Introduction to Environmental Science (SENG 101)

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Course Objectives:

- To introduce you to the world of our environment;
- Look at the environment in the light of your profession;
- To guide you in your designs to solve environmental and other engineering problems;
- To have a deep sense of commitment to the environment for sustainability in your career.

HUMANS AND THE ENVIRONMENT

Humans and Nature an Overview

- Environmental Science is broadly the protection of the environment
- Study is based on both the pure sciences and the Social Sciences
- To study our immediate environment the Earth and its cosmic environment must be understood
- Earth revolves around the Sun and the only planet where life is found.
- Failure of man to fit into the delicate structure is what is causing the environmental problems

The Sun and Solar System

- Sun provides the earth with all the energy it needs

- Sun is one of the stars in the Milky Way Galaxy
- Hot gases make up the Sun; it is 1.35 million kilometres in diameter and 150 million kilometres from the Earth
- Observation and facts about the sun were studied through X-ray telescopes
- Sun is a solar fusion reactor, which constantly converts Hydrogen atoms to produce Helium atoms
- The process involves a loss in weight, which is converted into energy in accordance with Einstein's law:

energy from the sun = mc^2

Structure of the Sun

The Convection Zone
Energy continues to move toward the surface through convection currents of heated and cooled gas in the convection zone.
The Corona
The ionized elements within the corona glow in the x-ray and extreme ultraviolet wavelengths. NASA instruments can image the Sun's corona at these higher energies since the photosphere is quite dim in these wavelengths.
The Radiative Zone
Energy moves slowly outward—taking more than 170,000 years to radiate through the layer of the Sun known as the radiative zone.
Sun's Core
Energy is generated by thermonuclear reactions creating extreme temperatures deep within the Sun's core.
The Chromosphere
The relatively thin layer of the Sun called the chromosphere is sculpted by magnetic field lines that restrain the electrically charged solar plasma. Occasionally larger plasma features—called prominences—form and extend far into the very tenuous and hot corona, sometimes ejecting material away from the Sun.
Coronal Streamers
The outward-flowing plasma of the corona is shaped by magnetic field lines into tapered forms called coronal streamers, which extend millions of miles into space.

CORE

- Innermost part of the sun
- Temperature more than a 1,000,000 ˚C
- Cannot be seen

PHOTOSPHERE

- Is visible and it gives off light
- Average temperature is about 6,000 ˚C

CHROMOSPHERE

- Inner part of the sun's atmosphere
- The red colour is caused by the glow of hydrogen
- The average temperature is 15,000 ˚C

- Chromosphere and Corona are visible only during a total solar eclipse
- The sun has cooler spots known as sun spots which appears dark
- The sun keeps the earth warm, gives it light and controls the weather

- These spots are accompanied by sun flares
- It provides energy for photosynthesis, and provides vitamin D.
- Without the sun, the earth's atmospheric temperature would be about 38˚C less than what it is now

Solar Electromagnetic spectrum

- What is **light Energy**? Made of many frequencies and wave lengths of which visible light forms a part

- EMS is a name given to a several types of radiations put together

- Radiations is a form of energy that travels and spreads out as it moves

- Energy levels of these radiations depend;
  (i) Speed
  (ii) Frequency

- Gamma rays,
- x-ray
- ultraviolet (UV rays)
- Visible Light rays
- Infrared
- Microwaves
- Radio waves etc

THE ELECTRO MAGNETIC SPECTRUM

THE ELECTROMAGNETIC SPECTRUM

THE PLANETS

- A planet is a celestial body orbiting a star
- Massive enough to be rounded by its own gravity,
- Not massive enough to cause thermonuclear fusion
- Cleared its neighbouring region of planetsimals (IAU, 2006)

- Objects thought to exist in protoplanetory disk

- A rotating circum stella disc of a young dense gas surrounding a newly formed star

- Become gravitationally dominant, and there are no other bodies of comparable size other than its own satellites or those otherwise under its gravitational influence
- There are **8 planets**

The solar system

Temperatures on other Planets and our Moon

Planet Mercury

- It is about **58mil.** km from the sun and the nearest
- Has no atmosphere due to low gravity and high day time temperature
- Temperature during the day is **400°C** and at night **-200°C**

Planet Venus

- It is **108mil.** km from the sun; has thin pale yellow clouds
- Earth's twin due to its size with a pale yellow cloud
- Atmosphere mainly Co_2 with **1** to **3%** Nitrogen
- Has small amounts of helium, argon and water vapour and allows only **25%** of the sun's rays to penetrate its surface and heat the rock.

Planet Mars

- About **249 mil.** km from the sun
- Referred to as the red planet with 2 moons
- Atmospheric daytime temperature ranges from **0°** to **27°C** because of its **Co_2**
- Night time temperature is about **–125°C** because of its thin atmosphere

Planet Jupiter

- More than 800 mil. km from the sun and has clouds
- Named after the Greek god Zeus is the 4th brightest with 2 moons
- Has H_2 He, methane, water droplets and ammonia crystals in it's atmosphere;
- Radiate more heat back into space than it get from the sun
- Cloud top temperature is about **-150°C**.

