Environment and its Components

Prof. S.A. Norbert
University of Colombo

- 'Environment' is a term much used in modern society.
- What does it mean?
- It is synonymous with nature.
- having a human element as represented by the cultivated landscape of agricultural areas.
- or the built environment of cities

- One of the most important factors in any study of the environment is the idea of relationships
- objects do not exist in their environments in complete isolation. Each is affected by adjacent objects and in turn many influence them.
- In the past, ecologists tended to concentrate on the living elements in the system, investigating individual species of plants and animals or community patterns of interdependent organisms, which along with their immediate surroundings formed an ecosystem.
- Environmental scientists on the hand approached their studies through the non-living elements of the system.
- As the human element has assumed a greater and greater role in modern environmental and ecological studies, the difference between the disciplines has declined.

- Now terms such as “environment” and “ecosystem” are often seen as interchangeable, particularly at the popular level, and although environmental scientists and ecologists continue to identify distinct differences between the disciplines.

- They often investigate similar issues using similar approaches and techniques. Both disciplines share the theme of “interrelationships”, a concept that recognizes the intimacy and potential impacts of linkages in the natural system.

- **What is Environment?**

  Environment = Surroundings?
  Linkages/ interrelationships
  Scale
  Change

  Environment = Nature?
- Environment = Nature
  +
  Human elements?



Cultivated landscape built environment

- Environment =Ecology?
- Both study the links between living (biotic) and non-living (abiotic) elements of the earth/atmosphere system

- When one element in an environment changes, others will be faced with the need to change also, a situation that has important implications for current and future environmental issues.

- Many current environmental problems, for example, have arisen because of ignorance of environmental interrelationships or knowing disregarded of them.

- There is also the question of scale.

- Many environments, ranging from microscopic scale to the whole earth environment itself. The individual elements in any one environment, the various environments are closely interlinked.

- As a result, the disruption of even a small-scale environment may be followed by change at a world scale.

- Change is an integral part of any environment, and , under normal circumstances, environments are dynamic or elastic to accommodate it.

- Most environments are in a continual state of flux, experiencing series of adjustments. – a state known as dynamic equilibrium.

- "When relative stability can be maintained with only minor adjustments, the environment is said to be in a steady state". These concepts have been central to the geographical approach to the environment for decades.

- It received under attention as part of the Gaia hypothesis promoted by James Lovelock (1972).
- There are times, when the amount of change exceeds the ability of the environment to accommodate it. The end result is environmental disruption.
- Although environmental change and environmental disruption occur naturally, climate change and associated environmental disruption appear regularly in the earth's history.
- In practice, human elements have become the main cause of change, disruption and deterioration in the environment. (Human beings as animals are an integral part of the environmental scheme of things.

- **Why has this been so?**

- It has much to do with the form that development has taken, along with society's attitude to environment and knowledge of how it works.

- It is common knowledge that the earth/atmosphere system is a closed system in material terms, and as a result, resources are finite.

- This was expressed in a more popular form, in 1966, by the economist Kenneth Boulding through the concept of **"Spaceship Earth"**.

- He linked the earth to a spaceship in which the occupants had to survive using the air, water and food available at lift-off, since there was no means of delivering additional material once the ship was in orbit.

- In the case of the earth, the concept applies to minerals and the other commodities upon which modern society has become to depend, but also to all those resources, including air, water, soil, vegetation and animals, that are normally considered part of the natural environment.

- The latter groups of resources has been used for thousands of years, but are mostly still available because of very efficient recycling processes built into the earth/atmosphere system.

- Chemical elements such as carbon, nitrogen and sulphur are recycled continuously, as is water.
- Plants and animals are also recycled in a way, in as much as they are able to perpetuate their species through reproduction.
- Unfortunately, these cycles have been disrupted as a result of human activities, leading to a variety of environmental problems.
- The disruption of the carbon cycle is associated with global warming and the disruption of the sulphur cycle is associated with acid rain. Similarly, pressure on the hydrological cycle in some areas has caused shortages of water and also series of water pollution.

- In contrast, where energy is considered, the earth/atmosphere system is an open system.

- Solar radiation provides the energy required to allow the multitude of elements that make up the environment to function, being converted in the process into terrestrial energy, which ultimately passes out of the system into space.

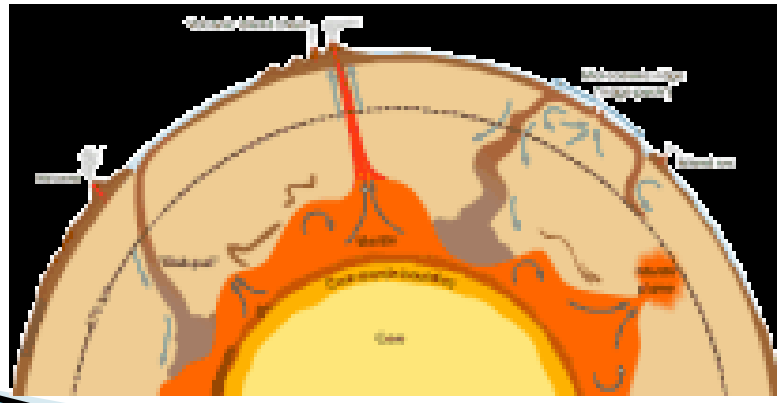
- The smooth flow of energy is interrupted by storage mechanisms, in which retain some of the solar energy in the system for periods ranging from a few months (stored in plants during growing season) – to millions of years (in fossil fuels in the earth's crust).

