to transport weathered material. Rivers themselves also act as agents of erosion by carving and eroding the land surface through the flow of water.

All the material transported by rivers is eventually deposited elsewhere on the land surface or in the ocean. Through the process of erosion, downhill transportation of material and its eventual deposition, rivers are responsible for changing the land surface and creating a variety of landforms.

Study Task

Study the section "Stream drainage" in Bergman and Renwick.

Note the following:

- where the water flowing in rivers comes from
- how surface and river run-off are organised in drainage basins
- the meanings of the terms "drainage density" and "run-off"
- how weathered material is transported by rivers
- the alternating occurrence of erosion and deposition in rivers
- how running water continually reshapes river channels
- specific landforms associated with rivers, including flood plains, meanders, deltas and alluvial fans
- where in the course of the river these specific landforms may be found
- the meaning of the term "graded stream"
- that the material transported by rivers is not moved and deposited at a final destination all at once, but that the process consists of several phases/steps

Activity 6.3

1. In which direction does water always flow?
2. Where does the water in rivers come from?

3. Which natural force controls the flow of water on the land surface?
4. Is surface flow a deterministic or a stochastic process? (You may need to find the answer in study unit 1.)
5. Which landform occurs at the mouth of the Nile River at the Mediterranean Sea?
6. Name the factors that determine how much sediment the water in a river is able to carry.
7. What happens when the amount of sediment entering a section of a river is greater than the amount of sediment leaving the same section of the river?

You may now think that surface run-off and river run-off are processes that occur exclusively under the influence of natural forces, but this is not so. Over the past several years, human activity has had an accelerating effect on both surface and river run-off.

Study Task

Study the section "Increased erosion from human activity" in Bergman and Renwick.

It is important to know that human activities affect erosion by running water in numerous ways. This range of activities includes virtually every facet of human existence, from agriculture to urbanisation, and takes place both in highly industrialised countries and in the developing countries of the world.

Activity 6.4

1. Explain how the transportation of sediment by rivers and the related erosion and deposition are influenced by accelerated erosion as a result of agricultural activities.
2. Do you agree or disagree with the following statement: "The significant increase in the world population since the 17th century has given rise to large-scale erosion." Briefly substantiate your point of view.

Weathered and eroded materials are not transported only by surface run-off and by river run-off. Wind also plays a role, especially in arid regions and in areas where the soil is not protected by vegetation. In the next study task we look at wind as an agent in shaping the land surface.

Study Task

Study the section "Effects of wind on landforms" in Bergman and Renwick.

Pay special attention to the following:

- that wind cannot transport large particles, but that it can transport large quantities of fine particles such as sand

- the appearance of the land surface where wind has removed weathered material
- the appearance of the land surface where wind deposits material
- that wind can also affect landforms in the wetter regions of the world
- the landforms and features typically associated with wind action, for example dunes, desert floors and loess

Activity 6.5

1. Briefly describe the typical landforms found in deserts.
2. How does climate affect the landforms found in deserts?

You now know how both internal (endogenic) and external (exogenic) processes affect the earth's surface. The appearance of the earth's surface, specifically the different landforms, may be related directly to the action of these two types of processes. We now look at the global pattern of landforms, and also attempt to classify it by using a simple system.

6.5 The Global Pattern of Landforms

The landforms created by internal and external processes vary significantly in shape, size and extent. Nevertheless, it is possible to classify these features into groups.

Landforms created directly by internal processes, for example volcanoes, are classified as initial landforms. As these landforms are changed by external processes, they are transformed into sequential landforms. A river valley is an example of a sequential landform.

Another way of classifying landforms is by relief that is their vertical dimension (height). Such a classification is meaningful and easy to understand – after all, landforms are noticeable because they differ in height from the surrounding landscape and landforms. This makes it possible to classify landforms as first-order, second-order and third-order landforms.

6.5.1 First-Order Landforms

First-order landforms include the continents and the ocean floor. The theories of plate tectonics and continental drift which we introduced earlier in this study unit provide an acceptable explanation for the current pattern of distribution of continents and oceans on the globe.

These theories are based on the assumption that the continents consist of a lighter material (sial) which is anchored in the heavier base material (sima). This layer of heavier base material is divided into plates that move towards each other, away from each other or slide past each other. The movement of the earth's crustal plates is made possible by the fact that they float on top of the "plastic" material of the earth's mantle.

In certain areas, such as the middle of the Atlantic Ocean, adjacent plates are forced apart by upwelling of magma (molten rock). The production of new crustal material does not, however, increase the size of the earth's surface, because this spreading effect is cancelled out when crustal material elsewhere is pulled down towards the earth's interior. This is what happens where an oceanic and a continental plate press against each other, for example at the western edge of the Pacific Basin, and the thicker, heavier oceanic crust is pushed down into the earth's molten interior, while the lighter continental crust is pushed upwards.

Oceans cover some 71% of the earth's surface, while the continents cover the remaining 29%. The true size of the continents, however, is much larger, because there is no abrupt perpendicular drop into the ocean at the edges of continents. The continents are surrounded by what is known as the continental shelf, where the oceans are no deeper than 200 m. A steep continental slope separates the continental shelf from the real ocean floor, which reaches depths of more than 2 000 m. If we use the continental slope as the dividing line between continents and oceans, it appears that continents cover 38% of the earth's surface and the oceans 62%.

Study Task

Study the map of the earth's topography on the inside cover of your prescribed book.

It is important that you know where the different continents and oceans are located.

Activity 6.6

Use an Atlas to identify the names of the continents and oceans on the world map.

6.5.2 Second-order Landforms

Besides the continents and the ocean floor, the most widespread relief features on earth are the continental mountain ranges, subcontinental plateaus and plains, and the large oceanic basins as well as oceanic ridges and oceanic troughs.

Many of the large continental mountain ranges have been formed by the movement of crustal plates. The rough mountain ranges on the west coast of the Americas, namely the Rocky Mountains and the Andes, were formed when the earth's crust was lifted where the westward-moving North American and South American plates collided with the plates of the Pacific Basin. The Himalayas were formed in a similar fashion when the plate carrying India drifted northwards and collided with the Eurasian plate.

Along the eastern coastline of the Americas and the western coastlines of both Europe and Africa, there are no active plate boundaries. As a result, these areas are not subject to mountain formation.

The large mountain ranges and plains have a decisive influence on human activity. Mountainous areas are usually steep and rocky, and not suitable for human habita-

tion or large-scale agriculture. Plains, on the other hand, are characterised by gentle slopes and fertile soils, and as a result most of the world's grain is grown on plains, and people settle in these areas on a large scale.

Study Task

Study the map of the earth's topography on the inside cover of Bergman and Renwick.

This time, it is important to note the following:

- the location of the large continental mountain ranges and subcontinental plateaus and plains
- the location of the main islands, bays and seas in the oceans

6.5.3 Third-order Landforms

Third-order landforms include the individual mountain slopes and valleys that make up the landscape. Whereas second-order landforms provide a bigger picture, third-order landforms provide the finer details. Third-order landforms are on the scale of people's immediate life world – relating, for example, to the distance that a hiker can cover in a couple of hours or in a day, and also to the incline and roughness of the terrain. Large structures constructed by people, such as dams and reservoirs, are on the same scale as third-order landforms.

Third-order landforms may be regarded as the result of the operation of exogenic earth processes, such as weathering and erosion. There is a large variety of third-order landforms. One approach to classifying these features is based on the assumption that all third-order landforms consist of some combination of slopes. According to this approach, the characteristics of any third-order landform may be explained in terms of the processes that determine the formation of its slopes. This approach emphasises the need for both quantitative measurement of landforms and knowledge of the processes whereby they are formed and altered.

Because the scope of third-order landforms is relatively restricted, their distribution cannot be meaningfully depicted on a world map. For this reason, only first-order landforms and the major second-order landforms are represented on the world map of topography as the one on the front inside cover of your prescribed book.

6.5.4 Concluding Remarks on Landforms

Although the classification of landforms of the world as first-order, second-order and third-order landforms helps give us some idea of how the world looks, it is important to realise that significance in terms of height is only one aspect of the land surface. Other important aspects of a landform include its shape, structure, composition and slope. Because our space is limited, we cannot deal with any of these here. You did, however, learn a fair amount about the shape of landforms and about slope in study unit 3.

Activity 6.7

1. Give a brief overview of the landforms that are created by continual water run-off from inland mountainous areas to the oceans.
2. Explain why erosion is more active in mountainous areas than on the plains.
3. Explain the effect of second-order landforms on human activities. Illustrate your answer by referring specifically to associations between landforms and human activities as shown in the various maps in your prescribed book. Refer specifically to some of these maps in your answer.
4. Explain and briefly illustrate the effects of human activities on landforms. Give specific examples.

IN CONCLUSION

In this study unit we have focused on the earth's surface. We started by considering the internal forces that impact on the earth's surface, and we saw how these forces resulted in the current distribution pattern of continents and oceans as well as the occurrence of features such as large mountain ranges and oceanic trenches. Secondly, we looked at the external forces that impact on the earth's surface and that create individual landforms on the earth's surface through processes such as weathering and erosion. We also looked at the world map of the distribution of landforms. The study unit concluded with a brief discussion of the mineral resources and fossil fuels which are actually found below the surface of the earth, but which are nevertheless of immense importance to people.

Study Unit 7
Global patterns of water, soil, plants and animals

INTRODUCTION

In previous study units you were introduced to the global climate as well as the nature of the land surface and how these affect life on earth. In this study unit we continue our investigation of the earth's natural systems by looking at the plant and animal life on earth. Pay special attention to the distribution patterns of plants and animals across the globe, and how these are affected not only by climate and the land surface, but also by soils (the medium in which plants grow) and the flow of energy and matter (e.g. water and carbon) through the earth's natural systems.

STUDY MATERIAL

You will find the study material for this study unit in chapter 4 of Bergman and Renwick.

Key Terms

- biomes
- biodiversity
- biogeochemical cycle
- hydrologic cycle
- water budget
- soil degradation
- ecosystem
- soil fertility
- evapotranspiration
- succession

Learning Outcomes

After you have worked through this study unit you should understand the spatial variation of vegetation and animal life on earth, and how climate, water, landforms,

soil and the circulation of energy and matter through the earth's natural systems contribute to such variation. You should also be familiar with and understand the world maps of soil types and also the major natural regions (known as biomes).

You will know that you have achieved these learning outcomes when you are able to:

- explain how energy and matter flow through the earth's natural systems
- explain what a biogeochemical cycle is and give two examples
- explain how water circulates through the earth's natural systems and represent this by means of a diagram
- explain how a water surplus or shortage arises on a local scale
- explain what a water budget is and its use
- explain how water budgets are affected by soils and plants
- explain how carbon and oxygen circulate through the earth's natural systems
- name five important factors of soil formation
- explain how soil is formed
- name the components of soil
- name the main soil types and their properties and describe where in the world these occur
- show the spatial distribution of the main soils on a world map
- explain the spatial covariation between the global distribution patterns of climates, soils and vegetation
- explain what soil degradation is and why it occurs
- explain what soil fertility is and how it may change
- explain what an ecosystem is and how it functions
- explain the importance of biodiversity
- explain what a biome is
- explain the global distribution pattern of biomes
- show the locations of the major biomes on a world map
- distinguish between the major biomes and name a few characteristics of each

The functioning of the earth's natural systems such as climate, water, soil, the land surface and plant and animal life are intimately related. This intimate interaction may be attributed to, among other things, the continual flow of energy and matter between the various systems. This not only establishes links between the systems, but also supports the living processes of plants and animals on earth. This flow of energy and matter takes place by means of biogeochemical cycles, which is our first topic of study in this study unit.

7.1 The Biogeochemical Cycles

The biogeochemical cycles are regulated by the laws of energy and matter, which state that energy and matter cannot be created or destroyed, but can be transformed

from one form to another. Without the transfer, storage and transformation of energy and matter by means of biogeochemical cycles, life on earth would not have been possible.

Study Task

Study the section "The biogeochemical Cycles" in Bergman and Renwick.

Note the following:

- that the biogeochemical cycles are the connection between the earth's natural systems established by the flow of water and the life processes of plants respectively
- the covariation between the patterns of plant and animal life, climate and landforms
- the dependence of all living processes on the exchange of energy and matter
- where energy and matter come from
- the principles of the laws of conservation of energy and matter
- the exchange of energy and matter by means of biogeochemical cycles
- the different functions of biogeochemical cycles

Now that you are familiar with the nature of biogeochemical cycles and their role in the functioning of the earth's natural systems, we can look in more detail at two examples of such cycles. The first is the hydrologic cycle or the water cycle.

7.1.1 The Hydrologic Cycle

Water is essential to the survival of all forms of life on earth. The amount of water available for use by people, animals and plants varies considerably (over both time and space). The next study task is intended not only to widen your knowledge of the hydrologic cycle, but also to examine the properties of water and to introduce the concept of a water budget.

Study Task

Study the sections "The hydrologic cycle" and "Water budgets" in Bergman and Renwick.

Pay special attention to the following:

- the properties of water
- the explanation of what happens during the hydrologic cycle
- where and how water is stored
- the amount of fresh water available on earth
- what a water budget is
- the nature of the global water budget

The global water budget that we have examined above does not reflect the variations from place to place and from time to time, which form an important feature of the distribution patterns of water on earth. In the next study task we shift our attention to local water budgets.

Study Task

Study the section "Evapotranspiration and local water budgets" and figure 4-7 (as well as the "Focus on") in Bergman and Renwick.

Pay attention to the following:

- what a local water budget is
- why local water budgets differ from the global water budget
- what evapotranspiration is and what the difference is between actual and potential evapotranspiration
- what a water budget diagram is
- how to go about getting information about water shortages/water surpluses from a water budget diagram (i.e. how to interpret a diagram of this type)
- how water budgets vary according to the type of climate

It is important that you understand how we obtain information on water shortages/surpluses through the course of a year from the water budget diagram prepared for a specific place. The key issue is that precipitation during the hot season may not be sufficient to supply the amount of water that may potentially evaporate. When this happens, there is a shortage of water and this shortage may be partially compensated for by using water stored in the soil. In autumn the potential evapotranspiration drops as it becomes cooler, until eventually it drops below the level of precipitation. This makes a surplus of water available which is used firstly to replenish the soil water while the rest becomes available as run-off. Note that the local water budgets outlined in Bergman and Renwick are all examples of water budgets in the northern hemisphere, where summer comes in the middle of the year and winter at the end/beginning of the year.

Activity 7.1

Answer the following questions about the water budget diagrams in figure 4-7 in Bergman and Renwick. Before you try to answer the questions, it is a good idea to look at an atlas and make sure that you know where the places in each of the graphs in figure 4-7 are located. Also read the "Focus on" box in Bergman and Renwick.

1. During which months is there a water shortage in Singapore? Explain this shortage in terms of the type of climate experienced in Singapore.
2. What is the main difference between the water budget diagrams for Singapore and for Cairo?

3. Why is POTET in Edinburgh greater than the precipitation from mid-March to the end of September? How does this affect the amount of water available for use by people, plants and animals?
4. When is soil water recharged at Churchill, and why then?
5. When is soil water used in Barrow, and why then? When and why does the use of soil water end?

Up to now, our emphasis has been on the effect of climate on water budgets. However, water budgets not only vary according to the type of climate, but are also influenced by soil and vegetation.

Study Task

Study the sections "Soil's role in the water budget" and "Vegetation and the hydrologic cycle" in Bergman and Renwick.

When it comes to soil, it is important to note the critical role of soil properties such as infiltration capacity and soil texture in water budgets. The usefulness of water budgets for water resource management is also spelt out here. It is important to note that they allow us to calculate the amount of water that will eventually be available for human consumption. Predictions of the average level of river run-off are also based on water budgets. The contribution of vegetation to water budgets is to be found in the transfer of water from the earth's surface to the atmosphere by means of transpiration. It is also important to note the effect of different types of root systems, as well as the fact that the water needs of different types of vegetation vary significantly. Finally, you need to take note of the impact of people on water budgets through the process of deforestation.

Now that you have carefully studied the hydrologic cycle, we look at another example of a biogeochemical cycle: the carbon cycle. Whereas water is essential for the survival of all forms of life on earth, carbon is the most important element in the biological processes that take place on earth. The carbon cycle is inseparably linked to the flow of oxygen and nutrients through the earth's natural systems. We therefore also need to look at the oxygen cycle and the nutrient cycle.

7.1.2 The Carbon, Oxygen and Nutrient Cycles

Although carbon is not the most abundant element on earth, it is an indispensable element, because together with hydrogen it forms the basis for all life on earth. It is also responsible for sustaining life. Carbon and hydrogen compounds, for example, form an important part of the food produced by plants and consumed by animals. They also form part of the fossil fuels (coal, oil and natural gas) which are a main source of energy for people. In the study task below we take a more detailed look at the carbon cycle, and especially at how it is regulated by biological processes.

Study Task

Study the section "Carbon, oxygen, and nutrient flow in the biosphere" in Bergman and Renwick.

Pay special attention to the following:

- how carbon is converted to carbohydrates during photosynthesis and stored in plants
- how carbon (in the form of carbon dioxide) is released in the atmosphere during respiration by animals (including people) and by decomposers
- in which natural systems the largest amount of carbon is stored
- the seasonal variation in the concentration of carbon dioxide in the atmosphere
- the increase over time in the concentration of carbon dioxide in the atmosphere as a result of people's burning fossil fuels
- how the carbon cycle is likely to be affected by changes in land use such as deforestation

By now you should have a better understanding of how energy and matter flow through the various natural systems on earth. These flows link the various systems and also provide nutrients for plants and animals. The natural systems that play a critical role in the biogeochemical processes that we have discussed so far in this module are the atmosphere, the hydrosphere and the lithosphere. We now look at the pedosphere, which is the soil, which forms the interface between the lithosphere and the biosphere.

