G.C.E (Advanced Level)

Geography

Teachers' Guide
Grade 13
(To be implemented from 2018)

Department of Social Sciences
Faculty of Languages, Humanities and Social Sciences
National Institute of Education
Maharagama
Sri Lanka

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Teachers' Guide

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Director General's Message

With the primary objective of realizing the National Educational Goals recommended by the National Education Commission, the then prevalent content based curriculum was modernized, and the first phase of the new competency based curriculum was introduced to the eight year curriculum cycle of the primary and secondary education in Sri Lanka in the year 2007.

The second phase of the curriculum cycle thus initiated was introduced to the education system in the year 2015 as a result of a curriculum rationalization process based on research findings and various proposals made by stake holders.

Within this rationalization process the concepts of vertical and horizontal integration have been employed in order to build up competencies of students, from foundation level to higher levels, and to avoid repetition of subject content in various subjects respectively and furthermore, to develop a curriculum that is implementable and student friendly.

The new Teachers' Guides have been introduced with the aim of providing the teachers with necessary guidance for planning lessons, engaging students effectively in the learning teaching process, and to make Teachers' Guides will help teachers to be more effective within the classroom. Further, the present Teachers' Guides have given the necessary freedom for the teachers to select quality inputs and activities in order to improve student competencies. Since the Teachers' Guides do not place greater emphasis on the subject content prescribed for the relevant grades, it is very much necessary to use these guides along with the text books compiled by the Educational Publications Department if, Guides are to be made more effective.

The primary objective of this rationalized new curriculum, the new Teachers' Guides, and the new prescribed texts is to transform the student population into a human resource replete with the skills and competencies required for the world of work, through embarking upon a pattern of education which is more student centered and activity based.

I wish to make use of this opportunity to thank and express my appreciation to the members of the Council and the Academic Affairs Board of the NIE the resource persons who contributed to the compiling of these Teachers' Guides and other parties for their dedication in this matter.

Dr. (Mrs.) JayanthiGunasekara
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Message from Ven. Deputy Director General

Learning expands into a wider scope. It makes life enormous and extremely simple. The human being is naturally excellent in the skill of learning. A country when human development is considered the main focus uses learning as a tool to do away with malpractices identified with intellect and to create a better world through good practices.

It is essential to create valuable things for learning and learning methods and facilities within the adhere of education. That is how the curriculum, syllabi, teachers' guides and facilitators join the learning system.

Modern Sri Lanka has possessed a self–directed education system which is a blend of global trends as well as ancient heritage.

It is necessary to maintain the consistency of the objectives of the subject at the national level. However, facilitators are free to modify or adapt learning teaching strategies creatively to achieve the learning outcomes, competency and competency level via the subject content prescribed in the Syllabus. Therefore, this Teachers' Guide has been prepared to promote the teachers' role and to support the students as well as the parents.

Furthermore, at the end of a lesson, the facilitators of the learning- teaching process along with the students should come to a verification of the achievement level on par with ones expected exam by a national level examiner, who evaluates the achievement levels of subjects expected. I sincerely wish to create such a self-progressive, motivational culture in the learning- teaching process. Blended with that verification, this Teachers' Guide would definitely be a canoe or a raft in this endeavor.

Ven. Dr. Mabulgoda Sumanarathana Thero
Deputy Director General
Faculty of Languages, Humanities and Social Sciences

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Content

Geography
Syllabus

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Introduction

Geography is a Discipline that helps to grasp the dynamism of the bio-world. This dynamism is enclosed in the geographical landscape which is the synthesized product of the interaction between the physical and human environment in space and time. Thus Geography is a Discipline that concerned with the understanding of environmental and social processes and their interrelationships at local to global levels from a spatial and temporal perspective. It is in this context that the Geography curriculum in the schools has been developed.

In the process of developing the curriculum proposed to be implemented from 2015, classroom observations, teacher-student experiences, research findings on the curriculum that was in operation during the past five years have been taken into consideration. It is expected that the proposed curriculum will be able to provide subject knowledge and understanding, skills and attitudes and in particular, the ability for searching different development options. It is hoped that this curricular will provide insight into managing resources which promote sustainability both in the short and long term.

Furthermore it envisages improving the ability to view the eco-societal interrelationship on the basis of ecological principles.

The syllabi have been formulated paying due consideration to the ten competencies and the seven aims related to the subject and in accordance with the age of the students and the varying competency levels depending on the learning ability. In the process it is expected that the teacher should play an evolving role using interacting teaching methods to develop competencies.

This curriculum proposed to be implemented from the year 2018 is the collective effort of a group consisting of Senior University Academics, Educationists, Educators and the Geography Project Team of the NIE. The ten major competencies related to the subject of Geography incorporated in preparing this curriculum are mentioned below:

1. Lives with awareness of the nature and processes of the environment in which he lives.

2. Reviews the basic concepts and methodologies which help to understand the physical and human landscape.

3. Acts with awareness of the components, characteristics and processes in the physical and human landscape

4. Acts with awareness of the manner in which the physical and human interaction impacts on the geographical environment.

5. Uses geographical techniques to collect, analyze, interpret and present data and information.

6. Applies the holistic approach in understanding, analyzing and interpreting the physical and human landscape.

7. Acts with sensitivity inculcating positive attitudes helpful in conserving and maintaining the physical and human landscape

8. Acts with an awareness of the earth and its people in order to promote a harmonious interrelationship between the environment and society.

9. Fosters special survival skills that help to overcome challenging life situations.

10. Develops skills needed for active participation in the world of work.

×

National Goals

i. Nation building and the establishment of a Sri Lankan identity through the promotion of national cohesion, national integrity, national unity, harmony and peace and recognizing cultural diversity in Sri Lanka's plural society within a concept of respect for human dignity.

ii. Recognizing and conserving the best elements of the nation's heritage while responding to the challenges of a changing world.

iii. Creating and supporting an environment imbued with the norms of social justice and a democratic way of life that promotes respect for human rights, awareness of duties and obligations and a deep and abiding concern for one another.

iv. Promoting the mental and physical well-being of individuals and a sustainable life style based on respect for human values.

v. Developing creativity, initiative, critical thinking, responsibility, accountability and other positive elements of a well-integrated and balanced personality.

vi. Human resource development by educating for productive work that enhances the quality of life of the individual and the nation and contributes to the economic development of Sri Lanka.

vii. Preparing individuals to adapt to and manage change, and to develop capacity to cope with complex and unforeseen situations in a rapidly changing world.

viii. Fostering attitudes and skills that will contribute to securing an honorable place in the international community, based on justice, equality and mutual respect. (Adapted from National Education Commission Report -2003)

Basic Competencies

The following Basic Competencies developed through education will contribute to achieve the above National Goals.

(i)   Competencies in Communication

Competencies in communication are based on four subsets: Literacy, Numeracy, Graphics and IT proficiency

Literacy   :   Listen attentively, speak clearly, read for meaning, write accurately and lucidly and communicate ideas effectively.

Numeracy   :   Use numbers for things, space and time, count, calculate and measure systematically.

Graphics   :   Make sense of line and form, express and record details, instructions and ideas with line from and colour.

IT proficiency :   Computer literacy and the use of information and communication technologies (ICT) in learning, in the work environment and in personal life.

(ii)   Competencies relating to personality Development

-        Generic skills such as creativity, divergent thinking, initiative, decision making, problem solving, critical and analytical thinking, team work, inter-personal relations, discovering and exploring;

-        Values such as integrity, tolerance and respect for human dignity;

-        Emotional intelligence.

(iii)   Competencies relating to the Environment

These competencies relate to the environment: social, biological and physical.

Social Environment   -   Awareness of the national heritage, sensitivity and skills linked to being members of a plural society, concern for distributive justice, social relationships, personal conduct, general and legal conventions, rights, responsibilities, duties and obligations.

Biological Environment   -   Awareness, sensitivity and skills linked to the living world, people and the eco-system, the trees, forests, seas, water, air and life-plant, animal and human life.

Physical Environment   -   Awareness, sensitivity and skills linked to space, energy, fuels, matter, materials and their links with human living, food, clothing, shelter, health, comfort, respiration, sleep, relaxation, rest, wastes and excretion.

Included here are skills in using tools and technologies for learning, working and living.

(iv)   Competencies relating to preparation for the World of Work

Employment related skills to maximize their potential and to enhance their capacity.

- To contribute to economic development.
- To discover their vocational interests and aptitudes,
- To choose a job that suits their abilities, and
- To engage in a rewarding and sustainable livelihood.

(v)   Competencies relating to Religion and Ethics

Assimilating and internalizing values, so that individuals may function in a manner consistent with the ethical, moral and religious modes of conduct in everyday living, selecting that which is most appropriate.

(vi)   Competencies in Play and the Use of Leisure

Pleasure, Joy, emotions and such human experiences as expressed through aesthetics, literature, play, sports and athletics, leisure pursuits and other creative modes of living.

(vii)   Competencies relating to ' learning to learn'

Empowering individuals to learn independently and to be sensitive and successful in responding to and managing change through a transformative process, in a rapidly changing, complex and interdependent world.

(Adopted from National Education Commission Report -2003)

Aims of teaching Geography is to:

1. Act with an awareness of the concepts, characteristics and processes of the physical and human landscape.

2. Study the interrelationships, their patterns and processes in nature and society from a spatial and temporal perspective.

3. Adapt oneself to use geographical techniques to collect, analyze, interpret and present data and information.

4. Comprehend the diversity of the world; adapt oneself to live harmoniously with the environment as well as with one another.

5. Inculcate positive attitudes supportive of conserving and sustaining the physical and human landscape.

6. Foster special survival skills that help to overcome challenging life situations.

7. Develop skills needed for active participation in the world of work.

Suggested Term Plan

Grade	Term	I	II	III
13	**I**	8.1, 8.2, 8.3, 8.4, 9.1, 9.2, 10.1, 10.2, 11.1 ⓪44	7.1, 8.1, 8.2, 8.3, 9.1 ⓪42	5.1, 5.2 ⓪26
	II	11.2, 12.1, 12.2, 12.3, 12.4 ⓪40	9.2, 9.3, 10.1, 10.2, 11.1 ⓪40	5.3, 5.4 ⓪30
	III	13.1, 14.1, 14.2 ⓪22	11.2, 11.3, 12.1 ⓪22	5.4, 5.5 ⓪20

Grade 13   Physical Geography

	Competency	Competency Level	Content	Learning Outcomes	Periods

8.0	Examines processes and contributory factors of global climate change and acts to maintain environmental balance	8.1 Describes the natural causes that have an impact on climate change	• Introduction to climate change
			
			• Natural causes that contribute to climate change
			  - greenhouse effect
			  - sun spots
			  - volcanoes
			  - ocean surface
			  - temperature changes on
			  - El Nino and La Nino
				- Defines climate change
				
				- Describes physical processes that cause climate change
					16

		8.2 Describes anthropogenic factors that influence climate change	• Anthropogenic factors influencing climate change and their impact
			  - Use of fossil fuels
			  - Industrialization
			  - Agriculture
			  - Animal husbandry
			  - Deforestation
			  - Emission of harmful gases
				- Describes anthropogenic factors that influence climate change	

		8.3 Describes how climate change affects human activities	• Impact of climate change on human activities
			  • Agriculture
			  • Industry
			  • Habitat
			  • Health
				• Describes with examples how climate change affect human activities	

Competency	Competency Level	Content	Learning Outcomes	Periods
	8.4 Discusses how man can contribute to mitigate the intensity of climate change	• Limiting over-consumption • Minimize carbon emission • conforming to national and international policies and recommendations	• Explains how man could contribute to mitigate the effects of climate change	
9.0 Understands the importance of water and acts to conserve water resources.	9.1 Studies the nature and distribution of world's water	• Distribution of world's water • Surface water (oceans and land) • Ground water (springs, connate water, magmatic water) • Atmospheric water	• Describes the nature and distribution of world's water	12
	9.2 Studies the factors that affect world's water resources and shows the importance of water conservation	• Factors affecting world's water resources • Need for water conservation • Water conservation techniques and their importance	• Describes factors affecting world's water resources • Explains the necessity of water conservation • Emphasizes the need for conserving water for survival of life	

Competency	Competency Level	Content	Learning Outcomes	Periods

10.0 Identifies Sri Lanka's water resources and helps in conservation	10.1 Reviews the nature and distribution of water resources in Sri Lanka	• Water resources of Sri Lanka
		  - nature
		  - water sources
		  - distribution
			• Describes the nature of water resources and sources of Sri Lanka
			
			• Describes with the aid of maps the distribution of water resources of Sri Lanka
				12

	10.2 Explains the importance of water conservation in Sri Lanka	• Water pollution in Sri Lanka • Water waste • Over exploitation of resources • Need for conservation	• explains how water is polluted in Sri Lanka • Explains how water is wasted in Sri Lanka • Explains how water resources are over-exploited • Presents information on the methods of water conservation in Sri Lanka	

Competency	Competency Level	Content	Learning Outcomes	Periods

11.0 Examines the components, characteristics and processes of the physical landscape and contributes to its conservation	11.1 World distribution of biomes and their characteristics	• Introduction to biomes
		
		• Types of biomes and their characteristics
		  - tropical rain forests
		  - deciduous forests
		  - chaparral
		  - Grasslands and Savanna
		  - deserts
		  - taiga
		  - Tundra
		• Problems faced by biomes
			• Defines what a biome is
			
			• Names the types of world's biomes
			
			• Reviews the characteristics of biomes
			
			• Examines the problems faced by biomes with selected examples
				40

	11.2 Explains the distribution and characteristics of eco-systems in Sri Lanka	• Distribution and characteristics of ecosystems in Sri Lanka
		
		  - forests
		  - scrubs
		  - grasslands
		  - wetlands
		• Problems faced by eco-systems in Sri Lanka
			• Names the eco-systems in Sri Lanka
			
			• Reviews and presents the features of Sri Lanka's eco-systems
			
			• Illustrates the distribution of eco-systems in Sri Lanka with the help of a map
			
			• Examines the problems faced by Sri Lanka's eco-systems	

Competency	Competency Level	Content	Learning Outcomes	Periods
	11.3 Evaluates ethics relating to eco-systems conservation in Sri Lanka	• Environmental ethics in Sri Lanka relating to - wetlands - forest and wild life reserves - coasts - bio-systems associated with reservoirs and tanks • Measures taken to conserve environmental systems in Sri Lanka	• Discusses the importance of environmental ethics in Sri Lanka • Explains the measures taken to conserve environmental systems in Sri Lanka	
12.0 Examines how natural hazards impact the physical and human landscape	12.1 Explains the difference between natural hazards and disasters	• Introduction to natural hazards and disasters	• Describes natural hazards • Describes natural disasters	20
	12.2 Explains natural hazards of the world	• World natural hazards - earthquakes - droughts - wild fires - tsunami - lightning - cyclones - floods - volcanic activity - landslides - avalanches	• Explains the major natural hazards of the world with examples	

Competency	Competency Level	Content	Learning Outcomes	Periods
	12.3 Reviews human and physical impacts of world's natural hazards	• Natural hazards - physical impact - human impact	• Describes the damage caused to the physical environment by natural hazards • Describes the damage caused to the human environment by disasters	
	12.4 Examines the human activities that intensify natural hazards	• Human activities that intensify natural hazards - improper land use - deforestation - industrial activities - unplanned constructions	• Presents with examples how human activities contribute to intensify the natural hazards	
13.0 Acts with positive attitudes that help in maintaining and conserving the physical and human landscape	13.1 Pro-actively contributes to disaster management in Sri Lanka	• Introduction to disaster management • Disaster management cycle mitigation preparedness response recovery • Disaster Management mechanism in Sri Lanka	• Describes what is meant by disaster management • Presents information on disaster management mechanism in Sri Lanka	12

Competency	Competency Level	Content	Learning Outcomes	Periods
14.0 Acts with proper understanding of the earth and its inhabitants to promote symbiotic relationships between nature and society	14.1 Examines the role of international and regional environmental organizations	• United Nations Environmental Program (UNEP) • International Union for Conservation of Nature (IUCN) • United Nations Framework convention on climate Change (UNFCC) • South Asia cooperative Environmental Programme (SACEP)	• Reviews and presents information on international and regional environmental organizations	12
	14.2 Examines the role of environmental organizations in Sri Lanka	• Central environmental Authority (CEA) • Natural Aquatic Resources Agency (NARA) • Coast conservation Department (CCD) • National Building and Research Organization (NBRO) • Geological Survey and Mining bureau (GSMB)	• Discuss the contribution made by the environmental organizations in Sri Lanka •	

Human Geography

Competency	Competency Level	Content	Learning Outcomes	Periods
7.0 Examines the trends in mining industry and explains the necessity of using mineral resources sustainably	7.1 Studies the distribution, production, trade, problems and trends in the world mining industry	• Introduction to mining industry • Selected mining industries - Petroleum - Coal - Iron Ore (distribution, production and trade) - Mining industry related trends and problems • Sustainable use of mineral resources	• Defines what is meant by mining industry • Explains the world distribution of petroleum, coal and iron with the help of maps • Describes the petroleum related industries and products • Explains the nature of world trade in petroleum • Describes the world production of coal and associated industries • Describes the nature of world trade in coal • Describes the characteristics associated with the production and trade of world's iron ore • Explains the trends associated with the world's mining industry • Explains the problems associated with the world's mining industry • Explains that mineral resources should be used sustainably	14

Competency	Competency Level	Content	Learning Outcomes	Periods

8.0 Examines the value of mineral resources in the economy of Sri Lanka and explains the importance of their sustainable use	8.1 Examines the distribution, production and trends in the use of mineral resources in Sri Lanka	• Introduction to mineral resources in Sri Lanka
		
		• Selected mineral resources of Sri Lanka
		
		  - graphite mineral sands
		
		  - apatite (discussion of the distribution, production and trends of the above
			• Presents with the help of a map the distribution of selected mineral resources of Sri Lanka
			
			• Explains the production and trends of selected mineral resources of Sri Lanka
				24

	8.2 Emphasizes the importance of mineral resources in the economy of Sri Lanka	• Significance of mineral resources in the economy of Sri Lanka	• Describes the importance of mineral resources as industrial raw materials • Examines with the help of data the contribution of mineral resources of Sri Lanka's national development • Describes using data mineral resources related employment • Explains the contribution of mineral resources to Sri Lanka's regional development	

Competency	Competency Level	Content	Learning Outcomes	Periods
	8.3 Acts to minimize environmental impacts arising from the exploitation of mineral resources in Sri Lanka	• Exploitation of mineral resources and its impact on: - physical landscape - water ;resources - land degradation - air pollution • Minimizing environmental impacts - developing environmentally friendly attitudes - implementing relevant regulations - political commitment - active participation of citizen committees and their empowerment	• Describes the environmental impacts resulting from the exploitation of mineral resources in Sri Lanka • Proposes the measures to mitigate the environmental impacts arising from mineral resource exploitation	

Competency	Competency Level	Content	Learning Outcomes	Periods

9.0 Examines the factors of industrial location and reviews their trends	9.1 Examines with examples the factors influencing world industrial location	• Factors influencing location of industries
		
		   - raw material
		   - energy
		   - capital
		   - labour
		   - technology
		   - market
		   - entrepreneurship
		   - state policies
		
		• Recent trends in industrial location
			• Explains what is meant by manufacturing industries
			
			• Describes with reference to selected industries the factors influencing industrial location
			
			• Explains recent trends in industrial location
				26

	9.2 Describes the contribution of industries to Sri Lanka's economy	• Contribution of the following Industries to the economy of Sri Lanka
		
		   - cement
		   - sugar
		   - garments
		   - rubber and plastic goods
		   - traditional handicrafts
			• Examines the contribution of industries to the economy of Sri Lanka	

Competency	Competency Level	Content	Learning Outcomes	Periods
	9.3 Examines the factors that have influenced the location of industries in Sri Lanka	• Factors that have influenced the location of industries in Sri Lanka • Trends in the location of industries in Sri Lanka	• Explains with reference to selected examples factors that have influenced the location of industries in Sri Lanka • Describes the trends in the location of industries in Sri Lanka •	
10.0 Examines the present status of tourism industry in Sri Lanka and makes suggestions for its development with due concern for culture and environment	10.1 Reviews the characteristics of Sri Lanka's tourism industry	• Characteristics of tourism industry in Sri Lanka - domestic and international tourism - tourism sectors: eco-tourism recreational tourism cultural tourism aesthetic tourism adventure tourism • Impact of tourism - economic - cultural and social - environmental	• Explains the characteristics of the tourism industry in Sri Lanka • Describes with the help of data the impact of tourism industry on the economy of Sri Lanka • Explains the impact of tourism on the society, culture and environment of Sri Lanka	14

Competency	Competency Level	Content	Learning Outcomes	Periods
	10.2 Make suggestions to promote the growth of tourism industry of Sri Lanka while protecting the country's cultural identity	• Measures to foster the growth of tourism industry - update policies relating to tourism industry in Sri Lanka - creation of an environment to ensure the security of tourists - promotion of domestic tourism industry - promotion of alternative tourism sectors - measures to mitigate unfavourable effects of tourism	• Explains the measures that could be taken to develop Sri Lanka's tourism industry	
11.0 Examines the nature of globalization from a comparative perspective	11.1 Reviews what is meant by globalization	• Introduction to Globalization • characteristics of Globalization • Advantages and disadvantages of globalization	• Explains globalization • analyses the advantages and disadvantages of globalization • Introduces the major components of globalization	20

Competency	Competency Level	Content	Learning Outcomes	Periods

	11.2 Reviews the drivers of globalization	• Drivers of globalization
		  - information and communication technology
		  - multinational corporations
		  - acceleration of human mobility
			• Introduces the drivers of globalization
			
			• Describes the contribution of information and communication technology and multi-national corporations to globalization
			
			• Describes ;how accelerated human mobility affects globalization	

	11.3 Examines the manner in which globalization affects developing countries	• Effects of positive and negative influences of globalization on developing countries
		  - economic
		  - social and cultural
		  - knowledge and technology
			• Describes the positive and negative effects of globalization on developing countries
			
			• Describes with examples the impact of globalization on Sri Lanka	

12.0 Examines the role of regional organizations and acts with an awareness of regional cooperation	12.1 Reviews the role of selected regional organizations	• Selected regional organizations - South Asian Association for Regional Cooperation (SAARC)	• Explains what is meant by regional organizations • Describes the functions of SAARC •	

Competency	Competency Level	Content	Learning Outcomes	Periods
		- Association for South East Asian Nations (ASEAN) - European Union (EU)	• Describes the functions of ASEAN • • Describes the functions of EU • Shows with the help of maps the countries belonging to regional organizations	

Practical Geography

Competency	Competency Level	Content	Learning Outcomes	Periods

5.0 Uses statistical techniques and graphical methods to analyze, interpret, and present, data and information	5.1 Reviews data sources	• Data
		  - definition
		  - sources of data
		  - types of data
		  - difference between data and information
			• Defines data
			• explains the properties of data
			• Explains the difference between data and information
				76

	5.2 Examines methods of data collection	• Methods of primary data collection
		    Surveys, interviews, observation, experiments
		• Sources of secondary data
		    Library sources, digital information maps
		    air photographs satellite images pictures and photographs
		• Organizing and tabulating data
			• Describes with examples methods of data collection	

Competency	Competency Level	Content	Learning Outcomes	Periods
	5.3 Analyzes and interprets data using statistical techniques	• Use of simple statistical techniques for data analysis - central tendency mode, mean, median - dispersion, range, quartiles, dispersion diagrams, inter-quartile range mean deviation, standard deviation • Data representation - histograms, frequencies, frequency polygon, frequency curve, cumulative frequency curve, percentage cumulative frequency curve	- Organizes and tabulate data - Constructs a data distribution - Analyzes and interpret data using statistical techniques	

Competency	Competency Level	Content	Learning Outcomes	Periods
	5.4 Uses graphical methods for data analysis and interpretation	• Graphical methods - line graphs simple and multiple - bar graphs simple and multiple, pyramid - pie charts divided circles\	- Analyses interpret data using graphical methods	
	5.5 Uses cartographic technique for data analysis	• Cartographic techniques - isopleth maps - choropleth maps	-	

Competency   **:**   **8.0**   **Examines processes and contributory factors of global climate change and acts to maintain environmental balance**

Competency Level   **:**   8.1   Describes the natural causes that have an impact on climate Change

     8.2   Describes anthropogenic factors that influence climate change

     8.3   Describes how climate change affects human activities

     8.4   Discusses how man can contribute to mitigate the intensity of climate change

Periods   **:**   16

Learning Outcomes **:**
- Defines climate change
- Describes physical processes that cause climate change
- Describes anthropogenic factors that influence climate change
- Describes with examples how climate change affect human activities
- Explains how man could contribute to mitigate the effects of climate change

Introduction   **:**   Climate changes have occurred even in the distant past but their intensity has increased at present due to human interventions. As such, it is extremely important to adopt environment friendly measures to maintain environmental balance and resource management on behalf of the future world. With that in mind, it is expected in this unit to identify climate change, study the physical and anthropogenic factors that contribute to climate change and explore the measures that could be adopted to mitigate its intensity. In the teaching process it is very important to provide learning opportunities and use techniques that ensure rational resource utilization and development of environment friendly attitudes.

A Guideline to clarify the Subject Matter:

8.1   **Climate Change**

- The average of the weather conditions over a period of 30 years is considered as climate.

- As evident, climate, too, could change from time to time.

- Since man has been changing the physical phenomena of the earth, climate also has been changing in relation to them.

- The 2007 Report of the Inter-governmental Panel on Climate Change has made it clear that the atmospheric temperature has been rising.

- It has been recorded that 1992-2006 as the period during which the temperature of the earth's surface increased rapidly. During the period of 100 years from 1906 to 2005 the temperature has increased by 0.74^0C.

- The graph below depicts how global average temperature has changed.

Fig. 1. Change in the global average temperature, 1860 – 2000
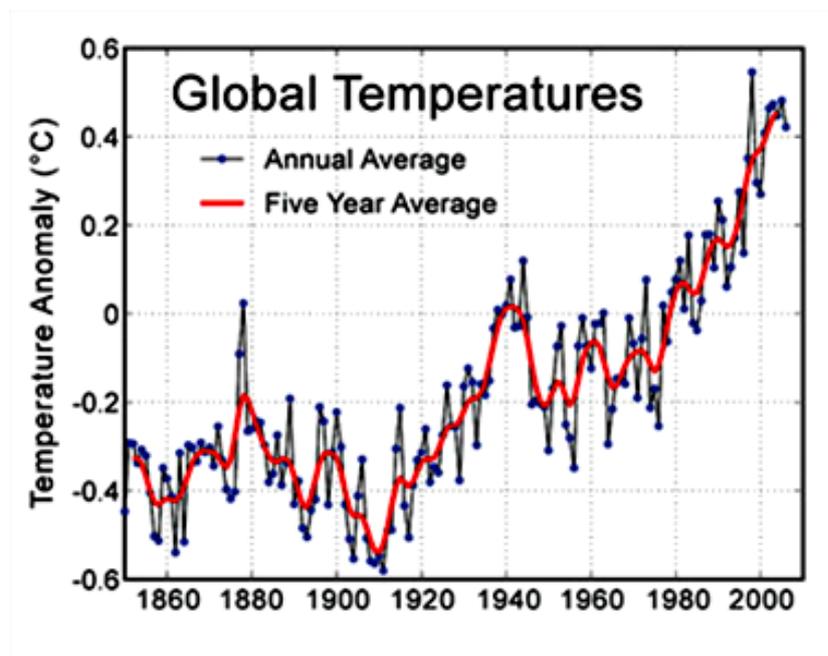
The Natural Causes that contribute to Climate Change

- The climate of the Earth depends on the amount of solar energy stored in the atmosphere.

- The difference between the solar radiation and terrestrial radiation determines the solar energy balance.

- The change in the energy balance results in the changes in global climate.

- Any activity that obstructs the energy balance results in climate change.
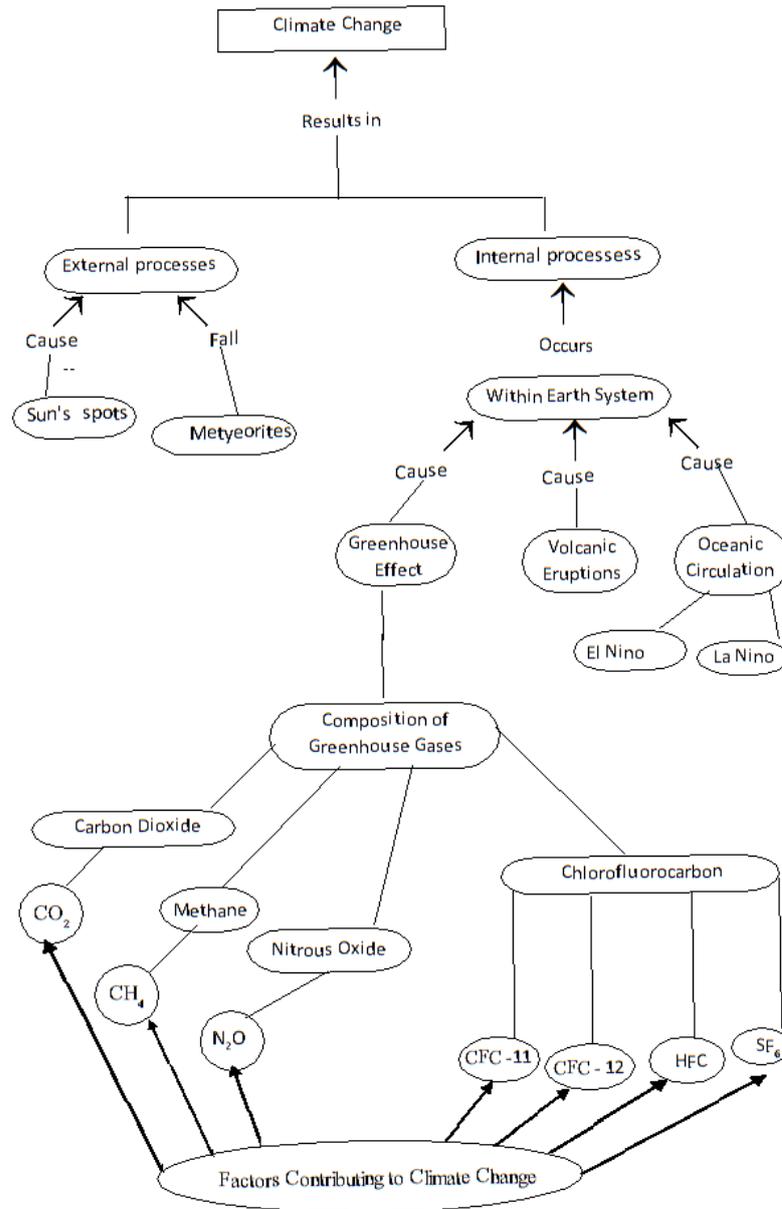
Factors Contributing to Climate Change

Greenhouse Effect

- The increase in atmospheric temperature could be cited as the main reason for climate change. The Greenhouse effect is the main reason for increasing temperature.

- Greenhouse effect is a natural process. It results in warming up of the earth's surface and atmosphere.

- Natural greenhouse effect is necessary for creating a favorable environment for existence of life.

- It helps to maintain the average temperature of the Earth at 15^0C level.

- If the natural greenhouse effect is absent the earth's average temperature will be at about 18^0C.

- The infrared rays or the long-wave rays emitted to the space by the Earth are absorbed by the gases such as Carbon Dioxide (CO_2), Methane (CH_2), Nitrous Oxide (N_2O), Chlorofluorocarbon (CFC), Ozone (O_3), sent back to the Earth.

- Due to this process the earth's atmosphere is immensely heated.

- The global warming has been taking place due to the emission of greenhouse gases into the atmosphere directly and indirectly since the industrial revolution started at about 1750 AD and by the irregular human activities.

- As a result, climate change is taking place. Table below shows how the concentration of greenhouse has changed:

Table 1. Change in the Greenhouse Gases in the Atmosphere

Gas	Concentration in the Troposphere before 1750	Concentration in the Troposphere at Present
Carbon Dioxide (parts per 1 million)	280	385
Methane	700	1857-1735
Nitrous Oxide (parts per billion)	270	321-320
CFC - 11	0	246-243
CFC – 12	0	541-537
HFC	0	49-41
SF_6 (parts per trillion)	0	6.40/6.03

Source: University of Peradeniya, Postgraduate Institute of Agriculture, Local Solutions for Climate Change

The picture below shows how the greenhouse effect is occurring:
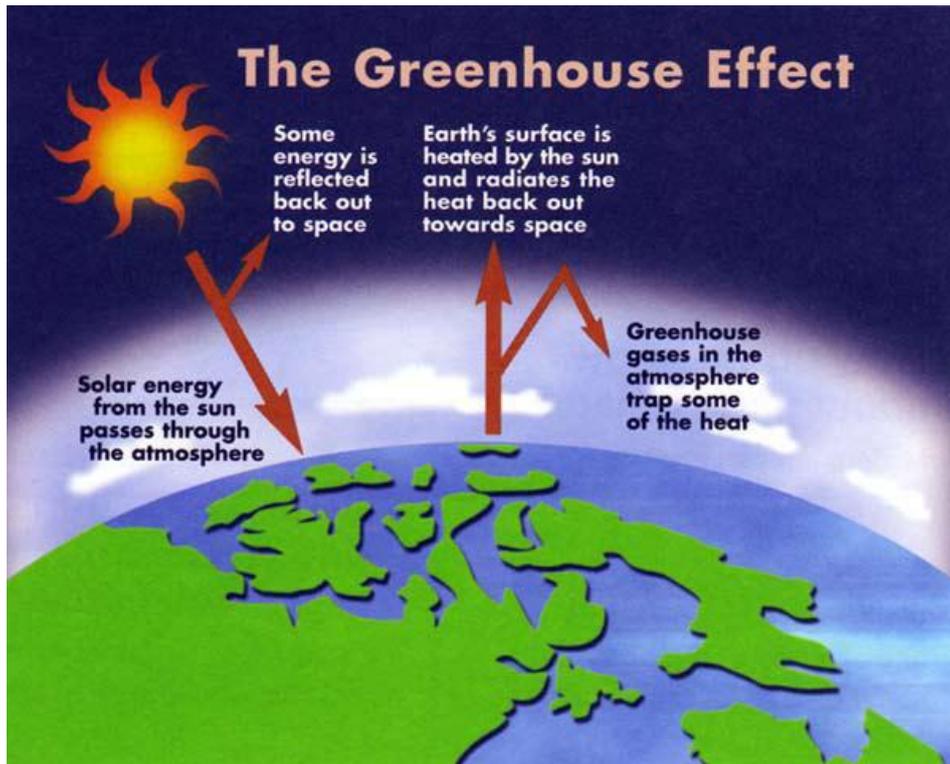
The Circular Graph below shows human activities that emit greenhouse gases into the atmosphere.

Global Greenhouse Gas Emission
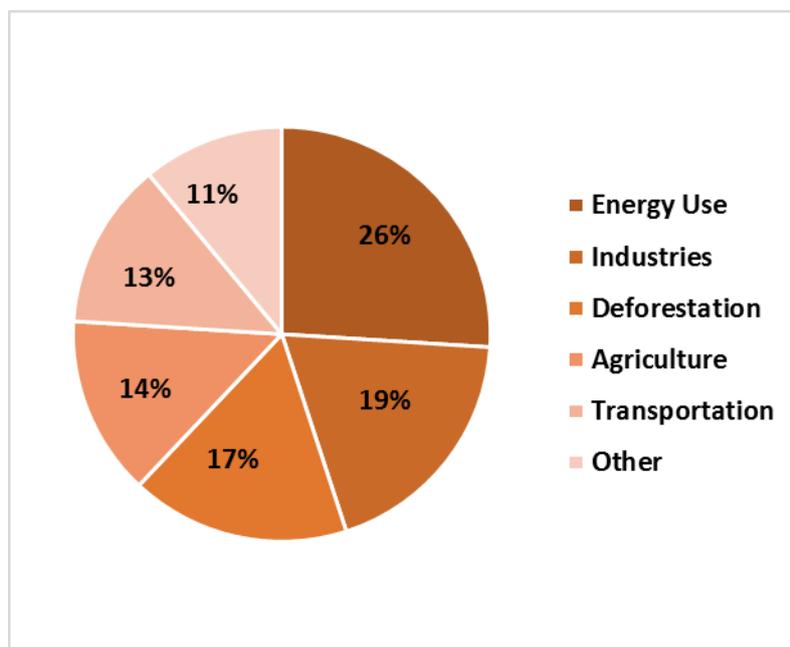
Global Greenhouse Gas Emission

The energy consumption (26%), industries (19%), and deforestation (17%) are the major global greenhouse gas emitting sectors. Agriculture (14%) and transportation sectors are also contributing to greenhouse gas emission.

