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Branch: Marine and continental hydrobiology
Second year Common core SNV

Course handout:

Environment and sustainable development

Prepared by (Responsible for the course):

Dr. MAHI Abdelhakim

Cours destiné aux étudiants de L2 :

Marine and continental hydrobiology, Ecology and Environment, Agricultural Sciences, Biological Sciences, Food Sciences.

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Environment and sustainable development

Responsible for the course: Dr. MAHI Abdelhakim

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Abstract

The course covers the fundamental concepts of sustainable development.

The aim of this course is to make students aware of the issues, content and actions involved in sustainable development. The aim is to make them aware that it is possible to act to preserve the environment, through their education, as well as at their own level, on their consumption, their daily activities and their society. During their university studies, whatever their speciality and their ambitions for their future career, students will have the opportunity to learn about and experience sustainable development.

Sustainable development is currently one of the responses emerging throughout the world to deal with the major ecological, economic and societal challenges facing the world today.

Preface

Sustainable development is gradually becoming a global issue. The idea of sustainable development emerged at the same time as industrial society. Sustainable development is a way of organising society so that it can exist in the long term. This means taking into account both present and future imperatives, such as the preservation of the environment and natural resources, and social and economic equity.
The subject is one of the introductory teaching units in the first semester of the second-year Bachelor's degree in Marine and Continental Hydrobiology. However, it may also be aimed at second-year undergraduate students in : Ecology and Environment, Agricultural Sciences, Biological Sciences and Food Sciences. This course is an educational document for the benefit of students, who will find the necessary information relating to the concept of sustainable development. This will enable them to give added value to sustainable development because of their better understanding of environmental issues.
The course content ranges from the definition of concepts in the field of sustainable development to some of the details on which this concept is based.

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1. Definitions:

1.1. Definition of the Environment:

The first technical Anglo-Saxon definition of "*environment*" appeared in the 1920s with the following statement: *natural (physical, chemical, biological) and cultural (sociological) conditions likely to affect all living organisms and human activities*. From the 1960s onward, the use of the term "environment" expanded to encompass and currently signify: *natural biotic resources (fauna, flora) and abiotic resources (air, water, soil) and their reciprocal interactions, the characteristic aspects of the landscape, and the assets that make up cultural heritage*.

Generally, assuming that humans are at the center of civilization, the environment is considered to be the set of factors that influence the human living space.

From a legal perspective, Algerian legislation defines the environment in Law No. 03-10 of July 19, 2003, as follows: *"Abiotic and biotic natural resources such as air, atmosphere, water, soil and subsoil, fauna and flora, including genetic heritage, interactions between these resources, as well as sites, landscapes, and natural monuments."*

1.2. Definition of Ecosystem:

Sometimes, the concept of an ecosystem is preferred over that of the environment. It is the association of two components (Fig.1):

- **Biotope:** A specific physico-chemical environment.
- **Biocenosis:** A living community

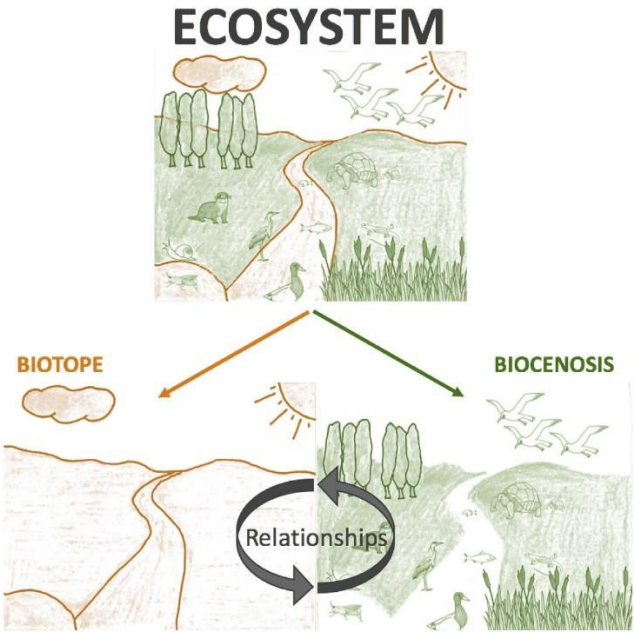


Fig.1. Ecosystem.

1.3. Components of an Environment:

The environment consists of the following four components:

1.3.1. Abiotic Factors of the Environment:

Abiotic factors are related to the physico-chemical conditions of the environment.

a. Climatic Factors:

Climate can be defined as the set of atmospheric conditions prevailing in a given region over a long period. These conditions represent the climatic factors.

-Light:

Light plays a crucial role in many fundamental biological processes. For example, in aquatic environments, aquatic plants perform photosynthesis thanks to this light.

-Temperature:

Temperature plays an important role for living beings. All metabolic processes depend on this factor. For example, photosynthesis, respiration, and digestion follow Van't Hoff's law, which states that the speed of a reaction depends on temperature.

Temperature is measured using a thermometer. There are different types of thermometers, each with its own usage method and measurement environment (Fig.2).

The units of temperature measurement are degrees Celsius (°C), degrees Fahrenheit (°F), and Kelvin (K).

Based on Organisms' Temperature Tolerance, There Are:

- Stenotherms: They tolerate a limited range of ambient temperatures.
- Eurytherms: They are characterized by a high ecological tolerance to temperature variations.
- Microtherms (Oligotherms): They adapt to low temperatures.
- Megatherms (Polytherms): They adapt to high temperatures.

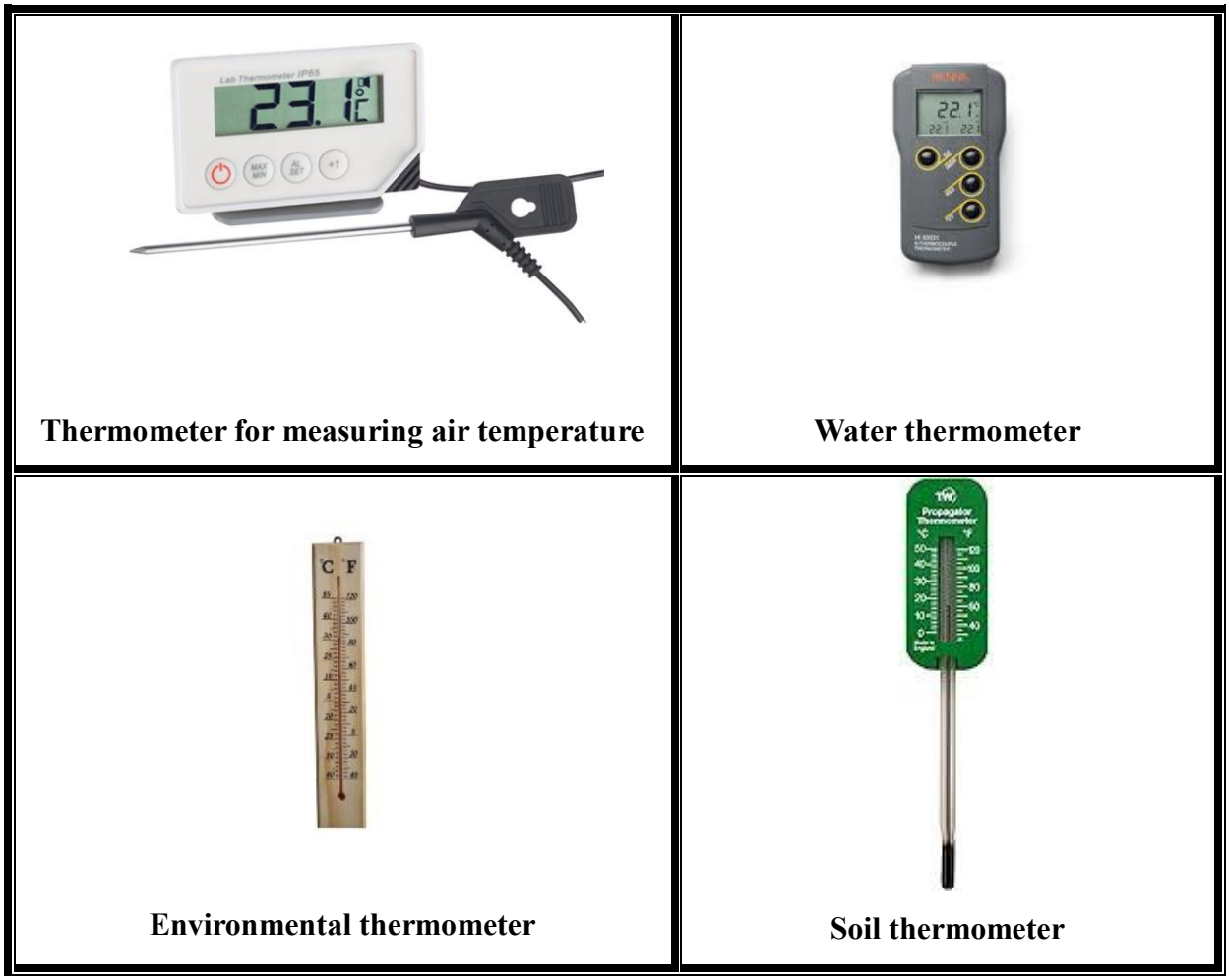


Fig.2. Some temperature measuring instruments

-Humidity and Rainfall:

Humidity is the amount of water vapor in the air. Relative humidity is the ratio between the amount of water present in a mass of air and the maximum amount of water that this air mass can hold. It is highly proportional to temperature and very sensitive to temperature variations.