7.2 The Pedosphere (soil)

Soil is the thin layer of material that covers the greatest part of the land surface and which simultaneously forms both the upper layer of the lithosphere and the bottom layer of the biosphere. It consists of a mixture of small particles of weathered rock material, minerals, decomposing organic matter, water, air and millions of tiny living micro-organisms. The importance of soil is that it serves as support for plants, and that it stores water for use by plants and provides nutrients for plants. We start our study of soil by looking at how it is formed and what its main properties are.

7.2.1 Soil Formation and the Properties of Soil

Soil formation is a slow process – it takes literally thousands of years. The climate, vegetation, soil organisms, animals and the nature of the land surface, among other things, make a significant contribution to this process. The nature of these contributions varies over both space and time. As a result, soil in different parts of the world is formed in different ways and has different properties.

Study Task

Study the sections "Soil", "Soil formation" and "Soil horizons" in Bergman and Renwick.

Note the following:

- the five factors that determine the properties of soil
- the importance of weathering in the formation of soil
- what parent material is and how it affects soil
- the role of water in soil formation
- how and why soils in wet areas differ from those in dry areas
- the role of plants and animals in soil formation
- how soil formation is affected by topography
- the role of time in soil formation
- the six main components of soil
- the different horizons (layers) that make up the soil profile

You have now studied the composition and development of soil. Although certain basic properties are common to all soils, the variations in the conditions under which soil develops in different parts of the world result in the creation of different types of soil (each with certain unique properties).

7.2.2 The Pattern of Global Distribution of Soils

Although soils may vary significantly across short distances, and although there are obviously great variations across the earth's surface, it is possible to divide the world into regions containing soils with similar properties. This division is made possible by the indisputable spatial covariation between the distribution patterns of climate, vegetation and soil on a global scale.

Study Task

Study the sections "Thousands of soils" and "Climate, vegetation, soil, and the landscape" in Bergman and Renwick. You also need to study figure 4-16.

As shown in the study task above, you need to pay attention to the direct correlation between climate and these soil groups. For example, aridisols, which are the soils of arid regions, are found exclusively in dry climates (i.e. areas with low rainfall). Soils such as oxisols and ultisols, on the other hand, are associated with the high rainfall and heat of the tropics and subtropics.

Apart from the soil types, you also need to be familiar with the soils listed in figure 4-15 in Bergman and Renwick. As for the global distribution patterns of these soils, it is important not to get lost in the detail, but to pay attention to broad patterns instead. For example, focus on broad categories such as the soils of the wet tropics,

soils of dry regions and soils of mountainous regions. Try to find the correlation between the global distribution pattern of soils and the global distribution patterns of other variables such as rainfall.

You now know that soil is a resource with many complex properties. You are also aware of the spatial variation of these properties. Naturally, the usefulness of soil to people varies accordingly. We conclude this section on soils by taking a brief look at a few problems relating to soil utilisation, and at some means of overcoming these problems.

7.2.3 Soil Utilisation

People's utilisation of soil has many impacts, most of which are not beneficial to the soil. Many of these impacts are associated with agricultural activities, and usually include loss of soil (soil erosion) and/or soil degradation.

Study Task

Study the sections "Soil problems" and "Soil fertility: natural and synthetic" in Bergman and Renwick.

Note the following:

- the meaning of the term "soil fertility"
- the effect of ongoing intensive agriculture on soil fertility
- ways of restoring the fertility of exhausted soils
- how undiscerning methods of cultivation cause soil erosion

At this stage you are familiar with all the natural systems that support and affect life on earth, and you know how energy and matter flow through these systems. In the next section we focus specifically on the plant and animal life on earth and examine the interaction between these and the other natural systems. We start by looking at the organisation of plant and animal life into ecosystems.

7.3 Ecosystems and Biodiversity

The concept of an ecosystem has to do with the fact that each plant and animal species has specific requirements as regards the environmental conditions in which it can function. As a result of these different requirements, different collections of plants and animals occur in different types of environments. Such a collection of plants and animals, together with the environment in which it occurs, may be regarded as an ecosystem. Ecosystems occur on a variety of scales, from global to small, discrete units such as a marsh, a forest floor, a swamp or a coral reef. Even your own backyard, and your house, and a glass bowl with a fish in it are ecosystems.

We begin our study of ecosystems by looking at both a formal definition of an ecosystem and at the components that make up any ecosystem.

Study Task

Study the section "Ecosystems" in Bergman and Renwick.

It is important that you are able to explain in your own words what an ecosystem is. You also need to understand the function of each of the following components of an ecosystem:

- producers
- consumers
- decomposers
- matter and energy

The plants and animals in an ecosystem are linked to one another and to the environment in which they occur through the transfer and flow of energy, water and nutrients. In their turn, the amount of energy and water and the amount and type of nutrients that are present in an ecosystem largely determine the number and type of species that the particular ecosystem can contain. Energy, water and nutrients are distributed throughout an ecosystem by means of "food chains".

Study Task

Study the section "Ecosystem processes" as well as figure 4-21 in Bergman and Renwick.

Note the following:

- how plants produce nutrients
- the different roles of herbivores, carnivores and omnivores in food chains
- what happens to plants and animals when they die
- what a trophic level is
- how nutrients are transferred between trophic levels
- the loss of energy when nutrients are transferred between trophic levels
- what happens to poisons such as DDT in food chains
- what biomagnification involves

It is important to be able to explain in your own words how energy in the form of nutrients moves through a food chain. You should also be able to explain what happens to energy as it moves through a food chain, and how this eventually affects the composition of the biological community in an ecosystem.

You now know that plants and animals need energy, water and nutrients to survive, and you also know how these resources are distributed between all organisms in an ecosystem by means of food chains. These resources are not always readily available, which means that organisms constantly compete with one another for their fair share. The plants and animals that are most successful at this competition become the dominant species in an ecosystem.

Study Task

Study the section "Plant and animal success in ecosystems" in Bergman and Renwick.

Pay special attention to the following:

- the meaning of the concept of "success of a species"
- why and for what plants compete with each other
- the things for which plants compete in dry and in wet environments respectively, and in environments with sufficient water and light
- how the competition for scarce resources has resulted in plant adaptations

The plants and animals that occur in an ecosystem form a biological community. The success of certain plant species in an ecosystem forms the basis for community succession, which means that plant species that form a biological community are eventually replaced by more dominant and longer-term species. Succession is often the response of a biological community to changes in environmental conditions.

Study Task

Study the section "Community succession" in Bergman and Renwick.

Note the following:

- that vegetation is not as stable a phenomenon as it may appear to be
- how succession takes place on fallow agricultural land
- the factors that affect the period over which succession takes place
- the effect of sudden environmental changes on succession
- examples of environmental changes that have a significant effect on the distribution of plant species across the globe

It should now be clear that the variety and types of species which occur on earth will vary from one ecosystem to the next. The existence of a variety of species is important, because it allows for multiple feeding options which enhance the likelihood of survival of individual species. We now take a closer look at the variety of species, also known as biodiversity.

Study Task

Study the section "Biodiversity" in Bergman and Renwick.

Note the following:

- the scope of biodiversity on earth
- the critical needs of plants
- the critical needs of animals

- the reasons for the increasing failure to meet the critical needs of species
- the phenomenon of habitat loss and how this may result in species becoming extinct
- changes in land use as the single most important cause of species becoming extinct
- what a biosphere reserve is and how it helps to reduce the impact of land use changes on the diversity of species

You are now familiar with the processes which support plant and animal life on earth, and also with the organisation of plant and animal life into ecosystems. You also know that the variety and types of species found in ecosystems are determined not only by environmental factors such as climate, soil, and water, the land surface and human activities, but also by competition between species for water, energy and nutrients. Against the background of this knowledge, you are now ready to examine the spatial distribution of plant and animal species across the globe, and to explain this distribution pattern in terms of the spatial distribution patterns of other natural phenomena such as climate, water, soil and landforms.

7.4 Global Patterns in the Biosphere: the World Map of Biomes

Since the type of vegetation found in an area is largely determined by the amount of energy and water available, there is a clear spatial covariation between the global patterns of climate and vegetation regions.

On a global scale, we can therefore distinguish between regions with a characteristic vegetation and climate. Such regions are known as biomes. A biome typically includes a large number of ecosystems and, in addition to climate and vegetation, it is also characterised by its specific animal life. Due to the mobility of animals, however, the boundaries between biomes in terms of animal life are less definite than in the case of vegetation.

The major biomes are forests, savanna/wood/scrubland, grasslands, deserts and tundra.

Study Task

Study figure 4-23 and the introduction to the section "Biomes: global patterns in the biosphere" in Bergman and Renwick.

It is important to pay attention to the spatial covariation between the distribution of climate regions and the distribution of plant regions.

In the rest of this section we look more closely at the vegetation and climate characterising each of the major biomes.

7.4.1 Forests

A forest is a collection of trees that grow so close together that their leaves and branches overlap, covering the soil in shade for at least part of the year. Trees are

not the only vegetation in forests, but they are the most dominant type of vegetation in that area. The presence of forests is associated with a variety of humid climates, where sufficient water is available throughout the year. Forests may be divided into four broad categories: tropical rainforests, midlatitude broadleaf deciduous forests, needleleaf or boreal (coniferous) forests, and temperate rainforests.

Study Task

Study the section "Forest biomes" in Bergman and Renwick.

It is important for you to understand that the differences between the four types of forests mentioned above may be attributed mainly to differences in climate. Tropical rainforests are found in regions with a humid tropical climate in the low latitudes, including Central America, the Amazon Basin, Equatorial Africa and Southeast Asia. Midlatitude broadleaf deciduous forests are found in humid regions in the subtropics and middle latitudes that are characterised by seasonal fluctuations in temperature. In the cold winter months the trees lose their leaves and become dormant. Needleleaf or boreal (coniferous) forests are found in the cold continental climates characteristic of the regions between the midlatitudes and the poles. Because there is little or virtually no land between the 50th and 70th latitude in the southern hemisphere, this type of forest is confined to the northern hemisphere. The temperate rainforests are found along the west coast of North and South America, among other regions. These regions are characterised by ample rainfall and moderate temperatures throughout the year – this climate is known as the marine west coast climate.

You need to know the following about each of the four types of forests:

- where it occurs
- what the climate conditions in its region are
- what vegetation is found in its region

When it comes to the tropical rainforests it is important to note the different strata or layers of plants that may be distinguished, the far greater biodiversity than in other forests, and the reasons why deforestation is regarded as a critical issue for this type of forest.

You also need to know how and why the soils of the midlatitude broadleaf deciduous forests differ from the soils of the tropical rainforests, and how the trees in both these types of forests have adapted to climatic conditions.

Finally, you need to know that needleleaf forests are also known as boreal forests, where this name comes from, how trees are able to survive the extreme climatic conditions between the 50th and 70th latitude in the northern hemisphere, and what soil conditions are associated with needleleaf forests.

Activity 7.2

1. Name three countries to which you could travel if you were interested in visiting a tropical rainforest.

2. What are tropical rainforests best known for?
3. Why are the soils of the midlatitude broadleaf deciduous forests less leached than the soils of the tropical rainforests?
4. How has the vegetation of the boreal forests adapted to withstand cold climatic conditions?
5. Name the biome in which the soil is generally characterised by:
   - a high degree of leaching
   - light-coloured sandy topsoil
   - high acidity
   - accumulation of iron and aluminium lower down in the soil profile
6. Name three countries in which temperate rainforests are found.

7.4.2 Savanna, Woodland and Scrubland

Savannas may be described as tropical grasslands with widely spaced trees. They are found between the regions with humid tropical climatic conditions and the dry regions at around 308˚ S and 308˚ N. Although the savannas do not correlate with a specific climate region, they do occur largely in seasonally tropical climates. The savannas vary from a type of woodland or scrubland covered in grass to open grassland with isolated trees.

Study Task

Study the section "Savanna, scrubland, and open woodland biomes" in Bergman and Renwick.

Pay attention to the following:

- the regions where savannas commonly occur
- the climate conditions of regions where savannas occur
- the role of fire (bushfires) in the savanna biome
- the soil conditions characteristic of the savannas
- how the composition of savanna vegetation changes in the direction of dry and desert regions
- the specific type of scrubland found in regions with a Mediterranean climate

7.4.3 Midlatitude Grasslands

Grasslands of the midlatitudes occur in the central parts of the USA, Eastern Europe, Central Asia and Argentina among other places, and also in South Africa. These grasslands are the only biomes that are widely known by their local names: the prairies of the USA, the steppes of Eastern Europe, the pampas of Argentina and the highveld of South Africa. The climate of regions in which this type of grassveld occurs is characterised by hot summers, cold winters and a moderate rainfall.

Study Task

Study the section "Midlatitude grassland biome" in Bergman and Renwick.

Note the following:

- the distinction between prairies and steppes on the basis of rainfall and length of grass
- why grass is the characteristic/dominant vegetation in this type of climate
- the role of fire in establishing and sustaining expansive grasslands
- the soil conditions that characterise midlatitude grasslands
- the suitability of this biome for agriculture and the extent to which these grasslands have been destroyed by agriculture

Activity 7.3

1. How does the vegetation of the prairies differ from that of the steppes?
2. Why are the midlatitude grasslands regarded as the "bread baskets" of the world?
3. How can the agricultural productivity of soils of the tropical savannas be improved?
4. Briefly explain the role of fire in the existence of grasslands.
5. Soils of tropical rainforests are infertile because the soluble minerals and nutrients have been removed from the soil by continual heavy precipitation.
6. Explain how and why the soils of forests, grasslands and deserts differ.
7. Explain how plants contribute to the interlinkage of and interaction between the different natural systems of the world.

7.4.4 Deserts

Desert biomes are associated with regions that have desert and semiarid climates. They therefore occur mostly in the subtropics, but also in certain parts of the midlatitudes. The largest desert area on earth stretches from the Sahara in North Africa, across the Arabian Peninsula to deep into Southwest Asia. Other major subtropical deserts are the Kalahari and the Namib in Southern Africa, the Mojave and Sonoran deserts in southwestern USA and the adjacent parts of Mexico, the Atacama in the western part of South America, and the Great Australian Desert. In the midlatitudes, deserts cover the arid parts of the Great American Basin, the southern and western parts of Argentina and large parts of Central Asia.

Study Task

Study the section "Desert biomes" in Bergman and Renwick.

Pay special attention to how desert vegetation has been adapted to dry conditions, and also to what soil conditions in deserts are like.

7.4.5 Tundra

Tundra vegetation is particularly tolerant of the cold and grows closest to the poles. It is also found above the treeline on high mountains. The three largest continuous areas of tundra vegetation are all in the northern hemisphere and include the northern part of North America (from Alaska in the west to Labrador in the east), the Arctic coast of Eurasia (from Norway in the west to the Bering Sea in the east) and the coastal area of Greenland.

Study Task

Study the section "Tundra biome" in Bergman and Renwick.

Note the following:

- how tundra vegetation has adapted to the extreme climatic conditions
- the soil conditions associated with the tundra
- the impact of human activities on the tundra

At this stage you should be familiar with the distribution pattern of the major biomes of the world, and you should also understand how this pattern is influenced by climate, water, soil, the land surface and human activities among other things. We conclude this study unit by looking at the interdependence of the different natural systems of the world, and at the increasing role of human activities in the functioning of these systems.

7.5 Natural Interactions in the Biosphere and Human Impacts on the Biosphere

Plants, animals, climate, water, soil, the land surface and human activities have a continual reciprocal effect on one another, each reflecting the impact of the other in some way.

With the exception of areas of intensive agricultural activity, there is a very clear spatial association between the world's climatic pattern and the global patterns of soil and vegetation. Human activities, however, have a significant effect on ecosystems in virtually all parts of the world, especially in those parts where agriculture is practised and land is used for crop cultivation and grazing. On a local scale, the land surface, geology and landforms also have a significant effect on soil and vegetation. On a regional and global scale, the climate is equally influenced by ecological processes and linkages between soil and vegetation.

These intimate relationships between plants, animals, climate, water, soil, the land surface and human activities allow us to see the earth not merely as a set of cause-effect relations, but rather as an interlinked dynamic system, almost like a living organism that functions in a specific manner.

Study Task

Study the sections "Natural and human effects on the biosphere" and "Conclusion: critical issues for the future" in Bergman and Renwick.

Note the following:

- how climate is affected by soil and vegetation
- desertification as an example of the interaction between human activities and natural processes
- what the Gaia Hypothesis is
- the disruption of ecosystems by human activities
- the important role that people play today in the functioning of the earth's environmental processes

IN CONCLUSION

In this study unit we have concluded our investigation into the earth's natural systems by looking at the distribution of plant and animal life. We have explained the dominant role of climate in the global distribution pattern of plants and animals, and we have highlighted the spatial covariation between the global distribution patterns of climates and vegetation. This study unit has also examined the roles of water, carbon and soil in the operation of biological processes, and explained the concept of an ecosystem and the basic life processes that occur in ecosystems. We concluded by looking at the world map of the major biomes and studying the main characteristics of the various biomes. The emphasis in this study unit has been on the interaction between the various natural systems as well as on how they are increasingly affected by human activities.

Study Unit 8
The world population

INTRODUCTION

In this study unit our focus is on people or human beings that populate various parts of the world or the earth as we know it today. The rather broad concept of world population has many facets, so we begin by examining where people have settled over the last few centuries and the reasons for the current global population distribution patterns.