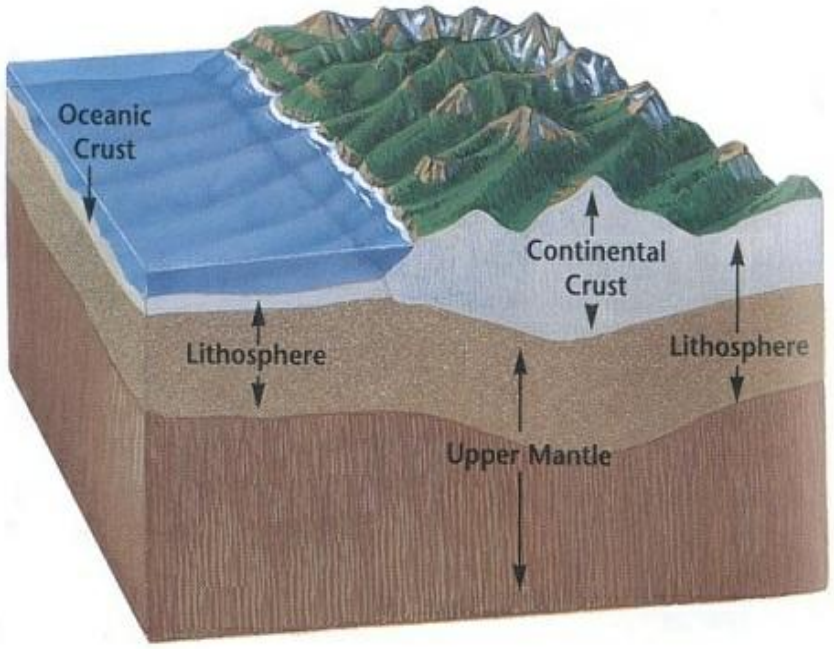
- disruption of the flow of energy through the system by human activities is associated with a number of pressing environmental issues, including global warming, ozone depletion and increased atmospheric turbidity.

There are many different approaches to the study of the earth/atmosphere system. But from the environmental view point there are advantages in considering the system as a group of inter locking components.

Lithosphere: The solid inorganic portion of the earth's surface consisting of the rocks of the crust, plus the broken and unconsolidated particles of mineral matter that released on it.
It is the most superficial layer of the solid Earth, characterized by its rigidity. It is formed by the earth's crust and the contiguous zone, the uppermost part of the mantle.

It is formed by plates that move over the semi-molten mantle. That movement causes the distance, approach and collision of the plates (called tectonics), creating or destroying the relief.





The lithosphere (from the Greek for "rocky" sphere) is the solid, outermost shell of a rocky planet. In the case of the Earth, the lithosphere includes the crust and the upper layer of the mantle that is joined to the crust.

The contains a rich variety of minerals. In addition, it continually interacts with the atmosphere and hydrosphere.

To sustain our lives, we need access to air, water, soil, and sunlight, and we need the ecosystems created by plants and animals. The lithosphere gives us access to all of these simultaneously.

In forming the lithosphere, the Earth's crust and upper mantle are attached to each other, but they differ in chemical composition. The boundary that marks this change in chemical composition is known as the **Mohorovičić discontinuity** (or the Moho discontinuity).

- Thus the distinguishing characteristic of the lithosphere is not its composition but its flow properties. It floats on the asthenosphere, which is the heat-softened layer of the mantle below the lithosphere.

- The lithosphere is fragmented into relatively strong pieces called *tectonic plates*, which move independently relative to one another. This movement of lithospheric plates over the asthenosphere is described as **plate tectonics**.



Atmosphere:

The vast gaseous envelope of air that surrounds the earth is the atmosphere.

The Atmosphere is divided into layers according to major changes in temperature. 99% of the total mass of the atmosphere is below 32 kilometers.

Troposphere - 0 to 12 km - Contains 75% of the gases in the atmosphere. This is where you live and where weather occurs. As height increases, temperature decreases. The temperature drops about 6.5 degrees Celsius for every kilometer above the earth's surface.