Relative air humidity can be measured using a hair hygrometer or a psychrometer. For soil humidity, instruments such as a moisture meter or a humidity tester can be used (Fig.3).

Un hygromètre à cheveu

Un psychomètre

Un humidimètre

Un testeur d'humidité

Fig.3. Some instruments for measuring humidity

Precipitation is considered one of the main components of Earth's water cycle. It exists in several forms: liquid precipitation (drizzle, rain) and solid precipitation (sleet, hail, snow).

The amount of precipitation reaching the ground, known as the water depth, is measured using different types of rain gauges (Fig.4). This measurement is expressed in millimeters.

 Cône pluviométrique pour mesurer les précipitations	 Pluviomètre
 Pluviomètre électronique	 Pluviomètre

Fig.4. Some instruments for measuring rainfall

According to Their Water Needs and Distribution in Environments, There Are:

- Hygrophilous species: Living in humid environments.
- Mesophilous species: Having moderate water needs and tolerating alternating dry and wet seasons.
- Xerophilous species: Living in dry environments where water scarcity is significant.

b. Edaphic Factors:

Edaphic or pedological factors include the physical and chemical characteristics of the soil. Soil forms the superficial layer of the Earth's crust.

-Physical Properties of Soil:

- Soil Texture (Tab.1 and Tab.2):

Texture is defined by the percentage of different mineral elements. These elements vary in size: clay, silt, sand, gravel, and pebbles. It corresponds to the granulometric composition of the soil (Fig.5 and Fig.6).

Tab.1: Clay, silt, and sand, which make up fine soil, include the following fractions:

Elements of fine earth	Dimension (µm)
Clay	< 2
Limon fin	2 - 20
Fine silt	20 - 50
Fine sand	50 - 200
Coarse sand	200 - 2000

Tab.2: The coarse elements include the following fractions:

Coarse elements	Dimension (cm)
Gravel	0,2 - 2 cm
Pebbles	2 - 7,5 cm
Stones	7,5 - 20 cm
Blocks	More than 20 cm

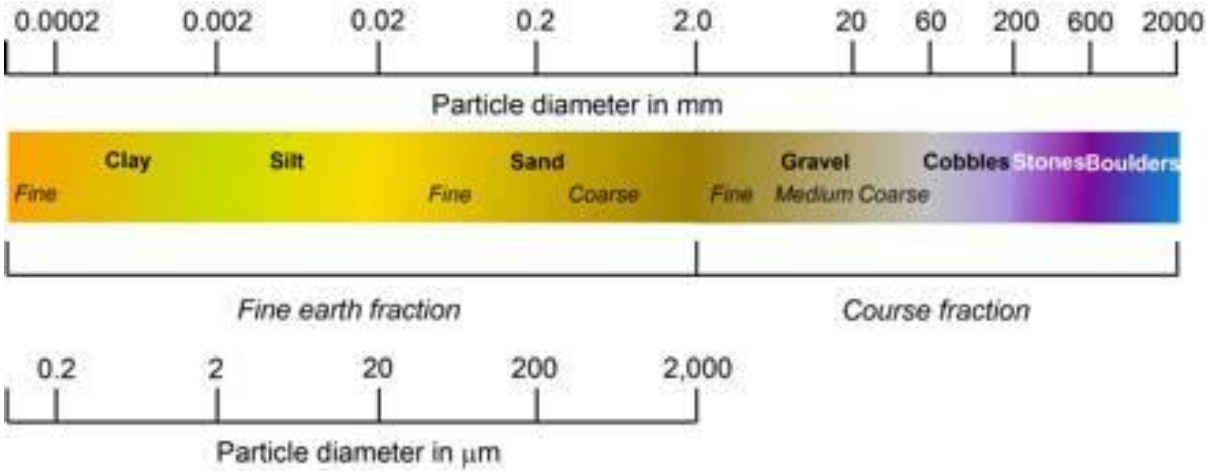


Fig.5. Grain size scale of soil texture

(http://www.terragis.bees.unsw.edu.au/terraGIS_soil/sp_particle_size_fractions.html)

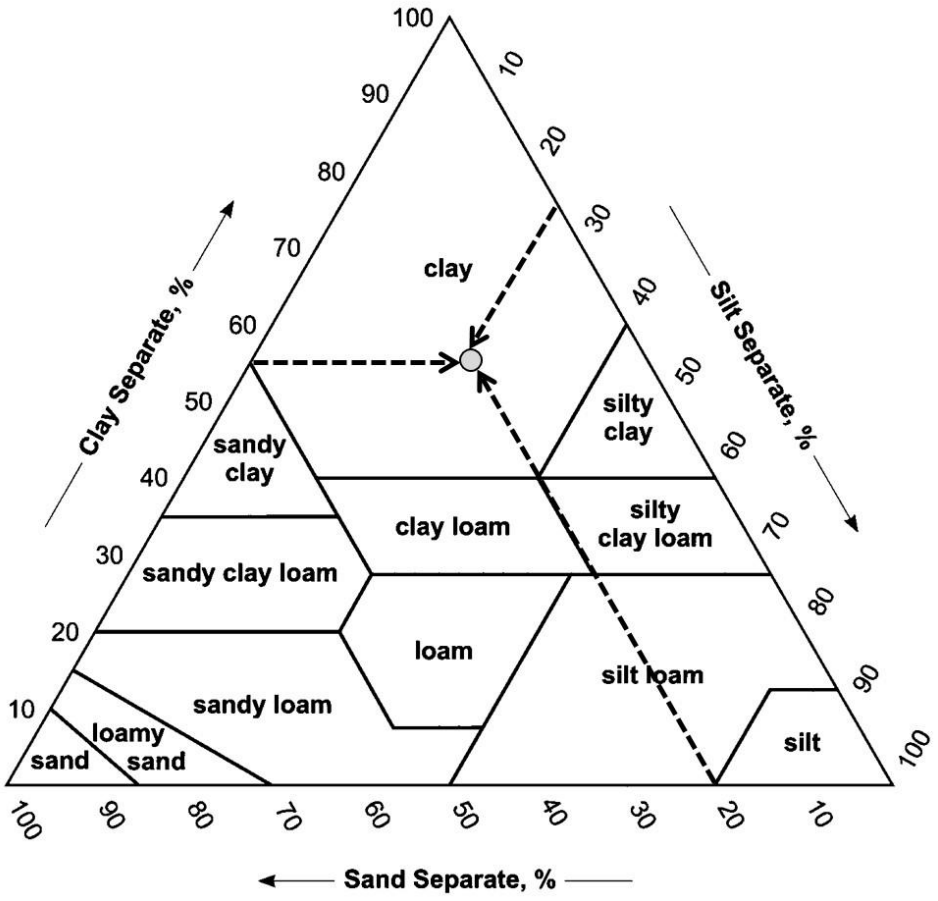


Fig.6. Soil texture triangle example. Figure adapted from King et al. (2003).

- Soil Structure:

Soil structure refers to the arrangement of different soil particles to form aggregates. In other words, an aggregate is the result of the natural organization of solid soil components.

The structure of soil is formed from different components, which can be divided into three groups:

- Materials: Clay, sand, silt, humus.
- Cements: Mucilage, polysaccharides, calcium, iron, aluminum.
- Builders: Biological activity in the soil, roots, fungal hyphae, micro- and macro-organisms.

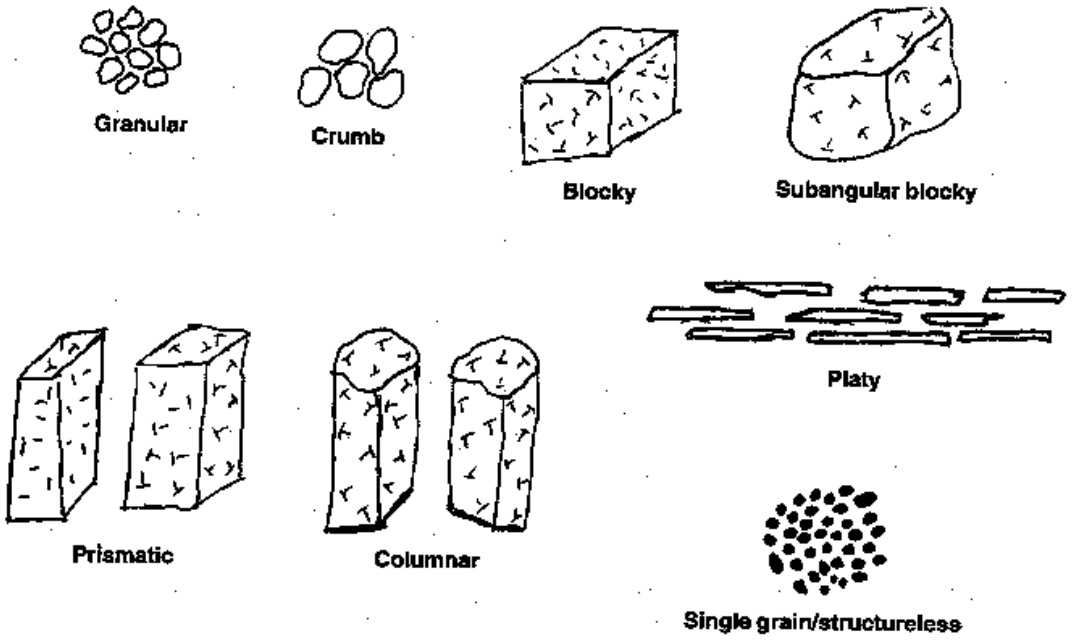


Fig.7. Soil structural types. (James M. Peterson, 1999)

- Porosity:

Porosity is the volume of empty space in the soil occupied by air or water. There are macropores where air circulates and micropores where water circulates.

