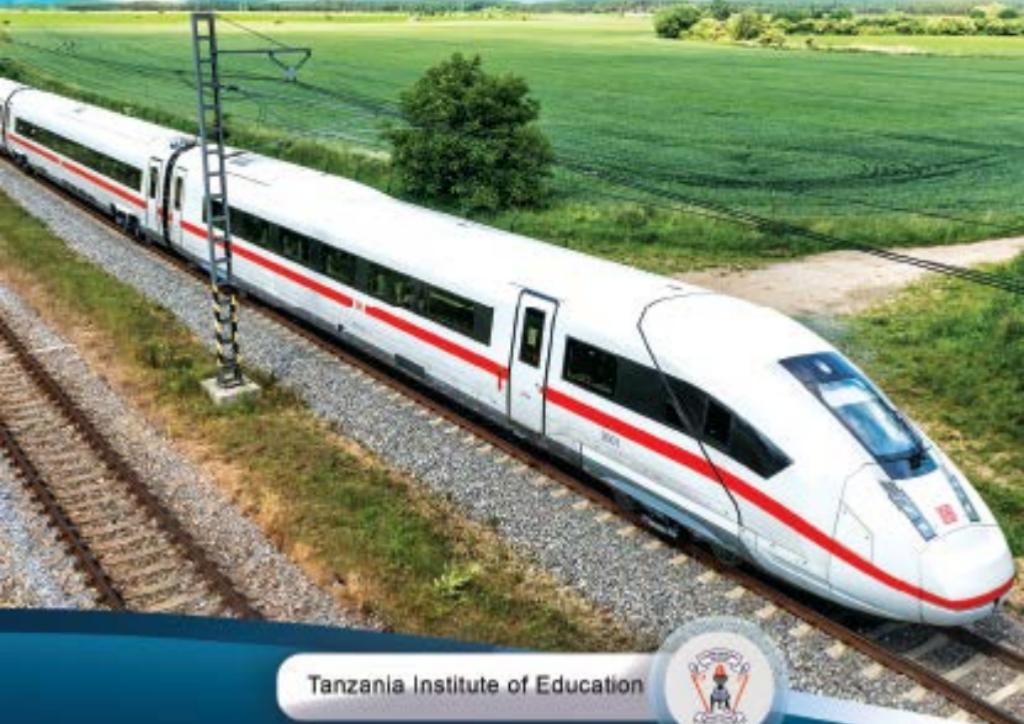


Geography

for Secondary Schools

Student's Book
Form Two



Tanzania Institute of Education

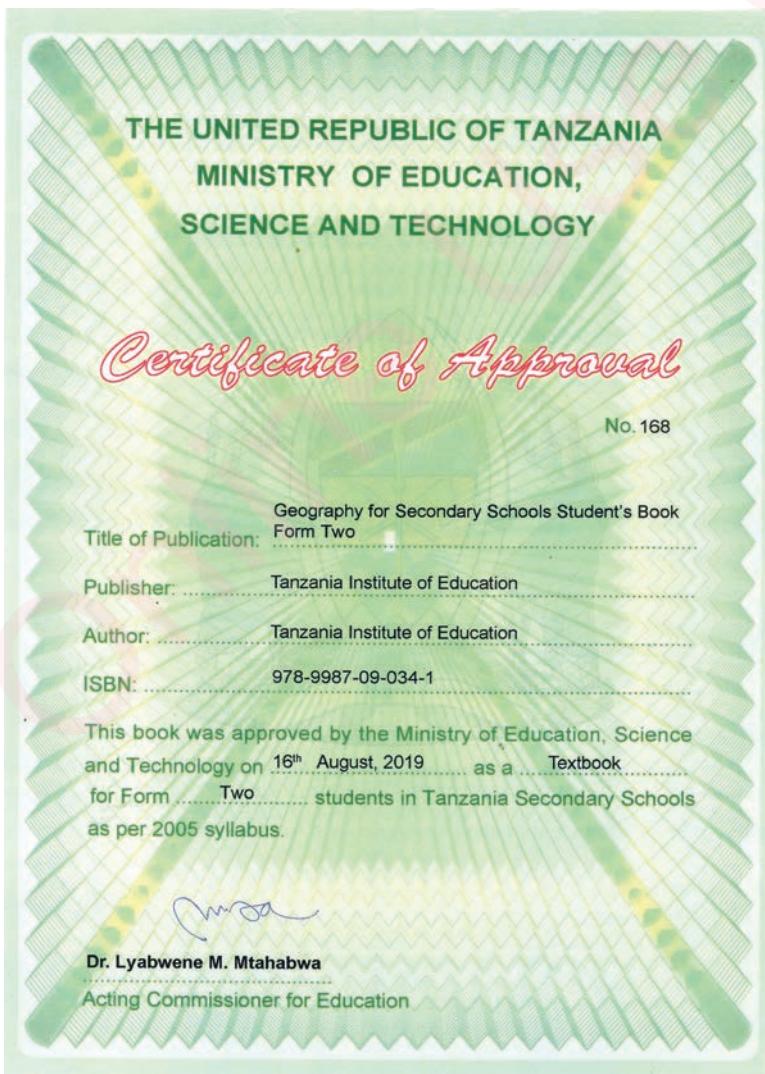


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Tanzania Institute of Education

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Preface

This book, *Geography for Secondary Schools* is written specifically for Form Two students in the United Republic of Tanzania. The book is prepared according to the 2005 Geography Syllabus for Secondary Schools, Form I-IV issued by the Ministry of Education and Vocational Training.

The book is divided into nine chapters, which are: Human activities, Agriculture, Water management for economic development, Sustainable use of forest resources, Mining industry, Tourism, Manufacturing industry, Sustainable use of power and energy resources, and Transport.

Besides the content, each chapter includes activities and exercises. Learners are encouraged to do all activities and answer all questions. These activities and questions will enhance the learners' acquisition of the intended knowledge, skills and competencies for the Form Two level.

Tanzania Institute of Education

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Chapter One

Human activities

Introduction

Human activities refer to things that people do or cause to happen. Human beings do such activities for social, economic, and political purposes. In this chapter, you will learn about human activities, types of human activities, and the importance of such activities.

The concept of human activities

Human activities are functions, tasks or works that human beings perform to earn a living. Different individuals or groups of people carry out different activities in different places. For example, the Maasai of Tanzania and Kenya practise nomadic pastoralism because of seasonal availability of pasture and water in an area. People in urban areas, on the other hand, engage in activities in industries and offices. Some people engage in providing services in education, administration, planning and health.

Types of human activities

There are three major categories of human activities. These are primary, secondary and tertiary activities.

Primary activities: Primary activities are done by people when they interact directly with the natural environment to obtain their essential needs. These activities include agriculture, forestry, mining and fishing.

Agriculture: Agriculture is an activity which involves crop cultivation and livestock-keeping. It is the oldest human activity which has been practised by all societies in the world. It provides food for households and raw materials for industries. The type of agriculture practised in a given place is determined by various conditions of the area including climate, water availability, soil characteristics and terrain. It is also influenced by financial resources, infrastructure, technology and conditions of the market.

Agriculture can be done by individual farmers, companies or co-operative societies. Crop farming is the type of agriculture that involves the cultivation of land to produce crops. Crop farming can be practised to produce food crops and cash crops.

Food crops include rice, beans, cassava, maize, wheat, bananas, and potatoes whereas cash crops include sisal, coffee, tea and cashew-nuts. Figure 1.1 shows a rice paddy.



Figure 1.1 Rice paddy

Source: Mwakalinga 03 June 2016: ippmedia.com

Besides crop farming, there is also livestock-keeping with animals domesticated or kept for meat, milk, wool, skins and hides. These domesticated animals include cattle, goats and sheep. Livestock-keeping is widely practised in Shinyanga, Mwanza, Mara and Arusha regions. Other regions famous for livestock-keeping include Kagera, Dodoma, Singida and Tabora. Ranching or commercial livestock-keeping is largely carried out by companies in Tanga, Iringa, Njombe, Kilimanjaro, Dodoma, Singida and Tabora. Figure 1.2 shows a herd of Ankole cattle as an example of domestic animals kept in Tanzania.



Figure 1.2 Herd of Ankole cattle found in Kagera

Source: <http://ilovekageratanzania.blogspot.com>

Mining: Mining is the process of extracting minerals from the crust of the Earth. Mining is done on both small and large-scales. Large-scale mining is done by companies using advanced technology and heavy equipment whereas small-scale mining is done by individuals who are known as artisanal miners using simple tools. Some of the minerals found in Tanzania include tanzanite, diamond, gold, coal, uranium, limestone, gemstones, salt, copper and gypsum. Figure 1.3 shows small-scale miners engaged in a mining activity.



Figure 1.3 Small-scale miners using simple tools in Tanzania

Source: <https://www.dailynews.co.tz/news/2019-02-195c6bb0690c91b.aspx>

Fishing: Fishing involves catching fish and other water creatures from oceans, lakes, seas, dams, rivers and ponds for domestic or commercial purposes. In Tanzania, fishing is done in the Indian Ocean and in lakes such as Victoria, Tanganyika, Rukwa and Nyasa. There is also fishing in rivers such as Ruvu, Kilombero and Rufiji. Fishing activities also take place in dams such as Mtera and Nyumba ya Mungu. Major fishing areas in the world are found in Norway, Namibia, Japan and Sweden.

Small-scale fishing relies on traditional methods such as the use of fish-nets or fish lines and hooks. Figure 1.4 shows small-scale fishing in the Indian ocean. Large-scale fishing is conducted in deep waters of the large seas and oceans where modern fishing methods such as fishing trawlers are used.



Figure 1.4 Small-scale fishing in the Indian Ocean

Source: <https://www.worldfishing.net/news101/Comment/ben-yami/speaking-up-for-small-scale-fisheries>

Forestry: Forestry is a set of practises that involve managing forests for ecological, social and economic purposes. There are two types of forests: natural and man-made (planted) forests.

Planted forests: Planted forests are those in which trees are planted by human beings. They are commonly known as grown trees. The trees may be obtained locally or from other countries. In Tanzania, mahogany and teak are examples of local species whereas pines and eucalyptus are species from other countries. Some examples of planted forests in Tanzania include The Sao Hill forest plantantion in Mafinga, Iringa Region and The West Kilimanjaro forest plantation in Kilimanjaro Region.

Natural forests: Natural forests are the forests that generated themselves naturally. Examples of natural forests include the Eastern Arc (Usambara) Mountains forests, Mdandu (Njombe and Ludewa), Mitarure (Kilwa, Lindi), Kikongoro and Minziro (Misenyi) and The Duru-Haitemba forest (Babati). Other examples of natural forests include The Congo rain-forest found in the Congo basin of the Democratic Republic of Congo and The Amazon forest in Latin America. Natural forests are also found in other countries such as Finland, Sweden, Canada and Russia. Forests offer many benefits to people living close to forested areas and even beyond. For example, charcoal is one of the largest industries in Tanzania, employing tens of thousands of rural people and supplying energy to millions



Figure 1.5 Forest products in Tanzania

Source: http://wwf.panda.org/wwf_news/?103600

of urban households. Figure 1.5 shows one of the products from forests. The forestry industry provides employment opportunities such as selling of timber, firewood and charcoal. Also some people are employed as forest guards and forest officers. Forests are also a source of employment for timber merchants and carpenters. Furthermore, the forestry industry is also a source of building materials such as wood, pulp and poles. In addition, forests serve as sites for recreation and research.

Secondary activities: Secondary activities are subsidiary as they are performed in addition to primary activities. They involve processing products obtained from primary activities. Occupations which produce finished goods using the products of

primary activities as raw materials are included in secondary activities. These include for example manufacturing of cloth from cotton, production of sugar from sugarcane and steel casting from iron ore.

Tertiary activities: Tertiary activities belong to the service sector. These activities involve the provision of specialised services required for primary and secondary activities. Such activities include transport and communication, trading, administration, banking and insurance.

Transport and communication: Transportation is the action or process of moving people, goods and services from one place to another. This may be done by road, railway, air, pipeline and water.

Likewise, communication is the exchange of information between and among different people. Major means of communication include radio, television, newspapers, telephone and the internet.

Tourism: Tourism is the movement of people within a country or from one country to another for the purpose of leisure, pleasure, studies or trade. Tourism involves travelling to and staying in places outside the usual residence for a certain period. Tourists travel to see the beauty of wildlife, landscape and man-made features. These features include wildlife conservation areas such as national parks and game reserves, beaches, and historic (heritage) and cultural sites. Beaches in Tanzania are found along the coast of the Indian Ocean and on shores of lakes Victoria, Tanganyika and Nyasa.

National parks are areas created and protected by law for the purpose of conservation of wildlife and its associated habitat. Examples of National Parks in Tanzania include Serengeti, Mikumi, Lake Manyara, Ruaha, Gombe, Mahale, Katavi, Kitulo, Saadani, Kilimanjaro, Mkomazi, Saanane Island, Rubondo, Nyerere National Park at Selous (the upper part of Selous), Udzungwa and Tarangire. Game reserves include the lower part of Selous (which is the largest protected area in Tanzania), Rukwa, Ugalla and Maswa. Ngorongoro conservation area is the only protected area in Tanzania where humans, livestock and wildlife live together in the same environment.

Tourism industry creates employment and stimulates the growth of service sectors such as transport, hospitality, insurance, communications and tour guiding. Figure 1.6 shows tourists in a car observing lions, one of the wildlife attractions.



Figure 1.6 Tourists observe lions at Tarangire National Park

Source: <https://www.tanzaniawildcats.com/tanzania-safaris/6-days-african-lions-safari>

Trading: Trading is the process of buying and selling goods and services between people, organisations and countries. It takes place between producers and consumers. Some of the things involved in trading include machinery, clothing, food, medicine, cars and fuel. Trade may take place within a country or between countries. International trade allows countries to expand markets for both goods and services, which are not available in a particular country. Furthermore, international trade allows countries to participate in global economy hence encouraging opportunities for foreign investment.

Importance of human activities

Human activities are important in many ways. People are employed in different sectors depending on the kind of activities they can do. For example, in mining there are multi-national companies such as Williamson Diamonds and Barrick Gold (now known as Acacia), which employ many people. The companies also pay tax to the government. Moreover, employment in different human activities generate income which improves people's standards of living.

Exercise

Answer the following questions:

1. Define the following terms:
 - (a) Human activity
 - (b) Mining
 - (c) Forestry
2. Mention human activities which are influenced by the weather of a particular area.
3. List four benefits of human activities in Tanzania.

4. Describe one activity that is done at home for increasing family income.
5. Write **True** or **False** for each of the following statements:
 - (a) Tertiary activities provide services whereas secondary activities are done for processing and manufacturing goods.
 - (b) Primary activities are associated with land degradation unlike secondary activities, which are associated with environmental pollution.
 - (c) The distribution of different types of human activities is related to the types of human settlements.
 - (d) Secondary activities are carried out without depending on primary and tertiary activities.
 - (e) Types of human activities is related to the types of human settlements.

Chapter Two

Agriculture

Introduction

In this chapter, you will learn about the meaning and types of agriculture, the effects of rapid population growth on small-scale agriculture, characteristics of small-scale agriculture, advantages and disadvantages of small-scale agriculture, and ways of improving small-scale agriculture. You will also learn about types of large-scale agriculture in the world, major crops grown in each type of large-scale agriculture, characteristics of large-scale agriculture and problems facing large-scale agriculture in Tanzania and the USA. Finally, you will learn about the various types of livestock keeping practises as well as their benefits and constraints by focusing on Tanzania and Australia.

The concept of agriculture

Agriculture is a science which deals with crop cultivation and livestock keeping. It is the oldest human activity which has been practised by many societies in the world. Through agriculture, human beings grow crops for use by households and supply to industries. Factors influencing agriculture include climate, water availability, soil characteristics and terrain. Agriculture is also influenced by availability of financial resources, infrastructure, technology and markets.

Crop cultivation

Crop cultivation can be categorised into different types basing on factors such as size of farms, type of crops, motive of production and level of mechanisation. Based on size, crop cultivation is divided into two types: small-scale and large-scale crop cultivation.

Small-scale crop cultivation: Small-scale crop cultivation is the growing of crops on a small piece of land. It is also called subsistence farming. It aims to produce enough food for the wellbeing of families. In some instances, when the production is high, the surplus is sold. Individuals engaging in small-scale crop cultivation are known as peasants. They are also called subsistence farmers as they grow food crops to feed themselves and their families with little or no surplus for sale.

As noted earlier, the agricultural system at subsistence level falls under this category. A farmer owns a small piece of land for food crops cultivation. The produce is enough only for the family. It is hand to mouth existence which may lead to famine if the harvest is bad. In years with good harvest the farmer

may have surplus to sell to the local markets. The farms are small, about one to five hectares owned by the family. Application of machines is difficult as farms are small.

Small-scale crop cultivation is done by using different methods such as shifting cultivation, crop rotation and bush fallowing.

Shifting cultivation: This is a traditional system of cultivation used in tropical rainforest and miombo wooded savanna. It operates where population is sparse. People farm and move to another fresh area when the yields are low. The cultivator or farmer burns the forest and sows seeds in the intermixed ash and soil. Little attention is given to the crops until they ripen. If the harvest declines, the land is abandoned and a fresh area is cleared. The yields decline after three to five years. The cultivator may return to the original land after some years. The constant moves ensure fresh land with high yields, as the land is fertile. There is no serious soil erosion since only a small area is exposed which support many crops and therefore little bare earth is seen. Any soil washed is trapped by dense plant roots and at the forest edge. The system is less risky of diseases.

The methods used in shifting cultivation differ with people's culture and the varieties of crops they grow. Some use fire to clear the land. Such system results to wastage of valuable timber, which took over a hundred years to grow but

destroyed in a few days. Green manure is ruined and soil profile is altered by the destruction of bacteria and humus. Areas practising this system include Malawi, Zambia, Liberia and Uganda. In Zambia this system is called 'slash and burn' agriculture or the 'Chitemene.' Shifting cultivation in Tanzania is commonly known in Kiswahili language as 'kilimo cha kuhamahama' (shifting agriculture), but also unofficially known as 'mahame' (shifted land) or 'malale' (fallow land). Regions practising shifting cultivation include Morogoro, Lindi, Rukwa, Mbeya, Iringa, Tabora, Dodoma and Tanga. In Tabora, for example, tobacco farming relies heavily on shifting cultivation.

Crop rotation: Crop rotation involves growing different crops on the same land at different times.

Bush fallowing: Bush fallowing is not different from shifting cultivation in that in bush fallowing people have permanent settlements. They clear the bush, burn the vegetation and sow seeds. Yield declines after three to five years. The farm is left to regain its fertility for nearly ten years. Another bush is cleared and cultivated. No movement is involved in bush fallowing. This is possible in areas with dense population.

Small-scale crop cultivation is advantageous to farmers. It allows them to grow varieties of food crops. Different crops grown in small farms make it easy to control pests and diseases.

Elementary tools such as pangas, hand hoes and axes lead to low cost of running the farms, hence low capital involved. Farmers depend on rainfall only which is unreliable hence, during droughts the farmers suffer from famine.

Characteristics of small-scale crop cultivation:

Small-scale crop cultivation is characterised by the following features:

- (a) The harvest from the farm is used for family consumption.
- (b) It is practised on small pieces of land, often less than five acres in size.
- (c) Peasants use simple tools such as hand-hoes and machetes for cultivation. In some cases, ox driven ploughs are used.
- (d) Farmers often grow different types of crops on the same field. This technique is known as intercropping. The crops grown may include grains such as beans, maize and millet.
- (e) It is associated with the use of organic manure to improve soil fertility.
- (f) Farming activities are mainly done by family members.

Relationship between population growth and small-scale crop production

Population growth is an increase in the number of people in a particular area. Rapid population growth could be due to natural increase or in-migration. The rapid

population growth puts more pressure on small-scale farmers. Yet, subsistence farmers are not likely to raise their output to feed the growing numbers because of lack of capital. Subsequently, land becomes overpopulated and resources overused. Also high population growth is associated with smaller farms and lower farm wages. As a result households in densely populated areas increasingly rely on off-farm income.

Effects of rapid population growth on small-scale crop cultivation

Overpopulation does not depend merely on the total number of people living in an area, or on the population density. It depends much on the available resources in a given area. When an area has more people than it can support to give them a reasonable standard of living, the area will suffer from *overpopulation* or *population pressure*. If the area has inhabitants who are too few to develop the resources available to improve living conditions, then the area suffers from under-population.

Population pressure is caused by rapid increase of population. In Third World countries, population is growing rapidly and food demand is high whereas food production is low. As the population increases, shortage of land in the productive areas becomes a source of serious concern. In some parts of regions such as Kilimanjaro, Mara, Kigoma, Shinyanga, Mbeya, Manyara and Morogoro, where a high population increase has occurred, land shortage has

become a serious problem. In fact, the land available has been over cultivated and exhausted, hence paving way to soil erosion. Over the years, many people have been migrating from their homelands to other regions in search of fertile land for cultivation.

The resulting population growth affects land use patterns. This may cause shortage of food and poor living standards. The solution to this problem is to improve small-scale crop cultivation. The government and other organisations should help farmers by providing them with education and capital to make subsistence agriculture more intensive and more productive. Moreover, the government, non-governmental organisations (NGOs) and co-operative societies should help the farmers to select better seeds, use proper insecticides, pesticides, and apply fertilisers properly. In addition, they should help in providing transport to make sure the products reach proper storage places and markets. Furthermore, the government should emphasise and support the opening of joint agriculture ventures, finding of markets for surplus products and establishing good storage facilities. Additionally, deliberate efforts should be made to provide education on good farming practises, for example, the use of simple but improved farming technology.

Advantages of small-scale crop cultivation: Small-scale crop production is cheap to operate since it involves the use of simple farming tools such as hand hoes and machetes. It is also cheap because the sources of labour are family members and, hence, easy to manage. In addition, small-scale agriculture needs small capital since it operates on small pieces of land.

This type of agriculture when intergrated with livestock-keeping provides biomass which is useful in the production of biogas energy. This energy is commonly used for cooking. Another advantage of small-scale crop cultivation is that farmers get fresh food such as vegetables and fruits. Therefore, small-scale agriculture contributes to the development of local communities.

Disadvantages of small-scale crop cultivation: Small-scale crop cultivation is associated with loss of soil fertility due to overuse of the same plots of land. Moreover, the practise of burning vegetation during farm preparation tends to destroy soil nutrients, hence lower its fertility. As a result, subsistence or peasant farmers' yields tend to fall. Such low yields are also contributed by low use of fertilisers and pesticides. Therefore, various ways are needed to reduce the challenges of small-scale crop cultivation.

Ways of improving small-scale crop cultivation:

Small-scale farmers need training on the best cultivation practises such as the application of manure and proper use of chemical fertilisers. Farmers should also be educated on the use of hybrid seeds and irrigation schemes. Furthermore, the establishment of co-operative unions can help small-scale farmers to get soft loans, access markets, undergo training and benefit from extension services.

Exercise 2.1**Answer the following questions:**

1. Define agriculture.
2. Name two types of agriculture.
3. Explain any four characteristics of small-scale crop cultivation.
 - (a) List any three advantages of small-scale crop cultivation.
 - (b) List any three disadvantages of small-scale crop cultivation.
4. Mention the effects of rapid population growth on small-scale crop cultivation.

Large-scale crop cultivation: Large-scale crop cultivation is a farming system that covers a large area of land to produce one type of crop for commercial purposes. This type of large-scale farming is also known as commercial agriculture.

In large-scale crop cultivation, the type of farming practise is mostly monoculture, in which a single crop is produced in large quantities. In developing countries monoculture is associated with tropical and sub-tropical plantation which were established through European colonisation. After independence of individual countries, the plantations were owned by government and others were allocated to individuals as small holders and peasant farmers. These plantations also known as estates are large and found in sparsely populated areas.

Crops from the plantations for example sisal and tobacco are processed before leaving the plantation and further processed right after harvesting to raise the value of the product per unit weight, and reduce its weight for long distance transferring. Mechanisation and irrigation are applicable on this kind of agriculture, hence weather change is not a problem. Poor people cannot manage this type of farming because it needs very big capital.

Characteristics of large-scale crop cultivation:

Large-scale crop cultivation is characterised by cultivation of a large area with the application of high level of technology. The technology involves the use of tractors, combine harvesters, and processing machines. As large-scale farming is highly mechanised, it employs few skilled people because machines carry out agricultural activities that otherwise could have been done manually by humans.

In addition, such commercial farming is capital-intensive to support the production. Also, it is often based on a single crop, a practise known as monoculture. Chemical fertilisers are highly used to maximise yields. Large-scale agriculture is basically a source of raw materials for different manufacturing industries.

Types of large-scale crop cultivation:

Large-scale crop cultivation can be divided into two types: plantation agriculture and extensive food cultivation. Plantation agriculture involves cultivation of cash crops on estates. The cultivation is highly mechanised. Major crops grown on plantations include coffee, cotton, tea, rubber, oil palms, cocoa, sisal and sugar cane. Plantation agriculture is dominant in some regions of Africa, Asia, North and South America where there are favourable climatic conditions. Extensive food cultivation deals with large-scale food crop production. Machines are highly used in ploughing, sowing, harvesting, processing, packaging and transportation of farm produce. Crops grown under extensive agriculture are cereals which include beans, maize and wheat. A description of some of the crops under large-scale crop production is provided in the following sub-sections.

Coffee: Coffee is a crop which produces coffee beans that are processed to make a beverage (Figure 2.1).



Figure 2.1 Coffee plant berries

source: <https://www.gettyimages.com/photo/coffee-plant>

It forms an important cash crop for export. In Tanzania, coffee is grown in Kagera, Kilimanjaro, Arusha, Mbeya, Katavi, Iringa, Mara, Njombe, Tanga, Morogoro, Kigoma and Ruvuma regions (Figure 2.2). Coffee is also grown in Kenya, Uganda, Democratic Republic of Congo, Zambia, Rwanda and Ethiopia. Other countries include Cameroon, Brazil, Columbia, Indonesia, Honduras, India, Vietnam, The Philippines and Mexico. There are over 60 varieties of coffee yet, only two of them have commercial importance; these are Arabica and Robusta.

Conditions necessary for growing coffee: There are four essential growth conditions required for the cultivation of coffee:

Climate

Coffee is a tropical plant, which is also grown in semi-tropical climate. It requires heat, humidity and abundant rainfall. The plant grows in warm to hot temperature ranging between 16°-21°C. Coffee needs abundant rainfall ranging from 1100 mm to 1780 mm annually and a relatively dry season for picking. Growth is most rapid during the hot rainy season, and during the cool dry season

berries ripen and are ready for picking. Bright sunshine and warm weather are necessary for the harvesting. Hill slopes, which receive orographic rainfall, are thus best for coffee cultivation.

Shade

Direct sunlight is harmful for coffee plants; therefore, these are planted under shade of taller trees such as bananas.

An ideal shade tree should belong to the leguminous type, because these not only provide shade but also enrich soil with nitrogen. Traditionally, most of the varieties of coffee plants were shade grown, as they were naturally intolerant of direct sunlight, hence they preferred a canopy of sun-filtering shade trees. The trees in coffee plantations play several roles including the following:

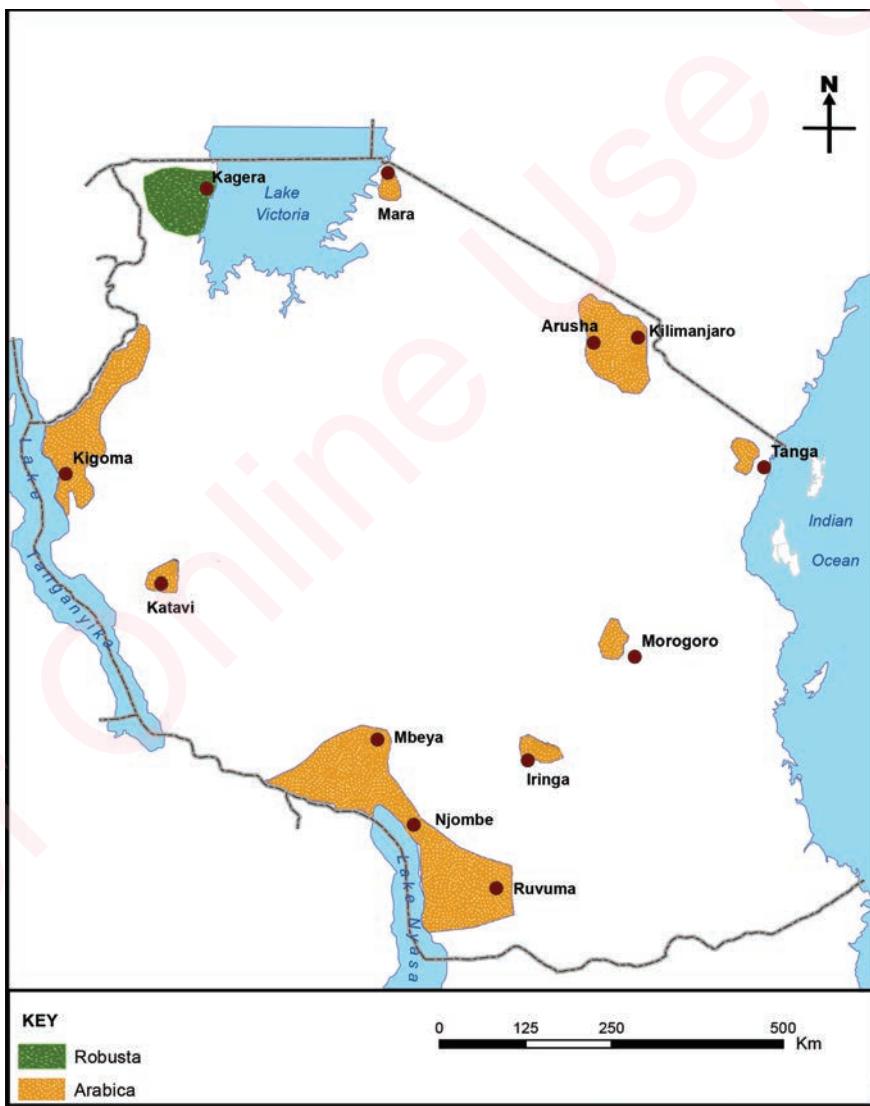


Figure 2.2 Coffee-producing regions in Tanzania

source: Coffeeboard.or.tz/news_Publications2009

- i. Protecting coffee from direct sunlight. Trees reduce the amount of heat reaching the coffee plant during the daytime.
- ii. Acting as physical barrier by protecting coffee plants from destruction by winds.
- iii. Mulching the soil with their fallen leaves which helps to protect the soil from excessive temperature and retain soil moisture thereof reducing evaporation.
- iv. Minimizing the erosive power of rainfall by acting as a physical barrier in reducing the amount of the rain reaching the ground.
- v. Maintaining the organic matter content in the soil which creates a conducive environment for many beneficial microorganisms like nitrogen fixers; hence trees contribute to soil fertility.
- vi. Providing a lively habitat, which is able to harbour different bird species. The birds help to facilitate pollination and serve as a biological insect control. Due to increasing demand of coffee, a scientific way of productivity which involve growing coffee plants in the open sun, was developed for coffee farming. This approach is accompanied with the continued application of chemical fertilisers and pesticides which, among other things, make up for the loss of nutrients.

Topography

Generally, coffee is grown on slopes having a height between 600 to 1,800 meters. Water stagnation is very harmful for coffee plants; therefore, hill slopes are best suitable for growing coffee.

Soils

Soil is the guiding factor in coffee plantation. Coffee plantation requires deep well drained soils which are rich in humus, minerals nutrients and of good texture to allow free air circulation.

Farm preparation, planting and care of coffee: Coffee farms need preparation for at least six months. The coffee seedlings are raised on seed-beds and transplanted after six months, with three meters spacing. The coffee trees are pruned annually to ensure maximum yield. Pruning is also done to facilitate the picking of coffee beans. Weeds such as star-grass and couch grass are removed to increase yields. In addition, spraying of coffee plants is done in cases of leaf rusting and Coffee Berry Diseases (CBD). Fertilisers such as nitrogen, phosphates, potassium and magnesium are applied in places where soil fertility is low.

Harvesting, processing, storage and transportation: Harvesting of coffee berries is done by hand. Only the red ripe berries are picked. Berries are dried in the sun and then are sorted, weighed and transported to the processing mills. Since coffee can easily absorb external odours which can affect its quality, it

must be stored in cool, dark and dry places to ensure freshness.

Uses of coffee: Coffee is mainly used as a beverage at home and in hotels. It also has healthy benefits such as preventing type 2 diabetes, burning fat, and improving body performance. People drink coffee to relieve mental and physical fatigue and to increase mental alertness. Other uses include treatment of headache, low blood pressure and obesity. The coffee pulp is used as fertilisers on farms.

Cotton: Cotton is a flowering plant which is grown for making cotton fabric and threads. It is a soft and fluffy fibre that grows in a boll or protective case around the seeds of a cotton plant. The plant is native to tropical and sub-tropical regions in the world including Africa and the Americas. The major cotton producers are China, USA, India, Pakistan, Brazil, Egypt, Benin, Mali, Cameroon, Uzbekistan, Vietnam, Australia, Turkey, Sudan, and Russia. In Tanzania, cotton is mainly grown in Mwanza, Tabora, Mara, Shinyanga, Geita and Simiyu regions. It is the second largest export crop after coffee and the fourth largest produced cash crop in Africa. Figure 2.3 shows a cotton farm.



Figure 2.3 Cotton farm

Source: worldwildlife.org/industries/cotton

Conditions necessary for growing cotton: Cotton grows in warm temperatures of about 25°C. It requires moderate rainfall of about 550 mm to 1,000 mm. However, in areas with less rainfall cotton can grow under irrigation. For example, the Gezira Irrigation Scheme in Sudan supports cotton growth. It also requires well-drained fertile soil. Moreover, cotton requires at least 200 frost-free days as the crop is sensitive to frost.

Farm preparation, planting and care of cotton: Cotton farms are prepared before the rainy season. The planting of cotton seeds takes place during the rainy season. Cotton flowering occurs between two and three months after planting. To maintain healthy cotton plants, there is a need for regular spraying of cotton plants with pesticides. This measure is necessary because a number of pests and diseases attack cotton plants. The common pests which usually attack cotton plants include cotton aphids, stink bugs and boll weevils. In addition, diseases such as cotton leaf curl, cotton blue and root rot attack cotton plants.

Harvesting, processing, storage and transportation of cotton: Cotton is usually ready for harvesting between five and seven months after planting. In most tropical countries including Tanzania, harvesting is done by hand. Large-scale cotton producers, on the other hand, use machines such as combine harvesters. Figure 2.4 shows a combine harvester at work.

**Figure 2.4** Cotton combine harvester

Source: <https://www.pinterest.com/pin>

After picking cotton, dirty or spoilt cotton is removed. Clean cotton is packed into sacks and transported to ginneries for removing seeds from lint. The lint is compressed into large bales and transported to textile industries or exported.

Uses of cotton: Cotton is used in different ways. Primarily, cotton fibres are used for making clothes and thread. The seeds from cotton are used to make oil which is used for cooking, making soap and margarine. Cotton by-products are also used for feeding animals. Besides, cotton wool is used for sanitary purposes. The cotton lint is used in making mattresses and pillows.

Oil palm: Oil palm is a plant grown in tropical areas specifically for producing palm oil. It is grown on both small-scale on farm lots and large-scale on plantations. In Tanzania palm oil is grown in Kigoma and Mbeya regions. Other palm oil growing countries in the world are Malaysia, Nigeria, Indonesia and the Democratic Republic of the Congo.

Conditions necessary for growing oil palm: Oil palm grows well in areas with high temperatures throughout the year with mean monthly temperature of over 21°C, heavy rainfall throughout the year (about 1,500 mm to 2,040 mm), and needs a well-drained soil to enable water to pass through.

Farm preparation, planting and care of oil palm: Farm preparation takes place before transplanting. Palm oil seeds are sown in nurseries which are later transplanted to a farm when they are 12-14 months old. Palm oil plants begin bearing fruits when they are five years old and reach maximum production after 8-10 years. After ten years, yields start to decline. Palm fruits usually grow in large bunches. Each oil palm plant has a capacity of bearing between two and ten bunches annually. Figure 2.5 shows a palm oil tree.



Figure 2.5 Palm oil tree

Source: inews.co.uk/news/world/palm-oil-industry-curb-deforestation-flaws-falling-prices/

Harvesting, processing, storage and transportation of oil palm: The fruits of the palm oil trees turn red, when they are ripe and ready for harvesting. Each fruit consists of a fleshy pericarp surrounding a nut. Fruits are boiled in pots or drums at high temperature. The processing continues to the point where the pericarp is compressed to obtain palm oil. Inside the pericarp there is a kernel which is also a source of oil. Oil from the kernel is obtained by crushing the nuts in a grinder and compressing them. The extracted palm oil is packed in containers ready for domestic use and export.

Uses of palm oil: Palm oil is used as vegetable oil for cooking, and making soap and candles. Residue from processed kernels can be used as animal fodder and manure.

Tea: Tea is a plant whose leaves are used for making a beverage. In Tanzania, tea is mainly grown in Mbeya, Iringa, Njombe, Kagera, Kilimanjaro and Tanga regions. Other major tea growing countries in the world are Kenya, Uganda, Malawi, China, Sri-Lanka, India, Indonesia and Argentina.

Conditions for growing tea: Tea grows well in warm to hot temperatures ranging from 15°C to 29°C. However, the temperature should not be below 21°C during the growing period. In addition, it needs high and well-distributed rainfall of about 1,400 mm to 1,750 mm. It also needs frost-free conditions during the growing periods and fertile, deep, well-drained soil able to retain moisture. The soil should also be slightly acidic with little calcium.

Farm preparation, planting and caring of tea: Farms for tea growing are prepared by clearing land. The ideal row spacing for tea plantation is 100 – 110 cm with the plant spacing of 65 – 75 cm. This spacing makes it possible to plant 15,000 plants in an acre.

Tea also needs full shade and protection from other previously planted trees. The trees protect the plants from being affected by wind. In other words, they act as a wind breaker. Tea production is a labour-intensive activity because planting, weeding, picking and processing largely depend on human labour.

Harvesting, processing, storage and transportation of tea: It takes two years for tea plants to be ready for harvesting. Picking of tea leaves requires experience because if it is done poorly, it may result in low quality tea. Tea plants are normally plucked for 3-4 years after which all old branches are pruned for new shoots to grow. The plucked tea leaves undergo fermentation under regulated moisture to ensure quality tea product. Thereafter, tea leaves are rolled to enhance the breakup of the leaf cells and fibres. The leaves are then dried in temperatures of about 105°C. This process is called roasting or firing. Roasting stops fermentation and reduces moisture. Cool and dried tea is sorted in different sizes and graded. Unwanted particles are removed before packing. At this stage, tea is ready for consumption and export. Figure 2.6 shows the plucking of tea leaves in Iringa.



Figure 2.6 Tea plucking in Mufindi, Iringa

Source: Tea production...ratetea.com

Uses of tea: Tea is primarily used as a beverage. A person with a sore throat and a hoarse voice can get better after taking a few cups of strong tea.

Sisal: Sisal is a tropical plant whose leaves produce strong threads (fibres) which are used for various purposes such as rope and carpet making. Sisal was originally grown in southern Mexico. Subsequently, it has been widely cultivated in many other countries. In fact, it has widely been introduced in the tropics and subtropics. In Tanzania, sisal was introduced in 1893 by Dr Richard Hindorf and the first 62 sisal plants were planted near Pangani in Tanga Region. Until the 1960s, Tanzania was the leading producer of sisal, but since then Brazil has become the major world producer of sisal, followed by Tanzania, Kenya, Madagascar and China. In Tanzania, sisal is grown in Tanga, Kilimanjaro, Arusha, Morogoro, Lindi and Mtwara regions.



Figure 2.7 Sisal farm in Tanga

Source: <https://www.ipppmedia.com/en/news/strategising-restore-sisal-cash-crop-day>

Conditions for growing sisal: Sisal growing needs high temperatures ranging between 25°C and 30°C. It also needs slight rainfall ranging from 650 mm to 1,500 mm. It is grown in well drained loamy soil. This type of soil contains a lot of decayed vegetable

matter with little amounts of sand and clay. Rainfall plays an important role as far as fibre production is concerned. On the whole, sisal does not need too much rainfall and cannot tolerate frosty conditions.

Farm preparation, planting and caring of sisal: It is recommended that land should be well-prepared by ploughing to a depth of 30 cm before planting.

Bulbils are initially grown in nurseries before being transplanted in double rows after a year. In the nursery, the bulbils should be planted in beds at 10 cm x 10 cm apart. It is recommended to use sisal waste for their growth. Thereafter, they are shifted to a second bed where they are planted at 30 cm x 30 cm apart. After 12 to 18 months, the young sisal plants are ready to be planted in the field. Unlike many other crops, sisal does not need much care. However, when it is planted on a previously used old land, it is important to use fertiliser. During the first two years it is important to control weeds by hand, machines or chemicals. Although the sisal plant is resistant to pests and diseases, it is important to control pests and diseases such as sisal weevil and bole rot. Growing sisal does not require irrigation as the sisal plant is drought-resistant and cultivated as a rain-fed crop.

Harvesting, processing and transportation of sisal: Harvesting of sisal begins when the colour of thorns at the tips changes from dark brown to light-brown. The processing of leaves should take place 48 hours after being harvested. Through processing, sisal fibres are obtained whereby the leaves are crushed between rollers and then mechanically scraped. Then the fibres are washed and dried. Drying of fibres is done in the sun or by using drying machines. This is followed by brushing of the dried fibres for straightening as well as polishing. Thereafter, the fibres are graded depending on their length and colour. It is important to ensure cleanliness of the bale. Graded fibres are then packed into bales either manually or by using machines.

