Environmental Geology

Introduction

What is Environmental Geology?

It is an exploration of the planet Earth.

More precisely, it explores the **human-planet relationship** – how **Earth processes** influence human lives on a daily basis, and how **human actions**, in turn, alter the functioning of **Earth systems**.

Earth processes affect every inhabitant of the Earth every day.

Some of these processes are **obvious** such as

earthquakes,
landslides, and
floods.

Others are **subtle** such as

- the role of mountains in shaping climatic zones,
- the influence of volcanism on the chemical evolution of the atmosphere,
- the formation of rich mineral deposits,
- and the contribution of floodwaters to the creation of fertile agricultural soils.

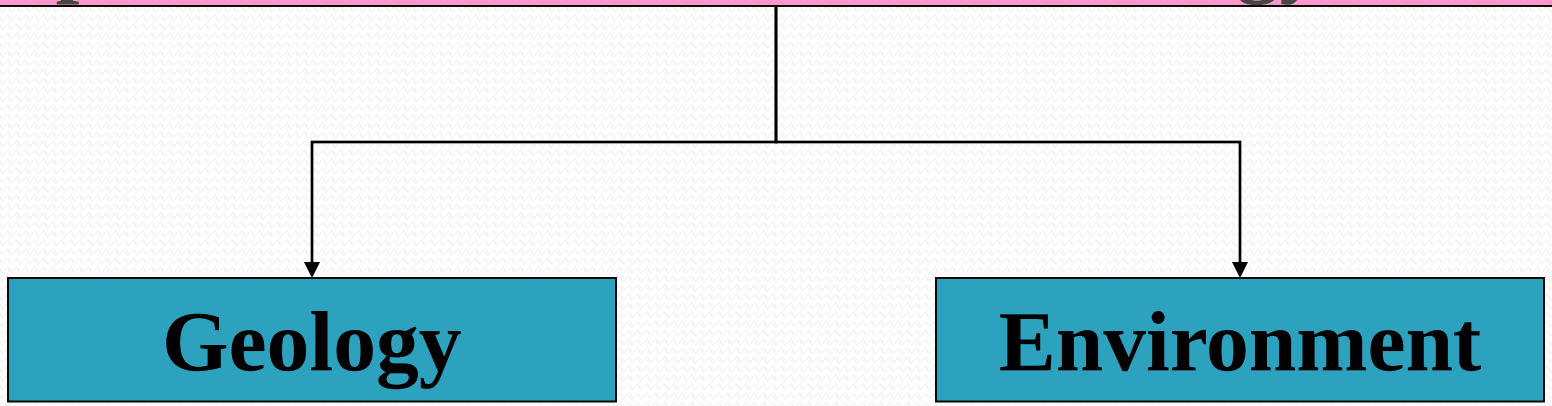
Humans are dependent on the material resources of the Earth such as metals, minerals, water, air, soil, and energy.

- In extracting these resources, humans become part of the **geologic cycle**, in that they move materials, create wastes, and alter natural **biogeochemical cycles**.
- These changes can cause changes in humans surrounding, eventually affecting humans quality of life and health

Again:
What is Environmental Geology?

- It is the study of
- the functioning of **Earth systems** and
- how they affect and
- are affected
- by **human activities**.

Components of Environmental Geology?



Geology

The scientific study of the Earth.

The word comes from two Greek roots:

- geo-, meaning “of the Earth”
- -logis, meaning “study” or “science”

Geology encompasses the study of the planet,

- its formation,
- its internal structure,
- its materials and their properties,
- its chemical and physical processes, and
- its history.

Geology

Physical Geology

Concerned with understanding the **processes** that operate at or beneath the surface of the Earth and the **materials** on which those processes operate.

Processes such as the causes of volcanic eruptions, earthquakes, landslides, and floods.

Materials include soils, sediments, rocks, air, and seawater.

Historical Geology

Concerned with the **chronology** of **events**, both physical and biologic, that have occurred in the past.

It seeks to resolve questions such as ***when the oceans formed, when dinosaurs first appeared, when and where the first trees appeared***.

Environment

The outer **biophysical system** in which people and other organisms exist. **(The United Nations Environment Program)**

In a broad sense, environment can be used to refer to anything, living or nonliving, that surrounds and influences living organisms.

Environment represents the interconnections, the dynamic relationships between organisms and their physical and biologic surroundings.

Humans as Agents of Geologic Change?

The Egyptian people have exerted a massive amount of effort to control the force of the Nile and to draw resources from it, but these activities have had some **UNANTICIPATED** consequences.