-Chemical Properties of the Soil:

The soil is a chemical complex in the system due to its ability to retain various substances. These properties are essential for understanding soil fertility and its ability to support plant growth. For example, some plants can tolerate salty soils (called halophytes),

while others can thrive in high limestone content (called calcicoles), and some plants can only tolerate trace amounts of calcium (called calcifuges).

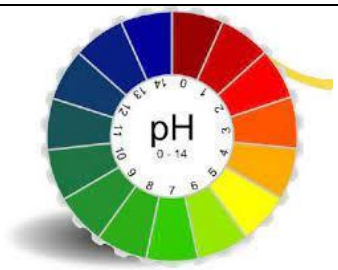
- pH:

The pH of the soil is a measure of its acidity and alkalinity on a scale from 0 to 14. A pH of 7 is considered neutral, a pH below 7 indicates acidic soil, and a pH above 7 indicates alkaline soil.

pH plays a key role in regulating the availability of nutrients and other soil processes. The pH of the soil can be measured by (Fig.8):

- Chemical Test Kit: This type of kit measures pH using a chemical indicator that changes color according to the soil's acidity or alkalinity.
- pH Paper: This is a special paper that changes color depending on the pH when immersed in water containing soil particles.
- pH Meter: This device typically comes with a probe.

Kit de test chimique



Papier pH

pH mètre

Fig.8. Some pH measuring instruments

- Calcium: Calcium is found in the following forms:
  - Inactive Limestone: This is calcium carbonate ($CaCO_3$).
  - Active Limestone: This is the fraction of calcium carbonate ($CaCO_3$).
  - Soluble Calcium.
  - Exchangeable Calcium.

The calcium content in these various forms defines the calcium status of the soil.

- Magnesium: Magnesium is found in the following forms:
  - Unchanged Reserve.
  - Mobilizable Reserve.
  - Exchangeable Magnesium.
  - Magnesium present in the soil solution as Mg^{2+} ions.
- Potassium:
  - Potassium is found in the following forms:
  - Potassium firmly bound in primary minerals.
  - Potassium associated with clay.
  - Potassium adsorbed onto the clay-humic complex.
  - Potassium present in the soil solution as K^{+} ions.
- Sodium:
  - Sodium is found in the following forms:
  - Sodium included in the substrate.
  - Sodium adsorbed onto the clay-humic complex.
  - Free sodium in the soil solution as Na^{+} ions.

1.3.2. Biotic Factors: (Fig.9)

Biotic factors represent the actions that living organisms, inhabiting a given environment, exert on one another. These interactions are of two types:

- Homotypic (intraspecific): These occur between individuals of the same species. Examples include: intraspecific competition, group effects.
- Heterotypic (interspecific): These occur between individuals of different species. Examples include: interspecific competition, mutualism, predation, commensalism, parasitism.

Among the biotic factors:

a. Neutralism:

When two species coexist in the same territory without influencing each other.

b. Interspecific Competition:

When competition occurs between individuals of different species for food, shelter, and breeding sites, where each species negatively impacts the other.

c. Intraspecific Competition:

This occurs between individuals of the same species in populations with very low densities.

d. Predation:

When a living organism captures and consumes prey.

e. Parasitism:

A parasite is an organism that does not live a free life and lives at the expense of another living organism called a host. It is associated with at least one stage of its development, either on the surface (ectoparasite) or inside (endoparasite) of its host.

f. Symbiosis:

It is a specific association between two organisms that cannot live without each other, with each partner benefiting from the other.

The various abiotic and biotic factors are shown in Figure 10.

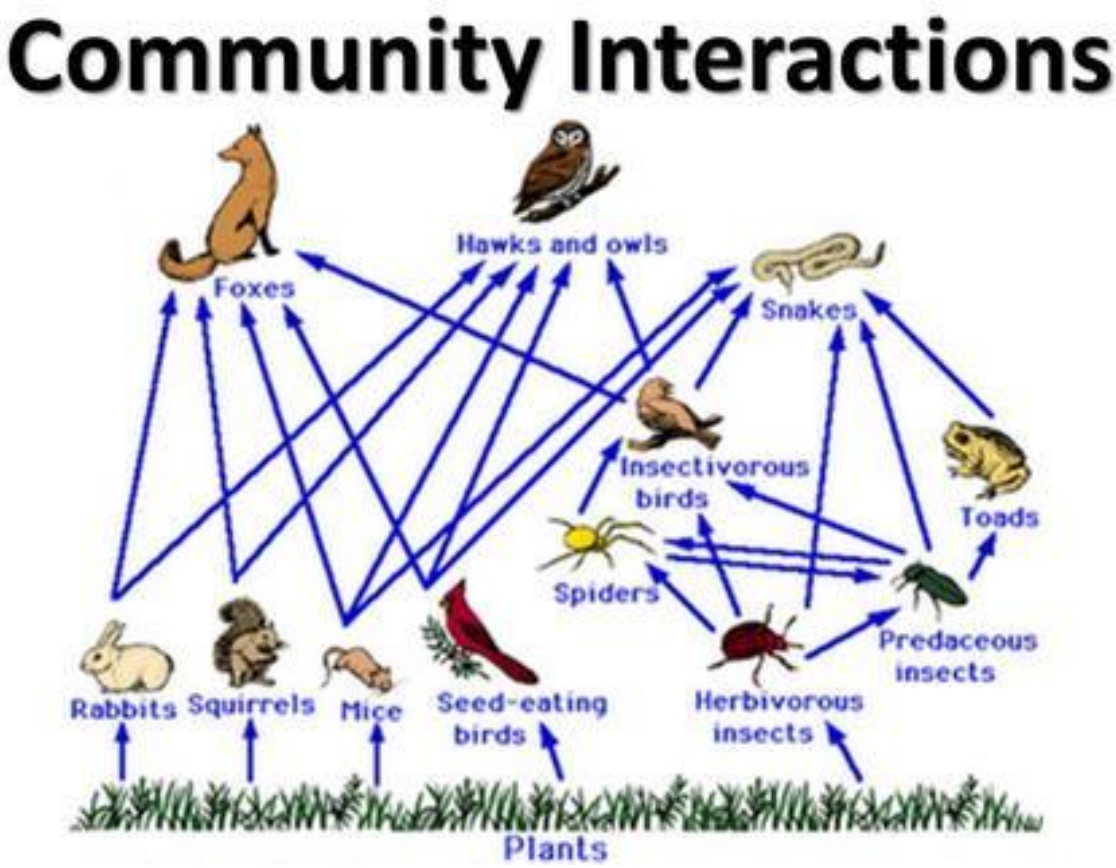


Fig.9. Biotic Factors

(https://slideplayer.com/slide/4328039/)

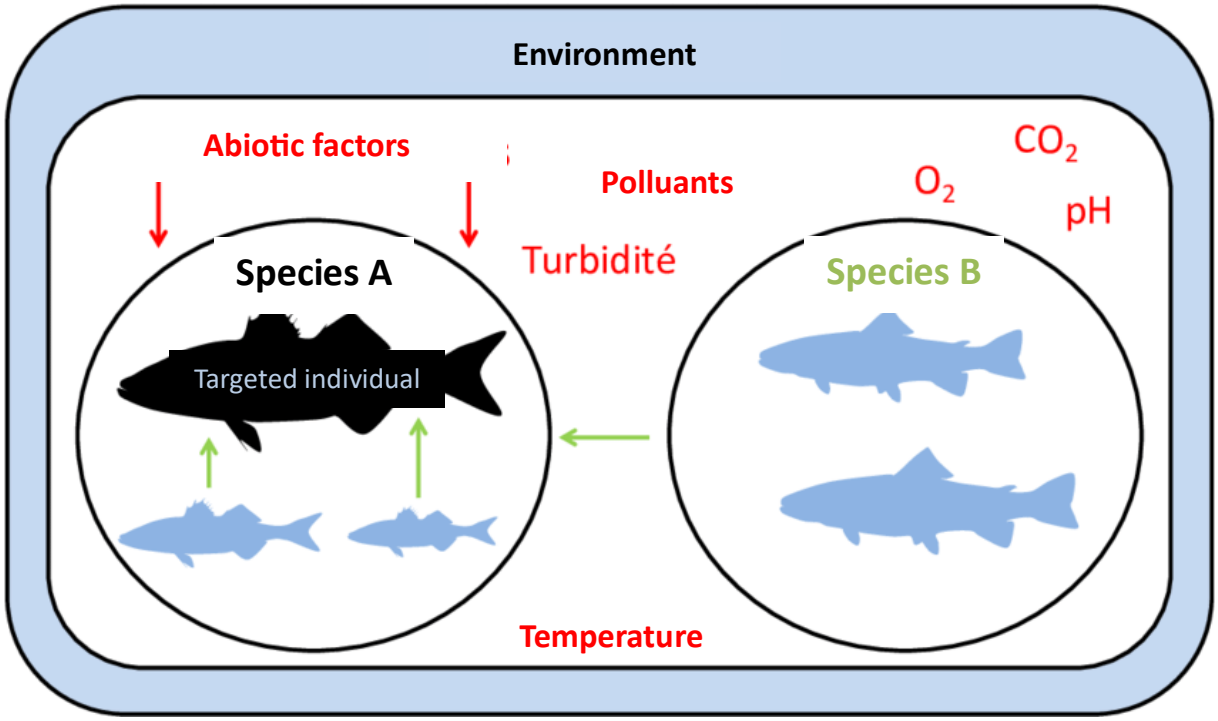


Fig.10. Biotic and abiotic environmental factors (Fischesser et Dupuis-Tate, 1996) (modified). Green color indicates biotic factors and red color abiotic factors.