STUDY MATERIAL

In this study unit we guide you through the first part of the chapter "Population, population increase and migration" in Bergman and Renwick.

Key Terms

- carrying capacity
- crude birth rate
- crude death rate
- natural increase
- population growth rate
- fertility rate
- replacement rate
- zero population growth
- doubling time
- population pyramid
- dependency ratio
- infant mortality rate

Learning Outcomes

After you have worked through this study unit you should understand and be able to explain how the world population is organised in space and why the pattern looks as it does. To reach these outcomes you should be able to

- describe the spatial distribution and density of the world population over the earth's surface
- indicate on a world map where the five main population concentrations occur
- interpret a cartogram
- identify and discuss the factors influencing population growth
- name and discuss the different natural and human factors which influence the spatial pattern of global population distribution
- name the factors which affect global population growth and explain the effect of each factor
- distinguish between demography and population geography
- define and explain the following terms: carrying capacity, crude birth rate, crude death rate, natural increase, population growth rate, fertility rate, replacement rate, zero population growth, doubling time, population pyramid, dependency ratio and infant mortality rate
- identify and discuss the different stages in the demographic transition model and illustrate them with appropriate examples
- briefly discuss the new factors which influence global population
- critically answer the question "Is the world overpopulated?"

Study Task

Study the section "Population, population increase and migration" in Bergman and Renwick.

We begin by looking at where an estimated 6,5 billion people are distributed across the earth's surface. Looking at the map in Bergman and Renwick (see rear endpaper of the book), it is clear that the global population is distributed unevenly over the earth's surface. The map displays three major concentrations of population: (1) East Asia, (2) south Asia and (3) Europe. Some parts have dense concentrations of people while other parts are relatively sparsely or thinly populated. Another striking phenomenon on the map is the dense concentrations of population along the coasts of the continents, while large areas of the interior are virtually uninhabited. Figure 5-2 of the prescribed book is a cartogram of world population. The size of each country reflects its population, not its land surface area. The most populous countries are shown as the biggest, and the least populous as the smallest. A number of factors are responsible for the distribution of the human population. These factors are explained in the following section.

Activity 8.1

1. What do we call the type of map in which Bergman and Renwick illustrate the global population distribution? How many people does one dot on the map represent?
2. Provide a possible explanation for the high concentration of people along the Nile River.

3. Provide a possible explanation of why the areas in the most northern parts of Canada are virtually unpopulated.
4. Provide possible reasons why the African countries of Mauritania, Namibia and Somalia are relatively sparsely populated.
5. Explain carrying capacity by means of an appropriate example. Hint: Bergman and Renwick define the most important terms that they use in the glossary at the end of the prescribed book.

8.1 Factors Which Influence Population Distribution

If we compare the map on the rear endpaper with figure 1-6 of Bergman and Renwick we see that ribbon-shaped concentrations occur around the Huang He and Yangtze rivers in China. People tend to live along rivers to have access to water and a means of transport. Soils are also very fertile in river valleys. These factors explain most population concentrations as well as why some areas are only sparsely populated. The distribution of the world population is therefore not the result of chance. The global population distribution pattern is the result of interaction of people and their environments in a large variety of socioeconomic circumstances. A considerable number of factors, both natural and human, influence the distribution of people over the earth's surface.

8.1.1 Natural Factors

Study Task

Study the section "Climate and topography and soils" in Bergman and Renwick.

The ability of an area to attract people to settle permanently has to do with the quality of the environment – people must see it as suitable for settlement. If you compare the spatial distribution of the population in the figure on the back inside cover in your prescribed book with the figures for rainfall (fig 2-30), climate (fig 2-31), soil types (fig 4-15), biomes (fig 4-23) and topography (see map on rear endpaper) you should see that there is a spatial association and even a spatial covariation between population density and the quality of the environment. People tend to avoid areas where it is too cold, too hot, too dry, too wet and too mountainous. People cannot, for instance, live comfortably in regions with a combination of high humidity and high temperatures for long, although the places on earth with such conditions are not all uninhabited. People survive in extreme climates with the aid of special clothing, housing, heating and air conditioning. The more developed a people's culture and technology, the more easily they are able to protect themselves against the limitations and onslaughts of the natural environment. People also do not all have the same perceptions of the environment and of environmental limitations.

Cultural norms differ and consequently so do people's perceptions of the environment. One group of people may regard an environment as uninhabitable, whereas another group may see it as an area which will fulfil their needs. In study unit 1 you had to distinguish between environmental determinism and possibilism in

Bergman and Renwick). The view of environmental determinism is that natural factors like rainfall and temperature are factors which directly determine global population distribution. The view of possibilism is that the natural environment is a limiting factor but not a determining factor. The natural environment offers people possibilities rather than limitations and people settle where they believe the natural environment meets their needs.

Other environmental factors, like plagues, diseases, earthquakes, floods and volcanic eruptions, also cause people to avoid certain areas. There is, however, no rule which says that areas prone to natural disasters and diseases will remain uninhabited. These factors have only a limiting effect on human settlement. So all we can say is that people tend to avoid areas with harsh environmental conditions and tend to settle in areas with more moderate conditions. But there are many exceptions to these general tendencies. All the natural factors which we have mentioned only influence people's choice of where to live – they do not determine it. Therefore we also have to look at other possible explanations for the current global population distribution pattern.

Activity 8.2

1. Use your atlas to establish how the rivers and the mountainous and low-lying areas in China, India and Pakistan have had an influence on the population distribution pattern in these countries.
2. Find the island of Java (see map on the rear endpaper) in Bergman and Renwick or use a world map in your atlas. What is the population density of the island? Give reasons for your answer.

8.1.2 Economic and Cultural Factors

Study Task

Study the section "History" in Bergman and Renwick.

The spatial distribution of the current world population has much to do with economic considerations, cultural developments and population growth, as well as with period of time. In the very earliest times there were very few people on earth. Over time their numbers increased and people began to spread to uninhabited parts of the earth's surface. In this section we are going to look at how economic considerations, culture, cultural innovations and migration influence population distribution. People have a natural urge to survive on earth. They are constantly looking for means to satisfy their need for food, clothing and shelter. People live in larger numbers in environments in which food and other resources are practically available and fairly dense populations of people arise in these areas. Where food and other resources are more difficult to obtain, people live in smaller social units. One of the driving forces behind people's spreading over the earth's surface is therefore economic. Economic factors are also variable over time and space. People are opportunistic and will settle in environments where there are economic opportunities, even if the environmental conditions are unsuitable. People find ways of

adapting to unsuitable environments if they can benefit economically. They will, for example, endure the cold of Alaska and find ways of adapting because there are gold deposits and promises of wealth.

However, once the economic opportunities are exhausted (e.g. when there is no longer any gold) people will leave a harsh environment. It therefore appears that population distribution may be explained more by economic and survival factors than by natural factors. But once again this is not always the case – there are no fixed rules. Although population densities tend to increase as the level of economic activity increases, there are also many exceptions. If we compare the map of population density in figure 5-2 with the map of the spatial distribution of economic development in the world in figure 12-6 in Bergman and Renwick, we see no relationship, association or spatial covariation. The parts of Asia which have high population densities have very low GNPs per capita (China and India are good examples), while other densely populated areas like the USA and Europe have high levels of economic development. The relationship between economic activity and population density is certainly not constant but varies over space and time.

Another factor which we can use to explain the population distribution pattern is human culture. People's activities and decisions are determined not only by economic and environmental conditions but also by cultural factors. The human population has very diverse cultures and technologies. The technology which people have developed over the centuries makes it possible for them to adapt the environment to meet their needs. The Egyptians, for example, have used irrigation techniques to make it possible to cultivate the desert, which has resulted in high population concentrations all along the Nile River.

Human culture and technological and economic innovation and progress are not, however, uniform across the world. Just as the quality of the environment differs from place to place so culture also differs from place to place on the earth's surface – compare, for instance, figures 6-15, 6-26 and 7-15 in Bergman and Renwick. Different societies have different cultural values, aims, needs and ways of life. Consequently their social, economic and political behaviour and their spatial organisation differ, as do their population densities. Culture, as it finds expression in religions, traditions and historical experiences, also influences population distribution. Cities like Medina and Mecca in the Middle East have major population concentrations mainly because they contain sacred Islamic sites. Muslims from all over the world make regular pilgrimages to these cities and many also migrate to these areas. In the USA, Mormons congregate around Salt Lake City because of their religious convictions. Migration patterns have a definite effect on the current population distribution pattern. Since the earliest times people have migrated from one place to another on earth. The influence of the very earliest migration patterns can still be observed in the present global population distribution pattern. If we compare the map on the rear endpaper with figure 5-22, we see that parts of Europe and Asia (which have two of the largest concentrations of population) were inhabited by modern humans more than 10 000 years ago. Some of the densely populated parts on earth were the sites of ancient civilisations. Later migration patterns also influenced the current population distribution pattern.

The high population densities along the Atlantic coast of Brazil can be traced to the trading patterns with Portugal when the country was still a Portuguese colony. European colonisation between 1800 and 1930 led to increased population densities in countries which previously had a sparse population distribution. The high population concentrations in North America are the result of colonisation and migration patterns. Other countries where colonisation and migration influenced population distribution are South Africa, Australia and New Zealand. In our study of the world population it is important not only to know what the distribution pattern looks like and why it looks like this, but also to consider how the structure of the world population changed in the past, how it is changing at present and how it might change in the future. The global population distribution pattern is not static but changes over time. The map on the back endpaper of your prescribed book shows only one stage in a changing pattern. Besides the patterns of population distribution and density, geographers are also interested in the growth of the global population. Population growth is another factor which we can use to explain the current population distribution pattern.

8.2 World population growth

Study Task

Study the section "World population growth" in Bergman and Renwick.

If we plotted the estimated number of people on earth over time on a graph (fig 5-6 of Bergman and Renwick), we would get a curve in the shape of the letter J. This type of increase in the population is known as exponential growth. For the first couple of million years humans survived on earth by hunting and gathering food and the population increased by only about 0,002% per year. This trend continued until about the 17th century. With the Industrial Revolution the population growth rate began to increase. It reached its height in 1970 (2,06%) and since then has slowly begun to fall to about 1,5% per year today. A decrease in the population growth rate does not, however, mean that population numbers in the world are falling. It means only that the population is growing more slowly. By the beginning of this century the global population reached the 6 billion (6 000 000 000) level. The growth rate then was 1,5%. Population growth is determined by the difference between the birth and the death rate, while the birth rate is determined by the fertility rate. Like the quality of the environment and cultural factors, the population growth rate is also not the same across the world. Population growth rates for individual countries in the world vary from less than 0% to as high as 6%. One of the first things that strikes you when you look at figure 5-7 of Bergman and Renwick is the above-average population growth rate in Africa. Nearly all the countries in Africa have a growth rate of more than 2% per annum.

Geographers are also interested in the composition of the population. An understanding of the composition of the population allows geographers to collect information about changes in population. Information about the composition of a population in terms of the number of men and women, number and proportion of old people and children, and number and proportion of economically active people

gives us valuable insight into population behaviour. Population composition can help us to understand and explain current and future population patterns.

It is significant that most of the less developed countries in the world have high birth rates, high fertility rates and high growth rates. These countries also have very young populations with a very high dependency ratio. The more developed countries like the USA and Germany have low birth rates, low fertility rates and relatively elderly populations.

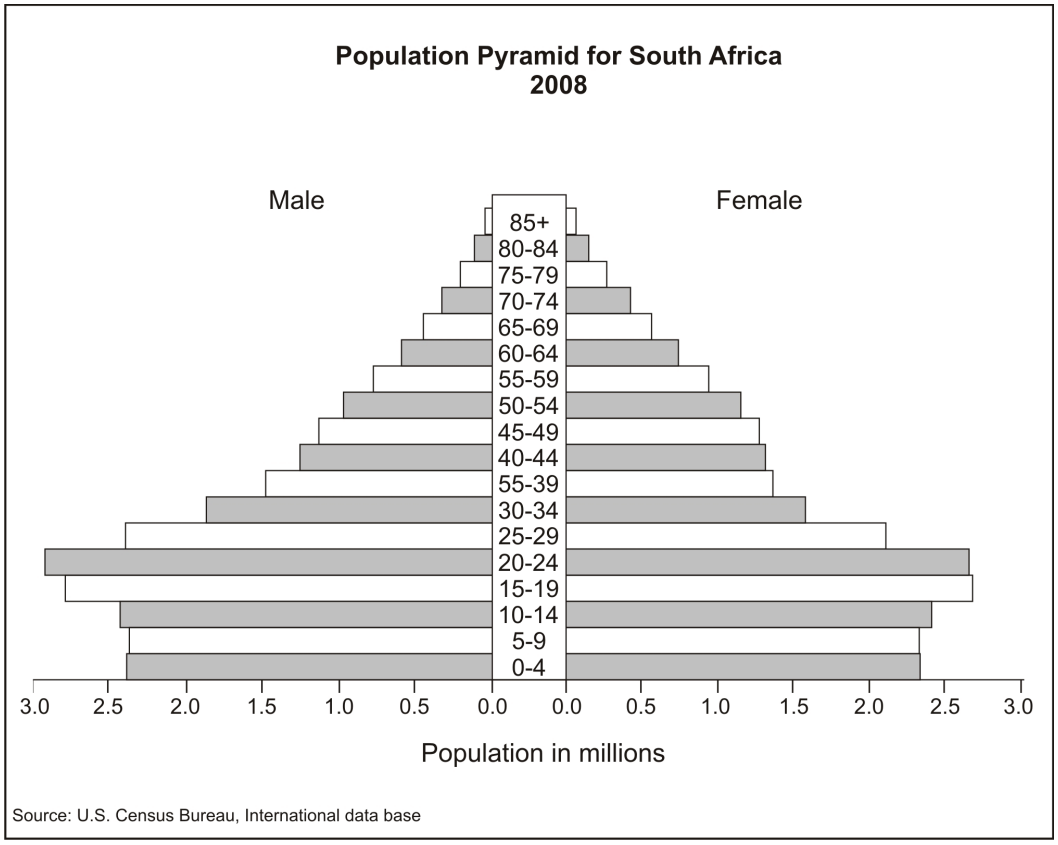


Figure 8.1: The age distribution of the South African population

Activity 8.3

1. Make sure that you understand what each of the following concepts means: birth rates, death rates, natural rate of increase, population growth rate, fertility rate, replacement rate, population projections and zero population growth.
2. Locate Angola on figure 5-7, using the legend in the figure; make a note of the annual population increase for Angola. Using figures 5-10, 5-11 and 5-12 to establish the age composition of Angola, as well as the infant mortality and birth rates.
3. Repeat the activity in question 2 above for Sweden.
4. Provide a very brief explanation for the different patterns you established in questions 2 and 3 above.
5. Refer to figure 5-9 (in Bergman and Renwick) and to figure 8.1. Give reasons for the different shapes of the population pyramids of the four countries.

6. What does dependency ratio mean? How do we calculate the dependency ratio from the population pyramid?
7. Why is the age structure of a population important? Discuss the shape of the population pyramid (fig 8-1) for the South African population in 2008.
8. Study figure 5-9 in Bergman and Renwick and compare it with figure 5-7. Is there a spatial association or variation between the population growth rate and the age of the population?
9. Explain what the shape of the population pyramid could look like in 10 years time, if the HIV/AIDS pandemic increases?

8.3 The Demographic Transition Model

Study Task

Study the section "The demographic transition" in Bergman and Renwick.

Many demographers believe that fertility and death rates are directly related to the level of economic development of a country, region or place. Using historical demographic data from the more developed countries they have built a model which indicates how populations change in terms of birth and death rates. The demographic transition is explained in three stages in the chapter "Population, population increase and migration" in your prescribed book. Although many people have criticised the model, it does give us an idea of the relationship between population growth and economic development.

8.4 New Developments Affecting the Global Population

Study Task

Study the section "Is the demographic transition model still relevant today?" in Bergman and Renwick.

Although you have to read the whole section, you should concentrate only on the sections referred to in activity 8.5. The demographic transition model describes the relationship between population growth and economic development. The model was, however, developed with data from more developed countries and it is not always appropriate to population growth, fertility trends and economic development in the less developed countries. Today we have many new developments which have made demographic trends in the world quite different from what they were in the past.

Activity 8.4

1. What is the mechanism for bringing down fertility rates according to the demographic transition model?
2. What is currently happening with economic development and fertility rates in the less developed countries?

3. Name three factors which influence fertility and briefly explain the influence of each.
4. Identify the five factors which complicate population control and briefly explain the influence of each factor.
5. Explain how an increase in death rates would affect global population growth and identify the factors which cause an increase in death rates worldwide.

8.5 Changes in World Death Rates

Study Task

Study the section "Changes in world death rates" in Bergman and Renwick.

A decrease in the crude birth rate is not the only event that can reduce the rate of human population increase. An increase in the crude death rate has the same effect (see Bergman and Renwick). The study of incidence, distribution and control of disease is called epidemiology. As countries develop, the primary cause of death shifts away from infectious diseases which are caused by disease-carrying organisms called pathogens. In the category of communicable/infectious disease, the single leading cause of death in the world today is the human immunodeficiency virus (HIV), which causes the acquired immune-deficiency syndrome (AIDS). Figure 5-19 of the prescribed book highlights the plight of adults and children living with HIV/AIDS in mid-2006. The second leading cause of death is diarrhoeal disease, the most important of which is cholera. Tuberculosis is the third leading cause of death. Human alteration of the environment can create a breeding ground for new viruses and can increase the pathways that viruses can take to new populations. Global warming is a hospitable environment for mosquitoes that carry malaria. Global warming can assist in the redistribution of other pathogens and diseases in ways we cannot foresee (in Bergman and Renwick).

