Multidisciplinary Nature of Environmental Studies 1

Learning objectives

- *To develop a comprehensive understanding of the concept and scope of environment studies.*
- *To know about the immense importance of environment as a subject.*
- *To develop public awareness about our environment and elicit collective response for its protection.*
- *To gather information about organizations and people relentlessly working in this field.*
- *To know and analyse the types of environment and environmental components and how they affect our survival.*

1.1 Definition and Concept of Environment

The word environment is derived from the French word *environ*, meaning external conditions or surroundings that favour the growth of flora and fauna, human beings and their properties and protect them from the effects of pollution.

According to Douglas and Holland (1947), environment is '*a word which describes, in the aggregate, all of the extrinsic (external) forces influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms*'.

'*Environment covers all the outside factors that have acted on the individual since he began life*'. (Woodworth and Marques, 1948)

Environment means the aggregate of a complex set of physical, geographical, biological, social, cultural and political conditions that surrounds an individual or organism and eventually determines its appearance as well as nature of its survival.

1.2 Types of Environment

Environment is practically everything that embraces an organism. Out of all the planets comprising the solar system, the only habitable planet to provide all the necessary conditions for existence of life is the Earth. The physical and chemical environments however varies at places and provides unique conditions for living beings to adapt and survive.

On the basis of human interference, environment can be categorized as natural, semi-synthetic or artificial.

- A **natural environment** is inherent, unaltered and not manipulated by man. Life processes and evolution progresses are unhindered in such an environment. However, one does not often find such places in the present day. The core areas of the biosphere reserve are examples of natural ecosystems.
- A **semi-synthetic environment** is the natural environment that is modified partially by human intervention, namely development of lakes, aquaculture tanks and so on.
- An **artificial or man-made or synthetic environment** is when the natural environment is deliberately controlled and converted by mankind. For example, aquariums, cities, community parks, paddy fields or the tissue culture laboratories.

Kurt Lewin, a German-American psychologist, emphasized three types of environment that manipulate the persona of an individual.

- **Physical environment** refers to the physical space, the weather and climatic conditions that influence the organism. The physique and working efficiency of an individual depends much on the climatic conditions. Short and sturdy build-ups are features of humans in cold climates; their reduced body surface area allows more heat to be retained. In hot regions, a thinner and long limbed structure allows more heat to be lost easily. Races such as Ethiopian or Negroids of Africa, the Caucasians of Europe, Western Asia, Australia and major part of America or Mongolians of East Indies, China, Japan, shows variation in skin colour owing to variation in the level of melanin synthesis. Lighter skin allows more penetration of UV rays to facilitate vitamin D synthesis whereas darker skin prevents the penetration of UV rays. The blacks having more dense bones, hence less buoyant but loose less than 1 percent of the bone mass annually after mid-thirties; Whites with less dense bones lose about 2.5 per cent of bone mass annually and is more prone to aging.
- **Social and cultural environment** is made up of moral values, cultural background and emotional drives that modify life and nature of an individual. This in turn is dependent on the social, economic and political conditions surrounding an individual.

  Man seems to be the most civilized and skillful of all the organisms. This contributes to a highly systemic social organization.
- **Psychological environment** is the physical, social and cultural environment that limits one's activities. This sets boundaries for the individual, triggering thought processes and changing behaviours of an individual.

1.3 Multidisciplinary Nature of Environmental Studies

Environmental studies cover every aspect that affect a living organism, as it interacts with the surroundings in its quest to live. Environmental studies are integrative, but the core of the subject comprises biological sciences like zoology, botany, microbiology and physiology. Many environmental concerns can be resolved through application of biotechnology and molecular biology, while bioinformatics can serve as a database at molecular level. Environmental studies is therefore multidisciplinary and aims at unraveling the ways in which human beings and nature correlate, sustaining life and man's unquenchable thirst for development with limited and finite resources.