1.3.3. Population:

The term "population" can have several meanings.

In demography, Gérard-François Dumont (2022) defines population as a group of people coexisting at a specific point in time and sharing at least one common characteristic. The most commonly used criterion is geographical, and the term population then refers to all the inhabitants of a given territory.

In ecology, the term population refers to a group of individuals of the same species, living in the same space and during the same period.

In anthropology, biology, and sociology, population refers to groups of people studied for certain characteristics that were previously determined for study.

1.3.4. Culture:

Culture has several definitions. In 1952, American anthropologists Alfred Kroeber and Clyde Kluckhohn counted over 150 definitions (Hayer, 2012). The UNESCO provides the following definition: "In its broadest sense, culture can today be considered as the set of distinctive spiritual and material traits, intellectual and emotional, that characterize a society or social group. It encompasses, in addition to the arts and letters, ways of life, fundamental human rights, value systems, traditions, and beliefs."

1.4. Definition of Sustainable Development:

Several definitions have been established. In 1980, the International Union for Conservation of Nature (IUCN) defined sustainable development as follows: "A development that provides real improvements in the quality of human life while conserving the vitality and diversity of the Earth. The goal is to achieve sustainable development. To this day, this concept may seem utopian, yet it is achievable."

In 1987, the United Nations (UN) proposed another definition: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

In 1997, the Earth Council proposed the following definition: "Living equitably, in harmony with natural means."

In 2001, the Organisation for Economic Co-operation and Development (OECD) defined sustainable development as: "A coordinated set of participatory processes that allow for continuous progress in the fields of analysis, debate, capacity building, planning, and resource mobilization, enabling the reconciliation of economic, social, and environmental objectives of society, and making trade-offs when necessary."

Later, the concept of sustainable development was introduced by the World Commission on Environment and Development, becoming a central concept: "Sustainable development is striving to meet the needs of the present without compromising the ability of future generations to meet their needs" (Brundtland, 1987).

Indeed, sustainable development takes into account three basic criteria: social equity, economic efficiency, and environmental respect (Fig.11).

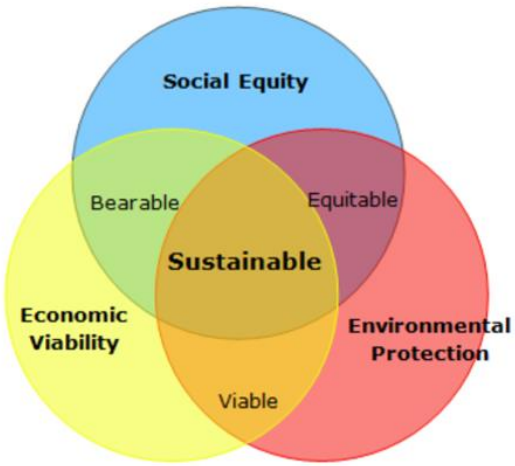


Fig.11. The three pillars of sustainability
(http://openlearn.open.ac.uk/mod/oucontent/view.php?id=405678&section=4)

1.4.1. Social Equity:

Equity corresponds to the idea of social justice and aims to ensure that all members of society have access to basic resources and services (education, healthcare, food, housing, etc.) to meet human needs, reduce inequalities, and maintain social cohesion. This allows individuals to be respected and their rights to be preserved.

The framework proposed by Meerow et al. (2019) defines three dimensions of social equity:

- Fair distribution of territorial resources
- Recognition of groups (e.g., Indigenous peoples, people with disabilities, women) within the territory
- Participatory governance

However, it is important to distinguish between equity and equality. Equality aims to provide the same opportunities to everyone, whereas equity seeks to provide fair advantages to each individual based on their specific needs (Fig.12).

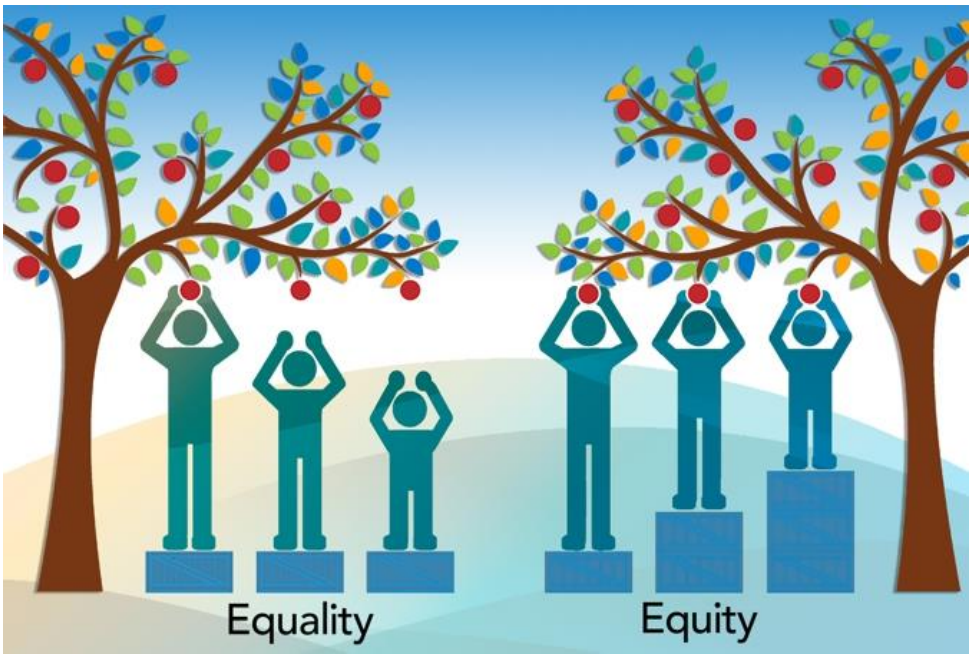


Fig.12. Difference between equity and equality

1.4.2. Economic Efficiency:

Economic prosperity must support social progress while balancing profit with sustainable environmental management. This approach helps reduce extreme poverty and ensures that the largest number of people have access to dignified, fairly paid employment.

1.4.3. Environmental Respect:

Respect for the environment stems from environmental responsibility. Human activities must be of high quality to minimize our impact on nature, preserve ecosystems, and protect natural resources to maintain long-term ecological balance.

2. Meaning of Sustainable Development:

2.1. Key Dimensions of the Environmental Crisis:

2.1.1. Human Demographics:

In 1800, the human population was barely one billion. As of 2022, the global population officially surpassed 8 billion. According to the latest United Nations estimates, the world population is expected to continue growing, reaching 9.7 billion by 2050, and peaking at 10.4 billion in the 2080s (Fig.13).

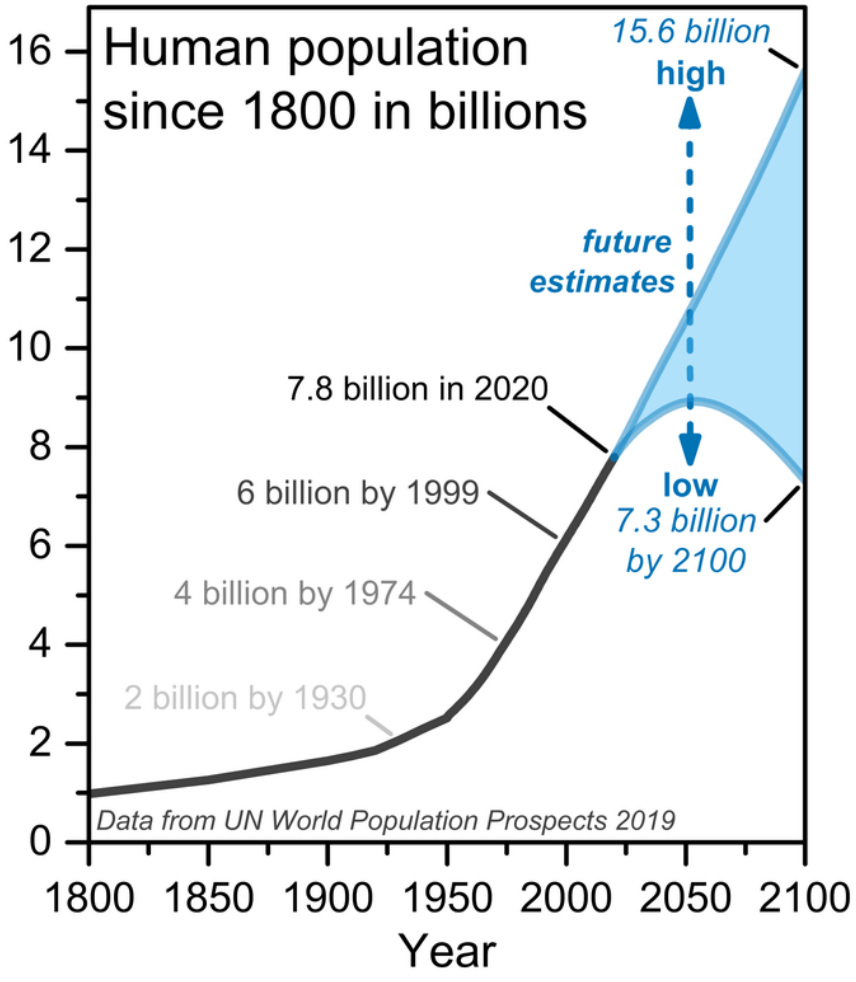


Fig.13. Growth of the Human Population.