Uses of sisal: Sisal is used to make ropes, buffing cloth, mattresses, carpets, handicraft mats, and baskets. Sisal is commonly used in the shipping industry for mooring small craft, lashing, and handling cargo. It is also used in the automobile industry with fiber glass in composite materials. Other products developed from sisal fibre include lumbar support belts, rugs, slippers, clothes and disc buffers. Farmers also use sisal fibre for tomato plant support and ropes for reinforcement of ceiling corners. Waste from sisal extraction can be used for making biogas, pharmaceutical ingredients and building materials. Fibres can also be used as fertiliser or animal feed.

Clove: Clove is an evergreen tree of humid tropical climate (Figure 2.8). Its flower buds are spices used in food, drinks and medicine. The clove was introduced in Zanzibar in the United Republic of Tanzania in the first half of the 19th century from Indonesia. Clove growing in Zanzibar started with plantations but it has progressively been fragmented into smaller holdings of about 3 acres. The prominent clove growing countries in the world are Indonesia, India and Madagascar. Indonesia is the biggest grower, importer and consumer of cloves.

Conditions for growing cloves: Cloves require a humid tropical climate with annual average temperatures of between 20°C and 30°C. They prefer well distributed rainfall, which is ideal for flowering. In this regard, the annual rainfall should range from 1,500 mm – 2,500 mm. In addition, cloves require deep loamy soils with high humus content and well-drained black loam soils of semi-forest regions. Cloves need good drainage and prefer partial shade and a cooler climate.



Figure 2.8 Clove plants in Zanzibar

Source: <https://www.alamcom/stock-photo/clove-plant.html>

Farm preparation, planting and care of cloves: Clove seeds are sown at 2 cm to 3 cm spacing with a depth of about 2 cm. The germinated seedlings are transplanted in bags. The seed-beds have to be protected from direct sunlight. The young plants are left for almost 2 years. Then the seedlings are transplanted in the field at the spacing of 6 to 7 meters apart.

Harvesting, processing and transportation of cloves: Clove trees can grow up to 15 meters high. Therefore, harvesting involves picking of flower buds which is done by climbing or scaling. Harvesting is done by hand by skilled climbers. In Zanzibar, the harvesting occurs from September to November. Sorting is necessary to separate leaves from the buds. The buds and flowers are left to dry in the sun for 3 - 7 days. To ensure quality, the dirty and unwanted particles are removed from the dried cloves. The Zanzibar State Trading Corporation (ZSTC) is an organ responsible for buying and exporting cloves from the Isles in Tanzania to major importers such as Taiwan, India, the United Arab Emirates and the United Kingdom.

Uses of cloves: Cloves can be used in the production of oil which is used in dentistry, sanitary applications and as medicine. They also serve as a spice in food. Moreover, cloves add flavour in tea and cigarettes. Cloves are a cash crop that is sold to earn foreign currency.

Table 2.1 shows major cash crops grown in Tanzania.

Table 2.1 Major cash crops grown in Tanzania

Crop	Areas
Coffee	Kagera, Kilimanjaro, Arusha, Mbeya, Ruvuma, Kigoma and Mara
Cotton	Mwanza, Tabora, Mara, Tanga, Shinyanga, Geita and Simiyu
Palm oil trees	Kigoma
Tea	Mbeya, Iringa, Njombe, Tanga, Kilimanjaro and Kagera
Sisal	Tanga, Kilimanjaro, Arusha, Morogoro, Lindi and Mtwara
Cloves	Unguja and Pemba

Activity

1. Visit a nearby plantation and mention the type of crop grown. Describe the conditions for growing that crop.
2. (a) Mention the uses of the crops listed in Table 2.1.
 (b) Describe their contribution to individual and national economy.

Cereal crops

This section describes the cereal crops which are cultivated under extensive large crop cultivation for food and commercial purposes. The major cereals in the world are maize, rice, wheat, barley and sorghum. The following section provides descriptions on maize, beans, wheat and rice. Figure 2.9 shows major cereal crops growing regions in Tanzania.

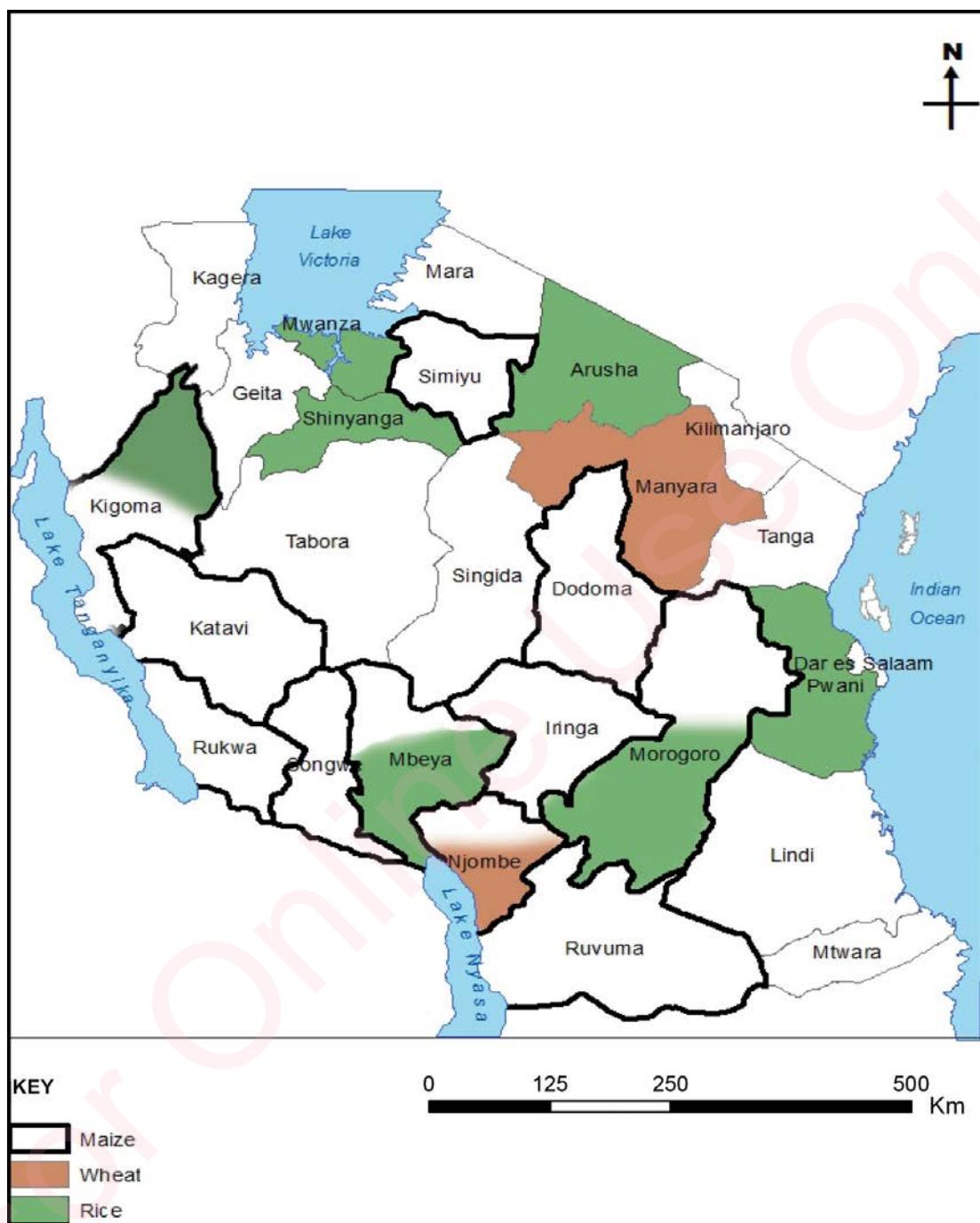


Figure 2.9 Major cereal crops growing regions in Tanzania

Maize

Maize is a cereal crop whose origin is South America. It is one of the most widely cultivated cereals grown in both tropical and warm temperate latitudes. In Tanzania, maize is widely grown as a staple food. Major maize producing regions are Rukwa, Katavi, Mbeya, Songwe, Njombe, Morogoro, Iringa and Ruvuma. Countries that are major maize growers in the world are United States of America, China, Brazil, South Africa, Russia, Yugoslavia and Romania.

Conditions for growing maize: Maize grows well in areas that experience summer temperatures of between 18°C and 27°C. It also needs a period of 140 frost-free days and annual precipitation ranging from 635 mm – 1,145 mm. Maize grows in a wide range of soil types. However, it grows better in deep rich soils of the sub-tropics with abundant nitrogen. In the tropics, maize can grow at altitudes ranging from sea level to 2,900 m above sea level. A dry sunny season is important for maize to grow, to enable cobs to ripen and the seeds to dry.

Farm preparation, planting and caring of maize: Maize requires deep tillage which is done by a hand-hoe and ox-drawn plough in small-scale or subsistence farming, and by using tractors in large-scale or commercial agriculture. Planting is done by burying seeds directly in the soil in a depth of at least 10 cm with spacing of 75 cm

between the rows and 30 cm between the plants. Germination usually takes place under warm, moist conditions. Seedlings emerge after about 6 - 10 days. However, under cool or dry conditions this may take two weeks or more. The optimum temperature range for germination is between 20°C and 30°C.

Maize needs good care which includes weeding, thinning and pest and disease management.

Weeds compete with maize plants for water, nutrients, space and light which reduce plant yield. The early stage of a maize plant (first three weeks) is very sensitive to weed competition. Weeding in a maize farm can be done using the hand-hoe, machine or through chemical weed control (herbicides).

Harvesting, processing and transportation of maize: Maize can be harvested after 3 - 6 months depending on variations in temperature and seed types. Harvesting methods include manual hand cut and machines (combine harvesters). The mechanised system removes not only the ear or husk from the plant but also the grain from the cob whereas hand harvesting requires initial removal of the ear or husk, which is shelled at a later stage. The grain is winnowed to remove unwanted materials and low quality grains. Then the product is stored in bags ready for transportation to homesteads, and some to silos and to the market.

Uses of maize: Maize is a staple food in Africa and Asia. It is also used to feed domestic animals such as cattle, pigs and chicken. Maize is also used to make industrial products such as vegetable oil, starch and alcohol. Domestically, maize stocks and cobs are burned to produce heat energy for cooking mainly in rural areas. Maize stalks are also used to make manure.

Wheat

Wheat is one of cereal crops which grows well in temperate regions. Wheat in Tanzania is grown almost exclusively as a commercial crop on a large-scale basis in the northern highlands (Manyara) and by small and medium scale farmers in the southern highlands (Njombe). It is also grown in Angola, Burundi, Democratic Republic of Congo, Ethiopia, Kenya, Madagascar, Mozambique, Rwanda, Uganda, Zambia and Zimbabwe. It is also grown in Greenland and distributed from Scandinavia to South America and across Asia.

Conditions for growing wheat: Wheat grows well in warm temperatures ranging from 21°C to 24°C. Wheat also needs a lot of sunshine, especially when the grains are filling. Areas with low humidity are better since many wheat diseases thrive in damp weather. The amount of rainfall required for wheat cultivation varies between 300 mm and 1,000 mm. The major wheat lands of the temperate regions have an annual rainfall of 380 mm - 800 mm.

Farm preparation, planting and caring of wheat: If the field has been previously used for farming purposes, it is recommended to smoothen the soil with a rake. A shovel is attached to a tractor to plough the field and dig long narrow furrows. Moderate quantities of natural manure is used to fertilise the soil and ensure proper growth of the wheat stalks. Wheat seeds are spread in the furrows using a semicircular movement of the wrist or a grain drill attached to a tractor. Immediately after planting the wheat seeds, watering is important. This is also done once each month during the growing season. If an area gets a lot of rain, it might not need to be watered at all. Fertiliser is used twice during the growing season. Although it may look primitive, several plastic flags or streamers are placed throughout the wheat patch. The noise made by the plastic blowing in the breeze deters birds from landing and scares off any birds that are already in the field. This prevents birds from eating the wheat seeds before they can sprout.

Harvesting, processing and transportation of wheat: In the process of harvesting, there is a need to test the crop. In this regard, fingers are used to rub the wheat head and pieces of grain are chewed. If the grains crack in the mouth and become soft as they are chewed, then they are ready for harvesting. Clean places are prepared for keeping the harvested wheat. When using a sickle for harvesting, it should be checked to make sure it is sharp enough for making

clean cuts. In commercial farming, the combine harvester is adjusted to harvest the wheat. Harvesting is done when the crop reaches maturity (at least 100 days). The part that is harvested is called kernels. Freshly harvested wheat is taken to a local grain elevator as soon as possible after harvest.

As wheat arrives in the mill, it passes through a cleaning process to remove coarse impurities, and to separate the grain by size, shape and weight. The finished product, that is, the whole pure wheat then goes through conditioning bins before milling to produce a uniform moisture content to prevent break-up of the bran (hard outer layer) during milling. After conditioning, different batches of wheat are blended together to make a mix capable of producing the required quality. Wheat is sold raw to manufacturers. From here it is milled into finished consumable products. On large farms, harvesting is done by combine harvesters whereas on small farms, it is done by hand using sickles. It is normally transported by road in lorries from the farm to the market and silos.

Uses of wheat: Wheat serves as food for human beings and animals. Human beings use wheat to make bread, cakes and, sometimes, stiff porridge. The remains of wheat are used to feed animals. Wheat starch is used in the manufacturing of paper. For example, in the United States wheat is used to strengthen paper.

Rice

Rice is an edible seed from one of the grass species. As a cereal crop, it is the most widely consumed staple food for a large part of the world's human population, especially in Asia. It is an agricultural commodity with the third-highest worldwide production. Rice is grown in most regions of Tanzania including Coast, Morogoro, Tabora, Mbeya, Mwanza, Shinyanga, Simiyu, and Geita. Globally, it is grown in China, India, Indonesia, Bangladesh, Brazil, Thailand, Japan and Kenya.

Conditions for growing rice: Rice is a tropical crop which grows well where the average temperature during the growing season is between 20°C and 27°C. Abundant sunshine is also essential during its four months of growth. The minimum temperature should not go below 15°C as germination cannot take place below that temperature. Rice requires more water than any other crop. As a result, paddy cultivation is done only in those areas where minimum rainfall is 1,150 mm. Paddy also needs flooded conditions with the depth of water varying over 25 mm at the time of transplanting to as much as 150 mm for 10 weeks of the growing period.

Farm preparation, planting and care of rice: Planting work begins with land preparation as well as the nursery bed for obtaining the seedlings. The seedlings should be planted as young as possible, usually at 20 days. Seeds are planted by removing them from the nursery to the

paddy fields. Good rice planting should use the pull to the right and to the left with a distance of 20 cm x 20 cm. This is to enable maintenance, either weeding or fertilising in addition to allowing each plant to receive enough sunlight and nutrients evenly. Seedlings are planted with just one seed in one planting hole. Farmers are required to maintain water and water discharge on paddy fields and weeding (weed control). Irrigating rice crops in rice fields should consider the depth of water in accordance with the age of the plant. Weeds are herbs that live with cultivated plants and are generally very harmful to rice crops. As such, weeding is very important. Fertilisation is done to add nutrients needed by plants in the soil. As the grain begins to mature, the farmers ‘lock up’ the water on the bays. This means no water leaves the paddock as it is fully utilised by the rice plant. The soil then dries out in time for harvest to begin.

Harvesting, processing and transportation of rice: Rice is processed in the following ways. Step one involves removal of the hard protective husk. The rice husk is the protective layer surrounding the grain. Once removed, the rice grain is packaged as brown rice. Brown rice is healthy because it still contains the rice germ and outer bran layers which is important for healthy body functions. Step two involves removal of the germ and brown layers. Gentle milling removes the germ and bran layers from the grain to expose a white starch center. The polished white

starch center is what we know as white rice. Large-scale farmers use large conventional grain harvesters whereas small-scale farmers use sharp sickles for harvesting. Farmers use tractors, power tillers and lorries to transport paddy from the farm to grain storage facilities at the farm or home or silos for large-scale grain storage. Rice in Tanzania and in most parts of the world is mostly sold to consumers as polished milled rice. From the farmers it is sold directly to the millers or middlemen.

Uses of rice: Rice is used in many ways for food and other purposes. The bran is used to make oil. Straws (grass) from the leaves and stems are used for weaving roof tops, baskets, hats, bedding and for feeding animals. Husks are used as a source of energy in bricks making. Table 2.2 shows some major cereal crops grown in Tanzania.

Table 2.2 Some major cereal crops grown in Tanzania.

Crop	Regions
Maize	Rukwa, Katavi, Mbeya, Songwe, Njombe, Morogoro, Kigoma, Iringa and Ruvuma
Wheat	Manyara and Njombe
Rice	Coast, Morogoro, Mbeya, Mwanza, Shinyanga, Arusha, Kigoma, Simiyu and Geita

Contribution of crop production to the economy of Tanzania

The majority of Tanzanians heavily depend on agriculture. It is estimated that 75% of the population is engaged in agriculture. It has played a significant role in improving people's lives. It has stimulated the development of industries especially those related to the processing of tea, fruits, sisal and sugar-cane, among others. The sector has also led to the creation of employment opportunities in the country as many people are employed in agro-related industries whereas others are self-employed. Furthermore, the sector has contributed to the generation of government revenue and capital development in form of tax and duty payment as well as exports. It has also stimulated external trade and international relations through the exportation of cash crops to earn foreign currency. It has contributed to the development of transport and communication system from the farm to the market and from the market to the farm. Additionally, it has encouraged the raising of the standard of living for the people in the country because of what individuals and families earn from farm produce.

Challenges facing large-scale crop cultivation in Tanzania: Some of the challenges facing large-scale crop cultivation in Tanzania are high cost of production. Large-scale farming requires a large capital investment to buy machinery and farm inputs, prepare land and pay farm labourers.

It also relies on seasonal rainfall. Climatic changes have largely affected the amount of rainfall in many areas of Tanzania. Since the majority of large-scale farmers in Tanzania rely on rain-fed agriculture, whenever there is a shortage of rainfall, agricultural production falls. Agricultural products from large-scale crop cultivation in Tanzania such as tea, sisal and coffee face stiff competition from other countries that produce the same crops. As a result, prices of such products tend to be low. In addition, large-scale crop cultivation in Tanzania has to contend with pests and diseases. Pests such as army worms and quelea quelea tend to destroy crops faster than measures aimed to control them can cope. Inadequate management of pest invasion leads to heavy loss of crop production. Similarly, the outbreak of diseases such as Coffee Berry Diseases (CBD) and army worms affect crops before they are ready for harvesting, which leads to low production.

Ways to improve large-scale crop cultivation in Tanzania:

There are several ways to improve large-scale crop cultivation in Tanzania. Improvement of the transport network and communication systems will facilitate the transportation of farm inputs to the farm and agricultural products to industrial centers and markets. The government should also render the necessary support to prop up large-scale farming by providing subsidies in addition to creating a conducive investment climate by reducing the heavy and number of taxes

on agricultural facilities. Moreover, there is also a need to establish and expand irrigation schemes through public and private partnerships. Furthermore, farmers should be empowered through the establishment of co-operative banks for loan provision and sustainable markets. There is also a need to enforce a mechanism aimed to ensure extension officers work in the field with farmers where they can provide technical assistance on the selection of seeds, use of fertilisers and pesticides, and processing and packaging of crops. Also provision of real-time weather related information to farmers is necessary.

Contribution of crop production to the economy of the United States of America

The United States of America (USA) has a diverse climate and the ability to grow a wide variety of crops across the vast country with 50 states. Agriculture is a major industry in the USA, which is a net exporter of food. Although agricultural activity occurs in every state, it is particularly concentrated in the Great Plains, a vast expanse of flat, arable land at the center of the nation in the region around the Great Lakes known as the Corn Belt. Corn is another name for maize which is a chief cereal crop. The economy of the USA heavily depends on manufacturing industries. However, it is so diversified and characterised with a variety of sectors including services, entertainment, telecommunications and agriculture.

Agriculture, which is highly mechanised, operates on a large-scale and makes a significant contribution to the USA economy through provision of employment opportunities to about 11% of the Americans. Through agriculture the country also earns foreign currency, which helps to increase the National Domestic Product (NDP) through the export of beverages and other processed foods. Improvement of standards of living of the people who live near plantations such as the Cotton and Corn belts is another contribution of large-scale agriculture in the USA. Furthermore, the country has benefited significantly from development and growth of beef and dairy farming industries, which employ the largest percentage, followed by bakery, fruit and vegetable plants. The agricultural sector also plays a role in stimulating the development and growth of towns and cities such as Chicago and St. Louis.

Challenges facing large-scale agriculture in USA: There are several challenges facing large-scale agriculture in the USA. Some of them are high cost of production as agriculture in the USA is highly mechanised. Automatic irrigation and agricultural machinery require fossil fuels and other sources of energy to run them. The increase in the price of fossil fuel, therefore, increases the cost of production. At times, there is a shortage of water as irrigation requires a lot of water. The amount of underground water drawn for irrigation is

increasing whereas the amount of water to refill is decreasing; which results in shortage of water for agricultural use. Another problem has to do with loss of soil fertility as the soil is eroded faster than it can be replenished due to over-cultivation. Also, over-irrigation causes leaching of soil nutrients.

Other challenges include the high cost of land management in large-scale agriculture where monoculture is a common practise. Monoculture exhausts nutrients from the soil that requires constant application of fertilisers. Natural disasters such as drought, hurricanes, floods and tornadoes also pose severe challenges to agricultural production. Crops are damaged by periodic drought, floods, tornadoes and hurricanes. This damage leads to low production which, ultimately, affects the economy. The natural disasters also affect transportation network which finally hinders the movement of agricultural products from the field to storage and market centers.

Exercise 2.2

A. For this section, do the following:

1. Give the meaning of the term small-scale agriculture.
2. State the disadvantages of large-scale agriculture.
3. Differentiate between plantation agriculture and extensive cereal cultivation.
4. List four characteristics of large-scale agriculture and give three examples of plantation agriculture in Africa.
5. Mention five crops grown in large-scale farms in Tanzania and outline their uses.
6. Explain why large-scale agriculture is not practised in many areas in Tanzania.
7. Mention three conditions necessary for successful growing of coffee.
8. Outline the contribution of crop production to Tanzania's economy.
9. Mention five major challenges facing large-scale agriculture in the USA.
10. Mention four ways to improve large-scale agriculture in Tanzania.

B. Write True or False for each of the following statements:

1. Brazil is a major coffee producer in the world.
2. In Tanzania, cotton is produced in Kilimanjaro and Arusha.
3. The Gezira Scheme in Sudan is an example of an irrigation project.
4. Palm oil tree is a tropical plant that originated from South Africa.
5. Europe is the major producer of maize in the world.

C. Fill the gaps in the following table with appropriate crop or country:

Crop	Major producing country in the world
(a) Cotton	_____
(b) _____	USA
(c) Palm oil trees	_____
(d) _____	Brazil
(e) _____	Tanzania

Livestock-keeping

Livestock-keeping is the rearing of animals and poultry for food and commercial purposes. The word 'livestock' applies primarily to cattle or dairy cows, goats, pigs, camels, horses, mules, poultry and sheep. Poultry includes ducks, chicken, turkey and geese. The population growth and ever increasing demand for food supply lead to the growth of livestock-keeping. Livestock-keeping contributes to the economic development of a country

since it is a source of food as well as raw materials for industries. It is also a source of income as well as employment opportunities. Besides, it is a source of foreign currency.

Livestock-keeping is categorised into traditional or subsistence and modern or commercial livestock-keeping. Categories of traditional livestock-keeping are nomadic, semi-nomadic, transhumance and sedentary. Traditional

or subsistence livestock-keeping is practised in arid areas that receive less rainfall per annum. These places do not support crop production. Ethnic groups that engage in traditional livestock-keeping are the Maasai, Sukuma and Barbaig of Tanzania. In Uganda, it is mostly practised by the Karamajong. In Kenya, it is practised by the Maasai, the Turkana and the Samburu.

Nomadic pastoralism/True pastoralism

Nomadic pastoralism involves continual movement of pastoralists with large numbers of animals from place to place in search of pasture and water. People involved in this practise are called nomads or pastoralists. Tribes which practise nomadic pastoralism include the Maasai, Barbaig, Kwavi and Karamajong. Nomadic pastoralism is mostly practised in sparsely populated areas where the natural vegetation is mainly grass and bushes and, sometimes, scattered trees. In these areas, rainfall is very low and unreliable. The pastoralists follow specific routes in their movements. Figure 2.10 shows a large herd of cattle. The animals kept by pastoralists are a source of food and income through the selling of animals and their products. Major products from animals are meat and milk. The pastoralists spend the money they earn to meet family needs such as buying cereals, paying school fees and meeting health expenses. In addition, the cattle raised are used for paying bride price and giving gifts as well as slaughtering during cultural

festivals. To the nomads, animals are a symbol of wealth and prestige.



Figure 2.10 A large herd of cattle

Source: <http://learn.e-limu.org/topic/view/?c=48&t=276>

Characteristics of nomadic

pastoralism: The nomads normally move in groups. These groups are formed through the integration of families or members of a given ethnic group. A group involves a chief or elders who make decisions for the entire group.

Indeed, large herd tend to cause overgrazing. Overgrazing is a situation where the number of cattle is greater than the carrying capacity of the grazing land. As a result, overgrazing causes soil erosion, land degradation and loss of valuable species.

Another feature of the nomadic pastoralists is the breeding process, which is uncontrolled. This situation may lead to the spread and outbreak of animal diseases, hence low animal quality and deaths.

In addition, there is poor control of pests and other diseases, which result to poor quality of animal products. Furthermore, nomadic pastoralism takes place where the population is scarce as the animals are grazed in open range, which needs a lot of space.

Advantages of nomadic pastoralism:

Generally, managing livestock using traditional methods under nomadic pastoralism is cheap. It also ensures the availability of food to the family. In addition, indigenous species of cattle such as Zebu, Boran and Ankole are resistant to diseases. Furthermore, the animals can tolerate walking over long distances and withstanding other environmental hardships such as high temperatures. They can also stay for a long time without water. Likewise, the cattle are cheap to manage in terms of shelter.

Disadvantages of nomadic pastoralism:

Nomadic pastoralism suffers from lack of processing and storage facilities, hence causing a significant loss of the products. Also, over-grazing under nomadic pastoralism leads to soil erosion. Moreover, the control of diseases is difficult since animals are always on the move, which can affect the health of the animals and lower productivity in the process. For example, there have been cases of loss of large numbers of livestock due to lack of water and pasture. This situation affects the economy of the pastoralists. Furthermore, the practise of nomadic

pastoralism tends to cause conflicts as they interfere with crop cultivators' land. Because of their nomadic nature, many of the pastoralists' children fail to attend formal education. As such, their periodic movements result in many of these children being denied their right to education and associated opportunities.

Semi-nomadism: Semi-nomadism is a transition between total nomadism and sedentary animal keeping. It involves keeping a large number of animals especially cattle. Tribes which practise semi-nomadism include the Turkana of northern Kenya. The people involved in semi-nomadism usually travel away from their home for long periods during the dry season in search of pasture and water. This season is associated with scarcity of grass and water. Also, the semi-nomads' movements contribute to the spread of diseases among their livestock. Semi-nomads usually cultivate crops during the rainy season to sustain their lives.***Transhumance:*** Transhumance is a seasonal movement of livestock from one grazing ground to another, specifically to lowlands in winter and highlands in summer. It is a form of semi-nomadic pastoralism in which domestic animals play a predominant but not an exclusive role in shaping the economic and cultural life of the people who depend on them.

Under transhumance, pastoralism is a predominant economic activity with varying emphasis on agriculture as a supplementary activity. Countries

that practise transhumance include Switzerland, Morocco, Kosovo and the Sudan-Saharan zone of Mali.

Advantages of transhumance:

Transhumance has several advantages including an attempt to maximise productivity by exploiting annual grazing imbalances. This ensures the availability of pasture to feed the animals throughout the year. It also enhances income earning from the sale of pastoral products. In addition, it stimulates considerable national, regional and international trade. Transhumance provides raw materials such as dairy and non-wood forest products for local industries. Moreover, it provides services to other sectors of the economy, thus serving as a complementary resource for the country's overall economy. It also offers many jobs for pastoral communities and a diversity of actors involved in the livestock marketing circuit and value chain for other products.

Disadvantages of transhumance:

Transhumance has disadvantages as it accelerates deforestation (as the case of southern regions of Mali), causes damage to crops, increases conflicts and contributes to natural resource degradation.

Sedentary livestock-keeping: Sedentary livestock-keeping involves keeping animals in a permanent place. In fact, this type of keeping animals is called sedentary when livestock are permanently held in an area. Sedentary

livestock-keeping is also known as zero grazing. This type of livestock-keeping is characterised by a small number of animals that are kept in sheds.

Advantages of sedentary livestock-keeping: The size of the livestock makes it easy to control diseases since livestock-keepers use modern methods of treatment. Sedentary livestock-keeping also takes place in places where the population prevents the movement of animals from one place to another in search of food and water. Keeping animals in barns also enables the keepers to engage in other economic activities such as trade. Sedentary livestock-keeping can either be for food or commercial purposes.

Disadvantages of sedentary livestock-keeping: Despite the advantages sedentary livestock-keeping presents, it is labour-intensive and can be time-consuming. It is also expensive in terms of building barns, feeding and taking care of the animals. In fact, livestock-keepers under the sedentary system sometimes have to deal with scarcity of animal feeds. This shortage may lower productivity particularly due to change of weather conditions such as prolonged drought.

In Tanzania, sedentary livestock-keeping is commonly practised among the Chagga of Kilimanjaro, Meru of Arusha and the Bena of Njombe. In Kenya, sedentary livestock keeping is commonly practised by the Kikuyu and to some extent the Kamba. Figure 2.11 exemplifies sedentary livestock-keeping.



Figure 2.11 Sedentary livestock-keeping

Source: flickr.com/photos/ilri/16563813546

Commercial livestock-keeping

Commercial livestock-keeping involves rearing of animals for the purpose of selling their products such as meat, milk, wool and hides. Ranching, as part of commercial livestock-keeping, is mostly practised in more remote areas where land is extensive and population density is low. Extensive land provides sufficient grass to support a large number of animals. Commercial livestock-keeping is determined by factors such as capital, level of technology, market, availability of pasture and climatic conditions. In temperate regions, supplementary food such as hay and root crops are used to feed them during winter. Animals are kept for meat (beef cattle), for milk (dairy cattle and camel) and for wool (sheep).

For such commercial livestock-keeping, land is managed to control soil erosion. Pasture for grazing and supplementary food also exist. In the meantime, water holes are created to ensure the availability of water for livestock and dips for pest control. Grazing is controlled by dividing the ranch into fenced-off sections known as paddocks.

Under this system, cattle move from one paddock to another to ensure that once a paddock has been grazed it has time to recover fully before being used again. Examples of ranches in Tanzania include Ruvu and Kongwa. There are many countries in the world with ranching systems. These countries include Argentina, USA, Northern Australia, Iran, India, China and New Zealand.

Dairy cattle keeping is common in areas where pasture is rich and where animals are fed with high quality fodder during winter. Moist and mild climates favour the growth of good pasture. Dairy farming deals with milk production for sale either in liquid form or as butter and cheese. Moreover, milk is condensed into powder especially in areas which are far from dairy farms. Dairy farming is a common practise in countries such as the USA, Germany, China, Netherlands, Brazil, India, Britain, Argentina and Australia. In Africa, dairy cattle-keeping countries include Tanzania and Namibia.

Characteristics of commercial livestock-keeping

Commercial livestock-keeping takes place on a large area with low population density. More space is needed for the construction of ranches and growing grass for feeding livestock. Generally, commercial livestock-keeping is practised in more remote areas where other forms of land use are limited. Usually, one type of animal is kept for quality control of products. In addition, commercial livestock-keeping is capital-intensive as it demands money for buying land, paying for labour, fencing and buying machines and equipment. Furthermore, cross breeding in commercial livestock-keeping is an important management practise.

Advantages of commercial livestock-keeping: Commercial livestock-keeping acts as a source of raw materials for industries such as food processing, shoe and cloth making. In addition, it is one of the sectors which employs people. It also serves as a source of government revenue. Commercial livestock-keeping provides food products such as meat and milk consumed by households and industries. Moreover, it contributes to the production of goods such as shoes, bags and animal foods. The benefits of commercial livestock keeping include the ability to utilise breeds that can enhance the reproductive performance. This practise also stimulates the development of transport and communication. Commercial livestock-keeping also facilitates the control of diseases and

pests because it limits animal movement. It also uses high technology and scientific methods in management.

Disadvantages of commercial livestock-keeping: Despite the advantages, commercial livestock-keeping is costly in establishing, operation and maintenance. Moreover, it uses much of the resources mainly human and physical in the production process. Furthermore, commercial livestock-keeping needs large sparsely populated areas. If animal wastes and discards are not properly treated they can cause water, land and air pollution, and diseases.

Benefits of livestock-keeping: Livestock-keeping stimulates the growth of industries that process different animal-related products such as hides, horns and hooves as raw materials. Also it is a source of income by selling animals and their products. In addition, livestock-keeping provides employment to people, which helps to improve their living conditions. Moreover, livestock keeping contributes to government revenue.

Challenges facing livestock-keeping: Livestock keeping faces a number of challenges. Climatic changes resulting in prolonged drought may lead to shortage of water and pasture which may cause animal deaths. In tropical conditions, animals are infected by tsetse flies, causing nagana disease. There are also diseases such as East Coast Fever, Rift Valley Fever (RVF), Foot and Mouth Disease

(FMD). Inadequate financial capital for investing in commercial livestock farming is another challenge.

Livestock-keeping is affected by poor transportation for animal products from farms to markets because some areas are inaccessible. In some cases, pastoralists suffer because of unreliable markets and poor storage facilities. As a result of poor transportation networking, especially due to poor and inaccessible roads, their animal-based products get spoiled before reaching the market. However, the market is very limited because of the low purchasing power of the people in some areas. This low purchasing power affects the income of livestock-keepers and, as a result, they fail to purchase vaccines for the growth and health of animals. Moreover, insufficient availability of seminars and training on modern livestock-keeping methods lead to low production. In some areas, animals are kept traditionally due to low-level of technology. The changing climate further compromises the availability of water and pasture for the animals.

Ways of solving problems facing pastoralists: There are several measures being taken by the government of Tanzania to solve problems facing pastoralists. These measures include providing education on sustainable livestock-keeping, improving extension services in pastoral areas so as to control pests and diseases and, hence, improve production. In addition, the

government has been striving to improve infrastructure and markets. There should also be partnership between the government and private sector in developing livestock keeping. Due to population pressure, nomads should be encouraged to switch to sedentary livestock-keeping.

Focal studies

Livestock-keeping in Tanzania

Livestock production is one of the major agricultural activities in Tanzania. It contributes to the availability of food and raw materials. The sector also contributes to the country's Gross Domestic Product (GDP). The National Ranching Company (NARCO) is responsible for managing all public ranches in the country. Most of the livestock products are for the domestic market. This sub-sector needs to be developed particularly in dairy farming and its products and meat processing to meet the domestic demands and for export. Overall, livestock-keeping helps to reduce household poverty and ensure food security.

Challenges facing livestock-keeping in Tanzania

Prevalence of pests and diseases affects animals' health and, eventually, causes low or poor production. Also, overgrazing causes shortage of water, pasture and soil erosion. There is also a problem of poor transportation of livestock and livestock products from one place to another. In addition, low level of technology to improve the

animal breeds as well as preserve animal products has been another limitation in the development of livestock-keeping in the country. These challenges lead to low quality and productivity. The low livestock production in turn, lowers the quality of life of livestock-keepers and affects development generally. Lack of reliable markets is a serious threat to the sustainability of the livestock-keeping sector.

In addition, low capital investment limits the development of the livestock-keeping sector in the country. Also, inadequate land for grazing leads to conflicts between farmers and pastoralists. Nomadic pastoralists, for example, always move from one place to another in search of pasture and water. As a result, they sometimes graze on the farms, hence conflicts arise between them and farmers. With nomadic pastoralism, the animals get tired due to long distances over which they move. Sometimes, the animals get sick and die, thus leading to low production in terms of quality and quantity.

Ways of solving challenges facing livestock-keeping in Tanzania: Challenges to livestock-keeping can be reduced through encouraging and supporting individual livestock keepers and their groups to buy modern accessories such as modern cattle sheds, cattle mats and cool roofs that would improve their livestock-keeping. In this regard, they would need support with

training in modern livestock-keeping coupled with easily accessible extension services. For commercial livestock-keeping, there is a need to attract foreign investment in the sector but such investment should also be geared towards benefiting local people. Availability of domestic and international markets will promote livestock-keeping significantly.

Livestock-keeping in Australia

Australia is made up of mainland Australia, the island of Tasmania and numerous isles. Livestock industries have played a fundamental role in the development of Australia over the past 200 years, first as an essential source of food and later as the principal source of exports which triggered the economic growth of the nation and supported the development of its land and water resources. The livestock export industry supports the livelihood of many people in both rural and urban areas. The sector contributes to about 45% of the gross value of annual production of Australia's agricultural sector.

The Australian government has responsibility in the export of livestock. Its Department of Agriculture and Water Resources, for example, regulates exports in the country's livestock industry. Livestock exporters must meet high animal welfare standards in the areas of production and transportation. The Merino is one of the most prevalent and economically influential breeds of sheep.

The Merino sheep breed produces high quality wool products not only in Australia but also in other parts of the world. The Australian Merino is not a single homogenous breed but a number of ‘strains’ of sheep of which, regardless of their origins, are uniquely Australian. The Merino originally came from Spain. Australian livestock industries are spread geographically throughout the entire continent. Sheep production is largely located in the southern states whereas beef production is found in every state and territory. Furthermore, pork, dairy and poultry tend to concentrate in regions that are reasonably near the major metropolitan areas or along the coast.

Challenges facing livestock keeping in Australia

Livestock farming is affected by climate change and weather, particularly changes in temperature and water. The increase in temperature affects the quality and quantity of pasture and forage crops.

Diseases may also increase due to changes in weather and climatic conditions. In addition, the establishment of cattle and sheep keeping in most cases have resulted in negative environmental impacts. The livestock industry is also a major source of land degradation, water pollution, in addition to being a driver of deforestation. It also faces a shortage of skilled labour. This type of labour is characterised by higher education and expertise levels obtained through training

and experience. Such expertise also demands higher salaries. The shortage of such highly skilled labour force can hinder operations in the livestock industries, hence reduce productivity and lower the national income. Furthermore, improper transport, processing and shipping infrastructure reduce the quality of the livestock products.

Similarities between livestock -keeping in Tanzania and Australia:

Livestock-keeping in Tanzania and Australia has the following similarities:

Both countries keep similar types of livestock, for example, cattle and poultry. Also, both countries have set aside areas for ranching. In Australia, ranching is found at Victoria River, Alexandria Station and Anna Creek. These places are found in Queensland, South Australia, Western Australia and the Northern Territory. Examples of ranches in Tanzania are Kongwa, Ruvu, Kagera, Arusha, Morogoro, Kitulo and Lushoto.

In both countries, dairy farming is practised where there is adequate water supply and plenty of pasture. Overall, the development of the livestock-keeping sector is important in both countries. Moreover, the two countries practise livestock at both the subsistence and commercial levels. The animals and their products can be used to meet family needs and sometimes be sold to raise revenue. In Tanzania, sedentary livestock-keeping is practised in densely populated areas and, hence, with a shortage of land such

as the slopes of Mount Kilimanjaro and the Southern Highlands whereas in Australia it is practised specifically in the South East of the country.

Differences between livestock-keeping in Tanzania and Australia: Livestock-keeping in the two countries has the following differences: The majority of livestock in Australia is kept for commercial purposes. Australian sheep, particularly the Merino, are mainly kept for wool production. More than 60 percent of livestock products from Australia are exported to Europe and other continents.

Livestock-keeping in Tanzania, on the contrary, is mainly for meeting domestic demands with some few animals and animal products being exported, but on a lower scale than in Australia. In Tanzania, sheep and goats are kept for meat and skins. Moreover, the application of science and technology in livestock-keeping is much more advanced in Australia than it is in Tanzania. The main rearing system of livestock-keeping in Tanzania is pastoralism and zero-grazing, whereas in Australia it is primarily the ranching system. In addition, Australia has many industries for processing animal products, whereas in Tanzania efforts are underway to establish such industries on a commercial scale.

Economic importance of livestock-keeping: In Tanzania and Australia livestock-keeping is important because it stimulates other sectors of the economy, for example, the development of transport and communication networks and processing industries such as leather and milk. Moreover, livestock-keeping promotes trade through selling animals and animal products within and outside these two countries. It also promotes employment to different people who work in processing industries. Livestock-keeping provides skins, hides, cheese, butter, milk and meat. These products are sold and enable individual households and the nation to earn money. Furthermore, the sector generates revenue to these countries through tax collection from the industries operating in this livestock sector. It also encourages the use of marginal lands. Livestock-keeping, especially ranching and pastoralism, which need large open areas, make use of land which is otherwise not suitable for other uses. Farmers also apply cattle manure to add nutrients to the soil and improve productivity.

Livestock farming businesses provide direct employment for the Australian people. The livestock and livestock processing industries also generate about \$11.2 billion in export revenue annually. In fact, the value of these exports has increased steadily over recent years generating foreign currency.