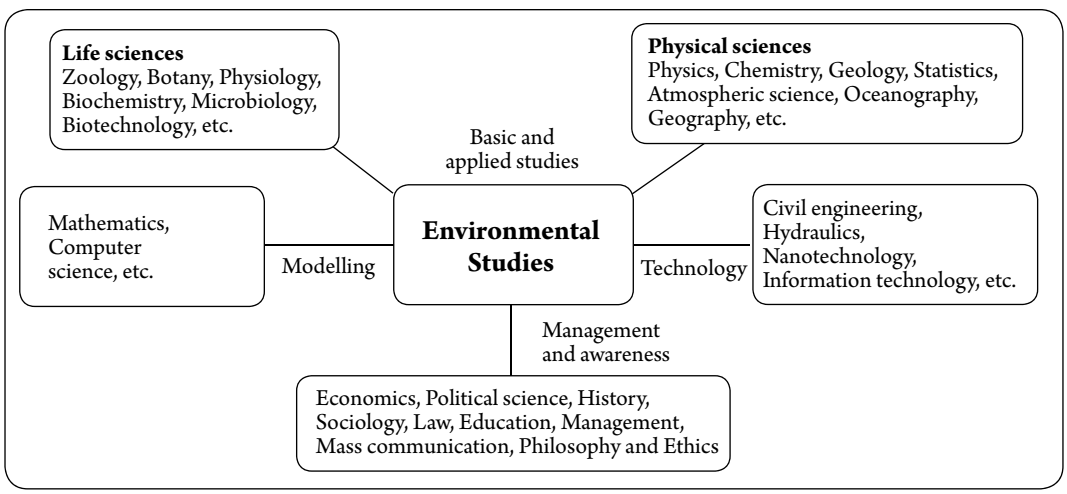
Physics, chemistry, biology, anthropology, geology, engineering, archaeology, sociology, economics, statistics, political science, law, anthropology, management, technology and health sciences are all its components. Among these physics, chemistry, geography, geology and atmospheric science help us understand the basic concepts of structural and functional organization, as well as the physical characteristics of our environment.

Data simulation and interpretation needs the application of statistics and computer application, while mathematical science is often used in environmental modeling. The technical solutions for pollution management, waste management, green building and green energy can be found with expertise from the fields of engineering and architecture. The achievement of sustainability at all levels is interwoven with and dependant on international cooperation which in turn rests on international relations. Principles of sustainable development determine the drafts and negotiation of international accords and security issues. International cooperation is an indispensible factor in dealing with global environmental issues like climate change, trans-boundary pollution, trade in hazardous substances, ozone layer depletion, biodiversity loss, etc. Economics enables us to gain a better understanding of the social background needed to achieve growth and development.

Keeping all these in mind, management studies will enable us to formulate policies, followed by legislation for their implementation. The study and treatment of environment is very much connected with philosophy, ethics and cultural traditions that help us achieve our goal sustainably. The air that we breathe, the water that sustains our lives, the food that gives us energy, the towns and the cities that we live in, in fact everything around us constitute the environment. It is the sum total of all life support systems.

The elements that constitute the environment have been revered and worshipped by our ancestors. Our forefathers, in almost all the major civilization around the world, understood the fragile nature of the environmental system. They also discovered the need to lead a lifestyle that was in sync with the environment. It was this basic understanding, profound as it may sound now, led to their worshipping of nature in its various forms.

Box 1.1: Multidisciplinary nature of environmental studies



However, the industrial revolution beginning in 1760 introduced a paradigm shift in man's interaction with the environment. Rapid industrialization needed huge amounts of resources to feed the wheels of progress. Europe and then America rode the tidal wave of economic development, discarding the frugal and stoic ways of our forefathers and speeding towards hedonistic lifestyles based heavily on a culture of consumption.

Dams were built that harnessed river water to generate electricity and provide water for agriculture. Traditional farming methods were replaced by ones that depended on massive infusion of chemicals in the form of fertilizers and pesticides. Agricultural production boomed, but entire riverine systems were destroyed irretrievably and ecosystems were devastated.

Factories needed to go full throttle to match the increasing demands, as a result nature's womb was pillaged – fossil fuels were extracted and burnt to power the surge of progress. However, in doing so, humans not only pushed the availability of resources towards exhaustion, but also sacrificed myriad life forms by forcing them towards untimely extinction.

A growing population and rapidly incremental demand needed more and more. This need led to the destruction of Earth's forest-cover, which in turn led to the loss of habitats for organisms that lived in these forests. Finally, it also added to the process of climate change and global warming.

1.4 Scope of Environmental Studies

The last two and a half centuries were most important since the beginning of history in terms of human development. In an all round attempt to control and exploit nature and its services, man has literally whacked up everything in the name of development. However, in doing so we set into motion complex changes that are changing the vary basics of nature and are promising to unleash furies the kind of which have not been witnessed before.