Data was sourced from the United Nations "World Population Prospects 2019"

(https://population.un.org/wpp/ , accessed April 17, 2020)

2.1.2. Climate Change:

Climate change refers to the increase in global temperatures due to industrial activities, particularly the greenhouse effect. It is often referred to as human-induced climate change or anthropogenic climate change, as its causes are primarily economic and industrial rather than natural. This phenomenon leads to long-term disruptions in weather patterns and ecosystems.

A report published by the Intergovernmental Panel on Climate Change (IPCC) in 2021 announced that since the 1800s, human activities have been the main driver of climate change, mainly due to the use of fossil fuels such as coal, oil and gas. Thus, the combustion of fossil fuels leads to the emission of greenhouse gases that act like a blanket enveloping the Earth, trapping the sun's heat and increasing temperatures.

Among the consequences of global warming:

- On ecosystems and the planet: Changes in usual weather patterns result in more storms, floods, cyclones, and droughts.
- On society and the economy: Societies must adapt to a new climate by adjusting infrastructure, healthcare systems, and buildings to withstand extreme weather conditions.
- On businesses: Companies may struggle to adapt their operations to the new environmental and regulatory challenges.

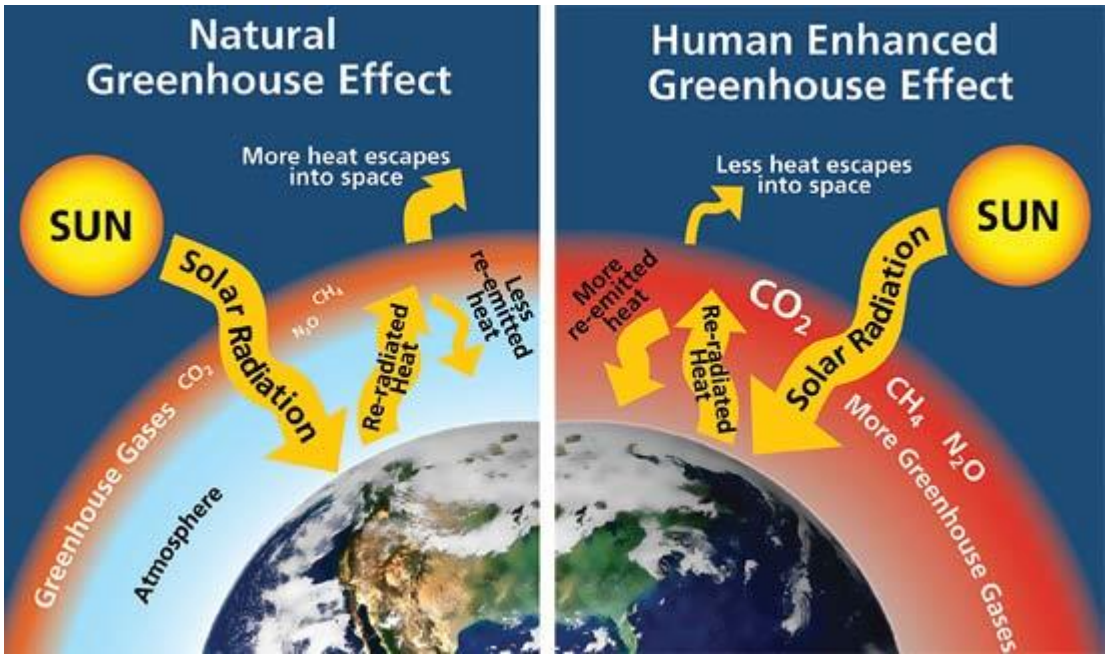


Fig.14. The Greenhouse Effect Explained

(www.nps.gov/goga/learn/nature/climate-change-causes.htm)

2.1.3. Fossil Fuels (Non-Renewable Energy):

Non-renewable energy sources regenerate much more slowly than they are consumed, making their replenishment negligible on a human timescale.

Fossil fuels come from coal, oil, and natural gas. They are called "fossil" because they originate from the slow decomposition of organic matter from biomass, accumulated over millions of years.

2.1.4. Depletion of Natural Resources:

The depletion of natural resources occurs when environmental resources are exploited faster than they can regenerate. This issue affects essential resources such as water, energy, food, fossil fuels, fertile soils, forests, and wildlife.

2.1.5. Drinking Water:

Water covers approximately 70% of the Earth's surface, totaling about 1.4 billion km^3. However, 97.2% of this water is saltwater, leaving only 2.8% as freshwater. The distribution of this freshwater is as follows:

- 2.15% is in polar ice caps.
- 0.63% is in underground water reserves.
- 0.02% is in surface water (lakes, rivers, streams).
- 0.001% exists as atmospheric water.

According to the World Health Organization (WHO) in 2019:

- 1 in 3 people worldwide lacks access to safe drinking water.
- 4.3 billion people lack basic sanitation.
- 3 billion people do not have facilities for handwashing.

The agricultural sector is the largest consumer of freshwater globally, accounting for approximately 70% of total freshwater consumption. This is followed by:

- The industrial sector (22% of consumption)
- Domestic use (8%)

2.1.6. Biodiversity:

The term biodiversity was coined by American biologist Walter G. Rosen during a 1985 symposium in the United States. The concept was later formalized in the Convention on Biological Diversity (CBD) at the 1992 Rio Earth Summit, which defined biodiversity as:
"The variability among living organisms from all sources [...] including diversity within species, between species, and of ecosystems."

However, human activities have caused a dramatic collapse in biodiversity. Over the past 200 years, species extinctions have occurred at a rate 10 to 1,000 times faster than the

natural background rate. At this pace, the Earth could lose 75% of its species within 500 years.

Among the causes threatening biodiversity:

- Expansion of agricultural land
- Pollution (water, soil, air)
- Urbanization
- Climate change
- Overexploitation of natural resources

Over the last few centuries biodiversity has lost a lot (Fig.15).

Year	Population	Land area converted for human use	Loss of species in ecosystems
1800	0.9 billion	7.6 %	-1.8 %
1900	1.7 billion	16.9 %	-4.9 %
2000	6.1 billion	39.3 %	-13.6 %
2100 Green model	8.7 billion	33.4 %	-11.6 %
2100 Current model	12 billion	49.1 %	-17 %

Fig.15. The loss of biodiversity over the last few centuries (projection of the UN Environment Program). (https://www.iberdrola.com/sustainability/biodiversity-loss)

2.1.7. Agriculture:

Agriculture is exposed to multiple risks such as droughts, floods, water shortages, declining crop yields, environmental degradation and biodiversity loss.

Agricultural production is influenced by two main factors: variations in water supply and extreme temperatures.

Agricultural drought is caused by three factors: a shortage of rainfall, a shortage of water in the soil and a drop in the level of water tables or reservoirs used for irrigation. For example, rice yields can fall by up to 90% when night-time temperatures rise from 27°C to 32°C (Peng et al., 2004).

Irrigation is often used to supplement rainfall in order to increase yields and extend the length of the agricultural season. In this way, 70% is used in agriculture (Fig.19).

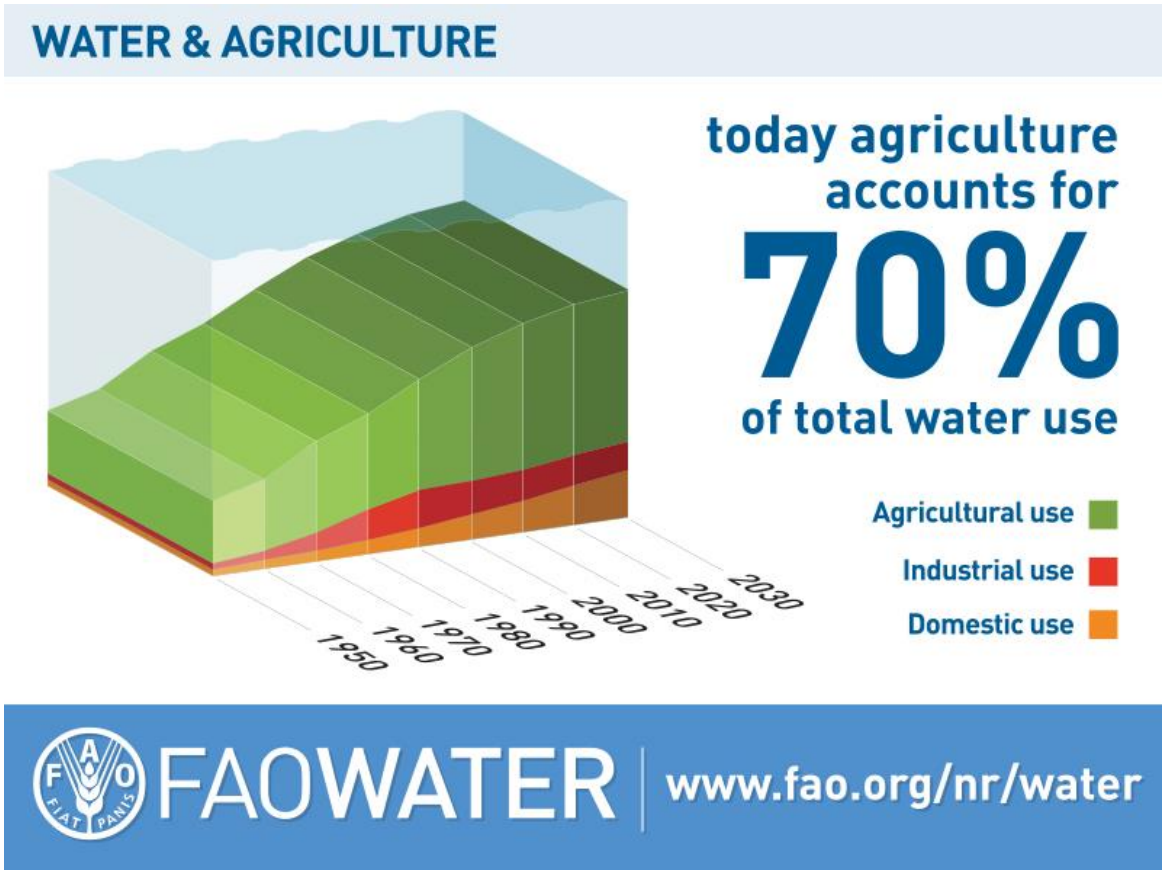


Fig.19. Use of water by agriculture

2.2. Why Sustainable Development?

In 2015, the United Nations (UN) committed to creating a fairer, more sustainable, and more peaceful world by 2030 through the establishment of 17 Sustainable Development Goals (SDGs). These goals include specific targets to be achieved (Fig.20).