Exercise 2.3**A. Circle the letter of the best answer**

1. Traditional livestock farming is practised in areas where there is:
 - (a) Very low rainfall
 - (b) Heavy rainfall
 - (c) No rainfall
 - (d) Dry lands
2. Examples of pastoralists include:
 - (a) Maasai, Barbaig and Karamajong
 - (b) Sukuma, Gogo and Nyamwezi
 - (c) Sangu, Kwavi, Ngoni and Hehe
 - (d) Ngoni, Sukuma and Maasai
3. Examples of societies that do not practise sedentary farming are:
 - (a) Sukuma, Gogo and Nyamwezi
 - (b) Chagga, Meru and Bena
 - (c) Sukuma, Meru and Nyamwezi
 - (d) Turkana, Maasai, Karamajong.
4. Three categories of commercial livestock-keeping are:
 - (a) Pastoralism, sedentary and nomadism.
 - (b) Traditional, modern and pure livestock-keeping.
 - (c) Beef livestock-keeping, dairy livestock-keeping and sheep-keeping.
 - (d) Traditional livestock, cattle-keeping and diary livestock-keeping.
5. Large-scale livestock farming is conducted in:
 - (a) Ranches
 - (b) National parks
 - (c) Zero-grazing
 - (d) Urban areas

B. Match each statement in Column A with the correct phrase in Column B:

Column A	Column B
1. A type of agriculture involving growing of cash crops on large areas of land, mostly in tropical regions.	(a) Tanzania, Ethiopia and Ghana
2. Agriculture confined to the production of food crops for consumption by household members.	(b) Commercial livestock-keeping
3. The system of keeping animals alongside cultivation.	(c) Slash and burn
4. Another name for shifting cultivation.	(d) Agriculture
5. Beverage crops produced in plantations.	(e) Mixed farming
6. Labour is provided by the owner of the land and members of the family.	(f) Subsistence agriculture
7. A system of agriculture aimed at making profit through regular sale of farm products.	(g) Coffee and tea
8. Countries practising the ranching system in the tropical savannah of Africa.	(h) Tea, cocoa and coffee
9. It refers to the rearing of livestock with the main aim of producing meat, milk, wool and hides for commercial purposes.	(i) Plantation agriculture
	(j) Small-scale agriculture
	(k) Large-scale agriculture
	(l) Ranching
	(m) Tanzania, Kenya and Uganda
	(n) Coffee, maize and tea

C. Answer the following questions:

1. Mention four crops that are grown in plantations.
2. Explain what nomadic pastoralism means.
3. Describe the primary purposes for keeping cattle.
4. Outline main challenges facing livestock keeping in Tanzania.
5. Suggest ways of solving challenges facing livestock-keeping in Tanzania.
6. Elaborate challenges facing livestock-keeping in Australia.
7. Differentiate between traditional and commercial livestock-keeping.

Chapter Three

Water management for economic development

Introduction

In this chapter, you will learn about the uses and economic importance of water; the relationship between family size, water supply, and the quality of life; the relationship between vegetation and water supply; and the effects of distance to water sources from households to a girl child in Tanzania. You will also learn about river basin development, requirements for establishing a river basin project, as well as benefits and challenges facing river basin projects. Finally, you will learn about land reclamation, underground water, aquatic resources, pollution and water conservation.

The concept of water management

Water is a colourless liquid found naturally on the land surface, atmosphere and underground reservoirs. Water can exist in liquid, solid, or gas state. Although water is a familiar substance, it is also a unique material of the earth. For a long time, water has been considered to be an abundant resource which is found freely to all people. Today, most countries are facing increasing pressure on water resources and growing competition between differing interests. Chronic water scarcity is perceived to be one of the threats to global prosperity and stability. Other threats include hydrological uncertainty and extreme weather disasters such as floods and droughts.

Access to water is fundamental to economic and social development. However, population growth, rapid urbanisation and industrialisation, the expansion of agriculture and tourism, and climate change all put water under increasing stress. This situation has impacted negatively the socio-economic development of most developing countries. As a result, at the global level, there is a major concern regarding the management of water resources. Water resources management emerged as a response to real and foreseen water crises and increasingly unsustainable pressure on the freshwater resources, which emanate from rising populations, growing demands for water due to competing water uses, and increasing pollution.

Water resource management refers to the process of planning, developing, distributing and managing the effective use of water resources. In today's interconnected world, there is no doubt about the value of integrated planning for sustainable development. There is a need to have an integrated water resources management that supports the economic, social and environmental dimensions of sustainable development. Integrated Water Resources Management is one of the initiatives for sustainable use of water resources, and it refers to a process of promoting the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. The management helps to protect the environment, foster

economic growth and sustainable agricultural development, promote democratic participation in governance, and improve human health.

Sources of water

There are several sources of water. These include rainfall, wells, springs, ponds, rivers, lakes, seas and oceans. There are various ways used to manage water resources. These are policies, by laws, regulations, and awareness raising campaigns.

Fresh water and hydrological cycle

The hydrological cycle is a continuous circulation of water from the earth's surface to the atmosphere through the process of evaporation, evapotranspiration, condensation, precipitation and infiltration. Figure 3.1 illustrates the hydrological cycle.

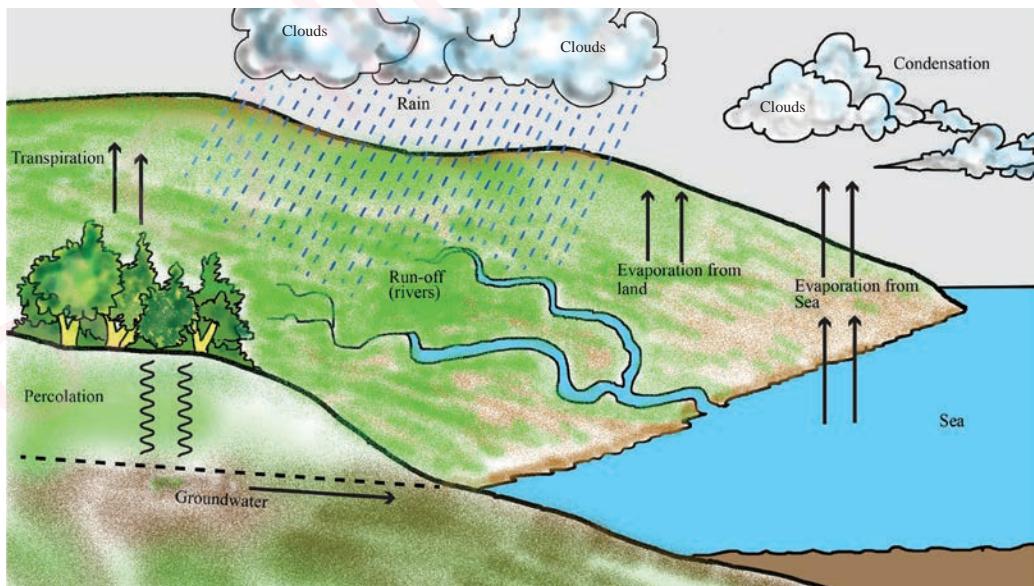


Figure 3.1 The hydrological cycle

Evaporation

Evaporation is the process by which water changes from liquid to gas or vapour. During evaporation, water moves into the atmosphere in the form of water vapour or moisture (see Figure 3.2). Water bodies such as rivers, lakes, seas and oceans contribute about 90% of the moisture found in the atmosphere through evaporation. Water changes into vapour under the great influence of temperature. Areas with high temperatures and low humidity experience a high rate of evaporation. Evaporation is also determined by humidity and wind.

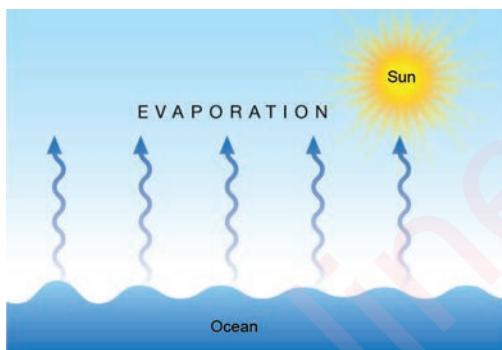


Figure 3.2 Evaporation from ocean water

Evapotranspiration

Evapotranspiration refers to the process whereby water is transferred from the land to the air through plant roots and leaves. Water from the land is carried by roots to the leaves, a process known as transpiration, and then from the leaves it changes into vapour and moves into atmosphere through the process of evaporation. The combination of these two processes form what is termed as evapotranspiration (Evaporation + transpiration = evapotranspiration) Figure 3.3. Evapotranspiration is determined by factors such as temperature, humidity, wind, soil and type of plants. These factors are hereby explained.

Temperature: An increase in temperature accelerates the rate of evaporation. During the warm season, plants open their stomata (pores) and then release water in the form of water vapour. During the cold season, plants close their stomata and thus prohibit the release of water. It should be noted that 10% of the moisture in the atmosphere is contributed by release of water from plants.

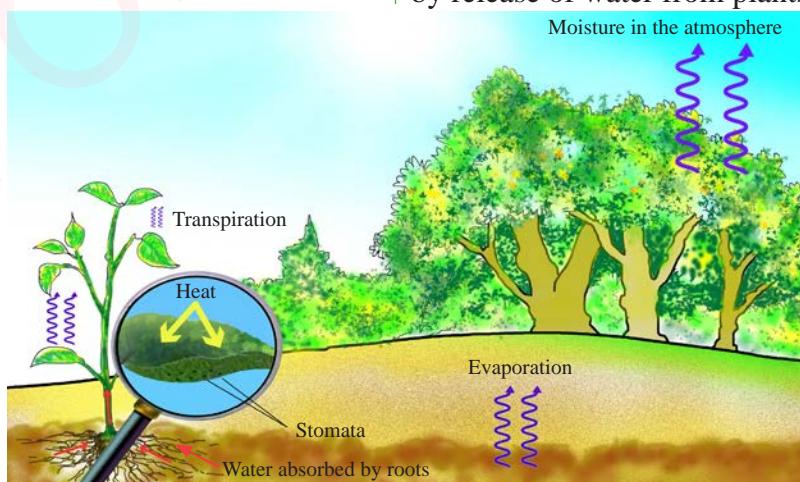


Figure 3.3 Evapotranspiration

Humidity: Evapotranspiration is also affected by humidity. When the air around the plant contains too much moisture, the rate of evapotranspiration is low. Indeed, when moist air surrounds the plant, the rate of evapotranspiration is low and vice-versa.

Wind: Wind affects evapotranspiration by keeping air in constant movement. This movement increases the rate of evapotranspiration as it clears any humidity around the plants, hence increasing the rate of transpiration.

Soil: The type of soil also determines the amount of water that can be retained in the soil and the amount of water that can be drawn from the soil through transpiration or evaporation. Fertile soil tends to support the growth of vegetation which increases the rate of evapotranspiration. Soil, which supports vegetation, allows much evapotranspiration to take place.

Types of plants: Plants with long taproots carry large amounts of water to the leaves, hence influencing the rate of evapotranspiration compared to plants with shallow roots.

Condensation

Condensation is the process whereby water in its gaseous form changes into liquid. The moist warm air from water bodies and plants moves upwards where there is very low temperature. Then it reaches a dew point (point at which water condenses) and forms clouds.

Clouds are masses of water droplets which continue to accumulate and when they are saturated, they become dense and fall as rain. Condensation is a very essential process in the hydrological cycle because it leads to the formation of clouds which produce rainfall (Figure 3.4). Rainfall is the main route through which water returns to the earth's surface.



Figure 3.4 Heavy clouds in the air

Source: ruvumapress.blogspot.com-mawingu mazito

Precipitation

Precipitation is the falling of water from the clouds in form of rain, snow, sleet or hail. Figure 3.5 shows different forms of precipitation. It is the last stage that demonstrates the return of water to the earth's surface after changing into a gaseous form. Precipitation may be heavy or light thereby creating heavy rain, snow or hail. Whereas rain is directly in liquid form, snow and hail are water in solid form as a result of freezing. Water reaches the ground in form of snow or hail after the temperature in the atmosphere fails to melt it completely before reaching the

ground. Upon reaching the ground, which has higher temperature than the atmosphere, the snow and hail melt into liquid as surface run-off. Also some water infiltrates into the earth's surface through soil and cracks.



Figure 3.5 Different forms of precipitation

Source:pinterest.com-forms of precipitation

Infiltration: Infiltration, which is sometimes called percolation, is the process whereby water that has reached the ground penetrates into the soil or rocks (Figure 3.6).

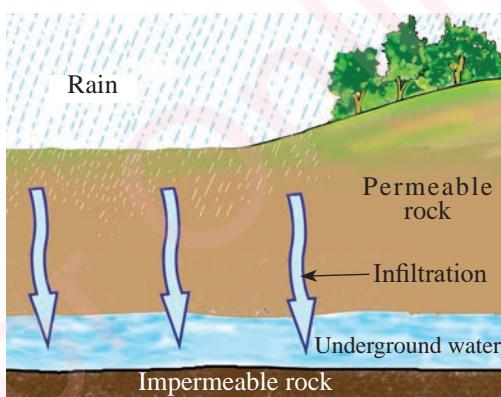


Figure 3.6 Water infiltration into the soil

Some of the water may seep through and go deep underground and create underground runoff or aquifer in the rocks. Water that percolates the land

surface is called underground water. Infiltration is an essential process as it feeds water bodies and soils which are sources of evaporation and evapotranspiration.

Economic importance of water

Water is a source of life for almost all living organisms including animals and plants. Numerous economic activities are conducted in water while others use water as part of raw material.

Human beings are primary users of water and integrate it in their economic activities in various ways. Their ability to plan and conduct economic activities is basically supported by water. Water is used as an important ingredient in sustaining life, especially for cooking, drinking and maintaining cleanliness. Generally, water is essential for economic development. It is used in the manufacturing industry, hydro-electric power generation, and navigation as well as domestic activities and trade.

Moreover, water is used in various processing and manufacturing industries for the production of food and beverages. It is important in mixing ingredients that are added to raw materials during food and beverage processing and production. For example, water is a component of most beverages such as soft drinks, milk, coffee and tea. These beverages contribute to the economy of many countries as a source of income generation. They are sold locally and exported to earn foreign income. Other

industrial uses of water include cooling and washing.

Also, water is important for irrigation purposes. Many countries around the world do not depend completely on rainfall for agriculture due to its uneven distribution. To ensure that agricultural activities are carried out largely for commercial purposes, irrigation has proven to be the best option. For example, in Tanzania, there are irrigation schemes in rice paddy plantations; these are Mbarali rice farm, Kapunga rice farm in Mbeya Region and sugar-cane plantations in Kilombero and Mtibwa in Morogoro Region; and Kagera sugar plantation in Kagera Region. Other countries which use water for irrigation on a large-scale in Africa include Sudan and Egypt. The irrigated plantations produce high output which contributes to economic development through sale in local markets and for exportation.

Water is also a source of electrical power. Modern economies depend much on the supply of electricity. One of the sources of electric power is water to produce what is commonly known as hydroelectric power (HEP). HEP is one of the cheapest and environmentally friendly sources of power. This power is used in industries to run machines, transport goods and provide services as well as in communication systems. Moreover, power contributes to the establishment of small and large-scale economic activities which eventually contribute to the economic growth of a given country.

Furthermore, water is useful in the navigation sector in various ways. Human beings navigate different vessels such as canoes, boats, ferries and ships to move people and goods. Transportation of heavy machines for factories and industries, vehicles, timber and logs is made possible on water. In Tanzania, water transport on lakes and oceans facilitates the importation and exportation of various goods such as machines and vehicles. In fact, water as a means of transport is likely to reduce the transport cost compared to other means of transport and, hence, contribute meaningfully to economic growth. Water is the habitat for aquatic organisms such as fish which are useful to human beings. Usually, water bodies such as oceans, sea, lakes, rivers, dams and ponds attract fishing and, hence, fishing related activities. Fishing provides human beings with food and income through local selling and exportation of fishing products. In addition, water is used for trading which supports local communities to earn income and the government to get the much-needed revenue.

Other uses of water which contribute to economic growth and prosperity are tourism and sports. Some water sceneries attract local and foreign tourists which helps to earn income for the host countries. Water-based sports such as skiing, surfing, canoeing and diving are also sources of income.

Family size, water supply and quality of life

Family size refers to the number of family members. The size of the family influences the household water demand and use, hence making it central to any measurement of socio-economic status. Indeed, the larger the family, the higher the water demand for domestic use. With adequate and reliable supply of water, the quality of life is improved as families will not need to spend most of their time searching for water.

International Treaties and Declarations of the United Nations recognise the right to water as essential for securing an adequate standard of living. The reason is that water is one of the most fundamental conditions for survival. The right to water, emphasises that everyone should have access to sufficient, safe and affordable water for personal and domestic uses. Article 11 of Human Rights of the United Nations recognises the right of everyone to adequate standard of living, including adequate health, sufficient food and shelter, all of which require access to clean water.

Many people in the world and particularly in the developing countries have inadequate water supply to meet their daily needs. Indeed, shortage of water has a serious health implication as it can lead to illness and even death among the poor in many developing countries. Water-borne diseases such as cholera, bilharzia, typhoid and

diarrhoea are common in areas with scarcity of water supply. About three-quarters of households in sub-Saharan Africa get water from sources located away from their homes, with women and girls bearing the main task of collecting water for their respective households.

Effects of distance to water sources on the girl-child in Tanzania

Water fetching in most Tanzanian societies is a cultural and gender-related activity in terms of who is responsible for carrying it from the sources. The responsibility of fetching water and the overall water management in households is influenced by gender and cultural norms. The burden of fetching water is borne by both women and children, particularly girls. They travel over long distances to fetch water for domestic purposes.

These distances coupled with other factors such as difficult terrain, poor water flow, and queues at the water sources take a lot of time from girls. Fetching water appears to have direct effect on the physical health of the girls and their ability to participate in domestic responsibilities.

Children, particularly girls, experience pains or movement problems associated with walking long distances in search of water. This, in turn, is associated with disability linked to spinal disorders and cervical compression syndromes. In addition, walking over

long distances while carrying water contributes to psycho-social and emotional suffering. The suffering can have general health implications that may lead to disability and affect work performance. Moreover, incidents and fear of physical and sexual violence are widely reported by women and children in relation to water-fetching activities.

The extent of the problem of walking over long distances to water sources is more pronounced in low and middle income societies than in high income ones. Since economic, political and social inequalities are reflected in access to drinking water, the marginalised groups may suffer differently from the negative economic and health effects of carrying water over long distances. Furthermore, this situation leads to material deprivation for women, lack of voice and capacity to cope with any form of crisis. This, in turn, widens the poverty gap and gender inequalities in Tanzania.

In addition, carrying water over long distances limits women's participation in productive economic activities, hence low school enrolment for girls. Access to water and sanitation is, therefore, related to the time that girls need to attend school, and can be among the reasons that keep them out of school. Therefore, access to fresh water and sanitation does not only

improve the health of a family, but also provides an opportunity for girls to attend school and spend their time more productively on academics than on fetching water.

Relationship between vegetation and water supply

Vegetation refers to the collection of plants growing in a particular area under certain climatic conditions. Vegetation growth depends on various factors such as rainfall, temperature, soil and relief. In particular, rainfall provides water which is required for the growth of plants. Areas with dense vegetation cover tend to experience high rates of evapotranspiration which is necessary for rain formation.

The amount of water supply in a particular area also determines the type of vegetation growth. For example, due to their semi-arid climatic conditions, central parts of Tanzania such as Dodoma and Singida experience little rainfall in a year. The vegetation cover is mainly shrubs with little influence on formation of rainfall. On the other hand, areas with equatorial climate are covered with thick vegetation (equatorial rainforests). This type of vegetation has significant influence on rain formation due to high rates of evapotranspiration determined by high temperatures in these regions. High rainfall results in adequate water supply.

Vegetation cover plays an important role in protecting catchment areas. In other words, vegetation reduces the amount of water loss in those areas. As a result, enough water supply to those areas is maintained. In Tanzania, the areas around the slopes of Mount Kilimanjaro experience constant flow of water throughout the year because of the presence of thick vegetation cover.

It should be noted that plants require different amounts of water for their growth. However, water is not evenly supplied. As such, plants adapt differently to their physical environment. This is one of the reasons for the different sizes and appearance of the plants in different geographical areas. For example, in dry areas, plants develop adaptation mechanisms.

The leaves develop thorny leaves or a waxy surface to reduce loss of water through transpiration. Plants develop deep roots in the ground to reach water. Other plants develop storage organs. For example, a baobab tree stores water in its trunk. Some plants shed their leaves during periods of water scarcity. The relationship between vegetation and water supply may be influenced by human activities such as water drilling and deforestation. Water drilling may increase water supply in areas with water scarcity and, thus, influence the growth of the planted vegetation. On the other hand, deforestation exposes the area previously covered by the forest to evaporation and thus destroys

the catchment areas. As a matter of fact, deforestation may turn an area into arid or semi-arid land.

Exercise 3.1

Answer the following questions:

1. What is the correct term for plants releasing water from their leaves, which then evaporates?
 - (a) Evaporation
 - (b) Precipitation
 - (c) Transpiration
 - (d) Condensation
2. What is evaporation?
 - (a) Water freezes
 - (b) Water vapour meets cold air and changes back into liquid
 - (c) Water gets warm and changes from liquid to water vapour
 - (d) Plants take in water from the soil
3. What is the correct term for the rising water vapour meeting with colder air and turning back into water droplets?
 - (a) Condensation
 - (b) Precipitation
 - (c) Evaporation
 - (d) Infiltration
4. Transpiration is...
 - (a) soil infiltration.
 - (b) water turning directly from ice to water vapour.
 - (c) evaporation from the leaves of trees.
 - (d) runoff from steep hills.

5. The process by which water is taken up by plants and released into the atmosphere is called:
 - (a) Condensation
 - (b) Evaporation
 - (c) Precipitation
 - (d) Transpiration
6. Name five uses of groundwater.
7. How and where does groundwater flow?

River basin development

A river basin is an area of land drained by a river and its tributaries. It has features such as tributaries, watershed and convergence. Tributaries are small rivers flowing into larger rivers whereas a watershed is an area of highland surrounding a river basin. Convergence, also known as confluence, is a place where a river joins another river. Figure 3.7 shows the sections of a river basin.

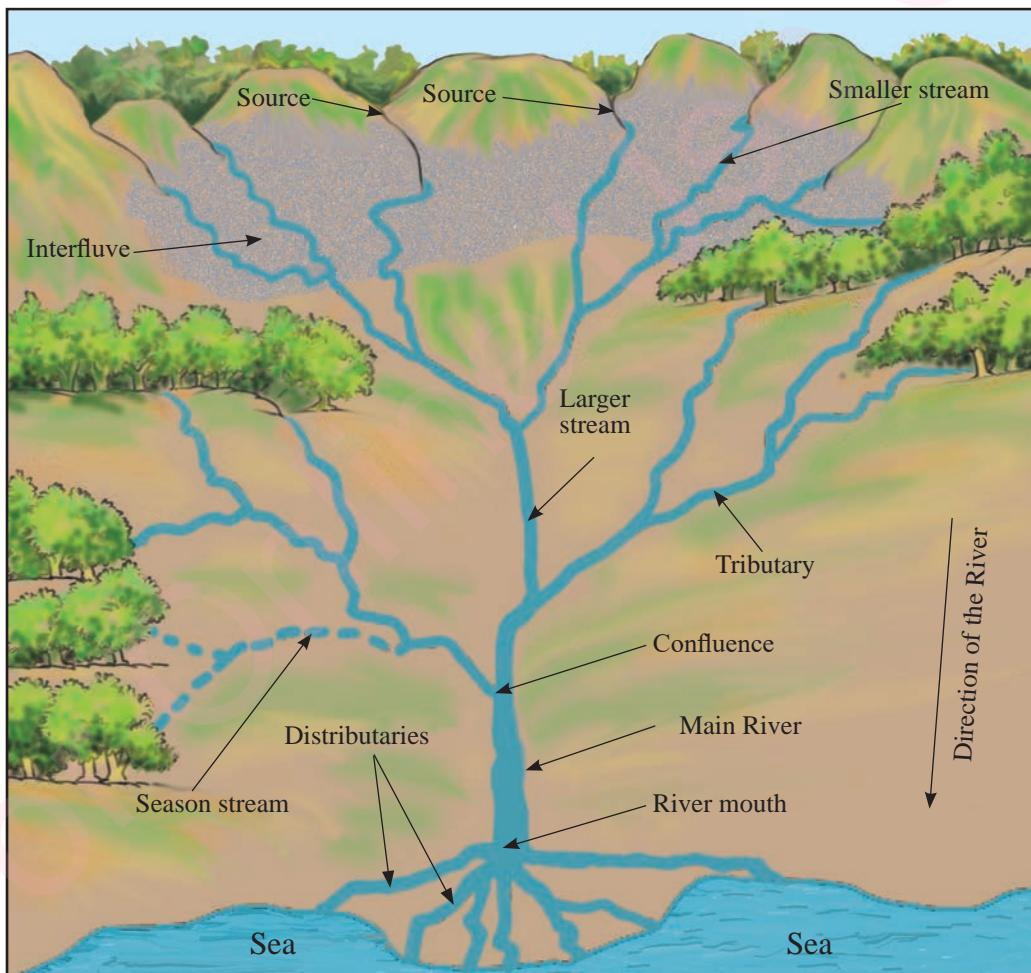


Figure 3.7 Sections of a river basin

River basin development is a long-term planning and management for a multipurpose project focusing on sustainable utilisation of the area within the basin. River basin development may include better land use, better water use, adequate energy and food supply, transport, flood control and protection of the environment.

A good river basin requires constant volume of water. This increases the possibility of carrying out various development projects. Projects which take place in river basins should not have negative impacts on the people or the environment. The impacts may include disturbing the habitat of various species such as fish. Other impacts are water pollution, disease outbreak and resettlement of villages.

In Tanzania, environmental impacts are controlled by carrying out Environmental Impact Assessment (EIA). The EIA aims to establish potential environmental impacts that may be caused by a given project that is planned to be conducted. It is usually done by a registered expert through the National Environment Management Council (NEMC).

Requirements for establishing a river basin project

As river basin projects serve social and economic purposes, they need to be carefully designed by observing a number of issues. The following are some of the requirements which should be observed when establishing a river basin project:

- (a) Construction of dams for retaining water.
- (b) Removal of silt or mud from the river or dam (dredging).
- (c) For transport purposes, the river channels should be straightened and widened so that they can accommodate more water.
- (d) Trees should be planted on marginal land, hill slopes and riverbanks. This will help to control soil erosion and check the movement of surface run-off, to reduce or prevent silting and flooding.

If such requirements are observed river basin projects will achieve the expected benefits.

Benefits of river basin development projects

The benefits of a river basin project vary depending on the nature and scale of the project, location and administrative structure. The lower section of rivers is usually exposed to excessive rain water, causing floods. To prevent floods, basin management establishes dams which serve as collection areas of excessive water. River basins in their natural state may hardly be safe for human settlement. In fact, the establishment of basin development projects increases the value of the basins and makes them more conducive for human settlement. This compels governments to extend social services such as infrastructure, health and education.

River basin development also attracts irrigation. Due to availability of water in a basin, commercial agriculture is

established through irrigation schemes. Sometimes, individual peasants use a well-managed river basin for watering their small farms using traditional mechanisms such as buckets. In addition, river basin development projects involve planting of trees and construction of dams. They also involve strict measures for prohibiting deforestation and poor cultivation practises. All these measures aim to foster appropriate use of the land to keep it productive. These measures also enable the preservation of the ecosystem. By doing so, these projects contribute to preventing the land from being eroded by environmental problems such as soil erosion, floods and loss of soil fertility.

Basin development projects involve the establishment of hydroelectric power plants following the construction of dams. The water from the dams is used to generate electricity for domestic and industrial purposes. In Tanzania, Mtera, Kidatu and Kihansi dams in Rufiji Basin are hydroelectric power stations. In addition to hydroelectric power, the constructed dams create opportunities for fishing; for example, Mtera Dam is one of the dams where fishing activities take place. Moreover, well-managed basins which have gorges, waterfalls, man made reservoirs and land scenery attract tourism. Tourism is one of the potential sources of income and contributes significantly to the national economy.

Basin development projects also generate employment opportunities in agriculture, forestry, tourism, transport and fishing. Such development projects contribute to income generation for the country and, consequently, to the growth of its economy. Nevertheless, there are challenges resulting from the establishment and running of these projects.

Challenges facing river basin projects

River basin projects face numerous challenges. Many of these challenges are caused by natural events and human activities that take place in the basins. These are described below.

Siltation

Siltation is one of the challenges facing river basin projects. The water in dams depends on the supply of water from highland areas through streams and rivers. Usually streams flowing into dams carry some sediments which ultimately accumulate in the dams. This accumulation of sediments leads to a decrease in the volume of water which may have numerous impacts. These impacts may include lowering the ability of dams to produce enough water necessary for electricity generation, in addition to affecting transport and destroying marine organisms.

Water pollution

Water pollution is another challenge related to the dam projects. In many cases, modern agriculture involves the use of agro-chemicals. These agro-chemicals dissolve in water and get

transported to the dams through water streams which may affect marine organisms, including fish.

Costs

Generally, the establishment and maintenance of river basin projects is costly. The cost may be higher particularly when the basins encounter unexpected natural events such as droughts or excessive rainfall. Whereas droughts reduce the volume of water in dams, excessive rainfall may lead to overflow and too much siltation in the dams. The overflow damages property and farms in outlining areas.

Trans-boundary conflicts

Some basin projects face management challenges as they extend to different countries. As a result, establishing any project in one of the partner countries of the basin may require a consensus from other countries which is not always guaranteed. For example, the Nile Basin is shared by Tanzania, Uganda, Sudan, Egypt, Ethiopia, South Sudan, Kenya, Rwanda, Burundi and Eritrea. For decades, there has been complaints from upstream countries (Kenya, Uganda, Tanzania, Ethiopia and Sudan) about the dominant use of the Nile waters by Egypt. The Nile Valley Initiative is a project that aims to solve these disputes peacefully.

Rufiji Basin in Tanzania

The Rufiji river basin is managed by the Rufiji Basin Water Board (RBWB) under the Ministry of Water. It is one of

the largest river basins in Africa, and covers an area of about 177,420 km². This basin occupies 20 percent of the country. It occupies parts of Iringa, Njombe, Mbeya, Ruvuma, Morogoro, Dodoma and Pwani Regions (Figure 3.8). The basin contains the Rufiji River which is the largest river in Tanzania. It originates from the south-western highlands. It has four main tributaries, namely, the Great Ruaha, Kilombero, Luwegu and the Rufiji lower section. These four tributaries join to form the Rufiji River.

There are several socio-economic activities within the basin which benefit individuals and the nation. These include agriculture, tourism, hydropower generation, fisheries, mining and livestock keeping. Land in the Rufiji Basin is used mainly for agriculture, tourism, wildlife conservation, fisheries and mining. Agriculture is mainly practised in the Usangu Plain in Mbeya and Kilombero Basin in Morogoro.

Apart from being rich in water resources and biodiversity, the basin is endowed with a good climate, fertile soil, minerals and human resources. It is known for its agricultural production and is often called the “bread basket” of Tanzania. Within the basin, there are important national parks (Kitulo, Ruaha, Mikumi, Udzungwa and Uluguru), large game reserves (the lower part of Selous, Rungwa, Usangu, Mpanga/ Kipengere, and Lunda), forest reserves, and pasture for livestock.

Fishery is practised in the Kilombero, Great Ruaha and Rufiji rivers.

Mining projects are developed in the Selous Basin at Namtumbo District where Uranium is developed and copper project in Iringa District at Nyang'oro Hills. Because of its large agricultural, hydroelectric and other potentials, the basin is the focus of the Government of Tanzania, donor and private development plans. It has also attracted large numbers of people migrating to the area seeking land for cropping and raising livestock. According to the national census of 2012, the districts within the basin had 9,032,089 people compared to 3,055,051 in 2002. It also contains Kihansi spray toads, which are a unique species for tourist attraction. These frog species are not found anywhere else in the world.

Benefits of the Rufiji Basin Water Board

- i. It has promoted the market of HEP from Kidatu power plant.
- ii. There has been flood control.
- iii. It has led to the creation of employment opportunities in the valley, thus promoted living standards of people.
- iv. It has led to the development of villages and towns, for example new towns like Kidatu, Makambako and Mikumi.
- v. The board provides expert advice to the farmers on good farming practice and solutions to their farming problems.
- vi. A number of large irrigation projects

on sugar and rice are carried out in the Kilombero Valley and Usangu Plains respectively.

- vii. There has been an increase in the planting of teak and rubber trees in some parts of the Rufiji Basin. These trees can potentially benefit the timber and rubber industries in the country. The irrigation projects also increase agricultural products for food and commercial purposes.

Challenges facing the Rufiji Basin Water Board

Apart from having benefits, the RBWB is also facing some challenges including the following:

- i. Poor labour supply due to out-migration to urban centers.
- ii. Diseases like cholera and malaria affect the farmers such that they fail to contribute effectively in the development of the scheme.
- iii. Climate related problems like drought have been affecting water availability; sometimes the volume of water in the river decreases. Climatic changes are experienced in most parts of Tanzania including Rufiji Basin, with prolonged drought and unreliable rainfall leading to insufficient water supply. This situation affects food production in the basin, sugar plantations, HEP and wildlife.
- iv. Transport problems prevail, especially during rainy season during which the area is not always accessible.

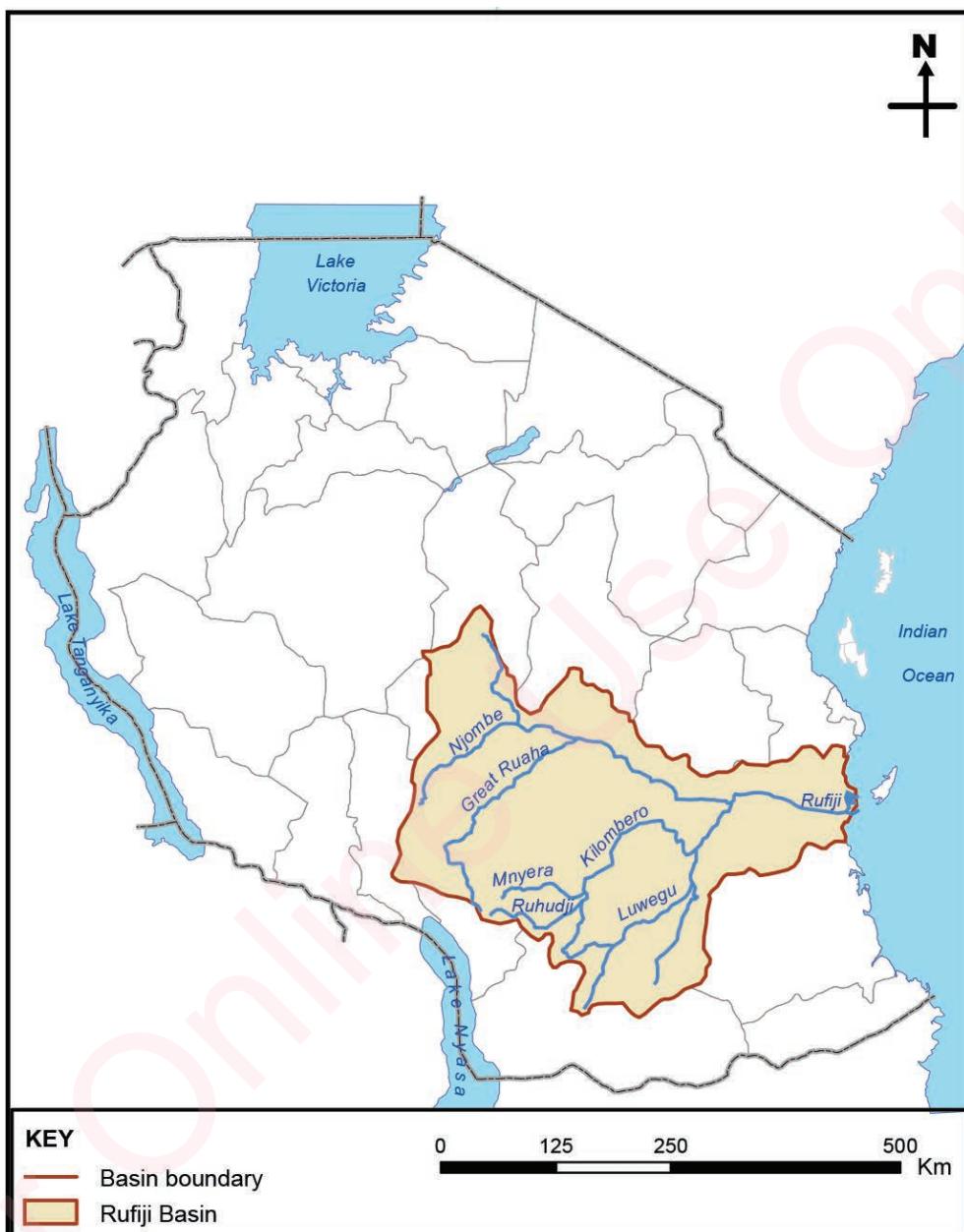


Figure 3.8 The Rufiji River Basin in Tanzania

Other river basin development projects

There are various river basin development projects in Africa under different authorities. In Tanzania, the river basins include Rufiji River Basin in which the Stiegler's Gorge project (Nyerere Hydroelectric Power Plant) for generation of hydroelectric power is located, and Kagera River Basin which is jointly managed by Tanzania, Rwanda, Uganda and Burundi. Other river basin development projects in Africa include the Gezira Irrigation Scheme (Sudan), Aswan High Dam (Egypt) and Galole Irrigation Scheme (Kenya). Others are the Volta River Project (Ghana), Orange River Project (South Africa), Cabo Bassa Basin (Mozambique) and Tana

River Development Project in Kenya. Outside Africa, river basin development projects include the Ganges Project (India), Amazon Basin Development Scheme (Brazil), and Tennessee River Basin Project in USA.

The Tennessee Valley Authority

The Tennessee Valley Authority (TVA) is a federal cooperation agency in the United States of America (USA). It is the largest public power company in the United States. It supplies electricity to millions of people in the USA. Tennessee River is a tributary of the River Ohio River, and the Ohio is a tributary of the River Mississippi River (Figure 3.9). The Tennessee River Basin lies in a seven-state area in the

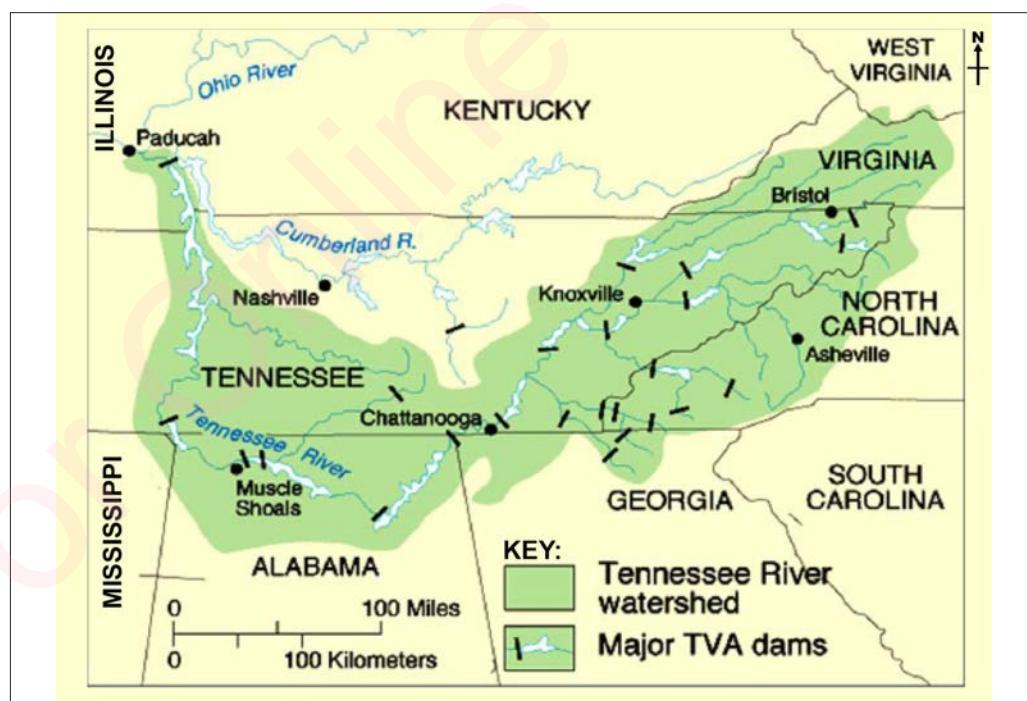


Figure 3.9 Tennessee Valley Authority

Source: bkushistory.pbworks.com/tva

south-eastern part of United States. Its drainage area covers 40,900 square miles (105,930 square kilometers), mostly in the State of Tennessee, but with parts also in Kentucky, Virginia, North Carolina, Georgia, Alabama, and Mississippi.

The TVA was established in 1933 by the US Government. The development of TVA was triggered by social and economic conditions in the Tennessee Valley in the 1930s. During those years the region was largely rural and undeveloped, poverty-stricken, and characterised by degraded environmental conditions due to poor farming methods. Similarly, there was severe erosion, extensive deforestation and deteriorating environment.