Activity 8.5

1. List the three leading causes of death in the world today, in the category of communicable disease.
2. Name at least two infectious diseases that have threatened to have an impact on world death rates since the year 2000.
3. Critically discuss the impact of HIV/AIDS.

8.6 Is the Earth Overpopulated?

Study Task

Study the sections "Is earth overpopulated?" and "Food supplies over the past 200 years" in Bergman and Renwick.

Population distribution, density and numbers are particularly meaningful to geographers when they relate them to the available space and the spatial distribution and

availability of resources in the world. One of the major issues being debated today by academics, politicians and other interested individuals is what the carrying capacity of the earth is in terms of human numbers.

Delegates at the World Population Conference in Cairo in 1994 asked the question: "How many people can the world adequately accommodate in terms of food, water, clean air and other basic resources which are necessary to live a happy, healthy and satisfactory life?" It is a very difficult question to answer and one which different people will answer differently.

Activity 8.6

1. Explain what Malthusian theory means.
2. Is the world overpopulated? Formulate your own point of view and make sure you can defend it.

IN CONCLUSION

The human population has increased over the centuries and today humans dominate the human-environment system in terms of numbers. The human population is distributed right across the world. Today people live in parts of the world which were regarded as uninhabitable a century ago. People's survival skills and knowledge make it possible for them to adapt the environment in such a way that it meets their needs; therefore the population might in the future migrate to parts of the world which are currently sparsely populated. We also have the ability to increase our food production so that total food production could increase more quickly than population growth.

In spite of humankind's ability to accommodate and feed increasing numbers on earth, about a quarter of the world's population live in terrible poverty. Besides the poverty issue, at the start of the 21st century we are also facing a variety of environmental problems resulting from our technological developments. Will the people of the 21st century be able to adapt the world in such a way that they can eliminate poverty, stabilise population growth and stop environmental degradation?

Study Unit 9
Migration

INTRODUCTION

In this study unit we discuss the migration of people. We look at the migrations of people since 1500 and the impact of international migration. We also pay attention to current patterns of global migration and the effect of international migration on the human-environment system. Today, most countries have laws and policies on migration to control both immigration and emigration of people. Migration control has become a very controversial matter all over the world. When people migrate (emigrate) legally from their country of origin and enter another country (immigrate), they become part of the vital statistics of the countries that they leave and enter. Some people do, however, migrate illegally as illegal immigrants to certain countries.

STUDY MATERIAL

The study material for this study unit comprises the second part of chapter 5 on population, population increase and migration in Bergman and Renwick.

Key Terms

- migration
- voluntary migration
- forced migration
- push factors
- pull factors
- African diaspora
- brain drain

Learning Outcomes

After you have worked through this study unit you should understand the patterns of migration on a global scale. You should be able to explain why people migrate and what the results of international migration are. To achieve these outcomes, you should be able to

- distinguish between the push factors and the pull factors that cause migration
- explain what voluntary and forced migration are and give examples of each
- show on a map of the world where the human population originated and how the population spread across the world
- explain how the distribution pattern of the world population has been influenced by large-scale migration (both forced and voluntary) since 1500
- describe and explain the spatial pattern of international migration (forced and voluntary)
- explain which types of push and pull factors are responsible for current international migration in the world
- draw and interpret flow lines on a map

9.1 Migration

A clear distinction can be made between migration and other types of human movement. Migration differs from short-term mobility where people move daily between their homes and places of work (commuting) or where people move between countries and regions as tourists. Migration involves the relocation of people (permanently changing their place of residence) and takes place on all spatial scales. Most migration is voluntary, but over the centuries forced migration (refugees and slavery) has had an enormous impact on global population distribution. Human beings tend to move about from one place to another. These movements are divided into push and pull factors. Push factors, such as starvation and political and religious persecution, force people away from a place. Pull factors, for example better socioeconomic opportunities and political and religious liberties, attract people to new destinations (in Bergman and Renwick). Features of physical geography can serve as push or pull factors. However, the environment itself never actually pushes or pulls; people ultimately decide after considering environmental factors. Figure 5-21 in Bergman and Renwick highlights the positive and negative experience of migration.

9.2 Prehistoric Human Migrations

Study Task

Study the sections in Chapter 5 in Prehistoric human migrations in Bergman and Renwick.

Human migration, the evolution of various cultures and the diffusion of those cultures through interaction and communication have had a major effect on the current global distribution of people. Although these ancient patterns of migration are important to explaining current population distribution patterns, the numbers of people who migrated were very small. Human migration in the past five centuries has, however, totally changed the world population distribution pattern. The greater part of this migration was caused by events in Europe.

Activity 9.1

Study the map "Prehistoric human migrations" in Bergman and Renwick. Describe the patterns of human migration in space and time (spatiotemporal pattern) from Africa to the rest of the world.

9.3 The Migrations of Peoples Since 1500

Study Task

Study the sections "European migration to the Americas", "The African diaspora" and "Political refugees" in Bergman and Renwick.

9.3.1 European Migration to the Americas

The 19th century saw the greatest migrations of Europeans to the western hemisphere. The western hemisphere was therefore regarded as the New World. Open as it was to European settlement, their massive migrations have changed hemisphere demographics for ever. Refer to the map in Bergman and Renwick on European migration in the 19th century to understand how massive these migrations were.

Most of these people lived in five urban centres in Europe, Asia (China and India) and Central and South America (Mexico and Peru). The various peoples and cultures developed and existed in relative isolation. The world as we know it today may be attributed largely to the migration of people, especially from Europe, during the past 500 years.

Voyages of exploration began during the Renaissance (1300–1600) in Western Europe, introducing people from Europe to the people and resources of the rest of the world. Have a look at the map of the voyages of exploration (fig 6-27) in Bergman and Renwick to find out which new parts of the world were "discovered", the dates when they were discovered and the routes that the various voyages of exploration followed to reach these new parts of the world.

The voyages were made possible by advances in shipbuilding technology and the scientific revolution. To the European rulers, voyages of exploration were a means to expand their power, wealth and territories. The first exploration opened up the "new" world for further exploration, trade and settlement. This led to the reclassification of plants and animals and the collection of new materials, ideas and techniques from all corners of the world. The voyages of exploration also helped establish the foundation for the Industrial Revolution in Europe and indirectly gave rise to the large-scale redistribution of the world population. The Industrial Revolution (in the 18th and 19th centuries) gave rise to large-scale mining and industrial development in Western Europe. The scientific and agricultural revolutions improved food production and raised living standards so that larger population numbers could be supported. Population growth increased as a result of advances in medical services and a diminishing mortality rate. This is the reason why this part of the world (Western Europe) has accommodated one of the world's highest population concentrations since the 18th century – and still does today.

Industrialisation in Western Europe caused people to migrate from rural areas to the cities. Increased use of machinery in agriculture and in manufacturing meant that many people coming to the cities were unable to find work or a place to live. Improved transportation technology and infrastructure made it possible for people who could not find work in the cities of Western Europe to migrate overseas in search of better prospects. The growing pressure of population numbers on Europe's resources and the growing need for basic raw materials from overseas territories resulted in the formulation of migration policies in many countries of Europe, but especially in Britain. This made large-scale emigration of people from Europe possible. The rate of migration then increased, and between 1835 and 1935 approximately 75 million people migrated from Europe to the New World (North and South America), Africa, Asia and Australasia.

9.3.2 The African Diaspora

The African diaspora is an example of migration which is usually related to violent times and events in history. The term African diaspora refers to black people who have migrated out of Africa, either freely or in slavery. Forced migration is often a result of war, religious or political persecution, or economic need. In the case of forced migration, the migrant plays no role in the decision to migrate. There are a number of different types of forced migration, and not all forced migration is international (migration from one country to another). The trans-Atlantic slave trade, where millions of people were transported from Africa to the Americas, is one of the major forced international migrations of the past. This migration was essential to European economic expansion from the 17th to the 19th centuries, and took the form of the forced removal of black people from Africa to work in the plantations of the New World. It is estimated that by the time slavery was abolished, between 10 and 12 million people had been transported from Africa across the Atlantic Ocean. People were not only transported from Africa to the New World.

Activity 9.2

1. Study the map (on the rear endpaper) and the map in figure 5-23 in Bergman and Renwick. Compare the migrations of Europeans in the 19th century that provided the foundation for the current world population distribution pattern. To which continent did most of the migrants from Europe move in the 19th century? Which continent received the second largest number of migrants from Europe?
2. How did the European migration affect the indigenous population of North America?
3. What does the term "African diaspora" mean, and which types of migration does it include?

9.3.3 Refugees

Forced migration is often the consequence and the cause of social and political crises. Some migrants are regarded as refugees in terms of international law. Ac-

cording to the 1951 Geneva Convention, a refugee is someone with a well-founded fear of being persecuted in his or her country of origin for reasons of race, religion, nationality, affiliation with a particular social or political group or opinion (see Bergman and Renwick). By law, signatories to the Convention are compelled to accept and grant refugees asylum. Civil wars and international wars displaced many people who have sought refuge in other countries. Alongside refugees, there are also migrants who search for better standards of living and work. These migrants are called economic refugees.

An example of forced migration has been unfolding in Zimbabwe for the last decade. Political instability, coupled with violence, intimidation and political intolerance in Zimbabwe, led to the downward spiral of economic and social wellbeing of millions of Zimbabweans. South Africa, being the neighbour of Zimbabwe, thus became the recipient of many forced migrants/refugees. If we calculate the total number of refugees in Africa from figure 5-31 in Bergman and Renwick, it totals almost 5 million (4 748 200). This means that Africa as a continent has the highest number of refugees in the world.

Bergman and Renwick discuss a number of cases of mass expulsion, where very many people have been expelled from certain countries. These people become stateless and are classified as international political refugees. As recent events in Africa have shown, refugee crises arise suddenly, and millions of people may be uprooted within a few weeks. This means that the map of refugees worldwide is not static, but is changing constantly. In recent times, many European countries have started amending their previously liberal policies on asylum in view of the increasing numbers of refugees applying for political asylum. In 1993 the French National Assembly and the German Bundestag both voted in favour of restricting the conditions under which asylum will be granted.

Refugees differ from voluntary migrants in terms of three main characteristics. Most refugees move without any luggage, taking only the possessions they can carry. They usually set out on foot or by bicycle, trailer or open boat, and they usually have no official documents such as a passport or visa. In many cases they do not even have any identification documents. Voluntary international migrants usually travel with many possessions, they use technologically more advanced forms of transport, and they carry the necessary passports, visas and migration permits.

Activity 9.3

1. What is the difference between a political and an economic refugee? Which push factors affect political refugees?

9.4 The Impact of International Migration

Study Task

Study the sections “The impact of international migration” and “Reasons for international migration” in Bergman and Renwick.

Immigrants are often disregarded and treated with disdain. Immigration has become an emotive and political issue in many receiving countries. Migrants are usu-

ally at the peak of their fertility years and have an impact on population growth. Migrants settle in a few places within a country – which makes them more visible, thereby accentuating cultural differences.

Previously migrants were grudgingly tolerated because they were willing to work in low-wage or dirty jobs. Today, however, migrants are actively competing for jobs. European countries are selective and welcome skilled educated immigrants. Many rich countries accept foreign workers but are reluctant to grant them citizenship or the rights that citizenship would bring. Illegal aliens tend to face the burden of discrimination on the work front and are often forced to accept lower wages and work under appalling working conditions.

Activity 9.4

1. Use examples to explain the difference between internal and external (international) migration.
2. The map in figure 5-26 in Bergman and Renwick is a flow line map showing both the direction of the slave trade (purple and brown lines) and the numbers of slaves transported (purple lines). The key to figure 5-26 shows different widths of arrows representing certain numbers of slaves. To interpret the flow lines on the map, we need to measure the width of each line (arrow) and compare it with the key at the bottom of the map. If we measure the width of the arrow representing 4 million slaves, we see that it is approximately 3 mm wide, whereas the one indicating 1 million is only 1 mm wide. The widths of the arrows are therefore not in exact proportion to the flow volumes. To be in exact proportion, the arrow indicating 1 million people would have to be only 0,75 mm in width. Consequently, we cannot use the map in figure 5-26 to measure exactly how many slaves were moved between Africa and the various other territories. We can nevertheless establish approximately how many slaves were transported along each route by visually comparing the width of the various arrows with the width of each arrow in the key. Based on such a visual comparison, it appears that approximately 4 million slaves were transported out of Africa to South America (especially Brazil), some 1 million to the Dutch Caribbean territories, 2,5 million to the French Caribbean territories, 2 million to the British and Danish Caribbean territories, 1,5 million to the Spanish Caribbean territories, and only about half a million (500 000) to North America. This amounts to a total of 11,5 million slaves. We know that the total number of slaves taken from Africa is estimated at between 10 and 12 million – refer to Bergman and Renwick for more in this regard. In spite of the slight inaccuracy in the construction of figure 5-26, it still gives us a fairly reliable picture, and we can see at a glance that many more slaves were taken to South America than to North America. (The data on the numbers of slaves taken from East and West Africa are so unreliable that the brown flow lines could not be constructed according to scale.)
3. Why is there no longer a policy of open migration in the world?
4. What is the effect of immigrants on the countries to which they migrate?
5. What does the "brain drain" mean? What effect does it have on the countries of origin and on the destination countries of international migrants?

IN CONCLUSION

The distribution of people in the world has changed over time and from place to place. As a result of technological advances, the populations of the Old World in turn spread to the larger, unpopulated parts of the world. Today, people live in every corner of the world and have even conquered space. The movement of people between countries continues, and every year there are more refugees, migrants and illegal migrants in the world. This large-scale migration of people worldwide at the start of the 21st century is a reflection of the interdependence of the global economy.

Study Unit 10
Cultures of the world

INTRODUCTION

We start this study unit by discussing the origin, diffusion and spatial distribution of cultural patterns, and then we pay special attention to language and religion as the two main attributes of culture.

STUDY MATERIAL

This study unit refers to the chapter "Cultural geography" in Bergman and Renwick.

Key Terms

- culture
- cultural diffusion
- acculturation
- folk culture
- popular culture

Learning Outcomes

We would like you to realise that global conflict can be reduced if people understand why and accept that we are not all the same. A knowledge and understanding of people's cultural backgrounds will enable you personally to make a positive contribution to peaceful coexistence. To show that you have reached these learning outcomes, you must be able to:

- define the term "culture" and list examples of cultural attributes
- explain how cultures are created and continually change through evolution and diffusion
- give recent examples of acculturation
- compare environmental determinism and environmental possibilism
- define, with examples, the terms folk culture and popular culture
- explain how trade can end cultural isolation and trigger cultural diffusion

- explain why it is sometimes said that the world is getting smaller
- interpret and visualise maps of the distribution of main languages and religions of the world
- explain where and why there are differences between a country's officially recognised language and the language(s) spoken at grassroots
- briefly explain the fundamental differences in the beliefs of the main religious groups of the world
- explain how and why religion affects different spheres of life
- name the conflict situations globally that may be attributed to language and religious differences

10.1 Culture

Study Task

Study chapter Cultural Geography in Bergman and Renwick.

The concept of culture describes everything about the way people live: their clothes, diets, customs and beliefs. Culture also includes patterns of behaviour as well as possessions. Human culture is dynamic, because people are constantly changing and learning new techniques, and developing new cultural traits. The process of spreading is called cultural diffusion, and the process of adopting some aspect of another culture is referred to as acculturation. Cultural diffusion can be imposed on people, for example when an outside power conquers a region and imposes its way of life, or it can be freely chosen when a group chooses to adopt a culture or way of life, which is known as acculturation.

Activity 10.1

Explain what you understand by:

- culture
- cultural diffusion
- acculturation

10.2 Cultures and Environments

Study Task

Study the section Cultures and environments in Bergman and Renwick.

The simplistic belief that human events can be explained entirely as a result of the effects of the physical environment is called environmental determinism. Climate is a good example of a factor that controls human activities. Many environmentally deterministic theories have exceptions. For example, the Dutch have successfully managed their watery environment for many years. The view of environmental

possibilism is seen as the solution to environmental determinism. According to the possibilistic view, the physical environment itself cannot determine what people will attempt, but may limit what people can profitably achieve.

Activity 10.2

Compare and contrast the concepts of environmental determinism and environmental possibilism.

10.3 Cultural Diffusion

Study Task

Study the section "Cultural Diffusion" in Bergman and Renwick.

With globalisation came an increase in global communication, transportation, increased trade and cultural exchanges. This interconnectivity has exposed people to other cultures and ways of doing things. The clothes people wear, different type of fashions, food and imported materials exemplify this interconnectedness. Geertz (1995) highlights two concepts: cultural evolution which Geertz calls "local harmonies" and cultural diffusion which is called "the noises of all-over present". Cultural diffusion has surpassed cultural evolution.

Today's rapid pace of cultural innovation and diffusion requires us to differentiate between folk culture and popular culture. Folk culture refers to a culture that preserves traditions. Folk groups are often connected by a distinct religion, language or national background and are often conservative and resistant to change. Folk culture suggests that any culture identified by the term is a lingering remnant of something that is plagued by the tide of modern change (in Bergman and Renwick). The Amish people of Pennsylvania in the USA are a good example of folk culture. Popular culture, by contrast, refers to the culture of people who accept innovation and changing norms. Popular culture can originate anywhere and tends to diffuse rapidly where people have the time and money to indulge in it. Fashion, books, food, CDs and music are good examples of popular culture that tends to filter down to people.

Activity 10.3

1. Define the following terms:
   - cultural diffusion
   - cultural evolution

2. Explain the difference between the terms "folk culture" and "popular culture" by describing the typical followers of the two types of culture.