Sunspots

- Heating of the atmospheric system by solar radiation is a general phenomenon.

- The large scale explosions that take place on the Sun's surface make changes in this general situation.

- These explosions take place due to the interactions in the sun's magnetic field.

- Large flares emerge due to these explosions. It has been revealed by observations that it takes about 11 years to cool down these flares. The locations of these explosions are dark in color. They are known as sunspots.

- The frequent occurrence of sunspots result in changes in the heat received by the earth.

- The heat absorbed by the atmosphere increases the temperature on Earth.

- Droughts, desertification, impact on plant growth, wild fires have been identified as consequences of this phenomenon.

Volcanoes

- Volcanic activity also contributes to an increase in the atmospheric temperature. When magma in the earth's interior comes to the surface of the earth through cleavages, joints and faults a huge amount of heat is also emitted to the atmosphere.

- In addition, a large amount of ash, smoke and dust is added to the atmosphere.

- As a result, changes in wind circulation patterns, high temperatures and heavy rainfall would occur.

Temperature changes on Ocean Surfaces

- The absorption of high temperatures in the atmosphere by oceans results in an increase in temperature of ocean water, reduction in its density and an increase in volume.

- It has been observed that this has resulted in a change in the circulation of global ocean currents.

- For example, in the summer, since there is a low pressure area in the warm Pacific coastal lands and a high pressure area on cold ocean surfaces an active and high velocity winds are generated.

- A large number of incidents, such as changes in the circulation pattern of warm and cold ocean currents, changes in wind patterns, occurrences of storms, submergence of low lying areas, destruction of mangrove environs, flowing of saline water into land areas, are taking place due to the changes in temperature on ocean surfaces.

El-Nino

- Once in every 3-5 years an extensive warm water surface is created on the surface of the Pacific Ocean and remain there for a year or more.

- Accordingly, the temperature of the water of the Pacific Ocean adjacent to Peru and Equador increases and the associated changes taking place in pressure and wind patterns have resulted in the occurrence of El-Nino.

- This phenomenon is called El-Nino, meaning Christ's Child, since it normally occurs during the Christmas period.

- El-Nino results in extreme weather conditions and leads to high global temperatures.

The Map below shows the region where El-Nino occurs:

Heavy Rainfall		Snow Storms
	Weather changes caused by El-Nino	
Drought		Cyclones
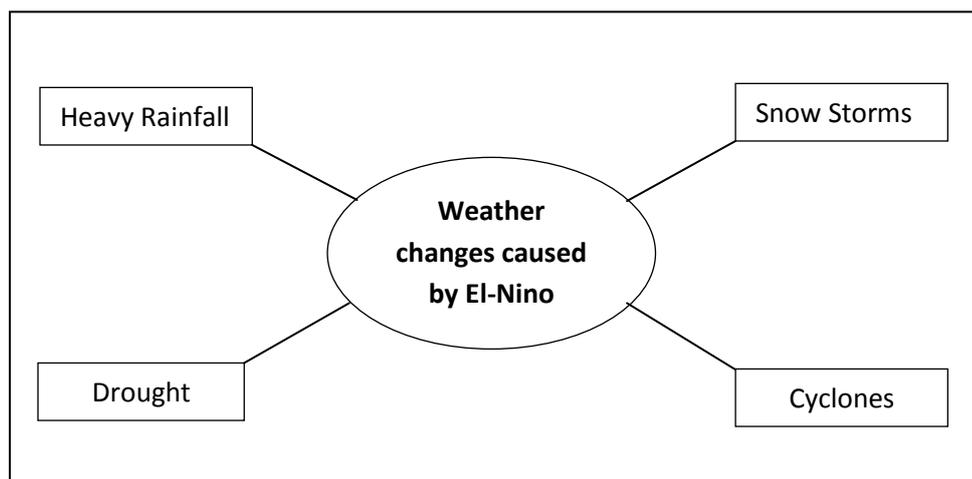
La-Nino

- As El-Nino ends, the La-Nino occurs.

- In Spanish, La-Nino means "Little Girl".

- The high temperature regions created by El-Nino are transformed into cold regions by La-Nino.

- Due to La-Nino, an extremely cold ocean surface is created in the south-west Pacific ocean region.

- For example, in June 1988, the surface of the Eastern Pacific Ocean was suddenly became colder resulting in high pressure and high velocity ocean currents.

The possible impacts of climate change

- Rise in sea level (up to 18-59cm)

- The global temperature could increase by from 1.1^0C to 6.4^0C in the 21st Century.

- Frequent periods of high temperatures and heavy rainfall.

- Droughts, cyclones and high tides could occur.

- All these occurrences have exerted an unfavorable impact on human and physical environment.

8.2   Anthropogenic factors contributing to climate change

- With industrial development, the changes in the phenomena, characteristics and processes of the earth have accelerated.

- The industrial revolution has immensely contributed to this change.

- With the intervention of man, the fossil fuel burning, deforestation, increase in the emission of greenhouse gases have contributed to climate change.

- The carbon dioxide concentration which was 280 ppm in 1750 has increased to 400 ppm by 2017. This has caused greenhouse effect.

Fossil Fuel Burning

- The decayed plant and animal matter subjected to high temperature and pressure over a very long period of time have made fossil fuels.

- At present, these fossil fuels are being used in various forms such as coal, petroleum and natural gas.

- Due to the burning of these fuels over a period of 200 years since the industrial revolution the amount of the carbon dioxide in the atmosphere has increased by 30 per cent.

- The activities in the industrial and transportation sectors have been the major contributors to this increase.

Industrialization

- Industrialization could be stated as a major anthropogenic activity that has contributed to climate change.

- Fossil fuels are widely used as a source of energy in industries.

- A number of greenhouse gases are added to the atmosphere in this process. Nitrous Oxide (N_2),   Methane (CH_2), Ozone (O_2), Hydrofluorocarbon (HFCs), Sulfur Hexafluoride (SF6), Perfluorocarbon (PFCs) are notable among them.

- Of the total greenhouse gas emission 19 per cent has been contributed by industries and the major contributors are developed industrial countries.

Agriculture

- The arable land area of the earth is around 40-50 per cent of the total land area.

- In the agricultural process, the greenhouse gases such as Carbon Dioxide, Methane and Nitrous Oxide are emitted the atmosphere.

    – The organic matter emitted during the preparation of soil

- Emission of methane from paddy fields

- Application of fertilizers with nitrogen have been responsible for this situation.

- Greenhouse gases are emitted during the production of chemical fertilizers.

- The life span of the Nitrogen Oxide emitted by agricultural activities are about 150 years. It immensely contributes to global warming.

Livestock Farming

- Livestock farming activities through greenhouse effect contributes to climate change.

- Animal waste, urine, and rumination contribute to the emission of methane gas.

- Commercial livestock farming is widely practiced in the temperate zone countries.

Deforestation

- Deforestation is also a dominant factor contributing to climate change. Deforestation and burning of bio-mass immensely contribute to emission of greenhouse gases.

- According to current estimates, the amount of carbon stored in forests is around 250 metric tons per hectare.

- The ability to absorb carbon dioxide in the atmosphere by plants is lost due to deforestation.

8.3 How climate change affects human activities

Agriculture

- Climate change affects agriculture directly. It could occur due to changes in rainfall pattern.

- The incidence of hazards like diseases and pests would increase due to climate change.

- Reduction and untimely fruit bearing of plants could occur.

- Land become unsuitable for cultivation due to increased acidity associated with drought conditions.

- The agricultural land in coastal areas will be lost to cultivation due to rise in sea levels.

- The agricultural economy could collapse due to the decrease in crop yields.

- Food security problems could emerge.

- Agricultural land could be destroyed due to natural disasters.

- In some regions, an advantageous situation could occur due to the shortening of the winter season and lengthening of summer.

Industries

- Decline in mining industry has taken place due to the conventions on global climate change ratified by many countries of the world that aims at controlling the emission of greenhouse gases.

- Increase in the costs of mining industry due to the introduction of new environmental regulations.

- The destruction of factories and their productions due to the increased incidence of natural disasters. E.g. 2015 Tsunami that devastated Japan.

- Water requirements of industries will encounter problems as there will be water shortages.

- Effects on the distribution of fishing grounds and fish populations.

Settlements

- Coastal settlements will be destroyed due to rise in sea levels associated with global warming.

- Of the total world population 50 per cent are living in an area 60 km from the coast. About ¾ of the World cities are located in this area.

- Increase in environmental temperature caused by global warming makes it difficult to live in housing complexes in urban areas.

- Provision of facilities to make living conditions in houses more comfortable would increase energy costs.

- Increase in costs of construction of housing.

- Increase in damages to houses due to natural disasters.

- Damages to houses from natural disasters such as droughts and floods.

- Impacts of extreme weather conditions. E.g. Cyclones

Health

- Increase in communicable diseases and their distribution. E.g Dengue, Malaria, Filariasis.

- Increasing incidence of cardiac diseases and skin cancer owing to the exposure to high temperature and cold.

- The unfavorable impacts of climate change on agricultural production would result in the decline in food consumption and nutritional levels thereby aggravating the morbidity conditions associated with nutritional deficiencies.

- Increase in respiratory ailments due to the increase in environmental temperature.

8.4   How mankind could contribute to minimize the intensity of climate change

- Reduction of over-consumption
  - Complex requirements of man has made him a consumer of an array of goods. This situation could be seen especially in developed countries.

  - There is a heavy demand for basic needs such as water, food, clothing and housing as well as for goods, equipment, modes of transport, service facilities used by man.

  - This has led to the consumption of a large amount of environmental resources. For example, the over consumption of water, soils, mineral resources, air, forests can be seen conspicuously.

  - As such, the use of fossil fuels has to be limited.

  - There is a necessity for using forests sustainably.

  - Man should limit over-consumption and adapted himself to a simple life style.

  - Through curtailing over-consumption resources could be used efficiently and productively.

- **Minimization of Carbon Emission**
  - The forest cover of the Earth should be conserved through protecting forests and by reforestation. The most effective natural means of absorbing greenhouse gases are forests.

  - Since fossil fuel combustion is a major contributor to carbon emission steps should be taken to limit fuel burning.

  - Carbon emission could be minimized through increased efficiency in energy, minimization of energy use, using alternative energy sources, limitation of livestock farming activities, increasing the efficiency in transportation activities, management of waste disposal, use of simple apparatus and living a simple life.

- **Confirming to National and International Policies and Recommendations**
  - Functioning according to the United Nations Framework Convention on Climate Change (UNFCC).

  - Confirming to Kyoto Protocol established with a legal authority in order to oversee the implementation of UNFCC globally.

  - Confirming to Paris Conference of Parties 21 on Climate Change (COP 21) and Paris Convention. 55 countries are signatories of this convention.

- **Contribution of Sri Lanka**

  - Sri Lanka became a signatory to the UNFCC in 1993.

  - Establishment of the Climate Change Secretariat under the Ministry of Environment and Natural Resources.

  - Establishment of National Carbon Fund

  - Establishment of Ozone Unit

  - Preparation of a Plan on climate for the use of Sri Lanka Civil Society (2015). Under this various activities have been planned.

    e.g. Reduction of fossil fuel burning, conservation of water, conservation of forests, introduction of renewable energy sources, rain water harvesting, increasing the awareness of climate, various policies, laws and regulations on emission of smoke from vehicles.

Teaching – Learning Activities

1. Presentation of a group activity on the factors responsible for climate change.

2. Creation of a folder with pictures and photographs that show how natural factors contribute to climate change

3. Creation of a wall paper with information on how anthropogenic factors have been responsible for greenhouse effect in the atmosphere.

4. Prepare a student presentation on how climate change has affected mankind and organize a programme to make other students aware of the subject.

5. Ask students to draw pictures and posters that contain information on measures that could be adopted to minimize the effects of climate change

Competency : **9.0 Understands the importance of water and acts to conserve water resources.**

Competency Level : 9.1 Studies the nature and distribution of world's water

9.2 Studies the factors that affect world's water resources and shows the importance of water conservation

Periods : 12

Learning Outcomes :

- Describes the nature and distribution of world's water
- Describes factors affecting world's water resources
- Explains the necessity of water conservation
- Emphasizes the need for conserving water for survival of life

Introduction : Water is an essential resource for sustenance of life. Without water, we will not be able to live more than three days. Although most of the earth's surface is covered by water the proportion of water resources which is suitable for human consumption is limited. Of the total global water resources only 0.03 per cent is suitable for human consumption. Even this limited amount is polluted due to human activities. The value of water has risen due to its scarcity. This is why people in some countries have been compelled to purchase water. The objective of this unit is to study the global distribution of water, factors affecting global water resources, and conservation of water.

A Guide to Clarify the Subject Matter:

9.1 Nature and Distribution of World's Water

The Blue Planet - The only planet with water among all planets.

- The chemical composition of water is expressed as H_2O. It means that in a molecule of water there are two hydrogen atoms and one atom of oxygen.

Various forms of water

Solid : Ice caps in mountain regions
Glaciers in Polar regions

Liquid : Surface water: water in oceans, rivers, lakes, tanks

Gas : Water vapor, Water droplets

Distribution of Water

- 71% of the global earth is covered with water.

- Of this 97.5% is found in oceans as saline water. The remaining 2.5 % is freshwater.

- Of the total amount of freshwater, 68.7%, 30.1% , 0.8% and 0.4% are found as glaciers, ground water, permanent frost, surface and atmospheric water, respectively.

- The surface and atmospheric water has distributed as follows:

  Water in freshwater lakes -   67.5%
  Water in soil   -   12.0%
  Atmospheric water   -   9.5%
  Water in wetlands   -   8.5%
  Water in rivers   -   1.5%
  Water in plants   -   1.0%
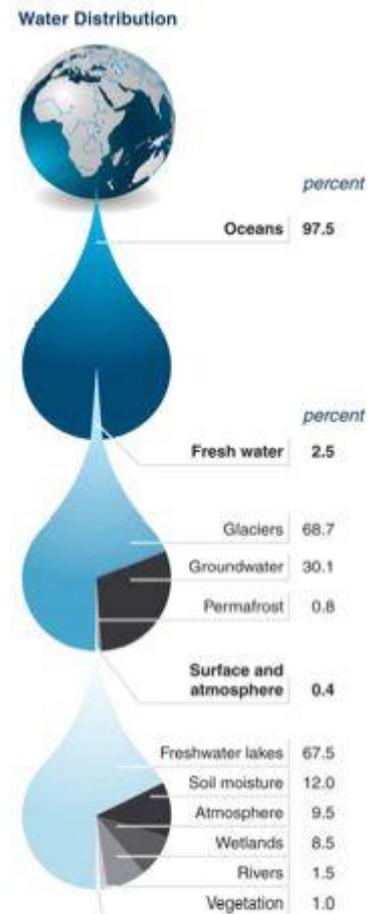
- Draw the attention of students to the functioning of the hydrological cycle studied in Grade 12.

- The process of the hydrological cycle provides water for sustenance of life.

- Earth surface receives water from rainfall. Some of it percolates and becomes ground water.

- There are about 263 of river basins in the world and their total size is about 231,059,898 km^2. It is about 45.3% of the total area of the earth.

Distribution of Earth's water
                Surface water
                Ground water
                Atmospheric water

Surface water
- Most of the liquid water exists as surface water. A large percentage of that exists as saline water in oceans.
- Water in rivers, streams, lakes and reservoirs is freshwater.
- What is important for mankind is freshwater.

Ground water

- Water deposited in the interior of the Earth

Meteoric water	-	water percolated into the earth
Connate water	-	water deposited between sedimentary layers
Magmatic water	-	Water found in hot water springs etc.

Atmospheric water   -   Water vapor and water droplets

Water is essential for the sustenance of life as well as for various human activities. It is used for

- Physiological requirements
- Industries
- Agricultural activities
- Domestic purposes
- Transportation
- Generation of energy
- Sports and recreation activities
- Water is a food store (fish, aquatic plants)

9.2   Factors Affecting the World Water Resources and the importance of Water Conservation

Factors affecting the World Water Resources

- Distribution and growth of population

    Increase in water requirements with growing population

- Urbanization

    Excessive water consumption; Obstruction of water ways

- Waste Disposal

    Water pollution due to the disposal of agricultural, industrial and domestic waste.

- Use of fertilizers and agricultural chemicals

    Disposal of various chemicals to water

- Mixing with animal matter

    Contamination and pollution of water

- Mining Industries

    Addition of waste to water and destruction of water sources due to mining industries such as coal, petroleum and other mining activities.

- Natural Disasters

    Water pollution due to disasters such as landslides and volcanic eruptions.

Necessity of Water Conservation

- There are two factors that emphasize the necessity for water conservation:

    1.   Unavailability of water to meet the demand

    2.   The constant pollution of existing water resources

- It has been revealed that by the year 2025, 2/3 of the world's population will have to live in areas where water is in short supply.

- By the year 2025, 25 countries in the African continent will become countries that do not have even the minimum requirements of water which is 1700 m^3(annual per capita water consumption is 1700m^3).

- 20 per cent of the current world population face the problem of not having pure drinking water. Due to this situation diseases are widely spread and children are dying in large numbers.

- As United Nations states, during this century there will be conflicts due to water sharing.

Water Pollution

- The quality of water resources has been changing due to human activities.

- Polluted water affects biotic community in various ways.

- Destruction of biodiversity, extinction of some animals and plants, gene mutilation, vulnerability to various diseases (curable, incurable and fatal).

- Ground water as well as surface water is being contaminated.

- As such, the necessity of the conservation of water is emerging.

Conservation of Water

- Protection of surface and ground water resources, controlling the consumption of water and development of water resources, prevention of pollution, and saving of water for the future are meant by conservation of water resources.

- Two factors should receive attention in the conservation of water.
    1. Sustenance of water supply in par with demand for water
    2. Protection of water quality and development of water resources

    Measures that could be adopted to realize above requirements:
    - Observe austerity in water consumption
    - Rain water harvesting
    - Make people aware of the need for conservation of water
    - Formulate measures to utilize ground water
    - Construct new reservoirs
    - Use of desalinated sea water
    - Recycling of once used water
    - Protection of water-shed (catchment) areas
    - Prevention of water contamination

Teaching Learning Activities
- Ask students to make a poster entitled "Global Water Resource".
- Prepare a report under the title "Protection of Water Resources" under following headings:
    - Factors responsible for water pollution
    - Need for water conservation
    - Measures that could be adopted to conserve water
    - Steps that could be taken to protect water resources in domestic water consumption

Competency : **10.0** **Identifies Sri Lanka's water resources and helps in conservation**

Competency Level : 10.1 Reviews the nature and distribution of water resources in Sri Lanka

10.2 Explains the importance of water conservation in Sri Lanka

Periods : 12

Learning Outcomes :
- Describes the nature of water sources and resources of Sri Lanka
- Describes with the aid of maps the distribution of water resources of Sri Lanka
- Explains how water is polluted in Sri Lanka
- Explains how water is wasted in Sri Lanka
- Explains how water resources are over-exploited
- Presents information on the methods of water conservation in Sri Lanka

Introduction : Water resources in Sri Lanka exist as surface and ground water. There is a dynamic balance between these two sources as part of the surface water becomes ground water and vice versa.

Sri Lanka is rich in water resources. The main determinant of our water resources is rainfall. The nature of Sri Lanka's water resources, its distribution, and the use of water resources are studied in this unit.

A Guideline to Clarify the Subject Matter

10.1 Nature and distribution of water resources of Sri Lanka

- Sri Lanka is rich in water resources. Sri Lanka receives its water mainly from rainfall.

- Rainfall is received in various ways throughout the year:
    - Convectional rains
    - Monsoon rains
    - Cyclonic rains

- Amount of Rainfall
  - The mean value of annual rainfall is 1861mm.
  - In western slopes of the Central highlands it exceeds 5000mm.
  - In semi-arid regions it is less than 1000mm.

- According to its location water resources could be divided into two segments.
  - Surface water
  - Ground water

- According to its nature water resources could be divided into three segments:
  - Freshwater
  - Salt water
  - Brackish water

Surface water

Surface water has distributed in three ways:
  - River basins
  - Inland reservoirs
  - Lagoons

River Basins

In Sri Lanka there are 103 river basins. Of them, 80 are flowing across the Dry Zone and most of them are seasonal.

The remaining rivers which are perennial belong to the Wet Zone. The longest river, the *Mahaweli* waters both Wet Zone and Dry Zone.

The catchment area of *Mahaweli* is 10,327 km^2. The catchment area of the second longest river, Malwatu Oya, is 3246km^2.

Most of the water received by rainfall flows into the sea. It is called runoff. The runoff of wet zone rivers is much more than that of dry zone rivers.

Information on Rivers of Sri Lanka

	River	Length (km)	Catchment Area (km²)	Av. Rainfall on catchment area (mm)	Runoff/Rainfall Ratio (%)
1	Mahaweli Gaga	335	10,237	1,946	20
2	Malwathu Oya	164	3,246	1,332	4
3	Kala Oya	148	2,772	1,192	12
4	Kelani Ganga	145	2,278	3,452	43
5	Yan Oya	142	1,520	1,404	6
6	Deduru Oya	142	2,616	1,728	36
7	Walawe Ganga	138	2,442	1,774	8
8	Maduru Oya	135	1,541	1,750	8
9	Maha Oya	134	1,510	2,722	42
10	Kalu Ganga	129	2,688	3,605	42
11	Kirindi Oya	117	1,165	1,618	4
12	Kumbukkan Oya	116	1,218	1,622	24
13	Menik Ganga	114	1,272	1,670	16
14	Gin Ganga	113	922	2,887	48
15	Mee Oya	109	1,516	1,218	2
16	Gal Oya	108	1,792	2,032	7

Source: Survey Department of Sri Lanka, National Atlas of Sri Lanka, School Edition, 2015.

Source: Survey Department of Sri Lanka, National Atlas of Sri Lanka, School Edition, 2015.

Inland Reservoirs

The land area under inland reservoirs in Sri Lanka is about 2905 ^{2}km^2. Of this, about 731 km^2 are in the North Central Province.

A number of lagoons are found in the coastal areas of the island. Sometimes, small streams empty themselves into these lagoons enclosed by sand spits with a narrow opening that connects them with the sea. The water in these lagoons are brackish. A few examples are Batticaloa, Puttalam, Dedduwa, and Kalametiya lagoons.

Ground water

The percolated water that is deposited on an impermeable rock layer is ground water. The amount of ground water depends on the porosity and permeability of rocks.

The Distribution of Ground Water in Sri Lanka

Source: Arjuna's Atlas of Sri Lanka

Water Consumption in Sri Lanka

Water is used for various purposes:

- For drinking
- For domestic activities
- Agricultural activities
- Industrial activities
- Fisheries
- Sports and recreation
- Tourism related activities
- Transportation
- Generation of hydroelectricity
- Beautification

10.2   Importance of Water Conservation in Sri Lanka

Water Pollution in Sri Lanka

- A few decades ago the surface and ground water in Sri Lanka could be directly used for drinking and other purposes.

- However, at present, the quality of water has declined. The rapid increase in the use of bottled drinking water is a proof.

- At present, the acute problem with water is its pollution.

- Water pollution leads to diseases. Problems like deaths of humans and animals could occur.

- Water pollution could occur due to both natural and man-made causes. Both leads to the decline in water quality.

- Water pollution due to natural causes:
    - Mixing with sea water
    - Concentration of micro-organisms

- Water pollution due to human activities:
    - Disposal of human waste to water
    - Disposal of domestic waste
    - Use of Chemical fertilizers
    - Use of agro-chemicals
    - Use of weedicides
    - Disposal of industrial waste
    - Mixing with polluted gases
    - Mining, sand mining, excavation of clay

Wastage of Water

- Another problem with water is wasting. Especially, in urban areas of Sri Lanka, a considerable cost has to be borne to supply water for domestic uses.

- The concrete flooring practiced in urban areas in Sri Lanka at present prevents percolation of water and increases the amount of waste thereby unfavorably affecting the ground water resources

- In agricultural, industrial and service activities water is wasted drastically. In most cases, the water resources used are purified water.

Over-exploitation of water resources

"When the withdrawal of water is more than its recharge rate in a particular area it is called over-exploitation of water resources" (World Economic Forum).

Over exploitation of water resources varies from region to region.

Over exploitation of water resources could be studied along various lines. They are:

- Food production
- Industrial production
- Daily consumption
- Environmental beautification

- Of the total quantity of freshwater 60% is spent on food production and according to the irrigation techniques practiced 50 per cent of the water used for food production is wasted. It leads to over-exploitation of water resources.

- In industrial activities, too, an over-exploitation of water resources take place. A huge amount of water is used in industries like textiles and ceramics. In our country, a huge amount of water is used in activities such as sand washing, mining, concrete production, construction industry etc. They amount to over-exploitation of water resources.

- On every occasion in daily water consumption an over-exploitation takes place. In washing (cloths, vehicles and other daily activities) water is used in quantities more than required.

- In our country, water is used in large quantities in environmental beautification activities. In such activities water is wasted. The situation becomes worse since it is the drinkable water we use for these purposes.

Need for Water Conservation in Sri Lanka

A few decades ago it was possible to utilize water resources freely and there was no issue about its conservation.

However, at present, due to various human activities water resources are being polluted at a rapid rate. Also, due to its misuse, water is wasted in large scale. As such, by preventing or minimizing the pollution and wastage, water resources must be protected for the future.

In conservation of water resources following factors should receive attention:

1. Efficient use of water
2. Prevention of over-exploitation of water
3. Prevention of water pollution

Adoption of the 3-R concept (Reduce, Reuse, Recycle) in order to use water efficiently.

Prevention of Over-use
- Use of water in domestic activities avoiding wastage

- Use of rain water, re-use of water after purification, avoiding water wastage and over-use by using modern equipment

- Maintain good water management practices in agriculture; using only the required amount of water in crop cultivation, use of various irrigation technologies.

- Use of water in industrial activities without wasting

Prevention of water pollution

- Adoption of measures to dispose human waste

- Recycling of household and sewage

- Minimization of the use of artificial fertilizers, insecticides and weedicides and imposition of limits on their use.

- Enactment of laws on industrial waste disposal

- Make people aware of the necessity of minimizing sand mining, other mining activities and extraction of clay.

- Punishments for people who contravene laws.

Teaching Learning activities

1. Ask students to make a poster showing the measures that could be taken to conserve water resources in Sri Lanka and exhibit it.

2. Ask students to prepare a brief note on the water sources, water consumption and water pollution in the area around school.

3. Ask students to suggest the measures that could be taken to conserve water at home and school and take steps to make students aware of them.

   (One or few of these activities may be organized as individual/group activities).

Competency	:	**11.0**	Examines the components, characteristics and processes of the physical landscape and contributes to its conservation.
Competency Level	:	11.1	Explains world distribution of biomes and their characteristics
		11.2	Explains the distribution and characteristics of environmental systems in Sri Lanka
		11.3	Evaluates concepts and ethics relating to ecosystems conservation in Sri Lanka
Periods	:	40	

Learning Outcomes :

- Defines what a biome is
- Names the types of world's biomes
- Reviews the characteristics of biomes
- Examines the problems faced by biomes with selected examples
- Names the ecosystems in Sri Lanka
- Reviews and presents the features of Sri Lanka's ecosystems
- Illustrates the distribution of ecosystems in Sri Lanka with the help of a map
- Examines the problems faced by Sri Lanka's eco-systems
- Discusses the importance of environmental ethics in Sri Lanka
- Explains the measures taken to conserve environmental systems in Sri Lanka

Introduction : Biome is a community of flora and fauna distributed in a particular region. Various types of biomes could be seen in different parts of the world. The characteristics of biomes vary. Climate is the decisive factor of that variation. Accordingly, seven major types of biomes have been identified. In some instances, Grasslands and Savanna have been identified as two types of biomes and 8 major biomes have been named. These biomes encounter numerous problems.

There may be a number of environmental systems within a biome. Environmental system is smaller than a biome. The environmental systems in Sri Lanka are such small systems.

The different characteristics are found in environmental systems in Sri Lanka and they face various problems. Also, there is a programme for environmental conservation and a code of environmental ethics for Sri Lanka.

It is expected from this unit to introduce biomes and study various types of biomes, their world distribution and characteristics, distribution and characteristics of environmental systems in Sri Lanka, and concepts and ethics related to their conservation.

A Guideline to Clarify the Subject Matter

11.1   World Distribution of Biomes and their Characteristics

Biome: Biome is an environment with a specific flora and fauna community adapted to a certain climate.

Major Biomes of the World
1.   Tropical Rain Forests
2.   Temperate zone forests
3.   Mediterranean woodlands
4.   Grasslands and Savanna
5.   Taiga Forests
6.   Deserts
7.   Tundra

World Distribution of Biomes
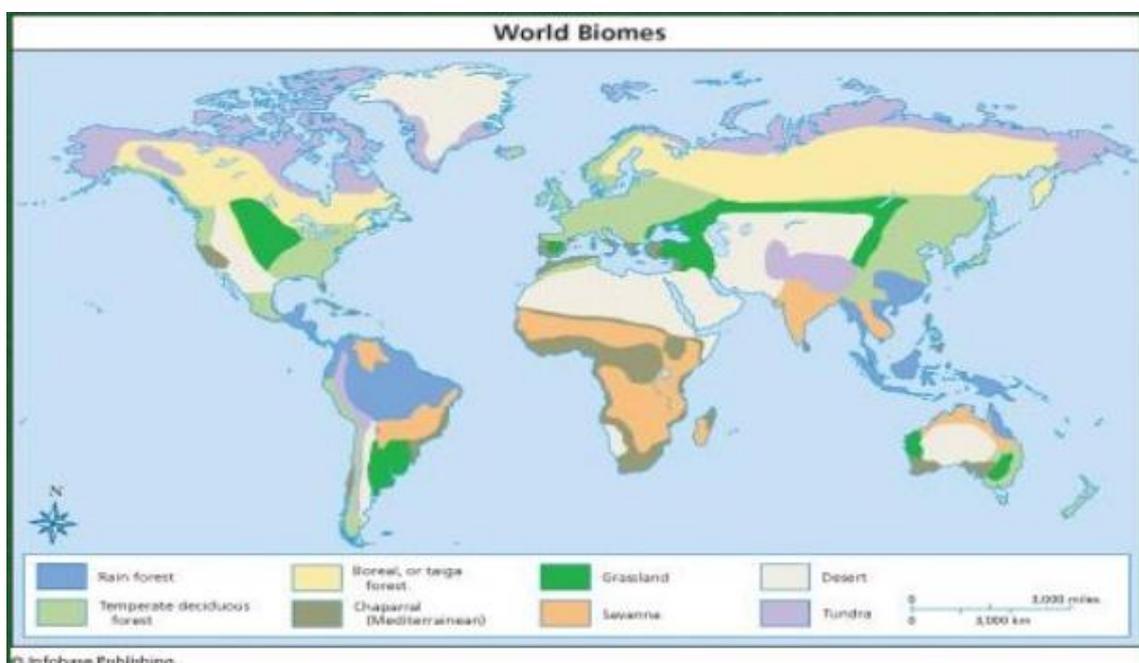
Tropical Rain Forest Biome

- Distribution
  - Tropical rain forests could be found in Asia, Africa, South America and in the Pacific Ocean Islands.
  - They are distributed on both sides of the equator (between the latitudes of 10^0N and 10^0S).
  - Nearly half of the tropical rain forests are located in Brazil, a country in South America.

- Climate
  - A temperature between 27^0C – 30^0C spread uniformly throughout the year can be seen.
  - Heavy rainfall spread throughout the year varies between 2500mm – 5000mm.
  - High relative humidity between 79% and 90%.
  - During most of the time in the year soil moisture remains.

- Characteristics of vegetation
  - Plants are evergreen.
  - Tree trunks are straight and roots are buttressed.
  - A variation in plants could be seen. Nearly 60 % of tree species of the world could be found in this biome. Bio-diversity is also high.
  - 65% of the mammalian species and 70%-80% of the insect species of the world live in these regions.
  - The penetration of sunlight varies with plant stratification.

    - Emergent Layer
      Giant trees emerging from the canopy layer can be seen. Grown apart from one another they are about 35m – 45 m in height.

    - Canopy layer
      Trees are located close to one another. They are about 25-45m in height.

    - Understory
      Trees are of 15-25m in height.

    - Shrubs layer
      Plants are of 5-15 m in height.
      - Cauliflory feature could be seen.
      - Parasite plants are numerous.
      - Year-round growth in vegetation.
      - Undergrowth is minimal due to the low penetration of sunlight.

- Plant species

  Ebony, *Hora, Na,* trees of Palu variety, Teak, Bamboo, Mahogany

- Animal species

Apes	: Baboon, Monkey, Chimpanzee
Reptiles	: Anaconda, Python, Cobra
Birds	: Parrot, Crow, Woodpecker
Other animals	: Bear, Leopard, Crocodile, Snail

Temperate Zone Forest Biome

Distribution
- Distributed in a zone between latitudes of 50^0-60 in both hemispheres. They could be seen in Eastern regions of North America, Northern and Central regions of Europe, Eastern regions of Asia (Korea, Japan, Eastern China), Eastern and Southern coastal region of Australia, and in the Western coastal area of South America.

- Climate
  - Clear seasonality can be seen.
  - Temperature is about 15^0C but not distributed uniformly over the year.
  - Annual rainfall is between 750-1500.
  - Although rainfall is low it is sufficient for plant growth.
  - Although snowfall takes place in winter it melts away quickly.
  - Temperature and humidity in summer are relatively high.
  - Soil is highly fertile. Rich in nutrients.

- Characteristics of Vegetation
  - Many plants are deciduous. Evergreen plants also could be seen.
  - Height of the dominant trees are about 25-30 meters and others are in the range between 8 – 32.
  - To some extent, a stratification could be seen. Tall dominant trees, scrubs, grasses, mosses constitute different layers.
  - Nature of plants change with seasons. Leaves fall in the winter.
  - A biodiversity exists but lower than that of tropical rain forests.

- Plant species

  Oak, beach, birch, maple, elm, chestnut

- Animal species

  African buffalo, deer, fox, porcupine, dove, squirrel, kingfisher, owl, cuckoo, robin.

There are two subtypes of this forest type according to the differences in climate and vegetation.

1. Temperate zone deciduous
2. Temperate zone evergreen

Mediterranean Biome

- Distribution
  - This Biome type could be seen in all continents in varying extents. It is found around the Mediterranean Sea in Europe and Northern Africa, California in North America, western coastal regions of South America (Chile), around Cape Town in South Africa, and in Perth and Adelaide in Australia.

- Climate

  - A dry and warm climate exists.
  - Temperature varies from 26.6^0C – 32.2^0C in Summer to 10^0C in Winter.
  - Rainfall is received in winter.
  - Mean annual rainfall is less than 762mm and it is rhythmic.
  - Salient features are winter rainfall and dry summers.

- Vegetation
  - Vegetation have adapted themselves to drought conditions of summer.
  - Leaves are thorny. They are insulated with wax and resin.
  - Leaf stoma are curved to make them turn away from sunlight.
  - Thick bark and gnarled trees
  - Ground water is absorbed by a deep root system.
  - Ground layer is covered with grass; trees and bushes can be seen in the higher layer.

- Plant species
    Eucalyptus, Cedar, Oak, Olive, Tulip, deodar, Pine, Rosemary, Lavender.

- Animal species
    Deer, Birds, Wolf, Dingo

Grasslands and Savanna Biome

This biome could be divided into two types:

      i.   Temperate zone grasslands
      ii.   Tropical grasslands

- Distribution

  Temperate Zone Grasslands
  > They are distributed in the interior parts of the continents in the mid-latitudes. Steppes in Russia, Prairies in North America, Pampas in Argentina, Downs in Australia, Velde in South Africa are examples.

  Tropical Grasslands
  > Savanna in Africa, Campos in Brazil, Lanos in Colombia and Venezuela are examples.

- Climate
  - In temperate zone grasslands a long dry season and a short rainy season could be seen.
  - Annual rainfall which is between 250-750mm, is not sufficient for growth of a forest.
  - Humidity is low.
  - The highest temperature in the coldest month is about 18^0C – 20^0C.
  - Annual rainfall in tropical grassland regions is about 1016 – 1500mm.
  - Strong dry winds

- Vegetation
  - In the temperate zone areas grass varieties and in savanna grasslands tall trees and scrubs could be seen. Grass varieties could also be found in abundance.

- Plant species
  - In temperate zone grasslands, various grass varieties and trees like Oak and Willow are found. In tropical savanna regions tall trees like Acacia and Biobab and scrubs are widely distributed.