The Sustainable Development Goals (SDGs) address a wide range of global challenges, including:

- Protecting the planet
- Building a more peaceful world
- Ensuring security and dignity for all
- Promoting equity

We will present below, for each sustainable development goal, some actions or sub-goals planned by 2030.

Fig.20. The Sustainable Development Goals

- **Goal 1:** NO POVERTY

Goal 1	

- Eradicate poverty in all its forms, everywhere in the world.
- Establish social protection systems and measures for all.
- Ensure equal rights to economic resources for the poor and vulnerable.
- To reduce by at least half the proportion of people (men, women and children) of all ages living in poverty.

- **Goal 2:** ZERO HUNGER

Goal 2	

- End hunger, achieve food security, improve nutrition and promote sustainable agriculture.
- End all forms of malnutrition.
- Double agricultural productivity and the incomes of small-scale food producers.
- Ensure the viability of food production systems.
- Preserve the genetic diversity of seeds, crops and farmed or domesticated animals.

- **Goal 3:** GOOD HEALTH AND WELL-BEING

Goal 3	

- To ensure a healthy life and promote well-being for all at all ages.
- Reduce the global maternal mortality ratio to below 70 per 100,000 live births.
- Reduce by one third, through prevention and treatment, the rate of premature mortality due to non-communicable diseases.
- To halve the number of deaths and injuries due to accidents worldwide.

- **Goal 4:** QUALITY EDUCATION

Goal 4	

- Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Significantly increase the number of young people and adults with skills.
- Eliminate gender inequalities in education and ensure equal access for vulnerable people.
- To ensure that all students acquire the knowledge and skills necessary to promote sustainable development.

- **Goal 5:** GENDER EQUALITY

Goal 5	

- Achieve gender equality and empower women and girls.
- End all forms of discrimination against women and girls worldwide.
- Eliminate all forms of violence against women and girls from public and private life.
- Eliminate all harmful practices, such as child marriage.

- **Goal 6:** CLEAN WATER AND SANITATION

Goal 6	

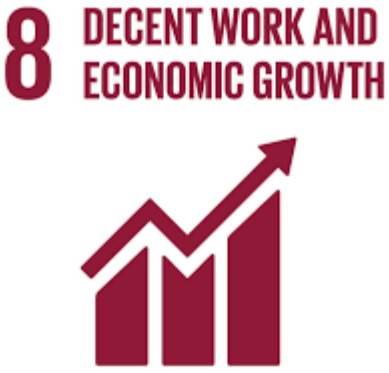
- Ensure universal and equitable access to drinking water at an affordable cost.
- Improve water quality by reducing pollution and eliminating the dumping of waste and hazardous materials.
- Implement integrated water resource management.
- Protect and restore water-related ecosystems.

- **Goal 7:** AFFORDABLE AND CLEAN ENERGY

Goal 7	

- Ensure access to reliable, modern and affordable energy services.
- Double the global rate of improvement in energy efficiency.
- Increase the share of renewable energy.

- **Goal 8:** DECENT WORK AND ECONOMIC GROWTH

Goal 8	

- Reduce the proportion of young people not in education, employment or training.
- Maintain a per capita economic growth rate appropriate to the national context.
- Promote development-oriented policies that encourage productive activities.
- Take immediate and effective measures to eliminate forced labour and put an end to modern slavery.

- **Goal 9:** INDUSTRY, INNOVATION, AND INFRASTRUCTURE

Goal 9	
• Promote sustainable industrialisation that benefits everyone. • Develop a high-quality, reliable, sustainable and resilient infrastructure. • Strengthen scientific research and improve the technological capabilities of the industrial sectors of all countries. • Modernise infrastructure and adapt industries to make them sustainable.	

- **Goal 10:** REDUCED INEQUALITIES

Goal 10	
• Improve the regulation and supervision of institutions and strengthen the application of rules. • Ensure equality of opportunity and reduce inequality of outcomes. • Ensure progressive improvements so that the incomes of the poorest 40% of the population increase faster than the national average income. • Adopt policies, for example budgetary plans, and gradually achieve greater equality.	

- **Goal 11:** SUSTAINABLE CITIES AND COMMUNITIES

Goal 11	
• Strengthen sustainable urbanisation for all and participatory planning and management capacities. • Ensure access for all to adequate, safe and affordable housing and basic services. • Ensure access for all to safe, accessible and sustainable transport systems at an affordable cost. • To strengthen efforts to protect and preserve the world's cultural and natural heritage.	

- **Goal 12:** RESPONSIBLE CONSUMPTION AND PRODUCTION

Goal 12	
• To achieve sustainable management and rational use of natural resources. • Encourage businesses to adopt sustainable practices. • Reduce waste production through prevention, reduction, recycling and reuse. • Introduce environmentally sound management of all waste throughout its life cycle.	

- **Goal 13 :** CLIMATE ACTION

Goal 13	

- Incorporate climate change measures into national policies, strategies and planning.
- Build resilience and adaptive capacity in the face of climate-related hazards and natural disasters.
- Improve education, awareness and individual and institutional capacities.

- **Goal 14:** LIFE BELOW WATER

Goal 14	

- Reduce ocean acidification and combat its effects.
- Preventing and significantly reducing marine pollution of all kinds.
- Manage and protect marine and coastal ecosystems.
- Preserve at least 10% of marine and coastal areas, in accordance with national and international law.

- **Goal 15:** LIFE ON LAND

Goal 15	
• Ensure the preservation, restoration and sustainable use of terrestrial and freshwater ecosystems. • Combat desertification and restore degraded land and soil. • Take urgent and energetic measures to reduce the degradation of the natural environment. • Promote the management of all types of forests.	

- **Goal 16:** PEACE, JUSTICE, AND STRONG INSTITUTIONS

Goal 16	
• Establish effective, accountable and transparent institutions at all levels. • Decision-making must be characterised by dynamism, openness, participation and representation at all levels. • Reduce illegal financial flows and arms trafficking. • Reduce all forms of violence and associated death rates worldwide.	

- **Goal 17:** PARTNERSHIPS FOR THE GOALS

Goal 17	
• Adopt and implement investment promotion schemes for the least developed countries. • Mobilise additional financial resources from various sources for developing countries. • To improve the mobilisation of domestic resources through international aid to developing countries. • To promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system.	

2.3. Concept of Sustainable Development

The concept of sustainable development aims to meet the needs of current societies while ensuring that future generations can meet their own needs. It aims to:

- Ensure the sustainable and prudent management of natural resources, as well as the rehabilitation and restoration of the environment that has suffered deterioration due to overexploitation.
- Integrate critical objectives related to development. These objectives mainly concern growth, poverty, the conservation of natural resources, the reorientation of technology, and risk management.

These needs can be physiological needs, safety needs, belongingness needs, esteem needs, and self-actualization needs. These needs exist in a hierarchy in the form of a pyramid model, called Maslow's pyramid (Fig.21).

Fig.21. Maslow's hierarchy of needs (Macleod, 2007)

2.3.1. Physiological needs:

It involves, for example, breathing, hunger, thirst, sleep, health. If we consider people who do not have access to a daily meal, there are initiatives that allow these people to access it even if they do not have money.

Example: if we take an employee who does not take breaks at work to eat, they will end up tired due to a lack of energy. This will have negative consequences on his concentration, performance, and productivity.

2.3.2. Safety needs :

These needs represent moral, psychological and physical security. They include personal, financial, employment, health and housing security.

Example: in a company, if there are no security measures, an employee will always worry about his or her physical safety. This will put the employee in a situation of anxiety and mistrust.

2.3.3. The need to belong :

The need to belong is essential for the proper development of the individual. The individual needs to belong to a social group, to feel integrated and accepted, and to have social status.

Example: a happy and satisfied employee finds support and motivation in his exchanges and interactions with his colleagues. This pushes the employee towards commitment and creativity.

2.3.4. Self-esteem needs:

The need for self-esteem is considered to be one of the driving forces behind individual and collective action. It is a need to succeed in whatever we undertake, to feel competent and to be recognised by others. This leads to feelings of self-confidence, strength, worth, competence and usefulness.

Example: an employee receives praise, thanks and promotion for outstanding work. This will boost their self-confidence.

2.3.5. Fulfilment needs :

A human being's need for fulfilment is the realisation of personal potential, creativity and self-fulfilment. This need consists of realising oneself as an individual by exploiting one's potential to the full in order to achieve one's goals, such as the realisation of personal and professional projects, creativity and learning.

Example: an employee at work continues to create projects, it's what he's always wanted to do, to be creative.

