

Chapter 3: Environment and Natural Resources

1. Introduction

We distinguish between different types of environment: economic, political, social, industrial, cultural, etc.

In this course, we are particularly interested in the **ecological environment**, which is related to our planet Earth — the place where human beings live and evolve.

2. Characteristics of Planet Earth

Let us begin by presenting planet Earth according to Professor Gérard Mégie's description:

"Since its origins, planet Earth has behaved as a complex interactive system. The conditions that allowed the appearance of humankind result from a delicate balance between the oceans, the atmosphere, solar energy, and the biosphere (living beings). This is a dynamic, not static, equilibrium, characterized by continuous exchanges that are themselves subject to variations in cosmic parameters. It is within solar radiation that Earth draws the energy necessary for the thermodynamic and chemical transformations that occur on its surface."

3. The Resources of Planet Earth

A. Water

The presence of water on Earth is the main characteristic that distinguishes this planet from the others and explains the concept of life and growth.

The total amount of water on Earth is **1,400 km³**, of which **1,365 km³** are salt water.

Freshwater is difficult to estimate, since **97%** of it is contained within the soil and the deep layers of the Earth.

- **a. Use:** Agriculture consumes more than **70%**, industry (particularly for electricity production) uses **20%**, and domestic use accounts for **10%**.
- **b. Renewal rate:** Water is continuously recycled on the Earth's surface. For reference, nearly **600,000 km³** of water evaporate each year.

B. Air

Another element specific to Earth and essential for life is air — especially **oxygen (O₂, at 21%)**.

1. **Use:**
Air, and particularly oxygen (O₂), is essential for the development and maintenance of life on Earth, as it forms the basis of respiration for living organisms.
2. **Renewal rate:**
The proportion of oxygen on Earth is considered stable since terrestrial and aquatic

photosynthetic organisms produce about 30×10^{13} kg of O_2 each year.
An equivalent quantity is also consumed through the respiration of living organisms.

3. **Stress:**

Humans breathe only a tiny fraction of the oxygen produced by plants, while the combustion of fossil fuels alone consumes about **4%** of this production.

4. **Issue:**

Air pollution poses a major threat to human health. This is mainly due to human activities that release pollutants such as **ozone, various oxides, fine particles** from industry, and **exhaust gases**.

C. Fossil Energies

About **86% of primary energy** comes from fossil fuels.

1. Petroleum

- **a. Uses:** Production of heat and electricity, automobile fuel, coatings, etc.
- **b. Renewal rate:** Takes millions of years to form.
- **c. Stress:** About **42 years of reserves** remain at the current rate of consumption.
- **d. Issue:** High demand, uneven distribution, and geopolitical tensions.

2. Natural Gas

- **a. Uses:** Production of heat and electricity, alternative fuel.
- **b. Renewal rate:** Takes millions of years to form.
- **c. Stress:** About **42 years of reserves** remain at the current rate of consumption.
- **d. Issue:** High demand, uneven distribution, and geopolitical tensions.

3. Coal

- **a. Uses:** Production of heat and electricity, steel industry, and cement manufacturing.
- **b. Renewal rate:** Takes millions of years to form.
- **c. Stress:** Around **150 years of reserves** remain at the current rate of consumption.
- **d. Issue:** Accelerates the emission of **carbon dioxide** and **sulfur and nitrogen oxides**.

4. Uranium

- **a. Uses:** Electricity production in nuclear reactors.
- **b. Renewal rate:** **Non-renewable**.
- **c. Stress:** Around **32 years of reserves** remain at the current rate of consumption.
- **d. Issue:** Fewer than **30 countries** possess the required technology, and there are serious issues concerning the management of radioactive waste.

D. Other Energies

Regarding these energy sources, it can be said that their **potential exceeds demand**. The only critical point is that **current technologies allow exploitation of only a very small portion** of this potential.

1. Solar Energy

- **b. Renewal rate:** Continuous flow.
- **c. Stress:** Available for about **7 billion years** (until the explosion of the sun).
- **d. Issue:** The **conversion efficiency** of solar energy into electricity is low (**around 10%**), and **solar panels (made of silicon)** are costly to produce. Moreover, solar energy is **intermittent**.

2. Wind Energy

- **a. Uses:** Electricity production.
- **b. Renewal rate:** Continuous flow.
- **c. Stress:** Available for about **7 billion years** (until the explosion of the sun).
- **d. Issue:** Electricity is produced **intermittently**. The **wind speed**—and therefore the **power output**—can vary greatly over time within the same region.

3. Hydropower

- **a. Uses:** Electricity production.
- **b. Renewal rate:** Continuous flow.
- **c. Stress:** Available for about **7 billion years** (until the explosion of the sun).
- **d. Issue:** The construction of **dams on rivers** causes significant **ecological impacts**, including **alteration of ecosystems**, **flooding of land**, and **displacement of local populations**.

4. Geothermal Energy

- **a. Uses:** Production of heat and electricity.
- **b. Renewal rate:** **Non-renewable**.
- **c. Stress:** Available **as long as radioactive elements exist within the Earth**, i.e., for several **billion years**.
- **d. Issue:** Except in certain regions, this resource is **generally difficult to access**, as it requires **deep drilling** operations.