- Animal varieties
  - In temperate zone grasslands animals like birds, Brown bear, Elk, and fox are found. In tropical grassland regions, animals such as lions, Zebras, Elephants, Giraffes, Bysons, and Ostriches could be seen.

Taiga (Coniferous) Biome

- Distribution
  - In the area between 45^0- 55^0 northern latitudes In North America and in the region between 50^0- 60^0 northern latitudes in Western Europe, taiga forests could be seen.

  - These forests extend as a belt from west to east in the continents of the northern hemisphere (e.g. from Canada through Northern Europe to Siberia)

- Climate
  - Winter and summer seasons are conspicuous. Autumn and Spring seasons are shorter.

  - Temperature is relatively low. It varies over the year. Average annual temperature ranges from -6^0C to -50^0C.

  - In a year, the temperature in six months is below 0^0C.

  - Winter is harsh.

  - Even in Summer the length of the daytime is short.

  - Average annual rainfall is between $300 - 850$mm. A large amount of the precipitation is received during warm, humid summer months.

- Vegetation
  - Plants are conical in shape. They have are needle –like leaves to make them resistant to heavy snowfall.
  - The number of plant species are very limited.
  - The maximum height of trees is about $12 - 20$ meters.
  - Poor Undergrowth.
  - Low biodiversity.

- Plant species
  - Austrian Pine, Fur, Spruce

- Animal species
  - Wolf, Red Deer, Moose, Elk, Porcupine, Bear, Rabbit

Desert Biome

Of the total land area of the world about 20 per cent is deserts. A salient feature of these deserts is low rainfall.

On the basis of temperature deserts could be divided into two types:

1. Hot deserts (in tropical regions)
2. Cold deserts (in cold regions)

- Distribution

  - Hot deserts are distributed in the region between 20^0- 35^0 latitudes in both northern and southern Hemispheres. They are located in the middle of continents.

  - Sahara and Kalahari in Africa, Arabian, the Great Australian Desert are examples for hot deserts.

  - Antarctica, Greenland, Gobi in Asia, Great Basin in North America, and Atacama in South America are cold deserts.

- Climate
  - The average annual rainfall in hot deserts is less than 150mm.

  - A uniform temperature exists throughout the year. It is between 20^0C -25^0C. Sometimes, the temperature is unstable. It could rise up to 43^0C – 49^0C.

  - Diurnal temperature variability is high.

  - A dry atmosphere prevails.

  - Dry winds blow both day and night.

  - In cold deserts the temperature in winter ranges from -2^0C to -4^0C. In the Summer it could be between 21^0C – 26^0C.

  - Cold deserts are covered with snow. Rainfall is received in Spring. It ranges from 150 – 260mm.

- Vegetation

  - Plant cover is not widespread.

  - Small plant covers could be seen in oases and areas that receive rainfall.

  - Existing plant cover has adapted itself to low humid and arid conditions.

  - As such,

- thin leaves
- defoliation
- waxy leaves
- Long root system
- Thorniness and juiciness
- Carnous (fleshy) nature, are salient features of the vegetation cover.

- Plant species
  - Cactus varieties, Desert ironwood, Aloe Vera, Thorny bushes, Mosses

  - Animal species

  - Animals have adapted themselves to aridity. Camel, who has a hump to store water is an example.
  - animals live in dug holes
  - Most animals are nocturnal.
  - To avoid high surface temperature some birds fly at an elevation of 300m.
  - Animals adapted to desert environment such as camels, desert lizards, ants, desert mice, reptiles can be seen.

Tundra Biome

This is the coldest biome of all biomes. It is divided into two types as Arctic Tundra and Alpine Tundra.

- Distribution

  - Arctic tundra is distributed in the polar regions of North America, Europe, Asia and Greenland.
    Alpine tundra is distributed in high mountain peaks such as Everest and Alpine.

- Climate
  Arctic Tundra
  - A harsh and long winter season exists.
  - Temperature in winter is about -34^0C.
  - Average temperature in Summer varies from 3^0C to 12^0C.
  - There are six months during which temperature falls below freezing point
  - Annual rainfall is between 150 – 250 mm.
  - During six months no sunlight is received. It hampers plant growth.
  - Frost could occur at any time.
  - Strong winds with a speed of 200km per hour could be seen.

Alpine Tundra
- In these regions, tundra biome features have occurred due to their altitude. Land is covered with snow throughout the year. Temperature in summer is about 10^0C.

- Vegetation

    - Plants grow only during the short summer season.
    - Low temperature is an obstacle to plant growth and, in consequence, biodiversity is low.
    - In snow-covered areas mosses are grown.
    - The dominant plant of the tundra plant community is grass. They are located as bushes from place to place. Woody plants are absent.
    - Leaves are lean. They are hairy and bent inwards.

- Animal species

    - Not a conducive environment for animal life. Animals like, Snow owl, Rain Deer, Penguin, Insects and Migrant birds who have adapted themselves to harsh cold conditions are seen.

The Problems faced by Biomes at Present

- At present all biomes are facing problems. They are twofold:

    i   Problems due to human activities
    ii   Problems caused by natural disasters

    Human activities

    - Agricultural activities

    - Deforestation due to the expansion in crop land is a major problem faced by tropical rain forest biomes.
      e.g. Amazon Basin, Congo Basin, Southeast Asia

    - In some areas desertification has occurred due to the expansion in cultivated area. This occurs in grassland areas.
      e.g.   Regions South of Sahara desert in Africa

    - The aquatic biomes are adversely affected by the use of insecticides and chemical fertilizers in agriculture.

- The biodiversity of tropical rainforests have been adversely affected by deforestation due to logging.

- Biomes are facing problems due to air pollution and water pollution caused by various industries. Taiga biomes have been adversely affected by acid rains.

- Oceanic biome encounter problems created by the extraction of petroleum in oceans. Mining accidents have caused destruction to plant and animal life. The accident took place in 2010 in the Gulf of Mexico is an example. Oceanic biomes face problems due to fisheries and sea transportation also.

- The development activities like the construction of highways, too, create problems to biomes. The various development activities taking place in the Amazon Forest are examples.

Natural Disasters

Biomes encounter various problems due to natural disasters such as volcanism, earthquakes, Tsunamis, Floods, Droughts, Land Slides, Cyclones etc.

Teaching – Learning Activities

1. Group the students in the class. Give each group a biome type and provide opportunity for each group to present the characteristics and problems faced by the biomes given to them.

   Ask them to prove the facts with pictures as much as possible.

11.2   Distribution and Characteristics of Environmental systems of Sri Lanka

An environmental system is a natural or man-made unit comprising a set of interconnected biotic and abiotic components. Sri Lanka is an island with an extent of 65,610km^2 located in the tropical zone. Although, no striking variability could be seen in climate, due to the temperature and being an island, a regional variation could be seen in environmental systems.

A Guideline to Clarify the Subject Matter

- Environmental Systems in Sri Lanka
  Four major environmental systems could be identified in Sri Lanka:

  -        Forests
  -        Shrubs
  -        Grasslands
  -        Wetlands

  Forest Environmental System
  Three types could be identified in the forest environmental system:
  1. Tropical Rainforests
  2. Evergreen Forests/Tropical Dry Mixed Evergreen Forests
  3. Montane Forests
  (See, Vegetation Zone Map, National Atlas Atlas of Sri Lanka (School Edition) 2015, p. 69).

Tropical Rainforests

- Belong to the Tropical Rainforest Biome type of the World. Has distributed in the lowland and mid-country wet zone. *Sinharaja, Kanneliya, Dediyagala, Nakiadeniya, Renakanda, Rammale* are examples.
- Distributed over about 8% of the total land area of Sri Lanka.
- These forests have been identified as a region where biodiversity is very high.

- Climate
  - Rainfall is between 2500 – 5000 mm.
  - It spreads throughout the year. Maximum rainfall is received in the months from May to September.
  - Temperature is around 27^{0}C, spread throughout the year.

- Vegetation
  - Plant diversity is high and they are evergreen.
  - About 100-140 endemic plants could be seen.

- Broad leaves with ------------------points that allow water flow

- Leaves of the plants in the ground layer is broad since the penetration of sunlight is low.

- A plant stratification could be seen and Tree trunks are straight.

- The emergent layer is at a height of 35-45 m.
  Hora, Duna and Bedi Del are dominant trees.

- Canopy layer is at a height of 20-25 m.
  Etamba, Domba, Keena, wal Del, Dawata, and Milla are dominant trees.

- Understory is at a height of 10-15m.
  Kitul, Diyapara, Godapara, Karanda are major trees.

- Shrub layer is at a height of 3 m.
  Major plants are Bamboo and Cane

- Accessibility to the forest is difficult due to the thick undergrowth.

- Ascending plants
  Rasaknda, Weniwel, Cane, Orchids are examples

- Animal species
  - Leopards, Reptiles, Birds, Snails and Insect species
  - 74% of the endemic animals of Sri Lanka are living in these forests.

Evergreen Forests (Tropical Dry Mixed Evergreen Forests)

- Distribution
  - Has distributed in 3/5 of the total land area in Sri Lanka.
  - Found in the Dry Zone and in a limited area of the Wet Zone of Sri Lanka (inclusive of national parks of *Ruhuna, Yala* and *Uda Walawa*). Spread in the northern, north-western and South-eastern regions of Sri Lanka).

- Climate
  - Annul rainfall is between 1250-2000mm.
  - A high temperature around $30^0C – 35^0C$ spread throughout the year.
  - Transpiration is high.
  - A drought period during May to September.

- Vegetation
  - A plant community adapted to the variability in rainfall is found.
  - Leaves fall during the drought period; rapid growth in the rainy season.
  - No stratification; plants are at a distance from each other..

- Height of plants is about 15-20m.
- Biodiversity per unit of land is relatively low.
- Plant crowns are mostly flat.
- Undergrowth of shrubs due to the penetration of sunlight.
- Epiphytic and ascending plants are low in number. Trees such as *Kolon, Milla, Wewarana*, Ebony, Satin, Teak, and *Kohomba* are grown well.

- Animal species
  - Elephants, monkeys, migrant birds, Moose, Deer, Leopards Wild Boar

Montane Forests

- Distribution
  - Distributed in areas with an elevation of 1200m from sea level.
    Pidurutalagala, Bopaththalawa, Kikiliyamana, Samanola, Knuckles

- Climate
  - Annual rainfall is over 3500mm. Spread throughout the year.
  - Temperature is around 20^0C -24^0C with diurnal and annual variability.
  - Seasonal strong winds.

- Vegetation
  - Plant diversity is low.
  - Thin leaves covered with wax and an epidermis.
  - Trees are not so tall (10-15m). At an elevation about 2000m they are much shorter (8-10m).
  - No stratification; Wide gap exists between trees.
  - Plant crowns are flat.
  - Twisted and studded trees due to strong winds.
  - Parasites such as orchids, mosses, lichens, are widespread on tree trunks. Ferns are abundant.
  - Plants like *Keena, Wal Sapu, Damba*, Montane cane varieties are abundant.

- Animal species
  - Quadruped al animals like Deer, Moose, Wild Boar and various types of lizards and birds

Scrub environmental system

- Distribution
  - Has distributed in the areas like Mannar, Puttalam, and Hambantota belonging to the semi-arid zone of Sri Lanka

- Climate

    - Annual rainfall is less than 1200mm. However, in most areas it is between 800-1000mm.
    - Receives a temperature as high as 30^0C.
    - A drought period from March to September.
    - Soil becomes dry quickly.

- Vegetation

    - Plants have adapted themselves to arid conditions.
    - Height of trees is between 3-6 m.
    - Plants are thorny and with thick leaves.
    - Plants with water storing capacity are widespread. Their root system has spread over a wide area.
    - Trees such as *Palu, Weera, Mahakaramba* are found. In bushes grown intermitantly *Andara, Eraminiya, Kukul Katu, Cactus, Ranawara, Komarika, Navahandi, Daluk* etc. are found.

- Animal species
    Wild buffalo , Wild boar, Peacock and bird varieties.

Grassland environmental system

- Distribution
    - The major vegetation type in Sri Lanka which does not belong to forests is grasslands.
    - On the basis of relief and climate four major grassland systems could be seen.

    1. Wet *Patana* Grasslands
        - These are distributed in Horton Plains, Seetha Eliya, Sandatenna, Agarapatana, Ambewela, and Kandapola located at an elevation over 2000m.
        - Dominant plant is grass. Scrub plants (*Maharatmal*) are also seen.

    2. Dry *Patana* Grasslands
        - Could be seen in areas at an elevation between 500-1000m. Uwa Basin, Rakwana area close to Sinharaja, Bandarawela and Welimada mountain areas are examples.
        - Rainfall is low.
        - At present non-endemic plants have been cultivated in these areas.

3. *Damana* Grasslands (*talawa*)
   - Distributes in lowland dry zone areas such as Gal oya, Polonnaruwa, Maduru Oya etc.
   - *Mana* (tall-grass) and *Iluk* are dominant grass varieties.

4. *Villu*
   - Could be seen in water-logged lowland areas during the rainy season. Distributed in in areas such as Somawathi, Manampitiya, Wilpattu National Park etc.

- General features of the vegetation
  - Dominant plant is grass.
  - Dwarf trees and shrubs could be seen intermittently.

- Animal species
  - Monkey, Moose, Wild Boar, reptiles and birds

Wetland Environmental System

According to the Ramsar Convention, wetlands are areas of marsh, fen or peatland or water, weather natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tides does not exceed six meters.

41 of the wetland sites in Sri Lanka are of international significance.

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                        Wetlands in Sri Lanka
                   ┌───────────────┴───────────────┐
                Natural                          Artificial
          ┌────────┴────────┐
     Freshwater        Brackish water
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Freshwater	Brackish water	Artificial
• Inland reservoirs • Rivers and Streams • Fresh water marshes • Floodplains • Villu	• Delta • Mangroves • Lagoons • Floodplains • Seaside wetlands • Brackish water wetlands • Coral Reefs	• Salterns • Constructed Reservoirs • Agricultural land (paddy Fields) • Quarries
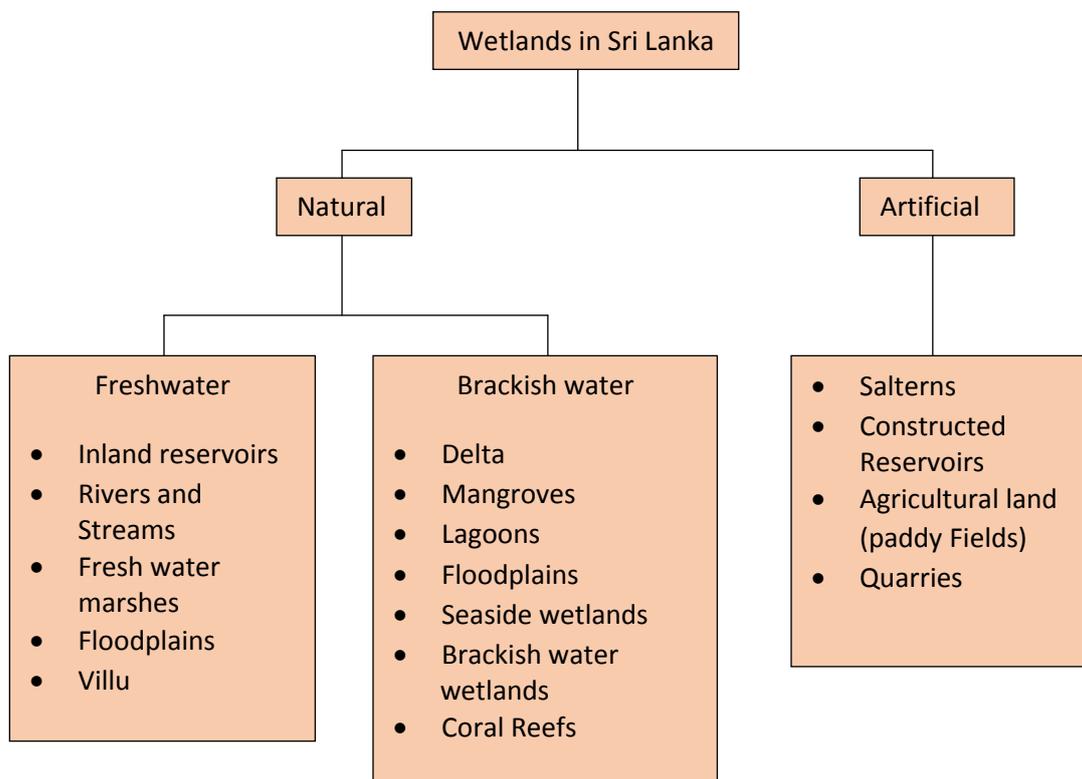
- Freshwater Wetlands
    - Floodplains and *Villu*

        Located adjacent to river valleys and between highlands. They are waterlogged due to intermittant inundation. *Vanathavillu* adjacent to *Mee Oya, Kala Oya* and *Mahaweli* valley are examples.

    - Freshwater Marshes
      Due to the existence of ground water, springs, water seepage, or floods these marshes are constantly wet.

    - Swamps

        Woody plants are seen in deep water.

        "Walawwewatte Waturana" swamp has drawn world attention.

- Brackish water
    - Lagoons and estuaries

    - Mangroves, grass layers in proximity to sea and deltas. E.g. Puttalam, Jaffna, Batticaloa and Negombo lagoons.

    - Low-lying marshes : Grasses tolerant of salt water and brackish water

    - Due to the intrusion of tidal water bushes are grown. E.g. Muthurajawela swamp.

    - Tidal flats

        These are known as salty marshes or fens. Could be seen in low lying coastal areas such as Mundel, Bundala and Trincomalee

- Artificial wetlands
    - Associated with irrigation tanks and canals.

    - Vegetation ranges from scrubs of grass to trees

- Vegetation
    - Mangroves are the dominant plant communities associated with wetlands. A large number of mangrove types of the world are found in Sri Lanka.
    - They have firmly adapted to the environment.
        * To encounter wind and water dynamics plants are equipped with buttress roots.
          e.g. *Punkanda, Mal Kadol, Katu Ikili, Maha Kadol, Kirala, Gin Pol*
        * Viviparity (in some mangroves)
    - Existence of flowering woody plants and bushes
      e.g. sea grasses (in Negombo, Mandathivu, Konesapuram, and Mannar Bay)
    - Plants such *as Alocasia, Kekatiya, Era, Midella* etc. are found.

- Animal species
  - A large number of both resident and migrant birds are seen.

    e.g. Poru Kedatta, Comorant (Punci Diyakawa), Ali Mana Koka and other storks, aquatic birds.

  - Migrant Birds:

    Caspian Seagull
    Rajasiyakkaraya

  - Fish (living in freshwater and brackish water)

    Kawatiya, Prawn, Lobster

Problems faced by Environmental Systems of Sri Lanka

- Deforestation is a major problem encountered by the environmental systems in Sri Lanka. In the year 1900 the Sri Lanka's forest cover was 70%. By 1920 it declined to 49% and in 2005 it was as low as 20%.

- Human activities have been responsible for problems associated with environmental systems in Sri Lanka.

- In the wet zone, the demand for land created by population pressure has threateningly affected the forests.

- The expansion of villages and towns has taken place in the vicinity of forested areas.

- The wet zone plants and wild life have been threatened by gene robbery and export of genes.

- Illicit logging – Land has been severely eroded in the bordering areas of *Sinharaja* forest.

- Use of wood as a fuel

- Illicit gemming within mountain environment systems e.g. Kehelgamu Oya and Ratnapura

- Establishment of settlements and construction of reservoirs

- Wetlands being used for filling and construction work without paying due attention to their significance.

- Destruction of mangroves due to human activities
  e.g. prawn culture and tourism industry

11.3   The Concepts and Ethics related to Environmental Conservation in Sri Lanka

A Guideline to Clarify the Subject Matter

Conservation of Environmental Systems

The role played by the environmental systems in the sustenance of water and soil resources and maintaining the environmental balance is enormous. In meeting the needs of the people, environmental systems are utilized in various ways. Environmental resources are widely utilized in the production of energy, agriculture, forestry and in various manufacturing industries and tourism industry.

The environmental balance hitherto existed has been disrupted due to the over consumption of resources associated with the rapid increase in population. At present, the destruction of environmental systems has become a major problem in Sri Lanka. Environmental conservation is the process that could be adopted by man himself in order to encounter those adverse consequences and protect environment. The meaning of environmental conservation is the rational use of environmental resources in meeting human needs.

Measures that have been adopted in the Conservation of Forests

The government has taken measures in the following two areas:

- Development of environmental-friendly attitudes among the people in forest conservation activities
- Enforcement of laws related to destruction and use of forests

- **Enactment of various Laws**
    1. Forest Act of No. 16 of 1907
        -       This is the earliest measure related to forests. Enacted with a view to protecting Crown Forests. It was amended in 1995 as Forest Act of No 25. The Protected Forests were declared and boundaries of forests were changed by that Act. It was declared that it is illegal to enter a protected   forest and do any harm.

    2. Wild Life and Vegetation Protection Act of 1937.
        -       Objective was to conserve wild life and vegetation in Sri Lanka.

        -       Authority to declare any region as a prohibited area or interim zone.

    3. National Environmental Act of 1980
        -       The Central Environmental Authority was established under the Act.

- It was provided with the authoritative power by an amendment made in 1988.

- It was amended again in 2000.

- For any activity or development project concerning the environment a license should be obtained from the Authority.

- The Act provides the opportunity for protecting forests and wild life, sustainable use of natural resources, controlling fisheries activities, soil conservation, maximum productivity in land use.

4. National Heritage Forest Sites Act of 1988
   - The Act entrusted the Minister of Environment with the power to declare forest lands of value.

   - It is prohibited to enter a National Heritage site without permission or indulge in any activity that cause destruction to environment.

   - It is a punishable offense to contradict law.

   - The Act could take over any property even though it does not belong to the state.

5. Export Laws
   - By the Circular No. 03/2001, the Ministry of Environment has introduced laws concerning the export of materials relating to forests.

   - There is an Annex describing the prohibition of exports.

Establishment of Protected Forests and Wild Life Reserves

Wild life reserves are few types:

1.	Strictly Protected Areas.	-	*Hakgala, Yala* (Central) *Ritigala*
2.	Nature Reserves	-	*Thrikonamadu, Minneriya, Giritale, Floodplains, Hikkaduwa* Coral Garden, River Basins
3.	National Parks	-	14 National Parks including *Wilpattu, Yala East*, *Wasgamuwa, Bundala, Uda Walawa*, Horton Plains.
4.	Sanctuaries	-	28 locations including Victoria, *Randenigala, Rantambe,Anavilundawa, Muthurajawela and Chundikulam.*

(Please see, National Atlas of Sri Lanka School Edition, p. 73).

Environmental Concepts and Ethics in Sri Lanka

Sri Lanka is endowed with socio-cultural characteristics molded by a multi-religious environment led by Buddhism. Every religion discusses environment and the relationship between man and environment.

- Every religion has emphasized the significance of protecting the environment inclusive of forests and wild life.
- Any measure that would disrupt the balance of the environment is harmful.
- This is why most countries in the world adopt various measures to upheld environmental concepts and environmental ethics.

Teaching- Learning Activities

1. Display of pictures and videos of Sri Lanka's environmental systems.

2. Field Trips
    Divide into groups and collection and presentation of reports by groups on various environmental systems of Sri Lanka, or,

    A presentation with the aid of computers

3. Ask students to make a wall chart with pictures depicting the nature of vegetation (using the throw away boards) in environmental systems in Sri Lanka. Group the students and provide them with various environmental systems.

Competency : **12.0 Examines how natural hazards impact the physical and human landscape.**

Competency Levels : 12.1 Explains the difference between natural hazards and disasters

12.2 Explains natural hazards of the world

12.3 Reviews human and physical impacts of world's natural hazards

12.4 Examines the human activities that intensify natural hazards

Learning Outcomes :

- Describes natural hazards
- Describes natural disasters
- Explains the major natural hazards of the world with examples
- Describes the damage caused to the physical environment by natural hazards
- Describes the damage caused to the human environment by disasters
- Presents with examples how human activities contribute to intensify the natural hazards

Periods : 26

Introduction : Natural hazards and disasters could be identified as major problems at present. It is necessary to differentiate hazards from disasters. Hazards have been in the world since the origin of life on the earth. However, there was no adequate understanding of the process or their impacts among the people in those days. Often, there were mythical beliefs relating to them. In contrast, with the development in science and technology at present, man has acquired an understanding about the changes taking place in the environment and their impacts.

In different parts of the world various natural hazards occur. When these hazards are activated and damage the property and affect human life they are called disasters. Among them, earthquakes, Tsunami, thunderstorms, cyclones, floods and avalanches are of significance. In addition, there are disasters caused by human activities, too. Sometimes, natural disasters

are intensified by human activities. As such, it is of importance to study how a natural hazard becomes a disaster and the physical process involved. Due to the ignorance or their unavoidability, the natural hazards transformed into natural disasters exert a tremendous impact on human life and physical environment. This could result in the disruption in day to day life and environmental balance. As such, it is opportune to be informed about natural hazards and disasters. Your attention is drawn to that in this chapter.

A Guide to Clarify the Subject Matter

12.1   Natural Hazards and Disasters

Hazard   :   A natural phenomenon that could result in damage to property and environment could be considered as a natural hazard.

Disaster   :   Activation of a hazard causing destruction to human life, property and environment is a disaster.

Sometimes, a hazard or a disaster could occur due to human activities.

12.2   Natural Hazards in the World

Classification of natural hazards:
Natural hazards have been classified according to various criteria.

1. By zones and Nature

    i.   Multiple hazards   :   Tsunami with earthquakes; Depressions and Cyclones and Floods
    ii   Hazards occurring in specific regions
                                      Earthquakes, Volcanic eruption, Tornado, Avalanches
    iii   Natural disasters that could occur in any area:
                                      Cyclones, Lightning, Floods

2. Classification of natural hazards by field of occurrence

    i   Geological hazards   -   Earthquakes, Tsunami, Volcanoes, Land slides

    ii   Meteorological Hazards   -   Cyclones, floods, Lightning, Drought, Avalanches

iii Biological Hazards   -   Wild fires

Earthquakes

- Earthquakes are special natural phenomena that occur widely in specific regions such the boundaries of the tectonic plates.

- In an Earthquake a sudden jerk or shock along the boundaries of the tectonic plates occur due to the sudden emission of the energy stored in earth's crust.

- Although the regions where earthquakes would occur have been identified, even the developments in science and technology are still unable to predict when and where the earthquakes would strike.

- The impact of the disaster vary with the strength of the earthquake. Depending on the density of population and the concentration of functions where the earthquake would occur the hazard might become a disaster and its intensity will increase.

Cyclones

- A **cyclone** is a rapidly rotating storm system characterized by a low-pressure center, strong winds, that produce heavy rains. They occur in the tropical zone.

- Cyclones could also be described as a phenomenon that causes a temporary change in the normal weather conditions that exists in a particular region.

- Cyclones are called by different names in different regions:

  - Northern Indian Ocean Region   -   Cyclone
  - Northern Pacific Ocean Region   -   Typhoon
  - Northern Atlantic Ocean Region   -   Hurricane
  - South of the Philippines   -   Bagio

  Also, there are two types of winds that occur for a short period of time;
  - Northern Australia   -   Willy Willis
  - Around the Caribbean   -   Tornado

- Generally, 80 – 100 cyclones occur in a year in the tropical zone.

- Cyclone, a multi-hazard phenomenon, results in heavy rains, floods, ocean surge etc. and cause destruction to life and property.

Drought

- Drought is the shortage of water caused by the unexpected lack of rainfall over a long period of time.

- Drought, a widespread disaster in the world, could be identified in three types:

    1. Meteorological drought created by insufficient rainfall or inadequate supply of water, its nature is determined by the intensity and duration.

    2. Agricultural drought   -   Attention is on the effects of meteorological drought on agricultural activities. Deficiency in soil moisture is a feature.

    3. Hydrological drought   -   Decline in the water levels of rivers and reservoirs and decrease in the ground water level few months after the meteorological drought.

- A drought hazard could become a disaster for following reasons:

    1. Over- utilization of ground water (water use in dry areas through tube wells, agricultural wells, etc.).

    2. Inadequate water storage facilities and their poor maintenance in low rain areas.

    3. Existence of drought for a longer period will adversely affect the water supply, especially for domestic use and the ground water level.

    4. Irregular and over-consumption of water.

    5. Cultivation of high water absorbing crops.

Lightning

- Lightning may be defined as the occurrence of a natural electrical discharge of very short duration and high voltage between a cloud and the ground or within a cloud, accompanied by a bright flash and typically of thunder.
  As such, lightning occur through different methods:
    • Electrical discharge from a cloud to the ground (CG lightning)

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- Electrical discharge between clouds (CC Lightning)
- Electrical discharge between a cloud and the space (CS Lightning)

  - Among them, CG lightning results in accidents on the earth surface.

  - In a lightning bolt between 20,000 – 30,000 amperes are contained and the amount of voltage nearly 1 billion.

  - Lightning and thunder is associated with the high altitude Cumulo-nimbus clouds developed under warm and humid unstable atmospheric conditions.

  - Hazards could occur due to lightning in any part of the world.

  - The hazardous lightning could become a disaster due to following factors:
    - Remaining in open spaces and travel in open vehicles
    - Use of electrical appliances during lightning occasions
    - Remaining in high altitude locations
    - Remaining in places near water bodies or indulge in unsecure activities like swimming during lightning occasions

Tsunami
- A Tsunami occurs when a suddenly upsurged ocean water sheet burst on to the coast as a gigantic wave.
- A natural phenomenon, Tsunami affects only the specific areas of the world. Tsunami occurs due to a number of reasons:

  1. Earthquakes that occur in the bottom of the oceans
  2. Volcanic eruptions taking place in ocean bottoms
  3. Meteors that fall on the ocean surface

- Of them, earthquakes have been the most common reason for Tsunami in the recent past.

- When the ocean floor at a plate boundary rises or falls suddenly, it displaces the water mass above it and launches the rolling waves that will burst on the coastline as gigantic sea waves.

- At the deep ocean the speed of the wave is about 800 km per hour but its height is very much low. At the coastline its speed could be 50 km per hour but the height could be as high as 30 m.

- The Tsunami hazard, due to number of reasons, will become a disaster.

  1. Lack of knowledge about Tsunami or how to respond in a tsunami situation
  2. Removal of plant cover in coastal areas

3. Unauthorized constructions in coastal areas
4. Lack of preparedness

Floods

- A widespread disaster in the world, the floods could occur in various ways.

    1. Floods in the river valley areas when the water level of the river channel increases
    2. Floods, especially in urban areas that occur due to the obstruction of water ways
    3. Floods due to sea invasions during cyclones and high tides

- The Mississippi, Hwang Ho, Ganges, etc. are the rivers where flood hazard widely occurs.

- Floods, a natural phenomenon is being transformed into a disaster by man himself.
- Land filling in low lying areas adjacent to rivers; lack of knowledge about disasters; poverty; unauthorized constructions etc. contribute to intensify the flood disaster.

- Economic activities in river banks contribute strongly to floods.

Wild Fires

- A disaster that occurs due to natural or human activity in natural forests could be described as wild fires.

- Wild fires occur due to:
    1. Magma flows caused by earth movements
    2. Ignition caused by rubbing of dry trees with one another
    3. Lightning

- Wildfires could occur due to earthquakes.
  Areas in tropical and temperate zones with dry climatic conditions are the places where wildfires occur widely. New South Wales State in Australia, California in the United States Alberta in Canada could be cited as examples.

Avalanche
- Masses of snow are formed in high latitude areas and mountain peaks due to very cold conditions. When they fall from high areas it is called an avalanche.

- Avalanches could occur due to a change in temperature or the impact of gravity.

- These accidents take place mostly due to the activities causing climate change (emission of greenhouse gases, volcanic eruptions, industrialization, sun's rays, etc.)

Volcanoes

- Volcanoes are formed when hot liquid magma in the earth's interior emits on to the surface through weak places or vents in the crust.

- It has been revealed that magma in the interior of the earth comes out to the surface along the boundaries of the tectonic plates and form volcanoes. There are four main zones of volcanic activity in the world.
    1. Circum-Pacific Zone (Ring of Fire)
    2. Mediterranean-Himalaya Zone
    3. Mid-Atlantic Ridge Zone
    4. African Rift Valley Zone.

- Volcanoes emit lava or ash and they are deposited on the surface or interior of the earth.

- Volcanoes are of tree types according to their behavior:
    1. Active Volcanoes
    2. Sleeping Volcanoes
    3. Dead Volcanoes

- Of the active volcanoes about 65% are in and around the Pacific Ocean.

- The establishment of settlements and maintenance of economic activities in areas closer to volcanoes would intensify the effect of the disaster.

Landslides

- A landslide could be described as a rapid downward movement of a mass of rocks, soils and other material in mountain slopes or areas of steep slopes with loose soils due to the gravity.

Landslides occur due to physical factors as well as human activities:

Physical factors:
    1. Intensity of rainfall   5. Geological composition
    2. Earthquakes   6 Soils and ground water
    3. Nature of rocks   7. Rock weathering
    4. Gradient of slope

Human activities

1. Improper land use
2. Obstruction of natural water ways
3. Storing water in highland
   -         areas
4. Destruction of forests
5. Mining
6. Explosions

- Reasons for landslide accidents to become disasters

  Establishment of settlements, constructions and maintaining agricultural activities in slope areas.

  Non-adherence to laws due to ignorance

  Unpreparedness

- The island of Haiti, Brazil, Chile, China etc. can be cited as examples for countries with large numbers accidents due to landslides.

12.3 Impact on the physical and human environments due to natural disasters

Since the impact of disasters on physical and human environments are generally similar, the attention is focused only on the impacts of two disasters in this section. The impact of other disasters should be explored accordingly.

Landslides:

Physical impact
- Change in the physical landscape of mountain regions due to collapse of hills
- change in the pathways of springs, drying up of springs and emergence of new ones
- Destruction of forests
- Change in soil structure
- Probability of floods

Impact on human environment
- Damages to houses and property
- Destruction of agricultural land
- Destruction of infrastructure facilities
- Shortage of drinkable water due to the collapse in drainage and water supply

Tsunami

Physical impact
- Change in coastal landscape; coral reefs and islets could be destroyed.
- Soil becoming infertile due to the intrusion of saline water to coastal soils
- Destruction of natural beauty of the coastal environment

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Impact on Human environment
- Destruction of human life, houses and property
- Destruction of infrastructure facilities
- Collapse of the economic activities in coastal areas such as fisheries and agriculture
- Emergence of social and psychological problems

12.4 Human activities that intensify natural hazards

How human activities intensify hazards and disasters

Natural hazards cannot be prevented. What could be done is to minimize their impact. Nevertheless, instead of minimizing the impacts of disasters man has been intensifying their impacts. In other words, they have increased the probability of transformation of a hazard into a disaster. A number of human activities is responsible for this situation:

- Improper land use
- Improper constructions
- Industrialization

Improper Land Use

Many natural hazards have become disasters due to the improper land use by man. If settlements are established in an area vulnerable to accidents it is improper land use. Also, in agriculture, attention has been only on cultivation and its ease. No attention is being paid to the environmental problems arising from such cultivation practices. Among the problems arising from improper land use the following are noteworthy:

- Cultivating on steep slope areas/cultivation of unsuitable crops (tobacco) result in landslides.
- Floods due to siltation with eroded soils from slopes
- Drying up of springs due to deforestation leads to droughts
- Damming of waterways to construct reservoirs leads to rise in soil water and landslides
- Unauthorized constructions in river mouth areas
- Reclamation of lowlands

Improper Constructions

With the increase of population, houses and infrastructure facilities are being constructed on unsuitable lands without obtaining advice from geologists and engineers. Disasters are intensified due to such constructions as houses, highways and other buildings made without environmental impact assessments. Such instances are:

- Occurrence of landslide accidents due to construction of highways and buildings without paying attention to slope gradient of the land

- Occurrence of floods due to the constructions built on filled lowlands which were absorbents of excess water

- Occurrence of floods and landslides due to application of inappropriate and poor technology in the construction of reservoirs and dams

- Occurrence of droughts and landslides due to development projects that destroy forests

- Construction of non-accident resistant and technologically inappropriate buildings in earthquake and Tsunami-prone areas

- Absence of lightning conductors on tall buildings located in areas prone to lightning accidents.