The establishment of the TVA was meant to achieve four key functions, which are: (i) To improve navigability and provide for the flood control of the Tennessee River; (ii) To provide for reforestation and the proper use of marginal lands in the Tennessee Valley; (iii) To provide for agricultural and industrial development of the Tennessee Valley; and (iv) To provide for national defence by the creation of a corporation for the operation of government properties. Later, after its establishment, the functions of the TVA were expanded to include:

- i. Management of the Tennessee Valley River system for multiple purposes including navigation, flood control, power generation, ensuring water quality, public land conversation, recreation, and

- economic development;
- ii. Generation of electricity;
- iii. Sale and transmission of electricity to wholesales and large industrial customers; and
- iv. Transmission of economic development activities that generate a higher quality of life for citizens of the Tennessee Valley.

Benefits of the Tennessee Valley Authority

The TVA has achieved many aims for its establishment. These are described in the following sections.

Power generation

TVA has the responsibility of providing reliable, affordable electric power that helps businesses and families prosper. In 1998 the main sources of power were hydro and thermal, which represent nearly 14 percent of TVA's total generating capacity. In 2008 the authority supplied power to 159 local power companies that served 8.7 million people, and 650,000 businesses and industries in the seven-state TVA area. In 2017, TVA's power portfolio contained 30 dams or hydroelectric facilities, eight coal plants, 16 natural gas plants, three nuclear plants, 14 solar energy sites, and one wind energy site. Currently, TVA supplies power from a diverse energy portfolio that includes nuclear, coal-fired, natural gas, hydroelectric, and renewable power. This is supplied to more than 10 million customers within the valley. Today, TVA is the largest public utility and one of the largest

electricity providers in the United States. Likewise, the generation of power has stimulated different manufacturing and heavy industries in the valley.

Environmental stewardship

TVA was mandated with the responsibility of managing the natural resources in the Valley for the benefit of the region and the nation. For example, the TVA manages the Tennessee River system and neighbouring public lands so as to reduce flooding, maintain navigation channels, support power production and recreation, improve water quality and supply, and protect shoreline resources. Currently, the authority has a sophisticated system of dams to control flooding along the Tennessee River watershed. This provides an opportunity of controlling the floods by controlling about \$ 260 million in flood damage annually. To date, the operation of this system has prevented over US\$5.4 billion in flood losses across the Tennessee Valley, including about US\$ 4.9 billion in damage averted at Chattanooga the Valley's most flood-prone city. The system has also prevented about US\$ 470 million in flood losses in the lower Ohio and Mississippi River drainage basin.

Economic development

TVA builds businesses and community partnerships that bring jobs to the region and keep them there with a view to making the economy stronger. For example, the Tennessee River has

always been a key to the economic development of the TVA through commercial ships which facilitate the movement of goods and machinery. Likewise, the authority managed to construct dams which increase the water supply for irrigation, domestic and industrial uses. Consequently, the dams have also led to the development of fishing industries for domestic and commercial purposes.

The TVA has managed to increase the land for the cultivation of crops. The land, which was earlier affected by soil erosion, has now been controlled using various methods. Trees have been replanted and good cultivation practises, such as construction of terraces, have been applied on the valley slopes. All these measures have stabilised agricultural production, which is a good indicator of agriculture's contribution to the improvement of income of the people in the Tennessee Valley. The TVA was charged with the following short-term objectives: To control floods, improve navigation, develop HEP, improve the land along the river banks, conserve soils and carry out reforestation projects to check erosion in the region.

TVA was also involved in other activities such as industrial development, wildlife conservation, forest, road and rail development, malaria control, planning for towns and educating farmers in sound agriculture techniques. The long-term aim of TVA was to raise the

standard of living of the people in the area. Moreover, the TVA has established more than 100 public parks and camping sites to attract tourists. Tourists visit the valley because of a number of attractive natural and man-made land sceneries. These developments in the basin have contributed to the establishment of a strong tourism industry in the valley.

Prospects of the Tennessee Valley Authority

The Tennessee Valley Authority is one of the largest river basin development projects in the world. Despite the innumerable successes achieved so far, TVA still has more room to establish more development projects. The authority aims to exploit sustainably every potential opportunity undertaken in the valley. TVA intends to increase electricity production to meet the ever increasing demand for electricity in the valley. The authority has expressed a desire of achieving more success in its 2019 Integrated Resource Plan (IRP). This is a long-term plan that provides direction on how TVA can best meet the electricity demand in the next 20 years. TVA also intends to provide electricity to the people at a price affordable to everyone.

Through this plan, TVA intends to provide regular updates to customers and stakeholders on every development and opportunity available.

It has also plans to conduct periodical online seminars to the public. These seminars aim to inform the entire USA community on initiatives geared towards improving the Tennessee River Basin. The seminars also intend to collect views from the public on how to improve the valley in future. The main target of the projected improvement which is emphasised by TVA when seeking the views from the people include increasing tourist attraction centers, expanding employment opportunities, improving water quality and aquatic life. Generally, TVA plans to ensure that the Tennessee Valley becomes a habitable place with minimum challenges.

Exercise 3.2

A. Answer the following questions:

1. Define a river basin.
2. Explain what a river basin development project is.
3. Describe necessary conditions for river basin development.
4. With reference to Rufiji Water Basin and TVA, explain how a community can benefit from the river basin.
5. Explain why river basin development projects are challenging to the authorities that manage the basins.

B. Match the development scheme in Column A with its corresponding country in Column B

Column A	Column B
1. Gezira Irrigation Scheme	(a) Brazil
2. Aswan High Dam	(b) India
3. Galole Irrigation Scheme	(c) Pakistan
4. Rufiji Basin Water Board	(d) USA
5. Amazon Basin Development Scheme	(e) Sudan
	(f) Egypt
	(g) Kenya
	(h) Tanzania

Land reclamation

Land reclamation refers to a process of turning waste or poor land into a useful state. In other words, land is changed from not being valuable to being valuable. It is turned into a state in which it can be used for growing crops, keeping animals, fostering settlement and boosting industrial development.

When land is reclaimed, it is termed as reclamation ground. Land reclamation aims to increase areas for agriculture and settlement. The reclamation also aims to obtain land for industries and places for recreation. Further, the focus is also on improving transport systems on the land and waterways as well as controlling floods that might take place in an area. Nevertheless, land reclamation processes are expensive and may damage corals and marine life

if not handled with great care. The reclaimed lands can also be vulnerable to natural hazards such as earthquakes because they are in most cases not as strong as naturally situated lands. In fact, the reclaimed land can easily sink when there is an earthquake. Erosion may also be severe in the reclaimed land because of the nature of the soil. Soil in the reclaimed land is not as compact as in the naturally situated land.

Methods used in land reclamation

Methods used for land reclamation depend on the nature, location and size of the land to be reclaimed. For example, land may be reclaimed from water bodies, dry land, saline land and swampy area.

These different types of land require different methods of reclamation as elaborated below:

- (a) Land affected by stagnant water or covered by water, draining techniques can be applied. The excess water is removed from the land by draining to make it useful for the intended purpose. An example of land reclamation by draining out water is the Zuider Zee Project in the Netherlands. In this project, dykes or high walls were built to enclose seawater and thus prevent it from entering the land. Then, the enclosed water was pumped out. The land obtained is regularly drained to remove salt for farming and settlement use.

- (b) Reclamation of a land affected by soil erosion differs from land covered by water. Soil affected by erosion calls for planting of trees. Trees will act as binding agents for keeping the soil particles together and absorbing excess water which would otherwise flow rapidly over the land. Moreover, using better methods of agriculture such as contour ploughing, terracing and strip farming especially in steep slopes helps to prevent erosion.
- (c) Land may also be reclaimed by restoring its fertility. In this case, land which has lost fertility may require planting cover crops and addition of organic manure and fertilisers to improve its fertility. The fertility will attract vegetation growth. Vegetation will not only bind the soil but also protect it from excessive loss of water through transpiration.
- (d) Land affected by excessive animal keeping can be restored by reducing the number of animals in the area. This simple reclamation method allows the land to be proportionally used.
- (e) Steep slopes may be reclaimed by levelling the land.

Land reclamation in Tanzania

There have been various projects and efforts for land reclamation in Tanzania. The major reclamation projects have been carried out by the government through its agencies and international agencies. In particular, major reclamation projects have been carried out in Dodoma and Shinyanga regions. They are soil conservation programmes better known by their Kiswahili acronyms as HADO (Hifadhi Ardhi Dodoma) and HASHI (Hifadhi Ardhi Shinyanga).

The HADO project was a large project implemented by the Government of Tanzania in 1973-1997, and was funded by the Swedish International Development Agency (SIDA). The main objective of the project was to conserve land and water, and rehabilitate the already depleted areas, particularly the severely affected Irangi Hills. The project strategies focused on promoting tree planting, bee-keeping, soil and water conservation, reclaiming degraded land, and local participation in conservation matters. The method of land reclamation involved the construction of terraces and cutting off drainage to check the speed of runoff water. However, the construction was not successful as grazing animals and uncontrolled runoff destroyed the barriers. HADO also involved wide areas, which were eroded due to uncontrolled livestock-keeping. As a result, huge gullies developed.

Therefore, to minimise the destruction of the barriers, about 85,000 animals (cattle, goats, sheep, and donkeys) were removed from the area. Afforestation was carried out to hold the soil and check the speed of runoff. The government stopped livestock from using these areas. The government through HADO campaigns also advised people interested in grazing to size down their livestock and try to practise zero-grazing. Significant gains have emerged from HADO initiatives.

Generally, the land has been restored as soil fertility and vegetation in the worst degraded areas have gained a new lease of life. The areas which were no longer useful for supporting human activities have been transformed into potential farming areas also suitable for other nature dependent activities.

Sustainable use of water resources

Water resources come in many forms, but the three main categories are saltwater, groundwater and surface water. Sustainable use of water resources includes all activities relating to current and future use of water resources in terms of protection, conservation and management. There are surface and underground water sources.

Salt water: Salt water fish are a staple in much of the world's diet (although overfishing and pollution has put much of the marine life population at risk). Furthermore, tidal waters are being used as a source of hydroelectric energy. So, while saltwater is not helpful in dealing

with scarce water supplies, it does provide resources that humans rely on.

Underground water: This is the most plentiful of all freshwater resources. As water percolates into the ground through layers of soil, clay, and rock, some of it adheres to the topmost layers to support plant growth. Most often, groundwater is accessed by humans via wells. To build a well, one must drill down past the water table. In most cases, a pump is placed at the bottom of the well, and water is pumped into homes, businesses and water treatment plants, where it is then distributed for usage.

Surface water: Surface water is water that exists in streams and lakes. This water is primarily used for potable water supply, recreation, irrigation, industry, livestock, transportation and hydroelectric energy. Over 63 percent of the public water supply is withdrawn from surface water. Irrigation gets 58 percent of its water supply from surface water. Industry gets almost 98 percent of its water from surface water systems. Small amounts may come from small channels.

Some springs release hot water, hence the name "hot springs". Other springs may eject hot water and steam hence the tag "geysers".

Boreholes

Sometimes, underground water gets out through human force. One way of getting out the water for various uses is through drilling of holes which are

called bores, hence the term borehole. The hole is drilled through the earth using a drilling machine until the water table is reached. The depth of the borehole may range from few to several hundred metres depending on the level of the water table. For a constant supply of water, the borehole is deepened down to a permanent water table. The water has to be raised by a mechanical or by electrical water pump. Figure 3.10 illustrates a borehole.

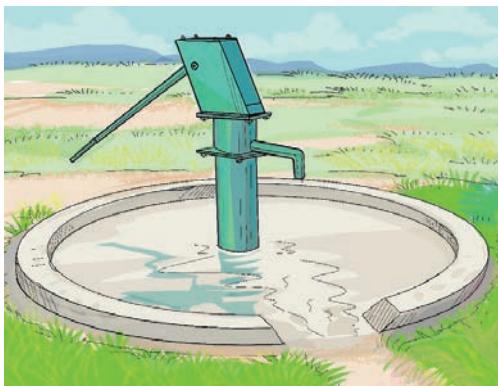


Figure 3. 10 A borehole

Underground water

Underground water is water beneath the earth's surface particularly in the faults or joints of rocks and soil pores. Usually, underground water is found in the rock spaces (aquifers) which collect after infiltration through rock faults or joints. The rocks that allow water to seep through are called permeable rocks (Figure 3.11). The rocks with holes or pores through which water can pass are called porous rocks whereas rocks with joints or faults through which water infiltrates are called pervious rocks.

The process of underground water formation primarily depends on the amount of rainfall in a particular area and the nature of rocks found there. When rain falls, water infiltrates through the soil and fills the joints and forms underground water. The water becomes naturally stored and ultimately gets out through springs, bore holes and wells.

Springs

Springs refer to natural overflows onto the land surface after the aquifer has been filled with infiltrating water, or when the water table meets the earth's surface. The amount of water released from the spring depends on the nature of the rocks and the position of the water table. A large amount of water from a spring can form a river while small amounts may form small channels.

Wells

A well is a structure usually constructed in the ground by digging to access water. The depth of the well depends on the level of the water table of the area. The walls of the well may be lined with bricks or stones to prevent them from collapsing into the bottom of the well. Sometimes well water is drawn from a shallow well. The water from shallow wells is mostly obtained from the soil and not rocks. In many cases, the water from shallow wells is largely unsafe for drinking by human beings if not treated. Figure 3.12 illustrates a water well whose water is drawn manually using a bucket.

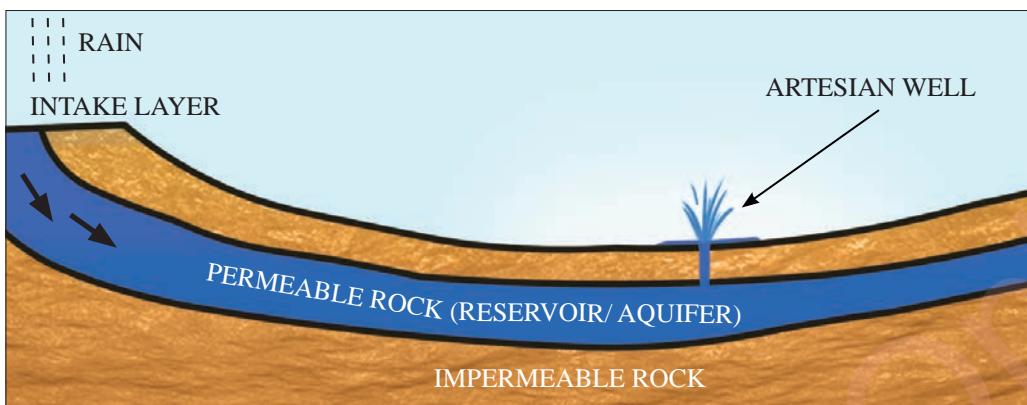


Figure 3.11 Rock structure for underground water

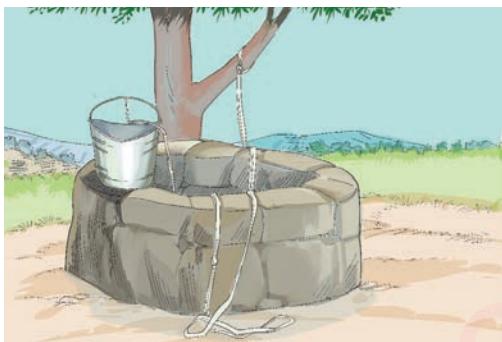


Figure 3.12 A well for drawing water manually

Areas where tapping underground water is practised widely in Tanzania include Dodoma, Singida, Dar es Salaam, Shinyanga, Manyara, Mara and Tabora. Due to climatic change, even areas which had enough surface water are facing water shortages. As a result, the government and individuals are now tapping underground water for different uses.

Resources obtained from water

A resource is anything useful that can be utilised if necessary. It is a stock consisting of substances such as water, minerals, air, forestry resources or land. Water resources are essential

and important assets for human beings. There are different types of water resources. These include fish, plantations, oil, natural gas, decoration materials, salt and some building materials. The seas and oceans possess mineral riches whose exploitation could be of great use to people. Exploitation of oil in Nigeria has made the country one of the stable countries in Africa in terms of economic development. The seas and oceans possess a wealth of minerals such as copper, manganese, nickel, cobalt and salt. Apart from vast oilfields, the continental shelves are rich in gas fields. All these water resources are of great use for the wellbeing of people in Africa.

Water resources are tapped using varying methods in different countries. Fishing is done using traditional as well as modern methods. Mwanza, Kigoma, Ruvuma, the coast of the Indian Ocean and Zanzibar are good examples of areas that exploit fish for domestic and industrial use. Japan is an excellent example of a country that exploits water resources through fish farming.

Fish can be farmed and harvested in the same way as crops. Fish is carefully tamed in special areas and containers and harvested for domestic use.

Other applicable methods depend on the scale of fishing. In many cases, small-scale fishing relies on the use of traditional methods as described below:

Hand lining method: This consists of a long stick or rod and hook attached to a string. A bait is attached to the hook to attract fish. The fisherman sinks the hook into the water to catch the fish. The method is time-consuming.

Trap method: A trap is used where there is a flood or along the coast where there are tides. The traps are set up at the bank of a river or on beaches. The fish is washed onto the banks or beaches by water and as the water goes back, the fish remains trapped behind in the traps.

Fish basket method: This method is used in shallow water lagoons and swamps, whereby a woven basket with an opening protruding inward is placed at the bottom of the water. A bait is placed inside the basket to attract fish. The fish enters the basket and fails to move back-Large-scale fishing is carried out in deep waters in the oceans and lakes. In Tanzania, large-scale fishing is practised in lake Victoria, Tanganyika, and Nyasa as well as in the Indian Ocean.



Figure 3.13 Fishing using a basket

Source: thisisafrica.me

Trawling method: A trawl net is a big bag-shaped net whose mouth is kept open by boards. Its mouth has floats at the top and weights at the bottom to pull it down (Figure 3.14.) The net is pulled by a trawler.

As the vessel moves, the fish is caught in the open mouth of the trawler net. When sufficient amounts of fish have been trapped the vessel stops and the net is pulled into the boat.

Other water resources

Other water resources include **oil**. Oil in Nigeria is obtained using a process of distillation after the extraction of crude oil. Refineries are used to distil crude oil into different by-products. **Building materials** from the sea are usually obtained by quarrying. Tanzania is one of the countries which quarry building materials along the Indian coast at an area known as Kunduchi.

Salt in Tanzania is obtained at Uvinza (Kigoma) and from Lake Balangida in Manyara through extraction and evaporation.

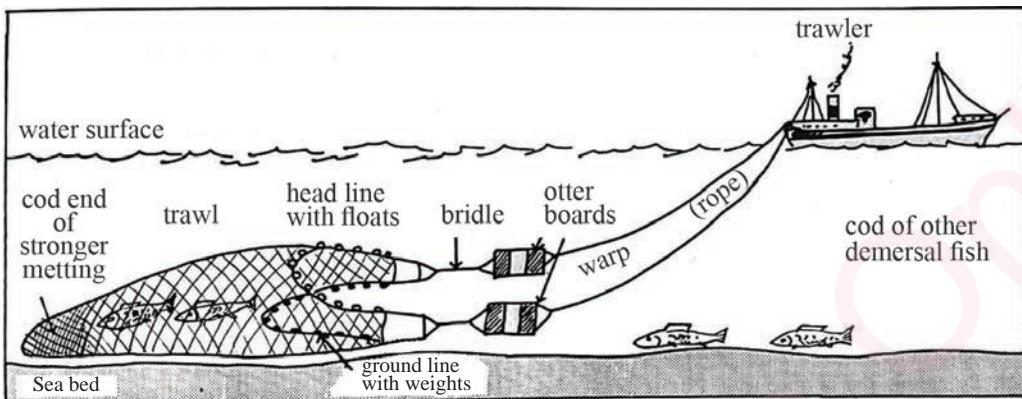


Figure 3.14 Fishing by trawling

Problems resulting from the extraction of water resources

Different methods used in harnessing water resources have resulted in both social and environmental impacts as explained below.

- (i) Pollution of marine water is one of the impacts the world is facing as a result of poor and bad methods of exploiting water resources. Polluted water affects marine animals such as fish and planktons.
- (ii) Illegal, unreported and unregulated fishing has resulted in some fish species disappearing.
- (iii) Poor methods of quarrying for building materials has led to further land degradation of shores in addition to the destruction of fish breeding areas and coral reefs.
- (iv) Excessive exploitation of marine life does not only lead to loss of life but also reduces the amount of fish, cuts down breeding capacity and replacement capacity of other species.
- (v) Pollution of water, apart from affecting the life of fish, may also damage the near shore marine environment.
- (vi) Pollution from industrial activities as is the case with oil drilling regions of the Niger Delta has resulted in damage to the environment in nearby shores.
- (vii) When fresh water resources become saline, they can no longer be used for irrigation or drinking. Saline water is toxic to plants, and high sodium levels cause dry soils to become hard and compact and reduce their ability to absorb

water. Ground water extraction and irrigation can increase salt concentrations in water. Irrigation can also cause salinization by raising the water table and lifting saline ground water near the surface into the root zone. This occurs when irrigation efficiency is poor, so a large fraction of irrigation water infiltrates into the soil, and groundwater flow is slow. A similar problem occurs in some regions when trees are cut down.

Water pollution

Water pollution occurs when harmful substances of different quality, quantity and form are mixed in underground water. The water may be polluted through discharging waste in it or mixing it with chemicals usually from factories and industries. Besides, water pollution is also caused by domestic practises especially channelling toilet waste into water streams. All the materials which pollute water are called pollutants. Water pollution is at times caused by the construction of latrines directly in the ground. This way of pollution affects mostly underground water. The latrines tend to seep wastes into the underground water. Many homes and industries with no access to sewerage systems rely on shallow underground disposal of waste.

This way of waste disposal contaminates shallow wells which may cause water-borne diseases such as cholera, diarrhoea and typhoid. Shallow wells are mostly

the source of water for domestic use in many communities, especially those which have no formal water supply from authorised dealers.

Transportation and storage of materials which may spill and leak is another source of underground water pollution. For example, chemicals used in manufacturing, processing and construction industries sometimes are not transported and stored by observing any specified handling precautions. This leads to spillage and leakage to the ground and, consequently, seepage into the soil which pollutes underground water through infiltration.

Furthermore, underground water is at times polluted by human activities in their effort to use the land to earn a livelihood. Experience shows that modern farming is characterised by the use of fertilisers, herbicides, insecticides and pesticides. The misuse of these chemicals in farming harms the soil and once rain falls the chemicals contaminate the underground water through infiltration.

Underground water can also be polluted naturally through volcanic eruption. This occurs in areas characterised by eruption of poisonous volcanic materials from the interior of the Earth. The erupted materials finally seep into the soil and mix with underground water. Generally, pollution of underground water is harmful to the lives of people and other living

organisms, which directly or indirectly use the water.

Ways of conserving water

Water conservation refers to the process of preserving and using water efficiently to reduce unnecessary loss. Water conservation is best done when collective efforts from individuals, groups, private agencies and the government bring about the desired results.

Each of the members in a given nation has a role to play in water conservation. The following are some of the measures for water conservation.

- (a) Preventing loss of water during irrigation can be achieved by applying efficient methods such as drip irrigation.
- (b) People should be educated on the importance of conserving water.
- (c) Water re-use is largely advisable. For example, water from the kitchen may be used for plant watering and water from laundry may be used for cleaning toilets.
- (d) It is advisable to make routine check-ups in the water supply system to ensure that there are no leakages. Doing so will ensure efficient use of water because most of the water will end up in the intended places.

(e) Watering should be done when necessary, particularly in the morning or late in the evening when the temperature is low, to avoid excessive evaporation.

(f) Sewage pits and canals should be properly connected to recycling systems for effective disposal. Therefore, there is a need to ensure that the laws and regulations of the land aimed to protect and conserve water are adhered to.

Exercise 3.3

- A. Write **True** or **False** for each of the following statements:
1. Condensation causes water vapour to turn into water droplets.
 2. Rocks that contain joints or faults are called porous rocks.
 3. Rocks that have pores through which water can infiltrate are called pervious rocks.
 4. There is a relationship between rainfall and underground water.
 5. Underground water can be polluted by improper solid waste disposal.

B. Briefly answer the following questions:

1. What are the causes of water pollution?
2. How can water pollution be controlled among communities in Tanzania?
3. What were the reasons for the establishment of HADO and HASHI projects?
4. What is the contribution of Rufiji Water Basin to environmental conservation?
5. What are the advantages of TVA in the United States of America?
6. What are the common domestic practises for water conservation in your community?
7. How is underground water accessed in Tanzania's societies?

Chapter Four

Sustainable use of forest resources

Introduction

In this chapter, you will learn about types of forests, distribution of forests by type, factors for their distribution, and the importance of forests in social and economic life. You will also learn about the importance of forests in the ecological and environmental balance as well as challenges facing the forest industry.

The concept of forest

A forest is an extensive area of land mostly covered by trees of different sizes, species and other forms of undergrowth. By 2015, it was estimated that forests covered about 31% of the earth's surface. Forest distribution on the earth's surface varies. Such variation is caused by the amount of rainfall available and the length of wet and warm seasons per year. Forests can be absent in some areas even where the climatic conditions allow tree growth. Absence of forests in extensive areas can be caused by actions of human beings and wild animals.

Human beings obtain various products and services from forests. Forest products can be timber and non-timber products that help to sustain human life. Non-timber forest products include fruits, honey, leaves, roots and barks. The process of managing forest resources for human use is known as forestry. Foresters engage in lumbering, which is an activity that involves cutting,

transporting, processing and selling timber. The terms 'timber' and 'log' are used interchangeably to mean branches or pieces of the trunk of a tree, but with the bark attached. Harvesting of forest resources is generally sustainable when there is no or little damage to the general environment. A forest can be natural or planted. Animals, birds and insects use forests to support their lives. Forests provide aesthetic value and services to human beings.

Natural forests: A natural forest refers to a collection of trees that have grown naturally. The types of natural forests include equatorial rainforest, tropical monsoon, deciduous, coniferous and mangrove. The natural forests are found in many countries. Figure 4.1 shows the distribution of various world natural forests.

Equatorial rainforest: This type of forest is found in the equatorial region between 5°N and 5°S of the Equator. In this forest there are large and tall trees

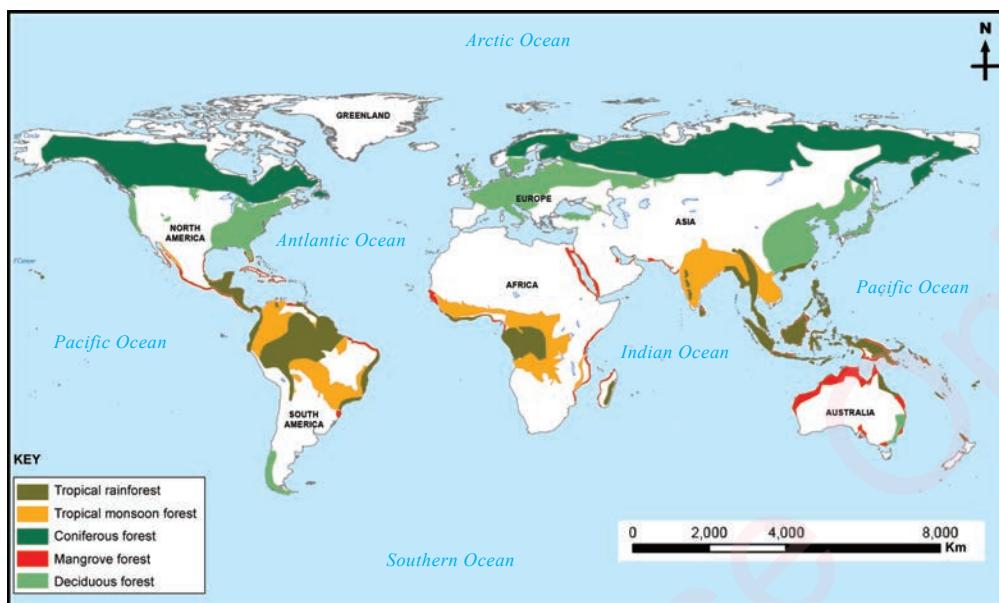


Figure 4.1 Distribution of the world's natural forests

that grows to over 80 metres high. Figure 4.2 shows an equatorial rainforest.

In Tanzania, equatorial rainforests are found in coastal areas, Kagera, Kilimanjaro and Kigoma regions. Other areas in the rest of the world that have equatorial rainforests are low-lying lands of the Congo Basin in Central Africa and the coastal lands of West Africa. This type of forest is also found in the Gulf of Guinea, West of Sierra Leone, Cameroon and Gabon, Eastern Coast of Madagascar, Amazon Basin and Malaysia.



Figure 4.2. Equatorial rainforest

Source: <http://erkundengeography.blogspot.com>

Characteristics of an equatorial rainforest

An equatorial rainforest has some characteristics that distinguish it from other types of forests. In an equatorial rainforest, the vegetation grows in layers. The upper layer forms a continuous canopy, which provides shade for lower layers. Trees grow to over 80 metres high. The second or middle layer grows up to about 30 metres high. The lower canopy grows to a range of 5 to 15 metres high. It consists of shrubs, palms and ferns with little undergrowth.

The trees in this tropical rainforest are of different species, which include mahogany, rosewood, greenheart, ironwood and ebony. Most trees have large buttress roots. In addition, tropical rainforests contain climber trees.

Nearly all the trees are broad-leaved and evergreen due to the availability of

rainfall throughout the year. However, due to constant climatic conditions, plants produce flowers, fruits and shade their leaves at the same time.

Mangrove forests: Mangroves are a collection of salt tolerant trees and shrubs that grow on estuaries and deltas of tropical and subtropical coastlines. Figure 4.3 shows mangrove forests. Mangroves grow well in places where fresh water mixes with sea water and where sediments are composed of accumulated deposits of mud. Most of the mangroves grow within 30° North and South of the Equator. Only a few of them have adapted to temperate climates.

In Tanzania, mangrove forests cover most of the coast of the Indian Ocean (Dar es Salaam, Tanga, Mtwara, Pwani and Zanzibar). Many mangrove forests are disturbed by human activities. In Tanzania, the least disturbed mangrove forests are found in the Rufiji Delta. Other countries with mangrove forests include Nigeria, Mozambique and Madagascar.

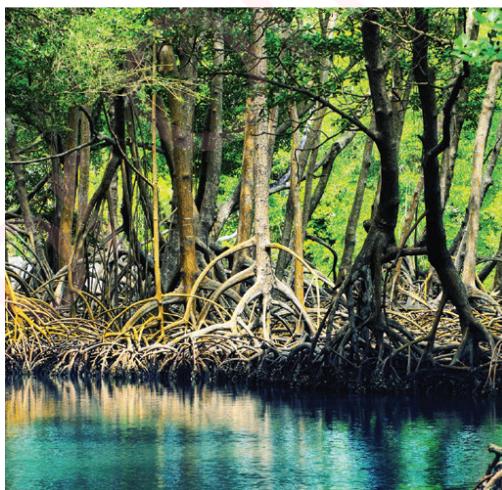


Figure 4.3 Mangrove forest

Source: <https://www.animalwised.com/endangered>

Characteristics of a mangrove forest: A mangrove forest has various characteristics that distinguish it from other types of forests. Trees in mangrove forests have deep root systems to enable them to withstand wave action. The roots in these forests are stilt and project above mud and water to absorb oxygen. Trees in these forests tolerate high salt concentration, which makes them grow and survive in salty water and mud. Mangrove trees usually provide hard timber. Hard timber is very useful in building houses or making boats.

Tropical monsoon forests: Tropical monsoon forests consist of deciduous trees that shed their leaves during the dry season. Figure 4.4 shows a section of a monsoon forest. These forests are located in the monsoon climate beyond the equatorial region between 10° and 25° North and South of the Equator. These forests are found in areas with seasonal rainfall, along coastal regions of Southwest India, Sri Lanka, Bangladesh, Myanmar, South Western Africa and North-East and South-East Brazil.



Figure 4.4 Tropical monsoon forest

Source: <https://www.wikiwand.com/en/Tropical>

Characteristics of a tropical monsoon forest: A monsoon forest has characteristics that distinguish it from other types of forests. Monsoon forests contain thick undergrowth of shrubs and small trees. This poses a challenge to people and animals when it comes to passing through these forests. However, the forest is more open compared to equatorial rainforests. The main trees in these forests are teak, acacia, casuarina and bamboo. Trees in this forest are moderately tall compared to trees of other types of forests. They grow up to 30 metres high. Trees are not as close as in tropical evergreen forests. Due to this reason the undergrowth tends to be a bit thick.

Deciduous forests: Deciduous forests are composed mainly of broad-leaved trees that shed all their leaves during the dry season. Figure 4.5 shows a part of a deciduous forest. These forests are located between 30° and 50° North and South of the Equator. They are found in the eastern side of North America, Western Europe, Northern Coast of China, Japan, Southern and Western Australia.



Figure 4.5 Deciduous forest

Source: <https://pediaaa.com/wp-content/uploads/2018/08>

Characteristics of a deciduous forest Deciduous forests have characteristics that distinguish them from other types of forests. They contain trees with broad leaves. Trees in these forests usually shed their leaves in autumn and they remain leafless throughout the cold winters to minimise loss of water by transpiration. Deciduous forests are composed of a mixture of various tree species. Deciduous forest trees include oak, elm, chestnut, maple, willow, ash and beech.

Coniferous forests: Coniferous forests have needle-like leaves and cone-shaped fruits. They are found in areas with long winters and moderate to high annual precipitation. Figure 4.6 shows a part of a coniferous forest. Coniferous forests are located between 50° and 70° North of the Equator. They cover an extensive area

of North America and Asia. They are also found on highlands and in mountainous areas. In Tanzania, coniferous forests are found in Mufindi in Iringa and Njombe. The climatic condition in these areas is mostly cold, which supports the growth of coniferous trees.



Figure 4.6 Coniferous forest

Source: <https://sites.google.com/site/teambarb28>

Characteristics of coniferous forests: Coniferous forests have characteristics that distinguish them from other types of forests. Trees in these forests are in most cases evergreen. In addition, the trees have needle-shaped leaves that limit transpiration in winter. Trees and fruits are conical in shape to avoid the accumulation of snow on branches and leaves. The trees in coniferous forests are of one type covering large areas. Species of coniferous trees produce soft wood. Coniferous trees include pines, fir, spruce and hemlock.

Planted forests: Planted forests refer to a collection of trees by human beings. These forests cover relatively large areas of land. Figure 4.7 shows part of a planted forest at Sao Hill in Iringa. Trees in these forests are of specific value such as commercial or land conservation. Planted forests are usually grown on a large-scale or small-scale basis. In many cases governments and companies or groups of people establish large-scale forests while small groups of people or individuals establish small-scale forests. In Tanzania, notable planted forests are in Iringa, Kagera, Kigoma, Kilimanjaro and Arusha regions. Trees are established through seeding and planting of either native or exotic species. These forests are properly managed from planting to harvesting time to ensure high productivity.

Characteristics of planted forests: The major characteristic of planted forests is that they are composed of trees which result from deliberate influence or intervention of human beings. However, there are other characteristics which distinguish them from natural forests.



Figure 4.7 Planted forest at Sao Hill

Mafinga - Iringa

Source: <https://dailynews.co.tz/news>

Most of the planted trees are of the same species because forest growers aim at specific tree species for targeted value. For example, at Sao Hill, most of the trees are pine and eucalyptus. Usually, trees in planted forests are of the same age because they are planted at the same time though the growth speed of the trees may vary. The difference in growth may cause them to be harvested at different periods. In addition, the difference in the harvesting of trees in planted forests may be caused by a system of planting trees in blocks.

Planted forests are regularly cleaned by removing unwanted undergrowth, which may hinder the healthy growth of the planted species. Foresters provide close

and strict supervision from planting to harvesting because of the commercial value of the trees. For example, planted trees in Sao Hill are for electrical polls, paper-making and timber production. Timber is sold locally or exported.

Factors influencing distribution of forests

The distribution of forests on the earth's surface depends on many factors. The common ones are temperature, rainfall, relief, soil, drainage and aspect.

Temperature: Temperature is a notable factor influencing the distribution of forests. Different plants require different temperature ranges. Temperature limits the growth of trees, thus leading to shallow forests or no forest at all. Areas that are hot and humid such as the equatorial region encourage the growth of large trees with broad leaves. Cooler temperate climates that experience snowfalls support coniferous type of trees that can withstand low temperatures and freezing conditions.

Rainfall: The distribution of forests is also influenced by rainfall. Forests thrive well in areas with plenty of rainfall of over 1200 mm throughout the year. The dense equatorial forests have thrived well because of the presence of heavy rainfall that is well distributed throughout the year. In deciduous forest regions, trees that can survive the dry season exist. These trees shed their leaves during the dry season to reduce water loss through transpiration as their means of survival.

Relief is another factor that influences the distribution of forests. It determines soil, temperature and vegetation distribution across gradient. Tree distribution varies with altitude. For example, on Mount Kilimanjaro at 1800-3000 m above sea level, forests consist of diverse tree species. At higher altitude (3000 m), alpine heath dominate. Thus, differences in relief are associated with variations in the type of forests.

Soil: Soil contributes much to the distribution of forests. In this case, soil type, drainage, texture, permeability, porosity and chemical composition play a significant role in tree growth. For example, soil rich in humus encourages tree growth, which may turn into a forest. Regarding drainage, well-drained soils support a variety of trees whereas poorly drained soils such as swamps or steep slope areas with immature soil cannot support tree growth. For example, coastal tropical areas with sea alluvial salty water attract mangrove forests growth. Also, tropical rainforest trees require deep well-drained soils for proper binding together whereas coniferous trees have fibrous roots which can grow in shallow soils.

Aspect: Aspect refers to the position of a place in relation to the sun. The influence of aspect on tree growth is well noted in temperate latitudes. In the Northern Hemisphere, the south-facing slopes are warmer than the north-facing slopes. In the Southern Hemisphere, on the other hand, the south facing slopes are cooler

than the north facing slopes. Trees need temperature and rainfall as important elements for their growth. Therefore, in the Northern Hemisphere the south facing slopes tend to have more dense forests compared to the north-facing slopes.

Human activities: Forest distribution can also be influenced by human activities in different ways. For example, cultivation, herding and mining contribute to the disappearance of forests. Indeed, large-scale agriculture requires the clearance of large areas of forests. In the meantime, industrial demand for hard and soft wood necessitates people to increase the size of planted forests. Extensive planted forests in Tanzania are found at Sao Hill in Iringa and Kawetere in Mbeya.

Importance of forest resources

Forests have significant contribution to social, economic and ecological development. They provide various products for human use such as timber, poles, wood, logs, leaves, roots and honey.

Source of income: Forest products are sold in the country or exported to earn income. It is common for products such as timber, rubber, wood and poles to be exported to earn foreign currency. Likewise, forests make up 22.2% of household incomes in developing countries. The main forest products that contribute to incomes are fuel wood, building poles, timber and building materials.

Paper-based materials: Logs are processed to make different types of paper. Also some trees have tissues which are processed to make glue commonly known as wood-glue.

Source of energy: Forests provide firewood and charcoal which are used as sources of energy in the households. Wood energy provides 9% of the global primary energy supply, making it the most important source of bioenergy in the world. In some parts of Africa, fuel wood is the most affordable source of energy and it accounts for about 90% of primary energy consumption.

Employment: Individuals are employed in the forestry sector as forest officers and forest guards. Others are employed as lumberers while some are self-employed in carpentry and joinery, and others are timber merchants who buy and sell timber. Forest industries provide formal employment to 0.4% of the global labour force, contributing to nearly 1% of global GDP in 2008.

Medicinal value: Some forest trees have medicinal value. They have roots, leaves, and bark which are used as medicine or processed to make medicine for human beings and animals. For example, the bark of the cinchona tree is used in manufacturing quinine which is useful for treatment of malaria. Also, some trees are used in making herbicides for use in agriculture.

Tourist attraction: Some forests have rare and unique species of animals and plants which attract people to observe. For example, Gombe Forests in Kigoma have chimpanzees, which are a great attraction for both local and foreign tourists. Many of the natural parks have forests that serve as habitats for attracting animals and plants.

Rainfall formation: Areas with heavy forests are characterised by frequent rainfall. For example, in the Amazon forests, 30 percent of rainfall is said to be influenced by moist air from trees.

Importance of forests in ecological and environmental balance

Ecology is the way in which plants, animals and people relate to each other and to their environment. Ecological and environmental balance is the mutual symbiotic system or state in which plants and animals benefit from each other, thus maintaining their survival in the environment. Plants, insects and animals live together in a particular environment. They live a symbiotic relationship by benefiting from each other. The specific roles forests play in fostering ecological and environmental balance are as elaborated in the paragraphs that follow:

During photosynthesis, oxygen is released by plants into the environment through the stomata, and this is used by animals. At the same time animals release carbon dioxide that is absorbed by the plants. By doing so, a balance between oxygen and carbon dioxide in the environment is maintained. Forests

provide suitable habitats for wildlife and, therefore, contribute to the balance of ecosystem. Various animals live in the forest which gives them shelter and food as they eat leaves, roots and fruits. Moreover, forests help to control soil erosion as they protect the soil from being eroded by blowing wind and running water. Trees in the forest bind together the soil particles using roots, and reduce the impact of raindrops with the same roots. Plant leaves reduce the impact of rain drops on the soil and reduce excessive evaporation of soil water.