Planet Saturn

- Named after sun god of Agric of the roman mythology
- It is the least dense with specific gravity of 0.7 i.e. less than water
- Atmosphere mainly 25% Hydrogen and 25% Helium with traces of water, methane and ammonia and a rock
- Has small amounts of helium, argon and water vapour and allows only 25% of the sun's rays to penetrate its surface and heat the rock.

Planet Uranus

- Named after the Greek god of the sky
- It has 7 rings
- The mass of Uranus is 14 times that of the earth.

Planet Neptune

- Named after roman god of the sea
- Is a dynamic planet with several large dark spots reminiscent of Jupiters hurricane-like storms

Our Planet Earth

- The planet earth is one of the 8 planets of the solar system; often called the living planet
- The earth is **12,800 km** in diameter;
- Earth's atmosphere has large amounts of oxygen and water vapour; help to make life possible on earth.
- Constantly revolves around the sun in an orbit once in 365 days in a year

- About 75% of the earth's surface is covered with water
- 97.1% of the water is Saline
- The remaining 2.9% are not available for use; tied in icecaps, glaciers and the atmosphere
- Only 0.32% of the world's water is available for use

The Earth's Moon

- Has no atmosphere and therefore no weathering takes place
- Also known as **lunar**, **Selene** or **Artimis**
- No wind and erosion and acquires light from the sun
- Temperature is **100°C** at daytime and **-150°C** at night time

Plate Tectonics

- The earth experiences a lot of non human activities which has serious consequences
- One of these is the plate Tectonics

  The earth is made up of the ff:

- Lithosphere (hard plate),
- Asthenosphere (hot gases and liquid)
- Innermost part (metal core)

The Earth

Atmosphere
Crust
Mantle
Outer core
Oceanic crust
Continental crust
Lithosphere
Upper mantle
Asthenosphere (part of mantle)
Mantle continues down to outer core
Outer core of molten metal
Solid metal inner core

- Theory of Plate Tectonics begins with the idea that the crust (lithosphere) of the earth is made up of seven major plates and several smaller plates

- A scientific theory that describes the large scale motions of Earth's lithosphere is known as the **Plate Tectonics**

The Earth's Plate Tectonics Behaviour

Seven major lithospheric plates:

- the Pacific,
- the North American,
- the South American,
- the Eurasian,
- the African,
- the Antarctic, and
- the Australian

Asthenosphere

- Although scientist are aware of plates boundaries, they are doubtful about its movements
- The asthenosphere is made up of hot liquid rock
- Hot liquid and gases flow outward from the inner part of the asthenosphere
- Flow of hot liquid rock below the lithosphere causes the plates to move

Ocean – Floor Spreading

- This concepts confirms Plate Tectonics
- These are formed in all oceans
- Deep rifts run via the centre and erupts out of the rift
- Eruption of lava from between plates can cause the opposite edges of plates to be pushed down into the asthenosphere
- The process is called Ocean Floor Spreading

Continental Drift

Earlier theory by Wegener in 1900 postulated:

- that all the continents were once together and drifted apart
- The theory of plate tectonics is key in the understanding of many natural occurrences like earthquakes in addition to ocean floor spreading and continental drift

Composition and Structure of the Earth's Atmosphere

- According to the temperature profile of the earth, there is heat within the earth atmosphere which affects our environment

- Earth's atmosphere is divided into 4 Major layers based on:

(A) ***Distance, temperature and gaseous composition***

These are;

- ***Troposphere, Stratosphere, Mesosphere & Thermosphere***

- The concept of the higher you go, the cooler it becomes occurs only between the ***Troposphere & Mesosphere***,
- That is, the stratosphere and thermosphere

The Temperature Profile of the Earth's Atmosphere

(B) Gaseous Composition

- Nitrogen 78.00%
- Oxygen 21.00%
- Argon 1.00%
- Carbon dioxide 0.03%

Albedo

-Is the reflection of solar radiation back into the atmosphere

- Abt. **30%** of solar radiation is reflected by clouds, dust from industry and land clearing activities

- Abt. **70%** of these is absorbed by the earth's atmosphere, lithosphere and hydrosphere

- Abt. 47% of the in coming radiation is used to heat the earth
- **23%** of the solar radiation is used to regulate the hydrological cycle

- Abt. **0.2%** is used to generate air currents and winds
- **0.00023%** is used for photosynthesize

EARTH'S ENERGY BUDGET
Reflected by atmosphere 6%
Reflected by clouds 20%
Reflected from earth's surface 4%
64%
6%
Incoming solar energy 100%
Radiated to space from clouds and atmosphere
Absorbed by atmosphere 16%
Radiated directly to space from earth
Absorbed by clouds 3%
Radiation absorbed by atmosphere 15%
Conduction and rising air 7%
Carried to clouds and atmophere by latent heat in water vapor 23%
Absorbed by land and oceans 51%