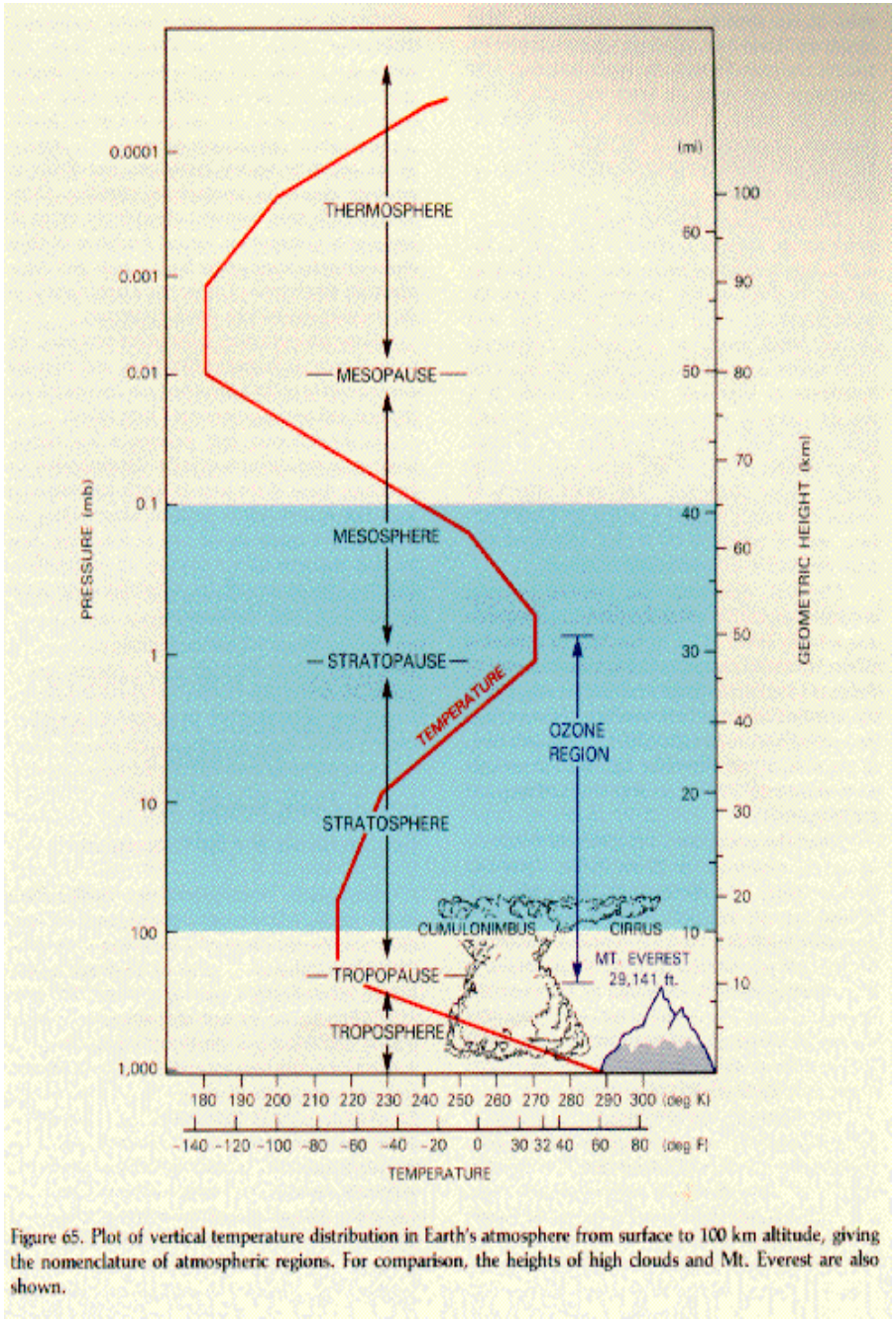


Figure 65. Plot of vertical temperature distribution in Earth's atmosphere from surface to 100 km altitude, giving the nomenclature of atmospheric regions. For comparison, the heights of high clouds and Mt. Everest are also shown.

- **Tropopause - located at the top of the troposhere. The temperature remains fairly constant here. This layer separates the troposphere from the stratosphere. We find the jet stream here. These are very strong winds that blow eastward.**

- **Stratosphere - 12 to 50 km - in the lower part of the stratosphere. The temperature remains fairly constant (-60 degrees Celsius). This layer contains the ozone layer. Ozone acts as a shield for in the earth's surface. It absorbs ultraviolet radiation from the sun. This causes a temperature increase in the upper part of the layer.**

- **Mesophere - 50 to 80 km - in the lower part of the stratosphere. The temperature drops in this layer to about -100 degrees Celsius. This is the coldest region of the atmosphere. This layer protects the earth from meteoroids. They burn up in this area.**

- **Thermosphere - 80 km and up - The air is very thin. Thermosphere means "heat sphere". The temperature is very high in this layer because ultraviolet radiation is turned into heat. Temperatures often reach 2000 degrees Celsius or more. This layer contains:**