Also, the remains of forest trees including foliage contribute to soil development through decomposition into organic matter, leading to formation of humus. Soil in the forest is very fertile due to humus from decomposed plant remains. Solar energy helps plants to manufacture their own food through photosynthesis. Plants are eaten by herbivores; likewise, herbivores are consumed by carnivores who feed on meat. When they all die, their remains are decomposed by bacteria which break down dead matter and release nutrients into the soil. Therefore, forests have input in the food chain. Tree canopies control the evaporation of water from the soil beneath, hence allow more retention of water in the soil. The canopies also enable recharging of ground water by controlling over land flow after rainfall. In addition, forest trees contribute to water vapour in the atmosphere which is important in regulating atmospheric conditions.

The humidity in the atmosphere is important in the rain formation process.

Activity 4.1

Visit any nearby forest and collect information that will help you to answer the following questions:

- (i) What type of forest is it?
- (ii) What factors may have contributed to its existence?
- (iii) Based on your observation, how is the forest being used by the people around it?
- (iv) Have you detected any problem facing the forest? If the answer is yes, explain what that problem is.
- (v) Explain what is likely to happen if the forest you visited is cleared or destroyed.

Exercise 4.1

Answer the following questions:

1. Define a forest.
2. List five types of natural forests.
3. Explain how temperature and rainfall influence the distribution of forests.
4. Mention three species of trees that are found in the following types of forests.
 - (a) Equatorial forests
 - (b) Coniferous forests
 - (c) Deciduous forests

5. Mention five products obtained from forests.
6. In four points, explain the importance of forest resources.
7. What is ecology?
8. In four points, explain the importance of forests in the environment.

Timber production in the world

Timber production is a process of growing, harvesting, and regenerating trees for industrial or domestic use. Worldwide, USA is leading in timber production with 481,092,992 cubic metres. In Africa, Ethiopia is a leading country with 91,283,543 cubic metres. There are ten leading timber-producing countries in the world as listed in Table 4.1. Tanzania is one of the countries that produce timber. The major timber producing regions of Tanzania are Tabora, Ruvuma, Coast, Njombe, Morogoro, Kilimanjaro, Kigoma, Kagera, Iringa, Lindi and Arusha.

Transportation of timber

In many parts of the world, logs are transported using different means. In Tanzania, timber and logs are transported mainly by road using large trucks and by railway. For example, the central railway and the Tanzania-Zambia Railway are used to transport logs. Some logs are transported by trucks to harbours like Dar es Salaam, Tanga, Mtwara and Mwanza for exportation. In other parts of the world, logs are transported by water to ports or industrial centers.

Table 4.1 World timber producing countries

Countries	Cubic Meters
USA	481,092,992
India	296,234,016
China	284,910,024
Brazil	236,422,218
Canada	176,692,000
Russia	162,300,000
Indonesia	119,208,572
Ethiopia	91,283,543
Democratic Republic of Congo	69,733,688
Nigeria	69,115,552

Source: Compare Infobase Limited, 2006
(Updated Feb, 2016)

This means of transportation of logs by water is common in the USA and Canada. It is considered relatively cheaper compared to other means of transportation. In Brazil and Mexico well connected networks of railways and roads are widely used as means of transportation of logs. In Russia, the trans-Siberia railway line is used for such transportation. Figure 4.8 shows logs floating in the Angara River on the way to downstream ports. In Asian countries, especially Myanmar (formerly Burma), logs are pulled to the edge of water bodies by elephants or tractors. Then, the logs are floated downstream during the rainy season.

**Figure 4.8** Transporting timber using the Angara River, Russia

Source: <https://www.robertharding.com/preview/869-10/forestry-trees-transport-logs-river/>

Heavy greenheart logs are transported by road. Later they are transported to river banks where they are loaded into pontoons and ferries. In the dense network of streams and major rivers in the Amazon and Congo basins, waterways have not sufficiently been utilised to transport logs. This leads to frequent stoppage of logs at difficult spots. In addition, the weight of huge logs make floating in rivers difficult. Rapids and falls interrupt these rivers, making floating of logs impossible. The scattered distribution of the most valuable trees complicates even further the river transportation of logs.

Challenges facing timber transportation in the world

Timber is useful for the achievement of social and economic development of various countries. However, transportation of timber faces a number of challenges.

The countries that depend on floating logs in water as the main means of transport, face challenges to transport heavy logs. Timber transportation may also pose a challenge especially when forests are located in remote areas away from market centers. In fact, this situation increases the transportation cost for harvested forest resources. For example, in the equatorial rainforest, forests are dense and located in hardly accessible areas and, therefore, making it difficult to transport logs to the processing areas. Seasonal variation of water in rivers is also a challenge for timber transportation. Water in rivers fluctuate seasonally.

During the dry season, the volume of water decreases whereas during the rainy season the volume increases. In this case, the reduction in the volume of water in the rivers hinders the transportation of logs to the processing industries. Similarly undeveloped means of transportation also pose challenges in timber transportation from the forest to the processing centers, by road and railway.

Challenges facing the forestry industry

Although forest resources contribute to the welfare of people, the forestry industry faces numerous challenges. Over-exploitation of forest resources is one of the challenges. Forest resources are harvested to the point of reducing their ability to regenerate. For example, some forest tree species, especially natural trees, are usually in high demand. The demand compels over-harvesting of such forest resources so much so that they face extinction. In some cases, forests are harvested without following governing procedures and, consequently, some tree species may disappear. Experience indicates that ungoverned exploitation is usually serious in public-owned natural forests than in private planted forests. Forests also face the problem of fire outbreaks with some fires occurring naturally while others are set by people. The fire, particularly during late burning, destroys trees and the undergrowth, which are the main constituents of forests. Estimates indicate that each year fires burn 6 – 14 million

hectares of forests around the world. Construction of different infrastructure for social and economic support is a challenge to the forestry industry. Different construction activities lead to the devastation of forests. For example, the construction of dams, roads and railway lines forces the clearing of some forest hectares. In addition, population increase presents another challenge to the forestry industry. As the population increases, more space for human settlement and life support is required. As a result, people tend to invade the forests and clear them for settlements, farming, charcoal burning and firewood fetching. Then there is the challenge of global warming. Global warming results from the accumulation of harmful gases in the atmosphere. In this case, the gases destroy the ozone layer and makes some trees in the forest wither and dry after failing to withstand the situation. Similarly, deforestation is a challenge to the forests. It exposes the soil, which was once protected by the forest cover, hence making it vulnerable to the agents of soil erosion such as wind, rainfall and water runoff. The resultant erosion affects the quality of the soil which loses its fertility, and limits the growth of trees.

Destruction of animal habitats is also a challenge to the forestry industry. Cutting down, burning and over-exploitation of trees destroy the homes of animals and soil organisms. Some animals may migrate to other less favourable and inhospitable areas only to die there. This act may lead to forest extinction

due to the absence of animals and other organisms that matter to the eco-system by keeping the forest soil fertile. Besides, destroying forest habitats may lead to scarcity of forest products such as trees of medicinal value, and honey.

Addressing challenges facing forest resources

Although forests continually face a number of challenges across the world, countries have been making concerted efforts to find lasting solutions to these challenges. Simply put, deforested area should be reforested. Reforestation is the establishment of a forest through planting trees in an area where plant cover was destroyed through careless felling of trees. A reforestation programme that has been implemented in Tanzania is the Management of Natural Resources Programme funded by the Governments of Norway and Tanzania. The programme was implemented by the Ministry of Natural Resources and Tourism (MNRT) between July 2002-June 2006. The objective of the programme was to increase benefits to rural communities based on sustainable natural resource management in Tanzania. The outcomes of the programme were to:

- (a) improve the quality of forests in all project regions: the number and intensity of fires have decreased significantly, woody vegetation, and canopy cover have increased, and the quantity and quality of water has improved;
- (b) enhance the regeneration of vegetation in degraded areas around Karatu villages; and

- (c) inculcate the culture of tree planting in some areas, particularly in Ruvu, which has enabled trees to be planted in people's farms.

Furthermore, there are two projects with a component of planting trees. These are Hifadhi Ardhi Shinyanga (HASHI) and Hifadhi Ardhi Dodoma (HADO). Improving tree harvesting practises in the forest as an appropriate mechanism for ensuring the trees are not depleted is important. Such eco-friendly practises include selective cutting of trees where only mature or weak (i.e. diseased trees) are removed. Selective cutting is practised in many countries including Tanzania, Southern USA, Finland and Sweden. This selective tree cutting ensures that enough trees are left to grow.

Moreover, forests must be protected from natural hazards such as fire and pests through close supervision and use of watch towers and air patrol. In the USA and Canada, an early sign of fire outbreak can be reported and addressed immediately. Fire can also be controlled through creating fire-breaks. Insects and pests must be prevented by regular inspection and spraying. Furthermore, it is also important to set preventive measures such as laws, regulations and creation of public awareness. Laws are to be enforced to prevent uncontrolled harvesting of trees. In Kilimanjaro Region, no trees for timber can be cut without permission from local government authorities. Forest guards also patrol forest areas.

In East Africa, forest guards receive training at forest training institutes such as Olmotonyi in Tanzania, Nakuru in Kenya and Uganda Forest School in Uganda. Regarding public awareness, people have to be educated on the importance of forest conservation. This awareness creation should extend to persuading people to participate fully in all activities involving the protection of forests. This may be done through the mass media such as radio, television and public meetings. Multiple uses of forest and forest products may also act as a measure for overcoming some of the forestry industry challenges. This is a practise whereby some species used for timber marketing could be used for extracting tannin and those used for the extraction of tannin could be used as a source of hardwood.

The practise is well established in developed countries such as the USA where old rubber trees could also be used for other purposes.

In Tanzania, forests serve as water catchment areas, which in turn enhance forest management. Alongside multiple uses, re-use and recycling of waste papers can also serve as a measure for forest conservation. It is also advisable to recycle used paper into other products or re-use it for other purposes. This may reduce cutting trees for paper-making. Products such as egg trays, packaging boxes, toilet paper and newsprints can be made from recycled paper products. In addition, alternative sources of energy may be opted to reduce the speed of use of forest resources. For example, the use

of alternative sources of energy such as solar energy, biogas, hydroelectric power, natural gas, instead of fuel wood and charcoal reduces pressure on the use of forest resources.

In Tanzania, the government puts emphasis on the use of alternative energy, especially for domestic use. It also stresses the use of recycled paper charcoal instead of charcoal made from trees. In addition, there has been an increase in the use of solar power, especially where there is no power.

Activity 4.2

- A.** Visit a place where charcoal is sold in large quantities. Ask the charcoal sellers the following questions and then write a brief essay based on the answers they provide:
 1. Where do they get charcoal?
 2. How is charcoal prepared?
 3. Which type of trees are used in preparing charcoal?
 4. Are the trees used for charcoal preparation regenerating?
- B.** In a group of five students
 1. Explain the types of energy used at your home for lighting and cooking.
 2. Explain how the energy in use contributes to destruction or conservation of forests.

Exercise 4.2

A. Answer the following questions:

1. With examples, mention problems facing forests resource harvesting.
2. Explain the role of mass media in forest conservation.
3. Outline efforts made by Tanzania in conserving forests.
4. List alternative sources of energy and explain how they can assist in reducing the use of forest products for fuel wood.
5. Draw a map of Africa and shade areas where equatorial forests are found.

B. Write True or False for each of the following statements:

1. A forest is an extensive lowland area covered with undergrowth.
2. A natural forest refers to a collection of trees that have naturally grown.
3. Most mangrove trees grow within 30° and 45° North of the Equator.
4. Planting trees where all the trees have been removed is called reforestation.
5. Important natural forests in Tanzania are found in Morogoro, Kagera, Coast, Kilimanjaro, Njombe, Tanga and Tabora regions.

Chapter Five

Mining industry

Introduction

In this chapter, you will learn about types of minerals found in the world, different ways of mining, ways of processing different types of minerals, and the contribution of the mining industry to the economy of Tanzania. You will also learn about the effects of mining on the environment, oil production in the Middle East, and natural gas production in Tanzania.

The concept of mining industry

Mining

Mining is a process of extracting valuable geological substances from the crust of the earth. The extracted materials may be minerals, fossil fuels, and other geological materials. However, not all geological substances are categorised as minerals. In science, a mineral has specific characteristics such as being solid, inorganic, naturally occurring, has definite chemical composition and ordered internal structure. Although oil, coal and natural gas do not possess most of these characteristics, they may be categorised as minerals. From a non-scientific view, a mineral refers to a non-living naturally occurring resource from the earth. As such, oil, coal, and natural gas also qualify to be called mineral resources. Thus, petroleum and natural gas which are discussed as case studies in this chapter are treated as minerals. Mining in a wider sense

includes extraction of any non-renewable resource such as petroleum, natural gas, or even water.

There are two main types of mining, namely, surface and underground mining. Minerals such as salts are found close to the earth surface; as such, open cast method of mining is used to exploit them. Other minerals like gold and diamond are found deep in the ground, hence underground mining methods are used to obtain them.

The world is full of different types of minerals. Minerals can be classified into five main groups, that is, rocks used as building stones, and for brick making; non-metallic minerals such as salt, sulphur, nitrates, and asbestos; metals like gold, iron, and silver; mineral fuels including coal, petroleum and gas; and water. The whole of the earth, therefore, is full of minerals which are of great value to human beings.

Mining industry

Mining is the branch of manufacturing industries and trade based on the extraction of ores, fossil fuels, minerals, stone, clay, gravel, and similar commodities. This does not include the refinement of these commodities. The mining industry contains five categories, which are defined by the resources they produce: oil and gas extraction, coal mining, metal ore mining, non-metallic mineral mining and quarrying, and support activities for mining.

Coal mining industry: The coal mining industry covers all industries established to produce bituminous coal, anthracite, and lignite, a fossil fuel that is used primarily for electric power generation and in the production of steel. Many coal seams are located close to the surface, however, which makes the extraction of this resource easier.

Metal mining industry: The metal mining industry covers all industries established to engage in mining, developing mines, or exploring for metallic minerals (ores) primarily gold, silver, iron, lead, and zinc. The extracted minerals have a variety of industrial purposes: gold and silver are primarily used in jewelry and high-end electronics, iron is used to produce steel, copper is the main component of electrical wiring, lead is used in batteries, and zinc is used to coat iron and steel to reduce corrosion and as an alloy in the making of bronze and brass.

Non-metallic mineral mining industry:

This industry is the one established primarily to engage in mining or quarrying, developing mines, or exploring for non-metallic minerals. The majority of the industry produces crushed stone, sand, and gravel for use in the construction of roads and buildings. Other important minerals produced are clays, primarily for ceramics, water filtration, and cement making; gypsum, the primary material used in wallboards; salt, used in foodstuffs and as an ice remover; phosphate, for use in fertilisers; and sulfur, the main component of sulfuric acid, a major industrial input.

Oil and gas extraction industry: This industry is established to produce crude petroleum and natural gas; extract oil from sands and oil shale; produce natural gasoline and cycle condensate, and produce gas and hydrocarbon liquids from coal at the mine site. The petroleum and natural gas are used to heat homes, fuel cars, and power factories. Petroleum products are also raw materials for plastics, chemicals, medicines, fertilisers, and synthetic fibers.

The occurrence of minerals: The occurrence of minerals falls into one of the four main types of modes of formation. These are veins and lodes, bed and seams, weathering products and alluvial or place deposits. Veins and lodes are formed when molten materials containing minerals intrude and solidify into cracks and crevices. These are mainly associated with igneous and

metamorphic intrusions. Examples of minerals formed in veins and lodes are tin, copper, silver, lead, manganese and zinc.

Bed and seams constitute another type of mineral formation. Coal, iron ore, gypsum, potash, salts and common salts are formed as a direct result of deposition, accumulation and concentration in the horizontal strata of the earth's crust. Gypsum, potash and salts, for example, are formed by the evaporation of lakes in desert areas and later are covered by other deposits so that they appear as seams.

Bauxite, the ore of aluminium is formed by the deep weathering of a variety of rocks. Leaching by underground water, produces red lateritic deposits which are iron concentrations found in many tropical soils. Many minerals such as gold, tin and platinum are found as alluvial deposits in mud, gravel and sands of alluvial fans at the base of hills or bottoms of valleys.

Distribution of minerals in the world

Minerals are unevenly distributed in the world. Some countries are rich in minerals while others are not. The distribution of minerals depends on geological processes which have taken place over a long period of time. The processes may lead to variation in the amount and types of minerals in different parts of the world. The availability of minerals may resemble or differ from country to country or region to region,

within the same country. Tanzania is one of the countries in the world that are rich in minerals. It is established that Tanzania has almost all types of minerals which are found in other parts of the world.

Diamond, gold, iron, coal, gypsum, copper, uranium, mica, graphite, tin and tanzanite are some of the minerals found in Tanzania. Figure 5.1 shows the distribution of various minerals in Tanzania. Tanzanite is a gemstone only found in Tanzania. Other minerals found in Tanzania are nickel, salt, asbestos, silver, titanium, lead, zinc, platinum, bauxite, soda ash, lime phosphate, sand and natural gas.

Minerals are also found in other countries on all continents of the world. For example, copper is found in Zambia, Democratic Republic of Congo (DRC), South Africa, Uganda, United States of America (USA) and Canada. Diamond is found in Botswana, Ghana, DRC, Canada, Brazil, Russia and Australia. Iron is found in Mauritania, Liberia and Canada. Coal is found in Russia, South Africa and Zambia. Gold is found in Russia, Ghana and Zimbabwe.

Tin is found in South Africa, Nigeria, Rwanda, DRC, China, Indonesia, Peru and Bolivia. Figure 5.2 shows the distribution of some of the major minerals in the world. Major factors affecting exploitation of mineral resources in the world include: quality of the ore (richness or grade), size of deposits, methods of mining, deposits,



Figure 5.1 Distribution of minerals in Tanzania

methods of mining, accessibility, transport facilities (cost), stage of industrial development of the country, technology, and other factors such as cheap labour, competition from other sources, political influence, and economic system and tariff policies of a country.

Uses of some minerals

Minerals are used for different purposes. This part explains the uses of eight minerals. These minerals are tanzanite, copper, diamond, gold, iron, coal, petroleum and natural gas.

Tanzanite: Tanzanite is the blue and violet of the mineral ziosite caused by small amounts of vanadium, belonging to the epidote group. Tanzanite is only found in Tanzania in a very small mining area approximately 7 km near Mererani Hills in Arusha. It was discovered in 1967.

Tanzanite is noted for its remarkably strong trichoism, appearing alternately as blue, violet and burgundy depending on crystal orientation. Tanzanite can also appear differently when viewed under different lighting conditions.

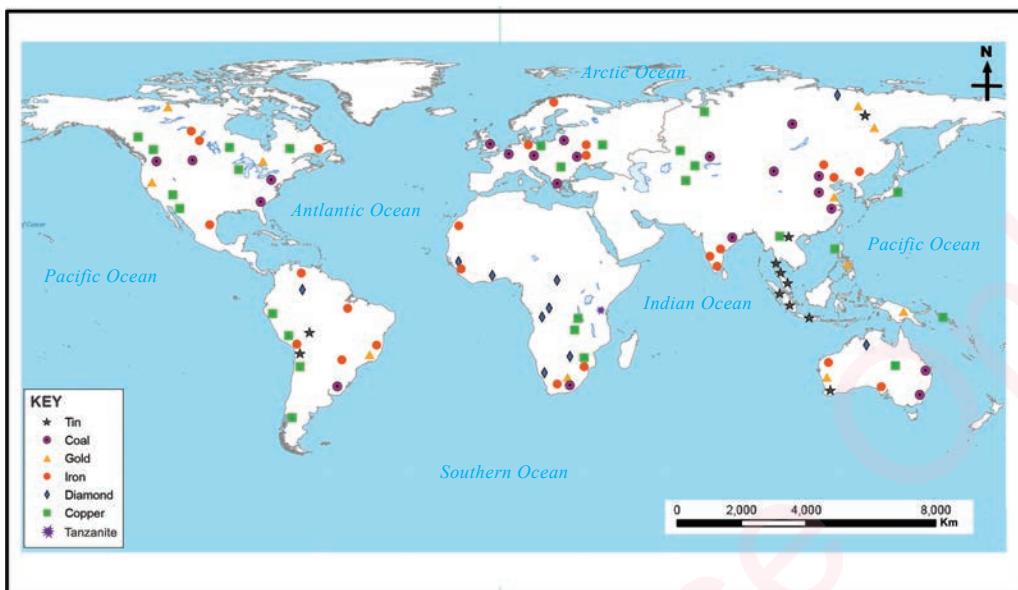


Figure 5.2 Distribution of some major minerals in the world

The gemstone was named ‘tanzanite’ by Tiffany and Company, after Tanzania, the country in which it was discovered. It is used in making bracelets, necklaces and earrings.

Copper: Copper is one of the most widely used industrial metals because it is a good conductor of heat and electricity. Copper is also very resistant to atmospheric corrosion; therefore, it is useful in the transmission of electricity. Copper is used in making alloys since it combines easily with other metals to produce new compounds. For example, copper combines with zinc to produce bronze which is used in making coins, ornaments and utensils. It is also used in making electronic and telecommunication appliances such as sockets, holders, connectors and parts

of mobile phones. These appliances are useful in industries and homes. In addition, copper is used in making corrosion-resistant materials for roofing, tubes, pipes, radiators and boilers.

Diamond: Diamond is a rare and the hardest naturally occurring mineral composed of pure carbon. It occurs commonly in rocks called kimberlite. It is used in glass cutting. Glass dealers use it to cut and sharpen glass into different shapes and sizes. Besides, the dust diamond is used for polishing other gemstone minerals such as tanzanite.

Moreover, diamond is used in making jewels and ornaments which are used as decorations in homes, offices, hotels and other public places. It is also used in making bits for drilling purposes and during oil and gas extraction.

Gold: Gold is one of the most valuable minerals in the world. Gold is able to conduct both electricity and heat easily. It does not lose its colour and brilliancy. It is useful in making jewels and ornaments. Gold is also used to make necklaces, and ear, arm and finger rings. Jewels and ornaments made of gold are usually expensive compared to most of the jewels and ornaments made from other minerals. The mineral is used in making valuable decorations for households, offices, hotels, places of worship such as churches, temples, synagogues and mosques. It is also used in making electronic appliances such as connectors and switches. Sometimes, gold is used in making gold coins. Some precious coins made of gold are used as currency. Other uses include making gold alloys for filling teeth gaps as well as medals, placards and trophies. Famous people in the world receive gold medals as recognition for their outstanding performance.

Iron: Iron is a basic raw material for iron and steel industries. When iron ore is smelt, iron metal is formed. Iron is used in making roofing materials and hardboards for vehicles, ferries and boats. It is also used in making machines, especially for heavy industries. Most of the parts in cars, vehicles and milling machines are made of iron. Furthermore, iron is used in making agricultural equipment such as hand-hoes, oxen ploughs, power tillers and tractors. Other uses of iron include the production of building and construction materials. Iron-bars are useful in the construction and building

of physical structures such as houses, railways, bridges and roads. Iron is also useful in designing fencing materials for security purposes. For example, people use iron-made fences to demarcate houses and plots and for providing security. Apart from that, iron is used for making tools that are useful in cutting and grinding other metals.

Coal: Coal is a black or brownish-black rock made of organic substances that have been deposited for a long period. The most significant uses of coal are in electricity generation, steel production, cement manufacturing and as a liquid fuel. A number of manufacturing industries use coal to run machines. For example, in Tanzania, coal from Mbinga and Kiwira is used as a source of energy in cement production industries. In addition, the carbon present in coal is an important element when mixed with other chemicals in paper, ink and pencil-making. The carbon in coal is also an ingredient used in drugs and chemical production. For example, aspirin contains some percentages of carbon from coal. Coal is also used in the production of valuable fertilisers that are used in agriculture. Some coal products are useful in making soap, solvents and plastic fibres such as rayon and nylon used for making clothes. Other uses of coal include making construction materials, particularly when it is mixed with cement, gravel and water to form concrete which is a basic building element in various infrastructures. China is the leading coal producer in the world.

Petroleum and natural gas: Petroleum and natural gas are in most cases related in occurrence. They are both products of animal and plant remains that have decomposed for a long time, usually billions of years.

They appear naturally below the earth's surface and are both fossil fuels. Whereas petroleum is a liquid substance, natural gas is a non-liquid substance. Petroleum and natural gas are in high demand in the world because of their large contribution to power and energy generation for domestic, automobile and industrial use. In Tanzania, natural gas is found in the southern parts of the country, particularly in Mtwara, Lindi and Ruvuma regions. Specifically, natural gas is produced at Songosongo, Mnazi Bay, Msimbati, Kiliwani North and Ntorya. Furthermore exploration of natural gas and petroleum is going on in Tanzania and there are signs of their availability in other coastal regions and islands of Tanzania. In recent years, the exploration has indicated the availability of petroleum and natural gas in Pemba – Zanzibar. The major producers of petroleum and natural gas in the world include USA, Saudi Arabia, Iran, Iraq, Russia, Nigeria, Gabon, Libya, Kuwait, Algeria, Angola, Gabon, Venezuela, Mexico and Egypt.

Petroleum and natural gas are used for different purposes in different sectors. Both minerals are sources of power generation. The power generated is used to run machines and engines. For example, most industrial machines, motor-vehicle engines and generators

use petroleum or gas to operate. Crude petroleum is a raw material for producing various products such as kerosene, diesel, petrol, oil and bitumen. Some by-products of petroleum are useful in chemical industries for manufacturing several products such as jelly, synthetic fibres, grease and other lubricants. In addition, petroleum wastes from refineries are used for road surfacing and wood treatment against damage and attack by insects. Natural gas is used for domestic purposes such as heating and cooking. For example, in recent years, Tanzanians have been good users of natural gas for cooking using gas stoves and gas cookers.

Other important minerals: Other important minerals include mineral salt produced in Tanzania and China; phosphate mined in Tanzania, Uganda, Togo and South Africa; tin mined in DRC, Nigeria, Rwanda, Burundi and Niger; bauxite in Guinea, Ghana, Jamaica and USA; and manganese mined in Gabon, Ghana, DRC, Ivory Coast, Angola and Zambia. Minerals such as stones, gravel and sand are found almost everywhere around the globe. These minerals have various uses in different sectors. For example, stones, gravel and sand are used in the construction industry.

Methods of mining

Methods of mining depend on the location of the mineral in the earth's crust. There are four methods of mining which are surface, underground, alluvial and in-situ mining.

Surface mining: Surface mining is done by removing (stripping) surface vegetation, dirt, and, if necessary, layers of bedrock in order to reach buried ore deposits. Techniques of surface mining include: open-pit mining or open cast mining, which is the recovery of materials from an open pit in the ground; and quarrying, identical to open-pit mining except that it refers to sand, stone and clay. Open cast mining is the cheapest method of extracting minerals. This method is used to extract minerals which usually occur close to the earth's surface. This method involves removing the top layers of the earth and other overlying materials above the mineral ores. Figure 5.3 shows an open cast mine. The extraction involves the use of earth moving machines and bulldozers, and electric shovels. Sometimes explosion is used to blow overlying materials in order to reach the ore beneath. This method is cheaper because the output is bigger than the costs of running. The open cast method is used to extract quarrying limestone, coal, and other surface minerals.

Underground or shaft mining: This method is used to excavate hard rocks to get valuable minerals which lay very deep below the earth's surface. The method is usually used to dig rocks that contain gold, copper, silver, zinc, tin, lead and diamond.



Figure 5.3 An open gold pit mine in Buzwagi, Shinyanga.

Source: <https://tumemadini.go.tz>

Under this method, a vertical shaft is sunk into the earth's crust to reach the layer with mineral ores. Passages and horizontal tunnels are then made to reach mineral deposits. Steel or concrete beams are erected to support tunnels and galleries from collapsing. Then, light railway trucks may be laid to carry the mineral ores to the foot of the shaft for lifting the ore to the surface.

Alluvial/Placer mining: This method is employed where minerals occur in alluvial deposits. The alluvial mining or placer mining method involves mixing of the alluvial deposits with water in a container. This is a simple method used in collecting gold and other alluvial minerals using a pan in a river valley. It is known as panning or placer mining. It involves digging

the sand and gravel from the river bed. The mineral is obtained by mixing the alluvial sand with water and swirling the pan around. Sometimes, it requires rotating the pan physically with force until the lighter particles are washed away and the heavier particles are left. Salt mining is an example of the alluvial mining method.

In-situ mining: In-situ mining is a mining process used to recover minerals such as copper and uranium through boreholes drilled into a deposit, in-situ. It involves dissolving the existing mineral resource and then processing it on the surface without moving rock from the ground.

Methods of mineral processing

Mineral processing involves separating valuable minerals from other materials. There are different methods through which minerals can be processed as described below.

Crushing and grinding: Crushing and grinding intend to reduce the size of ores to extract the valuable minerals from the rock. At the low level, the ore is crushed and dissolved in water but at the advanced level water and other chemicals are mixed together to obtain the minerals. For example, in gold processing, sodium cyanide is added to the solution. The chemical dissolves the gold particles, leaving behind stones and other mineral wastes. A sodium cyanide solution containing gold particles is drained off and mixed up with zinc

dust, which makes gold particles to solidify. The particles are then melted and moulded into different shapes.

Separation: Minerals that are magnetic such as magnetite can be separated from non-magnetic particles using strong magnets because the minerals are attracted to the magnet (ferromagnetic).

Sizing: Sizing is the separation of particles according to size. The method involves screening or passing the particles to be separated, through a screen.

Floatation: Floatation makes possible the processing of complex intergrown ores containing copper, lead, zinc and pyrite into separate concentrates and tailings. In the floatation the ores are crushed and the particles separated based on how they float on water or other liquids that allow unwanted materials to remain. For example, processing of copper ore into small particles involves mixing the ore with water. Then chemicals are added to the mixture and put into a floatation machine. The floating copper particles are then removed. The particles are dried and smelted into copper blisters. Copper blisters contain 97% - 98% copper. The blisters can be refined even further to remove other minerals or impurities.

Exercise 5.1**A. Short answer questions**

1. Mention any five types of minerals found in the world.
2. Explain the term ‘mining’.
3. Briefly explain types of minerals basing on their location.
4. Briefly describe three methods of mining.
5. Explain why diamonds, petroleum and natural gas are important.
6. Assume you are a mining expert, explain the methods you will use to extract minerals located at different depths.

B. Write True or False for each of the following statements:

1. Gold and copper are examples of non-metallic minerals.
2. The major producers of gold in Africa are Tanzania, Ghana and South Africa.
3. USA is the leading country in the production of coal in the world.
4. Alluvial mining is the same as drift mining.
5. In Tanzania natural gas energy is mostly used for domestic heating and cooking.

Contribution of the mining industry to the economy of Tanzania: Minerals are useful in the growth of any country’s economy. Some minerals have more demand than others due to their high value. Minerals are used in countries where they are produced and also they are exported to various countries to obtain foreign currency. The contribution of mining industries to the Tanzanian economy include the following:

Government revenue: The mining industry contributes to government revenue in terms of taxes and royalties. This is crucial for financing developmental plans of the country.

Employment: The mining industry contributes direct and indirect employment opportunities within the country. Some people get employed directly in the industry while others provide services related to mining in mining centers.

National gross domestic product: The mining industry contributes to the Gross Domestic Product (GDP). For example, mining and quarrying activities in Tanzania contributed about 4% to its GDP in 2015.

Raw materials: Minerals provide raw materials for various industries. For example, gypsum is used as a raw material in cement industries.

Social services: Mining stimulates the development of settlements. The

establishment of settlements in or near mining centers forces the government to provide social services such as health, and education. In addition, the development of settlements around mining centers has contributed to the growth of some towns such as Mwadui, Kahama, Geita, and Mererani.

Infrastructure: Mining stimulates the construction of roads to and from mining centers. For example, Kahama road networks were constructed due to gold mining. Similarly, Mwadui roads were built because of diamond mining.

Effects of the mining industry on the environment

Mining and processing activities have negative effects on the environment if not done carefully. The sections below describe some of the effects of mining on the environment.

Pollution: Mining activities can lead to water, air and noise pollution. To begin with, mining produces waste materials which pollute water bodies. For example, chemicals used in processing minerals such as mercury and sodium cyanide can pollute rivers, lakes and underground water. This may cause loss of life of living organisms, which depend on water. Large amounts of dust released into the air affects people, plants and animals found in nearby areas. Also, the blasting process causes noise and vibration which affect people and their properties in nearby areas.

Land degradation: Mining causes pits on the earth's surface. When mining is done on a large-scale, the destruction of the surrounding land is higher. Open cast mines produce much larger quantities of waste than underground mines. These open-pit mines produce 8 to 10 times as much waste as underground mines. In some areas, breaking of rocks may cause landslides on nearby land. Landslides can damage transport routes and nearby property.

Destruction of land surface appearance: This may happen in areas where there are no more minerals and mining activities have stopped, and land left without being reclaimed. In case of the open cast method of mining, land appearance is destroyed, deep holes are left on the earth's surface, creating problems related to soil erosion, health and death. If the holes are filled with water, they become breeding grounds for mosquitoes, which may spread malaria.

Deforestation and loss of biodiversity: Large-scale mining involves clearing of forests and any other vegetation cover. The clearance of vegetation causes loss of different plant and animal species. Mining causes direct and indirect damage to wild animals by altering their habitats. This may lead to the disappearance of various wildlife species such as birds and other animals.

Loss of soil productivity: Rocky soils left behind after mining cannot support

crop production because they have low fertility. In fact, the soil structure and texture is destroyed when it mixes with particles of rocks.

Effects on the water table: Deep mining that reaches the water table may cause underground water to flood the mines. As a result, the water has to be pumped out to allow mining to continue. Continued pumping of this underground water lowers the water table of the area.

Ways of minimising the effects of mining on the environment: The following are ways to minimise the effects of mining on the environment:

Land rehabilitation: Holes produced during mining should be covered with the removed soils. Planting trees and other vegetation cover helps to repair the damaged land.

Proper storage and use of chemicals: It is advisable to store chemicals in a strong room so that no leakage occurs into the soil and water. Moreover, chemicals are to be used with care to avoid polluting soil and water resources.

Waste management: There must be a proper waste disposal from mineral processing industries. This organised disposal includes treatment of the chemicals that flow from the industries into rivers and streams. In addition, there should be dust management programmes to avoid air pollution.

Safety education: Mining companies are required to provide safety education to workers and the communities surrounding the mining areas. Such education may include wearing of protective gear (helmets, gloves, overalls, glasses and masks). This protects the workers from accidents associated with mining activities. The community has to be educated on the importance of reporting any environmental problem they experience as a result of mining activities.

Mining regulations: The government should enforce mining and environmental laws and regulations that guide mining and mineral processing activities, to reduce the negative effects of mining.

Exercise 5.2

Answer the following questions:

1. Explain the meaning of each of the following terms:
 - (a) Alluvial mining
 - (b) Opencast mining
 - (c) Shaft mining
2. Mention any four mining centers found in Tanzania.
3. Explain ways to minimise the effects of mining on the environment and people.
4. Explain the importance of mining to the economy of Tanzania.

Focal studies

Oil production in the Middle East

The Middle East is one of the leading oil producing areas in the world. The major oil producing countries in the area include Saudi Arabia, Iran, Iraq, Kuwait, Qatar and the United Arab Emirates. Figure 5.4 shows major oil fields in the Middle East.

These countries contribute one-third of the total oil production in the world. These countries are members of the Organisation of Petroleum Exporting Countries (OPEC). They play a big role in deciding world oil prices. The main consumers of oil from the Middle East are Western Europe, Japan, USA, Canada and Australia. The Middle East exports about 70 percent of crude oil in the world.

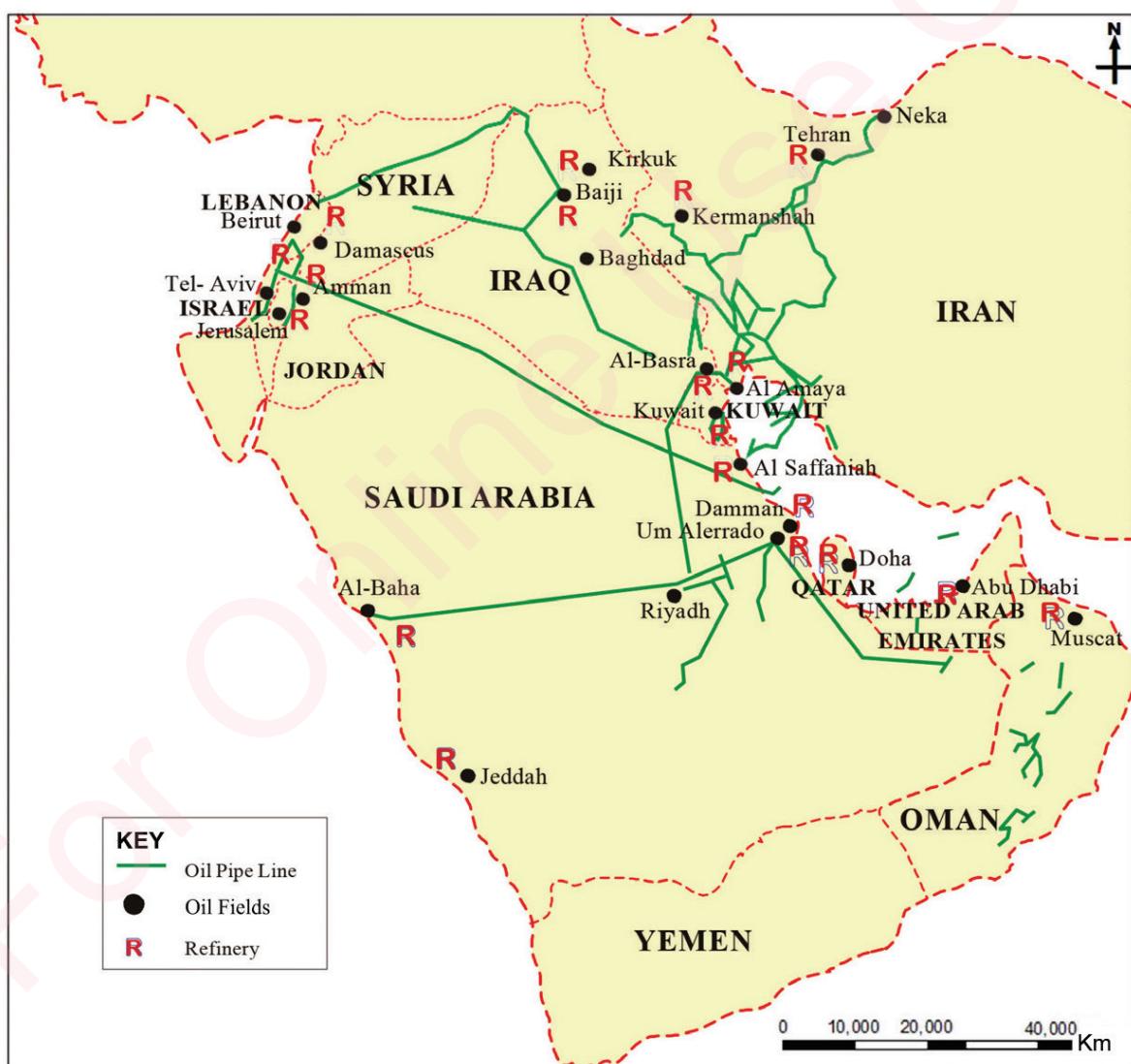


Figure 5.4 Distribution of major oil fields in the Middle East

Crude oil from oil fields is transported via pipelines and tankers to refineries or to coastal shipping terminals. Transportation by pipeline is very expensive because the initial capital for construction of a pipeline is very high. Once constructed, pipelines are very cheap to operate. An example of a major pipeline is the Trans-Arabian Pipelinen(TAP) which runs from inland fields on the Persian Gulf to the Mediterranean Coast. Transportation by tankers is a cheap means of conveyance.

Importance of oil production to

Middle East countries: The Middle East is located in an arid region. Oil production has contributed to economic and social development of the Middle East countries. The countries depend greatly on the exportation of petroleum and petroleum products to earn foreign currency. Companies involved in oil production in most of the Middle East countries are mostly state-owned. However, there are also some oil fields run by private companies. These companies pay taxes to the government. The revenue from oil refining and support industries is used to provide social services such as education and health. The revenue is also used in the construction and improvement of infrastructure such as roads, railways and airports. Jobs are also created in areas that produce oil as many people in the Middle East work in the petroleum refineries and petrochemical industries.

Oil production in the Middle East has stimulated the improvement of the transport sector. The export of petroleum and petroleum products has enabled Middle East countries to develop good transport networks. In addition, petroleum is a resource which provides energy and power for domestic and industrial purposes.

Challenges associated with oil production in the Middle East:

Oil production in the Middle East faces many challenges. With rising global demand, highly volatile prices are increasingly becoming stringe. The oil and gas industry faces three major challenges involving how to reduce costs, optimise the performance of its industrial base assets, and address its environmental footprint. Environmental pollution is one of these challenges. Oil refinery and production of petroleum products produce carbon dioxide and other gases such as methane which are harmful. As countries in the Middle East have large oil production industries, the emission of harmful gases is also high. These gases contribute to the pollution of water, air and land. Burning fossil fuels produces sulphur dioxide and nitrogen oxide. When they move into the atmosphere they produce acid rain, which damages buildings and vegetation in addition to affecting fish and other organisms that live in water. Another challenge facing oil production in the Middle East has to do with civil wars and social violence. Producing crude oil and refined products

at a lower cost to stay competitive on the market is one of the major challenges.

Natural gas production in Tanzania

Natural gas has been discovered at Songosongo in Kilwa and Mnazi Bay in Mtwara. The estimated natural gas reserve for Tanzania is 52 trillion cubic feet. The natural gas is mined and transported through pipelines to Dar es Salaam where it is used to generate electricity. Private companies such as Songas, Pan African Energy Tanzania (PAET), Maurel and Prom (MOP) in co-operation with the Tanzania Petroleum Development Corporation (TPDC) produce natural gas. Songas generates electricity using gas from the Songosongo Island gas fields. Figure 5.5 shows a gas plant at Songosongo.