The scope of Environmental Studies is not only limited to studying mere concepts, philosophy, ethics, components and the problems associated with resource depletion, pollution and population explosion, but also to find out a practical global solution in the form of raising public awareness – a heart to feel the immediate need for environmental protection leading to increased participation at all levels and a mind to develop scientific and effective management strategies and solution to all the problems we are currently facing. Acceptance of human error and the need for immediate steps to reverse the trends, in this context, is a relatively new concept. That the resources of the world are finite, that Mother Earth has enough for all of us, but not enough for our greed, too are concepts from the other side of the industrial revolution that are gradually regaining ground. And in their wake, the need to lead environmentally responsible and sustainable lifestyles is gaining currency.

Box 1.2: Scope of environmental studies

Expertise in the field of environmental science can be placed as:

- Environment consultant
- Toxicologist
- Environment manager
- Environmental engineer
- Conservation officer
- Waste management officer
- Scientist in water and air quality
- Public health practitioner
- Architect of landscape design
- Urban planner
- Transport management

1.4.1 Few applications

1.4.1.1 Green marketing

The term 'green marketing' signifies an all-inclusive marketing notion in which the manufacturing, marketing, consumption and disposal of goods and services take place in a manner that is less detrimental to the environment with increasing awareness and realization about the bearings of global warming, non-biodegradable solid leftover, dangerous impact of pollutants etc. This transference to 'green' sounds costly in the short run; but ultimately in the long term it shall certainly prove to be obligatory, valuable and cost effective. The concept of green marketing received importance in the late 1980s and1990s after the first workshop was organized in Austin, Texas in 1975 on the concept of 'ecological marketing'.

According to Peattie (2001) director, BRASS Research Center, Cardiff, UK, green marketing has three segments of growth.

- **'Ecological' green marketing** whereby all marketing activities were centered on removal of environment glitches and to put forward explanation for ecological apprehensions.
- **'Environmental' green marketing** whereby importance is given to clean technology which will address the issues of pollution and waste.
- **'Sustainable' green marketing** which gained importance in the late 1990s and early 2000 lays stress on sustainability.

Box 1.3: Characteristics of green products

- Products which are originally grown.
- Products which are recyclable, reusable and biodegradable.
- Products constituted with natural components.
- Products comprising recycled and non-toxic chemical substances.
- Products containing permitted chemicals.
- Products that will not contaminate the environment.
- Products that are tested on animals.
- Products that are packaged in an eco-friendly way i.e., with reusable and refillable containers etc.

Examples of green marketing in India: case studies

Case Study 1.1: State Bank of India (SBI)

The SBI is currently utilizing eco-friendly and energy-friendly tools in almost 10,000 new automated teller machines (ATMs). This enables SBI to save on power costs and earn carbon credits towards commitment of reducing its carbon footprint. SBI has also launched 'Green Channel Counter' towards green service. It emphasizes on banking without use of paper which means banking without any deposit or withdrawal slip, cheques or money dealing forms. All these dealings can be completed through SBI shopping and ATM cards. In addition to this, the SBI is the first in India to employ a wind farm of 15 MW capacity that has been developed by Suzlon for the generation of power.

1.4.1.2 Environmental management system and ISO14000

The ISO 14000 series provides the requirements and addresses various aspects of environmental management system. It is one of more than 15,000 voluntary International Standards published by the International Organization for Standardizations (ISO). It provides organizations with practical tools, particularly those looking forward to identify and control their environmental impact, and constantly improve their environmental performance.

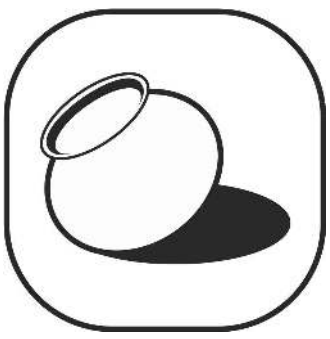
ISO 1400 has the following benefits:

- low raw material use;
- reduced energy expenditure;
- enhanced process efficiency;
- decreased waste generation and disposal costs; and
- use of recoverable resources.