- Construction of houses/buildings with non-resistant roofs in areas with strong winds

Industrial Activities

- Occurrence of disasters like drought, landslides and floods due to the destruction of forests necessitated by the construction of factories in large numbers with rapid industrialization

- In planning cities and highway systems associated with industrialization constructions were made obstructing natural waterways resulting in land fillings in lowland areas and floods

- Spread of epidemics caused by poisonous gases, solid waste and polluted water emitted by factories associated with industrial activities

- Various problems created by the emission of poisonous gases into the environment by the increasing use of motor vehicles

- The intensity of the natural disasters could be increased due to the population pressure, road congestion etc. associated with industrial activities

Deforestation

- Intensification of drought conditions due to the drying up of springs and destruction of water catchment areas associated with deforestation.

- Disasters like landslides could occur due to increased soil erosion.

- Occurrence of floods due to the siltation of waterways.

- Occurrence of disaster situations to wildlife due to the loss of their habitat associated with deforestation

Activities

1. Prepare a report on two recent disasters of the world with their year of occurrence, location and impacts.

2. Display the physical and human impacts of disasters other than lanslides and Tsunami in a Table.

Competency	:	**13.0**	**Acts with positive attitudes that help in maintaining and conserving the physical and human landscape**

Competency Level : 13.1 Pro-actively contributes to disaster management in Sri Lanka

Periods : 12

Learning Outcomes :
- Describes what is meant by disaster management

- Presents information on disaster management mechanism in Sri Lanka

Introduction : Although a hazard becomes a disaster naturally, human intervention is necessary to manage it in order to minimize its impact. The extent of the nature of human intervention determines the extent of a hazard becoming a disaster. Different regions of the world face different types of disasters and the intensity of their impacts also differ. Also, how a disaster will be managed would vary by regional differences and the nature of the disaster. Since Sri Lanka has become a country facing various disasters the disaster manage management has become important. Accordingly, it is expected in this unit to discuss Sri Lanka's disaster management process and related issues with examples.

A Guideline to Clarify the Subject Matter

13.1 Disaster Management in Sri Lanka

- It was during the International Decade for Natural Disaster Reduction (1990s) [that Sri Lanka paid attention to disaster management.

- The establishment of the Cabinet Sub-Committee on Disaster Management in 1995 was an important milestone.

- With the National Disaster Preparedness and Mitigation Act the National Disaster Preparedness and Mitigation Plan was introduced.

- The establishment of the National Disaster Management Centre under the Ministry of Social Services and Women's Affairs was another milestone.

Disaster Management

"Prevention of the causes of disasters and assist people to make necessary plans, prepare models for action and their activation, control and maintenance

in order to minimize the effects of disasters and emergency situations" could be stated as disaster management.

The Disaster Management Centre of Sri Lanka and its functions

- It was after the Tsunami disaster of 2004 that attention was paid to the risk of disasters in Sri Lanka. Accordingly, the Disaster Management Centre which was under the Ministry of social Services and Women's Affairs was assigned to a separate Ministry and made a priority area of attention.

- Implementation of a programme prepared with the participation of 21 members from all parties.

- Introduction of a legal framework for disaster risk management in 2005

- Enactment of the Sri Lanka Disaster Management Act in May 2005

- Establishment of Sri Lanka Disaster Management National Council on 13th May, 2005

- Establishment of the Disaster management Centre under a Director General in June 2005

- Relocation of the DMC within the newly established Ministry of Disaster Management and Human Rights.

- Among its objectives, the prevention and minimization of human, physical and economic deprivations faced by any nationality, society or individuals is of significance.

- The Disaster Management Centre is important in the recovery of the affected as soon as possible.

- The Organizational Structure of the Disaster Management Centre is shown below:

Organizational Structure of the Disaster Management National Council

Social Services		Police
Rehabilitation and Recreation		Finance
Housing		Land
Health	Chief Ministers / Members of the Opposition	Fisheries & Aquatic Resources
Science and Technology	Ministry of Disaster Management & Human Rights	Water Supply
Coast Conservation		
Irrigation		Urban Development
Energy	Disaster Management Centre	Education
Security		Environment
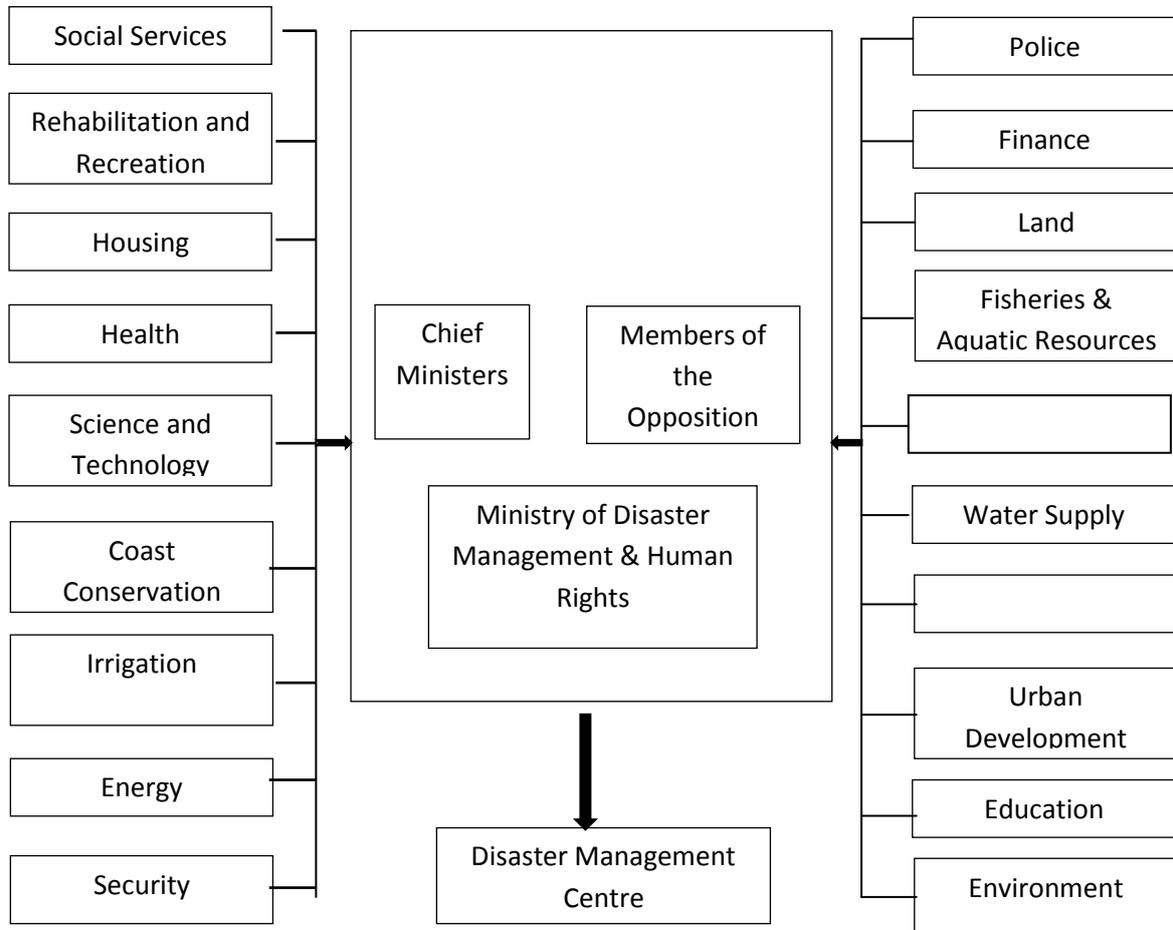
Source: Road Map for Disaster Risk Management, DMC, Colombo, December, 2005

- In the intervention for minimizing the impact of disasters, the Central Government gets the assistance of Provincial Councils and Local Government institutions.

- A few institutions from which the assistance is sought frequently in disaster management are cited below with their functions:

  - Geological Survey and Mines Bureau (GSMB)
    - Connected to the international and regional earthquake early warning system

    - Issuing of permits for mining of mineral resources

  - National Aquatic Resources Research and Development Agency (NARA)
    - Being vigilant of data provided by bathymetrical equipment located around the island

- Provision of information on disasters to vulnerable fishermen and fishing Communities
- Being vigilant of sea storm conditions

- Department of Meteorology
    - Provision of information on disasters such as Tsunami, cyclones, storms, invasion of coastal areas by sea as soon as possible and making predictions about them
    - Forecasting of disaster situations
    - Obtaining of active services within 24 hours

- Divisional Secretariats
    - Evacuations and rescue
    - Provision of safety camps and food
    - Rehabilitation and renovations
    - Provision of health and welfare facilities
    - Management and coordination of disaster management work

- It is the function of the Disaster Management Centre to launch Disaster Management process by coordinating the activities of the above mentioned institutions.

Disaster Management Cycle

- Different countries adopt different approaches in disaster management.
- Sri Lanka used to provide social services through relief measures prior to the Tsunami disaster
- With the incidence of the Tsunami disaster in 2004 Sri Lanka government enacted the Disaster Management Act and the Disaster Management Centre was given more powers.
- It has introduced a common management strategy to identify and manage each and every disaster occurring in Sri Lanka.
- It has paid attention to the reduction of risks, minimization, preparedness, and to the ability to absorb the impacts of disasters and to the capacity of the organization to implement policies, strategies and administrative decisions.

Preparedness

- Implementation of a systematic programme that enables identification of the causes of disasters, prediction of disasters, and equip people to respond and live with disasters

  Examples:
  - Before the occurrence of a landslide it is necessary to possess an ability to identify any change in weather or physical landscape

  - Such identification would enable people to face the disaster with strength

  - It makes possible to prepare programmes that would minimize the Risk

  - Implementation of programmes that makes people informed
    - Prepare a package of essential goods and keep it for use in an emergency situation
    - Listen to media/listen to warning signals

Response

Provision of security to people affected by the disaster and preparation of programmes to assist in the provision of relief services are done at this stage. Response could vary according to the nature of the disaster.

Example: Landslides
- Warning and rescuing
- Ensure safety
- Provision of medical services to affected people
- Evacuation of physical properties if possible
- Provision of temporary housing and food
- Assessment of the damage
- Efficient coordination

Recovery

While orienting the community to a new situation by minimizing the risk of the disaster, making decisions and their implementation in order to bring back the living standards of the affected people to the previous conditions or to a better condition take place at this stage.

This has to be taken into account in the formulation of development plans also.
Example: Landslide
- Implementation of a programme in order to recover the physiological and mental health conditions of the affected people

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- Implementation of programmes to re-construct the damaged houses and infrastructure facilities, temporarily or permanently
- Taking measures to improve the living condition of the affected community to a better level than it was before (provision of facilities for economic activities)

Mitigation

By mitigation, it is expected to minimize the vulnerability to disasters by suppressing hazards and creating peoples' abilities. In the disaster management cycle, the measures taken to mitigate disasters are connected to preparedness stage also. Therefore, the measures taken in both stages are included here. There are few approaches to mitigate the disaster risks.

- Before the disaster risk
    - Assess the risk
    - Installation of early warning systems
    - Familiarization of instruments used to mitigate the risk
    - Implementation of preparedness programs for mitigation
    - Make people aware and community participation
    - Strengthen the institutions

- Disaster Stage
    - Warning and Rescuing
    - Emergency measures
    - Strong coordination mechanism

- Post-disaster
    - Assess disaster damage and introduce solutions
    - Make awareness
    - Proceed with development work

Teaching –Learning activities
1. Select a disaster that affects Sri Lanka as an example and discuss how it is managed according to the disaster management cycle.
2. With reference to a disaster that affects Sri Lanka explain the role of the Disaster Management Centre.

Competency : **14.0 Acts with proper understanding of the earth and its inhabitants to promote symbiotic relationships between nature and society**

Competency Level : 14.1 Examines the role of international and regional environmental organizations

14.2 Examines the role of environmental organizations in Sri Lanka

Periods : 12

Learning Outcomes :
- Reviews and presents information on international and regional environmental organizations
- Discusses the contribution made by the environmental organizations in Sri Lanka

Introduction

At present, the world is facing a number of acute environmental problems and the intervention of man has aggravated their intensity. Also, these problems cannot be solved by a single country alone. The environment is common to the whole world and its problems, too, are common to the whole world. The world has to face the impacts of these problem together.

With development and population growth environmental problems have become severe and their intensity have been further increased by political factors. This has led the countries of the world to establish organizations with common objectives. As such, instead of trying to solve problems individually they are making efforts to solve them collectively. In Sri Lanka, too, many such organizations have been established and as a country, Sri Lanka is a member of many environmental organizations. Here, attention is focused on a few such organizations and their functions.

A Guideline to Clarify the Subject Matter

14.1 International and Regional Environmental Organizations

- United Nations Environmental Programme (UNEP)
    - United Nations Environmental Programme was established as a result of the United Nations first conference on Human Environment convened in Stockholm, Sweden in 1972.

- This organization, headquarters of which located in Nairobi, Kenya, functions in collaboration with other UN organizations as well as with other countries and non-governmental organizations.

- The priority of the organization is to ensure the accuracy and timeliness of the scientific data and make them available to the decision makers.

- Following the publication of 'Our Common Future' by the International Commission on Environment and Development under the chairmanship of Gro Harlem Brundtland, Prime Minister of Norway in 1987, the United Nations Conference on Environment and Development (Rio Conference/Earth Summit) was organized.

- In the publication 'Our Common Future', attention is focused on the protection of environment and the relationship between economic development and environment.

- The United Nations Conference on Environment and Development was convened in Rio de Janeiro, Brazil from 01st to 14th of July, 1992.

  - It was a conference participated by a largest number of leaders of the Nations representing 172 countries of the world.

  - The theme of the Earth Summit was 'Environment and Sustainable Development'.

  - A number of publications emerged from this conference:

    1. Agenda 21
    2. Rio Declaration on Development and Environment
    3. Declaration on the Principles of Forests
    4. United Nations Framework Convention on Climate Change
    5. United Nations Framework Convention on Biodiversity
    6. Protection of the Rights of the Indigenous People

As per above publications the function of the Earth Summit could be divided in to three sectors:

1. Protection of the environment that enables every human to face a stable future and take steps to ensure an alignment between environment and economic activities.

2. Aggregation of people with a view to orienting the future of the mankind to a new path

3. Sustenance of the quality of the environment and creation of an environmental friendly permanent development in every country (e.g. protection of the atmosphere, protection of Earth's resources).

-   After deliberations for number of days the Earth Summit introduced two protocols under the title 'Agenda 21' that each and every country should adhered to. Two of the important agreements contained in that were:

    -   All parties should agree to prevent the incidence of greenhouse effect caused by gases emitted to the atmosphere and human activities responsible for the emission of such gases into the atmosphere in order to prevent climate change.
    -   All parties should agree to secure biodiversity through the protection of animal and plant species and prevent all activities that destroy biodiversity.

-   The United Nations Environmental Programme, has divided its functions in to 11 sectors such as creating awareness about environment, control of desertification, etc.

-   UNEP has decentralized its functions to regional centres located in Bangkok, Mexico City, Kingston, Bahrain, Geneva and Athens.

-   UNEP is in charge of five Secretariats handling a few special subject areas:

    1. Harmful Chemical materials   -   Geneva
    2. Industries and Environment   -   Paris
    3. Control of the transportation of harmful waste across boundaries and their disposal   -   Geneva
    4. Convention of the Trade of endangered organisms   - Geneva
    5. Convention on Migrant animals   -   Bonn

International Union for Conservation of Nature (IUCN)

-   The first international Organization on Environment, the IUCN was located at its   headquarters at Fontainebleau in France in 1948.
-   Later, its headquarters was moved into the city of Gland in Switzerland.
-   Major functions of IUCN are as follows:

    1. Ensure sustainable development through proper maintenance of the potential of renewable resources for the benefit of present and future community

2. The conservation of natural resources through protection and management of land and oceans with no special protection and maintenance of many plants and animal species in specific numbers
3. Protection of lands and saline water and freshwater areas where representative and specific flora and fauna communities are found
4. Formulation of strategies to protect such flora and fauna ensuring that they will not face the threat of extinction.
5. Functioning in wider range relating to the atmosphere
6. Acting to fulfill the objectives of international conventions
7. Ensure the implementation of regional and state policies by respective governments

- IUCN also implements special projects such as conservation of specific animal species, conservation of plants, wetland conservation and management of protected areas with special reference to environment.

- IUCN publishes newsletters, magazines and the Red Data Book annually, bi-annually and monthly.

- IUCN provides aid to Sri Lanka in the form of technical assistance to the Department of Forest Conservation to study the types of bio-diversity in the physical environment of Sri Lanka and conservation of medicinal plants.

United Nations Framework Convention on Climate Change (UNFCC)

- This is an agreement made at the United Nations Environment Conference.
- This convention was enforced in June 1992.
- By 2015, there were 197 parties.
- Parties of the convention meet annually and the meeting is called the Convention of Parties (COP)
- The main objective of the UNFCC is to bring the amount of Greenhouse Gases to a stable level.
- No restrictions are imposed on any country on the emission of greenhouse gases and they have been provided with the opportunity to decide on the emission of such gases by them.
- However, at the Kyoto Conference, UNFCC has imposed restrictions on the emission of greenhouse gases by the developed countries.
- At the conference held in Cancun, Mexico, instructions have been provided on the control of global warming.
- At the Paris Conference in 2015, discussions have been made on the restriction of the emission of greenhouse gases.

South Asia Co-operative Environmental Programme (SACEP)

- Established in 1982 as a regional environmental organization it has a membership of 8 countries.

- The headquarters of the organization is located in Colombo, Sri Lanka.

- SACEP functions as the Secretariat of the South Asian Seas of the United Nations Environmental Programme also.

- This works in collaboration with international organizations such as South Asia Coral Reef Task Force.

- The organization has identified 15 subject areas and they have allocated among the member countries as follows:

1.	India	-	Formulation of laws, Education and Training
2.	Iran	-	Energy, Responsibilities and Environmental Quality
3.	Bangladesh	-	Mangroves, Deltas and Coastal Areas
4.	Nepal	-	Tourism Industry
5.	Pakistan	-	Environmental Systems and Community Forestry
6.	Sri Lanka	-	Environmental Impact Assessment, Analysis of Cost-Benefits
7.	SACEP	-	Desertification and Regional Seas (as a whole)

Teaching-Learning Activities

This could be organized either as a group or an individual activity.
Preparation of an information leaflet on three selected international environmental organizations

1. United Nations Environmental Programme (UNEP)
2. United Nations Framework Convention on Climate Change (UNFCC)
3. International Union for Conservation of Nature (IUCN)

It is expected to prepare the leaflet on above organizations according to the headings given below:
- Objectives/Role of the organization
- Details on the programmes implemented
- Role of Sri Lanka

14.2   The Role of Environmental Organizations functioning within Sri Lanka

Central Environmental Authority (CEA)

-   The Central Environmental Authority, the main institution that formulate environmental policies and strategies of Sri Lanka and coordinates various relevant institutions was established by the provisions of the National Environmental Act No. 47 of 1980.

-   The main responsibility of the authority is to focus attention on environment in the planning of development activities and provide information on natural resources and environment.

-   It was approved, to be implemented since 1984, that all government and private sector development projects should   prepare an environment impact assessment and it should obtain the recommendation and approval of CEA.

-   "The National Conservation Strategies" published by the CEA in 1988 is very important. In that the attention has been paid on how to minimize the environmental impacts of development.

-   In order to implement the Authority's activities island wide it has established 25 District Environmental Agencies.

-   When natural resources are adversely affected, it is the function of the Authority to obtain information on such instances and act accordingly.

-   This institution also implements programmes through various methods to make people aware of the importance of the environmental protection.

-   It is a primary function of the authority to provide an environmental education and create awareness in order to produce a population who are conscious of the environment.

-   CEA has established a National Environmental Investigation Bureau. It collects and maintains environment related data and information.

-   Creation of an information and data system needed from time to time is also done by this institution.

National Aquatic Resources Research and Development Agency (NARA)

-   NARA was established by the Act. No. 54 of 1981 with a view to developing, coordinating

of management affairs and research on aquatic resources of Sri Lanka.

- The main activity of the institution is to act on the problems arising in the Exclusive Maritime Economic Zone of Sri Lanka.

- The management, development and research on aquatic resources of Sri Lanka are carried out by NARA.

- It is a primary task of the institution to obtain assistance of the technical experts in the implementation of national development programmes related to biotic and abiotic aquatic resources.

- Provision of advisory services in relation to scientific, technical and legal aspects of the management of aquatic resources overuse, conservation and development and coordination of activities of other related institutions are also done by NARA.

- Collection, dissemination and publication of data and information relating to the fisheries industry in Sri Lanka and the development, conservation and management of aquatic resources also done by NARA.

- Collection, processing, and publication of hydrological data of deep and shallow seas around the island and internal reservoirs as well as naval information and conducting training programmes with a view to developing the human resources in all above sectors are done by NARA.

Coast Conservation Department (CCD)

- **B**eing an island nation, Sri Lanka's coastal zone is of much environmental and economic significance. In legal terms, coast is defined as the area extending 300m inland from the mean high-water level and 2 km toward sea from the mean low-water level.

- It was after 1963 that attention was paid on coast conservation. Prior to that activities related to coast conservation was carried out by various departments. In 1963, because of the importance of coast conservation a separate division was established under the Colombo Port Commission.

- In 1978, the portfolio of coast conservation was assigned to the Ministry of Fisheries and under the provisions of the Coast Conservation Act No. 57 of 1984 the Department of Coast Conservation was established.

- In the Amended Act No 64 of 1988 also, the objectives and activities relevant to coast conservation have been elaborated. Accordingly, a few Coast Conservation Plans have been presented.
    1. The Master Plan of Coast Conservation and Management, 1990
    2. Coast Conservation Plan, 1992
    3. Coast Conservation Plan, 1997
    4. Coast Conservation Plan, 2004

The functions of the Department of Coast Conservation are given below:

- Issue of permits for activities associated with the coastal area
- Formulation of national coastal region management plans
- Implementation of management activities in specifically selected areas
- Regulation of sand mining and coral mining
- Inspection of coastal region environmental activities
- Inspection of coastal region engineering activities
- Construction of coast protections
- Implementation of coastal security measures during disaster situations
- Implementation of education programmes related to coast conservation

National Building Research Organization (NBRO)

- This institution was established in 1983 within the Ministry of Disaster Management.

- NBRO is a multi-sectoral institution and has been divided into 6 scientific divisions.

    - Landslide Studies   - Geo-technology
    - Environmental Studies   - Human Settlements
    - Building Material Research   - Project Management

- Landslide studies include mapping of landslide regions, identification of landslide hazard, analysis of the risk of landslides, stabilization of the mountain slopes where landslides occurred and early warnings.

- Environmental studies encompass examination of the quality of water and air, measurement of noise and vibrations, environmental management, conduct of workshops and training programmes and control of environmental pollution.

- Geo-technology covers the investigation of terrain and soils, and the supervision of building construction.

- By the Building Materials research Division, the quality of concrete, conformity of steel rods, and the quality of clay, bricks, tile and cement products are examined.

- The Human Settlements Division studies the risk management and environmental impacts associated with human settlements.

- The Project Management Division, examines the architectural designs, structural engineering plans and water supply needed for building construction and prepares necessary estimates. It also prepares quality assessment reports on both new and old buildings after the analysis of their structural stability.

Geological Survey and Mining Bureau (GSMB)

- Geological Survey and Mining Bureau is an institution actively engaged in the investigation, study and regulation of geological surveys and mining.

- It is a semi-government institution established in March 1993, under the provisions of the Mines and Mining Materials Act No. 33 of 1992. Until 1993, it has been remained as the Department of Geological Survey.

- It has two Divisions, namely, the Geology Division and the Mining Division. They have been entrusted with te following main functions:

    1. Preparation of Geological Maps pertaining to Sri Lanka. (Cartography Unit).

    2. Collection of basic geological data necessary for the identification of mineral resources found in the land of Sri Lanka and make them available for detailed analysis and development of mineral resources and encouragement of their sustainable use. (Geo-physical Laboratory)

    3. Investigation of minerals, marketing, transportation and regulation of exports and act to obtain royalty (Permits and Processing)

    4. Advise the Minister in Charge on the development of mineral resources

    5. Observation of risks of natural disasters like earthquakes within and around Sri Lanka and contribution to geo-engineering project activities (Earthquake data and Tsunami Observation Centre)

Competency	:	7.0	Examines the trends in mining industry and explains the necessity of using Mineral resources sustainably

Competency Level	:	7.1	Studies the distribution, production, trade, problems and trends in the world Mining industry

Time Periods	:	14	

Learning Outcomes :

- Defines mining industry
- Explains the world distribution of petroleum, coal and iron with the help of maps
- Describes the petroleum related industries and products
- Explains the nature of world trade in petroleum
- Describes the world production of coal and associated industries
- Describes the nature of world trade in coal
- Describes the characteristics associated with the production and trade of world's iron ore
- Explains the trends associated with the world's mining industry
- Explains the problems associated with the world's mining industry

Introduction : Industries of the world could be divided into two categories: manufacturing and extractive. The production of goods using raw materials and other factors is called manufacturing industry. Extractive industry is the mining of minerals deposited in the earth. Mining is an extractive industry.

Mining of coal, iron ore, petroleum, natural gas limestones, gems, dolomite, mica etc. could be cited as examples for mining industry. It is expected from this unit to study the distribution, production, trade, trends and problems of some selected mining industries.

A Guideline to Clarify the Subject Matter

Evidence suggests that the mining industry has been in existence for more than thousand years ago. Later, with industrial growth there was a rapid development in the mining industry.

Mining is carried out in two ways:

- Surface mining

  Method of obtaining minerals deposited on the earth surface or closed to the surface or on slopes. e.g. Mining of pebbles, clay, sand, laterite, granite coal.

- Underground mining

  The process of extracting minerals that are buried far underground. E.g. mining of iron ore, coal, gold, petroleum etc.

Petroleum

This is a source of energy widely used in the world. Petroleum reserves are deposited in association with the sedimentary rock layers. The extracted crude oil are consumed as petrol, diesel and kerosene after refining.

- As a source of energy petroleum is used to activate machines, automobiles, and the production of electricity. In addition, a large number of by-products such as tar, chemical fertilizer, lubricant oils, plastics and creams are produced from petroleum.

- There are a few advantages of petroleum as a fuel. It is relatively light-weight. No residuals after burning. Could be transported easily since it is a liquid. Domestic use is easy.

Distribution

- Petroleum is not distributed everywhere in the world.

- Of the petroleum reserves discovered to date, more than half is found in countries of the Middle East.

- The petroleum reserve in the Middle East is more than that of all other areas of the world.

- The other countries where petroleum reserves can be found are Canada, Venezuela, USA, Russia, Libya, China, Nigeria and Kazakhstan.

Trade

There are a few salient features in the petroleum trade.

- Although USA, China and Canada are major producers they are not major exporters.

- The major petroleum exporting countries are (in 2014):

Country	Export Value ($ million)	Country	Export Value ($ million)
Russian Federation	153.9	Kazakhstan	53.6
Canada	88.1	Norway	45.5
UAE	75.4	Mexico	35.9
Nigeria	75.0	Oman	34.8
Kwait	69.3	United Kingdom	28.9

Source: http://www.gsmlondon.ac.uk

- The major petroleum importing countries are (2014):

Country	Import Value ($ million)	Country	Import Value ($ million)
United States	253.2	Germany	65.7
China	228.3	Netherlands	46.6
India	135.8	Spain	44.3
Japan	130.7	France	38.9
South Korea	95.0	Italy	38.5

Source: http://www.gsmlondon.ac.uk

- USA and China, the major petroleum producing countries are also the major petroleum importing countries.

- World petroleum production and trade is controlled by a few major companies:

Royal Dutch Shell	-	The Netherlands
Saudi Aramco	-	Saudi Arabia
British Petroleum	-	Britain
Exxon Mobil	-	USA
Total SA	-	South Africa

- Some organizations have been established with a view to maintaining a monopoly in Petroleum trade. E.g. The Organization of Petroleum Exporting Countries (OPEC).

- The demand for petroleum is increasing rapidly. Especially, there is a rising demand from the developing countries, too.

Coal

A fossil fuel, coal is formed by the decay of plant matter. When the decayed plant matter lay in between rock layers for long period of time thick layers of carbon are formed. Geologists assume that coal was formed during the Carboniferous era about 300 million years ago.

Coal is grouped into four major types:

Anthracite	(Carbon content is over 90%)
Bituminous	(Carbon content 60% - 80%)
Lignite	(Carbon content 45% - 60%)
Peat	(Carbon content (20 – 45%)

Distribution

- Over 95 per cent of the coal reserves are distributed in the northern hemisphere. China, USA, India, Australia, Russia, Indonesia and South Africa are major producing countries.

- In addition to those countries Germany, Poland, Kazakhstan, Turkey, Colombia, Ukraine, Greece, Canada and the Czech Republic, too, produce coal.

Four major areas could be identified in the distribution of coal.
1. Central and Eastern regions of North America
2. Northwest Europe
3. Russian region
4. East Asian region

(Direct students to identify the regional distribution of coal using maps)

Table 7.1
Coal Production of the World, 2015

Country	Production (million tons)
China	3,747.0
USA	812.8
India	677.5
Australia	484.5
Indonesia	377.3
Russia	392.0
South Africa	352.1
Germany	184.3
Poland	135.5
Kazakhstan	106.5

Source: http:/www.wikiwand.com/en/coal/coal Industry

Trade

- According to data for the period 2003 – 2012, the four major coal exporting countries of the world were Indonesia, Australia, Russia and USA (Table 7.2).

- According to data for the period 2006 – 2010, the major importers of coal were Japan, China, South Korea, and India (Table 7.3).

- During the period 2008 – 2013, the world trade in coal grew rapidly. There was a conspicuous decline in col trade in 2014. The major reason behind that was the decrease in imports by China.

Table 7.2   Export Trade in Coal 2003 – 2012 (million tons)

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Indonesia	107.8	131.4	142.0	192.2	221.9	228.2	261.4	316.2	331.4	421.8
Australia	238.1	247.6	255.0	255.0	268.5	278.0	288.5	328.1	313.6	332.4
Russia	41.0	55.7	98.6	103.4	112.2	115.4	130.9	122.1	140.1	150.7
USA	430	48.0	51.7	51.2	60.6	83.5	60.4	83.2	108.2	126.7
Colombia	50.4	56.4	59.2	68.3	74.5	74.7	75.7	76.4	89.0	92.2
South Africa	78.7	74.9	78.8	75.8	72.6	68.2	73.8	76.7	75.8	82.0
Canada	27.7	28.8	31.2	31.2	33.4	36.5	31.9	36.9	37.6	38.8
Kazakhstan	30.3	27.4	28.3	30.5	32.8	47.6	33.0	36.3	33.5	35.2
Mongolia	0.5	1.7	2.3	2.5	3.4	4.4	7.7	18.3	26.1	24.3
Vietnam	6.9	11.7	19.8	23.5	35.1	21.3	28.2	24.7	19.7	21.1
China	103.4	95.5	93.1	85.6	75.4	68.8	25.2	22.7	27.5	15.2
Poland	28.0	27.5	26.5	25.4	20.1	16.1	14.6	18.1	15.0	14.9
Total	713.9	764.4	936.0	1,000.6	1,073.4	1,087.3	1,090.8	1,212.8	1,286.7	1,413.9

Source: http:/www.en.m.wikipedia.org/wiki/coal

Table 7.3   Import Trade in Coal (million tons)

Country	2006	2007	2008	2009	2010
Japan	199.7	209.0	206.0	182.1	206.7
China	42.0	56.2	44.5	151.9	195.1
South Korea	84.1	94.1	107.1	109.9	125.8
India	52.7	29.6	70.9	76.7	101.6
Taiwan	69.1	72.5	70.9	64.6	71.1
Germany	50.6	56.2	55.7	45.9	55.1
Turkey	22.9	25.8	21.7	22.7	30.0
United Kingdom	56.8	48.9	49.2	42.2	29.3
Italy	27.9	28.0	27.9	20.9	23.7
The Netherlands	25.7	29.3	23.5	22.1	22.8
Russia	28.8	26.3	34.6	26.8	21.8
France	24.1	22.1	24.9	18.3	20.8
USA	40.3	38.8	37.8	23.1	20.6
Total	991.8	1,056.5	1,063.2	1,039.8	1,178.1

Source: Source: http:/www.en.m.wikipedia.org/wiki/coal

Iron Ore

- The rock that contains metallic iron is called iron ore. Of the total production of iron ore in the world about 95 per cent is used for the production of iron and steel.

- The iron ore which has the least content of iron is Siderite. Its iron content is only about 48%. The iron ore that contains the highest proportion of iron is called Hematite.

- Iron and steel are the basis of many industries.

Distribution

- Although deposits of iron ore could be found in many countries, the commercially utilizable high quality iron ore are distributed only in a few countries.   Among them, China ranks high and other major countries of iron ore production are Australia, Brazil, India and Russia.   Ukraine, South Africa, USA, Iran and Canada also are iron ore producing countries.

- The areas where iron ore has distributed could be identified as zones, too.

  - Great Lakes Region in North America

- o   Shanxi Region in China
- o   South Swatow in Brazil
- o   Hammersley Range in Australia
- o   South Wales, the Midlands valley, Sheffield and Birmingham in Great Britain

The major iron ore producing countries of the world are shown in Table 7.4.

Table 7.4   World Iron Ore Production - 2014

Country	Production (million metric tons)
China	1,500
Australia	660
Brazil	320
India	150
Russia	105
Ukraine	82
South Africa	78
USA	58
Iran	45
Canada	41

Source: hhtp://en.m.wikipedia.org/wiki/iron/ore

Trade
- The major iron ore exporting countries are Australia, Brazil, South Africa, Canada and India.

- Of them, Australia and Brazil rank high.

- The major iron ore importers are China, countries of the European Union, Japan, South Korea and Taiwan.

- A salient feature of the iron ore trade is the rapidly increasing demand.

Table 7.5 Iron Ore Exporting Countries - 2016

Country	Value (billion US$)	Percent of total exports
Australia	39.5	55.0
Brazil	13.3	18.5
South Africa	3.6	5.0
Canada	2.9	40
Ukraine	2.3	3.2
Sweden	1.6	2.2
The Netherlands	1.1	1.5
India	1.0	1.4
Iran	0.83	1.2
Chile	0.82	1.2

Source: hhtp://en.m.wikipedia.org/wiki/iron/ore

Trends in mining industry
- Major countries in iron ore production in the early period losing their position and new industrial countries becoming the leaders.
- Tendency to extract even low quality metals
- Decreasing significance of mineral ore areas as a factor in the location of industries
- Use of modern technology and mechanization
- Depletion of mineral resources and emphasis on alternative resources as a conservation strategy

Problems associated with the mining industry

At present, various problems have emerged in the mining industry. They are:
- Increasing depth of mines
- Increasing number of accidents associated with mines
- Decreasing demand for human labor
- Environmental problems
- Increasing production costs
- Conflicts between states as well as companies and local people

Mining industry is essential for continuation of the world economy. However, it is clear that there are many problems associated with the mining industry. A basic solution for them would be adopt measures to continue the mining industry in a sustainable manner. The technology used in production, minimization of the adverse effects of the mining industry on environment, increase the level of efficiency in the production process, make the consumption more austere, are some the some of the measures that could be taken make the mining industry sustainable.

Competency	:	**8.0**	Examines the value of mineral resources in the economy of Sri Lanka and explains the importance of their sustainable use

Competency Level	:	8.1	Examines the distribution, production and trends in the mineral resources in Sri Lanka
		8.2	Emphasizes the importance of mineral resources in the economy of Sri Lanka
		8.3	Acts to minimize environmental impacts arising from the exploitation of mineral resources in Sri Lanka

Time Periods : 24

Learning Outcomes :

- Defines mineral resources

- Presents with the help of a map the distribution of selected mineral resources of Sri Lanka

- Explains the production and trends of selected mineral resources of Sri Lanka

- Describes the importance of mineral resources as industrial raw materials

- Examines with the help of data the contribution of mineral resources to Sri Lanka's national development

- Describes using data mineral resources related employment

- Explains the contribution of mineral resources to Sri Lanka's regional development

- Describes the environmental impacts resulting from the exploitation of mineral resources in Sri Lanka

- Proposes measures to mitigate the environmental impacts arising from mineral resource exploitation

Introduction : Mineral resources and their associated activities have acquired a significant place in the economy of Sri Lanka. A considerable contribution has been made by the extraction of mineral resources employing modern technology and the production of various goods. Although various types of minerals are found in Sri Lanka their use in local production activities is low. As such, in addition to the export of mineral resources just as raw materials exporting

them as value added secondary products would be of more significance to the national income.

The increase in the exploitation of mineral resources will result in their depletion and environmental damage. It is expected from this unit to study the significance and distribution of mineral resources of Sri Lanka, and how to minimize the environmental impact of their use with a selected number of minerals.