5. Biomass

- **a. Uses:** Heating, electricity generation, and biofuel production.
- **b. Renewal rate:** **A few decades**.
- **c. Stress:** The **rate of extraction** is **lower than the rate of natural replenishment**.

- **d. Issue:** As the **main domestic energy source** for about **25% of the world's population**, the use of firewood **accelerates deforestation**.

E. Mineral Elements

What can be said about these resources is that their potential exceeds the current demand. The only critical point is that current technologies allow us to exploit only a very small portion of them.

1. Gold

- a. **Stock:** 150 billion tonnes
- b. **Location:** Known reserves are fairly scattered across the globe — South Africa (14%), Australia (12%), and Peru (8%).
- c. **Uses:** Jewelry and goldsmithing absorb 86% of total production.
- d. **Replenishment rate:** Non-renewable.
- e. **Stress:** 17 years of reserves at the current production rate (2,500 tonnes/year).

2. Silver

- a. **Stock:** 270,000 to 383,000 tonnes
- b. **Location:** Poland holds 20% of known reserves, Mexico 14%, and Peru 13%.
- c. **Uses:** Jewelry and silverware 31%, photography 24%, coins and medals 4%, other industrial uses 41%.
- d. **Replenishment rate:** Non-renewable.
- e. **Stress:** 13 years of reserves at the current production rate (20,500 tonnes/year).

3. Platinum

- a. **Stock:** 13,000 tonnes
- b. **Location:** Most of the known reserves are found in South Africa, within the Bushveld Complex. This country accounts for 80% of global production.
- c. **Uses:** Jewelry and silverware 31%, photography 24%, coins and medals 4%, and other industrial uses 41%.
- d. **Replenishment rate:** Non-renewable.
- e. **Stress:** 56 years of reserves at the current production rate (230 tonnes/year).

4. Iron

- a. **Stock:** 150 billion tonnes of iron ore
- b. **Location:** Ukraine holds 20% of known reserves, Russia 17%, China 14%, Brazil 11%, and Australia 11%.
- c. **Uses:** The steel industry absorbs 99% of production.
- d. **Replenishment rate:** Non-renewable.
- e. **Stress:** 79 years of reserves at the current production rate (1.9 billion tonnes/year).

There are essentially eight other elements and minerals that are overexploited and non-renewable. Examples include **Nickel, Copper, Lead, Cobalt, Zinc, Aluminum, Tin, and Palladium**.

F. Biodiversity

Scientists have identified nearly **1.7 million species**.

- a. **Uses:** Biodiversity provides numerous goods and services to humans: the supply of food, fresh water, and wood; a reservoir of chemical compounds used in pharmacology; purification of polluted water and soils; and the regulation of floods and erosion.
- b. **Replenishment rate:** Within species, the renewal of individuals takes from a few hours (as in microorganisms) to a few weeks (insects), or even several years (trees). However, once a species becomes extinct, it is lost forever.
- c. **Stress:** The current rate of species extinction is estimated to be one hundred to one thousand times higher than it was during geological times.
- d. **Issue:** The destruction of natural habitats, pollution (of water, air, and soil), and climate warming are all major threats to biodiversity. As a result, ecosystems and the services they provide to humans are being disrupted. Tropical forests are particularly endangered today.

G. Soils

Arable lands cover **1.5 billion hectares**.

- a. **Uses:** Soil is the natural support for animal and plant life. Hosting more than 80% of the Earth's living biomass, it represents a dynamic and living environment that also plays a role in the water cycle. Within this cycle, it performs regulatory and purification functions. Soils are exploited by humans for various purposes.
- b. **Replenishment rate:** Depending on climatic conditions, biological activity, and the nature of the rock on which it develops, soil formation takes several centuries to several thousand years—corresponding to an average formation rate of about **0.1 mm per year**.
- c. **Stress:** The natural rate of soil formation is **100 to 1,000 times slower** than the current rates of erosion.
- d. **Issue:** Nearly **half of all arable soils** (about 2 billion hectares) are degraded. The main causes are **wind and water erosion**, as well as **chemical alteration** (acidification, salinization). Agricultural practices, such as the use of pesticides, also contribute to soil degradation. Another observed issue is the **unequal natural distribution of arable land** between the North and the South, as well as the **extensive presence of desert areas such as the Sahara**.

H. Food Resources

Asia produces nearly half of the world's food resources. Examples include: **wheat (2,221 million tonnes), sugar plants (1,650 Mt), vegetables (903 Mt), tubers (737 Mt), fruits (526 Mt), meat (27 Mt), and fish (141 Mt)**.

- a. **Uses:** Human and animal consumption.
- b. **Replenishment rate:** Variable — from daily (eggs, milk) to seasonal (cereals and fruits), and even several years (livestock).
- c. **Stress:** Global cereal stocks can cover roughly ten weeks of consumption. It should also be noted that **a quarter of fish stocks are overexploited or depleted**.

d. **Issue:** Access to food resources is unequal. More than **800 million people worldwide** are undernourished. Population pressure and changing dietary habits explain the growing demand for these resources, leading to **an increase in their prices**.