10.4 Identity and Behavioural Geography

Study Task

Study the section Identity and behavioural geography in Bergman and Renwick.

You should be able to read between the lines that Bergman and Renwick call for sensitivity when we label people as belonging to some group or another. Dividing people into racial groups means that one or more biological (hereditary) traits, such as skin colour, blood type or genetic properties (e.g. DNA composition), are used to classify people. A person is therefore born into a particular race. Racial classification is obviously a relatively easy and simple means of classification. The question is whether it serves any purpose or makes any sense. Remember, you have already discovered that culture has many dimensions. It is not unusual for two people who share many cultural attributes, but who perhaps speak different languages or have different belief systems or support different political parties, to be intolerant of each other. Can you see why we have our doubts about racial classifications? They are based on a single attribute of culture. Classification implies that the people belonging to one category form a homogeneous group, whereas they may be totally heterogeneous in terms of other cultural attributes.

Race and ethnicity are sometimes wrongly used as synonyms. Ethnicity differs from race in that it is not based purely on biological features. It includes features such as the culture and the geographical and historical origins of the individual. The word "ethnic" is derived from the Greek word meaning "people" and suggests that an ethnic group is distinct from or differs from most of the people at a particular place and time. The term also contains a strong connotation of "minority". For example, we do not classify the Japanese residents of Tokyo as an ethnic group. However, should some 30 of them move to a suburb in Kimberley to establish an industry, we might well describe this group of Japanese people as an ethnic group. The group members therefore acquire ethnic status – they are not born with it.

Activity 10.4

1. Define the term "racism" and give at least one example of a racist ideology.
2. Compare the concepts of race and ethnicity.
3. Explain what you understand by the term "ethnocentrism".

Study Task

Study the section "World trade and cultural diffusion today" (up to "The acceleration of diffusion") in Bergman and Renwick. Be sure to note the following points relating to global trade, cultural diffusion and cultural change:

- Virtually the entire world is experiencing this evolution from self-sufficiency and cultural isolation to trade and cultural exchange.
- Not all cultural groups are equally attracted to the system of trade and circulation, but its power is so persuasive that some cultural groups join the system purely as a matter of survival.
- Not all communities and countries benefit equally from international trade.
- As a result of the rise of powerful multinational corporations and the phenomenon of international franchises, trading enterprises that look almost identical and that sell identical products may be found all over the world.

- Popular cultural commodities (items) are aggressively marketed worldwide. Marketing campaigns are directed at stimulating consumer demand for a product which is not really needed. Bergman and Renwick describe this trend as the creation of new felt needs. A desire is created in the consumer which is eventually experienced as a need, so that he or she then buys the product.

Remember what we said about commodities being the building blocks of lifestyles, social identity, cultural identity and self-perception? A teenage boy buys a pair of sports shoes, not necessarily to replace a worn pair, but as symbol of his lifestyle and the cultural group with which he identifies. The end result is that people become more similar in the food that they eat, the beverages that they drink, the clothes and shoes that they wear, and the soap operas that they watch. Such global homogenisation of taste is overwhelming indigenous folk cultures.

10.5 Demarcation of Cultural Regions

Study Task

Study the introductory paragraph to the theme "Cultural realm", the subsection "Problems in defining great culture regions" and the subsection "Forces that stabilize the pattern of culture realms" in Bergman and Renwick.

You should realise that defining cultural regions may be a highly subjective and controversial exercise. We cannot demarcate an area on earth and claim that everything and everyone within that area are the same. We can say, however, that defining a cultural region is invariably purpose-specific, so that using different criteria will produce different cultural regions. The following three comments will suffice:

1. A cultural region is homogeneous in the sense that the criterion on which demarcation is based will be dominant within the boundaries of the region (remember, anything more than 50% is technically dominant).
2. The line that demarcates the region is not real and in reality represents transitional zones.
3. Any culture or cultural region is at any stage subjected to two opposing forces, namely the force of change (diffusion and evolution) and the force of stabilisation (inertia).

Activity 10.5

Explain why traditions and existing infrastructure are regarded as inertia factors.

10.6 Global Westernisation

Study Task

Study the section Global westernization and the origin of global westernisation in Bergman and Renwick.

In spite of the variety of indigenous cultures around the world, cultural diversity has dwindled drastically over the past 500 years and the world has assumed a more homogeneous character based on the Western (European) culture. In contrast to the relative isolation that characterised cultural areas in the 15th century, global interconnectedness has become the rule. We start this section by looking at the historical events in which global Westernisation originated, and then we examine the reasons why this process continues to maintain its momentum even today.

10.6.1 The Origin of Global Westernisation

Bergman and Renwick (distinguish a number of Western-inspired events, initiatives and processes which have resulted in the interconnectedness of the world, and on the other hand in the diffusion of Western culture to virtually all corners of the world. Note that the stages distinguished in the table should not be regarded as separate time periods. Some stages did overlap and influence one another. Essentially, innovations stimulated development and progress. This resulted in new cultural products, lifestyles and perceptions, which imposed new marks on the landscape. Each stage also created new expectations, needs and aspirations, which were to serve as triggers for subsequent stages. Finally, it is important to note that although new knowledge, economic practices and lifestyles were created in Europe, they eventually spread to those parts of the world that were in contact with Europe, through a process of diffusion.

Era of voyages of exploration from 1415 Portugal, Spain, the Netherlands, France and England led the way. Technological development in shipping was stimulated. The boundaries of the world known to Europe expanded. Europe became aware of new, foreign products, seized opportunities and established trade links with different parts of the world (especially South America, Africa and Asia). Commercial revolution + 1650–1750 Trade flourished. Further development in shipping technology was initiated. Europe became ever more cosmopolitan. Europe not only left its own stamp (culture) on overseas trading posts – it also, for example, introduced Indian products to China and used Chinese plant materials to establish the tea industry in India and Sri Lanka (formerly Ceylon). Huge profits for Europe. Europe controlled the production, transportation and marketing components of global trade.

+ 1750–1850 Europe started changing from a society based on agriculture and trade to an industrial society. Influx of products and especially minerals created the need for financial institutions and industries. Development of the steam engine in Britain snowballs. More energy available to do work. Innovations in the manufacturing sector increased productivity. More factories were built, more products manufactured, transport networks (railway lines) were built. Faster, more reliable and more cost-effective means of transport invented (steam ship) to transport raw materials to the industries and manufactured products to the markets.

During the same era as the industrial revolution, a more scientific approach to agriculture in Europe emerged. Yields increased and agricultural activities became less labour-intensive. Surplus agricultural workers found employment in booming industrial sector. Political imperialism + 1415–1779 and last half of the 19th century Innovations diffused from central Europe to the rest of the continent, North America and overseas trading posts and empires. Europe was no longer satisfied

merely to trade, also became producers – invested in land and established commercial plantations along coastlines. Railways made it possible to use the best agricultural land in the interior and to mine minerals. Sphere of influence extended. Cities developed from which trade activities could be coordinated.

The need to protect trade interests and financial investments leads to annexation and subjugation of former trading partners. Era of colonialism. Only a few countries outside Europe were not subjected to colonial rule. Totally foreign European views forced upon the colonies, such as private ownership of land and labour as negotiable commodity. European powers implemented their European-developed administrative, government and economic systems. Indigenous populations were uprooted from their traditional social systems. The foundation was laid for cultural imperialism.

(Study carefully Bergman and Renwick, starting with the last paragraph up to "Cultural imperialism". There are many examples of how traditional rights, value systems and responsibilities were disregarded and suppressed.)

Cultural imperialism Definition: Cultural imperialism involves the replacement of cultural traditions by other traditions – either by means of force, rejection, expulsion, denigration or marginalisation of those opposed to acculturation.

Most Europeans were convinced that their own culture was superior; regarded indigenous cultures as inferior; saw it as their duty to eliminate indigenous cultures; destroyed traditional religious and political views, cultural artifacts such as artworks, architecture and even historical and scientific records. The nature of the Christian religion was a major driving force. Christians saw it as their divine duty to convert non-Christians. Cultural imperialism began by educating and converting the local elite (role of missionaries) who went on to do evangelical work themselves. Government schools produced Westernised people who went on to become state bureaucrats and officers in the armed forces and who were accepted as role models by virtue of their status. In many respects, colonial rule was a demonstration of race-based humiliation. Career success was possible only by learning the language of the "mother country" (i.e. the colonial motherland) and complying with the "rules" and norms of the European rulers. As a result, indigenous traditions were denied and died, and those of the dominant group were adopted and followed. Colonial schools commended the qualities and importance of the "motherland" at the expense of any knowledge of their pupils' own country and the world in general.

Activity 10.6

1. Name and discuss the mechanisms and strategies implemented to carry out cultural imperialism, which was used by so successfully in the colonies by Western imperial powers that they eventually led to self-Westernisation.
2. Write an essay on how Western culture has diffused to virtually every corner of the world from the 15th century to today. Use Bergman and Renwick to make a list of causes, then put the book aside and formulate your answer in your own words.
3. Briefly summarise the events leading to global westernisation.

10.6.2 Global Westernisation Today

Study Task

Study the sections "Westernization today", "US cultural dominance" and "The acceleration of diffusion" in Bergman and Renwick.

1. Give at least five reasons why acculturation to Western culture continues today.
2. In reference to American culture, Bergman and Renwick make the following statement: "No other culture today offers almost universal allure – values and ways of doing things that appeal to the rest of the world." Indicate whether you agree with or differ from the authors' statement, and substantiate your point of view.
3. We often hear that the world is getting smaller. Put the "shrinking" of the world in perspective by showing how cultural diffusion accelerates as a result of distances becoming easier to bridge.

Up to now we have been looking at culture in general. We now turn our attention to language and religion as two cultural attributes with which people identify most intensely. People with the same language and religion often also display other common features which enhance cooperation in the interlinked world of today. We deal first with language and then conclude the study unit by discussing the spatial patterns relating to religious faiths.

10.7 Language and Related Concepts

Study Task

Study the sections "Defining languages and language regions" and "The world's major languages" in Bergman and Renwick.

Activity 10.7

Define the following concepts, terms and phenomena:

1. language
2. dialect
3. standard language
4. lingua franca
5. the geography of language
6. isogloss
7. the role of distance in a geographic dialect continuum

10.8 The Major Languages and Language Families of the World

More than 3 000 different languages are spoken in the world. Some languages, such as those used in the isolated valleys of New Guinea, are extremely localised

and are spoken by only a few hundred people. At the other extreme are Chinese Mandarin (mother tongue of more than 850 million people), Hindi and English. English is the mother tongue of some 330 million people and is the official language or one of the official languages in approximately 50 countries. Like English, Arabic also has transnational significance. Followers of the Islamic religion, for example, are strongly encouraged to study the Islamic scriptures, the Koran, in the original Arabic.

Activity 10.8

Table 7-1 in Bergman and Renwick lists the 12 languages spoken by some 50% of the world population. Use table 7-1 together with figure 7-2 (which shows the spatial distribution of the world's official languages) to get some indication where one of these 12 languages is the official language. Because you had to create a mental map for yourself, we cannot give an answer for this activity. You should nevertheless note the following points. Figure 7-2 shows only official languages. In South Africa there are also many followers of Islam who are proficient in Arabic. However, Arabic is not an official language in South Africa and therefore does not appear on the map. Many languages (such as Danish) are relatively isolated, while others, such as English, Portuguese and French, are official languages on more than one continent.

10.9 The origin and Spread of Languages

Study Task

Study the section "The development and diffusion of languages" in Bergman and Renwick.

People who live in total isolation will develop an absolutely unique language peculiar to them. When members of such an isolated community spread farther afield, the various splinter groups will have the same core vocabulary. Each separate splinter group will create new words to describe new phenomena, experiences and feelings. The common core vocabulary of such splinter groups is known as a protolanguage.

Together, the comprehensive languages of the various splinter groups form a language group. The spatial distribution of the Indo-European group of languages is far wider than any other language group, and more people speak an Indo-European language than any other language in the other language groups.

Activity 10.9

1. Use figure 7-3 in Bergman and Renwick to explain the historical origins of two of South Africa's official languages, namely English and Afrikaans. **Note:** Do not attempt to memorise the figure.
2. Describe the world distribution of the Indo-European language group in terms of figure 7-4 in Bergman and Renwick.

3. Use the accompanying map of Africa (fig 10.1 in study unit 10) as a base map on which to trace the language groups of Africa. Also place a dot to show the country from which South Africa's indigenous languages diffused. Do not forget to provide a title and a legend for the map.

10.10 Orthography: Geography of Writing

Study Task

Study the section "The geography of orthography" in Bergman and Renwick.

Activity 10.10

1. Briefly explain the main difference between writing based on the alphabetic system and the writing used in China and Japan respectively.
2. Describe and give at least two examples to illustrate how religion has played a role in the diffusion of the art of writing.
3. Discuss, with reference to the newly independent republics that emerged in Central Asia after the fragmentation of the Soviet Union, how political agendas may influence orthography.
4. Give two examples of communities who speak the same language but write them differently.

10.11 Toponymy: the Study of Place Names

Study Task

Study the section "Toponymy: language on the landscape" in Bergman and Renwick.

It is important that place names often provide a record of the current or past natural environment. A place name may also tell the story of the origins or value system of the current or former inhabitants. This is all you need to know for examination purposes.

Activity 10.11

Look at the maps of South Africa in your atlas and see if you can find names of places or features that refer to:

1. the area of origin of its first inhabitants
2. the founder of the town or city
3. the original appearance of the environment
4. former leaders
5. current political figures

6. prominent women
7. people's religious belief

Also identify two places which have undergone a name change since 1994.

10.12 The Distribution and Explanation of Language Patterns in the Modern World

Study Task

Study the sections "Linguistic differentiation in the modern world" and "Languages in the United States" in Bergman and Renwick.

Activity 10.12

1. Language patterns are not static. The nature of a language at a particular time and at a particular place is the result of two opposing forces. What are these two forces? Give examples of how these forces bring about spatial variation in language dialects.
2. Why has it become difficult to guess a person's nationality purely on the basis of language?
3. In Africa, in particular, the language(s) spoken at grassroots is/are often not the official language(s). Give ideological and practical reasons to explain this state of affairs.
4. "Whatever the country's constitution or laws might say, one language will generally be the 'preferred' language." Discuss the validity of this statement by applying it to a multilingual state such as South Africa.
5. Why has there been an increase in the phenomenon of polyglot states? Also use figure 7-2 in Bergman and Renwick and write down one example of a polyglot state on each continent.

10.13 The Teachings, Origin and Distribution of the Main Religions of the World

Study Task

Study the six introductory paragraphs in the section "The teachings, origin, and diffusion of the world's major religions" in Bergman and Renwick.

Activity 10.13

Use the space provided below to define each of the terms very briefly and to give an example of each:

1. orthodoxy
2. orthopraxy

3. fundamentalism
4. secularism
5. proselytising (attempts to convert)
6. ethnic religion
7. universalising religion

We are trapped in the same dilemma as that referred to by Bergman and Renwick, since we do not intend you to have a thorough understanding of the teachings of the various religions. Because religion is such a major determinant of human behaviour, you should however attempt to isolate the essence of each.

Study Task

Study the section "The origins, nature, teachings and spread of each of the six major religions, namely Judaism, Christianity, Islam, Hinduism, Buddhism and animism" in Bergman and Renwick.

A religion is a system of beliefs regarding conduct in accordance with teachings found in sacred writings or declared by authoritative teachers. Most religions involve personal commitment to worship God or gods. The world today comprises many religions and sacred beliefs. Refer to figure 7-15 (the world map of dominant religions). You may also use table 7-3 in Bergman and Renwick, which provides the numbers for the dominant religions by continent.

Activity 10.14

Answer the following questions on the six major religions that you have studied:

1. Which religions are monotheistic?
2. Which religions regard proselytising as a divine command?
3. Think of your friends, family and acquaintances. How many religions are there in your circle?
4. Which cities are the capitals of Islam and of the Roman Catholic Church respectively? ..... and ..... . Find these cities in your atlas and show their locations on your world map.
5. To which states is Hinduism almost exclusively confined today?
6. Which religion that originated in East Asia has become very popular in the Western world?
7. What do animists believe?
8. Name the two Islamic sects that are often intolerant of and even hostile towards each other. ..... and .....
9. What are the points of view of the two major Christian denominations on birth control?
10. Briefly describe the global distribution of Islam.

11. Which events gave rise to the diffusion of Judaism from the Near East to many other parts of the world?
12. Which of the six major religions can be found in South Africa?
13. Describe the global distribution of Christianity and explain how this spatial distribution came about.
14. Which one of the major religions has the highest number of followers?
15. Which one of the major religions has the widest spatial distribution?
16. Name the religions that occur predominantly in Africa.
17. Summarise the discussion of the six major religions.

10.14 The Political and Social Impact of Religion

Study Task

Study the introductory paragraph under the heading "The political and social impact of the geography of religion" (summarise the precise meaning of this heading) and the section "The way in which religion influences various spheres of life" in Bergman and Renwick.

10.14.1 Religion and Politics

Study Task

Study the section "Religion and politics" in Bergman and Renwick.

Activity 10.15

1. Explain what a theocratic state is and indicate where you would find such a state.
2. Explain the concept of "secular government" and also indicate whether or not South Africa has such a government.
3. Use the spaces below to give examples of how Judaism and Islam are reflected in politics:
   a. Judaism
   b. Islam

10.14.2 Religion and Women's Rights

Study Task

Summarise the section "The essence of religion and women's rights" in Bergman and Renwick.