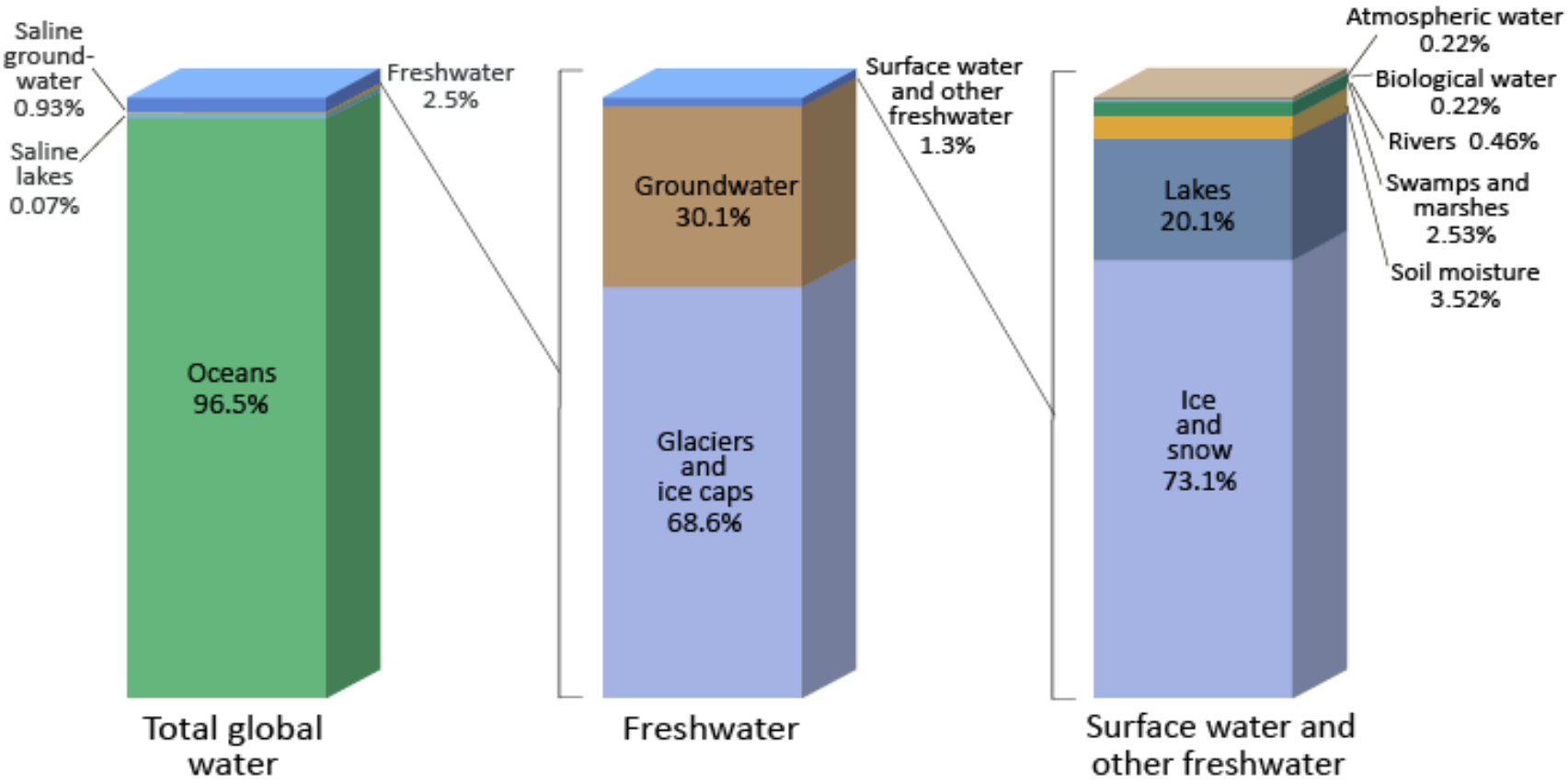
- **Ionosphere - It extends from about 80 to 550 km. Gas particles absorb ultraviolet and X-ray radiation from the sun. The particles of gas become electrically charged (ions). Radio waves are bounced off the ions and reflect waves back to earth. This generally helps radio communication. However, solar flares can increase the number of ions and can interfere with the transmission of some radio waves.**

- **Exosphere - the upper part of the thermosphere. It extends from about 550 km for thousands of kilometers. Air is very thin here. This is the area where satellites orbit the earth.**

- **Magnetosphere - the area around the earth that extends beyond the atmosphere. The earth's magnetic field operates here. It begins at about 1000 km. It is made up of positively charged protons and negatively charged electrons. This traps the particles that are given off by the sun.**

- **They are concentrated into belts or layers called the Van Allen radiation belts. The Van Allen belts trap deadly radiation. When large amounts are given off during a solar flare, the particles collide with each other causing the aurora borealis or the northern lights.**

Distribution of Earth's Water

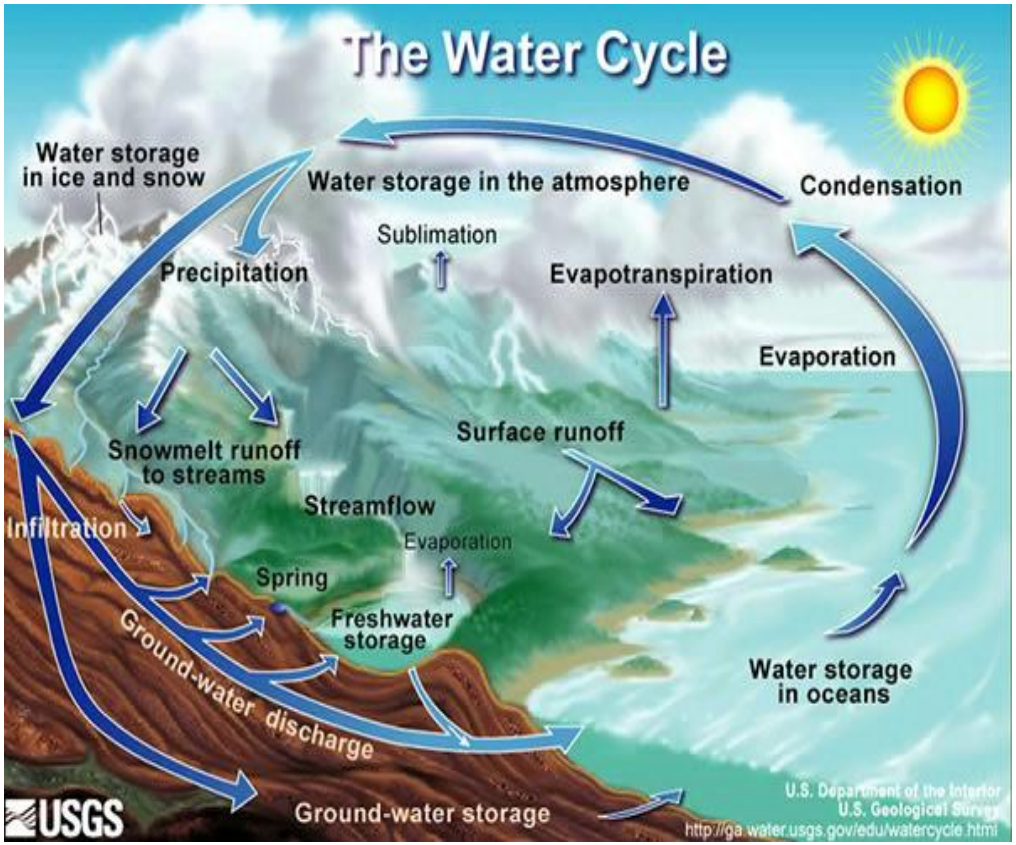


Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.