Figure 5.5 Songosongo gas plant

Source: Ipp media.com

Advantages of natural gas in Tanzania

Tanzania benefits a lot from its natural gas resources. The resources benefit the economy of the country but also

improve the lives of its people. Natural gas has contributed to the improvement of infrastructure. Transport and communication systems to and from source of natural gas areas have been improved. For example, the discovery and extraction of gas in Mtwara Region has stimulated improvement of the airport and the harbour in the region. As a result, air transport to and from Mtwara Region has also improved. Natural gas has also created the demand for labour, goods and services. There has been an increase in the demand for both skilled and unskilled labour to work in the mines and carry out mining-related activities. Moreover, natural gas extraction has added a source of income for the people. Companies involved in natural gas extraction usually pay taxes and other dues to the government. People living nearby natural gas extraction fields also benefit by selling goods, especially agricultural products to the mining community. People surrounding the mining areas also benefit from the social services such as schools, water and hospitals built to support the mining community. Natural gas may reduce environmental pollution as its use does not produce harmful gas substances compared to other sources of energy such as petroleum. Similarly, the use of natural gas at the domestic level may reduce fuel-wood consumption. This may, in turn, reduce deforestation.

Challenges of natural gas production in Tanzania:

Natural gas production faces numerous challenges in different aspects. Natural gas is a non-renewable

resource. Therefore, care has to be taken when extracting this resource. Natural gas production is new in Tanzania and, thus, it faces a shortage of skilled labour, especially in exploration and extraction activities. As a result, the government is often forced to employ foreign experts who are paid high salaries. Regarding the capacity to produce the natural gas, Tanzania has not been able to allocate enough funds for exploration, extraction, processing and distribution.

Tanzania's efforts in addressing the challenges of natural gas production

Tanzania has been trying to overcome the challenges associated with the production of its natural gas. The government has been emphasising the use of revenue from natural gas to benefit the people in the areas producing the gas and the nation as a whole. The revenue from natural gas is used to improve social services in education and health. There have been various public programmes aimed to educate the public on natural gas benefits. The ministries responsible for energy and mineral resources in Tanzania conduct awareness creation programmes through various ways such as meetings and the media. The government also provides opportunities for training to Tanzanians in oil and natural gas. These training opportunities aim to build the country's capacity for exploration, extraction, processing and supplying of natural gas.

Exercise 5.3

A. Write True or False for each of the following statements:

1. Middle East countries produce over one-third of the world's petroleum.
2. Transportation of petroleum by tankers is more expensive than transportation by pipelines.
3. Oil used in the Middle East is always imported.
4. Exploitation of natural gases in Tanzania is only done by public companies.
5. Kuwait, Saudi Arabia, USA and Western Europe are main consumers of oil from the Middle East.

B. Briefly answer the following questions:

1. Outline the importance of oil production to the Middle East countries.
2. Explain the challenges facing oil production in the Middle East.
3. Explain how Tanzanians benefit from the extraction of natural gas.
4. Outline the challenges facing natural gas extraction in Tanzania.
5. Explain how the effects of mining on the environment can be minimised.

Chapter

Six

Tourism

Introduction

In this chapter, you will learn about the concept of tourism, factors contributing to the development and growth of tourism in the world, the importance of tourism and its impact in the world. You will also learn about ways to address the negative impacts of tourism, factors for the development of tourism in Switzerland, Namibia and Tanzania. You will also learn about the problems facing the tourism industry in Tanzania. Finally, you will draw lessons from Switzerland and Namibia to help promote Tanzania's tourism industry.

The concept of tourism

Tourism is a temporary movement of people to places of interest for leisure, pleasure, studies and trade or business, outside their normal working stations or home. A tourist is a person who travels to different places for leisure. Tourism can be classified as either domestic or international. Domestic tourism comprises of tourists who travel within their own country. For example, if a Tanzanian living in Iringa visits Serengeti National Park he or she is a domestic tourist. International tourism, on the other hand, comprises of tourists who travel from their country to another country. For example, people from Switzerland can travel to Tanzania to visit national parks such as the Serengeti, Mikumi or Ruaha.

Factors for the development and growth of tourism in the world

The following are factors for the development and growth of tourism. These factors are features that encourage tourists to visit places for leisure, pleasure or education.

Tourist attractions: Tourist attractions include places with pleasant climate, beautiful and varied sceneries, different cultures, historical sites and monuments. Also, some features in Tanzania such as Mount Kilimanjaro, the highest free-standing mountain in the world, attract tourists.

Advancement in communication and transportation network: Reliable communication network and advanced technology encourage the development of tourism in a country. For example, the use of the internet, television

programmes, and social media, tourism trade fair and exhibitions has facilitated availability of information on tourism, hence it has led to an influx of tourists.

Good infrastructure: Presence of good infrastructure that makes a place easily accessible at affordable rates by car, train, bus, water and air helps to attract tourists. For example, air transport has shortened the time that a tourist spends for travelling to and from Tanzania and other parts of the world.

Good accommodation: Presence of adequate, comfortable and affordable hotels, camp sites and resorts attracts tourists. For example, in Tanzania, the presence of accommodation facilities which cater for tourists of varied economic status is one of the factors that attract tourists.

Peace and stability: Peace and stability in any country encourage the growth of the tourism sector. Tourists prefer to visit places with assured peace and security. Moreover, countries with political instability discourage tourism due to fear of war, violence and terrorist attacks, for example, Sudan, Democratic Republic of Congo (DRC) and Somalia.

Good hospitality: Tourists prefer to visit places where people are honest, generous and with hospitality. In fact, the tourism industry is more developed in various parts of the world where emphasis has been placed on training personnel to master hospitality skills.

Marketing: Countries with good marketing strategies also have the potential of attracting a great number of tourists. Marketing the tourism industry helps to communicate information about various attraction centers, hence calling for more visitors. Some of the marketing strategies include the use of diplomatic missions abroad such as embassies, high commissions and consulates, the mass media, special tourism envoys and advertisements during international exhibitions.

Importance of tourism in the world: Tourism contributes to the socio-economic development of the country. The tourism industry employs many people directly and indirectly, for example, hotel staff, tour guides, porters, drivers and airline staff. Others include those employed in the manufacturing of goods such as postcards, souvenirs and local handicrafts.

Tourists prefer and are encouraged to visit countries with which they have diplomatic relationship because this is one way of promoting cultural exchange to enhance international understanding and foster collective solving of global problems. People from different nationalities also learn to appreciate other cultures, hence promote cultural tolerance.

Generally, governments are committed to conserving tourist attractions because tourists are attracted by the presence of historical and cultural sites,

and wildlife. In Tanzania, the government also promotes sustainable conservation of the sites and national parks to ensure the growth of the tourism sector.

Tourism services also generate the much-needed foreign currency. Tourists arrive in the country with convertible currencies which boost the country's foreign currency. Moreover, taxes from this sector contribute to the growth of the national economy. This, in turn, lead to the development of other sectors such as health, education, infrastructure and water. Furthermore, existing roads are improved and new ones are built to connect tourist attraction sites. Airports are also developed and improved. Communication infrastructure is also improved to serve these areas.

Impact of tourism in the world

The tourism industry has both positive and negative impact in the world.

Positive impact of tourism: The tourism sector has the following positive impact on society. The development and expansion of international tourism has led to the creation of various *job opportunities*. Similarly, the tourism industry has led to job creation in rural areas, thereby reducing levels of rural-urban migration. An example can be cited from the area around Mount Kilimanjaro and Arusha in Tanzania where people secure jobs as porters, translators and guides on a sustainable basis.

As a result, both skilled and unskilled personnel find employment in the sector as well as the hospitality industry; hence they improve their standards of living.

Also, *roads, railways, airports* and *hotels*, are attractively constructed and maintained to sustain the tourism industry. For example, transport means to tourist attraction centers in Tanzania such as the Serengeti, Mikumi, and Mount Kilimanjaro national parks as well as Bagamoyo historical sites are well developed. Tourism has also encouraged *increase in production* in other sectors to meet the tourist needs. For example, other sectors such as transport, agriculture, trade and commerce are highly favoured.

Negative impact of tourism: The negative impact of tourism includes the following:

Tourism has sometimes led to *cultural interference and conflicts*. Sometimes tourists bring with them practises that are unacceptable to the people in the host country, for example, ways of dressing, food style and language.

Moral decay has occurred in places that are visited by tourists. For example, cases of prostitution, same sex relationships (homosexuality) and drug abuse have become common in areas with tourist attractions such as beaches and night clubs.

In addition, tourist activities in national parks and other protected areas may lead

to *environmental degradation* such as off road driving and dumping of waste such as paper and plastics.

Moreover, the continued presence of people and vehicles in the tourists sites may lead to *change in animal behaviours*.

Ways of addressing the negative impact of tourism

The following ways can be taken to minimise the negative impact of tourism:

- (a) Enforcing policies, laws and regulations by the Tanzania Government to provide guidance on the best ways of managing tourist activities to maximise benefits and minimise the negative effects.
- (b) Encouraging eco-tourism to conserve vulnerable natural ecosystems and create a conducive environment to enable local people share economic and social benefits.
- (c) Educating the local communities on cultural differences and the associated risk of copying cultural practises from the tourists (awareness creation and appreciation of other people's culture).
- (d) Promoting new tourism areas as alternative attractions, for example, Gombe Stream National Park, Katavi National Park, Selous Game Reserve (the lower part of Selous) and Ruaha National Park, to reduce congestion in the more popular ones such as the Serengeti, Ngorongoro, Mount

Kilimanjaro and Mikumi. For example, the government through the Ministry of Natural Resources and Tourism is currently promoting tourism in the southern circuit attractions through a dedicated Safari Channel in Tanzania Broadcasting Corporation (TBC) television.

- (e) Integrating tourist activities with the promotion of environmental conservation, to reduce negative impact on the environment.

Exercise 6.1

Answer the following questions:

1. Define the term 'tourism'.
2. Describe five benefits of tourism to Tanzania.
3. With examples, differentiate between domestic and international tourism.
4. Mention five factors for the development and growth of tourism in the world.
5. Mention any four positive and four negative impacts of tourism.
6. Mention any four ways of minimising negative outcomes of tourism in Tanzania.

Focal studies on the tourism industry
 In this section, you will study the tourism industry in selected countries, namely, Switzerland, Namibia and Tanzania. The purpose of focal studies is to enable you to understand how different countries practise tourism and learn best practises from them.

Tourism in Switzerland

Switzerland is a small land-locked country, located in Central Europe, east of France and north of Italy. It has a total area of 41,290 square kilometres. The country is mountainous with a physical landscape of plateaus of rolled hills, plains, glaciers and large lakes. For example, the Alps Mountains occupy about 60% of the total land. This offers a variety of scenery which comprises snow peaks, lakes, forested areas and glaciers. Switzerland is bordered by Austria, France, Germany, Italy, and Liechtenstein. Tourism in Switzerland takes place in the summer months of July - September when it is easy to view the snow-capped mountain peaks, clear blue skies and cascading

waterfalls. Winter months are decorated by abundant snow on mountain slopes for skiing and ice-skating.

The most frequently visited areas during the summer are the Swiss Plateau of Lausanne, Geneva, Bern, Zurich and lake shores. Other places are Tucino Mountain with towns like Lucerne and Lugano. Switzerland is referred to as the playground of the world because most of its fame comes from its tourism industry. Figure 6.1 shows tourist centers in Switzerland.

Pyramidal shaped mountains of the Alps and the U-shaped valleys are unique glaciated features that attract most of the tourists. Figure 6.2 shows the pyramidal peak and valleys of the Swiss Alps.

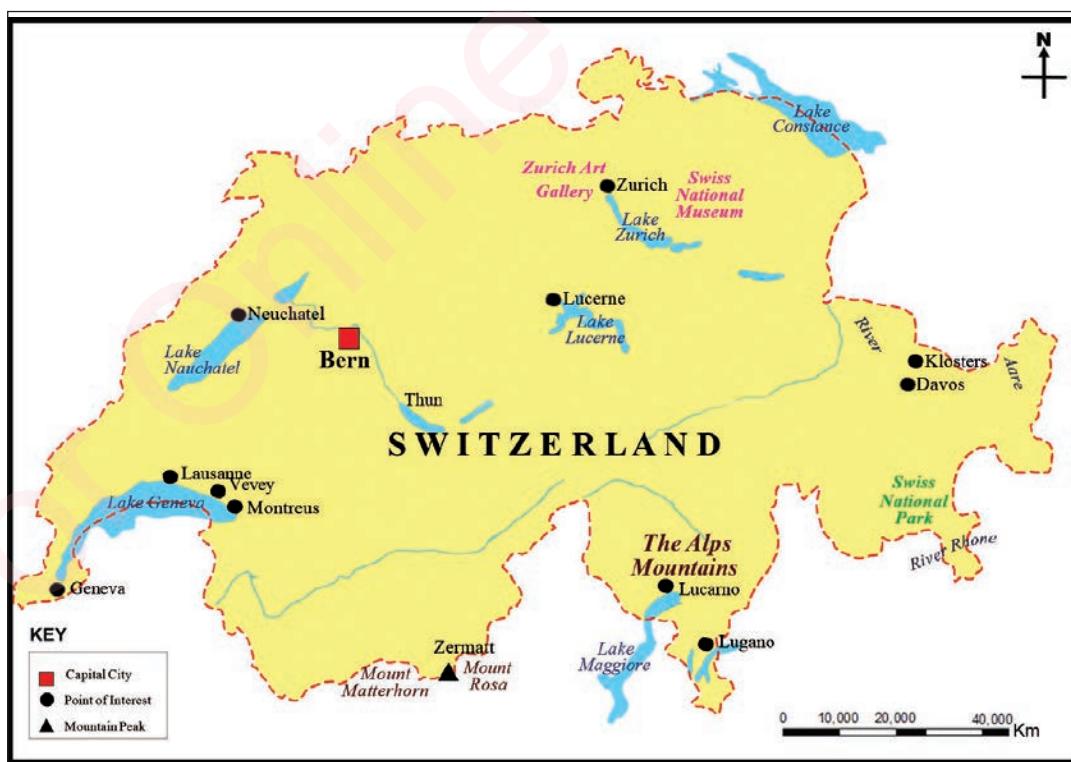


Figure 6.1 Tourist centers in Switzerland



Figure. 6.2 Pyramidal peaks and valleys of the Swiss Alps

Source: independent.co.uk/topic/swiss-alps

Other features such as lakes Geneva and Constance also add to the beauty of the country. Most of the tourists come from the United States of America, Western Europe and China.

Factors for development of tourism in Switzerland:

Several factors contribute to the development of Tourism in Switzerland. Switzerland is located in the center of Europe, making it accessible from various countries of Europe, America, and Asia. These countries include France, Germany, Italy, Britain, United States of America and China.

Switzerland has abundant beautiful sceneries, including the Alps Mountains with a large variety of peaks and valleys which attract many tourists. Also, its slopes have abundant snow which attracts tourists interested in skiing and ice-skating. Others are hills, plateaux, plains, large lakes and rivers.

On one hand, the alpine climate and landscapes are favourable for tourists as they consist of cold snowy winters and warm sunny summers. The snow during winter attracts winter sports such as skiing and ice-skating whereas warm and sunny summers attract tourists to view the beautiful sceneries, and engage in swimming and sunbathing.

The Swiss people are hospitable, and the personnel handling tourists are well trained. The Swiss speak a variety of languages, namely, German, French and Italian. With these languages, the Swiss can easily communicate with tourists from various countries. Switzerland has a well-connected transport network which ensures easy and cheap movement of tourists within and outside the country. A variety of means of transport such as buses, electric trains, cable cars or aerial lifts and airways help to access various tourist attractions in the country. The country has a great number of high class hotels to suit the needs of the tourists. Also, there are cottages, camping sites, taverns and guest houses.

Switzerland has been and continues to tolerate different political ideologies. Thus, tourists from various countries of the world find it comfortable to visit Switzerland. Many towns in Switzerland such as Geneva, Bern and Zurich are headquarters of most international meetings by different organisations and associations such as the World Health Organisation (WHO), International Labour Organisation (ILO) and Federal International Football Association

(FIFA). Therefore, people attending these meetings also take time off to visit tourist attractions, hence contributing to the country's tourism industry.

Importance of tourism in Switzerland:

Tourism contributes to the economic development of Switzerland.

Tourism promotes Switzerland's international relations and co-operation with other nations through tourist activities. Tourism also stimulates other related sectors of the economy such as agriculture, market and transportation since they all strive to help the provision of services in the tourism sector. Moreover, tourism is the major industry in Switzerland. It is the third largest export earner and contributes significantly to the national economy. Tourism promotes employment opportunities both within and outside the industry, therefore, it helps to improve people's living standards. Tourism promotes the spirit of appreciating other people's cultures which, in turn, brings about cultural tolerance. Furthermore, tourism contributes to the expansion of infrastructure throughout the country. Revenue collected from the tourism industry finances the expansion of roads and other related sectors such as education and health. Tourism also contributes to the earnings of foreign currency which facilitate the country's economic growth. Both domestic and international tourism are sources of foreign currency.

Challenges facing the tourism industry in Switzerland: Heavy snow during winter hinders movement on roads, rails and runways which lowers the influx of tourists. In some cases, the number of tourists fluctuate due to other competitive countries such as the United States of America. Tourist attraction centers also experience environmental pollution through littering and noise from transport means such as trains and cars.

Tourism in Namibia

Namibia is bordered by South Africa to the south, Botswana to the east and Angola to the north. It is also bordered by rivers Kunene and Okavango in the north and the Orange River in the south. From the coast, there is the Namib Desert with huge attractive sand-dunes and the largest canyon in the southern hemisphere. The Namib Desert is also known as the "living desert" because a large number of species live there. In the eastern part, Namibia is occupied by the Kalahari Desert. The land between the Namib and the Kalahari deserts is a rolling plain of 1,200m above sea level. Namibia has an area of 825, 419 square kilometres with a population of about 2,610,954 by 2018. Namibia's general climate is desert with scarce and unreliable rainfall. The country's attractive landscape makes it naturally attractive to tourism activities. It has rivers such as the Kwando that cuts through the Caprivi Strip, and Zambezi which flows along the north-eastern border. Namibia's landscape is mostly dominated by a high plateau which also

impresses visitors. This country is a home to a variety of wildlife including antelopes, rhinos, giraffes, lions, elephants and cheetahs which make it one of the leading countries in wild animal population in the world. Windhoek, the capital city of Namibia and the coastal town of Swakopmund have German buildings built during the colonial era. The Windhoek's Christukirche (Christ Church) built from quartz sandstone by the Germans in 1907 is one of the important structures that attract tourists.

Generally, the major tourist attractions (honey pots) in Namibia include the Skeleton Coast, Seal Reserve, Caprivi Game Park and Daan Viljoen Game Reserve. The Etosha National Park, Fish River Canyon and the Gross-Barmen Hot Springs Resort add to the list of tourist attractions. Other tourist attractions in the country include the Hardap Recreation Resort, Khaudum National Park and Naukluft Mountain Zebra Park. Figure 6.3 is a map of Namibia showing tourist attraction sites.

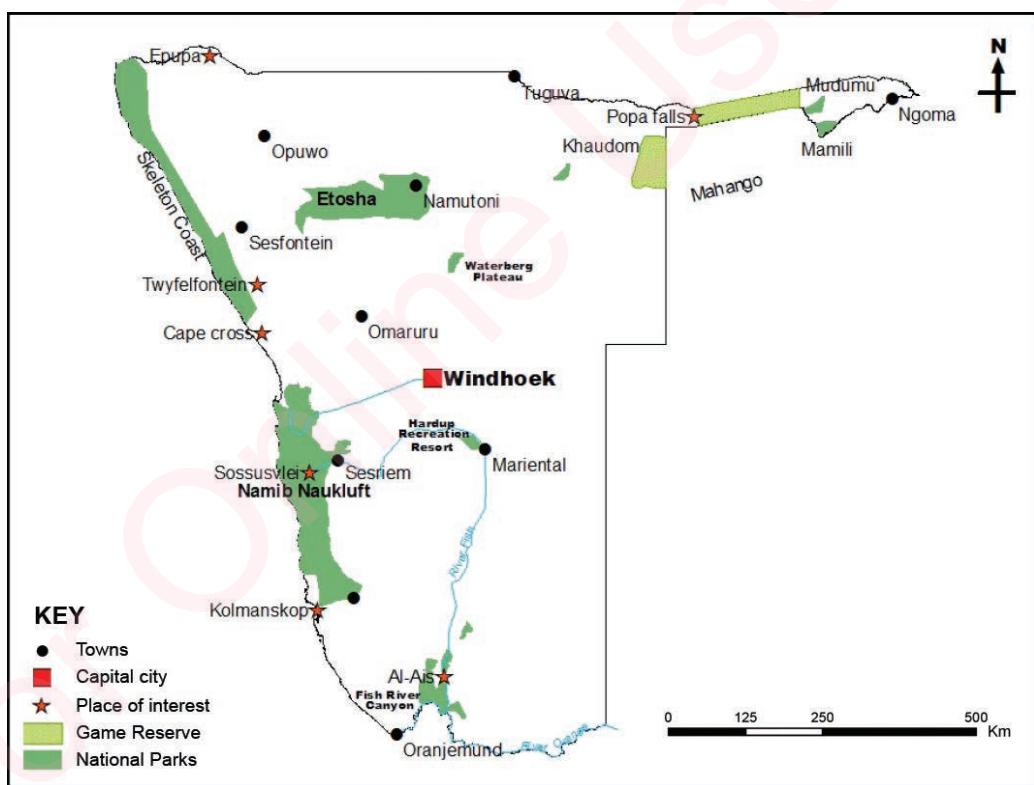


Figure 6.3 Major tourist sites in Namibia

The Namib Desert is one of tourist attractions in Namibia that possesses unique and the largest sand dunes of the world. Figure 6.4 shows sand dunes in the Namib Desert, Namibia.



Figure 6.4 Sand dunes in Namib Desert, Namibia

Source: touropia.com/tourist attraction

Tourism ranks third in Namibia's economy after mining and agriculture. The importance of the tourism sector in Namibia has forced the government to incorporate it in the National Development Plan. Under this plan, the government is committed to enhancing tourism development through several initiatives, as explained in the following sections.

Promoting access to tourist attraction centers: The distances between tourism sites in Namibia are large. This has forced the country to have a strong strategic upgrading of tourism infrastructure to promote the growth of the tourism industry.

Protecting the biodiversity: More than 17 percent of the land area in Namibia

is protected. The large number of parks and protected areas with flourishing wildlife populations is a significant ongoing attraction for international and domestic visitors.

Improving the tourist environment: Namibia has several advantages compared to its competitors in the region. It has attractive and unique tourism attractions such as the landscape, wildlife and indigenous culture. It is also a peaceful country. It has also a safe and extensive road network and sufficient lodging options. There are also abundant opportunities for adventure tourism which includes hiking, sky-diving, dune boarding, and game and trophy hunting. Adventure travel is one of the fastest growing sectors of the long-haul travel market.

Factors for the development of tourism in Namibia: Numerous attractions including the climate with plenty of sunshine, abundant wildlife, rivers and desert landscapes have contributed to the development of the tourism industry in Namibia. Other tourist attractions are the diverse cultural attractions such as baskets, shells, jewels, embroidery, bead works and traditional dances.

Improved infrastructure: The government has also invested in the improvement of infrastructure to facilitate access to tourist attractions. For example, there is a luxury train that runs between Swakopmund and Windhoek. Also, Air Namibia offers

several scheduled domestic flights to enhance tourist movements. The private sector is also working closely with the government to improve accommodation facilities.

Strong tourism policy: Namibia's national tourism policy aims to provide a framework for mobilising tourism resources to realise long-term national goals as defined in the country's Vision 2030. The policy ensures that tourism is developed in a sustainable, equitable and responsible manner. The policy also insists on eco-tourism as an integrated approach which involves carrying out tourist activities with minimum negative impact on the natural environment. This has, in turn, made a significant contribution to the economic development of Namibia that benefits all the people.

Namibia Tourism Board: The Namibia Tourism Board (NTB) is charged with the responsibility of regulating and marketing tourism activities. This board is also responsible for training people engaged in the tourism industry. For example, the NTB has established offices abroad to market and promote tourism in Namibia. These offices are in different parts of the world such as Johannesburg, Cape Town, Germany, New York, England and Spain. As a result, this aggressive promotion increases the number of tourists in the country.

Regional cooperation: Namibia is a member of Southern Africa Development

Community (SADC) which helps its members to promote tourism through the Regional Tourism Organisation of the Southern African Countries. This country has benefitted through this strategy.

Importance of tourism to Namibia

Many people have secured jobs in the tourism industry, for example, hotel staff, tour guides and drivers. Others are employed in the local handicrafts industry such as wood carving from Okavango and Caprivi and basketry from Himba. The tourist industry also contributes to the earning of a lot of foreign currency; for example, earnings from travel agencies, hotels and restaurants, entertainment groups and shops, as well as the National Reserve. The transport and communication network around tourist attractions have also been improved. This has benefited both the tourism industry and local communities. The provision of education, health services, water supply and electricity have improved as a result of the development of the tourism industry. This has, in turn, contributed to improvement of the standard of living of the people. Furthermore, tourism contributes to the growth of GDP, hence making it a valuable sector within the country. Tourism is a major industry contributing Namibian dollars (N\$) 7.2 billion to the country's GDP per year.

Challenges facing tourism in

Namibia: The tourism industry in Namibia is facing strong competition

for tourists from other neighbouring countries especially Botswana and South Africa. In addition, tourism industry in Namibia suffers from a shortage of a well-trained personnel who can offer standard services to tourists. Also, tourist opportunities are in the rural areas where the majority of the people are not well educated. The industry also suffers from high cost of investment, especially in the construction of infrastructure such as roads and hotels. Running costs such as maintaining the rural feeder roads to make them passable throughout the year also needs a lot of funds.

Furthermore, Namibia has a restrictive regime for business visas and work permits which lowers business in the tourism industry. As a result, skilled people from abroad who could serve the industry efficiently cannot easily get work permits. Other challenges facing tourism in Namibia include the growing rate of crime, corruption, poaching, poor water crisis management and high commodity prices.

Tourism in Tanzania

The United Republic of Tanzania is the largest country in East Africa located in the eastern coast part of Africa. The country has an Indian Ocean coastline of about 1,424 kilometers long. It covers an area of 947,300 square kilometers between latitude 10° and 12° S, and longitudes 29° and 41° E. It borders Kenya and Uganda to the north, Rwanda,

Burundi and the Democratic Republic of Congo (DRC) to the west, and Zambia, Malawi and Mozambique to the south. The country is gifted with unique and diverse natural and cultural tourist attractions such as national parks, game reserves with many species of wildlife, conserved areas, lakes, large plateaux, several marine parks, cultural heritage sites and several historical sites. Some of the National Parks include Serengeti, Ruaha, Mikumi, Lake Manyara, Katavi, Tarangire, Bugiri-Chato, Udzungwa Mountains and Saadani. Some of the game reserves include the lower part of Selous, Rukwa, Maswa, Mpanga-Kipengere and SwagaSwaga. Figure 6.6 is a map of Tanzania showing major tourist sites. Tourism in Tanzania is also marked by Mount Kilimanjaro (Figure 6.5) which is a National Park.



Figure 6.5 Mount Kilimanjaro in Tanzania

Source: <https://www.tanzaniatourism.go.tz>

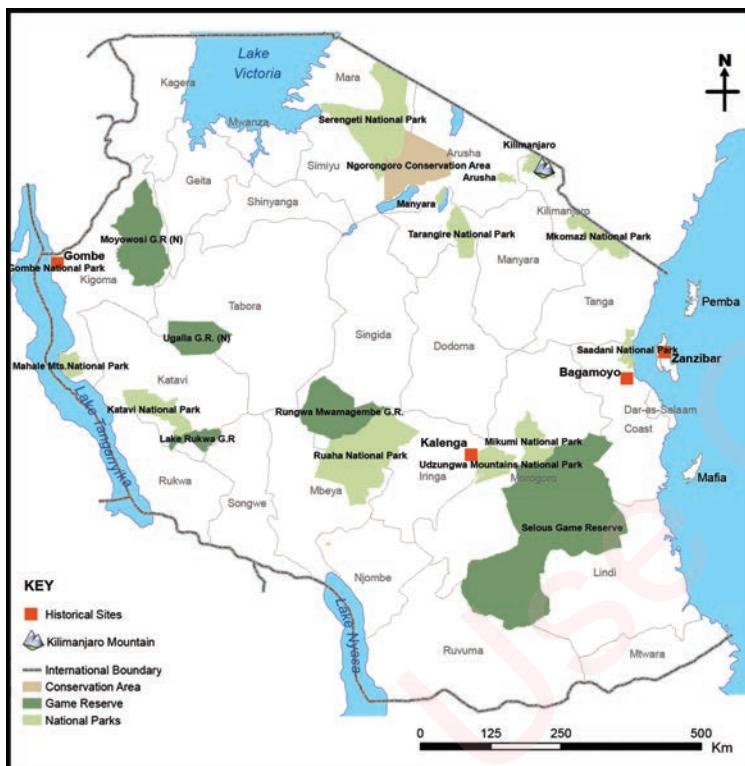


Figure 6.6 Major tourist sites in Tanzania

Management of national parks and game reserves in Tanzania: National parks in Tanzania are managed by the Tanzania National Parks Authority (TANAPA). This authority is responsible for the management and regulation of the use of all areas designated as national parks. The Tanzania Wildlife Authority (TAWA) is responsible for the management and regulation of the use of all the areas designated as game reserves and all wildlife outside national parks and the Ngorongoro Conservation Area (NCA). The NCA is managed by the Ngorongoro Conservation Area Authority (NCAA). This is the only conservation area in Tanzania where humans, livestock and wildlife share the same environment (multiple use

area). National parks, game reserves and the NCAA have the responsibility of ensuring that conservation benefits are shared with surrounding communities. This is done through provision of social services such as schools, water and health facilities, and provision of employment opportunities to local communities.



Figure. 6.7 Wild beasts in Serengeti National Park

Source: <https://depositphotos.com>

Factors for the development of tourism in Tanzania: Tanzania has a stable government, with peace and security which promote the tourism industry. In Tanzania, there are varieties of attractive sceneries including Mount Kilimanjaro, Ngorongoro Crater, Great Rift Valley and Amboni Caves. These landmarks contribute much to the development of tourism in the country. Others are Oldonyo Lengai and Mount Meru.

The country also has several national parks, game reserves and zoos which play a significant role in attracting different tourists. Examples of zoos include, the Dar es Salaam Zoo and Ifisi Zoo in Mbeya. The Indian Ocean also has good beaches and conditions favourable for aquatic sports such as swimming. Fine sand beaches in Mafia and Zanzibar, clear warm waters of the Indian Ocean and the inland lakes are attractions for both domestic and international tourists. Whereas national parks include Serengeti, Ruaha, Mikumi and Kilimanjaro, game reserves include the lower part of Selous, Ibanda, Mpanga Kipengere, Moyowosi, Ugalla and Mkomazi. Tanzania has moderate temperature and abundant sunshine which attract many tourists.

Tanzania has a national museum and several historical sites such as Olduvai Gorge, Isimila and Kalenga, Stone Town in Zanzibar and the meteorites in Ndolezi, Mbozi in Songwe Region. Other tourist attractions include local paintings in Kondoa-Irangi in Dodoma.

The improvement of transport and communication contributes to easy movement of tourists from one place to another. Tanzania is investing in improving airline transport to strengthen the tourism industry.

In addition, Tanzania has adequate and comfortable accommodation to cater for tourists with different economic status, hence attracting a large number of tourists. Tanzania also has friendly and hospitable people. The country is also rich in cultural diversity with more than 120 ethnic groups. Each of these ethnic groups has its unique culture which presents a wide range of cultural tourist attractions. Tanzania is also well known and respected for its unique language, Kiswahili which is ever expanding in Africa and worldwide.

Importance of tourism in Tanzania

(a) The tourism industry contributes to the Gross Domestic Product (GDP). Currently, tourism contributes about 17.5 % of the GDP. For example, Table 6.1 shows revenue collected by national parks in Tanzania Mainland in the years 2017 and 2018.

Table 6.1 Revenue collected by national parks in Tanzania Mainland in US\$

Year	Revenues (US\$ in millions)
2017	2,019.00
2018	2,043.00

Source: Standard Digital April 2019

- (b) The money obtained from tourism helps to improve and develop other sectors such as health, education, water supply, agriculture and transport.
- (c) Tourism also creates employment opportunities among Tanzanians. Both skilled and unskilled workers can secure jobs in national parks and game reserves, hotels and lodges, transport and tour companies.
- (d) Tourism contributes to the development of local handicraft industries. Tourists buy large quantities of handicrafts, especially wood carvings such as Makonde carvings, and wooden materials which attract more people to engage in such artistic productions.
- (e) Tourism promotes international relations through co-operation and cultural tolerance among people, to foster cultural diversity.
- (f) Tourism facilitates the development of infrastructure and services such as roads, airports, communication networks, water supply, electricity, hotels and proper sanitation. As a result, better services and standards of life are ensured for both tourists and natives.
- (g) Tourism promotes the spirit of environmental conservation and preservation of historical sites. This, in turn, leads to sustainable use of tourist attractions for national development.
- (h) Tourism is the source of foreign currency. Tourists pay for services they are provided with in foreign currency.
- (i) Tourism facilitates the creation of different recreational centers to attract even more tourists. Such attractions include night clubs, swimming pools and beaches.

Challenges facing tourism in Tanzania:

The tourism industry in Tanzania is faced with problems of transport and communication, which are not that well-developed, hence limiting tourist movement. For example, some of the roads are rough and, therefore, it is impossible to use them during the rainy season. Internet services are also expensive and not reliable. The country also faces a problem of poor co-ordination between the government and other players in the industry. In addition, there is a shortage of funds for the development of the tourism industry. Moreover, Tanzania does not have adequate and sustainable marketing strategies to advertise and promote the unique attraction sites available in the country.

Increase in population for settlement and agriculture expansion has led to encroachment on national parks and game reserves. This has led to degradation of wildlife areas, threatening their existence. In addition, crime and violent activities in some areas will discourage tourists from visiting such areas.

Promoting tourism in Tanzania: The following are the ways that can be used to promote tourism in Tanzania:

Marketing strategies and publicity: Marketing of the tourism sector both domestically and internationally should be enhanced. There is a need for the government and other players in the industry to market aggressively the country's tourist attractions in international media and forums.

Provision of training: Tourism is a service industry that demands quality services for its sustainability. It is, therefore, important to have trained personnel who can offer quality services to meet international standards. This, in turn, will lead to increased influx of tourists.

Development of tourist attractions: The government should invest in expanding the tourist attractions in the country. This can be done by opening up new areas and diversifying tourist activities but also by promoting them as viable alternatives.

Improvement of infrastructure: There is a need to improve the existing accommodation, transport and communication infrastructure. This will improve the provision of services needed by tourists in the hospitality industry.

Involving the local communities: Involvement of local communities will promote a sustainable tourism industry. Indeed, protection of national parks and

game reserves needs the commitment of the people living near the parks and game reserves. Moreover, communities should enjoy the benefits obtained from the use of protected areas by tourists.

Promotion of domestic tourism: Domestic tourism is not well-developed in Tanzania because of the high costs and lack of touring interest among natives. Therefore, domestic tourism should be promoted by offering affordable rates to natives. Also, eco-tourism should be established.

Lessons drawn to promote the tourism industry in Tanzania: The following are some of the lessons that can be drawn from focal studies discussed in relation to promoting the tourism industry in Tanzania.

Marketing: The Government of Tanzania as well as private players in the tourism industry should invest in marketing the country's tourism attractions all over the world. By doing so, the number of tourists will increase, thus contributing to the national economy.

Strong tourism policy: The government should formulate and enforce a strong tourism policy that is geared towards promoting culture-based tourism and eco-tourism.

Package tours: The government should promote package tours that allow for tour arrangements, including hotel reservations and travels to be done by a

company. This will increase the number of tourists visiting the country.

Regional co-operation: Tanzania, as a member of Southern Africa Development Community (SADC), has to fully utilise opportunities aimed to promote the tourism industry especially through the use of the Regional Tourism Organisation of the Southern Africa Countries (RETOSA).

Exercise 6.2

Answer the following questions:

1. Name any three tourist attractive sites for each of the following countries:
 - (i) Tanzania
 - (ii) Switzerland
 - (iii) Namibia
2. Draw a map of Tanzania and indicate five tourist attractions.

3. Explain how tourism is important in Tanzania, Namibia and Switzerland.
4. List and explain any three negative impacts of tourism in the world.
5. Explain the challenges facing the tourism industry in Tanzania.
6. Briefly, explain any five factors for the growth and development of tourism in Switzerland.
7. List any three lessons that Tanzania can learn from the tourism industry in Switzerland and Namibia.
8. Suggest any four ways:
 - (i) In which the tourism sector can be used to generate more income in Tanzania.
 - (ii) To promote tourism in Tanzania.
9. In a group of ten students, pair and share three major tourist attractions of a selected region in Tanzania.

Chapter Seven

Manufacturing industry

Introduction

In this chapter, you will learn about the concept of manufacturing industry, the importance of the manufacturing industry, types of manufacturing industries and the products of each type. You will also learn about factors necessary for locating an industry, and pollutants from manufacturing industries. Besides, you will learn about the production of cars in Japan, electronic devices in South Korea and textiles in Tanzania.

The concept of manufacturing industry

The manufacturing industry involves the processing and changing of raw materials into different semi-finished or finished products using tools and machines. It plays a major role in bringing about the development of a country. The ever growing population with increased demands for goods and services is accommodated by the establishment of manufacturing industries. Such increased population demands more food, shelter, clothes and other services. The following section explains the importance of manufacturing industries in the world.

Importance of manufacturing industries

(a) Manufacturing industries are sources of employment for both skilled and unskilled labour. These employees can raise their standards of living and improve quality of life with the income

they earn. The income they earn caters for basic needs such as food, shelter, clothes and education.

(b) Manufacturing industries also lead to the diversification of the country's economy due to their potentials for promoting other sectors of the economy. This reduces over-dependence on one or two economic sectors, which can be affected by fluctuation of prices in the world market.

(c) Manufacturing industries enable countries to process locally produced raw materials before they are exported. This process helps to add value to the exports.

(d) Manufacturing industries stimulate the development of infrastructure such as railways and roads. These means of transport are useful in carrying raw materials to manufacturing centers and the finished or unfinished goods to the markets.

(e) Industries also help to create a large internal market as workers get wages and salaries from industries which enable them to buy goods and services. In fact, the more the workers, the larger the market for manufacturing industries.

(f) Manufacturing industries also lead to increased agricultural production. For example, the textile industry requires cotton as raw material. Thus, it can stimulate the expansion of cotton growing.

(g) Manufacturing industries are sources of foreign currency. The products manufactured in a country are exported to other countries for sale which, in turn, attract foreign currency.

(h) Manufacturing industries reduce the country's dependence on imported goods because a country with well-developed manufacturing industries can meet the needs of the people.

(i) Manufacturing industries also stimulate the development of science and technology. Indeed, for a country to develop well in manufacturing industries, it needs to invest in science and technology to increase production.

(j) Manufacturing industries improve international relations through trade transactions with different countries. These trade transactions improve relations between the importing and exporting countries.

Types of manufacturing industries

Manufacturing industries can be grouped into two main types, namely, processing and fabrication industries.

Processing industries: Processing industries use raw materials from the primary industries. They produce goods which can be used as raw materials for other industries or can be directly consumed. These industries are also concerned with the processing of bulk raw materials into other products. Some of these are described below.

(a) *Textile processing industries:* These industries deal with spinning and weaving of textile materials from cotton, wool and silk. Artificial fibres such as rayon, nylon and dacron are used in textile industries. Textile industries in Tanzania include Musoma Textile (MUTEX), Mwanza Textile (MWATEX), Karibu Textile Mills (KTM) and Morogoro Polytex.

Leather processing industry includes hides, and skins. Despite its potential to contribute to the economy in terms of employment creation, income generation, foreign earnings and poverty reduction, its current contribution to development is still low. The comprehensive leather sector development strategy of Tanzania endeavours to generate the conditions for a favourable expansion of the industry so as to contribute to overall socio-economic development. Such development will require the coordination of various

activities such as the ability of stakeholders to plan and coordinate actions in results. The plants include Moshi industries, Tanzania leather industry, Afro leather, Kibaha Tannery, Himo Tanners and Salex Tanners.

(b) *Chemical industries:* These are industries which produce highly specialised products such as acids, gases, medicine, paints, pesticides, alkalis, soaps and fertilisers. Good examples are the Mansoor Daya Chemicals, Zenufa Laboratories and Unilever Tanzania which deal with detergents, soaps and other products. Their raw materials include acids, dyes and fertilisers. Zoom Tanzania manufactures chemicals for households and for industrial purposes, such as Pine disinfectant, A1 liquid soap, clorite bleach, and kioo glass cleaner.

(c) *Food and beverage processing industries:* These industries deal with the preparation of food stuffs and drinks such as meat packaging, fruit canning, flour milling, bottling and brewing, sugar refining, meat processing and packaging, Coca Cola, Pepsi Cola, Azam Cola and brewing industries. Examples include Cool Blue Tanzania (producing mineral water), Chai Bora (Tea leaves), Said Salim Bakhresa & Co. Ltd (Mzizima Flour Mill).