Give three examples of the places in the world where spatial variation of the status of women may be directly attributed to religious beliefs. Try to use three different religions as examples.

10.14.3 Religion and Diet

Study Task

Study the section "Religion and dietary habits" in Bergman and Renwick.

Activity 10.16

Give at least four examples of how religious beliefs influence the global distribution of food production and consumption.

10.14.4 Religion and the Economy

Study Task

Study the discussion on religion and economics in Bergman and Renwick before you do activity 10.18.

Activity 10.17

Briefly summarise how different religious beliefs can influence the economies of countries.

IN CONCLUSION

Have we succeeded in inspiring you to take a fresh look at the fascinating cultural world that we live in? We trust that you now know how cultures originate and spread, and that you have a mental map of the spatial distribution of the major cultural groups of the world. Can we assume that you realise that cultural patterns are not static, but are subject to the opposing forces of preservation and innovation? Have you also learnt that ways of doing things that differ from the ways to which we are accustomed are not necessarily less "effective", or "wrong", and that we need to learn to appreciate and respect the integrity of people who differ from us?

Study Unit 11
The spatial distribution of wealth in the world

INTRODUCTION

In study unit 9 we saw that migrants usually move from relatively unfavourable conditions in the countries of their birth to countries where people are better off. The pull and push factors of international migration are largely of an economic nature. In South Africa, for example, migrants are streaming in from the rest of Africa because economic conditions in South Africa are better than in other African countries. This study unit focuses on the spatial distribution of wealth and development in the world. We examine the different criteria used to measure development and compare the spatial patterns of development that arise when using different criteria. We also look at a few of the explanations for the different spatial patterns.

STUDY MATERIAL

In this study unit you will study the last part of chapter 11 and the first part of chapter 12 references to this first part of the chapter – because of figures, tables, maps in-between, in Bergman and Renwick.

Key Terms

- development
- core-periphery model
- gross national product (GNP)
- gross domestic product (GDP)
- more developed countries (MDCs)
- less developed countries (LDCs)
- North-South division
- human development index

Learning Outcomes

After you have worked through this study unit you should be able to:

- explain the spatial variation in the global distribution of wealth and development and why not all countries have reached the same level of development

- explain the meaning of the term "development"
- describe the core-periphery model of development and apply it on a global scale
- explain what gross national product (GNP) and gross domestic product (GDP) involve, how they are used to measure global wealth and what the merits of these criteria for development are
- describe and briefly explain the spatial pattern of wealth on a global scale in terms of measures such as per capita GNP, percentage of the labour force involved in specific economic sectors, and per capita energy consumption
- distinguish between economic measures of development and the human development index
- explain the spatial patterns of human rights on a global scale and their correlation with the patterns of economic development
- explain the meanings of the terms "poor" and "rich" countries, developing and developed countries, and Third World and First World
- indicate on a world map where large-scale manufacturing takes place and discuss the relationship between manufacturing and development
- explain the relationship between development and infrastructure

11.1 Global Wealth and Development

Study Task

Study the first two paragraphs under the heading "Analyzing and comparing countries' economies" in Bergman and Renwick.

Some parts of the world are economically and technologically advanced, while others are less developed. Development is a very complex term and there is no generally accepted theoretical and practical definition of development. Development means different things to different people. There is also no universally accepted criterion for measuring and comparing the levels of development of countries. From an economic-geographic point of view, we concentrate on socioeconomic development which implies an improvement in material wellbeing and living standards, modernisation and progress. Economic development, moreover, implies a process of change in the nature and composition of the economy in a country or region. Economic development is related to an improvement in the material or monetary wealth of people and may be described in terms of productivity, production, living standards, buying power and income. Levels of economic development are measured largely in terms of per capita national income – that is, income per person. In this study unit we discuss only the criteria and spatial patterns of socioeconomic development on a global scale. We do not involve ourselves in the debate about what development is.

There are considerable differences in the living standards and economic development of people in what are known as "rich" countries and those living in "poor" countries. This difference in the level of development between rich and poor countries tends to grow over time. In 1900, the ratio between the average per capita

income (income per person) in a typical rich or developed country and in a typical poor or undeveloped country was approximately 4 to 1. Today this ratio stands at 17 to 1. Geographers and economists use a wide variety of descriptions to describe and explain imbalances or disparities in the world. In several places in this tutorial letter 501 and in Bergman and Renwick you will come across the distinction between more developed countries (MDCs) and less developed countries (LDCs), developed and developing countries, rich and poor countries, and even Third World and First World countries. These are only a few of the descriptions used to explain the spatial patterns of development.

Activity 11.1

1. Is there a simple criterion for measuring the living standard of people in particular countries of the world and comparing it with that in other countries?
2. Explain what a process of modernisation means in terms of economic development.
3. Explain the meaning of the ratios 4 to 1 and 17 to 1 used above.

11.2 The Core-periphery Model of Development

The spatial pattern of global economic development looks like a patchwork quilt, with enormous differences between countries (e.g. figure 12-6 in Bergman and Renwick). Geographically, the single most important feature of this spatial pattern of economic development on a global scale is the uneven or unequal distribution of wealth. The unequal spatial pattern of development may be explained geographically in terms of the core-periphery model of development.

In its simplest form, the core-periphery model provides for two spatial components: an economically strong core region which covers a relatively small proportion of the globe, and a periphery which is economically less developed and spatially large. This bipolar classification does not imply that either the core or the periphery is a homogeneous entity. On a macro scale (global scale) the developed industrial countries form the core of the global economic system, while the developing countries form the periphery.

In this study unit we refer throughout to the economy of the world as a whole as the global economic system. The core-periphery model may be applied to all spatial scales, and we may use it to describe and explain development on all spatial scales – global, continental, regional, national and local. Economic core areas may be identified within a region (e.g. Polokwane is the core of the Limpopo Province in South Africa), within an individual country (Gauteng is the economic core of South Africa and dominates its spatial economy), at continental level (South Africa and Egypt may be regarded as the cores of Africa) and on a global scale (Japan, the USA and Europe form the tripolar core of the global economic system). Together, the core and periphery form an integrated whole, and processes and forces that operate in one will influence the other.

The terms “core” and “periphery” therefore not only refer to the spatial structure of development, but also explain the unequal economic and power relationships and

dynamic interaction of the core and the periphery of the global economic system. The core-periphery model describes how economic, political and cultural forces are spatially distributed in the global economic system. These two broad geographic divisions (core and periphery) arose as a result of a combination of processes of private economic competition and competition between the states of the world. Cultural and political factors also played a role in creating the distinction between core and periphery.

The core-periphery model may be further expanded to include three spatial components, namely the core, the semiperiphery and the periphery. This is a more acceptable classification than the simple bipolar classification. Figure 11.1 shows the division of the world into core, periphery and semiperiphery. Core countries are figure 11.1: showing the core, periphery and semiperiphery in the world with the Brandt line (Knox and Agnew 1998:60, figure 2-16) characterised by high wages, advanced technology, the highest levels of productivity and wealth and economies with a wide diversity of economic activities. These countries maintain high levels of economic development and are the dominant participants in the global economic system. In contrast to core countries, the countries in the periphery of the global economic system are usually poor and dependent upon the core in a variety of fields.

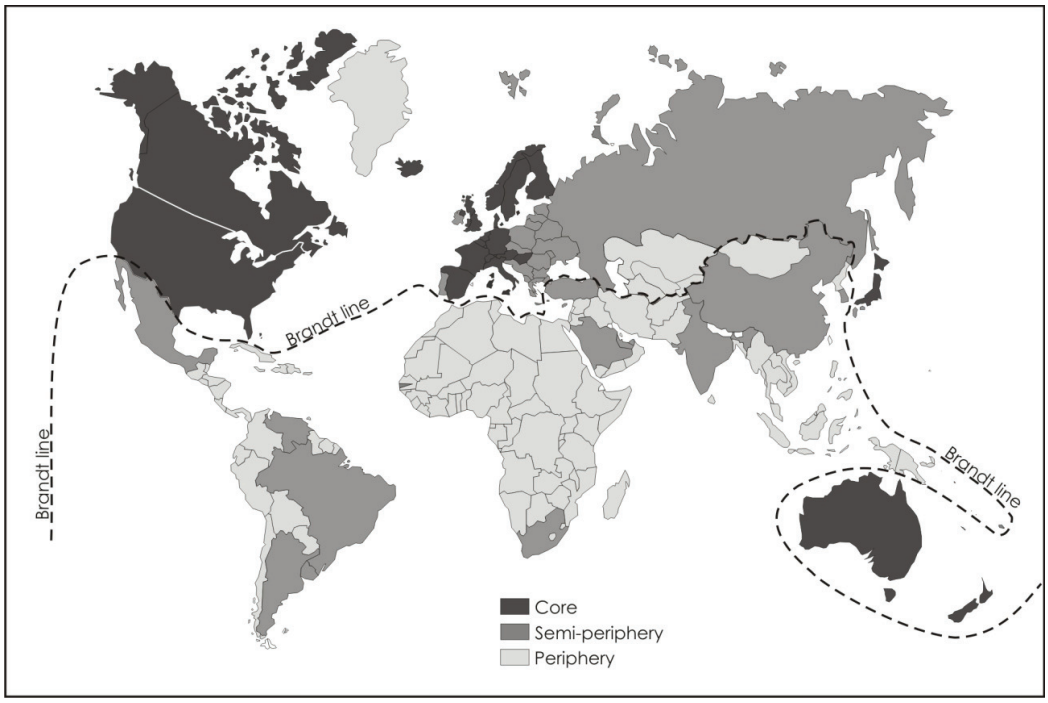


Figure 11.1: Map showing the core, periphery and semiperiphery in the world with the Brand Line (Knox and Agnew 1998:60, figure 2-16)

The periphery is usually characterised by low wages, elementary technology, low productivity and a lack of wealth. The economies of the peripheral countries often contain only a few types of economic activity and they are mainly producers of primary products for export to core countries. Countries in the periphery experience many demographic, economic and social problems. The populations of these countries are generally characterised by high growth rates, average to high mortality rates, and a low life expectancy. A large percentage of the population of these countries is under the age of 15 years (see study unit 8). Countries of the

semiperiphery are characterised by a combination of the features and relationships of the core and the periphery. The core tends to dominate and exploit the periphery, as reflected in the patterns of trade, wealth and the locus (or centre) of economic control in the world.

Peripheral countries actually have very little control over their own economic affairs. Countries in the semiperiphery also tend to exploit the periphery, but they are in turn dominated and exploited by countries in the core. The semiperipheral category is an indication that countries do not have permanent status as part of the core or of the periphery. As countries develop or decline, their status as part of the core, semiperiphery or periphery may change.

In 1980, a major report was published: *North-South: a programme for survival* (Report of the Independent Commission on International Development Issues), known as the Brandt Report. According to this report, the world can be divided into the "rich" North and the "poor" South (figure 11.1). The imaginary line that divides the economic North and economic South is called the Brandt line. It is important to note that this North-South division is not a geographic division, but an economic division between the rich and poor countries of the world. The globe is divided at the equator into a geographic North and South and, as you will see in figure 11.1, the Brandt line does not run along the equator. Figure 12-31 in Bergman and Renwick also separates North and South. This map differs from figure 11.1 in that South Africa forms part of the North in figure 12-31. Figure 11.1 reflects the original division according to the Brandt Report, whereas figure 12-31 in Bergman and Renwick has included the semiperiphery in the North.

The North consists of the economically developed regions such as North America, Europe, Russia, Japan, Australia and New Zealand. The rest of the world is part of the South. The countries in the South are generally poor and economically less developed. However, not all the countries in the South are poor, and there are two specific exceptions when it comes to wealth in the South. The first exception is the group of countries that produces a large proportion of the world's oil and who are grouped together as the Organization of Petroleum Export Countries (OPEC). The other groups of more prosperous countries in the South are the newly industrialised countries, or NICs, in Southeast Asia. In the world, as divided by the Brandt line, the South contains some 75% of the world's population but only 20% of global income and only 10% of the world's industries. As you can see in figure 11.1, the North-South division in the Brandt Report corresponds largely with the core-periphery division on global scale.

Activity 11.2

1. Write a paragraph in which you clearly distinguish between the characteristics – both spatial and in terms of power relationships – of the core, the semiperiphery and the periphery.
2. Distinguish between primary, secondary, tertiary and quaternary economic activities.

3. Use figure 11.1 and your atlas to identify examples of countries in the core, the semiperiphery and the periphery of the world. Where is each of these countries located in relation to the Brandt line?

Although the core-periphery model is very useful for understanding and explaining the geography of economic development, most countries and world organisations prefer to use quantitative criteria to place countries along a development continuum which runs from the least developed to the most developed country.

11.3 Criteria for Economic Development

Study Task

Study the following sections and maps in Bergman and Renwick: "Measures of gross product and their limitations", "Gross product and the environment", "The gross national product and the quality of life", "Sectoral evolution changes national employment" and "Measuring how each sector contributes to GDP".

Economic measures of development measure a country's development by evaluating the economic activities in the country. Per capita income or production is one of the measures used most commonly to measure a country's level of economic development. Per capita gross national product (GNP) is the most useful measure for distinguishing levels of development, because it is readily available for all parts of the world. If we compare the GNP figure of the various countries in appendix III in Bergman and Renwick, we see that it varies from as high as $41 210 per capita in Luxemburg to as low as $80 per capita in Mozambique. Figure 12-6 in Bergman and Renwick gives the global spatial distribution of per capita GNP. One of the striking features on this map is the spatial concentration of countries with high levels of per capita GNP on either side of the North Atlantic. Another feature is the enormous inequality that exists.

If we compare figures 5-2, 12-5 and 12-6 in Bergman and Renwick, we see that the sizes of Europe and Africa differ in the respective representations. Africa's land area is approximately five times greater than Europe's, and in figure 12-6 Africa is therefore much larger than Europe. In the cartogram in figure 12-5 (do you remember what a cartogram is? – if not, refer to study unit 8) the countries have been drawn according to the size of their economic outputs (their national production).

Most of the individual countries in Europe are economically larger than the whole of Africa! Although the countries in Africa cover large areas, they are economically less developed and their production levels are very low and their economies very small. If we compare figures 5-2 and 12-5, we see that Africa and Europe have similar population sizes, but that Europe has a high level of economic production and therefore a higher per capita GNP, whereas Africa as a continent has very low economic production when taking population size into account. African states therefore generally have lower per capita GNPs.

Economic activities show a clear historical course of development which is characterised by a shift in labour from the primary to the secondary and from there to

the tertiary and quaternary sectors. The primary sector of a national economy is the sector that produces and offers for sale raw materials and other commodities in their natural form. Agriculture, forestry, fisheries and mining are examples of primary activities. In section 11.2 above we pointed out that the countries of the periphery are mostly producers of primary products or raw materials.

In the early stage of a country's development, labour is engaged predominantly in primary activities, but as the economic structure diversifies (becomes more complex), first the secondary sector and later the tertiary sector becomes dominant. From this historical course of events, we can assume that a high level of economic development will be accompanied by a relatively high percentage of workers being employed in tertiary and secondary activities and a low percentage in the primary sector. It is therefore possible to divide the countries of the world into different development categories according to the percentage of the labour force involved in primary activities (see figure 12-10 in Bergman and Renwick).

The pattern of spatial differentiation (see study unit 1 to make sure what this means) in terms of economic activity shows an unbalanced pattern that largely corresponds with the spatial distribution pattern of per capita GNP. Primary industries are found mainly in rural areas and secondary, tertiary and quaternary industries in urban areas. If the labour force shifts from primary to secondary industries it will be accompanied by a corresponding movement of people from rural to urban areas. In most instances a high rate of urbanisation (see figure 10-2 in Bergman and Renwick) is therefore indicative of a high level of economic development. Economies of scale (in Bergman and Renwick) and increased labour productivity in cities results in increased per capita GNP in highly urbanised countries. In these countries there is a positive correlation between urbanisation and economic prosperity.

This correlation is fairly strong in developed countries and even in NICs, but in African states and other developing countries the correlation between urbanisation and economic development is not as simple or easily explained. It stands to reason that industrialisation will result in high energy consumption. To overcome the problem of differences in the size of populations, the per capita energy consumption per country is often used as a measure of development. Globally, per capita energy consumption varies from a mere 7 kg per person in Somalia to 33 843 kg per person in the Virgin Islands and 12 597 kg per person in Qatar. The spatial pattern of per capita energy consumption is also unbalanced globally. The global spatial pattern of per capita energy consumption corresponds with the spatial pattern of per capita GNP.

The World Bank divides the countries of the world into four groups based on income:

1. the low-income countries
2. the lower-middle income countries
3. the upper-middle income countries
4. the upper income countries

This classification is based on a wide range of measures that include per capita GNP. There are about 56 low-income countries. They are concentrated in Africa and in South, Southeast and East Asia. The countries that had the lowest income in the late 1990s were Cambodia in Asia and Mozambique, Chad, Tanzania and

Democratic Republic of the Congo (DRC, previously Zaïre) in Africa. There are about 65 middle income countries, and many of these countries are in Central and South America. In Africa, countries such as South Africa, Botswana, Namibia, Morocco, Algeria, Tunisia and Egypt are classified as lower-middle income countries, while Libya and Gabon are classified as upper-middle income countries. The upper income countries include the rich oil-producing countries of the Middle East (i.e. the OPEC countries), the affluent Western European states, and Japan, Korea, Taiwan, Brunei, Australia, New Zealand, the USA and Canada.