A Guideline to Clarify the Subject Matter

8.1   Distribution, Production and Trends in the Mineral Resources of Sri Lanka

Introduction to Mineral Resources
- Minerals, originated from one or by the association few elements, become a resource when it is used for a certain economic activity.

- Sri Lanka is rich in industrial minerals but energy minerals are scant.
  A few mineral resources in Sri Lanka:
    Graphite
    Mineral Sands
    Apatite

Graphite

- Graphite is a form of naturally created crystalline carbon.

- Graphite industry in Sri Lanka has a long history.

- Since graphite in Sri Lanka possesses a carbon content as high as 99 per cent its economic value is high.

- In Sri Lanka, the type that is mined mostly is the graphite located as large veins along the natural cleavages of rocks.

- In Sri Lanka, a type of graphite formed as chips is also found. They are called Mica.

Distribution
- The vein graphite type is distributed in Central, Sabaragamuwa, Southern, North Western and North Central Provinces. In the Districts of Kandy, Badulla and Matale, Mica is distributed.

- Some of the functional graphite mines in Si Lanka are Bogala, Kahatagaha and Ragedara. At present, the extraction of graphite from these mines has been mechanized.

Table 8.1 Production of Graphite in Sri Lanka (metric tons)

Type \ Year	2010	2011	2012	2013
Vein Graphite	3,437	3,357	4,137	3,143
Mica	2,095	2,927	1,260	1,493

Source: Sri Lanka Minerals Year Book, 2014.

- Graphite is mineral resistant to high temperature.

- Pencil sticks, explosives, moulds, lubricants, paints, hearths, batteries are products manufactured with graphite.

- Mica chips are used in the production of electrical appliances and in electronic industry.

- As an industrial raw material graphite is used in small quantities locally. Almost all Mica production is exported. (In 2013, local use of graphite was only 38 metric tons.

Table 8.2 Sri Lanka - Export of Graphite (major countries)

Country	Quantity (m.t)	Value (US $)
Japan	1,247	1,396,100
USA	638	1,133,599
German	562	665,241
Chez Republic	360	362,758

Source: Sri Lanka Minerals Year Book, 2014.

Table 8.3   Sri Lanka – Export of Mica (major Countries)

Country	Quantity (m.t)	Value (US $)
Japan	1,048	602,420
China	455	12,570
India	453	169,987
Russia	224	103,500

Source: Sri Lanka Minerals Year Book, 2014.

Recent Trends

- High cost of production due to increased depth of mines

- Private sector playing a major role in the mining industry of Sri Lanka

- Tendency to mechanize the mining operations

- 99 per cent of the extracted amount is exported.

Mineral Sands

- Mineral sands are a highly valuable mineral.

- Due to the rarity of the chemical elements found in the major components of mineral sands namely Zircon (Zr), Titanium (T), Thorium (Th), Tungsten (W), they have a high value.

- The mineral sands in Sri Lanka is mainly concentrated in the sea sands in the coastal areas.

- The following minerals are found in the mineral sands of Sri Lanka:

Ilmenite	(about 70-72%)
Rutile	(about 8 %)
Zircon	(8 – 10%)
Silimenite	(about 1%)
Monazite	(about 0.3%)

- The deposits of mineral sands of high value are distributed in Pulmoddai, Kaikawala, Polkotuwa, and Kudiramale.
- The Pulmoddai Ilmenite deposit is considered as a high quality deposit of mineral sands in the World. It has been identified that the titanium mineral found in the Pulmoddai deposit is not found in other mineral sand deposits.

Distribution

- The Pulmoddai Ilmenite deposit has finely concentrated in the Northeastern coastal of Sri Lanka.
- It is about 10 km in length and 100 meters in width.
- Similar three such deposits have been found at Nayaru, Pudawaikattu, and Nevikallu between Mullativu and Nilaveli.
- Other utilizable mineral sand deposits are distributed in Induruwa, Beruwala and Kelani river estuary area, North of Negombo, Kudiramale and Mannar.
- Furthermore, Garnet sands are found in the coastal area from Dondra to Hambantota.
- It has been computed that the quantity of coastal mineral sands deposits is about 60 million metric tons.

Production

- Although the mineral sands are used locally a vast majority of them are exported.

Table 8.4   Sri Lanka – Production of Mineral Sands

Mineral Sand	2012	2013
Ilmenite	40,118	44,129
Rutile	1,590	1,749
Zircon	293	323

Source: Sri Lanka Minerals Year Book, 2014.

- Monazite is used in steel production as a metal mix.
- Mineral sands in Sri Lanka are mainly utilized to extract titanium metal.
- The titanium metal is utilized in aircraft production, and for fixing colors on TV screens.
- Titanium is also used to make colors on computer monitors and X-ray screens and to add brightness to them.

Trends

- In the recent past due to the unfavorable security situation there was a disruption in the production of mineral sands. Now the situation has been rectified.

- Due to the application of new techniques the employment of human labor has decreased.

- Since a modern technology is being applied to extract titanium, the demand for ilmenite has increased tremendously in the recent past.

- Although the use of mineral sands in the industrial sector in Sri Lanka has increased in the recent past the bulk of the production I still exported.

Apatite

- In 1971, the Department of Geological Surveys of Sri Lanka discovered a phosphate deposit contained in apatite rocks.
- In this deposit, about 32-37% of Phosphorous Pentoxide, a dehydration agent, is found. In certain areas, it is as high as 70 per cent.
- By grinding this rock phosphate fertilizer could be produced.
- Phosphate possesses a high economic value.

Distribution

- The apatite deposit is located at Eppawala, near Talawa in the Anuradhapura District.
- Distributed in an area of 7 km^2, the total reserve of this deposit is about 60 million metric tons.
- This has depth about 12 meters from the surface of the earth.

Production
- The Phosphate production consists of four functions.
  - Breaking down of Apatite in to blocks
  - Separation of Phosphate
  - Grinding (jaw crushers are used)
  - Milling (Roller Mills are used)

- Production is done by the Sri Lanka Phosphate Company. It produces two types of fertilizers.
  - **HERP** (High Grade Eppawala Rock Phosphate 38% P205)
  - **ERP** (Eppawala Rock Phosphate 28% P205)

- Current Production is used for,
  - Fertilizer production
  - Ink production
  - Production of drugs, etc.

Table 8.5 Phosphate Production in Sri Lanka

2010	2011	2012	2013
47,778	58,254	47,558	49,106

Source: Sri Lanka Minerals Year Book, 2014.

Trends

- The fertilizers produced at present are used mainly for long-term crops (Tea, Rubber, Coconuts)
- In recent times the income generated by fertilizer production has increased rapidly.
- The government has imposed certain limitations for the export of Phosphate.

In addition, Granite and Gneiss rocks, which are widely found minerals in Sri Lanka are also used in various industrial activities.

8.2   The significance of Minerals in the Economy of Sri Lanka

- Mineral resources have made a considerable contribution to the economy of Sri Lanka.
- Instead of exporting as a raw material it would be more economic if minerals could be developed and export in the form secondary products.

Significance of Minerals as an Industrial raw material

- Certain productions made combining locally produced minerals with imported raw materials.

    Example: Asbestos industry.

- Using Kaolin as a raw material few major companies are engaged in the production of ceramic ware. Examples: Dankotuwa Porcelain and Lanka Wall Tiles Ceramic ware, Wall tiles, Sanitary ware, Pottery and ceramic insulators, ornamental products etc.

- Silica is an important raw material used in the production of glassware widely used locally.

- Mineral resources while being consumed locally are utilized as a foreign exchange earner also. E.g. Gems, Graphite, Mineral sands.

Employment Associated with Mineral Resources of Sri Lanka

- It has opened a source of employment in the primary sector as well in the secondary sector.

- Mineral resources such as Clay, Limestones, Gems, Graphite, Mineral Sands, Silica, River Sand, and Apatite are utilized in industrial activities and It has been estimated that they provide around 400,000 employment opportunities, both direct and indirect.

- With the production of goods within the country itself it is possible to increase employment opportunities. It would be a solution to the unemployment problem in Sri Lanka.

The Contribution of Mineral Resources to Regional Development in Sri Lanka
- The mineral resources in Sri Lanka shows a regional distribution. The production process generated by the utilization of mineral resources results in regional development.

- By extracting and using them in manufacturing industries regional development could be accelerated

- Through the extraction of mineral resources people in these region could enjoy a favorable economy and social service facilities.

Contribution of Mineral Resources to National Development of Sri Lanka

- The data for past several years indicate that mining sector has vastly contributed to the Gross National Product.

Table 8.6   Contribution of Mining to Gross National Product of Si Lanka (Rs. million)

Year	2003	2004	2005	2006	2007
Mining	25,523	30,123	35,932	46,202	56,645

Source: Central Bank of Sri Lanka,2007

- A large amount of foreign exchange is earned from Ilmenite, Rutile, Zircon, Garnet, Monazite, etc. which can be extracted easily from the coastal area.

Table 8.7   Foreign Export Earnings from a few Selected Mineral Sands (Rs. million)

Mineral	2010	2011	2012	2013
Ilmenite	561.73	1,497.05	2,999.33	713.31
Rutile	202.53	332.81	1,072	157.73
Zircon	223.04	123.69	161.16	129.92

Source: Sri Lanka Minerals Year Book, 2014.

- In 2007, US$ 136 million were earned from the mineral exports (Of the total, US$ 120 million were earned from gems alone).

- Other than from gems, the amount of foreign exchange earned from other minerals is small. A possible reason may be that they are exported as raw material.

- Japan and the USA are the major buyers of vein graphite of Sri Lanka. The largest amount of mica is purchased by China.

Grade 13 - Geography

Table 8.8 Exports of Vein Graphite of Sri Lanka

Country	2011		2012		2013	
	Quantity (m.t.)	Income (US$)	Quantity (m.t.)	Income (US$)	Quantity (m.t.)	Income (US$)
Japan	1,538	1,457,889	1,640	953,300	1,247	1,396100
USA	658	1,122,265	411	750,843	638	1,133,599
Germany	527	550,187	626	708,274	562	665,241
Chez Republic	-	-	-	-	360	362,758
South Korea	83	152,120	71	237,537	74	247,573

Source: Sri Lanka Minerals Year Book, 2014.

Table 8.9 - Exports of Mica from Sri Lanka

Country	2011		2012		2013	
	Quantity (m.t.)	Income (US $)	Quantity (m.t.)	Income (US $)	Quantity (m.t.)	Income (US $)
Japan	1,237	575,825	1,428	808,925	1,048	602,420
China	1,002	371,609	694	264,634	455	172,570
India	563	192,994	315	129,9363	453	169,987
Russia	-	-	171	90,440	224	103,500
Germany	80	28,816	40	14,412	120	56,175

Source: Sri Lanka Minerals Year Book, 2014.

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8.3 Environmental Impacts of the Utilization of Mineral Resources

- Environment is affected in many ways in the utilization of mineral resources.
- These environmental impacts could be studied under several sectors:
    - Water resources
    - Land degradation
    - Air pollution

Water Resources
- A major problem associated with the mining industry that could be identified in many countries of the world is water pollution.

- In the excavation of minerals small hollows are formed on the surface of the Earth.

- These hollows are filled with water when it rains.

    e.g. Gem Pits

    Gem mining in the adjacent areas of the *Kalu Ganga* affect the drainage in the area.

- Water sources are polluted by the solid and liquid waste disposed in the mineral extraction and production activities.

- Water pollution leads to health problems.

- Flooding, inflow of salt water, lowering of the ground water table causing shortages in drinking water are the other unfavorable effects of mining.

Land Degradation

- Land is degraded by large hollows and heaps of soil created by gem mining and excavation of graphite.

- Gemming in the adjacent areas of rivers has, in some instances, change the course of rivers thereby changing the landscape.

- Minerals like apatite, in many instances, are located in highlands. Due to their excavation large scale hollows are created and highlands have vanished.

- Whatever the mineral, its excavation affects the vegetation cover thereby intensifying soil erosion. This will result in the change in landscape and also in the destruction of natural beauty.

Air Pollution

- On the surface of the earth as well as in the mines air is polluted due to mineral extraction industry.

- Impure and poisonous gases in mines result in the loss of life.

- Environment is polluted through the spread of dust due to extraction of minerals. e.g. air pollution associated with Phosphate production.

- Commuters face difficulties due to air pollution caused by the transportation of minerals without adequate covering.

- Air is polluted due to explosions associated with mining.

Measures that could be adopted minimize the environmental degradation

- Although it is not possible to prevent environmental destruction totally, measures could be taken to minimize the effects. Following techniques could be adopted in that direction:

    - Development of environment friendly attitudes
    - Empowerment of relevant laws and regulations and their implementation
    - Political commitment
    - Obtaining the support of civic organizations

Environment friendly Attitudes

- Keeping away from illegal activities like sand mining, coral mining and gem mining as they cause an enormous damage to the environment.

- Following environment friendly methods even in legal mining operations

    e.g.   Refraining from sand mining at the same site

    closing the hollows after mining

- Tendency to utilize minerals with austerity.

- Development of environment-friendly attitudes pertaining to mining through the inclusion of relevant instructions to school curricula.

Empowerment of relevant laws and regulations and their implementation

In order to create the necessary legal background for utilization of mineral resources and control of related activities in Sri Lanka laws have been enacted.

- Mines and Minerals Act number 33 of 1992
    - According to para 26 of this Act any mineral located in place of Sri Lanka is State property.
    - According to para 34 of the Act, Only the Geological Survey and mines Bureau could issue permits for extraction of minerals and their transportation.

- Permission should be obtained from the Divisional Secretariat for mining sand in river beds.

- Introduction of environmental laws pertaining to the utilization of mineral resources by Mining Regulations No. 1 of 1993.

- Relevant authorities should take necessary steps to empower these acts and regulations

- In the empowerment of above mentioned laws and regulations community also has a responsibility. For example, in the case of illegal sand mining, members of the community could make the relevant authorities aware of the activity.

Political Commitment

- Act to make the people aware of the environmental impact of mining through a political leadership committed to sustainable conservation.

- Inclusion of information on environmental ethics in the policy statements of political organizations.

- The political leadership acting as a model in environmental protection

Obtaining the support of civic organizations

- Incidents taking place make it clear that the active participation and commitment of the civic organizations is essential in the empowerment of laws and regulations pertaining to the prevention of illegal mining in spite of the fact that such laws and regulations exist in abundance.

- Evidence suggests that there has been political backing behind illegal sand mining, gem mining, coral mining and maintenance of quarries. In such instances it is necessary to form environment friendly organizations and act irrespective of politics.

- Development of environment friendly attitudes pertaining to mineral production and consumption by the environmental organizations.

Activity
- Prepare an article on 'The Economic Significance of Mineral Resources in Sri Lanka'.
  to be published in a geographical magazine.

Competency	:	9.0	Examines the factors of industrial location and reviews their trends

Competency Level	:	9.1	Examines with examples the factors influencing world industrial location
		9.2	Describes the contribution of industries to Sri Lanka's economy
		9.3	Examines the factors that have influenced the location of industries in Sri Lanka

Periods	:	26

Learning Outcomes :

- Explains what is meant by manufacturing industries
- Describes with reference to selected industries the factors influencing industrial location
- Explains recent trends in industrial location
- Examines the contribution of industries to the economy of Sri Lanka
- Explains with reference to selected examples factors that have influenced the location of industries in Sri Lanka
- Describes the trends in the location of industries in Sri Lanka

Introduction : In the evolution of human civilization from the beginning to date industries have played an important role. Industry is the production of finished or semi-finished goods to satisfy human needs through the manipulation of natural resources and factors of production using human intelligence.

In the location of industries the factors such as raw material, energy, capital, labor, technology, market, transportation, entrepreneurship and state policies are significant. In the past, the areas where raw materials were found played a major role in the location of industries but, later, the market, energy, and transportation facilities have changed the location. In this unit, it is expected to study the factors of location of industries and their trends. Also, it is expected to direct the teaching learning process through paying attention to the industrial sector in Sri Lanka and its contribution to the economy of the country. Furthermore, it is also expected to study the factors of location and their trends by paying attention to a few selected industries.

A Guideline to Clarify the Subject Matter

Introduction to Manufacturing Industries

- Transformation of a raw material into a finished product is known as manufacturing industry.

- In this process, a value addition is made by mixing one or more raw materials.

- Manufacturing industry has a long history and it has evolved continuously from the beginnings of the human civilization to date.

- It is possible to identify a large number of changes in taken place in manufacturing industries in response to contemporary social requirements.

- Due to the use of machinery in the production process in the industrial sector associated with the industrial revolution in Europe that took place in the 19th century the volume and quality of industrial products increased.

- During the past 200 years a rapid development in industrial sector has taken place.

- At present, in the measuring development industrial sector is taken into account and the development in agriculture and service sectors also have an impact on industrial growth.

- The manufacturing industry in the world has distributed unevenly.

Factors Affecting the Location of Manufacturing Industries

Raw Materials
- Raw materials are important as a primary factor in the location of any industry.

- Basically, raw materials could be divided into two types:
  Agricultural raw material   :   example: Cain Sugar for sugar industry
  Mineral raw materials   :   example: Iron Ore for iron and steel industry

- In the past, industries located where raw materials were available. It was due to the difficulty in transportation. The location of iron and steel industry in the Great Lakes region in the United States of America, and Damodar valley in India are examples.

- In contrast, the iron and steel industry in Japan depends on the imported raw materials. Iron and Steel industry in Japan has located in regions such as Tokyo, Nagoya and Kobe.

- It is apparent that the influence of raw material on the location of industries has changed.

Energy

- The sources that are used to generate power needed for industry is called energy.

- From time to time, different types of energy sources were used in industry. They included, human labor, wood, running water, water vapor, coal, mineral oil, electricity, wind, solar radiation, and nuclear power.

- In the past, industries were located in areas where coal was found in abundance. E.g. Liverpool in the United Kingdom and Pittsburgh in the United States.

- With the depletion of coal attention was focused on alternative sources of energy. Sources of energy have been changing with the use of hydroelectricity, mineral oil, and nuclear power. For example, In Mumbai-Pune industrial area, the energy produced in the Tharapur Nuclear Power Plant is being used in place of coal.

- In the use of energy as a factor of location in industry attention is being focused on their production cost, efficiency and their environmental impact.

Capital

- In the production process the financial and human resources used to transform raw materials and energy into finished products is considered as capital.

- Capital could be classified as physical capital and human capital.

- Financial resources, machinery and tools and buildings belong to physical capital.

  The labor resources with abilities and skills, creativeness, training and competencies is known as human capital.

- Capital is essential for the location of an industry. The investment for an industry is made by individuals, groups of individuals, multinational corporations or the state.

- In market economy countries the investments are made by private entrepreneurs and in the developing countries investments are made by the state.

- In most of the developed countries industries were started by the individuals and companies.

      e.g. Companies in the UK, USA, France, and Germany (BMW, Ford etc.)

- In developing countries the state takes the lead in establishing industries.

- At present, multinational corporations have entered the industrial sector. This has resulted in the growth of industrial sector in the countries in South Asia as well as in Latin America.

Labour

- In the location of industries labour resources are very important. Labour resources could be classified as trained and untrained labour.

- The individuals who have been trained in a relevant industry could be termed as trained labour. Untrained labour are the individuals who have not undergone formal training.

- Industries could be classified as labour-intensive and capital-intensive according to their nature.

- Industries to which more contribution is made by human labor are labour-intensive. E.g. textiles, ship building, air craft construction and production of weapons.

- The industries in which the machinery is used in large scale in the production process are called capital-intensive. E.g. Motor vehicle industry, Iron and Steel Industry.

- Earlier, In the European countries and America, industries were located as trained labor was available in abundance.

- At present, due to the availability of cheap labor, the developed countries are locating their industries in developing countries of South and Southeast Asia, Africa and Latin America. For example, the availability of cheap labor has encouraged developed countries to locate garment, food processing, and other processing industries considered as light industries in the developing countries.

- Labour resources have become an important factor in the location of high-tech industries. These industries are located in areas where scientists, researchers, managers and technicians are available. E.g. Taiwan, Malaysia, Singapore, Thailand, China, Hong Kong.

Technology

- Technology is the methodology applied in a particular process.

- Technology includes abilities and skills of people, techniques adopted, and instruments and tools used.

- Mankind's intelligence, skills and knowledge lead to improvement in technology.

- Advancement in technology is a major factor in the development of industries.

- Industrial revolution is a significant milestone in technological development.

- With the development in technology there have been changes in the effects of factors of industrial location.

- As a result, the industries which had been located on the basis of raw materials have moved to other locations.

- With the development in technology the industries that used human capital largely in the early stages, have transformed themselves into industries largely using physical capital. E.g. Iron and Steel industry.

Market

- Consumers and producers are connected by the market.

- The present-day market is complex and in addition to producers and consumers many other people and factors such as middlemen, companies and advertising constitute the market.

- Market has expanded from local to national, regional and international levels and it has become an important factor in the location of industries.

- With the development in technology the market transactions are carried out through the internet. This has resulted in eliminating the narrow market limits and making the market more open.

Transport

- For an industry, transport is needed to procure raw material and energy resources and send the finished product to the market

- As such, transportation play an important role in the location of industries.

- At present, industries are located at the places where energy resources could be easily obtained and the production cost is least.

- Technology has reduced the time taken for transportation and thereby facilitating the exchange of finished products with any country of the world.

- Accordingly, industries are being located where air, naval and land transportation facilities are available sufficiently.
  e.g. Tokyo in Japan, Chicago, Pittsburgh, Ohio, Philadelphia and Buffalo in the United States

Entrepreneurship

- Enterprise and Entrepreneurs are important factors in the location of industries.

- In the past, rich people started the industries and they were considered as entrepreneurs.

- Later, private entrepreneurs as well as the state enterprise entered the industrial sector.

- At present, the role of entrepreneurship has expanded. Individuals as well groups of individuals and multinational corporations are involved in the industrial sector.

- At present, the multinational corporations' enterprise and their decisions have become significant in the location of industries.

State policies

- State policies are extremely important in the location of industries.

- State policies have an impact on the location of industries by the private sector. However, it is more important in the location of industries by the government.

- Through the state policies on environmental conservation and regional development government influences the location of industries by the private sector.

- The governments have located industries in the Special Industrial Zones, Industrial Estates, Industrial Cities, etc.
  e.g.   Industrial City of Pittsburg in the United States and Tokyo-Yokohama
          Industrial region in Japan.

Recent Trends in the Location of Industries

- Instead of individual enterprises, groups of companies and multinational corporations functioning as entrepreneurs in locating industries.

- Location of high-tech industries in association with universities and research institutes

- Location of industries in an environment friendly manner by adhering to environmental conservation strategies

- In addition to conventional factors of industrial location the increasing importance of information and communication technology

- The current globalization process has changed the influence of the factors of location of Industries

- At present the decisions taken by the multinational corporations are more important in the location of industries.

- Growth in footloose industries

Teaching and Learning Activities

- Presentation of the factors of location of industries with the aid of a concept map

9.2   The Contribution of Industries to the Economy of Sri Lanka

- The industrial sector contributes to the economy of Sri Lanka through different fields. The gross domestic product, employment, foreign exchange earnings, utilization of local resources, growth in infrastructure facilities, regional development are few examples for such fields.

- The contribution of the Industrial sector to the Gross Domestic Product is 32.3 per cent (Annual Report of the Central Bank of Sri Lanka, 2014).

- The share of the industrial sector of the total employment of Sri Lanka is 6.5 per cent (Annual Report of the Central Bank of Sri Lanka, 2014).

- The industrial sector provides 74.2 per cent of the foreign exchange earnings of the country, also (Annual Report of the Central Bank of Sri Lanka, 2014).

    Examples: **Processed Agricultural and Animal husbandry Products**
        Vegetables, Fruits

        Minerals
        Kaolin, Silica sand, varieties of Clay, Limestone

- Development of infrastructure facilities such as railways, highways, electricity, telephone services, and transportation in association with Industrial Plants and Industrial Cities, Industrial Estates and Free Trade Zones.

- Contribution to regional development through decentralization of industries.

- Industrial sector contributes immensely to the economy of Sri Lanka through all above mentioned fields.

Cement Industry

- Cement industry is very important in the economy of Sri Lanka.

- The cement plants at Kankasanturai and Puttalam have been located on the basis of local raw materials and the plants at Galle and Trincomalee depend on imported clinker and gypsum.

- These industries have created a large number of direct and indirect employment opportunities in their regions.

- There is large demand for cement in the local market especially in relation to building and construction industry.

- Cement is an essential raw material for various constructions such as Expressways, Bridges, Fly Overs, Ports, Railways, Housing projects and Apartments.

- Cement is used for the production of ornamental products, landscape beautifying products and cement furniture resulting in the creation of a large number of jobs and a specialized market.

- The demand for timber products has somewhat declined due to the use of cement as a substitute for timber

- Various industries using cement have widely distributed in the rural areas having an impact on regional development.

Sugar Industry

- Sugar cane industry is significant in the economy of Sri Lanka as a local industry.

- In 2014, of the total sugar consumption in Sri Lanka 9.2 per cent was provided by the local sugar industry.

- Direct employment opportunities have been created in the sugar factories at Pelwatte, Sewanagala, Galoya, and Kantale.

- Indirect employment opportunities have been created through the generation of income earning sources for farmers who cultivate sugar cane.

- The fact that only the locally grown sugar cane is used in the production of sugar is a special characteristic.

- Liquor and perfumes are significant as by-products of the sugar cane industry.

- The distribution of sugar factories and sugar cane cultivations in the districts of Moneragala, Ampara, Trincomalee have contributed to the improvement in infrastructure and regional development.

Garment Industry

- A field that makes an active contribution to the economy of Sri Lanka.

- An export-oriented industry.

- Leading supplier of garments at a competitive price to the European Union and the USA.

- Garment industry has recorded a growth rate of 19.7% in 2014.

- Garment industry is fairly distributed within the country thereby contributing to regional development.

- A major export that earns foreign exchange for Sri Lanka. A higher proportion of the total export income is provided by the garment industry.

- The export income from textiles and garments has increased by 10.5 per cent in 2014.

- Garment industry has provided employment opportunities for a large number of people.

- The programmes such as Free Trade Zones, Industrial Cities, and Industrial Parks have greatly facilitated the garment industry. It has contributed to employment creation as well a regional development.

Rubber and Plastics Industry

- Rubber and plastics industries are very important in the economy of Sri Lanka.

- Rubber and plastics industry has grown by 13.6 per cent in 2014.

- Rubber and plastics industry represents 12 per cent of the total industrial products.

- Direct and indirect employment opportunities have emerged in association with this industry (production, distribution and trade in goods).

- The industry has developed using the local rubber latex as well as imported rubber and plastics raw material.

Traditional Handicraft Industries

- From the distant past the traditional handicraft industry has been of importance in the economy of Sri Lanka.

- These industries have distributed in rural areas as well as in special villages.

- A special feature of these industries is the use of technologies transferring from generation to generation.

- This sector has recorded a growth rate of 2.5 per cent in 2014.

- These productions earn foreign exchange also.

- The State, through various Ministries and Departments, has taken steps to for the development of these industries.

- A large number of jobs, direct and indirect, have emerged in association with these industries.

- Since the products of these industries attract tourists there is a tendency to develop the tourism industry, too.

- These industries use local raw materials in large quantities.

- Due to the emergence of specialized markets and creation of employment opportunities it has contributed to regional development also.

9.3   Factors Influencing the location of Industries in Sri Lanka

A large number of factors affect the location of industries in Sri Lanka.
Raw materials, Energy, capital, labor, transport, technology, market, entrepreneurship, state Policies are important among them.

- All these factors do not affect the location of each and every industry in the same manner. In some countries number of factors would be of importance abut in another country one single factor may of significance.

Sugar Industry

- Sugar factories are located at Kantale, Hingurana, Pelwatte and Sewanagala.

- In general, sugar industry is located where raw material could be easily obtained. The underlying reason is that the volume of raw material used is much larger than that of the product.

- The ease of finding labor from the areas where sugar cane is cultivated is also a factor influencing the location near raw material.

- The relatively high cost incurred in transporting the finished product to the market tends to locate the industry near raw materials.

Cement Industry

Cement industry could be described as a large scale industry established in Sri Lanka. It is an industry located in close proximity to raw materials which are an important factor of location in any industry. If the raw materials used in an industry are weigh loosing or perishable the industry tends to be located closed to raw material sources. If the finished products are of high value and the cost of transport is low the industry may not be located at raw material sources. Few factors have influenced the location of the cement industry in Sri Lanka.

- The Kankasanturai and Puttalam cement factories have been established utilizing the raw material obtained from the limestone strip extending from Puttalam to Jaffna.

- The cement factory at Galle has been located on the influence of transport facilities and market. At present, the factories at Trincomalee and other places are located on the influence of these factors.

Garment Industry
- The factors such as labor, capital and market are important in the location of garment industry.
- State policies also have influenced the location of garment factories. The availability of transport facilities to transport the finished products to the market, too, has influenced the location of garment factories.
- Another factor of location is the availability of infrastructure facilities like electricity and water that facilitate the investors to keep up their industries.

Rubber and Plastics Industry
- Shows a wide distribution in the industry at present.

- Industries that use latex rubber as raw material are located in close proximity to rubber plantations.

- Industries that use processed rubber are located around Colombo

- The plastics industry uses the by-products of the Oil Refinery as raw material. These industry has widely distributed around Sapugaskanda where raw materials could be obtained easily. They have been also located within the Katunayake and Biyagama Free Trade Zones as well in industrial areas around Colombo.

- The local market, transport and labor are the other factors of location.

- Since materials produced through recycling are also being used as raw material the industry tends to be located in proximity to the market.

Traditional Handicraft Industry
- Raw materials and labor are the main factors of location of these industries.

- The industry being established from generation to generation in traditional villages.
    e.g.   Brassware industry in Pilimatalawa
            Mask making industry at Ambalangoda

- Location of specific industries in areas such as Kalapura at Kundasale, Weweldeniya, Kiriwawula and Ambekka.

- Contribution of labor

- The market factor functions in association with the tourism industry.

Activities

Prepare a poster describing the factors influencing the location of industries in Sri Lanka with the aid of few selected industries.

Competency   **:**   **10.0**   **Examines the present status of tourism industry in Sri Lanka and makes suggestions for its development with due concern for culture and environment**

Competency Levels :   10.1   Reviews the characteristics of Sri Lanka's tourism industry

                              10.2   Make suggestions to promote the growth of tourism industry of Sri Lanka while protecting the country's cultural identity

Time Periods   **:**   14
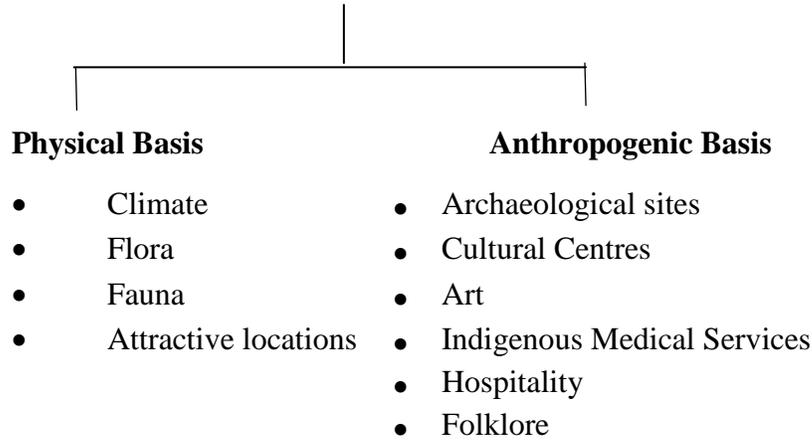
Learning Outcomes :
- Explains the characteristics of the tourism industry in Sri Lanka
- Describes with the help of data the impact of tourism industry on the economy of Sri Lanka
- Explains the impact of tourism on the society, culture and environment of Sri Lanka
- Explains the measures that could be taken to develop Sri Lanka's tourism industry

Introduction   **:**   Tourism industry has become a sector that exerts a considerable impact on the economic growth as well as on social, cultural and environmental setup of Sri Lanka. The physical and anthropogenic heritage that inherited by Sri Lanka from the distant past have contributed to the development of tourism industry. Also, Sri Lanka is significant as a country that provides various tourism opportunities and a destination for enjoying holidays. In the recent past, tourism industry has developed due to the government assistance. Tourism industry exerts favorable as well as unfavorable impacts.

It is expected from this unit to provide an understanding of the characteristics of the tourism industry of Sri Lanka as well as its economic, cultural, social and environmental impacts and the measures that could be taken to develop it while securing the countries identity.

A Guideline to Clarify the Subject Matter

Foundations of the Tourism Industry

Physical Basis

- Climate
- Flora
- Fauna
- Attractive locations

Anthropogenic Basis

- Archaeological sites
- Cultural Centres
- Art
- Indigenous Medical Services
- Hospitality
- Folklore

The Tourist Board of Sri Lanka has named seven major tourist zones in Sri Lanka. They are:

Map 10.1 Tourist Zones of Sri Lanka

1.   The City of Colombo
2.   Greater Colombo
3.   Southern Coast
4.   Eastern Coast
5.   Highlands
6.   Ancient Cities
7.   Northern Region
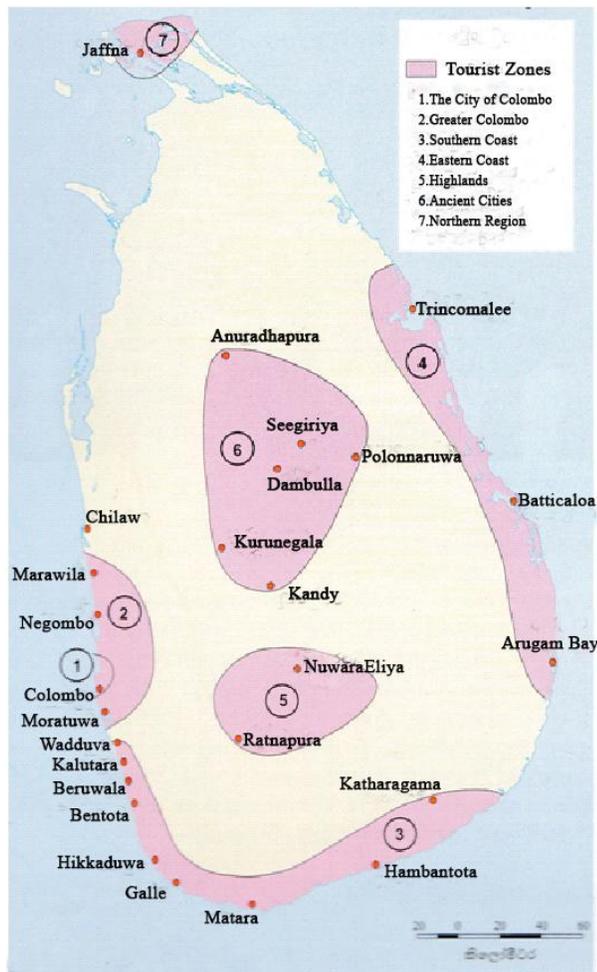
Source: Sri Lanka National Atlas, School Edition, 2015

(For a map of Tourism and Recreation of Sri Lanka, please see, National Atlas, Volume 2, 2007, p.49 And Sri Lanka National Atlas, School Edition, 2015 p.141).

- The number of Tourists and their Origins
  According to the international definitions, the visitors who spend at least one night in the country could be considered as tourists of Sri Lanka.