(d) *Metallurgical industries:* Metallurgical industries deal with the production of iron and steel as raw materials in engineering industries, for example, Aluminium Africa Limited (ALAF), the Motisun Group in Dar es Salaam and AIM Steel Ltd in Arusha that deal with steel and pre-coated sheets.

(e) *Craft industries:* These are industries which deal with spinning, weaving, dyeing of cotton cloth, tanning and leather making, wool carving, basket making, pottery and gold, and silver smelting. Examples include MIKONO Craft Industry, Kwanza Collections, Maznat Designs, Makonde Handicraft Village, Nyumba ya Sanaa in Dar es salaam.

Fabrication industries: Fabrication industries produce new products from processed raw materials. Such fabrication industries can be heavy or light. Heavy fabrication industries produce bulky and heavy products such as iron and steel. Other heavy fabrication industries include car assembly and ship building. Light fabrication industries produce light products such as plastics, textiles, shoes and electronics.

Types of manufacturing industries in East Africa: There are different types of manufacturing industries in East Africa. They can be grouped as follows:

- Food and beverage industries
- Chemical industries
- Textile industries
- Mineral extraction industries

- v. Iron and steel industries: They make iron and steel bars, wires, and other iron and steel products.
- vi. Lumbering industries: These industries deal with the production of timber, wood pulp and other products from wood. Paper industries rely on softwood which grows fast.
- vii. Fuel and power industries: These industries deal with the extraction of oil, petroleum, coal, natural gas, and refining and generation of power from various sources such as steam and coal.

Factors for the location of manufacturing industries: The establishment of an industry in a certain area depends on many factors, some of which are described below.

Availability of raw materials: Closeness to the sources of raw materials reduces transport costs and time for the materials to reach the industry. In most industries, transportation of raw materials from the source to the industries is part of the production cost. Industries which use heavy and bulky raw materials are usually located near the source of raw materials. For example, Twiga Cement Industry in Dar es Salaam is located near limestone deposits (Figure 7.1). Other cement industries are Dangote (Mtwara), Tanga Cement and Mbeya Cement in Tanga and Mbeya respectively.



Figure 7.1 Lorries carrying cement at Twiga Cement factory, Tanzania

Power supply: Industries need reliable and adequate power supply to run machines. The availability of this power supply ensures constant production of goods in the industries. The common sources of power used in manufacturing industries are hydro-electrical power, coal, natural gas, solar and nuclear power. Industries located close to sources of power are more profitable than those located far away.

Transport and communication networks: Transport is an essential component in movement of raw materials to the industrial areas and the manufactured goods to the markets. A good transport network helps to reduce costs and facilitates the movement of raw materials and manufactured products. The commonly used means of transport are roads, railways, waterways and airways.

Market: The availability of a reliable market for the manufactured goods is one of the essential factors that account for the development of manufacturing industries. Availability of the markets can determine production efficiency.

Industrial production depends on the demand for goods, which also determines the location of such industries.

Labour: The labour force required by an industry depends on the type of the manufacturing industry. Both skilled and unskilled labour is required for the development of manufacturing industries. Thus, the development of manufacturing industries tend to flourish in areas where labour is available and stable.

Capital: Availability of capital is a very important factor for the development of manufacturing industries. This is money invested in starting a business. Money is required to buy the site, build offices, purchase raw materials, pay workers and market products.

Government policy: Government policies may encourage or discourage the location of industries in certain areas due to social (population or market), economic (introduction of protective tariffs), political (civil wars, political influence) or environmental (climate) reasons. Supportive policies attract both internal and external investors. Supportive policies provide possibilities for financial support through loans and friendly conditions to investors.

Water: Availability of regular and abundant supply of water is essential for the development of industries since most industries require large quantities of water for their operations. For

example, iron and steel industries require water for cooling purposes, textile industries for washing fibres, chemical, pulping and timber industries for proper functioning. Water may be required either in the processing of raw materials or for cooling machines.

Activity 7.1

With the guidance of your Geography Teacher visit a nearby manufacturing plant and find out the reasons for its location, the source of power used in that industry and identify the manufactured products and their market. Then in groups, discuss the importance of that industry.

Pollutants from manufacturing industries:

Industrial pollutants are substances that make air, water and soil harmful to living organisms. The manufacturing industries produce different pollutants which are dangerous to human health and the environment. These pollutants are categorised as gas, solids, liquids and noise.

Industrial pollution: The manufacturing process turns raw materials into useful goods. But some of the by-products of manufacturing waste materials left over or substances produced by the manufacturing process itself, may be harmful to the environment. Manufacturing contributes to air and water pollution for example the Wazo Hill Cement industry in Dar es Salaam.

Air pollution: Pollution can easily be observed from oil refining industries. These manufacturing industries use heat from coal or diesel furnaces to provide steam power to run the plants. Burning this fuel can also release pollutants into the air.

Gases: Industrial activities produce harmful gases that pollute the environment. Such gases are sulphur dioxide, nitrogen dioxide, carbon dioxide, methane and other hydrocarbons. The gases emitted may cause respiratory and skin diseases. Sulphur dioxide can form sulphuric acid when it comes into contact with water in the atmosphere to form acid rain. Such rain corrodes rocks, iron sheets and pollute soils, lakes and rivers. Carbon dioxide is produced due to incomplete combustion of gases, oil, coal and wood. The high concentration of carbon dioxide in the atmosphere causes global warming.

Industrial solid waste: Solid waste such as paper and plastic products, bottles and cans, food and garden wastes from industries pollutes the environment. Waste is harmful as it may contribute to the transmission of diseases to human beings and plants.

Liquid pollutants: Dirty water from industries may contain heavy metals such as lead and mercury, harmful chemicals, radioactive waste or organic sludge. This waste pollutes water when discharged into rivers, oceans or lakes and destroys aquatic life. If water with

liquid pollutants is used for irrigation, it may harm the crops and people's health. These pollutants may also alter the soil composition and texture, hence making it unproductive.

Noise pollution: The operation of machines may produce loud noises that disturb people working in the industries. The noises can also affect hearing in human beings, and may also disturb people living near the industries, by disrupting their sleep and rest.

Major ways of reducing industrial pollution

There are several ways of reducing pollution from industries. These ways include the following:

- (a) Locating industries away from residential areas. There should be a proper policy on locating industries.
- (b) Laws and by-laws should be enacted to protect the environment against pollution.
- (c) Encouraging the use of alternative sources of energy which are environmental friendly, for example, the use of solar energy and hydro-electric power.
- (d) Complete combustion of fuels in industrial machines should be ensured as it reduces air pollution.
- (e) Liquid waste from industries should be treated before it is discharged as waste, to reduce the effects on the environment.

- (f) Industrial waste can be reduced through re-use and recycling of plastic materials, bottles and cans to produce other materials.
- (g) Routine inspection and maintenance of industrial machines should be carried out on a regular basis.

Exercise 7.1

Answer the following questions:

1. Define the following terms:
 - (a) Manufacturing industries
 - (b) Processing industries
2. Mention two types of manufacturing industries and give two examples for each type.
3. Describe five types of processing industries in Tanzania and give two examples for each type.
4. Describe any three factors affecting the location of industries.
5. Define industrial pollution.
6. Mention any three industrial pollutants and explain their effects to people and environment.
7. Outline five ways of reducing industrial pollution.

Focal studies

Car manufacturing industries in Japan

Japan is a chain of islands in the eastern part of Asia. It has an area of about 377,972 square kilometers. The population of Japan was about 126.8 million people in 2018 (Population, 2019). It is located between North Pacific and the Sea of Japan. It is one of the leading car producers in the world ahead of other producers such as Germany, United States of America, France, United Kingdom, South Korea, China, India and South Africa. The major industrial centers in Japan are located in the coastal cities of Tokyo, Osaka, Kobe and Yawata. Other cities include Nagoya, Kyushu, Shikoku, Honshu and Hokkaido. Japan produces various types of vehicles such as Mitsubishi, Isuzu, Suzuki and Toyota. Cars from Japan are more marketable because they are durable and of high quality. Spare parts are also easily available and affordable.

Factors contributing to the development of industries in Japan

The growth of car manufacturing industries in Japan has been facilitated by the following factors:

Power supply: Japan has a good supply of reliable power to support industrial development. The country has well-developed hydroelectric power and nuclear energy to provide power for industries.

Harbours: Japan has natural harbours for large ships that enhance the importation and exportation of both raw materials and manufactured products in large quantities.

Reliable market: Car manufacturing industries in Japan have a reliable market both within and outside the country. The growing Japanese population offers market for the manufactured cars. Moreover, the quality and availability of spare-parts from Japan guarantee the ever growing market almost all over the world.

Labour: The educated population of Japan provides reliable source of skilled labour able to work in various industrial fields. The government has invested much in science subjects in schools and universities to create highly skilled labourforce to work in industries.

Good transport and communication network: Japan has a well-developed transport and communication network including roads, modern railway systems, seaports and airports. These promote development of car manufacturing industries. Transport and communication network facilitates the movement of raw materials to the industries and manufactured goods to the markets.

Capital: Japan's economy is one of the biggest in the world, hence the country has adequate capital to support industrial development. This has enabled it to finance the development of its giant car manufacturing industries.

Technology: Japan is highly developed in technology useful in car manufacturing industries. The use of computer and robot technology in manufacturing has increased production. Research in Japan is also an ongoing practise that ensures better methods of industrial production.

Hard working: The Japanese are well known all over the world for their spirit of hard-work. They are committed in their work and to the development of their country. This spirit has improved their car manufacturing industries.

Electronic equipment industry in South Korea

South Korea is located in Eastern Asia south of the Korean Peninsula. It occupies the southern half of the peninsula. It has an area of about 98,000 square kilometers. The population of South Korea was about 51.5 million people in 2017. It is one of the highly industrialised countries of the world in electronic manufacturing. Its economy is growing very fast due to foreign investments in many electronic equipment such as televisions, radios, calculators, watches, magnetic discs for computers, computer software, cell phones, computer terminals and radar.

The major electronic production centers include Busan, Daegu, Gwangju, Jeju and Seoul (Figure 7.2). Daegu alone has more than 150 electronic factories. The major electronic manufacturing

companies in South Korea are Samsung, LG electronics, Daewoo and Hyundai. Other competitors in the electronic manufacturing industry include Hong Kong, Singapore, Malaysia and Taiwan.



Figure 7.2 Electronic production centers in South Korea

Factors contributing to the development of electronic manufacturing industries in South Korea

The following are factors that contribute to the development of electronic manufacturing industries in South Korea:

Capital: South Korea has capital which is available through bank loans and government assistance. This capital has enabled the growth and diversification of industries. Also, the capital has facilitated the development of infrastructure and factories in addition to funding scientific research for the development of such industries.

Policies: South Korea's government has supportive policies that promote the development of electronic industries by providing financial support through loans and research. The policies are also supportive in attracting foreign investors from Japan and the USA to invest in electronic manufacturing industries through friendly policies.

Labour: South Korea has a skilled labourforce since the country has invested heavily in education and technological innovations. For example, the literacy level is estimated to be over 98 percent with emphasis on science subjects in schools and colleges.

Transport and communication: There is efficient means of transport and communication that facilitate the transportation of raw materials and manufactured goods.

Market: The electronic industries produce goods of high quality which are also in high demand both within and outside the country. The products have a ready market all over the world which, in turn, promotes production.

Science and technology: South Korea has invested heavily in science and technology and, as a result, it sets high standards of new technology. The country puts emphasis on scientific innovation, investigation and research. This focus has given the country's electronic industry an edge over other electronic manufacturers in the world.

Energy: South Korea has available and affordable energy that is generated from different sources, including nuclear power that contributes to about 45 percent of the total power production. Other sources include solar energy and hydroelectric power, which are reliable and affordable, thus enhancing production.

Research and development: Electronic manufacturing industries in South Korea rely much on research and development to attract and widen the market. A lot of government funds are directed towards the improvement of the existing products and developing new ones.

Activity 7.2

In groups, note down the similarities in the factors contributing to the development of car manufacturing industries in Japan and electronics manufacturing industries in South Korea and then present to the class.

Textile industries in Tanzania

Textile industries deal with the manufacturing of clothes from cotton, wool, silk, nylon, rayon or linen as raw materials. Textile manufacturing involves the design, production and distribution of textiles, fabrics and clothes. Examples of textile industries in Tanzania include Urafiki Textile Mills, Kilimanjaro Textile Mills (KILTEX), Karibu Textile Mills (KTM), Mwanza Textile Mills (MWATEX), Musoma Textile Mills (MUTEX) (Figure 7.3).

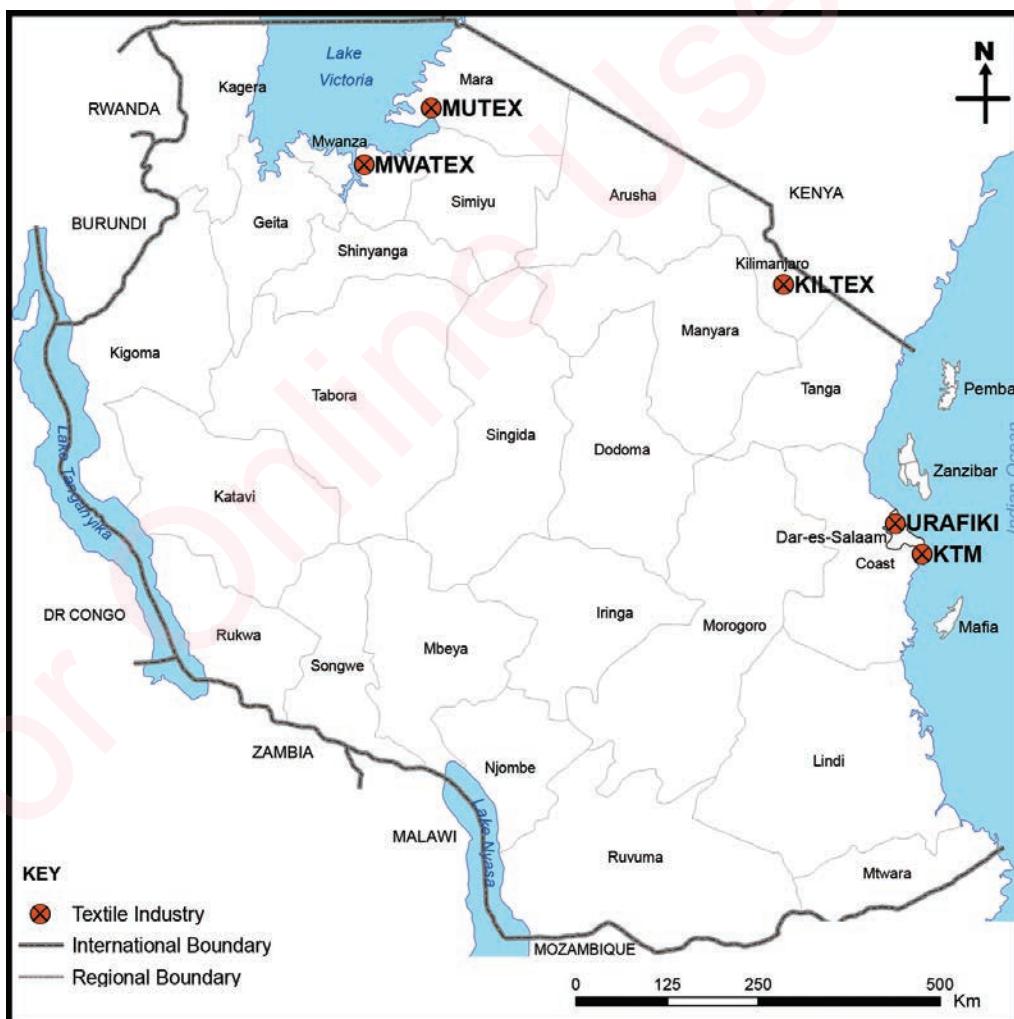


Figure 7.3 Location of some textile industries in Tanzania

Importance of textile industries in Tanzania: The textile industry provides employment opportunities to both skilled and unskilled labourers. Skilled labour is required in the textile industry for designing, spinning, cotton weaving, bleaching, dyeing and printing of cotton fabrics. These workers are specialised in one section. Unskilled labour is equally needed to support skilled workers, for example, by clearing and providing security.

The textile industry also stimulates production in other sectors of the economy such as agriculture, transportation, commerce and trade. The industry operates because raw materials are readily available. In Tanzania, cotton is the main raw material for the textile industry. Farmers will continue to produce cotton when they are assured of ready markets for their cotton.

Another important contribution is the development of transport infrastructure such as roads and railways. Good transport enables cotton to reach the factory and products to reach the market at a minimum cost, and in time. In addition, textile industries are sources of foreign currency. The development of the textile industry depends on the availability of both internal and international markets. Since there is no country that can meet the demands of its people by only using locally produced goods, there is a need to produce more for export to get foreign currency. Textile industries

also promote international relations through trade. There is so much trading in the world because of differences in resource endowment and climate. For example, there are countries producing cars (Japan) while others produce textile materials (Tanzania). This distribution of manufactures justifies the need for trading of the products among nations, which also helps build healthy and good relations.

Challenges facing textile industries in Tanzania:

Many of the textile industries have been operating for a long time in such a way that their machines have become out of date. With the advancement of technology, the old machines in textile industries need to be replaced by new ones for efficiency purposes. There is also lack of adequate skilled labour. This leads to the need to import labour from outside the country, resulting in increased production costs. Lack of adequate capital and inadequate supply of raw materials limit the ability of the industries to increase productivity.

Poor transport and communication system also hinders timely transportation of raw materials to industries and manufactured goods to the markets. High costs and unreliable power supply constitute other challenges because they reduce profit from industrial production. The chemicals used in textile industries are also expensive. This also leads to reduced profit from textile industries.

Lessons from Japanese and South Korean industries for Tanzania

Japan and South Korea are industrialised countries. They produce electronic equipment and cars of good quality which are sold all over the world. The following are some of the lessons Tanzania can learn from Japan and South Korean:

Management of industries: Various industries in Japan and South Korea are properly managed. For example, industries employ skilled workers with the required qualifications. Workers use time and other industry's resources effectively. As a result, they produce efficiently for profit. The industrial managers work on a set of objectives and are not involved in any type of corruption. The same practises should be adopted in Tanzania's industries.

Improved transport and communication network: Well-developed transport and communication in Japan and Korea play a big role in the development of industries as the transportation of raw materials tends to be easy and at low costs. Similar conditions should be created to increase productivity in Tanzania's industries.

Investment in research: Both Japan and Korea have heavily invested in research and development particularly on better, efficient and effective production methods. This has continually improved their production methods and made the costs manageable. Therefore, Tanzania needs to invest in research.

Training and development of workers:

Japan and Korea have been allocating adequate funds for training to enhance workers' productivity. This is something that Tanzania should also do to improve the industrial sector.

Spirit of commitment and hard work:

The workers in Japan and South Korea are committed to accomplishing the duties and responsibilities assigned to them. This practise has led to increased efficiency in their industrial production. Therefore, workers in Tanzania's industries should develop the same spirit.

Production of high quality products:

Industrial products from Japan and South Korea are of high quality and can compete with similar products from other competitors. Therefore, Tanzania has the duty to ensure that its industrial products meet international standards.

Reliable source of power and energy:

Japan and South Korea exploit different sources of energy, hence making power cheap and available all the time. They have hydro-electric power and nuclear power which make the availability of power very reliable. Tanzania should follow this example by exploiting various sources of energy rather than depending only on hydro-electric power.

Exercise 7.2**Answer the following questions:**

1. Mention the regions in Tanzania where textile industries are located.
2. Explain the following terms:
 - (a) Fabrication industries
 - (b) Processing industries
 - (c) Manufacturing industries
 - (d) Industrial pollution
3. Mention any five ways in which textile industries are important in Tanzania.
4. Describe any four factors contributing to the development of manufacturing industries.
5. Mention any five factors contributing to the development of electronic equipment industries in South Korea.
6. List major electronic equipment produced in South Korea.
7. Mention two major industrial areas in South Korea.
8. Explain any five factors contributing to the development of industries in Japan.
9. List down four lessons that Tanzania can learn from Japan's and South Korea's industries.
10. Name and explain any five problems facing textile industries in Tanzania.

Chapter Eight

Sustainable use of power and energy resources

Introduction

Power and energy are important for every aspect of human life. They may be generated from waves, winds, waterfalls, solar, natural gases, geothermo, oil and coal. In this chapter, you will learn about the major sources of power, the methods of acquiring and extracting power and energy, and the uses of power and energy resources. You will also learn about the problems facing power and energy production, specifically solar and wind power production in the USA, hydroelectric and biogas production in Tanzania. Finally, you will learn about problems related to power and energy extraction in the USA and Tanzania.

The concept of Power and Energy

Power: Power is the flow of energy at any one time, and can be generated from renewable energy resources through solar conversion (solar, thermal electricity, solar heating); harnessing water (hydropower for electricity, wave and tidal generation through turbines); harnessing the wind (wind pumps for water, wind turbines for electricity); and a variety of other energy sources. The main power sources are petroleum (oil), natural gas, water, coal and nuclear. Other sources include the earth's interior (hot springs), wind, sun, tides, and waves, wood, peat and cattle or cow dung (biogas).

Power is found within our bodies, machines, in plants and bodies of animals, insects and birds. Power is also inherently present in natural forces like wind, tides, waves, and water whose

movements can be utilized to drive machines, or generate electricity. In our daily lives, power is needed to cook food, to drive machinery in industrial plants , to provide light and heat, and to propel vehicles of different types.

Energy: Energy can be defined as the capacity for, or equivalent of, doing work. Energy is the ability to work so as to produce motion. For example, when water turns a turbine, electricity is produced. Also energy is used to drive machines and provide heat and light.

The society requires energy for transportation, heating and cooling of buildings, powering production processes in industry, and various household needs. Energy can be grouped into various types as explained below.

Primary and secondary energy: Primary energy sources are those that are either found or stored in nature. This type of energy is captured directly from natural resources. Common primary energy sources are coal, oil, natural gas, and biomass (such as wood). Other primary energy sources include available nuclear energy from radioactive substances, thermal energy stored in the earth's interior, and potential energy due to earth's gravity. The primary energy sources are converted into secondary energy sources; for example coal, oil or gas are converted into steam and electricity. Also, heat is a primary energy, which can be transformed into secondary geothermal or solar electricity.

Commercial and non-commercial energy: Energy sources are regarded as commercial if they are available in the market for a definite price. The most common examples of these energy sources are electricity, coal, and refined petroleum products. These sources are the basis for industrial, agricultural, transport and commercial development in the contemporary world. Likewise, they are predominant sources of household energy especially in developed countries. Likewise, the non-commercial energy sources are not available in the commercial market for a price. They include fuels such as firewood, cattle dung, and agricultural waste used by households. These are traditionally gathered and not bought at any price especially in rural areas. Examples include firewood, agro-waste, solar energy for water heating, electricity

generation, drying grain, fish and fruits; animal power for transport, threshing, lifting water for irrigation, crushing sugarcane; wind energy for lifting water and generation of electricity.

Renewable and non-renewable energy: Renewable energy is energy generated from sources that are essentially inexhaustible. Examples of renewable energy sources include wind power, solar power, geothermal energy, tidal power, and hydroelectric power. Non-renewable energy includes conventional fossil fuels such as coal, oil and gas, which are likely to get depleted with use.

Conventional and non-conventional energy: Conventional energy is an energy source which is fixed in nature like oil, gas, and coal, and hydropower generation. It is also termed as non-renewable energy or thermal energy. The conventional energy resources are being used extensively; as a result, their known reserves have been depleted to a great extent. The use of conventional energy has emerging effects on the environment.

The non-conventional energy involves energy generated by wind, tides, solar and biomass. These are renewable sources of energy and not exhaustible.

Major sources of power and energy
The primary source of energy is the Sun. Other sources of power and energy are fuelwood, water, coal, natural gas, oil, hot springs, wind, biomass and tidal waves. The sources of energy are categorised as renewable and non-renewable.

Renewable energy sources: Renewable energy is any energy source that is naturally replaced. The energy can be derived from sunlight, tides, wind, water, geothermal, or hydroelectric action. Likewise, energy produced from the refining of various forms of biomass is often classified as renewable. The renewable energy sources are usually regarded as environmentally friendly, because they release few chemicals that can harm the environment. These are energy resources that are naturally reused. Renewable sources are sustainable if they are carefully managed and maintained. They have minimal negative effects on the environment. Renewable energy sources include sunlight, geothermal heat, wind, tides, water and various forms of biomass. Some of these energy sources are described in the following sub-sections.

Biogas energy: Biogas is a mixture of gases produced by decomposition of organic matter such as waste from manure, plant materials, sewage, green waste, or food waste. The main components of biogas are methane and carbon dioxide. Biogas may be used to reduce high cost associated with other sources of energy and reduce over-dependence on fuelwood as the only source of energy. Biogas is less costly than other sources of energy and does not require specialised knowledge to operate.

Wind energy: Wind energy refers to the energy that is generated from wind. Wind mills have been used for hundreds of years to pump water from the ground. Currently, wind turbines are used to generate electricity. Wind is the second most frequently applied energy source in the world with a total installed capacity of 539.123 Gigawatt (GW) in 2017. Before harnessing wind energy, research on variables such as speed, direction and persistency is necessary. Thereafter, wind turbines have to be set. A wind turbine operates on the following simple principles:

- (i) The power from the wind turns the windmill that has two or three propeller-like blades around a rotor.
- (ii) The motor is connected to a main shaft that spins a generator to generate energy. Figure 8.1 shows a windmill farm.

In Tanzania the utilisation of wind energy is encouraged by factors such as the increase in the costs of oil along frequent hydro power cuts, and increased demand of power which is influenced by high population growth. Tanzania has areas of high wind potential that cover more than 10% of its land.

Research works indicate that Tanzania has a lot of wind energy resources in the areas of Great Lakes, the plains, and the highland plateau regions of the Rift Valley. Also areas such as Makambako (Njombe) and Kititimo (Singida) have sufficient wind speed for grid scale electricity generation.

The advantage of using wind energy is that it does not pollute the environment. Also, it occupies a small ground space. The limitation of using wind energy is that wind turbines can disturb, or kill flying creatures like birds.



Figure 8.1 Windmill farm

Source: <https://www.desertsun.com/story/tech/science/energy>

Solar energy: Solar energy is generated from the Sun using collector panels. The collected energy can be used to provide heat, light, or other forms of electricity. It is used in Tanzania though in small-scale. The distribution of solar energy depends on the overhead sun of a particular place. It is harnessed by using two methods: (i) through plates which are used to collect and reflect heat to power generators; (ii) by using Photovoltaic Cells (PV) composed of semi-conducting materials

that convert sunrays into electric currents. This method is commonly used in many places for lighting homes and traffic roads as well as street lights.

The PV cells are combined to form solar panels (Figure 8.2). The panels usually differ in size depending on the purpose of their installation. The series of combined PV cells are usually placed on roofs of houses or on top of traffic lights to form the panels, which capture solar energy. For adequate energy to be obtained, solar panels should face the sun so that more sunrays are converted into electrical energy.

China, Germany, Italy, the USA, and Japan possess the biggest solar photovoltaic (PV) technology capacity in the world.

In Tanzania, solar energy is used as a source of power by 24.7% of the households that have access to electricity. High potentials of solar energy resources are found in the central parts of the country.

Currently, solar energy is used in different parts of Tanzania. Solar thermal is used for heating and drying; and photovoltaic is used for lighting, water pumps, refrigeration purposes and telecommunication. Solar energy is used mostly in rural areas by about 64% of its people compared to urban areas with only 3.4%. The regions of Lindi, Njombe, Mtwara, Katavi, and Ruvuma lead in the use of solar power electricity in Tanzania. The advantages of using

solar energy is that it is friendly to the environment. However, the technology for utilising and harnessing solar energy is expensive.



Figure 8.2 Solar panels

Source: shuttersstock.com

Geothermal energy: Geothermal energy refers to the heat energy generated and stored in the earth. Tapping this energy involves pumping cold water into hot rock boreholes and extracting the steam through another borehole. Due to the force by which the hot water comes out, it has the ability to drive turbines to generate electricity. Geothermal power production is mostly found in volcanic areas. Geothermal evidence in Tanzania is found in Mara, Manyara, Mbeya and Rukwa. In these areas, water naturally flows out as hot fountains. Geothermal evidence is also found in Kenya, South-Eastern Nigeria, Madagascar, USA, New Zealand and Iceland. Figure 8.3 shows a geothermal plant generating electricity. Geothermal energy can be used for domestic purposes or on large-scale by industries. It was used during earliest times for bathing and space heating. The biggest disadvantage with geothermal energy is that it can only be produced at selected sites.



Figure 8.3 Geothermal Plant

Source: Free photo on pixabay.com

Hydro-electric power energy: Hydro-electric power is created by the force of flowing water from mountains or high landform streams. Thus hydro-electric power is a result of water in motion. Moving water possesses energy which can be converted into electric energy if the following conditions are met:

- (i) There should be a constant supply of water. This is possible if the sources of water are areas where there is heavy rainfall, natural lake or melting water from mountain glaciers. It is also possible where there is a reservoir that could be a lake or dam to store the water needed.
- (ii) There must be a ready market for the power generated. The aim is to minimise the cost of transmitting electricity.
- (iii) The ground has to be steep to allow fast flow of water. For example, a waterfall that can drive hydro turbines.

A dam can be constructed across a river or along the coastal strip where tidal waves are common. The power house is

constructed adjacent to the dam. Then, water at very high speed (from streams, glaciers, natural water falls or man-made dams) is directed to the turbine chamber.

As the turbine rotates, the generator or dynamo also rotates to produce electric power. The power generated is then transmitted to the transformer where it is transmitted for industrial and domestic uses, as shown in Figure 8.4.

HEP is primarily advantageous because it does not discharge pollutants into the environment. In addition, if people turn to using hydroelectric power, deforestation caused by use of fuelwood may be reduced. The problems faced with hydropower have to do with the aging of the dams. It is costly to maintain them for their functionality and safety. Globally, China has the biggest hydroelectric generation capacity in

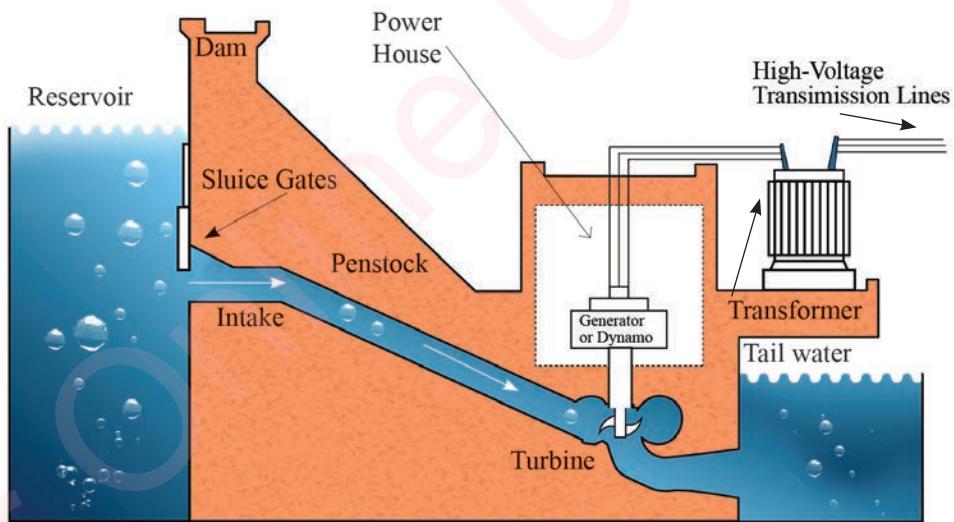


Figure 8.4 A model of a hydro-electric power plant

the world, followed by Brazil, Canada, and Russia. Currently, hydropower constitutes over 45% of the total power generated in Tanzania.

Fuelwood: Wood energy is energy generated from wood extracted products through combustion processes. The energy is used for cooking, heating, and generation for electricity. Likewise, the term “wood energy” is used to refer to wood and materials developed from wood used for energy purposes (“woodfuel”). Woodfuel can be in solid, liquid or gaseous form. Examples of solid woodfuel include firewood, charcoal, and wood pellets produced from wood or wood residues. Liquid woodfuel include Bio-oil, Bioethanol and gaseous woodfuel including wood gas.

Fuelwood comprises unprocessed wood biomass harvested from stems, branches or other parts of trees. Likewise, sometimes it is generated from wood residues such as sawdust and wood shavings generated from timber harvesting, or wood processing industries. Globally, roughly 2500 million people rely on wood fuel for heating and cooking. In USA, the community uses about 85% of all the wood collected from forests as fuel or charcoal for heating and cooking.

In Tanzania, biomass/bio-power (wood) is the largest energy source. More than 1 million people engage in charcoal production and supply. Currently, there is an upsurge in modern biomass

utilisation. The raw materials available such as municipal solid waste, forest residues, sugar bagasse, rice husk, sisal, and coffee can be used to generate power.

Non-renewable energy sources: These refer to sources of energy that cannot be re-used. They are non-renewable because their formation takes a long time, usually millions of years. Fossil fuels such as coal, oil and natural gas are non-renewable sources of energy. They originate from remains of plants and animals which have decomposed for a long time under high pressure and heat. These energy sources are described in the following sub-sections.

Nuclear energy: Nuclear energy is derived from atoms by altering or breaking their structure. Alteration of the structure of the atom leads to a release of energy in the form of heat. Released energy is used to generate electricity. An important raw material for this process is uranium. Although nuclear energy itself is a renewable energy source, the material used in nuclear plants is not renewable. Nuclear power is mostly generated in USA, France, Russia, China, India, Canada, Israel and UK. Nuclear power plants do not produce or emit greenhouse gases. They can be built in both rural and urban areas, and do not destroy the surrounding environment. However, nuclear energy is difficult to harvest and nuclear plants are very complicated to build and run. Likewise, in many communities there is limited capacity to develop a safe and reliable

nuclear energy programme. Nuclear energy also produces radioactive materials, which increase health risks in the communities where the plants are located.

Coal energy: Coal occurs in sedimentary rocks in layers or seams of varying thickness. It is available in different countries such as Tanzania, China, USA and South Africa. If the coal seams are near the earth's surface, coal is extracted through strip mining. Under this method, coal is exposed via an open-pit into coal deposits. If coal is found in a mountain peak, extraction involves the removal of the highest part of that mountain to recover the coal. Burned coal produces heat energy, which is used for purposes such as domestic heating, smelting of iron and steel, boiling of water and steam production.

Petroleum: Petroleum is organic in origin. It occurs in the pore spaces between sedimentary rocks. Once a drilling site is decided upon, a steel derrick about 30 metres or more depending on the location of the petroleum bearing rock is fixed upright and the equipment for drilling is used. Steel tubes are inserted into the boreholes. Once the drill reaches the oil bearing rock layer, oil flows out through the boreholes and keeps flowing as shown in Figure 8.5. The oil is then transported through pipelines to the refinery.

Natural gas energy: Natural gas is often found together with petroleum. It is found concentrated in the uppermost part of the trap. Sometimes, natural gas occurrence is independent of petroleum. Natural gas is mainly composed of hydrogen, carbons and methane. Other ingredients of natural gas include butane, propane,

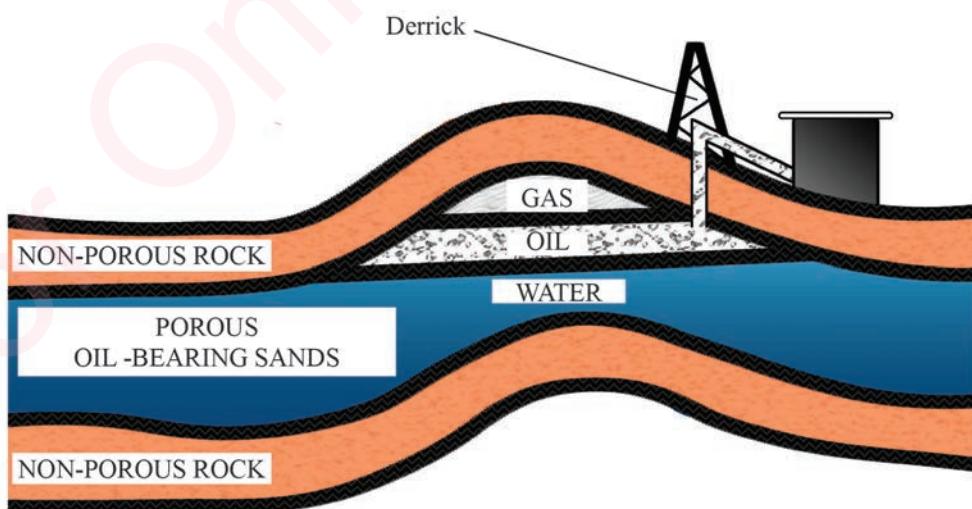


Figure 8.5 A derrick at an oil well

ethane, helium, nitrogen, carbon dioxide and hydrogen sulphide. Natural gas is extracted by drilling a borehole in the ground before inserting steel tubes into the borehole. Once the drill has reached the gas-bearing rock layer, gas flows out through the borehole and keeps flowing through special pipes up to the power generating plant where the refining takes place. Figure 8.6 is an example of a natural gas plant.



Figure 8.6 Natural gas plant at Kinyerezi 1, Dar es Salaam

Source: <http://csi.energy/project/kinyerezi-1-power-plant-150-mw/>

Importance of power and energy

The following section explains why power and energy are important to human life.

Running machines: Power and energy are used to run machines in industries and provide light at homes, schools, hospitals and other institutions. In the agricultural sector, energy is used to run farm machinery and equipment such as tractors and combine harvesters.

Raw materials: Some sources of energy are raw materials of some industries. For example, oil is a raw material for petrochemical and refinery industries in the making of plastics, medicines, clothes and ropes.

Transport enhancement: Energy plays an important role in improving the transport sector because vehicles, locomotives, aircraft and vessels use petrol or diesel.

Economic development: Energy is a source of foreign currency. Some countries export electricity to other countries. Other sources such as oil, coal and natural gas are exported to other countries and earn foreign currency, which is used to develop other sectors such as agriculture, education and health. Also the generated electricity can be sold to other countries and earn foreign currency.

Tourist attraction: Places with energy installations tend to attract tourists, for example, geothermal, HEP stations, and windmill plants.

Fishing and irrigation areas: The dams constructed to produce HEP become useful in fishing and irrigation. For example, Mtera Dam has become a source of fish for commercial and domestic use.

Employment: Power and energy generation employs so many people who work in the power plants.

Challenges facing power and energy production

Power and energy production is facing many challenges. Some of these are described below.

Drought: Prolonged droughts decrease the volume of water, which in turn reduces the ability of hydro-electric power plants to produce electricity.

Inadequate capital: The construction of dams and hydro-electric power stations requires heavy capital outlays. Capital is also essential in the production and transportation of natural gas. Unfortunately, many developing countries lack capital to harness fossil fuel and hydropower potentials.

Transport and communication networks: These are inadequate in many developing countries, which hinders the extraction or transmission of energy and power.

Poor technology and lack of skilled personnel: Some energy and power production systems such as nuclear, tidal and geothermal energy require advanced technology, which is lacking in most developing countries.

Environmental pollution: Energy and power production may lead to environmental pollution. This happens when fossil fuel produces pollutants, including greenhouse gases such as carbon dioxide, methane and nitrogen oxide due to burning. This contributes to water and air pollution, global warming, and climate change.

Dam siltation: Siltation of dams constructed for HEP reduces the capacity of reservoirs. This affects the generation of hydro-electric power, and sometimes causes flooding.

Disposal of nuclear waste: Nuclear waste is highly radioactive. It needs to be safely disposed off or stored for many years. But the process is extremely expensive.

Environmental disaster: Nuclear power generation if not well-handled can be disastrous due to leakage at nuclear plants. For example, Fukushima in Japan in 2011 and Chernobyl in Russia in 1986 had nuclear leakage, which led to environmental disaster including air and land pollution, and loss of biodiversity.

Forest degradation and loss: Establishment of hydro-electric power stations leads to clearance of vegetation or submerges large tracts of land which destroys wild life habitats and, sometimes, reduces land for agriculture.

Price fluctuation: Fluctuations of prices of fossil fuel affect production. Sometimes, oil producing countries have to reduce oil production to control the price in the world market. This calculated reduction affects economies of supplying and buying countries.

Addressing the challenges of energy and power production: Different measures can be taken to address power

and energy production challenges, they include the following:

Desilting of dams: Regular removal of silt (desilting) from the dams is recommended to maintain the necessary depth for power generation. If desilting is ignored, the decreased depth of dams may affect the production of HEP since the storage capacity of the dam is severely reduced.

Alternative energy sources: Alternative sources of energy such as solar energy should be used to reduce the effect of pollution caused by the use of fossil fuels and fuelwood.

Environmental conservation projects:

The establishment of power and energy production projects should go hand in hand with environmental conservation projects such as afforestation, reforestation and proper waste management.

Community awareness creation:

Environmental conservation education should be provided to the people. Such education will encourage community members to report and take permanent or temporary measures in the utilisation of power and energy to avoid endangering the environment.

Research on power and energy: There is a need for governments to invest comprehensively in research on power and energy resources to identify different sources of power and efficient use of the existing energy resources.

Technology: Environmentally friendly technologies for power and energy production should be developed.

Activity

Visit a nearby HEP station and study the processes involved in the production of power and then:

- (i) Identify and list the favourable conditions that determine the location of the HEP station.
- (ii) In groups of five, discuss and list the challenges that face HEP production in that HEP station.