Activity 11.3

1. Briefly explain the difference between GDP and GNP as measures of development. Why are the differences between these two measures important to the study of spatial patterns of wealth?
2. Explain what per capita GDP means by using an appropriate example.
3. What does it mean when a country has a trade deficit? Explain what type of trade balance South Africa has.
4. Briefly explain the advantages and disadvantages of per capita GDP and per capita GNP as measures of levels of development.
5. What does the gross sustainable product involve? Can it be used to measure development? Substantiate your answer.
6. Study figures 5-2, 12-5 and 12-6 in Bergman and Renwick. Compare the sizes of Europe and Africa in these three maps and explain why the sizes of the two continents vary as they do in these representations.
7. Use figure 12-6 in Bergman and Renwick and identify at least three countries with a per capita GNP of more than US$9 385, three countries with a per capita GNP of between US$3 036 and US$9 385, and three countries with a per capita GNP of less than US$765. Does a general spatial pattern emerge from the maps in questions 6 and 7?
8. Study the following maps in Bergman and Renwick: the distribution of per capita GNP (figure 12-6), per capita energy consumption and urbanisation (figure 10-2) on a global scale. Is there any correlation between these three spatial distributions on a global scale? How can we describe this correlation?
9. Distinguish between the three types of economic societies and the sectoral classification of labour in each type.
10. Compare figures 12-6 and 12-10 in Bergman and Renwick.

Do all countries with a high per capita GNP have a small percentage of people working in the agricultural sector? What is the correlation between per capita GNP and the agricultural labour force?

The rich countries may be distinguished from the poor countries on the basis of the differences in per capita GNP, per capita energy consumption and the sectoral clas-

sification of the labour force. However, these are not the only variables that we can use for spatial differentiation. A wide range of other economic and social indicators may be used. Other measures, such as the ratio between rural and urban populations, life expectancy, and population growth rate, infant mortality rate, nutritional and educational levels, housing quality and quantity, general social services and the general quality of the environment, may all be used to measure the wealth or level of development of countries or regions.

11.4 The Human Development Index

Study Task

Study the sections "Measuring and mapping individual rights" and "Noneconomic measures of national welfare" in Bergman and Renwick.

Measures of human welfare evaluate the level of development of a country by considering the country's ability to satisfy the needs of its people. The human development index uses a combination of three measures to determine the levels of development. In spite of general agreement that measures of development involve more than merely per capita GNP, additional variables do not present a different spatial pattern from the spatial differentiation that emerges from per capita GNP; we can therefore accept the latter as a representative classification of the levels of development of countries.

Activity 11.4

1. What type of map is shown in figures 11-33, 11-34, 12-6 and 12-8 in Bergman and Renwick? Hint: See study unit 3 if you do not know.
2. Is there any spatial variation in women's rights in the world? Is there a correlation between the level of development and women's rights in the world? In which countries were women still disenfranchised (without the right to vote) in 1994? Find these countries in your atlas and show them on your own world map.
3. Which continent has the lowest level of adult literacy in the world? Identify at least two countries where adult literacy is between 10 and 30%. What is the per capita GNP of these countries?
4. Which criteria does the UN use to devise an index of freedom?
5. Study the figures showing life expectancy and mortality, birth and population growth rates on a global scale again (figures 5-7, 5-11, 5-14 and 5-17 in Bergman and Renwick). Also study the distribution of the food supply, availability of safe water sources (figure 9-24), literacy (figure 11-33) and freedom (figure 4-34) on a global scale. What is the correlation between each of these distributions and the distribution of per capita GNP on a global scale?
6. Which measures are included in the human development index? Study figure 12-6 in Bergman and Renwick. Is there any spatial covariation between per capita GNP and the human development index? Substantiate your answer by referring to specific countries.

An overview of the levels of economic development in different parts of the world emphasises the significant differences between countries. These differences may be linked to the nature and intensity of economic activity, which in turn tend to undergo structural changes over time and at the same time affect the spatial distribution of economic activities.

11.5 Explanation of Unbalanced Economic Development

Study Task

Study the sections "Why some countries are rich and some countries are poor" and "Where is the Third World?", and the map in figure 12-18 in Bergman and Renwick.

Seen against the background of the diversity of the earth's surface and the peoples and cultures of the world, international differences between countries are unavoidable. Countries differ in respect of natural resources, human resources, per capita national income, the sectoral distribution of national income, demographic structures, productivity, and economic, social and political organisation, as well as many other fields. Differences in the levels of development therefore cannot be explained only in terms of differences in the available resources or favourable or unfavourable location (i.e. environmental determinism) or in terms of differences in culture (i.e. cultural determinism). We need to find more integrated and comprehensive explanations for the differences in the levels of development between countries.

One of the main differences between developed and developing countries is in the levels of industrialisation. Industrial activities occur mainly in the core areas (on all scales) and on a global scale most of the industrial activities occur in developed countries. Industrial goods are manufactured predominantly in the countries of the core and are traded among core countries. Manufactured goods are also exported to the countries in the periphery. Peripheral countries play a dual role in the global economic system: they are importers of manufactured products from the core and exporters of primary products (raw materials) to the core countries.

The term "Third World" is still frequently used as a synonym for underdeveloped or less developed countries. The use of this term implies that there are at least two other worlds. After World War II (1939–1945), the world was politically divided into three "worlds". Since the collapse of the USSR (in 1991) this division into the First, Second and Third World has lost its validity. The terminology of North and South, developed and developing countries, and core, semiperiphery and periphery is more acceptable today than First and Third World.

Activity 11.5

1. Explain why the countries that have the most raw materials do not necessarily have dense populations or the highest per capita GNP.
2. Explain, by using an appropriate South African example, what value adding means. What effect does it have on development in the core and in peripheral countries?

3. Do you remember what a process is? Explain why economic development may be regarded as a process.
4. What are the main exports of the countries in the periphery and in the core respectively?
5. Compare figure 12-6 with figure 12-18 in Bergman and Renwick. Identify the countries in which the major industrial regions are found. What is the per capita GNP of these countries? Can we regard the countries with major industrial regions as developed or rich countries?
6. Which countries in Africa have industrial centres? What is the per capita GNP of these countries? Are these countries developed or developing countries? Be sure to show these countries and those in the previous question on your own world map.
7. Why should we use the term "developing countries" rather than "Third World countries"?

By now you should know that we concentrate on the global patterns of a number of natural and human phenomena. In this study unit our main aim has been to examine the spatial patterns of development and wealth on a global scale.

11.6 Other Measures of Development

Study Task

Study the sections "National transportation infrastructures" and "National communications infrastructures", as well as figures 12-26 in Bergman and Renwick.

In the previous sections we discussed a number of economic measures and several indexes (an index uses more than one measure) of development. Naturally, there are many other methods of determining the level of development of a country. There are also other indicators that may be used to explain why a country is not more developed than it is. One such measure or indicator is the volume of infrastructure in a country.

Activity 11.6

1. In which parts of the world are the road and railway networks most dense? What are the population densities and the per capita GNPs of these areas?
2. Which areas have few roads and railway lines and how does this affect their level of economic development?
3. Is there a spatial covariation between the distribution of roads, radios and telephone lines in the world?

IN CONCLUSION

In spite of its identified shortcomings, per capita GNP is used most frequently as a criterion for measuring levels of development. The spatial distribution of per capita

GNP on a global scale shows an unbalanced pattern which corresponds largely with the core-periphery structure, the spatial distribution of the human development index and infrastructure provision. You have also seen that the global distribution of wealth does not correspond with the spatial distribution of natural raw materials and that core countries tend to dominate the peripheral countries in the economic field, which gives rise to a process of underdevelopment in the peripheral countries of the world.

Although the world may be regarded as a global village these days, when it comes to development the system does not ensure equal rights and privileges for all. On the one hand we have highly developed communities that continue to experience economic development and increasing living standards and human rights. On the other hand, there are places where people still eke out an existence through subsistence farming and primitive agriculture. There are different ways in which these developing or peripheral countries can develop from a state of poverty to one of economic and social prosperity. This process of development is neither simple nor obvious. The core-periphery relationship makes it very difficult for the peripheral countries to improve economically.

Study Unit 12
From global to local

INTRODUCTION

In this last study unit we focus on analysing and comparing countries' economies. The process of globalisation is changing our world. In spite of the world becoming "smaller" and more integrated, people still live in their distinct or unique environments which are affected in different ways by integration into a global economy. In this study unit we move away from general patterns and pay attention to unique characteristics found in local conditions and to the variability of locations. In a world of increasing global communication networks and global problems, the geography of individual places does not disappear; on the contrary, it becomes an ever more important element in attempts to understand and process the changing international order.

STUDY MATERIAL

In this study unit you will study the last part of "National paths to economic growth", the last part of "Political regionalization and globalization" and some parts of Bergman and Renwick.

Key Terms

- globalisation
- foreign direct investment (FDI)
- transnational corporations (TNC)
- sustainable development

Learning Outcomes

After you have worked through this study unit you should understand that we live in a single integrated world. You should be able to explain why not all countries have been integrated to the same extent into this global system and why not all people are affected in the same way by globalisation. To achieve these outcomes, you should be able to

- describe how, where and when the global economy came into being
- explain the concept of globalisation with relevant examples

- distinguish between national and transnational companies
- explain the nature of the global spatial pattern of foreign direct investment
- evaluate South Africa's position in the global economy

12.1 The Formation of the Global Economy

International trade has been carried on for millennia. Trade is the cornerstone of regional specialisation and productivity, as well as new cultural possibilities and combinations (see Bergman and Renwick). Advancement in technology has linked world regions, therefore increasing production and trade. Inevitably better goods are produced at lower cost and more goods are produced for trade, thereby growing faster than production. International economic and communication links have "shrunk" the earth in terms of time and costs or costs distance. Economic globalisation has far outpaced cultural or political integration. Economic globalisation is dominating every part of the economy and countries are continuously renegotiating conditions of production, trade and exchange.

12.2 Transnational Investment and Production

Two developments in economic globalisation accelerated in the late 19th century. One was the evolution of the world market for certain primary products. The second development was an increase in international investments. Initially these investments were limited to shares of stocks and bonds representing minority holdings in foreign companies, called portfolio investments, but foreign direct investments soon followed. Foreign direct investment (FDI) means investments in enterprises that are actually operated by foreign power. Enormous enterprises have grown rapidly, thereby coordinating production and marketing facilities in several countries. These are called multinational or transnational corporations. Refer to the table in Bergman and Renwick depicting the sales of the world's largest corporations compared to countries' GDPs.

12.3 The Global Economy

In the previous study unit we explained the distribution of wealth in the world in terms of the global economic system. Similarly, the political system may be regarded as a subsystem of the human-environment system. The global economic system is powerful, but in reality it cannot be isolated from the international political system. Economic and political activities on a global scale are not separate processes, but aspects of an overall international political economy which is generally known as the global economy. The global economy is a complex system which is interlinked to form an integrated, interdependent whole. It is an interdependent system of states linked together by means of political and economic bonds.

Today, all the states of the world are to a greater or lesser extent linked to this overall system which influences economic and political events in virtually every state of the world. The ability to see places and regions as components of this ever changing system is essential as a basis for knowledge and understanding of our world.

The global economy is characterised by ongoing internationalisation of production, trade and services. Interaction in the global economy is fuelled and sustained by the governments of the most powerful states of the world, transnational corporations (TNCs), international banks and trade networks and agreements. These governments and institutions are located mostly in the core areas of the world, but their influence stretches to the farthest corners of the world.

The global economy of today is characterised by diminishing trade barriers between countries and an increase in the influence of transnational corporations. This is accompanied by a relative weakening of the power of individual states, and economic activities and consumer patterns of the world tend to vary less from state to state and region to region. Rapid advances in global transportation and communication networks have aided these trends. The emergence of international organisations, agencies and institutions, a standardised system of global time, and the recognition of international agreements and trade treaties have made a system of internationally shared values of citizenship and human rights possible. We are truly living in a global village created by the process of globalisation. The world has become largely integrated, and places and regions are becoming more interdependent as a result of the spatial expansion of economic, social and cultural interactions. Such interactions have a greater impact on some places than on others, but they are reaching such a large part of the globe that we can combine them under the term "globalisation". Globalisation is regarded largely as an economic phenomenon or process affected by four interrelated factors:

1. the new international division of labour
2. the internationalisation of finance
3. a new technological system
4. homogenisation of international consumer markets

One obvious feature of globalisation is the increase in the percentage of the world's economic and cultural activities that has become internationalised. This increase is linked to a significant shift in the nature of economic activities. Financial transactions and trade are linking people in remote areas to one another and are bringing about cultural diffusion and acculturation. Economic and political events in one part of the world have an almost immediate effect on areas thousands of kilometres away. The integration of activities in the global economy tends to blur certain national and regional differences as the consequences of globalisation disperse throughout the world. The impact of economic globalisation differs from place to place and is related to the global spatial patterns of culture, development, production and trade. Within the new global context, local differences in resource endowment and human activities, and therefore ever changing local diversity, remain.

At local level, people still value their own culture and, in spite of increased integration and globalisation, there are still unique cultural and economic features. Local cultures therefore continue to exist. Places and regions will of necessity change as a result of globalisation, but the geography of places will still matter, because of transportation costs, discrepancies in resource endowment, fundamental principles of spatial organisation, people's territorial instincts, the resilience of local cultures and the heritage of the past, among other things. The common experiences of

globalisation are modified by local conditions. Different communities process and adopt the structures and processes of globalisation in different ways.

Although globalisation is increasingly steering the world towards an integrated interdependent global economy, it is at the same time highlighting the differences between the core and periphery. In the core of the global economy, people, places and regions are directly involved as producers and consumers in transnational industries, modern telecommunications, materialistic consumption and international news and entertainment, while the people, places and regions of the periphery participate in these activities to a very limited extent. The greater part of the world population (the majority being in the periphery) is not fully integrated into this global economy, and in reality many people are living in two worlds at once.

Take, for example, the residents of squatter camps round Johannesburg (South Africa). Their incomes are very low (many have no income at all), they live in makeshift shacks and have had little or no formal schooling. And yet they are fairly well informed about things like international sport (soccer in particular), fashion, diet, telecommunications, music and possibly also television and films. It may seem as if they are untouched by modern developments in the world, and yet they are part of the modern world. People who do still live on their traditional tribal lands are also affected by globalisation. Most of these people wear modern clothing, eat modern foods and are aware of many world events. Very few people and places are therefore untouched by globalisation; the only difference is in the degree to which the processes of globalisation are adopted in different places in the world.

Study Task

Study the sections "The formation of the global economy", "Transnational investment and production" and "The international tertiary sector" in Bergman and Renwick.

Activity 12.1

1. Bergman and Renwick (2009:521) state that the world has shrunk in terms of time and costs. Explain the meaning of this statement by using appropriate examples.
2. Define "globalisation" and use appropriate examples to distinguish between economic, cultural and political globalisation.
3. Which two developments accelerated globalisation?
4. What is foreign direct investment (FDI) and what role does this type of investment play in the process of globalisation?
5. Use appropriate examples to explain what transnational corporations (TNCs) are and how they function in the global economy.
6. How do international tertiary activities help to reinforce the process of globalisation?

12.4 The Geography of Foreign Direct Investment

Today the amount of FDI is several times the amount of foreign aid being given around the world, and FDI has been more successful in triggering economic growth than foreign aid. Developing countries used to seek aid from foreign governments and international lending institutions, but today they are more likely to seek assistance from foreign companies in terms of investment in their countries. The flow of FDI has increased and significantly redistributed the world's productive capacity. Companies are actively investing in other countries. For example, transnational corporations from developing countries such as Thailand, Brazil, South Korea and Mexico have reached around the world. However, the USA, the combined European Union (EU) countries and Japan still account for about 80% of FDI (in Bergman and Renwick). Three trends characterise the geography of FDI. First, the greatest share of global FDI, about 75%, is investment from one rich country to another. Second, FDI in the developing countries has been geographically selective. Countries that have attracted the most investment are countries that have chosen the export-led method of economic growth. Areas that have not attracted FDI have been slower to develop.

Study Task

Study the sections "The geography of foreign direct investment", "The globalization of finance" and "Tourism" in Bergman and Renwick.

TNCs are regarded as the main participants in the global economy, and their activities stretch across national boundaries. The flow of goods, capital and information between TNCs in the global economy is becoming more important, and it is even beginning to outstrip the significance of imports and exports between countries. Foreign direct investment (FDI) is the main criterion or yardstick for measuring the activities of TNCs. Geographically, FDI shows a very uneven distribution pattern. Developed core countries are not only the dominant source of FDI, but also the main destination. Most FDI therefore takes place between the core countries of the global economy. Although total investment in developing countries is relatively small (25% of the world total), such investments are very important to the economies of developing countries. The distribution pattern of FDI is also very uneven among the developing countries. Countries in the semiperiphery of the global economy attract more FDI than countries in the periphery.

Activity 12.2

1. Distinguish between the volume of FDI, foreign aid and international trade in the global economy.
2. Name the three countries that are responsible for the largest volume of FDI in the world today.
3. Where are these countries located in terms of the core-periphery model? To which countries does the FDI flow? Find these three countries on the world map and also show these countries on your own world map.
4. Identify the three geographic features of FDI and explain the meaning of "geographically selective".

5. Which countries are recipients of American, European and Japanese FDI? Show these countries on your world map. Are there signs of FDI decreasing as distance increases (distance decay)?
6. What characteristics do states need to become eligible for FDI?
7. What is the spatial impact of other types of financing, apart from FDI, in the global economy?
8. What is the role of tourism in the global economy and in the economies of individual states?
9. Explain the characteristics that a country needs in order to attract international tourism. How many of these requirements characterise South Africa? Substantiate your answer.
10. What does the abbreviation GATT mean? Which organisation replaced GATT in 1995?