The waters on and in the earth's surface make up the hydrosphere and all living things comprise the biosphere or ecosphere.

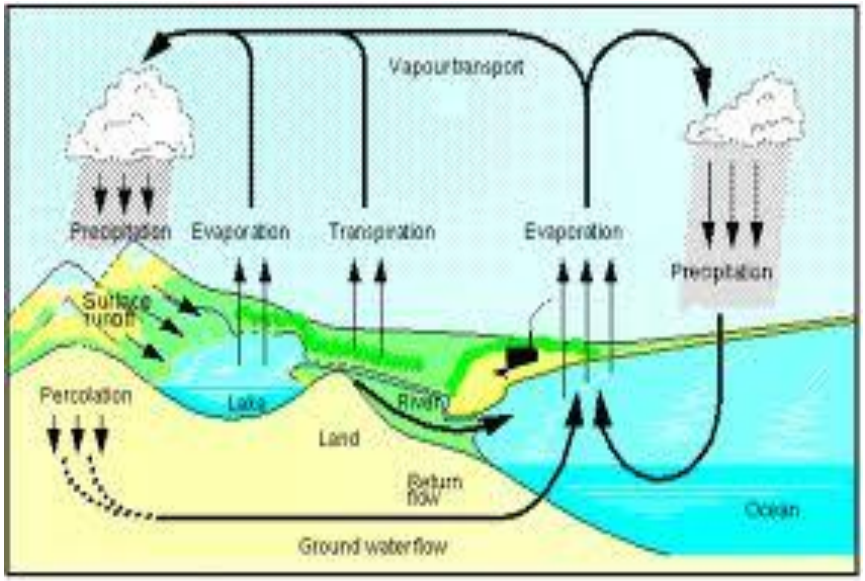
About 97 percent of all water is in the oceans. Three percent of all Earth's water is freshwater. The majority, about 69 percent, is locked up in glaciers and icecaps, mainly in Greenland and Antarctica.

Of all the freshwater on Earth, only about 0.3 percent is contained in rivers and lakes.



- The world's total water supply of about 332.5 million cubic miles (about 1,385 million cubic kilometers) of water, over 96 percent is saline. And, of the total freshwater, over 68 percent is locked up in ice and glaciers.

- Another 30 percent of freshwater is in the ground. Thus, rivers and lakes that supply fresh surface water for human uses only constitute about 22,300 cubic miles (93,100 cubic kilometers), which is about 0.007 percent of total water, yet rivers are the source of most of the water people use.



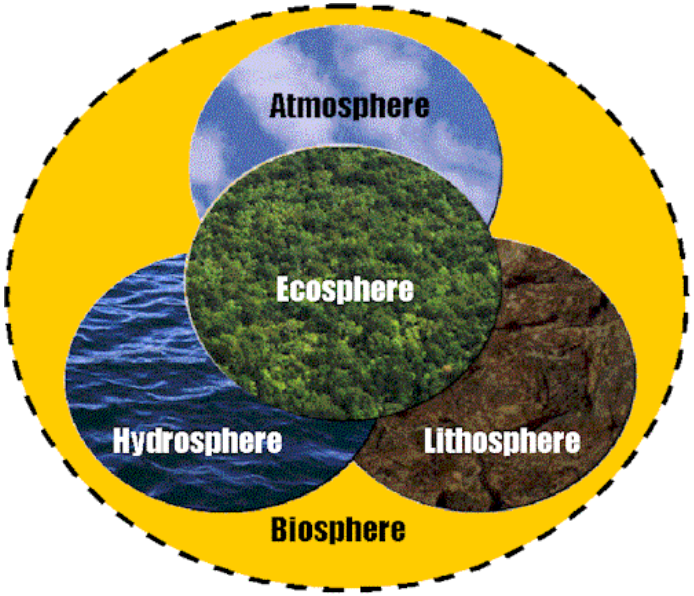
Courtesy Erich Roeckner, Max Planck Institute for Meteorology

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The **four spheres** are not discrete articles. They are strongly interlinked with the combination of the elements in the lithosphere, hydrosphere and atmosphere providing conditions appropriate for the life that is characteristics of the biosphere.

Each containing the elements of the others. The oceans are a major part of the hydrosphere but they receive sediments from the lithosphere and the fish and other organisms they contain are part of the biosphere.

The atmosphere contains water from the hydrosphere and particulate matter from the lithosphere.





- The biosphere also affects the emissions of certain gases flows, such as carbon dioxide and methane. The plankton in the ocean surface uses the dissolved carbon dioxide for photosynthesis. This establishes a gas flow with the ocean. In fact, it fixes the gas from the atmosphere. At death, the plankton transports carbon dioxide to the ocean floor.

- It is estimated that up to 80% of the oxygen produced by photosynthesis is the result of the action of ocean algae, especially in the coastal areas.

- The biosphere also affects the amount of aerosols in the atmosphere. Billions of spores, viruses, bacteria, pollen and other tiny organic species are transported by wind and solar radiation that affects and influences the overall energy budget.