2.4. Areas of sustainable development :

2.4.1. Economic :

Balanced economic growth, based on the development of responsible economic models, aims to ensure sound management of human activities, without damage to the environment, as well as a reduction in extreme poverty.

2.4.2. Social :

Respect for individual rights, such as health needs, education, housing and the prevention of exclusion, must be ensured within an intergenerational and intragenerational framework.

2.4.3 Environmental :

Natural resources must be protected by assessing their consumption. Greenhouse gas emissions and waste must also be reduced.

2.5. The principles of sustainable development and their origins :

2.5.1. Precautionary principle :

According to principle 15 of the 1992 Rio Declaration on Environment and Development, which remains the most generally accepted reference text: 'To protect the environment, precautionary measures shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'.

The presence of a threat or risk of serious harm; and the fact that a lack of scientific certainty should not be used as a reason for postponing measures to prevent such harm (Sands and Peel, 2012).

Example: in the case of the mad cow epidemic, where the probability of transmission of the virus from animals to humans was unknown, the Court of Justice of the European Union ruled in the 'National Farmers' case that 'where there is uncertainty as to the existence or extent of risks to human health, precautionary measures may be taken.

2.5.2. Prevention principle :

The prevention principle applies to situations where the risk is known and the damage foreseeable. According to Magali Dreyfus (2017), it is 'the principle according to which it is necessary to avoid or reduce damage linked to proven risks of harm to the environment, by acting as a priority at source and using the best available techniques'.

Example: To reduce noise-related risks, noise sources must be made less noisy, noise propagation must be dampened by soundproofing the vessel and exposure time must be limited.

M. Callon & P. Lascoumes & Y. Barthe point out that the precautionary principle is not the same as risk prevention, 'it is not an incentive to abstain, it does not require the demonstration of zero risk'. In fact, when faced with a risk, the precautionary principle acts to make things reversible without assessing the costs. The prevention principle, on the other

hand, analyses the situation in terms of the cost of clean-up and the benefits, while taking into account the jobs created.

2.5.3. Principle of responsibility :

The principle of responsibility no longer refers only to past actions but also to the future as a whole: 'No previous ethic had to take into consideration the global condition of human life and the distant future and existence of the species itself', he states in the Principle of Responsibility.

The principle of responsibility applies at two levels: individual and collective.

- On an individual level, the choices and decisions we make will have an impact on many aspects of our lives, such as our lifestyle, our home, our family, our professional life, our cultural life and our political life.
- On a collective level, the state, represented by these institutions as well as local and collective authorities, provides the right atmosphere for sustainable development.

Example: the responsibility of parents towards their minor children. Or the responsibility of citizens towards their country.

2.5.4. Principle of solidarity :

The first meaning of the word solidarity originated in Roman law and comes from the Latin solidum. In Antiquity, this term referred to collective legal responsibility, which held associates jointly and severally liable (Musso, 2015).

A second meaning then emerged within the nascent associationist movement: empirically on the one hand, via the multitude of experimental associations created by the workers' movement (Chanial and Laville, 2001).

Solidarity remains a principle that must be applied to all others, such as disadvantaged populations, the excluded, the weakest, the most deprived and the poorest. It is expressed in two ways:

- Intra-generational solidarity: expressed on a territorial scale, from local to global.
- Intergenerational solidarity: this is expressed through actions and decisions taken with a long-term view, taking future generations into consideration.

2.5.5. Principle of equity :

This is one of the principles adopted in the Rio Declaration: 'The right to development should be realised in a manner that equitably meets the developmental and environmental needs of present and future generations'.

In its spatial dimension, this principle aims to ensure intergenerational equity in terms of exploiting the planet's natural and cultural resources and safeguarding the environment. Similarly, in its temporal dimension, this principle aims to ensure intra-generational equity by strengthening solidarity between rich and poor, between States and all peoples in order to eliminate all forms of poverty and meet the needs of current generations.

Example: Equity recognises that a visually impaired person may need different technology, or that a person in a wheelchair may need different access to a lift than another person.

2.5.6. Polluter pays principle :

The polluter pays principle is an economic principle, adopted by the Organisation for Economic Co-operation and Development (OECD) in 1972, which places the costs of preventing, reducing and combating pollution on the polluter, with the aim of limiting the impact of human activities on the environment.

The polluter pays principle was understood as an economic principle, prohibiting State aid to polluting companies and covering the costs of preventing pollution rather than restoring the environment (De Sadeleer, 1999).

Example: Producers of tobacco products must pay for the collection and removal of discarded cigarette butts.

2.6. Some sustainable development indicators :

2.6.1. Ecological footprint and biocapacity:

The concept of the ecological footprint was developed by William Rees and Mathis Wackernagel in the early 1990s. It was not until the late 1990s that the validity of the ecological footprint as an indicator of sustainable development was debated in the scientific literature.

According to Kitzes et al. (2007), 'the ecological footprint measures the area of productive land or water that an individual, a city, a country, a region or humanity uses to produce the resources it consumes and to absorb the waste it generates'.

The ecological footprint can be measured for an individual, a company, a city, a sub-national territory, a country or the planet (Kitzes et al., 2007).

So there are several ecological footprints:

- Individual ecological footprint: this is the estimated surface area (in hectares) that the earth needs to meet our needs (food, housing, transport, waste management).
- A country's ecological footprint: this is the estimated surface area required (in hectares) to produce all the resources consumed by a country's entire population and to absorb all the waste it produces.
- Ecological footprint of a district, town, region or planet.

The calculation of the EF is based on the following six main land categories:

- Land for energy ;
- Agricultural land ;
- Pasture land ;
- Forestry ;
- Built-up areas ;
- Sea.

Biocapacity (BC) represents the capacity of ecosystems to supply useful biological materials and assimilate waste generated by humans using existing management methods and extraction technologies (Global Footprint Network definition, 2014).

2.6.2 Impact on the environment:

2.6.3 Environmental Performance Index (EPI):

The environmental performance index is calculated on the basis of 32 indicators divided into 11 categories. These categories include air quality, water quality, waste and heavy metal management, and CO2 and greenhouse gas emissions. The EPI also assesses the preservation of terrestrial and marine biodiversity, the management of climate change, and each country's agricultural policy.

The EPI is a mirror image in that the value of the index is high when the potential for ecological advantage is low (Claassen et al., 2004).

2.6.4 Human Development Index (HDI) :

The Human Development Index (HDI) was created by the Pakistani economist Mahbub ul-Haq and subsequently adopted in 1990 by the UNDP (United Nations Development Programme) to capture the development of countries.

It is a composite index (between 0 and 1) of :

- Life expectancy, a measure of the health and lifespan of a population in relation to the HDI.
- Knowledge and education assessed by the adult literacy rate and the combined gross enrolment ratio in primary, secondary and tertiary education (average number of years of schooling completed and number of years of schooling expected on entry into the education system).
- GDP per capita in terms of purchasing power parity.

2.6.5. Gross domestic product (GDP):

This is the sum of the gross value added in money terms of all goods and services produced in a country during a given period.

It is an indicator of development and prosperity. It is used to measure a country's newly produced wealth over a given period. In other words, gross domestic product is an economic indicator of the wealth produced per year in a country (Fig.22).

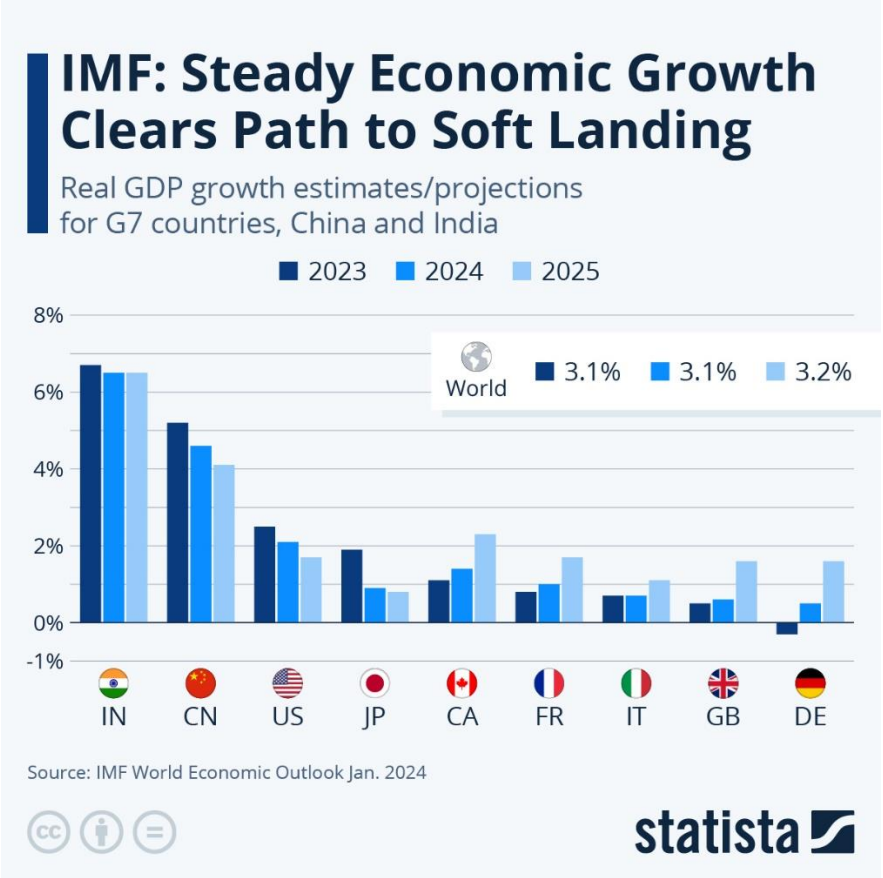


Fig.22. Real GDP growth estimates/projections

2.6.6. Male/female enrolment rate (societal):

The enrolment rate takes into account the number of children enrolled in school (or attending school) as a proportion of all children of school age. This indicator is calculated on the basis of statistically 'visible' children, i.e. those living in households. It is considered that censuses or national surveys are carried out on the basis of population samples, or those counted in school statistics (Fig.23 and Fig.24).