  The number of tourists who arrived in Sri Lanka from 2011 to 2014 are as follows:

 | Year | Number |
  |------|--------|
  | 2011 | 855,975 |
  | 2012 | 1,006,605 |
  | 2013 | 1,274,593 |
  | 2014 | 1,527,153 |

Tourist Arrivals
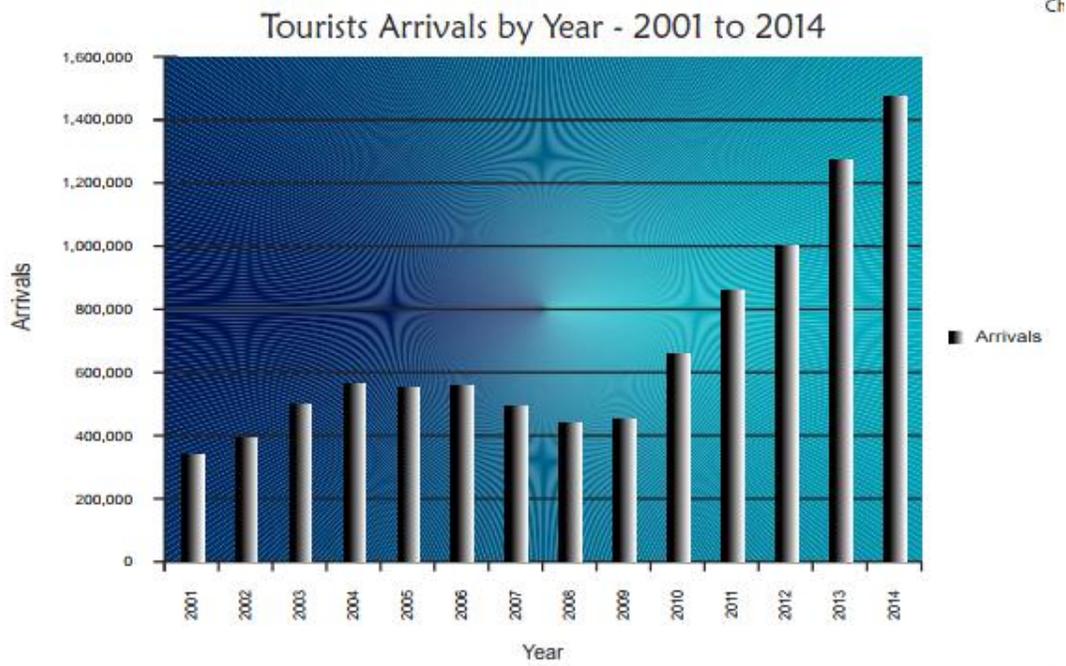
Source: Source: Sri Lanka Tourist Promotion Authority, Statistical Report 2014

- According to the graph it is apparent that the arrivals of tourists in Sri Lanka, as a whole, has increased from 2001 to 2014. However, in the years 2008 and 2009 it has rapidly decreased and increased again from 2010 to 2014.

- In 2014, more than 1.5 million tourists have arrived in Sri Lanka. The target for 2016 was 2.5 million tourists.

- According to the number of tourists arrived in Sri Lanka in the years 2013 1nd 2014, the ten major countries of their origin are shown in graph below.

- In 2013, the three major countries of tourists' origin were India, United Kingdom and Germany in that order. In 2014, it changed as India, United Kingdom and China.

Tourist Arrivals by the countries of origin, 2013 and 2014.
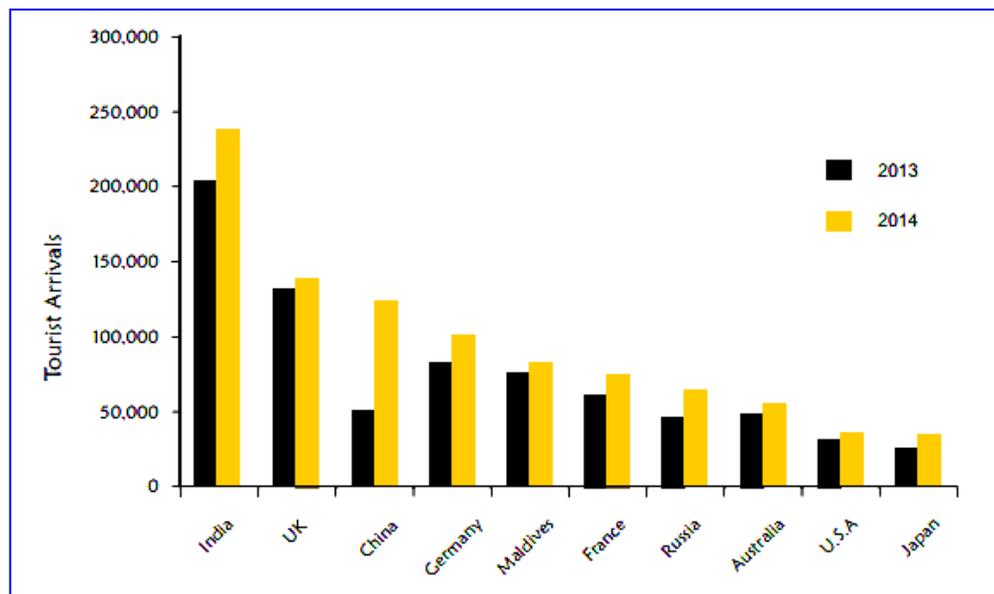
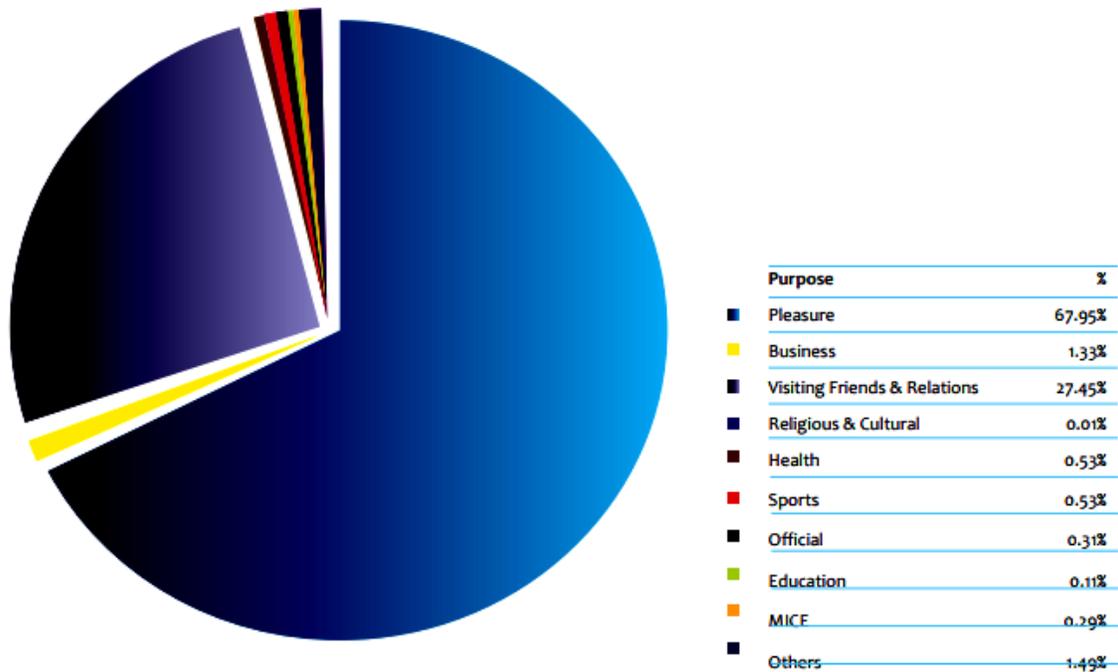Source: Sri Lanka Tourism Promotion Authority, Statistical Report, 2014

- **Different Objectives of the Tourists arriving in Sri Lanka**

  The objectives of the tourists arriving in Sri Lanka, according to the statistics for 2014, are given in the graph below. Accordingly, in 2014, the objectives of the tourists and their percentages are as follows:

For leisure and recreation	67.95%
For visiting relatives and friends	27.45%
For business activities	1.33%

  The percentages for each of other objectives were less than 1 per cent. Health, sports, diplomatic, education, meetings and conferences, exhibitions, religious and cultural purposes were important among them.
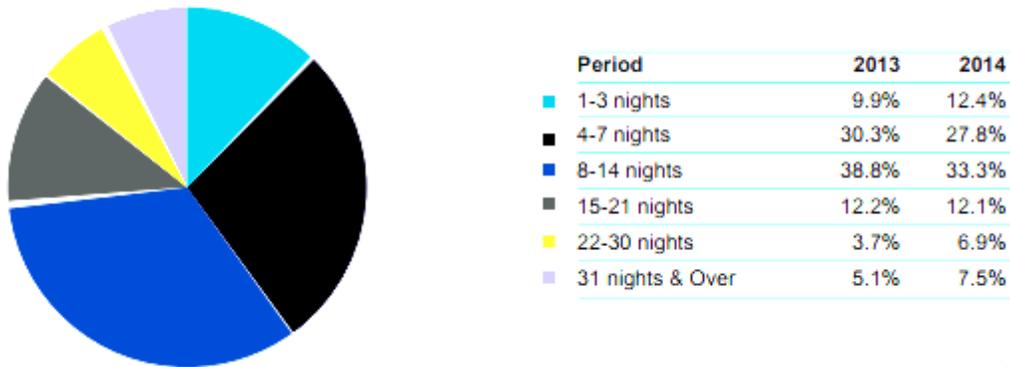
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Objectives of tourists 2014

Purpose	%
■ Pleasure	67.95%
■ Business	1.33%
■ Visiting Friends & Relations	27.45%
■ Religious & Cultural	0.01%
■ Health	0.53%
■ Sports	0.53%
■ Official	0.31%
■ Education	0.11%
■ MICE	0.29%
■ Others	1.49%

Source: Sri Lanka Tourism Promotion Authority, Statistical Report, 2014

- Tourists arrive in Sri Lanka for various reasons.
    - The varying attractiveness of the physical landscape although Sri Lanka is a small island.

    - The diversity in a limited space and the ease of reaching the diverse places

    - The development of recent trends within the tourism field; e.g. Bio-tourism activities, mountaineering, adventurous sorts, indigenous medical services, local cuisines, marriage customs etc.

    - The period of stay in the country is important as well as the arrival of tourists.

Period of Stay - 2014

Period	2013	2014
1-3 nights	9.9%	12.4%
4-7 nights	30.3%	27.8%
8-14 nights	38.8%	33.3%
15-21 nights	12.2%	12.1%
22-30 nights	3.7%	6.9%
31 nights & Over	5.1%	7.5%

Source: Sri Lanka Tourism Promotion Authority, Statistical Report, 2014

- As is apparent, a highest percentage of tourists who arrived in Sri Lanka in 2013 and 2014 have spent 8-14 nights in the country.

- There are two sectors in Sri Lanka's tourism industry: domestic tourism and international tourism.

  International tourism is the industry involved with the tourists who are arriving from overseas. The local people who are visiting the places of attraction in the country constitute domestic tourism.

In Sri Lanka's tourism there are few types:
1. Ecotourism
   Visiting and studying the components of environment while appreciating them. (forests like Sinharaja and Kanneliya, bird sanctuaries like Kumana and National Parks)

2. Cultural Tourism
   This is a very strong attraction in tourism industry of Sri Lanka. In Sri Lanka there are a number of attractions that exhibits the identity of ancient culture of Sri Lanka (Tanks, Pagodas, Kovils, places of special religious value, Ruins).

3. Recreation Tourism
   Tourism that takes with the objective leisure and recreation (enjoying coast, mountains and sports like water skiing).

4. Aesthetic tourism
   Tourism that takes place appreciating and experiencing the aesthetic value of environment (environmental attractions like coast, waterfalls, mountainous environment and forests).

5. Adventure Tourism
     Tourism that provides adventurous experiences (water rafting, mountaineering).

- New areas in Tourism Industry
    - Possibility of providing various expectations of tourists due to diversification and the addition of new types to tourism.
         Sea sports, cultural tourism, adventurous tourism

    - Expansion in the macro-tourism industry: tourism centered on Sun, Sand, Sea and Services

    - Tourism industry has been developing in association with regional development activities   (Pinnawala, Dambulla, Jaffna, Pasikuda, Kataragama)

    - Attraction of tourists from non-traditional markets

    - Creation of an environment friendly tourism market

- Relationship with World Tourism Organizations
    - United Nations World Tourism Organization (UNWTO). This was established in Madrid, Spain in 1970. It provides assistance to developing countries including Sri Lanka to promote tourism industry.

    - Pacific Asia Tourism Association (PATA): Established in 1951 with headquarters in Honolulu. This is an institution established to promote tourism in the Pacific and Asian region. Participating in its annual conferences Sri Lanka exchanges information on tourism.

    - The closest association to Sri Lanka, the SAARC, has taken various measures to develop tourism industry in its member countries (frequent meetings on tourism; declaration of the year 2006 as the South Asian Tourism Year; development of SARRC region as a common destination)

Impacts of the Tourism Industry
Economic Impacts

- A major source of foreign exchange earnings in Sri Lanka's economy

- The foreign exchange earnings through tourism industry in 2013 amounted to US $ million 1,715). It reached US$ million 2,431 in 2014. It was an increase of 41.7% (Annual Report of the Central Bank o Sri Lanka, 2014).

- The average expenditure of a tourist per day was US $ 160.8.

- Tourism industry is important for Sri Lanka as a method of employment generation also.

Direct Employment in the Tourism Industry
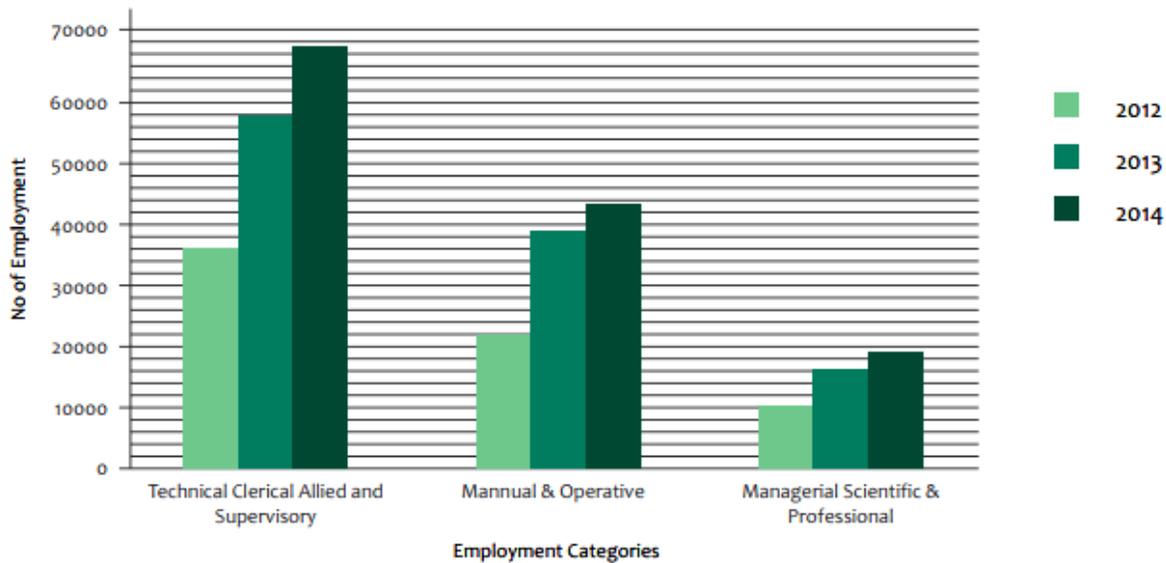
Source: Sri Lanka Tourism Promotion Authority, Statistical Report, 2014

- In 2014, the provision of direct employment opportunities in the tourism sector was 129,790.
  Its distribution was as follows:

  Managerial, Scientific and ----------- 19,445
  Technical, Clerical and Supervisory 67,508
  Labor and Mechanical   42,837
          Total   129,790

- The employment opportunities increase gradually year by year.

- Tourism industry has produced a large number of indirect employment opportunities also (providers of auxiliary services, suppliers of ornamental products and garments, makers and traders of souvenir gems and jewelry)

- The regional development associated with tourism industry is also a beneficial trend. The construction of hotels in the peripheral areas, urbanization, improvements in infrastructure facilities are significant.

- The increase in investments associated with tourism industry is also advantageous to the economy of the country.

- In 2014, investments have been approved for 40 hotel projects costing US $ million 423.4. Most of them are connected with the international hotel chain. The government income has been increasing in various ways due the arrival of tourists. They include taxes, tickets, airline fees etc.

- The income of the people living in tourism areas also have increased due tourism industry. The people in those areas could earn an income through providing various services.

- Unfavorable economic effects also could be seen in association with the tourism industry. The limitation in the arrival of tourists to a certain period of the year, problems faced by the consumers due to increase in the prices of local products, the adverse effects of the multinational corporations are some examples.

Social and Cultural Impacts

- Opportunity for knowing various nationalities and cultures
- Propensity to learn foreign languages by Sri Lankans
- Exchange of social and cultural values
- The contribution received for the conservation of World Heritages and Archaeological Assets

There are unfavorable social and cultural effects also associated with the tourism industry
- Propensity to follow unfavorable foreign habits
- Decline in morality
- Increase in child abuses
- Spread of venereal diseases
- Increase in drug use
- Smuggling of products of religious and cultural value
- Failing of some tourists to observe local and religious customs

Environmental Impacts

- Tourism industry largely depends on the environment. As a result, attention is being focused on environmental conservation attitudes and measures and act accordingly.
- Receipt of foreign aid to protect land, water, flora and fauna.

- Coast conservation

There are unfavorable environmental effects also.
- Destruction caused to the aesthetic value of the landscape due to the construction of hotels on sites of scenic beauty and forests
- Coastal erosion and destruction coral reefs
- Problems related to the waste disposal
- The destruction caused to the bio systems due to the intolerable numbers of tourists arriving in certain places
- Smuggling of parts of animals and plants

Measures that could be adopted to develop Tourism Industry

- Updating the policies on tourism industry
- Creation of an environment that ensures the security of the tourist
- Promotion of the domestic Tourism industry
- Promotion of new fields within the tourism industry
- Adoption of measures to minimize the adverse effects of tourism industry

Updating the policies on tourism industry
- Implementation of tourism promotion programmers in overseas counters
- Focusing special attention on tourism zones when government development programmes are implemented
- Solicitation of the assistance of Provincial Councils and local government institutions for the promotion of the tourism industry
- Following more flexible policies in the issue of Tourist Visa

Creation of an environment that ensures the security of the tourist
- Implementation of strict laws and regulations for the security of tourists
- Training of tourist guides, hotel staff and drivers and establishment of relevant institutions
- Creation of opportunities for tourists to spend their time in Sri Lanka pleasantly.
- Development of knowledge and favorable attitudes among the community on tourism industry

Promotion of the domestic Tourism industry
- Provision and development of accommodation facilities in par with international standards
- Development of environmental tourism, infrastructure facilities, lodgings, observation cars etc.

- Improvement of transportation facilities for tourists (air, highways, railways and other).
- Utilization of the physical and anthropogenic foundations to develop tourist attractions
- Decentralization of the tourism industry; Development of tourism zones covering the entire island.
- Improvement of existing tourist attractions (Pinnawala, Southern coast, Sinharaja, Knuckles, Ritigala, World Heritage sites).
- The tourism industry should be restructured to ensure the development of the industry through permanent solutions.

Promotion of new fields within the tourism industry
- In addition to the current group tourism, development of various other fields
- Paying attention to alternatives such as local foods, local medical treatments, local culture etc.
- Promotion of special tourist zones that exhibit ancient life styles

Adoption of measures to minimize the adverse effects of tourism industry
- Implementation of laws and regulations
- improving peoples' awareness
- Taking steps to develop favorable attitudes
- Prevention of frauds and malpractices through the introduction of modern technology
  (Theft of genes, archaeological assets etc.)

Competency	**:**	**11.0 Examines the nature of globalization from a comparative perspective**

Competency Level	**:**	11.1 Reviews what is meant by globalization
		11.2 Reviews the drivers of globalization
		11.3 Examines the manner in which globalization affects developing Countries

Periods	:	20

Learning Outcomes	**:**	• Explains Globalization
		• Analyses the advantages and disadvantages of globalization
		• Introduces the drivers of globalization
		• Describes the contribution of information and communication technology and multi-national corporations to globalization
		• Describes how accelerated human mobility affects globalization
		• Describes the positive and negative effects of globalization on developing countries
		• Describes with examples the impact of globalization on Sri Lanka

Introduction	**:**	Within the current economic, social, cultural and political processes which are integrated with the rapid developments taking place in the fields of science and technology, transportation, communication etc. no country in the world cannot function in isolation today. Accordingly, countries of the world maintain various relationships between them. The process that countries of the whole world maintaining relationships with one another could be simply called globalization. It could also be described as a process that integrates the global community as a single society working together.

A Guideline to Clarify the Subject Matter

- Globalization has been defined in the Cambridge Dictionary as a 'process that gradually makes all countries of the world same through economic, social and cultural impacts'.

Characteristics of Globalization

-   The rapid developments that took place in the fields of information and communication and infrastructure have accelerated the pace of globalization.

-   Although there were various relationship among the countries in past, the current globalization process is a different and complex one.

-   Because of the processes such as exploration and colonization the countries became closer to each other.

-   At present, the globalization process is taking place at a rapid pace.

-   The International Monetary Fund (IMF) has shown that the globalization process takes place through four basic fields:

    1.   Trade and Transactions
    2.   Capital and Investments
    3.   Migration
    4.   Dissemination of Knowledge

-   The environmental challenges that affect the world's countries irrespective of their boundaries such as global warming, water pollution and air pollution, the economic problems such oceanic fishing and social challenges like terrorism, and refugee problems also have been connected to globalization today.

-   Globalization is a process that affects the economy, society, culture and environment and, in turn, globalization itself is affected by them.

-   There are few sectors in globalization:

    -   Economic Globalization
    -   Cultural Globalization
    -   Political Globalization
    -   Technological Globalization

-   At present, term globalization is used to denote, the transformation of national economies into global economies through trade, foreign direct investments, financial flow, migration and expansion in technology.

Advantages of Globalization:

-   Opportunities are created to acquire new knowledge and enterprise for countries where they are not available.

-   Opportunities are created for industrially less developed countries to enter world market

- Opportunities are created for inflow of capital, technology and human capital; possibilities for expanding import and import trade.

- Opportunities are provided for entrepreneurs of the industrially less developed countries to become stakeholders of the international production network.

- Opportunities to acquire education and exchange technological knowhow.

Disadvantages of Globalization

- Increase in income disparities between industrialized countries and industrially less developed countries and also within the less developed countries as well.

- The protection policies of the developed countries controlling opportunities available for developing countries to access the export market.

- The measures followed by developing countries in competition with other developing countries with a view to attracting foreign capital investments create environmental problems.

- In practice, the globalization process operates from developed countries to developing countries only.

- Gradual disappearance of cultural identity and cultural uniqueness of many countries and the spread of a global culture based on westernization led by the United States.

- The global commerce operates with a view only to maximizing the profits of the multinational companies and not according to the development objectives of individual countries or their people. As such it will not be beneficial to developing countries.

11.2.1 Main Drivers of Globalization

- Information and Communication Technology

  - The process of data collection, processing, storing and dissemination of information is called the information and communication technology. The processing of data through electronic means is notable.

  - The radio, television, computers, computer networks, telephones, satellites, other electronic communication apparatus are significant in this process,

  - The rapid and huge development which has been realized by the information and communication technology has affected globalization tremendously.

- Not only the exchange of physical resources but also of human resources is a major feature of globalization. Due to these relationships, not only in technological sector but also in cultural and social sectors, it has been possible to exchange views, skills and attitudes of each other and improve their conditions.

- Especially due to the development in communication technology these relationships have become closer. The communication process, started with the newspaper and progressed through radio, television, telephone, computer and the Internet has reached the apex today.

- With the emergence of satellite technology, fiber optics cables, wireless networks, and mobile telephones it has been possible for the majority of the world's people to be aware of any incident occurring in the world within a very short period of time.

- Due to the spread of the microchip it has been possible to process the information at a great speed and store a large amount information in a very small space.

- It is possible to understand the extent of the impact of the development in information and communication technology on globalization from the above factors.

- Although the information and communication technology accelerates globalization it has adverse effects, too.

- One problem is the limitless inflow of necessary as well as unnecessary things into the country through the Internet and television. This has been responsible for misguiding the children and the youth.

- Multinational Corporations

  - The large companies who are having businesses at least in one country outside their home country are known as multinational companies. Generally, the offices and factories of these companies are established in various countries and their coordination is done by the main office located in the home country.

  - At present there are about 600 multinational companies in the world in operation and of them about 30 have their central offices in the United States. Another 160 companies are Japanese companies and of them about 60 are owned by the American businessmen.

- A few multinational companies of the World are listed below:

Monsanto	-	USA	Mitsui	-	Japan
Unilever	-	UK	KFC	-	USA
Merck	-	UK	Coca Cola	-	USA

- These companies invest money in order to spread their businesses in other countries. It is called Foreign Direct Investment (FDI).

- The low cost of production in developing countries, the opening of the economies by these countries in order to expand foreign investments, relaxation of tax policies, relaxation of labor laws, expansion of infrastructure facilities etc. have increased the investments by multinational companies in them. As such, the activities of the multinational companies exert a huge impact on the globalization process.

- The leading companies of the world either by spreading their own businesses in the countries world over or investing to establish businesses in other countries contribute to globalization.

- Increased human mobility

  - The regional or international migration of the people is called human mobility.

  - Human mobility takes place due to various factors such as employment, education, pleasure, business activities, and religious purposes.

  - In a globalized world counties are open to a large extent. Especially due to the information and communication technology it has become easy to acquire knowledge and understanding about the World.

  - It has opened the space for people to migrate for educational, employment, pleasure, and business purposes. Especially, it has become possible to reserve air tickets and accommodation easily through the Internet.

  - Due to human mobility, the social and spatial gap between countries have reduced. Educational opportunities have widened. Opportunities are created for exchanging entrepreneurs. Opportunities for exchange of technology are created. These factors lead to globalization.

  - On the other hand, globalization itself tends to accelerate human mobility.
  - As such, human mobility and globalization are two interrelated processes.

11.3   Favorable and Unfavorable Effects of Globalization on Developing Countries

- Economic Impacts

  - In the past developing countries had difficulties to enter the global economy. Due to globalization most of those obstructions have disappeared.

  - It is significant that the developing countries have been provided with accessibility to markets and development needs through the large scale loan facilities provided by the financial institutions such as the World Bank, International Monetary Fund.

  - At present, opportunities have been created for foreign investment and employment opportunities since many developing countries have inclined toward open economy.

  - Especially due to the developments in information and communication technology field foreign companies have been provided with opportunities for free trade.

  - It is an advantage that opportunities are available for establishing group enterprises and friendly agreements world over.

  - Since limitations have been eliminated enterprises are able to obtain cheap labor, raw materials and technological facilities. For example, many American software companies have located their productions in India. It is advantageous to both countries.

Sometimes unfavorable economic impacts also could occur.

  - Widening gap between rich and poor in the country
  - Mal-distribution of the fruits of development within the country
  - Environmental problems due to wide distribution of factories
  - Decline in local industries and investments
  - Suppression of human rights and governance due to global capital needs
  - Decrease in human labor requirements for certain professions in developing countries due to the application of modern technological methods

Knowledge and Technology

  - The keenness of people to develop their skills triggered by the dissemination of information on education, opening of educational opportunities globally and the ease of utilization of those opportunities is an advantageous situation.

  - The increase in the number of students entering higher education due to globalization as also an advantageous situation.

  - The increase in the opportunities for exchanging knowledge and technology through the expansion in foreign investments is another advantageous situation.

Social and Cultural Impacts

- Culture is entwined in human civilizations and changes from society to society and from one country to another.

- Cultural globalization means the infiltration of the traits of a dominant culture into another culture through various media and methods.

- In this process, commercial products, the Internet and other communication media have taken the lead. E.g. Western Music.

- Transformation of traditional cultures into Western cultures also is an impact of globalization.

- The impact of cultural globalization is much forceful on the young generation. These impacts can be seen in clothing, fashions, music, food habits etc. The spread of international restaurant networks such McDonalds, KFC, Dominos, Pizza Hut can be cited as examples.

- Deterioration of traditional cultural traits, change in language, changes taking place in family institution, are the unfavorable effects of globalization.

Activity

1. Collect examples of evidence as much as possible on the impact of globalization on Sri Lanka.

2. Classify them as
   o Economic
   o Knowledge and Technology
   o Social and Cultural

   and prepare a table to present them as favorable and unfavorable impacts.

| **Competency** | **:** | **12.0** | **Examines the role of regional organizations and acts with an awareness of regional cooperation** |

| **Competency Level** | **:** | 12.1 | Reviews the role of selected regional organizations |

| **Periods** | **:** | 08 |

Learning Outcomes :

- Explains what is meant by regional organizations
- Describes the functions of SAARC
- Describes the functions of ASEAN
- Describes the functions of EU
- Shows with the help of maps the countries belonging to regional organizations

Introduction **:** Every country in the world today maintaining relationships with other countries tries to develop international relations**.** These relationships are developed with a view to maintaining their sovereignty, security, economic and social activities successfully. These countries while developing their relationships individually hold memberships of the international organizations in order to face the global challenges. These organizations have been established at global level as well as regional level and by geographical regions.

In most cases, regional groupings have been established on the basis of geographical regions. At present, regional organizations have been established to represent all geographical regions.

In this unit it is expected to study regional organizations such as SAARC, ASEAN and European Union and their functions.

A Guideline to Clarify the Subject Matter

- Regional Organizations
  - The regions that belong to various parts of the world displaying similar geographical characteristics could be termed as regions.

- Western Europe, Asia, South Asia, Southeast Asia, Middle East, South America are examples for such unique regions.

- Regional organizations have been established with a view to facing the problems economic, social, political, and technological and security problems in these specific regions. Many countries in these respective regions hold memberships of the organizations.

- SAARC, ASEAN and the European Union are examples

- The South Asian Association for Regional Cooperation (SAARC)

  - An organization established in 1985 with the cooperation of seven countries.

  - Established according a thought of the Late Sheik Mujiber Rahman, Ex-President of Bangladesh.

  - The declaration that includes the fields of cooperation ratified at a meeting of the Foreign ministers of the countries in region is called 'The New Delhi Declaration'. The agreed fields of cooperation were,

∗ Agriculture	∗ Transport
∗ Rural Development	∗ Postal Services
∗ Communication	∗ Science and Technology
∗ Meteorology	∗ Sports, Art and Cultural
∗ Health and Population Issues	Affairs

  - Officially inaugurated on 8th of December, 1985 in Dhaka, Bangladesh.

  - Founding Members:

• Bangladesh	• the Maldives
• Bhutan	• Nepal
• India	• Pakistan
	• Sri Lanka

  In 2007, Afghanistan joined the Organization.

Objectives and Functions of the SAARC

- Elimination of poverty through uplifting the welfare and levels of living of the people in the region

- Establishment of an Agricultural Center for food security and food stock in Bangladesh

- Taking decisions by leaders at state level to prevent terrorism and implementation of terrorism prevention agreements

- Through the Japan- SAARC Fund for Economic Promotion and Solving of Health Problems and the South Asian Development Fund provide financial and material aid and promote cooperation

- To establish,

  - South Asian Preferential Trade Agreement (SAPTA), and
  - South Asian Free Trade Area (SAFTA)

  with a view to minimizing the trade problems and promote trade activities among the countries in the region

Problems and Challenges

- Slipping away the expected cooperation among the member countries of SAARC (e.g. the issues between India and Pakistan)

- Although tended to cooperate as a region some countries trying act on their own independently of the region

The Association of the South East Asian Countries (ASEAN)

- Establishment with the participation of five countries on 8th August, 1967 in Bangkok, Thailand.

- Founding Members are:

  - Indonesia
  - The Philippines
  - Taiwan
  - Malaysia
  - Singapore

- Other member countries are:

  - Brunei
  - Vietnam
  - Laos
  - Myanmar
  - Cambodia

The Objectives and Functions of the ASEAN

- Ensure Peace and Security in the Region

- Implementation of an integrated economy among the member countries on the basis of cooperation.

- Development of research activities through mutual cooperation and participation

- While engaging in trade activities as individual countries developing strategies to encounter the trading problems at international level

- Obtain assistance of New Zealand for developing animal husbandry to establish food security and forest projects

- Obtain assistance from Canada for developing fisheries activities

- Establishment of Disaster Communication Centre in order to encounter natural disasters

- Establishment of Science and Technology Committees in Asia

- Implementation of tax policies to encounter challenges related to trade

Problems and Challenges
- Elimination of poverty of the people in the Region is still a problem
- Member countries becoming targets of terrorist attacks (e.g. Bomb explosion in Bali)
- Drug trade and illegal weapon trade are challenges at present

European Union
- Established under the Maastricht Treaty on 1st of November 1993.
- Initially with a membership of 26 countries European Union is an Economic and Political organization.
- Founding member Countries were:
  - Belgium
  - Italy
  - France
  - Luxemburg
  - West Germany
  - the Netherlands

At present there are 26 member countries:

- Austria
- Belgium
- Bulgaria
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Romania
- Spain

- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Slovakia
- Sweden

- Latvia
- Lithuania
- Luxemburg
- Malta
- the Netherlands
- Poland
- Portugal
- Slovenia

Objectives and Functions of the European Union
- Providing a free market of goods, services and capital for the people
- Implementation of all activities in trade, agriculture, fisheries and regional development under a common policy
- Introduction of EURO as a single currency for member countries

Problems and Challenges
- Emergence of problematic situations due to political problems, low rates of economic growth, unemployment etc. in member countries
- Emergence of unemployment problems all over Europe.
- Some countries breaking away from the Union e.g. Great Britain.

Activities
- Mark and name the member countries of SAARC, ASEAN and European Union in a World map.
- Prepare a folder displaying the factors that affects the sustainability of the SAARC.

Competency	**:**	**5.0**	**Uses statistical techniques and graphical methods to analyze, interpret, and present, data and information**

Competency Level	:	5.1	Reviews data source
		5.2	Examines methods of data collection
		5.3	Analyzes and interprets data using statistical techniques
		5.4	Uses graphical methods for data analysis and interpretation
		5.5	Uses cartographic techniques for data analysis

Periods	**:**	76

Learning Outcomes	**:**	• Defines data
		• Explains the properties of data
		• Explains the difference between data and information
		• Describes with examples methods of data collection
		• Organizes and tabulate data
		• Constructs a data distribution
		• Analyzes and interpret data using statistical techniques
		• Analyses interpret data using graphical methods
		• Analyses and interpret data using cartographic techniques

Introduction	**:**	There is a close relationship between statistics and geography. In the early beginnings of geography, in addition to maps, statistical data have been used to present various information and with the developments in modern technology new methods of data collection and storage have been identified.
		A rapid progress has been achieved in storage, tabulation and classification of data with the use of the computer. Accordingly, in geographical explanations, based on the statistical measurements and information, the relationships between man and his environment are identified and interpreted.
		A special feature of the data used in geography is their spatial and temporal nature. It is the primary objective of this unit to provide an understanding of the principles of data usage in geography, various types of data used and the various statistical methods used to collect them and how they are analysed. It is also expected to provide an understanding of the interpretation and representation of data and how they are being in day to day activities.

A Guideline to clarify the subject matter

5.1   Data

Facts and statistics collected for investigation and analysis (Oxford Dictionary).

Data Sources
- Sources from which a researcher obtains data are data sources.
- Data sources and data collection methods vary according to the objective of the study.
- There are two types data sources, namely, the primary sources of data and the secondary sources of data
- It is important to mention the source of data when constructing graphs, diagrams and maps.

Types of Data
- Data can be classified in various ways.
    1. **Quantitative and Qualitative Data**
        - Data that could be presented numerically are quantitative data
        - Data not presented in numerical form are qualitative data

    2. **Primary Data and Secondary Data**
        - Data collected primarily for a specific purpose **are primary data.**

        - Since the investigator collects the data from the field by himself the value of data is Higher. Reliability is also higher.

        - However, the cost of time, labor and resources in the collection of primary is also high.

        - When sing data collected by another person or an institution they are called **Secondary Data.**

        - The time and cost of collection of secondary data is low.

        - However, the secondary data have not been collected according to the objectives of the researcher. There could be errors in copying data. Their reliability is also low.

    3. **Continuous and Discrete Data**
        - Data can be classified according to the nature of the values contained in them

        - If the data shows a continues distribution they are known as **Continuous Data**. Examples are data showing height, weight, time, temperature etc.

        - If data do not show a continuous distribution, they are called **Discrete Data.**

(e.g. number of children in a family, number of tanks in Anuradhapura district)

4.   **Ungrouped and Grouped Data**
  -    The original form of the data we collect are not organized and they are raw data. These unorganized and raw but having a specific value in them are called ungrouped data. The   marks obtained each student of a class at an examination are ungrouped data.

       When these data are grouped to express some idea of their distribution they are called grouped data. The data in a class interval are grouped data.

Difference between Data and Information

Information is gathered from data.