Each year, for a period of about 100 days, the Nile river **swelled** as if by magic, since Egypt experienced no great rains.

The **flooding** left behind **deposits rich in potash and soft silts** that were easily tilled.

These **rich muds** formed a **natural fertilizer** that, when **warmed by the spring sun**, allowed crops to flourish.

Yet as soon as one crop was harvested, the nutrients in the sediment were **exhausted**.

Only the next flooding of the Nile would render the field suitable for cultivation again.

The Nile was also a **destructive force**.

Only through the **coordination of human efforts** could its power be brought under control.

The construction of the **Aswan High Dam**:

Benefits include:

- Generating more than half the electricity produced in Egypt.

- Adding significantly to the amount of land fit for cultivation.

Costs include:

- The dam has interfered with the distribution of sediment to agricultural areas downstream, forcing them to become dependent on chemical fertilizers.

- The lack of nutrient-laden sediments reaching the Mediterranean has affected the offshore fishing industry.

- Other **unexpected effects** include:

  salinization of irrigated areas,

  erosion of sediment-starved coastlines,

  saltwater intrusion of coastal freshwater supplies, and

  the spread of water-borne diseases.

Over many millennia humans **slowly changed the Earth's natural landscapes** as they

built villages and cities,

converted forests to agricultural land, and

dammed and diverted streams.

Beginning in the nineteenth century, ever-greater amounts of mineral and energy resources were needed to fuel the industrial technologies of increasingly populous societies.

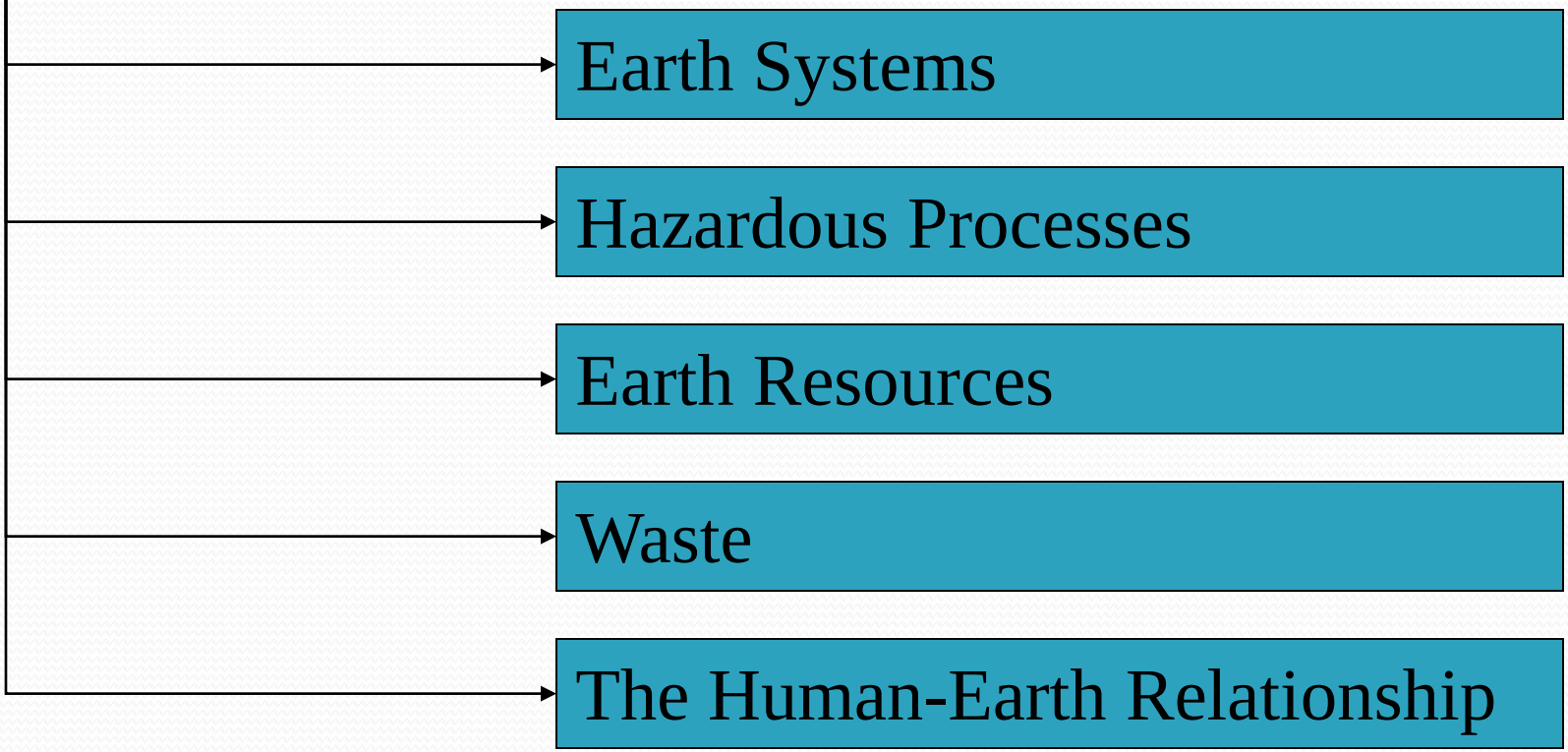
In spite of the **benefits** involved, the exploitation of our planet's rich natural resources has not been without **cost**. Examples include:

Pollution of oceans and groundwater

Changing the composition of the atmosphere

Causing the extinction of species at a rate unmatched in the past 65 million years

Fundamental Concepts of Environmental Geology!



Earth Systems

System:

A portion of the universe that can be isolated from the rest of the universe for the purpose of observing changes.

The Earth is unique:

As far as we know, the Earth is unique among planets as a home base for life.

The Earth is a closed system:

This implies that different parts of the Earth's biophysical system are intricately interrelated and dynamically balanced.

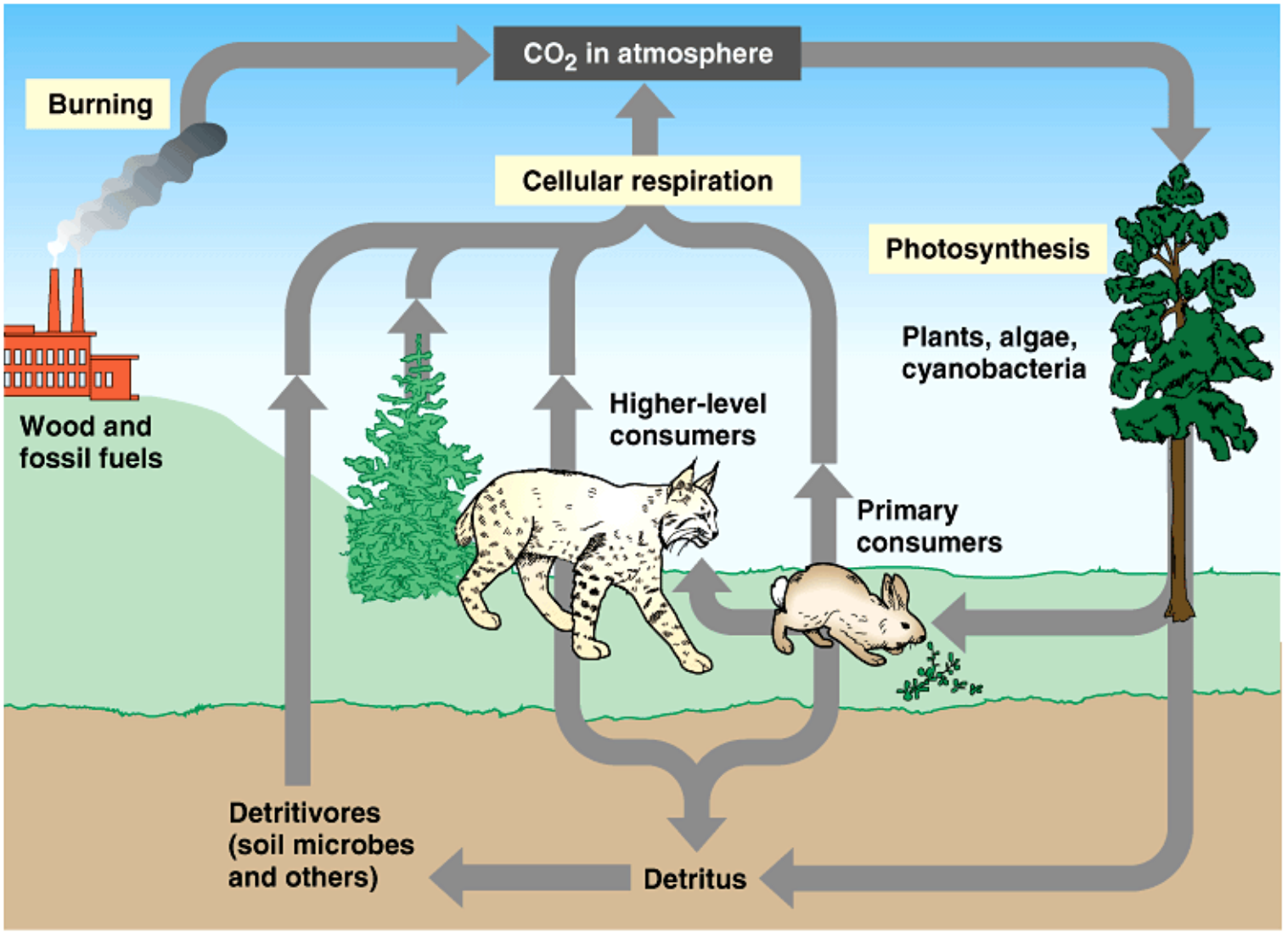
If you make a change in one part of the system, its impacts are likely to be felt elsewhere in the system. **(Gaia Hypothesis)**