For a variety of reasons, states in the global economy often find it necessary to co-operate at international level. In the previous section you were introduced to trade agreements that governments enter into to regulate international trade. Governments of states also enter into agreements or form international organisations to regulate and coordinate other types of mutual activities.

12.5 Global Government

Although the number of politically independent states in the world has increased over the past 50 years, the actual independence of individual states has diminished as a result of the interrelated nature of the global economy. International economic treaties and trade have set the example, and today states network increasingly to realise common objectives in many fields. Many international and supranational organisations coordinate policies between countries. The activities of these international organisations cover a wide range of activities, from trade, to defence, to environmental conservation.

In the case of the EU and the North American Free Trade Agreement (NAFTA), participating countries have significant economic and military power, and individual countries have sacrificed a considerable amount of their sovereignty in favour of a central body or a common policy (in Bergman and Renwick). These two international organisations include only a specific number of countries within a specific geographic region. Since our focus in this module is global, we do not study international organisations representing selective geographic areas in any detail. Apart from international organisations that regulate global economic interaction, there are also international treaties that control and protect the oceans, the airspace and uninhabited open spaces that do not form part of any state (such as Antarctica and the high seas) from exploitation. These organisations are also involved in protecting the world's natural environment against various threats.

Study Task

Study the sections "Global government", "The United Nations" and "Is national sovereignty inviolable?" in Bergman and Renwick.

Activity 12.3

1. Distinguish between international and supranational organisations and give examples of each type.
2. How many of the world's states are at present members of the United Nations (UN)? Which five states are permanent members of the UN's General Assembly? Where are these countries located in terms of the core and periphery of the global economy?
3. Name at least four places in the world to which the UN has sent observers and/or troops during the past couple of years. Where are these countries located in terms of the core and periphery of the global economy? Make sure that you can indicate these countries on a world map.
4. Bergman and Renwick discuss the UN's intervention in Iraq. Can you think of an example of similar intervention in the past few years?
5. Explain how countries' views on human rights are influenced by culture and their level of economic development.
6. Is South Africa a member of the UN? Does South Africa have a Bill of Human Rights?

12.6 Jurisdiction Over the Earth's Open Spaces

The expansion of the global economy and globalisation of industry will undoubtedly raise the global demand for basic raw materials and energy sources in future. This will result in the development of the rich resources of the global system's previously underexploited or unexploited areas. Many of these undeveloped areas are located in the oceans and in the uninhabited Polar Regions.

Activity 12.4

1. At which degree of latitude is the North Pole or Arctic Circle?
2. Which countries have territory north of the Arctic Circle?
3. What do we find at the geographic North and South Poles: land or sea?
4. Which countries claim territory in Antarctica?
5. Explain the opposing demands that are made in respect of using Antarctic resources.
6. Write a paragraph to explain the different demands and boundaries in respect of territorial waters in the world's oceans.
7. Which country controls the greater part of the world's oceans? Explain why this country controls the economic rights for such a large part of the oceans.
8. Explain by using an example from Southern Africa what a landlocked state is and why the DRC is not a landlocked state.
9. Which part of the ocean is known as the high seas?
10. What type of control does a state have over its airspace?

12.7 Conservation of the Global Environment

Study Task

Study the sections "Protecting the global environment", "Energy consumption", "Energy efficiency trends", "Development, pollution, and the quality of life", "Balancing development and environmental preservation" and "Can we trade wealth for environmental quality?" in Bergman and Renwick.

The transnational nature of many environmental problems presents many challenges to the modern global economy. Effective organised action to counter environmental problems requires international institutions with the kind of power and authority that is actually the domain of individual states. As international organisations assume the task of making and enforcing laws, there is a danger of serious economic implications if all places on earth are treated in the same way. Places and countries show geographic variation in terms of lifestyles, economic wealth and social stability, which should always be taken into account by international organisations.

The UN's Conference on the Environment and Development, held in Rio de Janeiro in 1992 (the second Earth Summit), was attended by more than 100 world leaders and 30 000 other participants. The central focus of the conference was to ensure a sustainable future for the earth by means of conventions on global environmental problems such as climatic change and the loss of biodiversity. The Earth Summit in Rio revealed that the environmental and development priorities of the core and periphery do not always correspond. To countries in the periphery, economic development has priority, and their position is that core countries that are responsible for most of the environmental degradation should bear the financial burden of combating degradation and of environmental rehabilitation. The core countries regard environmental degradation as a problem to be addressed by all countries.

For centuries, humankind has adapted the natural environment to satisfy its needs. Environmental changes are not new. The combined effect of rapidly growing populations and technological advances and developments in the 20th century has, however, given rise to environmental change that some experts consider to be irreversible. There is a link between economic, social and ecological problems, while the needs of the growing world population are placing enormous strain on natural resources.

There are no simple solutions to today's environmental problems, but the general feeling is that there should be a balance between development and environmental change. The concept of sustainable development refers to development that will meet the needs of the present generations without endangering the ability of future generations to satisfy their own needs. The concept of sustainable development demands that economic production be in harmony with the natural resources.

Economic development should never take place at the expense of the environment and environmental resources. According to this approach, economic development is successful only if is not at the expense of the resources that are essential for supporting life on earth. Sustainable development is also culture-specific and technol-

ogy-specific, and a strategy that ensures sustainable development in a developed country cannot necessarily be applied unchanged in a developing country.

As a result of the nature and scope of the human impact on the environment, it is important that we understand and respond appropriately to global environmental change. Geographers have long been interested in the nature and consequences of environmental change. Geography is in fact one of few scientific disciplines in which the relationship between people and their environment is the primary focus (see study unit 1). Geographers' interest in the spatial arrangement and interrelatedness of things on earth provides us with a useful platform for studying environmental changes brought about by people. Although the transnational lifestyle and common environmental problems of globalisation appear to be causing a loss of territorial identity and a sense of place, the fact is that people, states and regions differ in many respects, and this diversity creates a barrier to a stable global political structure. Politically independent states, in spite of their shortcomings, remain the most important building blocks of the global economy.

Activity 12.5

1. Explain the difference between levels of pollution in developed and in developing countries.
2. Why is utilisation of natural resources increasing in developing countries while the level of usage in developed countries is dropping?
3. In study unit 11 we looked at the correlation between per capita energy use and level of economic development. Is there a similar correlation between per capita energy use and levels of pollution? Substantiate your answer.
4. Explain why the relationship between material wealth and environmental quality is not the same in developed and developing countries of the world.
5. Define sustainable development by using an appropriate example. What are the possibilities of applying a policy of sustainable development in practice?

12.8 Nation-States of the World

Study Task

You need study only the sections "The development of the nation-state idea", "The idea of the nation", "The nation-state", "Cultural sub nationalism", "Efforts to achieve a world map of nation-states" and "Redrawing the world political map" in Bergman and Renwick.

Also study figure 11-7 and figures 11-10(a), 11-9(a) and 11-11 in Bergman and Renwick.

The political map of the world clearly shows that states differ in respect of size, shape and location. In addition to differences in culture, population composition and levels of economic development, states also differ in respect of resources and economic and political organisation. Some states are poor and others are wealthy, some are big and some are small, and some are powerful and others are weak.

Individual states also show internal differences in respect of characteristics such as cultural and linguistic composition and levels of economic development. The divergent categories of spatial economic development in the international system, as evidenced in rich and poor, developed and developing, core and periphery, are often also present at national level (within states). A state is a sovereign (or independent) institution with absolute authority over its inhabitants. A state is a complex phenomenon consisting of elements such as population, system of government, political processes, territory and power. Individual states, in spite of their sovereignty, are nevertheless compelled to liaise and cooperate with each other in order to ensure peaceful coexistence and eliminate conflict.

When a state's population has developed certain homogeneous cultural characteristics, it is called a nation. A nation refers to people who are bound by some invisible bond so that they may be distinguished by some characteristic feature from the inhabitants of other states. There are different definitions of the concept of nation, but generally it relates to unity, cohesion, communality and homogeneity. Nations usually come into being where people, localised and relatively isolated in and round their own core area, develop a common language, viewpoint, history and sense of belonging. When the population of a state is also a nation, the state may be regarded as a nation-state.

In the 20th century, the desire of nations to have their own territories has caused several states to disintegrate. Examples include the disintegration of the former Soviet Union (USSR), Yugoslavia and Czechoslovakia, the independence of Pakistan and Bangladesh from India, the independence struggle in East Timor and the wars between Eritrea and Ethiopia, and Eritrea's subsequent independence. When nations strive for independence and cultural identity, it often leads to wars and genocide. Bergman and Renwick mention Bulgaria, Iraq, Bhutan, Bosnia, the Great Lakes Region in Africa (Rwanda, Burundi and DRC), Mauritania and Senegal, as examples of areas where civil war and genocide have occurred. The global system of states is actually very weak. Both supranational organisations and subnational movements threaten the survival of separate states in the state system. The states and international borders that exist at the start of the 21st century were created mainly in the 19th century. Changes in the social and economic geography of nations have blurred the existing borders as subnationalism causes states to disintegrate and supranationalism is combining states into greater political units.

Activity 12.6

1. Where does the idea come from that a state has exclusive sovereignty over a specific demarcated territory?
2. Explain by using appropriate examples what the difference is between a nation and a state.
3. Can South Africa be regarded as a nation-state? Substantiate your answer by first defining the term "nation-state" and then giving reasons for your answer.
4. What does cultural subnationalism mean and why is it a centrifugal force in a state?
5. Most of the countries in the world today are politically independent states. And yet there is little real independence, especially for states in the periphery and

semiperiphery of the global economy. Explain this statement and give as many examples as possible.

Globalisation is giving rise to continued expansion of the global economy and ongoing internationalisation of industries, financing, culture and political decision making. At the same time, political, social and cultural forces are increasing people's awareness of their unique local circumstances. The global economy abounds with ever changing local variety, and in the future this spatial pattern will become even more complex. It creates economic, social and cultural patterns that look less and less like the political map of the world.

12.9 South Africa in a Global Context

The process of globalisation means that economic patterns and processes are very similar all over the world. We need to evaluate South African society and the development initiatives in the country in terms of the wider global context, because South Africa is actively part of the global economy. Global crises and economic forces have a direct bearing on the country and affect policies, trade and investment. As in the global economy, there are also spatial imbalances in South Africa – especially in respect of resources and the distribution of wealth. Certain people, places and regions are more developed than others and are more integrated with the global economy. Yet we are all part of the global economy and are all affected, directly or indirectly, by the processes of globalisation every day. The use of development mechanisms, such as export-driven economic growth and a shift towards a neoliberal economic policy (as contained in the government's Growth, Employment and Redistribution: a Macroeconomic Strategy, or GEAR) indicate that South Africa is not ignoring the trends in the global economy. The South African government participates in several international treaties or conventions and institutions, and cooperates with the global financial institutions. South Africa receives, relative to other African states, significant international investments in the form of FDI. A few key transnational corporations (such as Anglo American, Rembrandt and De Beers) came into being inside South Africa. As a result of economic conditions, social conditions (especially crime), political conditions and labour conditions in South Africa, some of these corporations have however moved their headquarters to other countries in recent years.

South Africa participates in various international and supranational organisations such as the UN, the Commonwealth of Nations, the Organization for African Unity (OAU) and the Southern African Development Community (SADC), to mention but a few. You have seen in the previous study unit that the World Bank regards South Africa as a middle income country, and we have classified South Africa as being in the semiperiphery of the global economic system. Globalisation does not affect South Africa only politically and economically. Culturally and socially we are also part of the global village. This is reflected, for example, in the clothing, cars, appliances and customs of people living in the cities, revealing much the same trends as in most other cities of the world. We listen to much the same types of music, watch the same movies, read the same books and even study the same content at university, as do most other people in other places of the world. Nevertheless, many local influences remain evident in our lifestyles. It is possible that,

as the world becomes more integrated and "smaller", such local differences may disappear completely. Some experts, however, are of the opinion that increasing globalisation and global integration will cause people to concentrate increasingly on unique characteristics in order to maintain their own identity.

Activity 12.7

1. Explain the effect of globalisation on South Africa and its people. Highlight your answer with relevant examples.
2. Give examples of activities, customs or artefacts that are typically South African.

IN CONCLUSION

The modern global economy is dynamic and changing over time. Increasing interdependence in the global economy means that the social, economic and political welfare of nations, cities and regions all over the world depends increasingly on complex interactions determined on a global scale. Although local, regional and national conditions are very important, what happens in a country or at a place is determined largely by the role of the place or country in the global system of production, trade and consumption. The paradox that confronts us at the beginning of the new millennium is that, while living in an increasingly integrated world, the distinction between rich and poor, developed and developing, core and periphery, or simply between the haves and the have-nots in the global economy remains clear – and is in fact inclined to grow.

As globalisation accelerates and the world becomes more integrated, these differences become more pronounced, and in future the world will become even more divided into those who have access to information and knowledge and those who do not. In the immediate future, the world is likely to undergo several geopolitical and geo-economic transformations. All these processes of change will of necessity give rise to critical issues, conflicts and threats within the global economy.

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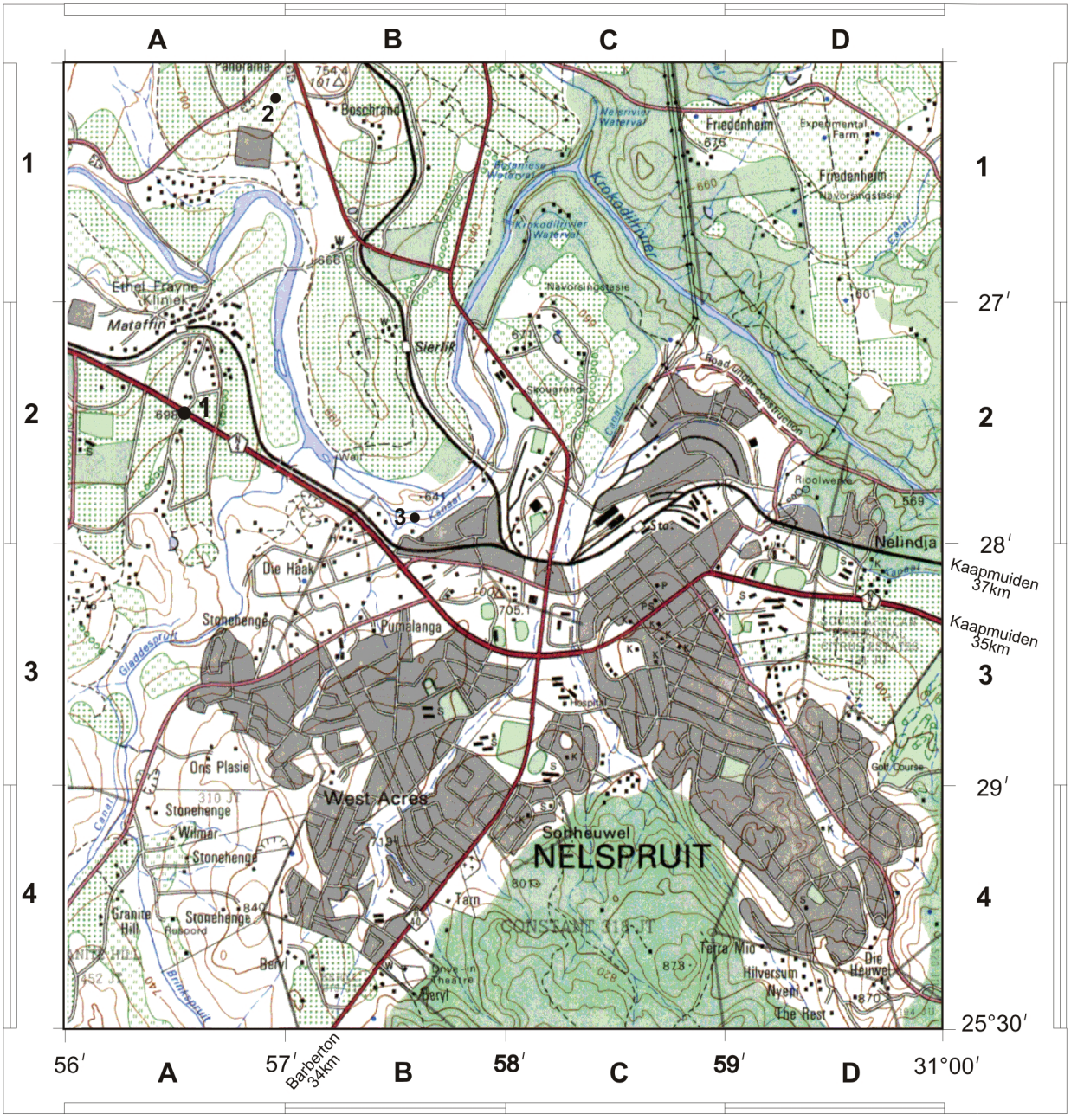
Appendix A
Bylae A

GGH101Q/PA/001

Map 2528CD RIETVLEI DAM

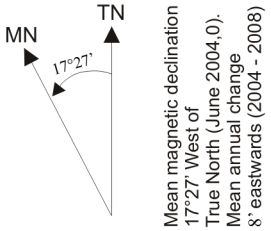
Appendix B
Bylae B

GGH101Q/PA/001



Heights are in metres above sea level
CONTOUR INTERVAL 20 METRES

Gauss Conform Projection.
Central Meridian 31° East.
Clarke 1880 Spheroid



Mean magnetic declination
17°27' West of
True North (June 2004,0).
Mean annual change
8' eastwards (2004 - 2008)

1 000 0 1 2 3
Metres Kilometres

Map 2530DB NELSPRUIT

Appendix C

GGH101Q/PA/001