ISO 14000 standards series

- ISO 14001: Specifies the actual requirements for an environmental management system.
- ISO 14004: General guidelines on principles and on the development and implementation. of environmental management systems and also their co-ordination with other management systems.
- ISO 14010, 14011 and 14012: Guidelines for environmental auditing.
- ISO 14020, 14021, and 14024: Environmental labeling and declarations.
- ISO 14031 and 14032: Environmental Performance Evaluation (EPE).
- ISO 14040, 14041, 14042, and 14043: Life Cycle Assessment (LCA).
- ISO 14050: Terms and definitions.
- ISO/TR 14061: Information to assist forestry organizations in the use of environmental management system standards.
- ISO 14062: Discusses making improvements to environmental impact goals.
- ISO 14063: Environmental communication – guidelines and examples.
- ISO 14064: Measuring, quantifying, and reducing greenhouse gas emissions (GHGs).
- ISO 19011: Specifies one audit protocol for both 14000 and 9000 series standards together.

Figure 1.1: Eco mark logo in India



1.4.1.3 Eco-mark scheme in India

In order to boost customer consciousness or awareness, the Indian government have launched the eco-labeling plan known as 'Eco-mark' in 1991 to facilitate simple recognition of eco-friendly goods.

These standards follow a cradle-to-grave approach, i.e. starting from the extraction of raw materials to production and finally up to disposal. An earthen pot is the logo of Eco-mark scheme in India.

1.5 Components of Environment

The components of environment are atmosphere, hydrosphere, lithosphere and biosphere.

1.5.1 Structure of atmosphere

The layer of air surrounding the Earth is the atmosphere. The atmospheric mass is about 5×10^{18} kg, 75 per cent of which is limited within about 10 km. The atmosphere thins out with increasing altitude, with no distinct boundaries. The Karman line at 100 km is often used as the partition between the atmosphere and outer space. Several layers can be distinguished in the atmosphere, based on composition and temperature variation. Atmospheric science or aerology is the study of Earth's atmosphere and its processes.

Starting from the ground level is the troposphere that varies between 8 and 12 km in thickness. It is thin at the poles (8 km) and thicker at the equator (18 km). Typically air is composed of nitrogen (78.08 per cent), oxygen (20.95 per cent), argon (0.93 per cent), carbon dioxide(0.031 per cent) along with water vapour, neon, helium, krypton, xenon, hydrogen, methane, nitrogen monoxide, ozone, etc. Warm air, being lighter near the surface of the Earth can readily rise above. The molecules can travel to and fro in the troposphere in just a few days. Such vertical movement or convection of air produces clouds and rain and gives rise to most of the weather conditions. Temperature decreases with increase in altitude in the troposphere till people reach the topmost layer or tropopause. Temperature decreases at a rate of 6.5°C for every 1 km and this is known as **environmental lapse rate**. Tropopause may reach a temperature of –55°C at the poles. Sometimes the temperature increases with altitude in the troposphere, giving rise to a situation called **temperature inversion**. Such conditions restrict the vertical mixing of air and result in air pollution incidences at ground level.

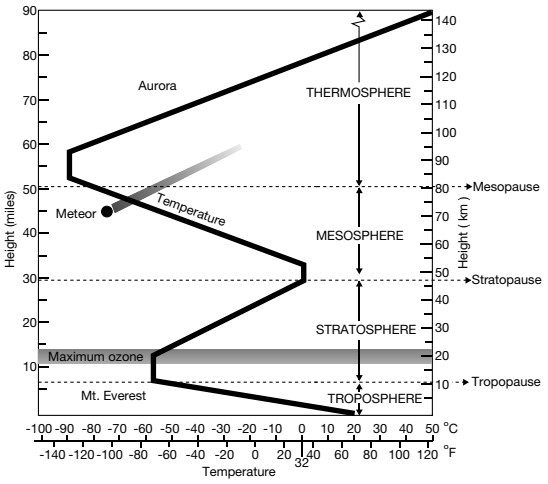
The second layer or stratopause extends from tropopause to about 50 km till stratopause. The region is clear and dry with strong and steady winds. Owing to non-turbulence, presence of steady horizontal winds and being located above stormy weather, jet planes route through stratosphere. Temperature is relatively constant up to 25 km and then increases as one goes up the stratosphere. Top of the stratosphere may attain temperatures close to 0°C. Ozone layer is mostly concentrated between 20–30 km. The ozone absorbs the UV (Ultraviolet) B radiation in the wavelength of 290–320 nm. Since ozone is present in this layer it is also called ozonosphere.