Focal study

Hydro-electric power and biogas in Tanzania:

Hydro-electric power, as discussed earlier, is produced by utilising the power of fast moving water such as a waterfall. HEP is one of the main sources of power in Tanzania. In Tanzania, electricity generation depends heavily on HEP. However, this type of energy cannot be relied upon in times of drought. The government through the Tanzania Electric Supply Company (TANESCO), a parastatal organisation, manages the HEP across the country. The company produces hydro-electricity from natural waterfalls or man-made dams and supplies it to the users in the country.

The main hydro-electric power stations are Mtera and Kidatu on Ruaha River,

Kihansi on Kihansi River, Nyumba ya Mungu and Hale on Pangani River. Biogas is a renewable source of energy generated from the decay of plants and animal waste. The gases include methane and ethane. Biogas requires high initial capital in construction of a biogas plant. The major components include trench silo for storage of solid raw material; digester (decomposer) reservoir for completing biogas production; liquid manure tank for keeping fresh liquid manure; solid manure tank for keeping and adding solid manure; pipes for distribution of biogas; and power station for provision of power (Figure 8.7). Notably, production of biogas is possible in cattle rearing regions because the major raw material for the production is cow

dung. Mwanza, Tabora, Shinyanga, Mara, Rukwa, Iringa, Mbeya, Tanga, Kagera, Morogoro and Singida are cattle rearing regions and, hence, have high potential for producing biogas. Yet, biogas in Tanzania is not well developed.

In most cases, individuals and groups carry out biogas projects at a local level, for example, the Hamasa biogas project in Marimba and Majabimu in Muheza. There are also few national programmes dealing with biogas, for example, the Tanzania Domestic Biogas Programme. It is estimated that Tanzania has 4,633 verified biogas plants and 9,990 unverified plants. Overall, the country has a potential to build 20,000 institutional plants.

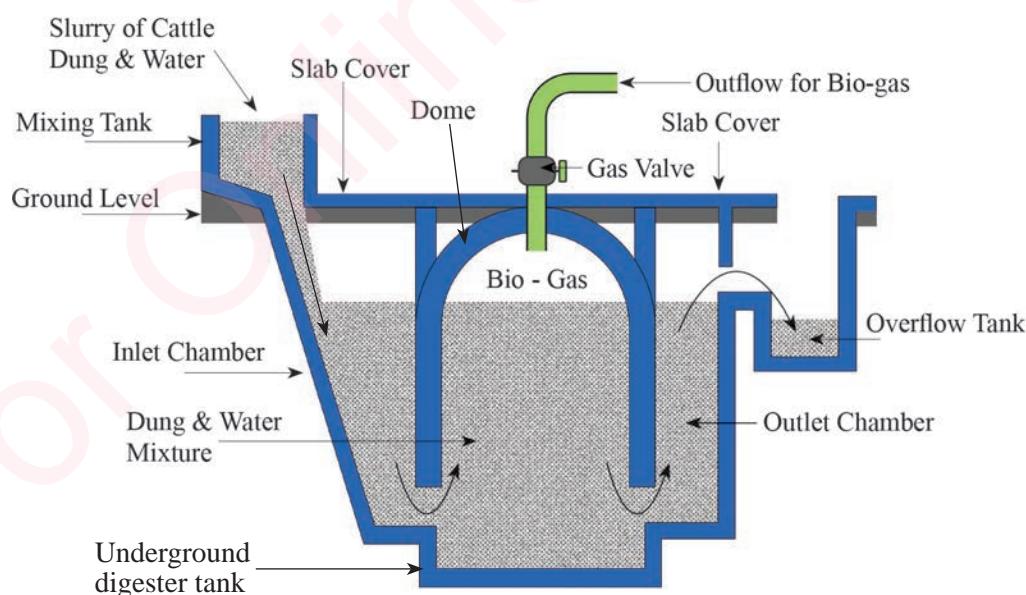


Figure 8.7 Biogas power plant

Source: Acrosystech.com

Importance of HEP and biogas energy resources in Tanzania

Tanzania's major electrical energy is obtained primarily from HEP followed by natural gas. These energy sources are important to the economy of the country. HEP and biogas energy are important in many ways.

Use at the local level: Production of biogas requires simple technology, which can be handled by any interested person. Based on technological simplicity, biogas is prominent at local levels in Tanzania.

Waste management: Use of biogas enhances management of wastes mainly animal dung. All animal dung around people's homes is collected and ferried to the processing area to produce power. People with many livestock find biogas production as an effective way of keeping their areas clean.

Reduced over-dependence on fuelwood: The use of biogas reduces over-dependence on fuelwood as a source of energy. In areas where biogas is used, people have reduced the use of fuelwood for heating and cooking. This may in turn reduce deforestation and emission of greenhouse gases.

Major source of electricity: HEP is a major source of electricity, which is widely used in Tanzania. As the government centrally manages HEP by 98 percent, all the regions access it through TANESCO, a public utility company, and puts it into various uses, lighting being the main use.

Improvement of standards of living: The availability of biogas and hydro-electric power in rural areas has improved people's standards of living. With power, people have managed to start small projects such as welding, carpentry, and milling. Such projects have become sources of income for the people and have improved their standards of living.

Reduction of health risks: It is medically proven that soot breathed from household air pollution causes respiratory diseases among children. Thus, by using HEP and biogas, such kind of respiratory diseases are reduced or eradicated.

Establishment and growth of industries: The availability of energy, especially HEP promotes the establishment and growth of industries that, in turn, creates employment opportunities.

Employment opportunities: HEP and biogas energy resources create employment opportunities especially during production, transmission and distribution of electricity from HEP stations.

Challenges to harnessing power and energy in Tanzania: Power and energy harnessing in Tanzania faces various challenges ranging from naturally occurring to human-made ones. The following are some of the challenges facing power and energy harnessing in Tanzania.

Fluctuation of river volume: In the dry season, rain may be scarce or completely absent which reduces water in dams and, consequently, lowers the generation of HEP. Tanzania has been experiencing periods of power-cut particularly during the dry season because of over-dependence on HEP.

Inadequate capital for exploration: Exploration of sources of power and their harnessing is supposed to be a continuous activity. However, exploration demands large injection of capital, which is not readily available particularly in developing countries. Inadequate funds for the exploration of power sources and their harnessing has been a recurrent problem in Tanzania. There is generally little or no establishment of new sources of energy. As a result, there has been over-dependence on the same sources of power and energy, mainly HEP and natural gas.

Human activities: Human activities such as construction and cultivation expose soil to running water. This water carries silt which is deposited in the dam causing siltation. Siltation usually reduces the capacity of dams to store water, which in turn affects production of HEP.

Conflicts and sabotage: Construction of dams, roads and pipelines can lead to the displacement of people. When people are displaced without being compensated for their houses and farms, conflicts and sabotage may arise. An example of such scenario is the 2013 protest by Mtwara

residents over the construction of natural gas pipeline.

High initial investment costs: High costs of transmission of power from its source has affected the government's efforts in transmitting power to different parts of the country. A large percentage of Tanzania is not electrified. By year 2012 statistics indicated that only 14 percent of the country was electrified, of which 12 percent was urban and two percent was rural. Access to electricity was only 18.4 percent in the same period.

Water-borne diseases: Construction of reservoirs and dams may lead to the occurrence of water-borne and waterrelated diseases such as cholera, typhoid and bilharzia. For example, statistics indicate that about 15 million people in sub-Saharan Africa live within five kilometres of large dams and more than 1.1 million cases of malaria annually are associated with these dams.

Addressing challenges to power and energy harnessing in Tanzania: Despite the challenges to harnessing power and energy, the following are some of the solutions to the challenges facing power and energy harnessing in Tanzania.

Alternative sources of power: Alternative sources of power to support the existing sources should be explored to meet the increasing power demand in Tanzania. By 2013, the annual power demand increase was between 10 percent and 15 percent. The demand for power and

energy is expected to increase because of the new industries that are to be constructed.

Funds allocation for exploration: The government is required to allocate adequate funds for exploring other sources of power. Tanzania is endowed with many power and energy sources, which have not been yet harnessed due to lack of capital.

Training of skilled personnel: More young Tanzanians should be trained on HEP and biogas exploration and production.

Improvement of infrastructure: In making energy more accessible to all, infrastructure should be improved. Inland roads in remote areas should be rehabilitated to ease transportation of poles for the supply of electricity. Pipeline networks for natural gas distribution should also be built in various parts of the country for electricity generation.

Community awareness creation: The society should be educated on the need to conserve the environment by using environmentally-friendly sources of power.

Environmental conservation campaign: Various campaigns towards environmental conservation have been launched in Tanzania. Examples include the Mama Misitu campaign which was launched in Tanzania. This five-year (2011 - 2016) campaign aimed to improve community

based forest governance. When forests are protected there would be less erosion and, hence, less siltation.

Solar and wind energy harnessing in USA

USA is one of the leading countries in the world harnessing energy from the Sun. Before 2008, much of the electricity was generated from other sources such as fossil fuel and HEP. By 2018, solar power accounted for 1.44 percent of the total USA electricity, generating about 58.9 terawatt-hours (TWH).

USA needs energy that is secure, reliable, protective of the environment, and able to address climate change, create jobs and improve public health. USA reduced the use of fossil fuel as a source of energy because it is expensive and not renewable. The American Government reduces the cost of solar power and increases the cost of fossil fuel to encourage use of the former. USA, as a highly developed country in terms of technology and economy, has a very high demand for power and energy for industrial and domestic use.

Solar energy is harnessed on a large-scale in the states of California, Nevada, Arizona, North Carolina, New Jersey and Massachusetts. These areas are more conducive for harnessing solar power because of the sunny climate, clear skies and plenty of land. The electricity generated is integrated into the US National Grid.

Wind energy is also used more in USA compared to solar energy. The country has a big potential of onshore and offshore winds. Wind energy is used in running large farms and industries. The leading wind energy producing centers are California, Oklahoma, Illinois and Kansas. Wind power generation and use in USA is expanding quickly. It experiences an annual growth of 25.6 percent. For example, in 2017, wind power generated 6.3 percent of electricity in the USA.

Importance of solar and wind

energy in USA: USA finds it more economical to use solar and wind energy than other sources of energy as they have minimal environmental effects. Solar and wind energy in USA is important in so many ways.

Environmentally-friendly: The production of solar and wind energy involves activities which produce less waste in the environment compared to other sources of energy. These energies, therefore, are considered to be environmentally-friendly. For example, their production reduces the emission of carbon-dioxide and other pollutants.

Creation of employment opportunities: Installation and management of solar panels and wind mills require many employees. This industry generates jobs for thousands of people.

Industrial development: In USA, solar and wind energy have been found to be

feasible sources of alternative energy for industrial development. The energy generated is considered cheaper than other available sources of energy such as fossil energy, HEP, natural gas and nuclear energy.

Expansion of agriculture: Large-scale agriculture has been made possible by the availability of electricity from this source. The power is used in irrigation and processing of agricultural products.

Affordability: Solar and wind energy are relatively cheaper for many people in USA especially those who are unable to use other sources of electricity because it is subsidised by the government. This has improved their living standards.

Challenges facing solar and wind energy in USA: Although USA has a large and strong economy, it faces challenges related to the wind and solar energy sector. The following are some of the challenges.

Solar panel efficiency: Most solar power panels are 10 – 20 percent efficient, as they are stationary and cannot move to capture the sun's rays. That being the case, a large percentage of the energy from the sun remains largely untapped, although the cost of solar power has decreased.

Reliability: Solar and wind energy are not reliable sources of energy because sunrays and wind happen naturally and human beings can hardly control their

occurrence. The extent of solar and wind energy production will largely depend on the intensity of wind and sunrays and the technology available to tap them.

Cost of installation: The initial installation cost of solar infrastructures is high. US government subsidises solar installation. This enables many people interested in this energy to afford the cost.

Transmission costs: Although a certain amount of wind may be available everywhere, not all wind speeds are favourable to produce wind energy. There are specific sites with the potential for wind energy production. These sites are often located in remote locations far from cities, hence making transmission of energy for use expensive.

Land use: Harnessing wind power tends to compete with alternative uses of land. For example, a place with strong winds, which may be considered to have the potential for harnessing wind energy may also be important for industrial development. Both are important uses of the land, hence deciding on the best use of the site might not be easy.

Noise and aesthetic pollution: Wind power plants may produce unwanted noise from turbine blades. They may also disturb the visual aspect of the landscape. However, compared to other conventional power plants, they have relatively less negative impact on the environment.

Addressing challenges facing solar and wind energy in USA: The challenges facing solar and wind energy production may hinder the expected harnessing of this potential energy if deliberate efforts are not made to address them.

Installation of wind turbines and solar panels: Solar and wind energy depends very much on the number and quality of wind turbines and solar panels. The higher the quality of gadgets available, the more the amount of energy produced. It is, therefore, advisable to install enough wind turbines and solar panels over a wide area to increase the amount of energy harnessed.

Research: Research on solar and wind energy is likely to find some solutions to many challenges facing the production of energy from wind and the sun. Research may involve studying the behaviour of wind and new technologies for tapping solar energy day and night.

Information dissemination: Information dissemination to the public and companies on the possibilities of combining multiple energy sources to enhance efficiency should be undertaken.

Exercise 8**A. Answer the following questions:**

1. In four points, explain the advantages of using natural gas.
2. Briefly, explain four uses of power and energy from different sources.
3. With examples, distinguish between renewable and non-renewable sources of power.
4. State five challenges facing solar and wind energy production in USA.
5. List the advantages that Tanzania can get by using solar energy.
6. Explain why wind is a renewable energy source.
7. List and locate on a map major hydro-electric power stations in Tanzania.
8. Describe how biogas energy is produced.
9. Mention the challenges facing power and energy harnessing in Tanzania.
10. Explain how challenges facing power and energy production in Tanzania can be addressed.
11. Explain why electricity is preferable to the use of fuelwood.
12. Describe the lessons Tanzania can draw from solar energy production in USA.

B. Write True or False for each of the following statements:

1. The generation and distribution of electric power in Tanzania is done by the Tanzania Petroleum Development Corporation (TPDC).
2. Kidatu and Kihansi are the only hydro-electric power stations in Tanzania.
3. Fossil fuel is more expensive to harness than biogas.
4. The use of solar energy in Tanzania may help to address the problem of deforestation.
5. The major source of power and energy in the USA is the Sun.
6. Human activities around rivers affect HEP production through siltation.

Chapter Nine

Transport

Introduction

In this chapter, you will learn about types of transport systems used in different parts of the world, including East Africa, the importance of transport in Tanzania and East Africa; and the problems facing transportation in East Africa. You will also learn about measures to address the problems facing transportation in Tanzania.

The concept of transport

Transport refers to the physical movement of people, goods and services from one place to another. It is an important link between different parts of the world. Transport is one of the key sectors that play a crucial role in efforts aimed to achieve sustainable economic growth. The transport system ensures a balanced distribution of goods and services in different parts of the world. Transport is an important sector that enhances the socio-economic development of the world. For the transport sector to play its important role, it has to be developed and co-ordinated with the ultimate aim of bringing about a reliable, efficient, safe and environmentally-sound system of moving passengers and goods.

Main types of transport

Transport is categorised into land, air and water systems as illustrated in Figure 9.1:

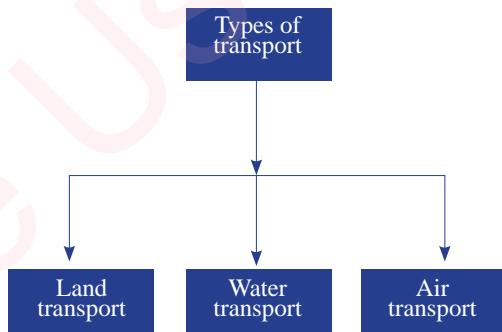


Figure 9.1 Types of transport

Land transport: Land transport involves the movement of people, goods and services from one location to another, on land. It is the most commonly used mode of transportation in the world. Land transport may further be divided into road transport, rail transport, cable transport and pipeline transport. The description of each mode of transport is provided in the sections that follow.

Road transport: Road transport is a means of transport that connects one place to another on the surface of the earth. It is the most common means

of transport used all over the world. Transport on roads can be grouped into the transport of goods and people. Movement along roads may be done by bike or automobile, truck, or by animals such as horses, donkeys or oxen. Cargo may be transported by trucking companies, while passengers may be transported via mass transit. Road transport is the most frequently used mode of transport in the world. It involves the use of various types of animals, vehicles, motorcycles and bicycles. Roads play a great role in socio-economic development. In most cases, the delivery of goods between cities, towns and villages is facilitated by road transport. The advantage of road transport over other modes of transport is that it even operates where other means of transport are not available.

Animal transport involves carts drawn by donkeys, camels, horses and oxen. This type of transport is common especially in places where other means of transport are not available. Animal transport is mostly used in mountainous regions and deserts to carry crops, straw, fodder and people. Luggage is packed into carts pulled by horses, donkeys and bullocks. For camels, goods are fastened to the animal. Transport of goods by road depends on the degree of development of the local infrastructure, distance, type of goods, weight and volume of the shipment. Figure 9.2 shows trucks that exemplify motor-driven transport, Figure 9.3 shows a donkey with luggage strapped onto its back and Figure 9.4 shows a man riding a cart pulled by a donkey.



Figure 9.2 Transportation by trucks

Source: ajot.com



Figure 9.3 Transportation by animals

Source: spana.org



Figure 9.4 Transportation by a donkey driven cart

Rail transport: Railway transport is the second most important mode of transport after road transport. Rail transport involves the movement of goods and passengers on rail lines by trains. It is an important land transport mode and the most appropriate means of transportation for bulky goods over long distances. Railway transport carries many people and goods at

once compared to other means of land transport. Trains are of two main categories: passenger trains and cargo train.

Passenger trains carry both people and a limited quantity of goods, cargo trains are exclusively used for carrying goods or cargo from one place to another. Figure 9.5 shows a passenger train.



Figure 9.5 TAZARA passenger train

Source: www.zambianpolitics.com

In East Africa, there are several railway lines. These include the Tanzania-Zambia Railway Authority (TAZARA) covering 1,067 km, connecting Dar es Salaam to Kapiri Mposhi in Zambia; Tanzania Railway Corporation (TRC) covering 2,600 km from Dar es Salaam to Kigoma and Mwanza; and the Kenya-Uganda line that runs from Mombasa to Kasese in Uganda covering 1,507.23 km. Also, there is a standard gauge railway under construction in Tanzania which will run from Dar es Salaam-Morogoro (300 km), Morogoro-Dodoma (426 km), Dodoma-Isaka (435 km), Isaka-Mwanza (220 km) to Isaka-Rusumo (371 km). Another railway line under construction is from Mombasa in Kenya to Kigali in Rwanda about 1500 kilometers long.

Pipeline transport: Pipeline transport refers to the carrying of liquid and gaseous products such as petroleum, natural gas, water and milk over long distances. For example, water supply to residential and commercial areas is distributed through a system of pipes. Pipeline transport is the most convenient and economical means of land transport especially for petroleum and natural gas, compared to road and rail transport.

A good example of pipeline transport in Tanzania is the Tanzania-Zambia Mafuta (TAZAMA) pipeline that runs from the port of Dar es Salaam to Ndola in Zambia. Another pipeline transports natural gas from Mnazi Bay in Mtwara to Kinyerezi in Dar es Salaam. Also, Tanzania and Uganda are currently constructing a trans-border pipeline known as the East African Crude Oil Pipeline that will run from Hoima in Uganda to Tanga in Tanzania covering 1,444 km. In Kenya, there is a Kenya-Uganda- Rwanda petroleum products pipeline from Mombasa to Nairobi and Eldoret. The plan is to extend it to Kampala in Uganda and Kigali in Rwanda. Figure 9.6 shows a TAZAMA oil pumping station in Tanzania.



Figure 9.6 TAZAMA oil pumping station

Source: tazama.co.zm-pumping-station

Other types of land transport include the use of cables and conveyor belts. Cable transport uses cable cars and ski lifts to convey passengers and goods. The run way is made up of cables or ropes. This means of transport is most appropriate in difficult terrain especially mountainous areas such as Switzerland, Poland, Austria and South Africa. Figure 9.7 shows cable transport.



Figure 9.7 Cable transport in Cape Town, South Africa

Source: <https://img.theculturetrip.com>

A conveyor-belt is a continuous moving strip of rubber or metal mostly used in industries, airports, harbours and in mines to move objects along. It can also be called a flexible endless strip of fabric or linked plates driven by rollers to transport goods. The conveyor-belt facilitates the transportation of materials and goods over short distances. Figure 9.8 shows a conveyor-belt transporting coal in a mining industry.



Figure 9.8 A conveyor-belt transporting coal

Source: http://www.iconsteel.net/pages/online/applications_coal.coke.fuel

Air transport: Air transport is a means of transport that carries passengers and goods through airways. Air transport facilitates integration of the global economy and provides ripe connectivity on a national, regional and international scale. It uses different aircrafts such as passenger aircraft, cargo aircrafts and helicopters. Air transport is the fastest means of transport in the world, that covers long distances within a short time. It is the most appropriate means of transportation for perishable goods. However, it is also one of the most expensive means of transport. Some of the international airports in East Africa include the Julius Nyerere International Airport and Kenyatta International Airport in Dar es Salaam and Nairobi, respectively.

Air transport is categorised into domestic and international. Domestic air transport is mainly for movement within the same country whereas an international air transport is used for carrying goods and passengers between countries. Figure 9.9 shows an air Tanzania plane.



Figure 9.9 An Air Tanzania passenger plane

Source: airtanzania.com

Water transport: Water transport refers to the movement of goods and passengers on waterways through various means such as boats, steamers, dhows and ships. This type of transport takes place on dams, canals, rivers, lakes, seas and oceans. It is usually the cheapest of all modes of transport. This mode of transport is appropriate for bulky goods. There are two forms of water transport: inland and ocean water ways.

Inland transport is facilitated by ships via inland waterways such as canals, rivers and lakes between inland ports.

Rivers: The navigable rivers in East Africa include Rufiji, Ruvuma, Mara and Ruvu in Tanzania; Tana, Sondu Mirio and Athi in Kenya; and the Nile in Uganda. Other rivers include Rhone, Elbe, Danube and Rhine in Europe; Ganges, Indus, Hwang-Ho Yangtze Kiang and Si-Kiang in Asia; Congo, Nile, Limpopo and Senegal in Africa; and the Mississippi, Ohio and Tennessee in the United States of America. Unfortunately, most of the rivers are of limited use for navigation for the following reasons.

Seasonal fluctuations: The level of water in many rivers varies from one season to another. After heavy rains, these rivers tend to flood. However, during the dry season the water volume decreases, and some rivers almost disappear.

Rapids or waterfalls: Many rivers have rapids and waterfalls. These rapids and waterfalls may divide the river into

a number of navigable sections, for example, the Congo River.

Short, shallow or too swift rivers waters: Many rivers are too short, too shallow or too swift to be useful for navigation. The narrowness of the country or the size of the islands makes rivers of little navigation value; for example, rivers of Japan, Korea; Indonesia, the Philippines and New Zealand, have limited navigation value.

Canals: A canal is a long narrow stretch of water artificially made to enable boats and ships to travel along. Examples of canals include the Suez in Egypt, the Panama and Great Lakes of North America joined by canals with Saint Lawrence Seaway, Amsterdam - Rhine and North Sea in Netherlands and the Caledonian in England.

Lakes: A lake is a hollow or depression in the Earth's surface that contains fresh or salty water. Many lakes are artificial as they have been constructed to store water for HEP generation using a dam. Other lakes have been created for aesthetic, recreational, industrial, agricultural and domestic purposes. Examples of lakes in East Africa are Tanganyika, Nyasa, Kivu, Edward, Albert, Rudolf and Victoria. Others are Michigan, Erie, Ontario, Huron and Superior in North America. Figure 9.10 shows a cargo ship carrying containers whereas, Figure 9.11 shows a passenger boat.



Figure 9.10 A container ship

Source: <http://www.imoveintl.com/container-shipping.htm>



Figure 9.11 A passenger boat

Source: azammarine.com

Oceans: Major ocean shipping routes in the world ocean shipping services transport more than 80 percent of all globally traded products. Marine trade contributes greatly to international trade. For example, vehicles, clothes, fuel, electronic equipment such as TV sets are carried from various manufacturing industries of the world to the market using ships. There are several shipping routes for ocean vessels to ensure a quick and safe delivery of the goods. Some of these world shipping routes are described below.

North Atlantic route

This is the busiest sea route in the world connecting the major ports of Amsterdam, London, Rotterdam, Lisbon and Oslo. These are the popular heavily industrialised parts of the world. The

route links North Eastern USA, and North Western Europe, the two most developed regions of the world. The major ports on this route are London, Hamburg, Liverpool, Glasgow, Rotterdam, Southampton, Copenhagen, Lisbon, Stockholm and Oslo.

The English Channel

This separates England from France, connecting the North Sea and Atlantic Ocean. It is today one of the busiest shipping routes on the planet. It is approximately 350 miles long. About 500 ships travel via the channel daily, hence making it a critical route in the European shipping network.

Strait of Malacca

This is the shortest route between the Pacific and Indian oceans. It links major Asian economies such as India, Malaysia, Indonesia, Singapore, Japan, China, South Korea and Taiwan. The Strait of Malacca is the world's second busiest water way with more than 83,000 vessels taking this route each year. Goods transported through this strait include coal, palm oil, Indonesian coffee and liquefied natural gas. The Malacca water ways connect the Indian Ocean and the South China Sea (Pacific Ocean).

Suez Canal

The Suez Canal is commonly known as the Highway to India. Suez Canal is a manually constructed canal which creates the shortest maritime route between the Atlantic and Indian oceans. The route stretches from the Port of Suez in Egypt, through the Mediterranean

Sea to the Port of Suez at the Red Sea, connecting Europe and Asia without navigating around Africa. It is one of the world's most heavily used shipping lanes with more than 100 vessels traversing it every day. More than 900,000 tonnes of cargo travel through the canal. Major commodities transported are petroleum, coal, metals, wood, oil seeds, cement and fertilisers.

Saint Lawrence Seaway

This is the most important shipping lane in North America which connects the Atlantic Ocean with the Great Lakes. The Great Lakes and St. Lawrence River form the longest deep-draft navigation system in the world. It extends about 2,300 miles into North America and directly serves Ontario and Quebec (in Canada), Illinois, Michigan, Ohio, Indiana, Wisconsin, New York and Pennsylvania (in the United States of America). The Sea way is named after Saint Lawrence River which flows from Lake Ontario to the Atlantic Ocean. Yearly, more than 350,000 tonnes of raw materials, agricultural commodities

and manufactured products pass through this route.

The Panama Canal

This is an artificial passage way designed to reduce transit time between the Pacific and Atlantic oceans. The Panama Canal connects the Atlantic and Pacific oceans across the Isthmus of Panama. The Canal is about 80 km long. More than 14,000 ships navigate the Panama Canal each year, carrying vegetable oil and fats, canned and refrigerated foods, chemicals and petroleum chemicals, lumber machinery parts and grains.

The Cape of Good Hope

This route connects Europe and Africa passing by the Cape of Good Hope and Cape Agulhas at the Southern edge of Africa. It is also known as the sea route to India. It is important to the east and far west as it facilitates the transportation of tropical raw materials from Africa to Europe and the rest of the world and manufactured goods from Europe to Africa. Figure 9.12 presents major ocean shipping routes of the world.

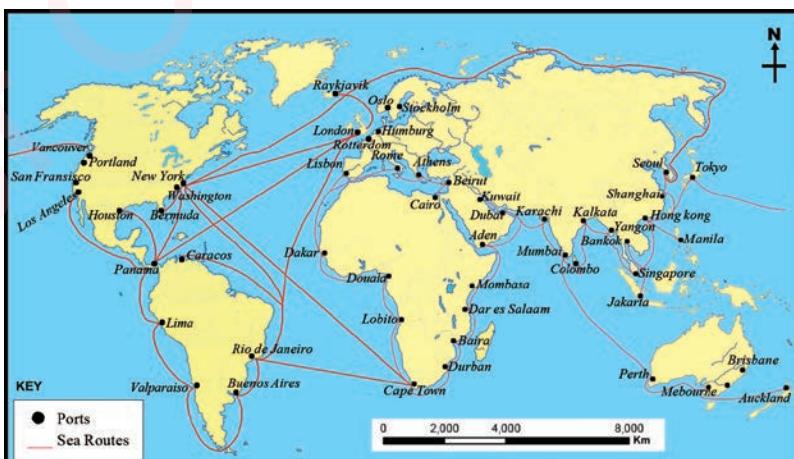


Figure 9.12 Major ocean shipping routes of the world

Activity

1. Observe the various modes of transport near your residence and list their advantages and disadvantages.
2. Visit the nearest market of your area and ask the retailers and wholesalers which mode of transport they use to transport their goods and why.
3. What modes of transport do you use in your family for different occasions?

Importance of the transport industry in East Africa: The transport industry is important for the socio-economic development of East African countries. The following sections explains the importance of transport in East Africa.

Facilitating the availability of goods to customers: Transport makes it possible for the easy and quick movement of goods from one place to another. Thus, consumers spread in different parts of the country have the benefit of consuming goods produced at various distant places.

Making available raw materials to manufacturers or producers: Transport makes it possible to carry raw materials from places where they are available, to places where they can be processed and assembled into finished goods.

Creation of employment opportunities: The transport sector generates employment opportunities for drivers, conductors, pilots, cabin crew and ship captains. In addition, it creates jobs

for people indirectly in the industries that make various parts or machines and other transport equipment as well as those involved in construction and maintenance.

Enhancing the standard of living: Easy means of transport facilitates large-scale production of goods at a low cost. It gives consumers opportunity to choose from a variety of goods. As such, transport helps to raise the standards of living for the people.

Facilitating movement during emergencies and natural calamities: During crises, such as war or internal disturbances such as earthquakes, floods and fire outbreaks, transport helps to quicken the movement of troops and relief supplies needed in the rescue operation.

Helping labour mobility: Transport helps in providing mobility to workers. It facilitates movement of workers from one country to another country, to work in different economic sectors.

Promotion of international relations: Transport facilitates the movement of people from one country to another. It helps promote the exchange of cultures, views and practises between people of different nationalities. This exchange brings about greater understanding among the people and awareness about different countries and their cultures. Thus, it helps to promote a feeling of international brotherhood. Figure 9.13 shows main roads and railway lines in East Africa.



Figure 9.13 Road and Railway line transport network in East Africa

Advantage and disadvantages of the transport sector: All means of transport have advantages and disadvantages depending on the needs at a given time. Road transport is flexible and quick, and it can connect many places. Likewise, construction and maintenance of roads is cheaper than railways.

Railway transport has the capacity to carry both heavy and bulky goods as well as passengers. The standard gauge railway train is faster and saves time too.

Air transport is fast and suitable to use, and it cannot be affected by physical barriers.

Apart from having advantages the transport sector also faces disadvantages. For example, air transport is very expensive and it needs trained and skilled personnel. In addition, it depends a lot on the weather of the day; if the weather is bad the journey can be postponed.

Pipelines are expensive to develop and they are selective in transporting goods. Only fluid materials and natural gases are transported via pipelines.

Railway transport is not flexible and it takes long to reach the destination. For example it takes almost three days to reach Kigoma from Dar es Salaam.

Vehicles emit gases which are harmful to living organisms and the atmosphere. Their mobility can also be easily affected by weather conditions, especially during

the rainy season when many roads in the rural areas become impassable.

Challenges facing the transport industry in East Africa: The East African governments have made efforts to develop an adequate, safe, secure and affordable transport system that is aimed to eradicate poverty and bring about sustainable development.

Despite these concerted efforts, the transport sector experiences several challenges and constraints as discussed in the subsequent sections.

Inappropriate national policies and their limited implementation: The transport industry suffers from inappropriate and badly-formulated policies which in turn slow down the implementation of sub-regional and regional agreements. In addition, these countries lack policies that allow and promote private sector participation in transport infrastructure development and operation.

Liberalisation and privatisation in rail, air and maritime transport are still in their infancy: Efforts to harmonise policies and regulations pertaining to cross-border movement of goods, services and people have yet to become effective. Therefore, the East African countries have not fully implemented agreements aimed to facilitate cross-border movement of goods and passengers.

Lack or poor transport network connectivity: The transport sector in East Africa suffers from a poor transport

network which is characterised by several missing transport networks in each country and between countries. As a result, the majority of rural population live without access to markets and essential economic and social services. In addition, a large proportion of the transport network is also in poor state.

Inadequate human and institutional capacity: Although the number of workers in East African public transport enterprises and agencies is relatively high, the availability of skilled personnel is limited in most transport organisations. In addition to lack of adequate skilled human resources, institutions also lack people with appropriate knowledge and skills to plan, and manage infrastructural development and services.

High transport costs: East Africa is one of the regions with the highest transport costs in the world. Transport services are unaffordable to many African citizens.

Poor transport safety and security: The prevailing poor road safety remains a serious challenge in East Africa. Accidents and the resulting loss of life and destruction of property have assumed intolerable proportions. A major weakness in this area is associated with lack of responsible personnel for road safety. In many cases, the major constraint common to all the weaknesses identified in the management of road safety is the lack of adequate financial resources. The poor safety record of many East African airlines is another area of major concern in Africa.

Poor transport information systems: Statistical information is a key input at every stage of the development process, including planning and implementation of programmes and projects. Adequate and well-organised statistical information provides tools for making informed decisions in identifying gaps, formulating policies and strategies, developing effective investment programmes and in effective monitoring and evaluation. However, in East Africa, the availability of such data is limited and poorly organised. Likewise, despite the importance of Information and Communication Technology (ICT) the transport sector has not taken full advantage of the technology due to lack of a proper policy for ICT development and integration in transport.

Limited financial resources: Despite efforts made by East African governments and international and domestic development partners to mobilise financial resources for investing in transport infrastructure and maintenance of the existing facilities, huge gaps remain between the demand and supply of resources. Sustainable transport development requires huge financial outlays to build infrastructure, and provide energy-efficient and environmental-friendly transport equipment, among others.

Measures to address transport challenges in Tanzania: Tanzania needs to take several initiatives in a bid to address the transport challenges facing the country. Such initiatives should focus

on policy, strategy, resource mobilisation and capacity-building. The initiatives aim at translating policies and strategies into action. The following sections present some of the measures aimed to address the identified challenges.

National policies and sub-regional and regional agreements: Tanzania has to demonstrate its commitment in improving the domestic investment environment by taking necessary steps. The actions need to target full liberalisation of the transport sector to attract investors, and strengthening the regulatory and enforcement mechanisms. In addition, improving co-ordination in developing and implementing regional and sub-regional agreements on transport facilitation and air transport liberalisation should be seriously considered.

Human and institutional capacity building: Efforts should be directed towards institutions to ensure that they have appropriate mandates and are staffed with highly motivated and skilled human resources. These measures should involve key elements in the development of a safe, secure, affordable and environmentally-sound transport system. Also, responsible authorities need to develop and implement capacity building programmes to upgrade the knowledge and skills of staff involved in policy formulation, planning and implementation as well as those engaged in regulatory and enforcement functions.

Environmental Impact Assessment (EIA): The development of a sustainable transport system, requires carrying out an environmental impact assessment. This assessment should be incorporated into the infrastructure development plans of the country. In this regard, any plan for transport construction should undergo EIA processes before approval.

Energy efficiency and transport cost: Transport services in Tanzania are associated with high costs due to inadequate and poor infrastructure, poor transport facilities as well as limited competition.

Transport safety and security: The government of Tanzania needs to plan for initiatives aimed to improve safety in all modes of transport. This can be done by establishing effective institutional frameworks and strengthening the existing frameworks to manage traffic and ensure safety. Moreover, there is a need to ensure compliance with safety and security regulations and standards established by relevant local, international and regional authorities.

Transport information systems: Given the high demand for the use of information in the transport sector and inadequacy of necessary information in the country, Information and Communication Technology (ICT) offers a powerful tool for accessing, processing and disseminating large volumes of information in the shortest time possible.

Financial resources: Despite the efforts made by the government to allocate funds for transport development, the amount is far below what is actually required to finance and maintain the existing transport network. Thus, there is a need to engage the private sector in infrastructure development. The involvement of the private sector in infrastructural development and operations can help ease public resource constraints. The private sector has the potential of enhancing the productivity and efficiency of infrastructure services. This calls for improving the investment climate by updating institutional and regulatory frameworks and reducing bureaucratic procedures and practises.

Exercise**A. Answer the following questions:**

1. Explain what you understand by the term ‘transport’.
2. Identify the main types of transport in the world.
3. Describe types of land transport.
4. Mention any five major ocean routes in the world.
5. Mention three railway lines found in East Africa.
6. List any five benefits of transport systems in East Africa
7. Mention any five challenges facing transport systems in East Africa.
8. Suggest what should be done to address the challenges facing the transport sector in Tanzania.

B. Write True or False for each of the following statements:

1. Air transport is the fastest mode of transport.
2. Air transport is not affected by adverse weather conditions.
3. Air transport is not suitable for short distances.
4. Helicopters are generally used for international flights.
5. Air transport does not provide any support to national security.
6. Railway transport is well connected to all regions of Tanzania.
7. Water transport is mostly used to transport goods.

Glossary

Afforestation	The process of planting trees, or sowing seeds in a barren land devoid of any trees, to create a forest.	Desertification	A process through which fertile land becomes desert, as a result of drought, deforestation, or inappropriate method of farming.
Agriculture	Cultivation of crops and rearing of livestock.	Distributaries	Streams which split away from the main channel and never re-join the channel.
Aquifer	An underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials.	Ecology	A study of the ecosystem with particular reference to the relationship between plants and animals and the environment.
Biofuel	Fuel that is derived from biological materials, such as plants and animals.	Ecosystem	Group of plants and animals that work together to remain healthy.
Biogas	Form of biofuel energy whereby methane gas is obtained from decomposing biomass.	Eco-tourism	Tourism directed towards exotic, often threatened natural environment, intended to support conservation efforts and save wildlife.
Biomass	Total amount of organic material.	Energy	The capacity to do work.
Bush fallowing	Letting the land idle from time to time to maintain the fertility of the soil.	Footloose	Are industries whose location does not rely on the location of raw materials or the cost of transporting them.
Dairy farming	The rearing of livestock for the production of milk.	Fossil	Fuel formed by a natural process, such as anaerobic decomposition of buried dead organisms that lived a million years of age.
Deforestation	Removal of forest cover due to cutting or burning of trees.	Fossilisation	The process by which a fossil is formed.
Delta	Triangular tract of sediment deposited at the mouth of a river, where it diverges into several outlets.		
Desert	Dry, barren area of land, that is characteristically desolate, waterless, and without vegetation.		

Forest	Large area dominated by trees.	Irrigation The artificial application of water to the land or soil for agricultural production.
Forestry	The science or practise of planting and managing forests.	Land degradation A process in which the value of the biophysical environment is degraded through a combination of human-induced processes acting upon the land.
Geothermal energy	Heat energy generated from the interior of the earth.	
Glacier	A mass of ice formed through the accumulation of snow for a long period of time.	Land reclamation A process of improving or recovering of new land for human use.
Global warming	A gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect.	Livestock Domestic animals, such as cattle or horses, raised for home use or for sale.
Habitat	A particular environment in which one species of a plant or animal lives.	Lumbering A process of cutting trees for making timber for transport and sale.
Herbicides	Chemicals used to control or prevent weed growth.	Mining The extraction of minerals from the earth's crust.
Human activity	Anything done (either economic or social), as a way of life.	Monoculture An agricultural system in which the cultivation of a single crop dominates.
Industrialisation	The move from an economy dominated by agricultural production to one dominated by manufacturing.	Nomadic pastolarism Livestock-keeping in which the farmer keeps on moving from place to place in search of pasture and water.
Infrastructure	A set of interconnected structural elements that provide a framework for supporting development processes.	Overgrazing Keeping large herds of animals on the land or for a long time, which degrades the land.
Intercropping	The practise involving growing of two or more crops in the same field.	Pervious rocks Rocks that allow water to flow along cracks or joints.
		Pesticides Chemicals used to prevent diseases or kill pests which attack plants and crops.

Pasture	Land covered with grass and other low plants suitable for grazing animals.
Pollutant	A substance that contaminates something especially water or the atmosphere.
Power	The flow of energy at any one time, and can be generated from renewable energy resources.
Population growth	The increase in the number of people in an area due to in-migration and natural increase.
Radiation	The process of sending off energy in the form of light, heat, x-rays or nuclear particles.
Ranching	Vast, extensive livestock farms usually found in remote, marginal areas.
Reforestation	The replanting of trees in depleted forests and woodlands.
Renewable resources	Resources which can be recovered or replaced after being used; they include hydro-electric power, tidal power, wind energy, geothermal power, solar power and biogas.
River basin	Land that is drained by a river and its tributaries.
Sedimentary rock	Any rock formed through compaction and cementation of sediments.

Slash and burn agriculture	A farming method that involves the cutting and burning of plants in a forest or woodland to create a farm.
Soil erosion	The washing or blowing away (by water or wind respectively) of the top layer of soil.
Soil fertility	The ability of soil to provide nutrients for plant growth.
Tidal wave	An exceptionally large ocean wave, especially one caused by underwater earthquake or volcanic eruption.
Tributary	A small stream in the upper course of a river that joins another stream to form the main river.
Vegetation	Assemblage of plants in a particular area.
Water management	The process of effective supply, utilisation and conservation of water resources.
Water table	The upper boundary of a saturated portion of soil or rock.

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