Data and Information
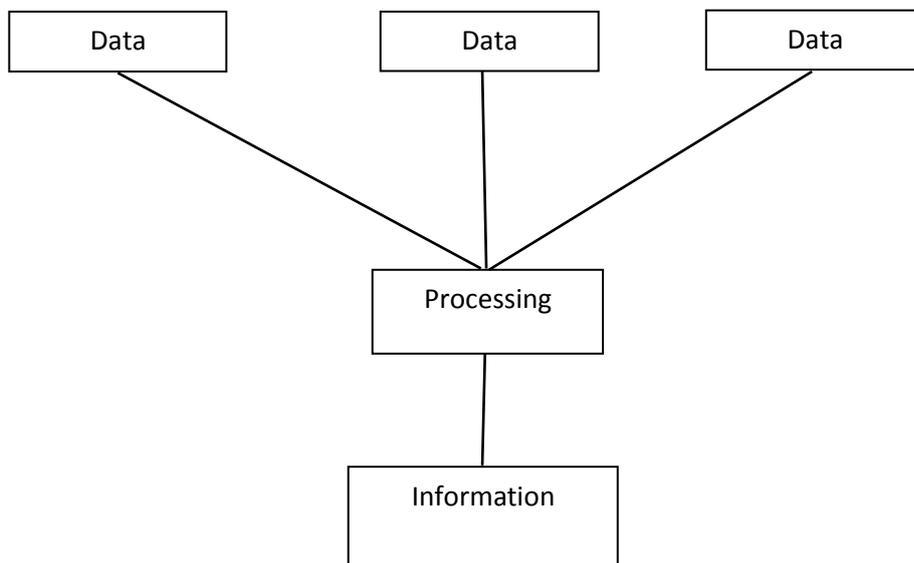
Data are unorganized and unprocessed facts. When they are organized and processed and presented in a meaningful way they become information.

5.2 Data Collection

Methods of Primary Data Collection

- The original data collected with a specific objective through a method like a survey are called primary data.
- Primary data are generated in various ways.
- They can be collected through methods such as surveys, observation and measurement.

Surveys

- When the researcher/investigator collects data by himself for his study from the field surveys are needed.

    e.g.   A survey on the teaching of geography in G. C. E (A/L) classes in Sri Lanka

- A good understanding of the facts relevant to the objective of the study could be gained from the primary data collected through surveys.
- However, it is time and labor consuming costly process.
- It is from a sample or a population that survey data are collected.
- Population means the totality of the subjects of a particular study—everything or everyone who is the subject of a statistical observation.

    e.g. In a study of the teaching of geography in G C E (A/L) classes in Sri Lanka the population is all schools with G C E A/L classes teaching geography.

- However, it is not an easy task to collect data from the total population and, therefore, data will be collected from a sample that represents the population.
- Selection of 50 schools with classes teaching A/L Geography would be sample of the total schools with A/L Geography classes.
- Surveys are carried out using various methods.

1.   Questionnaires
- By a questionnaire data and information are collected from the selected respondents.
- After preparing a questionnaire that contains all the questions that will provide answers necessary for the study it will be sent to the intended respondents or will be directly administered by meeting them.

- The investigator must have a good training for the preparation and to administer the questionnaire.

- Questions should be short, simple and easily understandable.

- Through questionnaires responses could be obtained from a large number. Time and labor will be saved and the cost will be less.

- Data and information could also be obtained by mailing the questionnaire to the relevant respondents.

- It is also possible to obtain information through the telephone.

2. Interviews

- Obtaining data through discussions at the meetings with the subjects in the sample or population who were selected for the study

- This is a suitable method for knowing the attitudes and views of the respondents

- This method is useful for obtaining correct information and also allows to continue the discussion while explaining the unclear facts to the respondent

- Interviews provide more time to the respondent to express his views and therefore provides an opportunity to gather more information relevant to the objectives of the research.

- However, the increase in time and labor spent and the high cost are problems.

- The availability to the investigator to manipulate the respondent is also a deficiency.

Measurements

- It is necessary to use measurements to obtain certain data.

- Especially the data of geographic significance such as weather and climate data are collected from measurements done using instruments.

- Data on altitude, rainfall and temperature are examples for data collected by measurements.

Observation

- Collection of data relevant to the study through observation.
  There are two methods of observation:
    1. Direct observation
    2. Participatory observation

- Direct observation means the collection of data by carefully observing the subject.

    An example is the observation of the changes in water level in a river or a well

- In participatory observation, the researcher or the investigator spend some time in the field with the subjects and collect information. In this method, more time and labor have to be spent and the collected information might be biased.

Methods of Secondary Data Collection

- In order to strengthen the argument presented the data used from other sources such as studies conducted by an institution or an individual are secondary data. Library, the Internet, maps, aerial photographs, satellite images, pictures and photos are sources of secondary data.

Library
- The library could be used for sources of published or unpublished documents Books, journals, reports and New Papers are these sources.

- It is important to mention the source when others' data are used.

The Internet
- A widely used source for collection of secondary data at present.

- Through the Internet most recent data could be retrieved fast.

- Social Websites could also be used to gather information

Maps, Aerial Photographs, Satellite Images and Photos

- Data on land use, forest cover, weather and climate data, data on relief etc. could be obtained from above sources.

- These data are very important for geographers.

5.3   Statistical Methods

Organization and Tabulation of Data
- In statistics numerical data are used.
- When they are taken individually a meaningful idea cannot be expressed.
- If they are organized in some order using statistical methods not only they provide a meaning but also make it possible for analysis and arrive at correct conclusions.
- The simplest method in data organization is to transform them into a data array.
- Data array is distribution of data organized in ascending or descending order.
- Various types of tables are prepared to organize data correctly. Repairs the necessary
- Tabulation of data means the organization of numerical data in rows and columns.
- Tables prepare the background for data analysis or interpretation. For example, Table 5.3.1 shows the marks scored by 28 students in a class at a term test. At a glance, they do not express a clear idea.

Table 5.3.1

40	25	52	17	58	70	58
65	75	42	82	25	78	42
36	42	48	55	82	9	48
78	58	60	65	42	46	50

- In Table 5.3.2 the same data are presented in ascending order to give some idea of the distribution of data.
- The lowest mark is 9 and the highest is 82.
- A student who has scored 9 and two students scored 82 each can be easily identified.

Table 5.3.2

9	17	25	25	36	40	42	42	42	42	46	48	48	50
52	55	58	58	58	60	65	65	70	75	78	78	82	82

- In Table 5.3.3, another method has been presented to understand above data distribution more easily and quickly. In that table' the marks scored by students are presented by class intervals.

Table 5.3.3   Grouped Data Distribution

X Class Interval	t Tally	F Frequency
0-9	/	01
10-19	/	01
20-29	//	02
30-39	/	01
40-49	⧸⧸⧸⧸ ///	08
50-59	⧸⧸⧸⧸ /	06
60-69	///	03
70-79	////	04
80-89	//	02

Cumulative Frequency Distribution

- Sometimes it is necessary to know not only the distribution of a variable but also the frequency above and below of a certain value.

- The cumulative frequency is useful for that purpose.

- In a grouped frequency distribution, the cumulative frequency could be obtained by adding the frequency of a certain class interval to the frequency of the class interval above it.

- Cumulative frequency at a certain class interval could be stated as a percentage of the total frequency. It is known as the Percentage Cumulative Frequency.

    Example:

    At class interval 0-9 $\frac{1}{28} \times 100 = 3.57\%$

    At class interval 40-49 $\frac{13}{28} \times 100 = 46.4\%$

- Cumulative Frequencies of a data distribution presented by class intervals are shown in Table 5.3.4. In the last column of the table, percentage cumulative frequency is given.

Table 5.3.4   Marks Scored by Students at a Term Test

X Class Interval	f Frequency	cf Cumulative Frequency	cf% Percentage Cumulative Frequency
0 – 9	1	1	3.57
10 – 19	1	2	7.14
20 – 29	2	4	14.28
30 – 39	1	5	17.85
40 – 49	8	13	46.42
50 – 59	6	19	67.85
60 – 69	3	22	78.57
70 – 79	4	26	92.85
80 - 89	2	28	100.00

Application of Simple Statistical Methods in Data Analysis

- Measures of Central Tendency and Measures of Dispersion could be shown as simple statistical methods.

- Diagrams and Graphs could be used to represent those data.

Central Tendency
- This could be described as a method of summarizing a data distribution. There are three measures of central tendency.
     1. Mode
     2. Median
     3. Mean

Mode
- Mode is the value with the highest frequency in a data distribution.
- In a grouped data distribution mode is shown as a class interval.
- It is called modal class.
- In some instances, there may more than one mode.
- If there is one mode the data distribution is known as unimodal. When there are two modes the data distribution is bi-modal. If there are more than two modes the data distribution in multi-modal.
- Mode is useful when there is a necessity for the most common value. For example if a shopkeeper wants to know the product with the highest demand mode is useful.

Median

- When a data distribution is arranged in an order the value at mid-point is median.

- It can be stated as the dividing point which separates the data distribution into two equal halves.

- When total number of values in the data distribution is an odd number median will be the middle value. If the total number of values in the data distribution is an even number median lies in between the two middle values.

- In an ungrouped data distribution the median can be found using the following formula:

$$Mdn = \frac{N+1}{2}$$

Mdn = Median

N = Total No. of Values

- This simple formula could be applied to find the median of the data distribution given in Table 5.3.2.

$$Mdn = \frac{28+1}{2} = 14.5$$

- Median lies at 14.5^{th} place of the data distribution. In other words, it lies between 14th and 15th places. In Table 5.3.2, in the data distribution arranged in an ascending order values of 14th and 15th places are 50 and 52. Therefore the median is:

$$\frac{50+52}{2} = 51$$

- This means that the median of the distribution of marks is 51 and out of the total of 28 students 50 percent have scored below 51 percent and the 50 per cent has scored above 51.

- However, when the size of the data distribution becomes larger it is difficult to calculate the median using the above formula. In such situations, the median could be calculated from a grouped data distribution with class intervals.
  The following formula could be used for that purpose:

$$Mdn = l + \left(\frac{\frac{N}{2} - fb}{fw}\right) C$$

Where,

l	=	Lower limit of the class interval within which the median lies (assumed)
N	=	Number of values
fb	=	Cumulative frequency below the class interval within which median lies
fw	=	Frequency within the assumed median class
C	=	Size of the class interval

Table 5.3.5 shows a grouped frequency distribution of marks scored by 28 students at a term test. The median of the grouped data distribution could be calculated using the above formula:

Table 5.3.5   Marks Scored by 28 Students at a Term Test

x	f	cf
0 -9	1	1
10 – 19	1	2
20 – 29	2	4
30 - 39	1	5
40 - 49	8	13
50 - 59	6	19
60 -69	3	22
70 – 79	4	26
80 - 89	2	28

$$= 49.5 + \left(\frac{\frac{28}{2} - 13}{6}\right) 10$$

$$= 49.5 + \left(\frac{14 - 13}{6}\right) 10$$

$= 49.5 + (0.16) \, 10$

$= 49.5 + 1.60$

$= 51.1$

- In explaining a data distribution of population data median is very useful.

- However, inability show the average of the data distribution is a drawback.

Mean

- Mean is average value of a data distribution.
- Mean is derived by dividing the total value of a data distribution by the number of Values
- It could be expressed mathematically as follows:

$$\bar{x} = \frac{\Sigma x}{n}$$

$\bar{x}$ = Mean

Ex = Total of values

n = Number of values

This simple formula could be applied to calculate the data given in Table 5.3.1.

$$\bar{X} = \frac{1448}{28}$$

$$= \quad 51.7$$

- It is difficult to calculate the mean of a grouped data distribution using above formula.

- The following formula could be used to calculate mean of the grouped data distribution.

$$\bar{x} = \frac{\Sigma fx}{n}$$

$\bar{x}$ = mean

f = frequency

x = mid value of the class interval

n = number of values

Table 5.3.6   Marks Scored by 28 Students at a Term Test

Class Interval	f Frequency	x Mid - Point	$\dot{f}x$
0 - 9	1	4.5	4.5
10 -19	1	14.5	14.5
20 - 29	2	24.5	49.0
30 - 39	1	34.5	34.5
40 – 49	8	44.5	356.0
50 – 59	6	54.5	327.0
60 – 69	3	64.5	193.5
70 – 79	4	74.5	298.0
80 - 89	2	84.5	169.0

$\Sigma f = 28$ $\Sigma fx = 1446$

$$\bar{x} = \frac{\Sigma fx}{n}$$

$$\bar{x} = \frac{1446}{28}$$

$$\bar{x} = 51.6$$

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- It is somewhat difficult to calculate the mean using above formula.

- There is another formula that can be easily used.

- It is known as the assumed mean method.

- The method is mathematically expressed as follows:

$$\bar{x} = x_0 + \frac{(\Sigma fd)}{n} C$$

$\bar{x}$ = Mean

x_0 = Mid-value of the class interval within which the assumed mean lies

C = Size of the class interval

f = Frequency

d = Deviation from the class interval within which the assumed mean lies

n = number of values

Table 5.3.7   Marks Scored by 28 Students at a Term Test

Class Interval	Mid-point X_0	Frequency f	Deviation d	fd
0 – 9		1	-4	-4
10 -19		1	-3	-3
20 -29		2	-2	-4
30 - 39		1	-1	-1
40 – 49	44.5	8	0	0
50 – 59		6	1	6
60 – 69		3	2	6
70 – 79		4	3	12
80 - 89		2	4	8

$\bar{x} = X_0 + \frac{(\Sigma fd)}{n} C$

$= 44.5 + \left(\frac{20}{28}\right) 10$

$= 44.5 + (0.71$

$= 44.5 + 7.1$

$= 51.6$

$\Sigma f = 28 \qquad \Sigma fd = 20$

- In the calculation of the central tendency of a large number of values symmetrically distributed around a central point, standard deviation and correlation co-efficient mean is important.

- Every unit of values are represented by the mean.

- Means could be compared with each other.

Dispersion

- Measures of dispersion show how the values in a data distribution are dispersed from a central value.

- Measures of dispersion show the spread, deviation and dispersion of values.

- A number of measures is used to calculate the dispersion.

Range

- Range is the difference between the highest value and the lowest value in a data distribution.

    Range = (highest value - lowest value) + 1

- This is the simplest method that could be used to show the dispersion of a data distribution.

- The main drawback in this measure is that it depends on two extreme values and therefore does not show how other values are distributed

Quartiles

- When data are arranged in an ascending order, the points located at 1/4, 1/2 and 3/4 positions are called quartiles.
- They are known as Q_1, Q_2 and Q_3 respectively.
- The point where up to ¼ of the data distribution is located is called Q_1 or lower quartile. The point at which up to ¾ of the data distribution is located is Q_3 or the Upper quartile.
- Of the total values of data distribution, 25 per cent lie up to Q_1, 50 per cent up to Q_2, (i.e the median), and 75 per cent up to Q_3.

100%		
75%	Q_3	Upper quartile
50%	Q_2	Median
25%	Q_1	Lower quartile
0%		
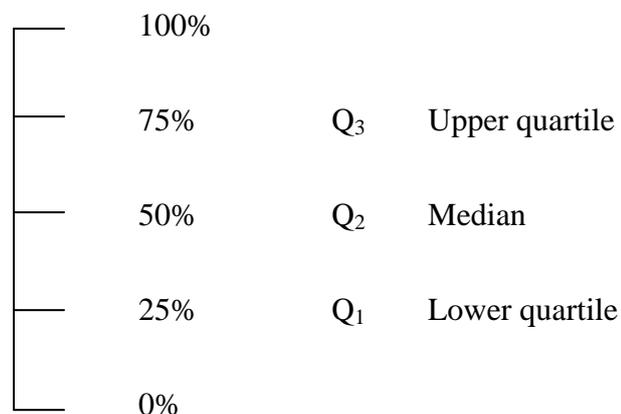
- When number of values in the data distribution is 'n' , the following formulae could be used to calculate quartiles.

$$Q_1 = \frac{1}{4}\ (n+1)$$

$$Q_2 = \frac{12}{4}\ (n+1) = \frac{n+1}{2}$$

$$Q_3 = \frac{3}{4}\ (n+1)$$

Tab;e 5.3.8 Marks Scored by 23 Students for Geography at a Term Test

82		$Q_3 = \frac{3}{4}\ (n+1)$
80		$= \frac{3}{4}(23+1)$
78		
75		$= 72/4$
66	$\longrightarrow$ Q_3 Upper Quartile	$= 18^{th}$ Value
65		$= 66$
60		
58		
56		$Q_2 = \frac{n+1}{2}$
55		$= \frac{23+1}{2}$
52	$\longrightarrow$ Q_2 Median	$= \frac{24}{2}$
50		$= 12^{th}$ Value
49		$= 52$
48		
46		
44		$Q_1 = \frac{1}{4}(N+1)$
42	$\longrightarrow$ Q_1 Lower Quartile	$= \frac{1}{4}(23+1)$
40		
36		$= \frac{24}{4}$
26		
25		$= 6^{TH}$ Value
17		$= 42$

Dispersion Diagrams
- Dispersion diagrams are the graphical presentation of quartiles.
- In geographical studies dispersion diagrams are widely used.
- This is drawn as a column.
- On the left side of the column vertical scale is marked. Inside the column, values of the data distribution are marked in dots.

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- The mid-point of the dots is the median of the data distribution. The mid-point of the dots between the median and the lowest value of the distribution is lower quartile. The mid-point of the dots between the median and the highest value of the data distribution is the upper quartile.

Figure 5.3.1 Dispersion Diagram
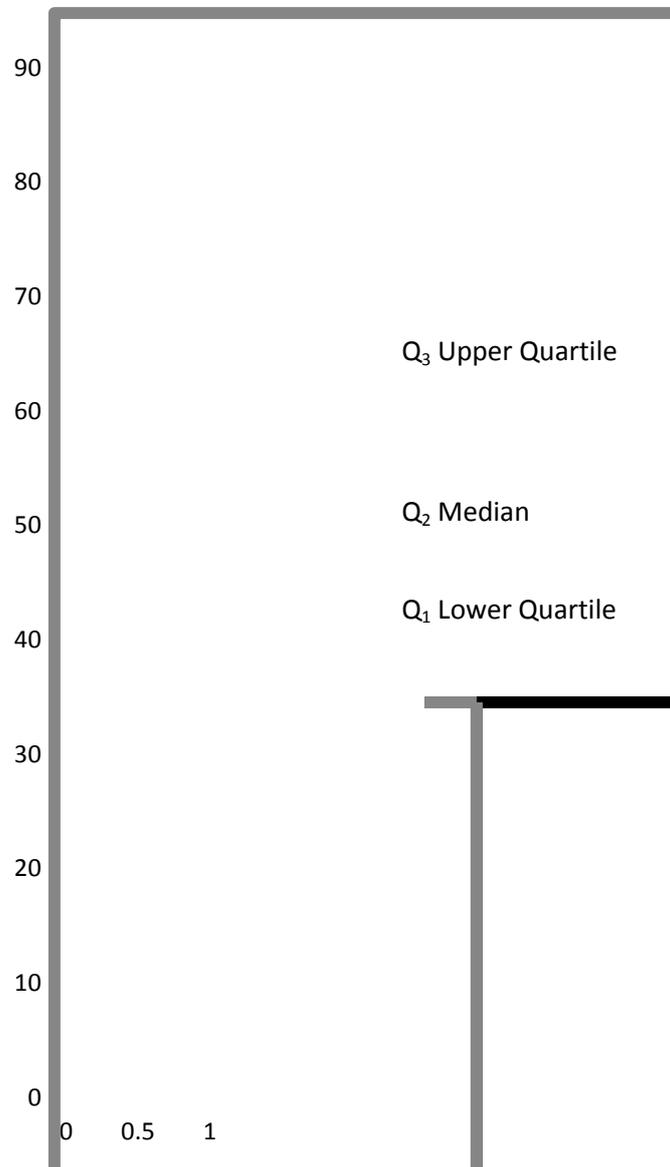
Source: Dept. of Meteorology

Inter-quartile Range
- Inter-quartile range is the range between the 25th percentile and the 75th percentile of a data distribution.

- In other words, the range between the upper-quartile and the lower-quartile.

- Inter-quartile represents 50 per cent of the values in a data distribution.

Example:

Inter-quartile Range = $Q_3 - Q_1$

= 66 – 42

= 24

Mean Deviation

- In order to obtain a measurement of the absolute deviation of the values from the mean, Mean Deviation is calculated. In the calculation all deviations are considered as positive.

- Mean deviation could be stated quantitatively by dividing the total of deviations from the mean by the number of values.

- Following equation is used to calculate the mean deviation:

$$MD = \frac{\Sigma|x - \bar{x}|}{n}$$

Where,

MD	=	Mean deviation
x	=	Variable
$\bar{x}$	=	Mean
n	=	Number of values

Table 5.3.9   Paddy Production in Sri Lanka – *Maha* Season, 2006 – 2015
(000' metric tons)

Year	Production
2006	2136
2007	1973
2008	2125
2009	2384
2010	2630
2011	1996
2012	2717
2013	2846
2014	2236
2015	2877

x	$\bar{x}$	$x - \bar{x}$
2136		-256
1973		-419
2125		-267
2384		-8
2630	2392	238
1996		-396
2717		325
2846		454
2236		-156
2877		485
$\Sigma|x - \bar{x}| = 3004$		

$$\bar{x} = \Sigma x$$

Σx = 23,920

n = 10

$\bar{x} = \frac{23920}{10}$

$\bar{x}$ = 2392

Source: Dept. of Census and Statistics, Sri Lanka

$$MD = \frac{\Sigma|x - \bar{x}|}{n}$$
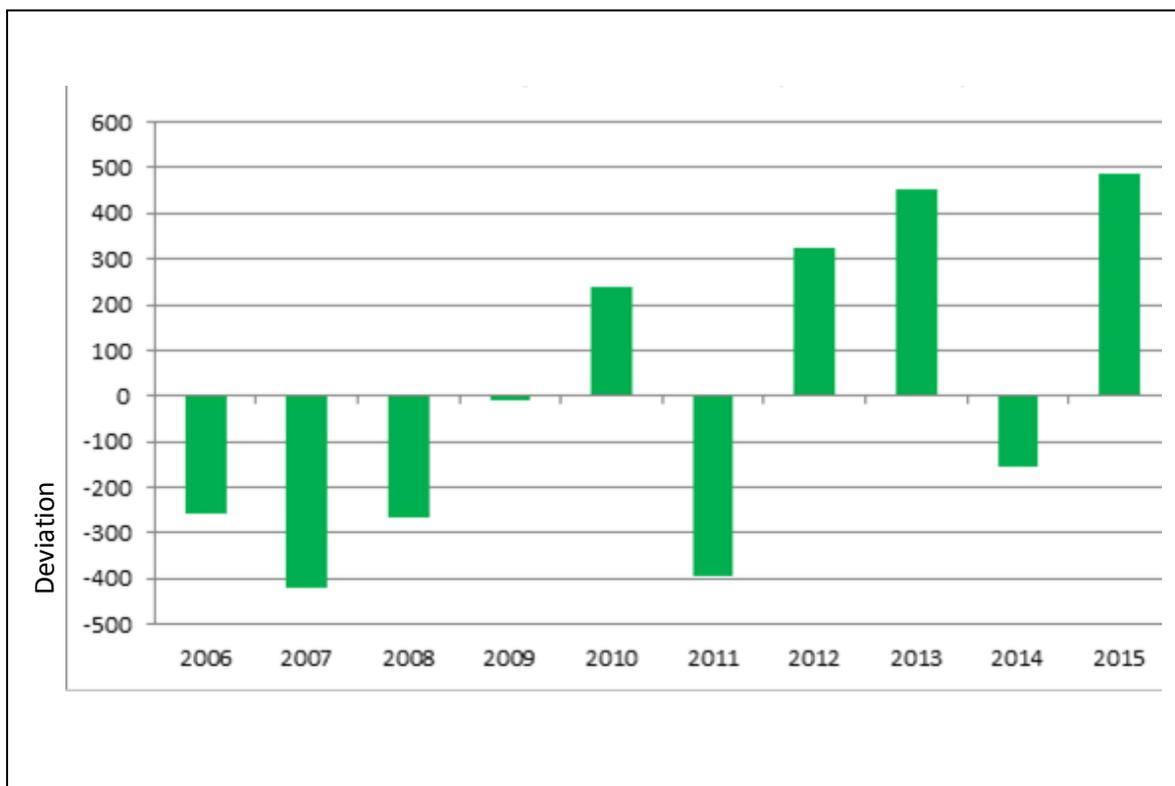
$$\Sigma|x - \bar{x}| = 3004$$

$$n = 10$$

$$\therefore = 300.4$$

- Deviation in a data distribution could be expressed in graphical form, too.

- It is called the deviation graph.

- How individual values deviate from the mean value of a data distribution is shown by a deviation graph.

Fig. 5.3.2 Deviation Graph

Paddy Production in Sri Lanka – *Maha* Season, 2006 – 2015 (in 000 metric tons)

Source: Department of Census and Statistics, Sri Lanka

Standard Deviation

- Standard deviation is the square root of the mean of the squared deviation of the individual values from the mean of a data distribution.

- Standard deviation is the most widely used measure of dispersion.

- If the value of standard deviation is small it means that the values in a data distribution are concentrated around the mean.

- Conversely, if the value of standard deviation is large it means that the individual values in the data distribution are dispersed from the mean.

- Following formula could be used to calculate the standard deviation:

$$\sigma = \sqrt{\frac{\Sigma(x-\bar{x})}{n}}$$

where,

σ	=	Standard deviation
x	=	variables
$\bar{x}$	=	Mean
n	=	Number of values

In Table 5.3.10 shows the standard deviation of the data on paddy production in Sri Lanka given in Table 5.3.9:

x	$\bar{x}$	$x - \bar{x}$	$(x - \bar{x})^2$
2136		-256	65536
1973		-419	175561
2125		-267	71289
2384		-8	64
2630	2392	238	56644
1996		-396	156816
2717		325	105625
2846		454	206116
2236		-156	24336
2877		485	235225
$\Sigma(x-\bar{x})^2$ = 1097212			

$$\sigma = \sqrt{\frac{\Sigma(x-\bar{x})}{n}}$$

$$\sigma = \Sigma(x - \bar{x}) = 1097212$$

$$n = 10$$

$$\sigma = \sqrt{\frac{1097212}{10}}$$

$$\sigma = \sqrt{109721.2}$$

Data Representation

- Histogram is a graphical representation of a data distribution.

- In a histogram, columns should be tied together.

- In a histogram, the horizontal axis shows the class intervals and their frequency is shown in the vertical axis.

- A histogram could be drawn using the data given in Table 5.3.11.

Table 5.3.11 -   Population Density in Sri Lanka by Districts – 2015

District	Population Density
Colombo	3513
Gampaha	1755
Kalutara	793
Kandy	739
Matale	251
Nuwara Eliya	434
Galle	675
Matara	659
Hambantota	252
Jaffna	643
Mannar	55
Vavuniya	96
Mullativu	39
Kilinochchi	100
Batticaloa	207
Ampara	160
Trincomalee	157
Kurunegala	359
Puttalam	274
Anuradhapura	134
Polonnaruwa	136
Badulla	299
Moneragala	86
Ratnapura	348
Kegalle	511

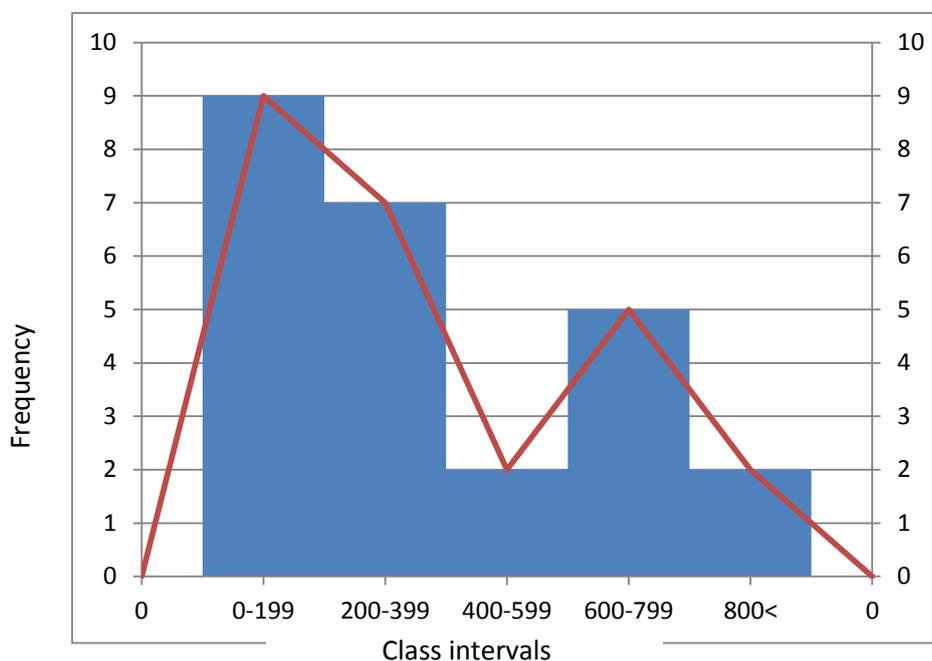| Class Interval	Frequency
0 - 199	9
200 - 399	7
400 - 599	2
600 - 799	5
Over 800	2

Fig 5.3.3 Population Density in Sri Lanka by Districts - 2015
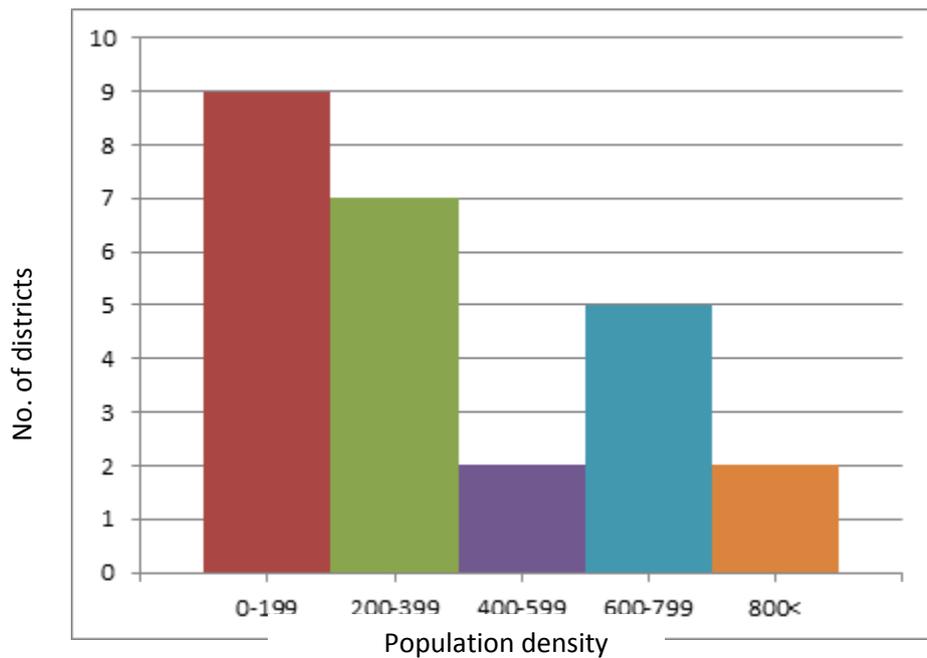
Source: Registrar General's Department, Sri Lanka

Frequency Polygon

- When the mid-points of the columns representing the frequencies of a data distribution are connected by a line it is called a frequency polygon (Fig. 5.3.4).

- The beginning as well as the end point of the frequency polygon should touch the horizontal axis of the histogram.

- In order to do that, there should be space for half a column at the beginning and the end of the histogram.

Cumulative Frequency Curve

- When the cumulative frequency is presented by a graph it is called a cumulative frequency curve.

- In the horizontal axis of the graph the upper limit of the class intervals are marked and the cumulative frequency is marked on the vertical axis.

- In Fig. 5.3.5 the cumulative frequency curve of the rainfall in Vavuniya from 2000 to 2015 is shown.

Table 5.3.12 Annual Rainfall in Vavuniya, 2000 – 2015

Year	Rainfall
2000	276.9
2001	94.9
2002	58.9
2003	133.4
2004	115.5
2005	77.3
2006	81.3
2007	156.5

Year	Rainfall
2008	104.7
2009	104.7
2010	163.9
2011	123.2
2012	225.7
2013	81.8
2014	205.2
2015	136.5

Source: Dept. of Meteorology

Table 5.3.13   Annual Rainfall in Vavuniya, 2000 – 2015 (mm)

| Class Interval x	Frequency f	Cumulative Frequency cf	Cumulative Frequency Percentage $Cf\%$
51 – 100	5	5	31.25
101 – 150	6	11	68.75
151 – 200	2	13	81.25
201 – 250	2	15	93.75
251 - 300	1	16	100.00

Fig. 5.3.5 Annual Rainfall in Vavuniya, 2000 – 2015 (mm)
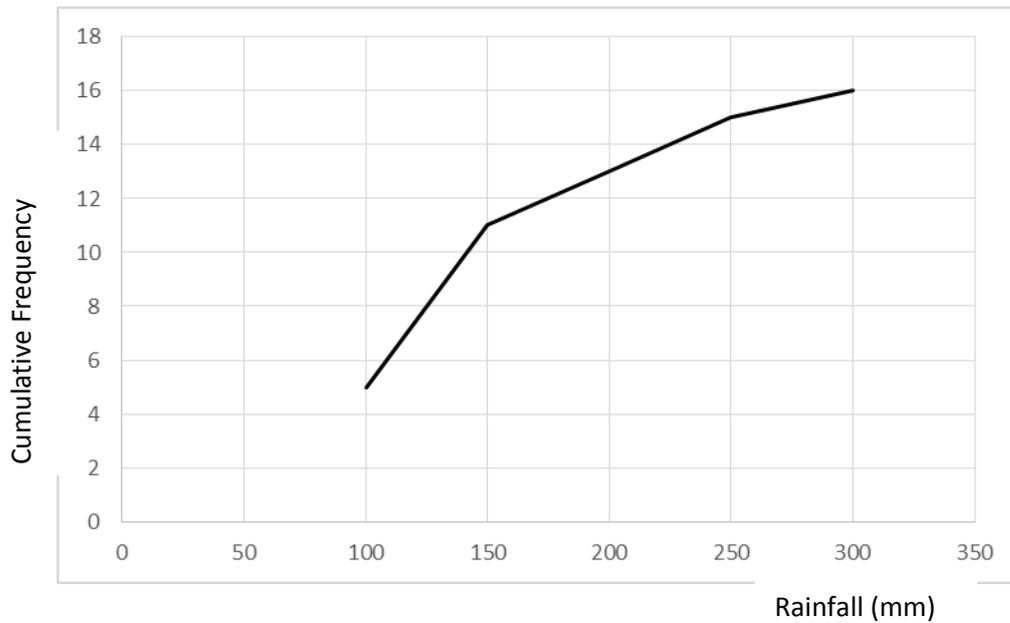
Cumulative Percentage Frequency Curve (Ogive)

-   When the percentage cumulative frequency is presented in graphical form it is called Cumulative Percentage Frequency Curve (Ogive).

-   It has been calculated in the fourth column of Table 5.3.13.

-   The cumulative frequency percentage is marked on the vertical axis.

-   From this curve information on the frequencies below or above a certain value could be obtained.

Fig. 5.365 Annual Rainfall in Vavuniya, 2000 – 2015
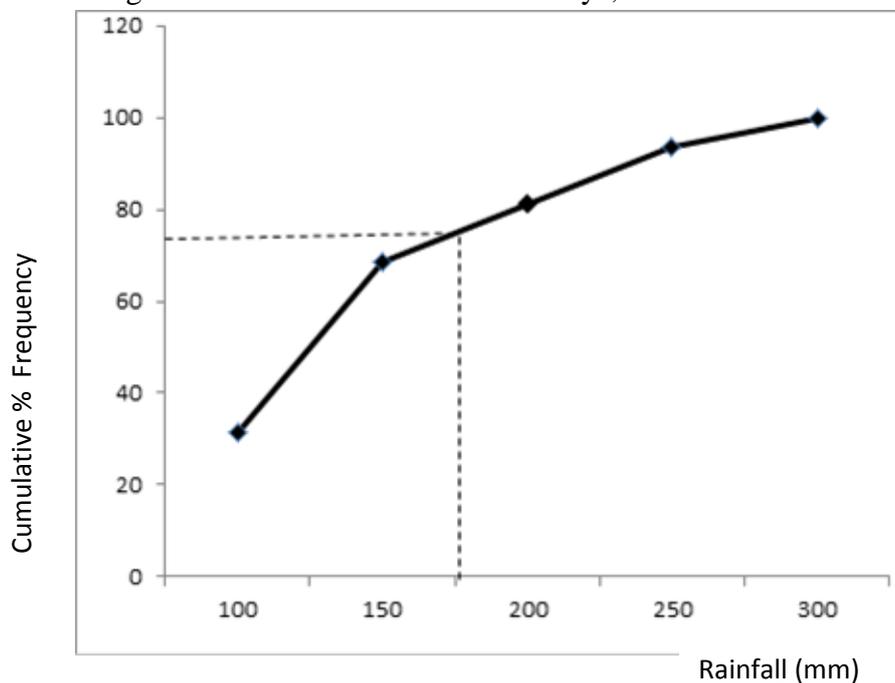
- An advantage of the ogive is that it is of help in deriving the frequency up to any value of the data distribution.