Mesosphere lying above the stratosphere extends from above 50 km to about 80 km. It contains almost 0.1 per cent of the atmospheric mass and is rarified. Mesosphere is highly turbulent and experience waves. The excited atoms here absorb a great deal of solar radiation, even then temperature drops to about -100 to -90°C at mesopause. Water vapor freezes into ice clouds which can be seen after sunset if hit by sunlight. They are called Noctilucent Clouds (NLC). This is the

stratum in which many meteors burn up while entering the Earth's atmosphere and are perceived as shooting stars from the Earth's surface.

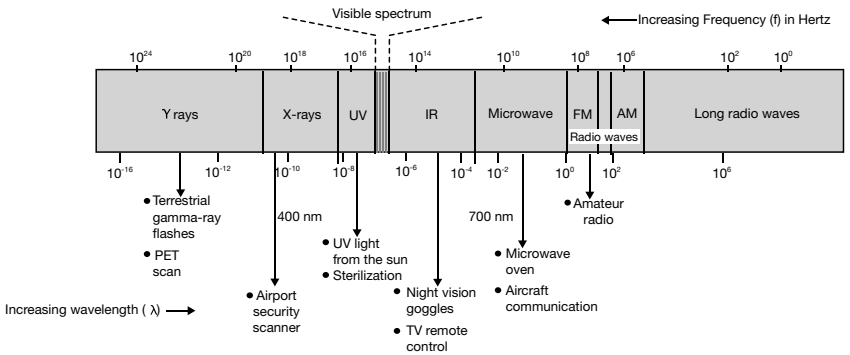
The topmost layer from mesopause is the thermosphere. Temperature increases with increasing altitude and can be more than 1500°C. This is due to the absorption of the UV radiation and X rays by the few molecules present there. Nitrogen and oxygen are found mainly in between 100 to 200 km. The part of the thermosphere (80 km to 500 km) above the Earth's surface is referred to as ionosphere. The atoms exist as ions and hence this layer gets its name. Space Shuttles, the Hubble Telescope and many Earth observing satellites are stationed in this region. The ionization process leads to the creation of beautiful illumination; the Aurora Borealis in the northern hemisphere and Aurora Australis in the southern hemisphere. Auroras are usually observable from within the Arctic or Antarctic circles. The free electrons present in the ionosphere cause the high frequency waves to be refracted and ultimately reflected back to earth. The more the density of the electrons, the higher will be the frequencies that can be reflected. During daytime four regions (D from 50–90 kms, E from 90 to 140 kms, F1 from 140–210 kms and F2 above 210 kms) exist. Sometimes F1 and F2 might merge to form F region. During night time D, E and F1 regions become depleted of free electrons leaving only F2 region available for communications. Hence F2 region is the most important for high frequency radio wave propagation as it allows longest communication pathways on account of its highest altitude and that the lifetime of the free electrons is greatest in this region. The outer most layer above 500 km to about 10,000 km is the exosphere which gradually merges into space. Molecules here have enough kinetic energy to escape the Earth's gravity. Hydrogen and helium are the prime components in this region. The region between 5,000 km to >> 60,000 km is also referred to as magnetosphere as it is strongly influenced by the Earth's magnetic field and the solar wind. This region is occupied by Geosynchronous satellites and comprises the Van Allen radiation.

Figure 1.2: Thermal stratification of atmosphere



The atmosphere is a protective blanket of gases, surrounding the Earth that helps in sustaining life on the Earth. It protects us from the hostile environment of outer space, absorbing most of the cosmic rays and harmful UV radiation. It transmits the visible, near infrared radiation (300 to 2,500 nm), part of UV radiation (mainly UV A) and radio waves.

Figure 1.3: Human application of the solar spectrum

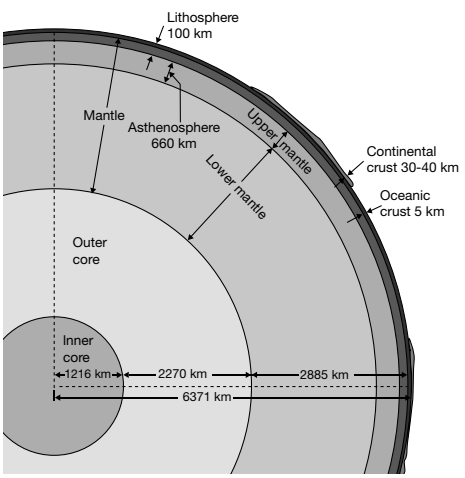


1.5.2 Structure of lithosphere

The diameter of Earth is about 12,700 km. The temperature and pressure increases as one penetrates deeper and deeper. The core temperature is assumed to be 5000–6000°K.