- Oceanic primary productivity produces compounds known as dimetilsulfitos, which are oxidized in the atmosphere to form sulfate aerosols that serve as condensation nuclei for water vapor, thus helping to form clouds. The clouds in turn, have a complex effect on the energy budget climate. So, any change in the primary productivity of the oceans may indirectly affect global climate.

- **Soil** consists mainly of mineral water from the lithosphere but also contains organisms that are part of biosphere.
- Soil moisture from the hydrosphere and air from the atmosphere in its pore spheres.
- Many modern environmental issues arise as a result of society's failure to appreciate the complexities of these inter relationships.
- When environmentalists deal with the primary environmental elements the atmosphere, hydrosphere, and biosphere usually receive most of the attention. The lithosphere seems relatively less important because it have a stability that the others lack.

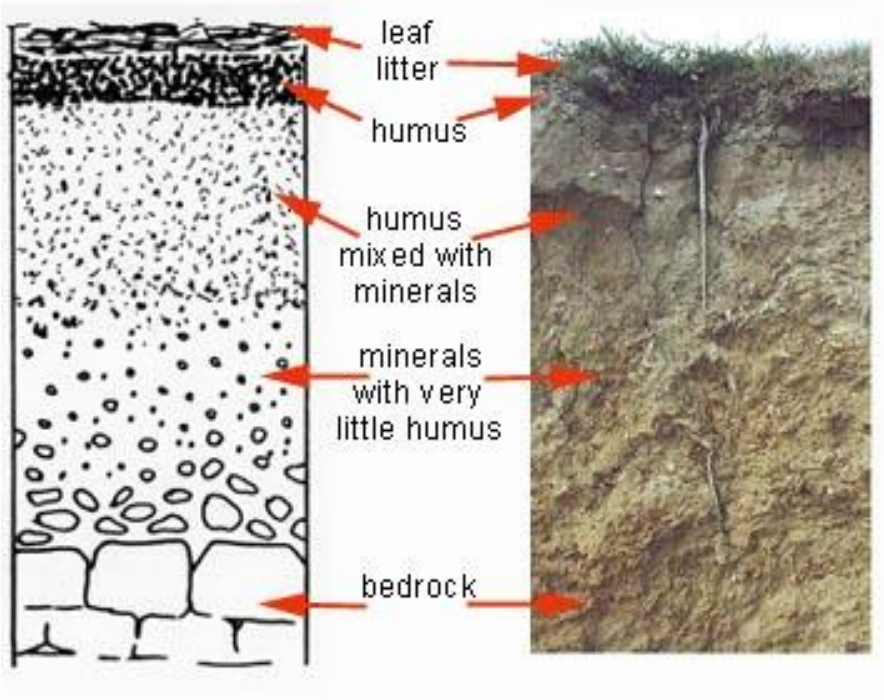


There are four distinct layers of soil under the leaf litter.

Soil profile:

Whereas soil is formed from the rock below, it is eroded away from the top. A cover of plant life slows down erosion, allowing the soil layer to build up, but there is more going on.

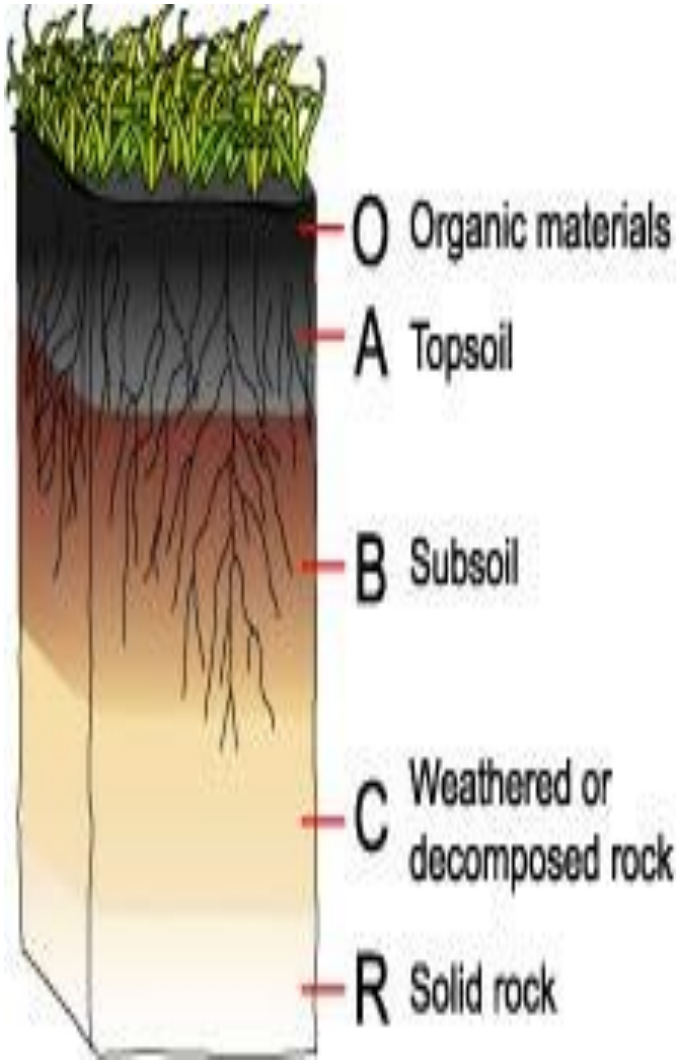
Just above the base rock, is the C-horizon, containing the recently weathered and still weathering soil. It is rich in nutrients.