Emissivity: The total amount of heat flow into space

FACTORS AFFECTING EMISSIVITY

- H_2O vapour [water vapour]
- CO [Carbon monoxide]
- CO_2 [Carbon dioxide]
- CH_4 [methane]

Human Societies and Their Impacts on the Environment

Mankind has been on the planet earth and has survived via

- Cooperation
- Use of tools to gather food
- Use of language for communication
- Belief in a supreme being

However, man has survived today depending on

- Easy life style & effective knowledge transfer
- High usage of synthetic products
- Polished and refined food
- Luxurious life style & think that resources are unlimited
- Throwaway society and a rush through life

Human Societies and Their Impacts on the Environment

1. Early Hunter Gatherers :

- Nature controlled them
- Material possession was minimal
- Used crude tools
- Cooperation and sharing of resources
- Survival was based on ecological wisdom
- Effective social organization
- Belief in a supreme Being as the Creator

2. Advanced Hunter Gatherers :

- Had affluent life styles

- Fire for hunting and stone axes were made
- Fire destroyed their local environment
- Survival was also based on ecological wisdom
- Nature controlled this society as well

Agricultural Society :

- Learned to use fire to clear land and practiced mono cropping
- They became shepherds of large flock
- Landscape was changed dramatically
- Plant and animal diseases (Pests)
- Communicable diseases in man

Industrial Society :

- Machines were made to manufacture goods and provide services in agriculture
- Synthetic products to mimic natural things
- Water and Air pollution (acid rain)

Computer and Robotics Age :

- Fast transfer of information
- Rapid production, improvement and efficiency of delivery in the manufacturing industry
- Health problems which includes blood pressure, diabetes etc
- Increased organised crime

Nano age

Medical breakthroughs , communication, other impacts not yet known

Nanotechnology

- This is the design, manipulation, precision, placement, modelling or fabrication of matter at nano scale
- At least 1 dimension should measure at least 100nm or less
- This is the engineering of functional systems at the molecular and atomic level.

It makes most products

- *lighter*
- *stronger*
- *cleaner*
- *cheaper and less expensive.*
- *Utilise less quantity of resources*

Some applications of Nanotech

Nano structures

Human activities contribute heat to our environment

- Use of air condition in a house
- Use of washing machine
- Use of microwave oven

Resources and population growth

Natural resources in danger

What is the global resources regarding population growth?

Resource: Anything needed by an organism or ecosystem

1. **Renewable resources:** Can theoretically last for ever

   Eg Plants, animals, fresh soil, energy from the sun, wind, tides and flowing water

2. **Non renewable resources:** Can be depleted over a relatively short period of time, further recovery is impossible or expensive Eg. Metallic (Fe, Al, Cu, Ur)

   Non metallic (Fossil fuels, clay, sand, salt, Phosphate)

- Are we running out of resources?
- What can be done?

Population versus resources

A Population is a group of individual species that lives in a particular area

And this changes with time due to some factors

1. **FACTORS INFLUENCING POPULATION GROWTH:**

- Birth,
- Immigration

2. **FACTORS LIMITING POPULATION GROWTH**

- Emigration,
- Death

❖ If resources that support a population are depleted, this population could become extinct.

- Factors that **limit population growth** is known as **limiting factors**

Eg Fertility rate, migration and emigration, availability of food, conflict, education and disease

Equation for population studies

- Birth rate
- Death rate
- Rate of increase
- Percentage annual growth
- Approximate doubling time

THE LOOMING CRISIS (J- CURVE)

- Most of the population growth occurs within the developing countries

- Since we share common boarders, the effect of one country may affect the other

- There is therefore the need to control those increasing too fast and those reducing too fast

- **Carrying capacity**
- Is the maximum abundance of a species that can be sustained within a given area of habitat

- Or the maximum population a given ecosystem (or planet) can support indefinitely without harming the ecosystem so future generation will not have to reduce their number

- When an ideal population is at equilibrium with the carrying capacity of its environment, the birth and death rates are equal, ie the size of the population remains constant

- However, in nature, neither the carrying capacity nor the population size remains constant

Due to the following;

Climate change, successional development, fire outbreaks, wind storm, pollution etc

- **Carrying capacity for humans**
- Humans like other species need to sustain themselves by having access to products and services of their environment

- **The earthmanship society**

➢ In view of the destruction of nature, rapid population growth, depletion of resources and population etc man must move into a better society, living with the environment instead of living against the environment

➢ **The earthmanship** society is based on cooperation with nature through matter recycling, energy conservation, population control and reduction in resources use

THE ENVIRONMENT

What Environment Is

- The sum total of external influences acting on an organism or on part of an organism

Some Terminologies Relating To Environment Studies

- Environmental Control Systems (Engineering)

  the system provides the occupants with a suitably controlled atmosphere to permit them to live and work in the area.
- Environmental Engineering
- EIA etc

What Environmental Engineering Is

- The solution of problems of environmental sanitation,
- Control of water,
- Soil,
- Atmospheric pollution, and
- Social and environmental impact of these solutions

Engineering Ethics And The Environment

❖ **Environmental ethics deals with:**

- the attitude of people towards other living things and
- towards the natural environment