- Through the coordinates drawn to any position of the ogive percentage values and relevant data could be obtained.

- These graphs are of importance in comparing the data (in this case data on rainfall).

5.4   Graphical Methods

- Graphs could be described as a visual method of representing quantitative data.

- Primary data as well as secondary data could be presented in graphs.

- Graphs are drawn in order to represent data more attractively and understand them easily.

- Understanding of information on subject matter is facilitated by providing a visual image to a data distribution.

- A few factors require attention in presenting data through visual media. Among them,

    1.   Accuracy of the graph

    2.   Comprehensiveness

    3.   Attractiveness, and

    4.   Clarity, are important.

- In order to preserve the above qualities the graph should consists of the basic requirements such as title, scale, legend, use of color, data source and frame.

- In the presentation of geographical data various graphical methods such as line graphs, bar graphs and circular graphs are used.

Line Graphs

- This graphical method is widely used owing to its simplicity in construction and easiness in understanding.

- It is a frequently used graphical method to present temporal data like temperature, atmospheric pressure, trends in population and production.

- There are many types of line graphs.

Simple Line Graph

- A simple line graph is constructed with a vertical axis and a horizontal axis that cross each other at rectangles.

- In the horizontal axis time is plotted and on the vertical axis data values are marked.

- If data consist of high values they could be shown to their nearest value (in thousands, millions etc.).

- The scale of the vertical axis should begin with zero at all times. If the range of data is extremely large a breaker could be inserted on the vertical axis.
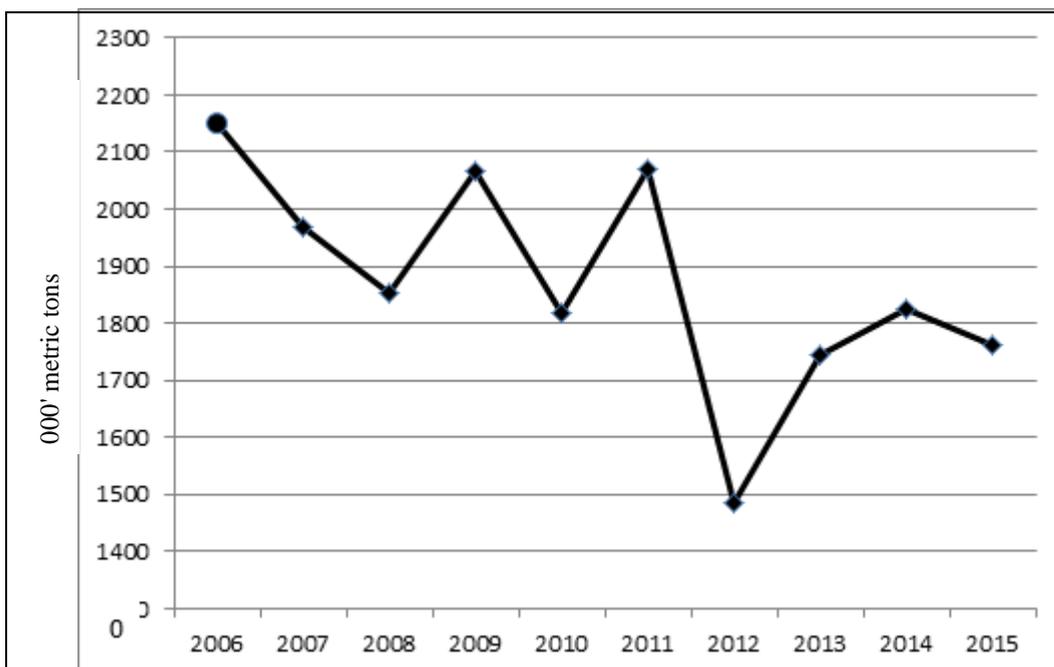
- A simple line graph could be constructed using the data given in Table 5.4.1.

Table 5.4.1   Sri Lanka - The imports of Crude Oil, 2006 -2015 (000' metric tons)

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Quantity	2151	1968	1853	2066	1819	2070	1486	1743	1824	1763

Source:

Fig. 5.4.1   Sri Lanka - The imports of Crude Oil, 2006 -2015 (000' metric tons)

Multiple Line Graphs

- This is also known as Multi-line graphs, group or comparative line graphs.

- In this graph data on number of variables could be shown by lines.

- Another advantage is to the ability to show variables pertaining to different regions or time periods so that they could be compared.

- However, if the number of variables are large then there will too many lines making it difficult to understand the graph.

Table 5.4.2 – Sri Lanka Trends in Births, Deaths and Infant Mortality Rates 2006 – 2015

(per 1000)

Year	Crude Birth Rate	Crude Death Rate	Infant Mortality Rate
2006	18.8	5.9	10.0
2007	19.3	5.9	8.5
2008	18.8	5.9	8.5
2009	18.4	5.9	9.7
2010	17.6	6.2	9.4
2011	17.4	5.9	8.5
2012	17.5	6.0	9.4
2013	17.9	6.2	9.7
2014	16.9	6.2	9.9
2015	16.0	6.3	8.2

Source: Annual Report, Ministry of Finance and Planning

Fig. 5.4.2 Sri Lanka Trends in Births, Deaths and Infant Mortality Rates 2006 – 2015 (per 1000)
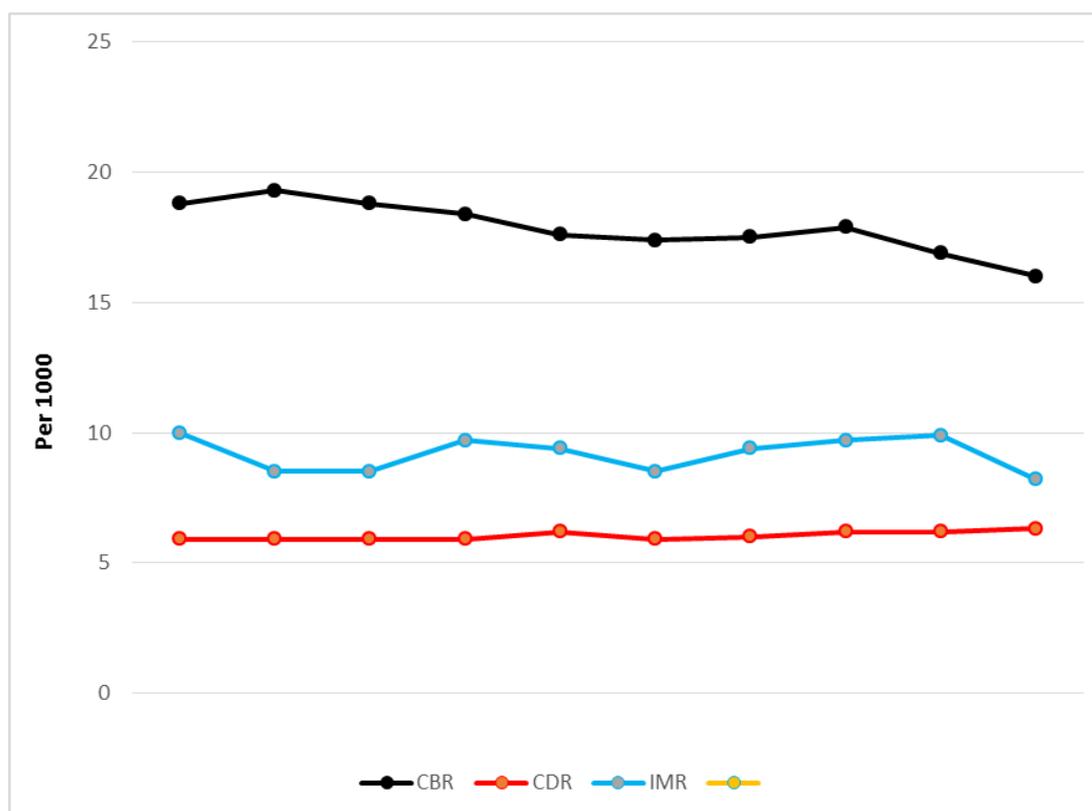
Source: Annual Report, Ministry of Finance and Planning

Bar Graphs

- The graphical method that represents a data distribution using bars is known as bar graphs.

- It is a method that presents data with simplicity and clarity.

- This method is also known as column graphs.

- There are a few variants of bar graphs that could be used according to the nature of data.

Simple Bar Graphs

- A simple bar graph is a chart that shows comparisons between data.

- The bars can be either horizontal or vertical.

- Bars should be of equal width and at regular intervals.

- Height of a bar is very important.

- The mega cities of the world with more than 20 million people are given in the table below. Using the data in the table a bar graph can be constructed.
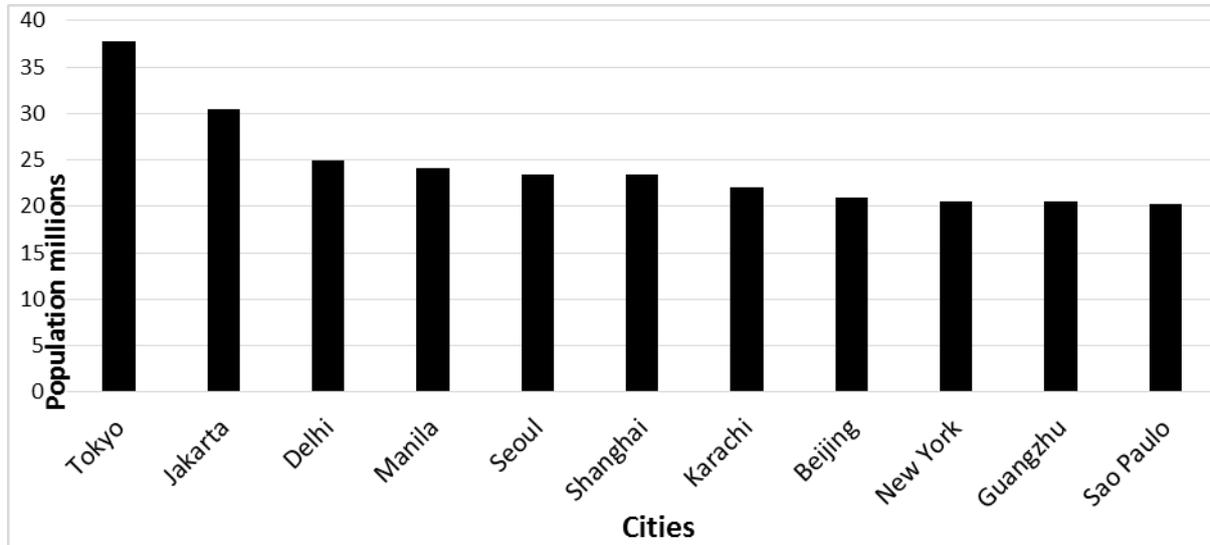
Table   5.4.3

Mega Cities of the World with more than 20 million people

City	Population (millions)
Tokyo	37.8
Jakarta	30.5
Delhi	24.9
Manila	24.1
Seoul	23.5
Shanghai	23.4
Karachi	22.1
Beijing	21.0
New York	20.6
Guangzhou	20.5
Sao Paulo	20.3

Source: www.allianz.com/en/about.us

Fig. 5.4.3 Mega-Cities of the World with more than 20 million people - 2015

Source: Source: www.allianz.com/en/about.us

- The difference between the values shown by bars can be clearly seen from the above graph.

- Bar graph is suitable for presenting data on population, crop yield, tourist arrivals, production of industrial goods, imports over a number of years. It is also useful to show the spatial distribution of a variable in a given year.

Twin Bar Graph

- The method that presents two variables by bars tied together.

- Data on imports-exports, immigration and emigration, Paddy Production in Yala and Maha seasons, Sex composition of the population of a country in a year or number of years could be shown by this method.

- In the construction, two bars should be tied together and the tied bars should be positioned at regular intervals.

Table 5.4.4   Paddy Production in Sri Lanka in Yala and Maha Seasons, 2010 – 2015 (million metric tons)

Season	2010	2011	2012	2013	2014	2015
Maha	2630	1996	2717	2846	2236	2877
Yala	1671	1898	1129	1774	1145	1942

Source: Department of Census and Statistics, Sri Lanka

Fig.5.4.4   Paddy Production in Sri Lanka in Yala and Maha Seasons, 2010 – 2015 (million metric tons)
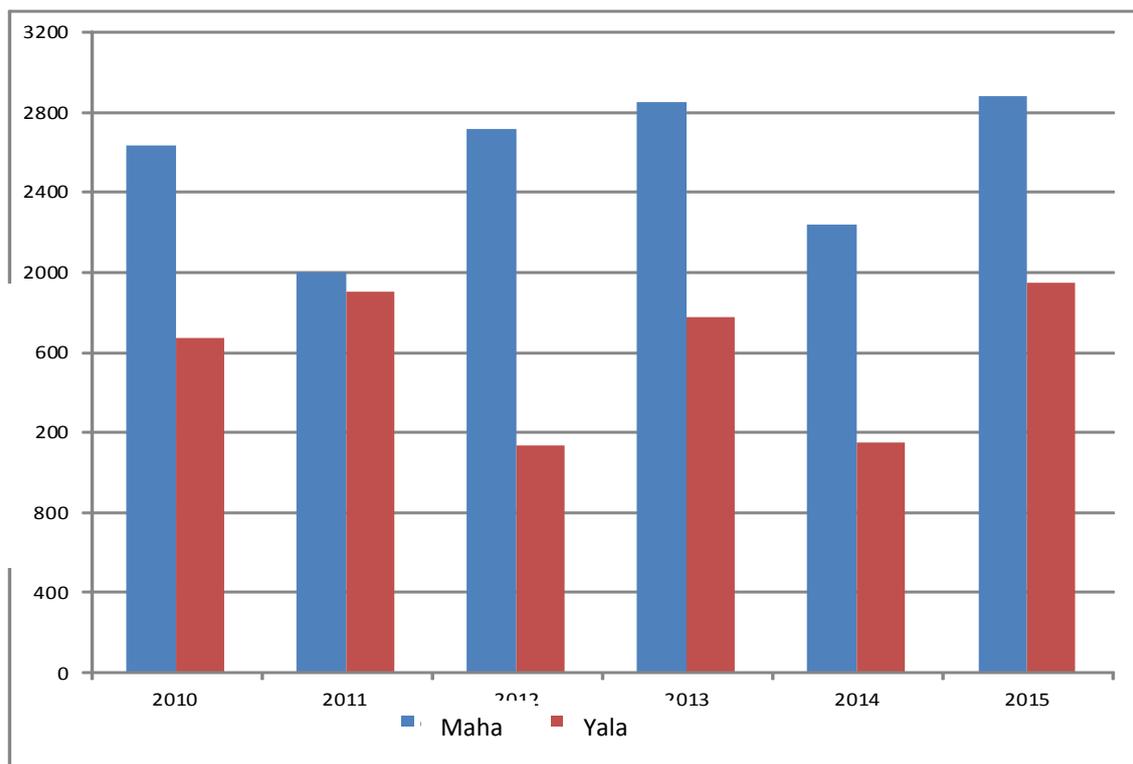
- This is a suitable graph to observe the changes in the selected variables as well as for comparing each other.

Multiple Bar Graphs

- Multiple bar graphs are also known as Comparative Bar graphs and Grouped Bar Graphs.

- In this methods a number of bars are tied together.

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-       In the construction of multiple bar graphs bars should be arranged from the highest value to the lowest value. A legend also should be provided.

Table 5.4.5   Imports of Motor Cars 2013 – 2015 (000')

Type of Vehicle	2013	2014	2015
Trishaws	80,586	83,233	132,865
Motor Cycles	159,791	322,257	349,441
Motor Cars	27,084	41,030	108,866
Goods Transporting vehicles	25,655	25,664	44,218
Passenger transport Vans and Buses	1,627	3,906	4,687

Source: Sri Lanka Customs Department

Fig. 5.4.5   Imports of Motor Cars 2013 – 2015 (000')
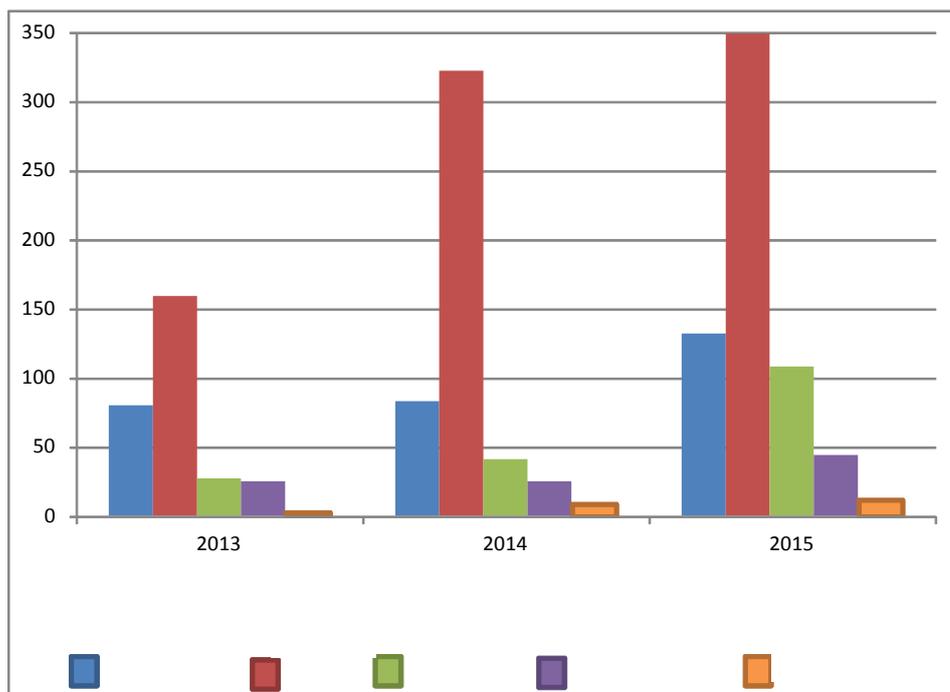
The differences between selected variables in given years as well their changes over time could be presented by this method.

- The ability to present the temporal change of a number of variables in one graph is an advantage.

  If data are related to spatial units, this graph could be used to present spatial changes of a particular variable over time. For example this graph could be used to show temporal changes in the production of tea, coconuts, rubber and paddy as well as the changes in the area under them.

Pyramid Graph

- Pyramid graph is used to show the sex ratio and age structure of the population of a country.

- Since the length of the horizontal bars at the bottom is more than that of the upper bars it takes a pyramid shape.

Table 5.4.6 Age Structure of the Population of Sri Lanka – 2013

Age Group (years)	Male	Female
0-4	871,000	891,000
5-9	869,000	895,000
10-14	810,000	835,000
15-19	839,000	819,000
20-24	777,000	754,000
265-29	806,000	751,000
30-34	849,000	799,000
35-39	732,000	688,000
40-44	711,000	673,000
45-49	666,000	625,000
50-54	643,000	585,000
55-59	561,000	505,000
60-64	495,000	428,000
65-69	348,000	287,000
70-74	231,000	182,000
75 and over	334,000	223,000
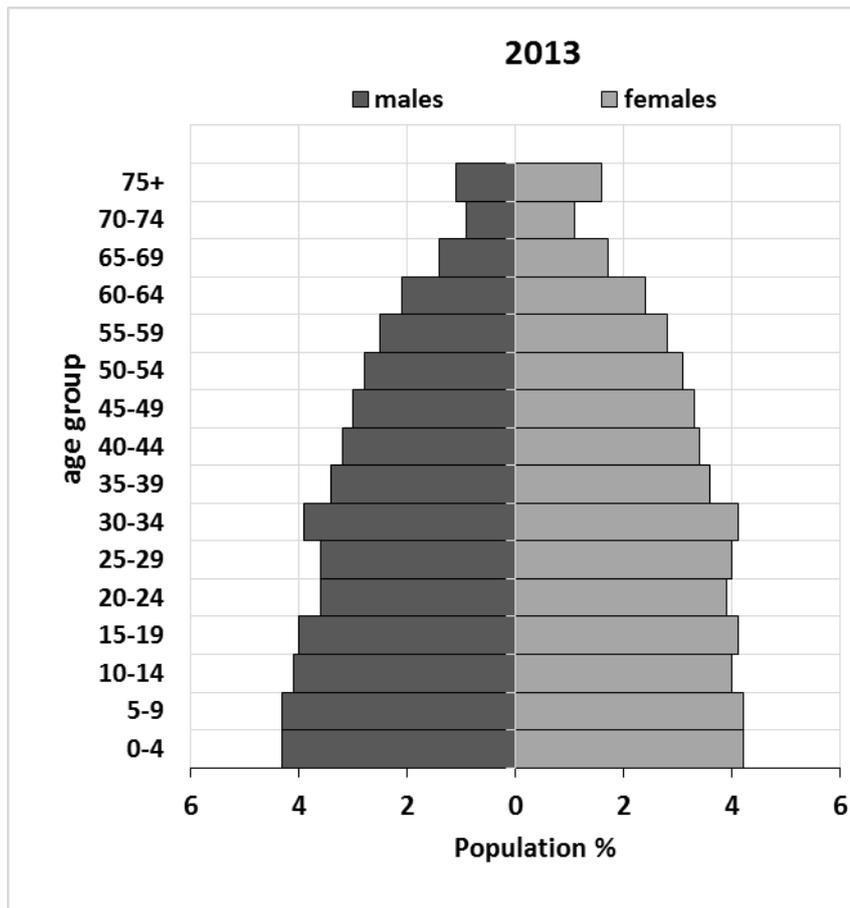
- In the Pyramid graph, bars representing age groups are drawn horizontally, and the length of the bar represents the number of persons in that age group.

  In the vertical axis of the pyramid age groups are marked. Normally, two vertical axes are drawn in the middle dividing the horizontal bars into two equal halves. On the left side of axis males are represented and females are represented on right side.

- In the pyramid, age groups are plotted with the lowest age groups at the bottom.

- A major advantage of this graph is its ability to present a complete picture of the structure of the population of a country.

- Age pyramid is of help to identify whether the country's population is at stable, expanding or contracting stage.

- It is of help to understand not only the current age structure and sex ratio but also the changes that would take place in the future.

- The percentage of dependents in relation to the labor force could also be identified.

- It makes possible to understand the problems of future development and prepare economic and social development plans for future.

  Example: Decrease in child population

 Increased percentage of aged population in the future

Circular Graphs

- Circular graphs are known as Divided Circles also.

- Circular graphs are used to show the composition of a variable such as ethnic and religious composition of a population, composition of imports and exports etc.

- In the construction of this graph, the total value of the variables are equated to 360^0 and components of the variable are shown as fractions of 360^0.

- According to the degree values so obtained the circle is apportioned.

Table 5.4.7   Composition of the Agricultural Exports of Sri Lanka – 2015 ($ million)

Crop	$ millions	Per cent of the total	As fraction of 360^0
Tea	1,340.5	54	194
Rubber	26.1	1	4
Coconuts	351.7	14	50
Spices	377.4	15	54
Other Agricultural Crops	385.8	16	38
Total	12,481.5	100	360

Composition of the Agricultural Exports Sri Lanka – 2015 ($ million)
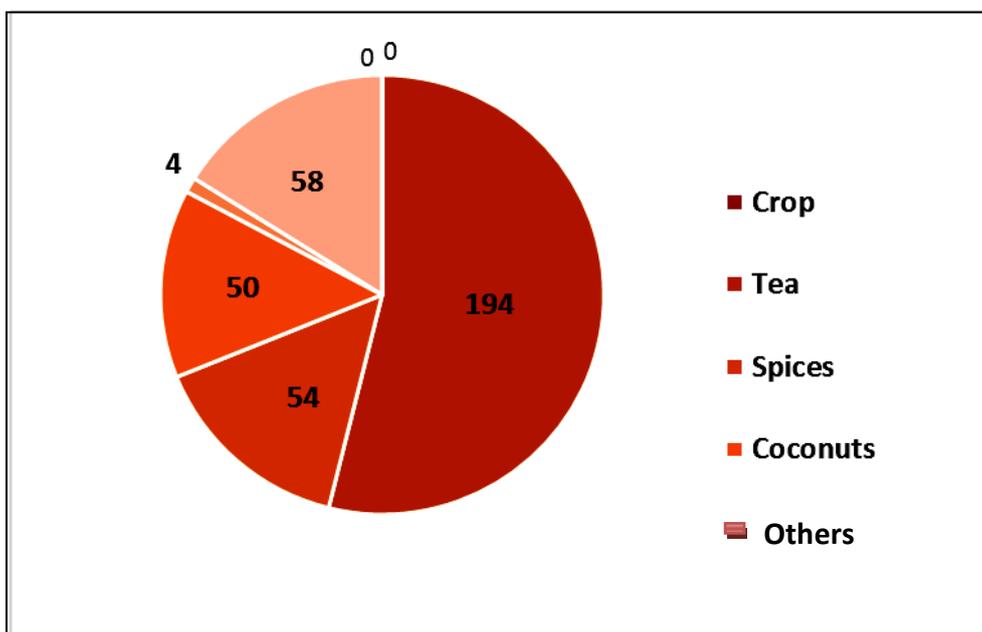
- The apportioning of the circle should be done clockwise from the apex.

- The values should be inserted in descending order with the highest value first.

- However, if there are categories like 'other' or 'not classified" they should be placed last irrespective of their value (even if they represent high values).

- It would be useful to insert the values of each category within the circle.

- The size of the circle does not express anything about scale.

- The simple divided circles are useful to show only the composition of a variable.

- If it is necessary to show data for a number of years a circle for each year has to be drawn.

- If the composition of population relating to three years is to be shown the three circles would be of equal size but no idea on population growth will be indicated.

5.5 Cartographic Techniques

- When statistical data on a variable that depicts a spatial distribution are presented through visual mode cartographic techniques will be very useful.

- Although there are many cartographic techniques, only two types of cartographic techniques are discussed here.

    1. Isopleth Maps
    2. Choropleth Maps

Isopleth Maps

- Isopleth map is a map consisting of lines connecting the points of equal value.

- Basically, these maps are drawn with data pertaining to spatial distributions.

- Since these maps are based on point value the spatial distribution of those values could be shown.

    E.g. Altitude, Temperature, Rainfall, Pressure. These maps are widely used to show distribution of rainfall in Sri Lanka.

- These isopleth maps are constructed by connecting the points of equal rainfall values.

- By studying those maps the regional distribution of rainfall in Sri Lanka could be understood.

- Isopleths could be used to show human geographic variables, too. An example would be transport costs incurred from a particular place.

- In an isopleth map each line has a specific value. This value should be inserted into the isopleth in the same color.

- Since the values show only the situation along the isopleth, no idea could be obtained on the values for areas between isopleths. It is a deficiency.

Fig. 5.5.1 An Isopleth map showing the Mean Inter-Monsson

Rainfall in Sri Lanka
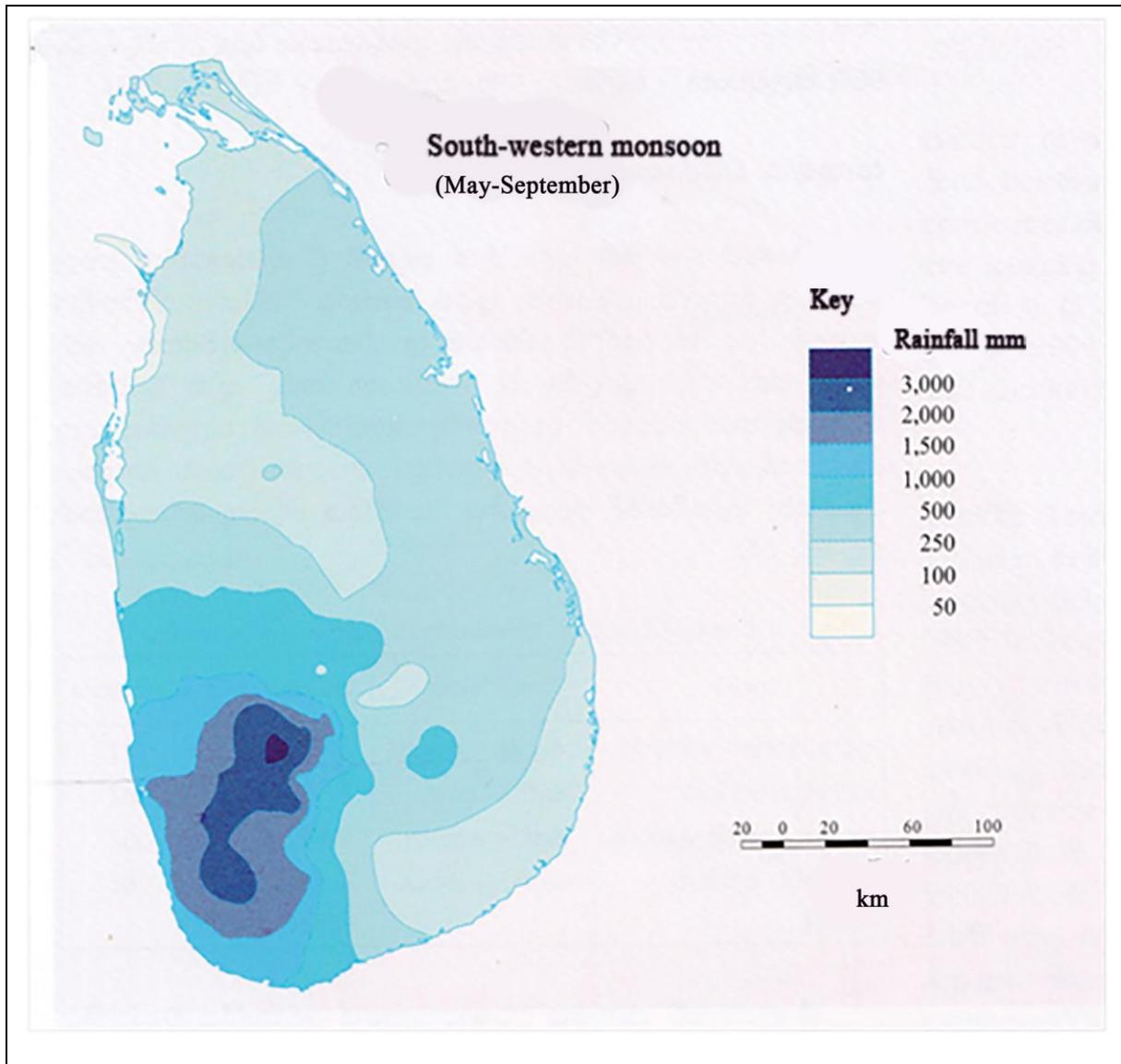
Source: Sri Lanka National Atlas, vol. I

Choropleth Maps

- Choropleth Maps are used to show the relationship between the space (land) and statistical data with the help of average densities.

- These maps are widely used to present distributions such as number of people per km^2, density of animals per km^2, Yield per hectare etc.

- For choropleth maps the data given should be grouped.

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- The grouped values should be included in the relevant map (of geographical or administrative units) and shaded. A legend must be provided.

- Table 5.5.1 shows the Density of Population in Sri Lanka by Districts in 2015. It is presented in a choropleth map in Fig. 5.5.2.

Table 5.5.1 Density of Population in Sri Lanka by Districts - 2015

District	Density of Population	District	Density of Population
Colombo	3513	Kilinochchi	100
Gampaha	1755	Batticaloa	207
Kalutara	793	Amapara	160
Kandy	739	Trincomalee	157
Matale	251	Kurunegala	359
Nuwara Eliya	434	Puttalam	274
Galle	675	Anuradhapura	134
Matara	659	Polonnaruwa	136
Hambantota	252	Badulla	299
Jaffna	643	Moneragala	86
Mannar	55	Ratnapura	348
Vavuniya	96	Kegalle	511
Mullativu	39		

Source: Dept. of Registrar General

Density of Population in Sri Lanka by Districts - 2015

District.shp

	39 – 165
	166 – 434
	435 – 793
	794 – 1755
	1756 – 3519

10 0 10 20 Kilometers

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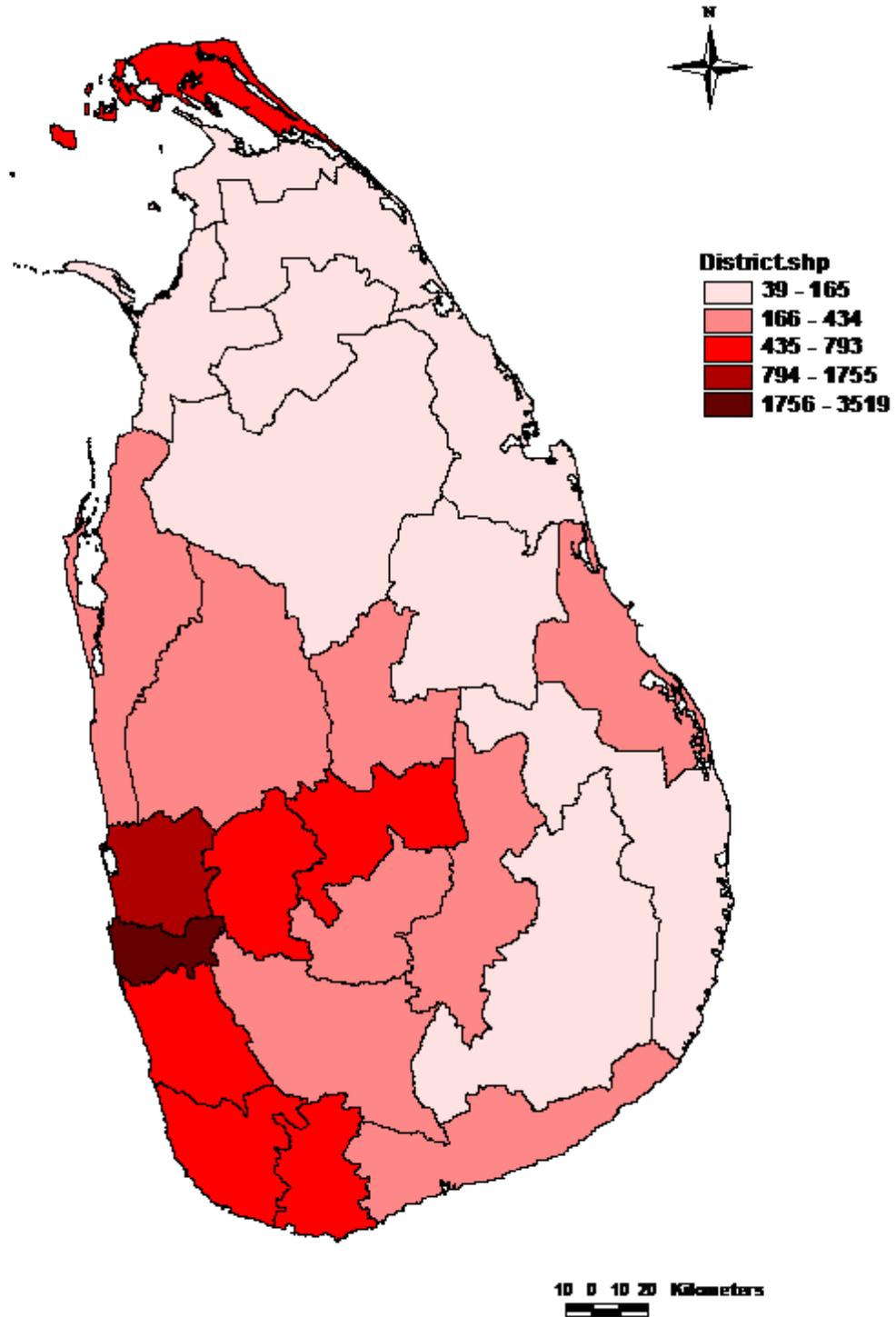
-   The distribution pattern of a variable is presented by this cartographic method.

-   In Fig. 5.5.2, the spatial distribution of the density of population in Sri Lanka is depicted.

-   Since, data are grouped, a comparative understanding of the distribution of population could be gained.

-   However, the inability to show the values pertaining to specific locations is a deficiency.
    e.g. the map does not show how the density of population has distributed within a district.

-   Giving an impression that the density of population within a km^2 has distributed evenly is misleading.

-   Although people inhabit marshy lands, deserts, forests etc. in very small numbers, the variation is not indicated by this method. It gives an incorrect understanding.

-   Especially the variations that could be seen around district boundaries are not shown in this method.

-   It provides values pertaining only to groups. No place values are indicated.