The A-horizon is where most plant roots are found and all soil organisms. Its nutrients have been used by plants or leached downward, so it is relatively poor in nutrients, but rich in life.

By comparison, the B-horizon is the zone where new material from below and nutrients from above accumulate. Sometimes an impermeable layer or pan is formed above it (podsol), denying plants to access this rejuvenating source of new nutrients.

On the surface of the soil, often a thin layer is found, rich in leaf litter and other organic material.



- It is not subject to the short term changes associated with the weather systems in the atmosphere.
- The daily tidal variations of the oceans.
- Seasonal changes in the river flow characteristic of hydrosphere
- But it appears to endure in changing for decades or over centuries.
- If modern environmental problems are viewed in terms of relationships between people and their environment then the lithosphere deserve greater consideration.

- Most people are located, most of the problems are initiated.
- In Sociological terms the lithosphere consists of earth's crust and the underlying rigid section of the mantle.
- It is thinnest beneath the ocean basins but thickens under the continental blocks to as much as 300 km in places.
- It is these continental blocks that make up the earth's land surface and are most directly involved in environmental issues.

- The land surface is very unevenly distributed into a number continents separated by large expanses of ocean.
- Most of the land is in the northern hemisphere.
- All of the major industrial nations are in the northern hemisphere.
- Problems have arisen such as air pollution, water pollution, and waste disposal.
- In the northern hemisphere

  More land, more resources
  More resources, more people
  More people, more development
  More development, greater stress on the environment

Structural Features Of the Continents

Shield

- All of the continents have structural features in common namely shield areas, fold mountains and plains.
- The shield areas are the oldest geologically, with ages above 3 billion years. They are the exposed areas of ancient, stable continental rocks.
- All shield areas have mineral potential
- The world's shield areas have become major mineral store houses.
- Obtaining these minerals has led to many environmental problems.

- In the shield areas rocks are old, they have undergone the heating and pressure changes associated with metamorphosis or where they include the roots of ancient mountain chains, they have been injected with magma from the molten material that lies beneath them.

- Together these have caused minerals to accumulate in concentrations that exceed normal levels in the earth's crust.

- Landscape and hydrological changes associated with extraction and disposal and gases from the smelting of nickel ores(in Canadian shield) caused acid rain.

- Natural vegetation of the northern shield areas in North America, Europe, and Russia is coniferous forest which has provided timber for construction and the making of pulp and paper.
- Cut much faster than it can reproduce naturally
- Landscape has been changed
- Hydrological cycle has been altered
- Animal habitats have been lost or become adapted

Fold Mountains

- Along the margins of some of the continental, the world's fold mountains have been formed.
- All current fold mountains are geologically younger than the shield areas.
- Developing technology, growing demand for resources and changing socio-economic conditions that encouraged rapid population growth changed the situation.
- Activities ranging from mining, forestry and hydro-electric power production to tourism and recreation have now created serious and growing environmental deterioration in many mountain areas.

Plains

- The plains are large areas of low relief composed of sediments eroded form adjacent shield or fold mountains and deposited in major sedimentary basins.

- Plains are also found in coastal areas formed by marine erosion and deposition or caused by changing sea level.

- Commercially valuable resources such as coal, petroleum and building stone are often present in there sediments.

- Much of the environmental stress in the shield areas and in the mountains can be linked directly with the needs and wants of the more densely populated plains.

- Human population impact on the plain for several years
- First agricultural revolution took place on the plains
- Society became to domesticate plants and animals
- This is a very important stage in society's relationship with the environment
- First time human activity had altered the environment
- Domesticated flocks and herds replaced wild animal
- The aquatic environment was altered by irrigation and deterioration of the soil began

- Inappropriate land use, fertilizer use, herbicides and pesticides use, coal mining, extraction of oil and natural gas
- The agriculture and mineral resources of the plains
- Growing population and towns and cities
- As transport system improved, the resources of the shields and mountain areas were brought to the plains to be processed
- Processing and manufacturing led to the growth of industrial towns with their accompany of pollution
- The rivers became polluted with human an industrial waste
- Pollutants darkened the skies and the precipitation that fell from the clouds became acidic

- The lithosphere is not static. The process of weathering, erosion, transport and deposition continue slowly to change the shape of the landscape.
- Mass movements on slopes, flowing water, waves and ice remove some 10 million tones of sediments from the continental land misses every year.
- The lithosphere participates actively in various processes that are characteristic of a dynamic environment.
- It is linked to the hydrosphere through its influence on the hydrologic cycle, to the atmosphere through the processes that produce gases and particulate matter and to the biosphere through soils, vegetation and animals. All of these links are two-way.

- Through the 19th and 20th centuries, as the world's population expanded and technology advanced, natural landscapes were replaced at an unprecedented rate by the semi-natural landscapes of agricultural development or the un-natural conditions of industrial and urban environment.

- As a result, the natural habitat of as much as two-thirds of earth's habitable surface has been altered by human activity.

- A habitat is a specific environment that provides a population or a community of organisms with the conditions under which they are able to survive.

Threats to vegetation and wildlife

Threats to the land from human activities

- Resource extraction and depletion
- Disruption of flora and fauna
- Urbanization, Infrastructure development and waste disposal

forestry
Agriculture
Over-harvesting of fish and wildlife
Habitat destruction

- Petroleum exploration and development would interfere with the environment by destroying habitat and disrupting migration patterns.