Geology is moving toward the study of the Earth as a unified system rather than focusing on separate parts of the system.

Materials and energy tend to cycle from one reservoir to another:

Within the Earth system, materials and energy are constantly moving from one reservoir to another.

Examples include the hydrologic cycle, carbon cycle, nitrogen cycle, … etc.



The physical structure and chemical composition of the Earth affect our lives in many different ways:

The structure and composition of the Earth, inside and out, are important to us in a variety of ways.

The internal structure of the Earth plays a significant part in shaping our landscape and causing geologic events that may be hazardous for people.

We rely on the materials of the solid Earth as resources.

Geologic processes and human beings operate on different time scales:

People are **newcomers** on the geologic scene.

The history of our species spans less than a half million years.

The things that are important to us are measured on time scales of **years**, **decades**, or **centuries**.

Meanwhile, geologic processes that affect our lives on a daily basis operate on time scales ranging from a **few seconds** (**an earthquake**), to a **few millennia** (**soil formation**), to **millions**, even **billions of years** (**the formation of mineral deposits**).

Different time scales make for **difficult management problems**.

For example, in some parts of the world huge agricultural enterprises are based on the pumping of groundwater, which once depleted, may not be replenished for centuries

Hazardous Processes

Hazardous geologic processes have always existed:

Humans define Earth processes as **hazardous** only when they have a **direct negative impact** on their interest.

Risk is characteristic of the human-Earth relationship:

Geologic processes challenge us with events that seem, to us, hazardous.

One of the main goals of environmental geology is to **understand such processes so that we can predict and control them or at least mitigate their effects**.

Humans are dependent on earth resources:

We depend on this small planet for all our material resources – *the minerals, rocks, and metals with which we construct our built environment; the energy with which we run it; the soil that sustains agriculture and other planet life; and the air and water that sustain life itself.*

Geologic processes control our lives by determining the abundance, availability, and distribution of these resources.

Earth resources are limited:

One of the consequences of the fact that the Earth is a **closed system** is the finite nature of the planet's material resources.

Some resources, such as groundwater, are **renewable** on a human time scale – if they are managed properly.

Others, such as fossil fuels and mineral resources, are **nonrenewable** on any humanly accessible time scale.

Earth resources can be managed properly:

If we are to continue to use Earth resources and ensure their availability for future generations, we must **manage them more wisely**.

This includes taking into account the **real environmental costs** of extraction, production, and use, as well as the possibility of depletion or exhaustion of resources.

Human activities generate waste:

In extracting and utilizing Earth resources humans generate leftover or waste.

We **can not eliminate** all waste but we **can minimize** our production of waste through

more efficient industrial methods and

reuse or recycling of materials.

Waste

There is no ‘away’ to throw things to:

Another corollary of the concept of the Earth as a **closed system** is that **the planet must eventually absorb all waste materials**.

Humans have become a geologic force to be reckoned with:

Through the amount of material we move each year,

through our interference in the functioning of Earth processes, and

through our influence on biogeochemical cycles,

we have become an enormous agent of geologic change.

The Human-Earth Relationship

Managing the environment means managing human behavior:

Managing human behavior means

dealing with exponential population growth and its environmental implications,

reexamining our consumption-oriented lifestyles, and

finding a way to reach an international consensus on the best course of action for the protection and maintenance of commonly owned resources.

Restoration and preservation are also part of the human-Earth relationship:

Humans can have **positive** impacts on the environment, as well as **negative** ones.

It is possible to continue to make use of Earth resources and manipulate our physical surroundings, but to do it in such a way that natural systems can continue to function unimpaired and undepleted.

We still have much to learn about the functioning of Earth systems:

We are **beginning to understand** the complexities and interrelationships of such systems as the Earth's climate, oceans, and shifting continents.