Earth comprises three concentric regions:

Figure 1.4: A sketch to show the internal structure of the Earth



- The **core** of approximately 7,000 km diameter is divided into inner core and outer core. The solid inner core has a radius of 1,216 km and density of 13 grams/cc. The liquid outer core has an average thickness of 2,270 km and density of 11 grams/cc. The core is supposed to be composed of an iron and nickel alloy. About 10 per cent of the layer is supposed to be composed of sulphur and oxygen as these elements are abundant in the cosmos and dissolve readily in molten iron.
- The middle layer is the **mantle** which is about 2,900 km thick. The upper mantle of 660–670 km thickness from the base of the crust, mostly contain olivine and pyroxene minerals. The asthenosphere, lying at a depth of 100–200 km from the Earth's surface, is a weak and deformed layer, which acts as a lubricant for the plate tectonics to glide and may extend up to 660 km. The lower mantle stretches from 670 km to 2,900 km below the Earth's surface. The lower mantle probably comprises silicon, magnesium and oxygen along with some iron, calcium and aluminium.
- The outer most part of Earth is the **crust**. Outer crust or continental crust may be 30 to 40 km in thickness containing mostly granite rocks with a density of 2.7grams/cc. The predominant elements are silicon and aluminium, hence is known as Sial layer. The inner crust or oceanic

crust is only 5 to 10 km thick containing basaltic rocks with an average density of 3.0 grams/cc. This layer contains silicon and magnesium and hence is known as Sima layer. Six major plates (Eurasian, American, African, Indo-Australian and Pacific) and twenty minor plates are involved in plate tectonics.

Lithosphere is a 100 km thick layer comprising the crust and the upper part of asthenosphere that can glide over the rest of the mantle. This is the region of earthquakes, volcanic eruptions, building of mountains and continental drifts. It exhibits various topographical features like continents, oceans, seas, lakes, mountains, plateau, plains, deltas, beaches, cliffs and dunes. It comprises rocks (igneous, sedimentary and metamorphic rocks) that contain all the minerals (dolomite, magnetite, hematite, etc.) and elements (iron, nickel, nitrogen, hydrogen, oxygen, sulphur, phosphorus, etc.) needed for our survival and prosperity. The rocks turn into soil by pedogenesis, which sustains the biota. A tabular representation about earth's interior is uploaded on the website.

1.5.3 Structure of hydrosphere

Water is found in hydrosphere, lithosphere and atmosphere and in almost everything including our body cells. It is an oxide of hydrogen and serves as one of the source to hydrogen and oxygen in metabolism. Its physical and chemical properties make it unique. It is present as water vapour in the atmosphere which takes part in the formation of clouds and fogs thus regulating our weather conditions. In the soil, water is usually present in form of gravitational water, capillary water, hygroscopic water and as combined water. The water that percolates down under gravitational force until it reaches the saturated zone is the gravitational water. The part lying above this saturated zone is water table. Such water is used when it comes out naturally as spring or by digging of wells. The water retained in the soil against the gravitational pull around the soil particles is capillary water. Capillary water is apprehended by cohesion (attraction between the water molecules to each other) and adhesion (attraction of water molecule with the soil particle). Water remaining in the soil after drying of capillary water is known as hygroscopic water which is lost when the soil is subjected to a temperature of 105°C. Water forms very thin film around soil particles and are not available to the plant. After hygroscopic water is lost, all that remains is known as is combined water. Both combined and hygroscopic water is of no use to plants.

Most of the water found on Earth is marine. The oceans and seas contain more than 97 per cent of the hydrosphere. Ice caps and glaciers comprise a slightly more than 2 per cent of all water on Earth. The groundwater and soil water makes up about 0.63 per cent and 0.005 per cent of freshwater, respectively. Soil water refers to the water arrested in spaces amid soil particles. Of the total water on Earth, freshwater streams, rivers, ponds, lakes, and inlands seas comprise less than 0.03 per cent. The water content of the atmosphere is about 0.0001 per cent.