- Some observers suggest that the herd could decline by 20-40% if development is allowed, changing not only the natural balance in the ecosystem, but also causing hardship to some 700 indigenous people in both Canada and Alaska.

- The oil developments in the deserts of Saudi Arabia and around the Persian Gulf have largely destroyed the desert biome in that area, replacing the limited flora and fauna with the industrial infrastructure of the petroleum industry and built environment of growing urban centers.

Hot desert biome

- Habitats are vulnerable to change
- Both are lightly populated with indigenous groups.
- In the past lived in reasonable harmony with their environment
- Like the tundra, the desert biome was spared much human interference in the past because of its inhospitality.
- The population lived a nomadic life style for the most part.
- Permanent settlement restricted to areas where water was readily available either at oases or along river systems (Egypt).

- The oil developments in the deserts of Saudi Arabia and around the Persian Gulf have largely destroyed the desert biome in that area, replacing the limited flora and fauna with the industrial infrastructure of the petroleum industry and built environment of growing urban centers.

- The large mammals that habitat the desert, such as wild goats, gazelles and the cheetah have been displaced from their natural habitat and they have been come under increasing threat from hunters armed with automatic weapons and riding in four-wheel drive vehicles.

- The cheetah may already have been extirpated, and the Arabian bustard is under threat.

- The disruption of traditional herding practices has caused over-grazing of already sparse vegetation.
- The demand for food from the growing population has increased the area under irrigation, replacing the plants of the naturally arid habitat with cultivated crops.
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- The Arabian Oryx, once extinct in the wild, has been reintroduced using captive stock (UNEP, 2002)

Grass Land

- The world's grass lands and forests have experienced the greatest habitat changes. Sub-tropical and temperate grass lands reflect precipitation availability.
- Grasses growing rapidly during the rainy season and dying off in the dry season
- The grassland habitats are under stress in Africa, immediately South of the Sahara Desert, as a result of overpopulation, farming practices that encourage over-grazing, land-use conflicts and the ever-recurring drought in that area.

Forest

Forests are the most complex and most diverse of the earth's terrestrial ecosystems covering about one-third of the earth's land area.

Tropical and sub-tropical forests account for about 505 of the total, with the remaining 44% being temperate and boreal (UNEP, 2002)

Human activities, both deliberate and inadvertent, contribute to a continuing decline of the forested areas.

Deforestation is high on the list of serious environmental problems.

- In the 1990s, agricultural expansion was responsible for about 70% of reduction in forest area.
- In North America and Europe, in the 1960s, 1970s and 1980s significant problems arose in forested areas as a result of industrial pollution mainly in the form of acid rain.
- Explosion of Chernobyl reactor in 1986 – regional habitat change.
- Poverty, population growth and expanding markets for forest products – create conflicts between the need to conserve forest resources and the need to exploit them for economic development.
- Changes in forest areas or removal of the trees – destroy the habitat for other plants and forest-dwelling animals – and reduce its overall bio diversity.

Tropical forest

- The Food and Agricultural Organization of the United Nations has estimated a loss of 15.2 million ha per annum during the 1990s (FAO, 2001), up from 11.3 million ha per annum in 1980 (FAO/UNEP, 1982)

- Data from the FAO (1997) indicate that between 1990 and 1995 forest cover was lost at a rate of 4.6 million per annum in South America 3.6 m in Africa, 3.0 m. in Asia.

- Berundi in Tropical Africa lost 15,000 ha
- Brazilian Amazon 2.9 m. ha in 1994, 1.6 m. ha in 1999 (4 m. ha were destroyed by fire in 1998)
- Democratic Republic of Congo 532,000 ha
- Nigeria 398,000 ha
- Cote d' I voire 265,000 ha
- Indonesia 9.7 m. ha (fire) in 1997 and 1998

The main causes of tropical deforestation are commercial logging, the clearing of land for agriculture and the cutting of fuel wood.

Tropical hard woods such as mahogany, ebony and teak have been in high demand in the developed world for a long time, and developing nation see them as an important source of revenue.

Logging increased rapidly in the second half of the 20th century as demand for wood grew in the developed world.

In Malaysia the production of logs was six times higher in 1990 than in 1960 and in Sarawak there was a fifteen-fold increase over the same time period.

Most production being exported to Japan

- Commercial logging is the most immediate source of income for many developing nations in the tropics.
- The demand for foreign currency in the developing nations combined with the demand for forest products in developed world.
- It has led multinational companies to become involved in working the tropical forests, with major concessions granted to them to countries such as the Philippines and Brazil.
- With their traditional focus on short-term gain, it is unlikely that these multinationals will be contribute to the development of sustainability in the tropical forests.
- The network of roads needed before logging can begin contributes to the fragmentation of the forest ecosystem and encourages erosion, while improving access for hunting, farming, mining and other activities that can alter the ecosystem.

- Modern mechanized logging using bulldozers and skidders causes serious damage to the soil through compaction and the disturbance of the ground vegetation and upper horizons of the soil which increase the potential for erosion.

- Exposure of solar radiation – rapid release of nutrients in surface layers – percolating water and leaching – little organic matter is returned to the soil following the removal of the trees. The soil loses its fertility.

- Selective harvesting is not widely used, however, and damage to the forest may be more extensive than is indicated by the total area logged.

- It has been estimated, that in the Amazon, between 1.0 m. ha and 1.5 m. ha of land may be damaged every year during logging operations.