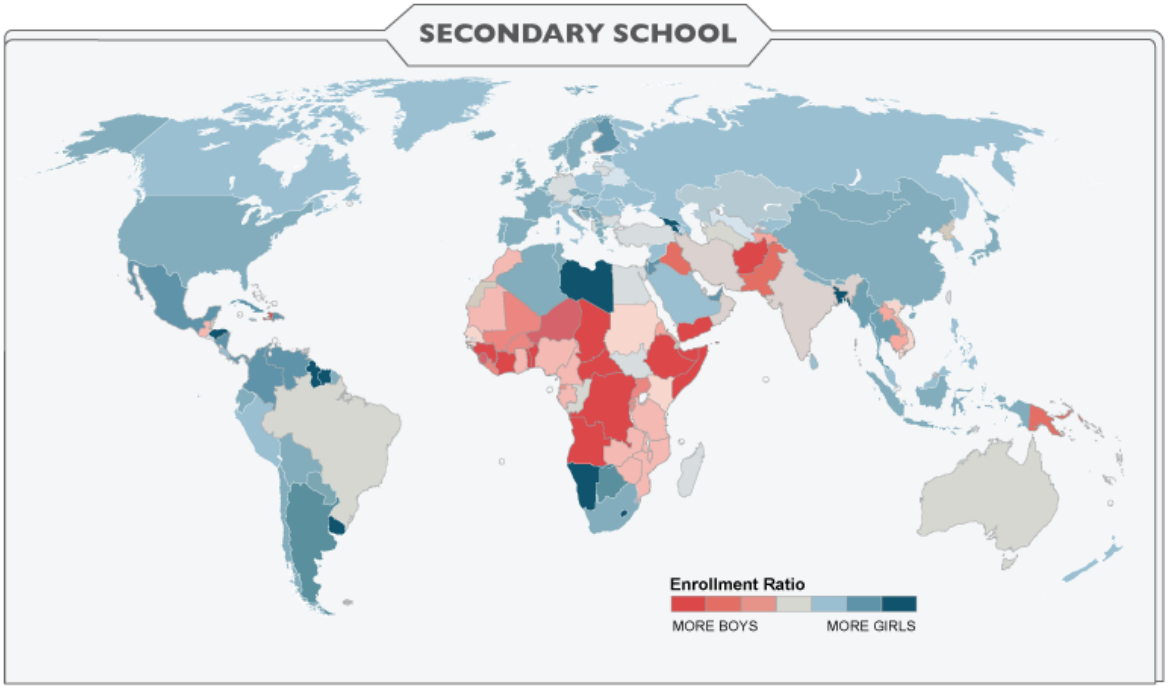


Fig.23. Secondary school
(https://www.worldvision.org/gender-equality-news-stories/behind-the-curtain)

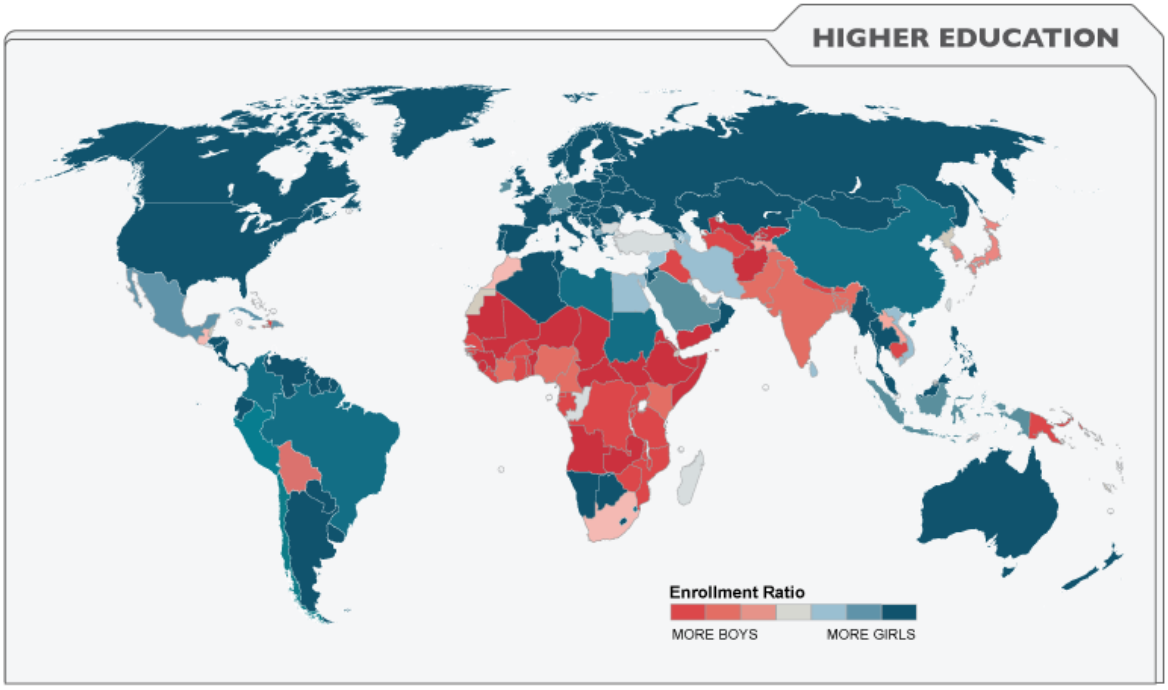


Fig.24. Higher education
(https://www.worldvision.org/gender-equality-news-stories/behind-the-curtain)

2.6.7. Accessibility to care (societal):

Classically, three notions are regularly described (Laurent Chambaud, 2018):

- Physical accessibility: A supply of care services must be available within a reasonable distance for the people who need them.
- Financial accessibility: This involves analysing people's ability to pay for services without financial difficulties. Affordability can be a major obstacle to accessing care and services, and is a major factor in inequalities in use.
- Acceptability: This term mainly covers the reality of the use of services by people who need or want care. Acceptability also depends on the way in which services are organised.

2.7. Environmental education, awareness-raising and nature events, environmental communication:

2.7.1. Environmental education in schools:

There are a number of teaching tools for Environmental Education. These include:

- **The educator's guide :**

This is a set of guides for the three school levels (primary, intermediate, secondary), in the form of a binder with a section reserved for each school level, and comprises four sections (Fig.25).

- An introductory section defining the concepts and issues involved.
- A descriptive section with an overview of the current situation
- A methodological section.
- A suggestive section with suggested thematic technical sheets.

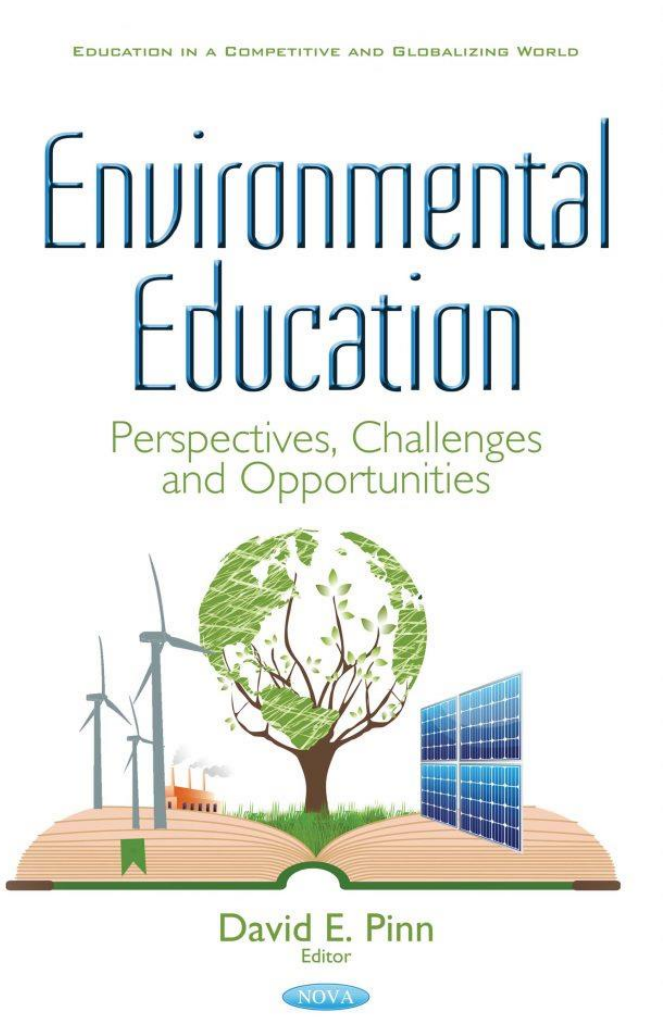


Fig.25. An example of a guide for environmental education

- **Green club kit:**

The green club kit is the teaching tool for activities carried out by pupils and leaders in the green club. It includes (Fig.26):

- The Leader's Guide.
- A methodological guide in the form of a directory.
- Teaching sheets for preparing activities.
- Green School Club member's booklet.
- The School Environmental Charter.

Fig.26. Some elements making up the green club case

- **Student's exercise book :**

This book complements the knowledge acquired in class by using exercises on environmental themes (Fig.27).

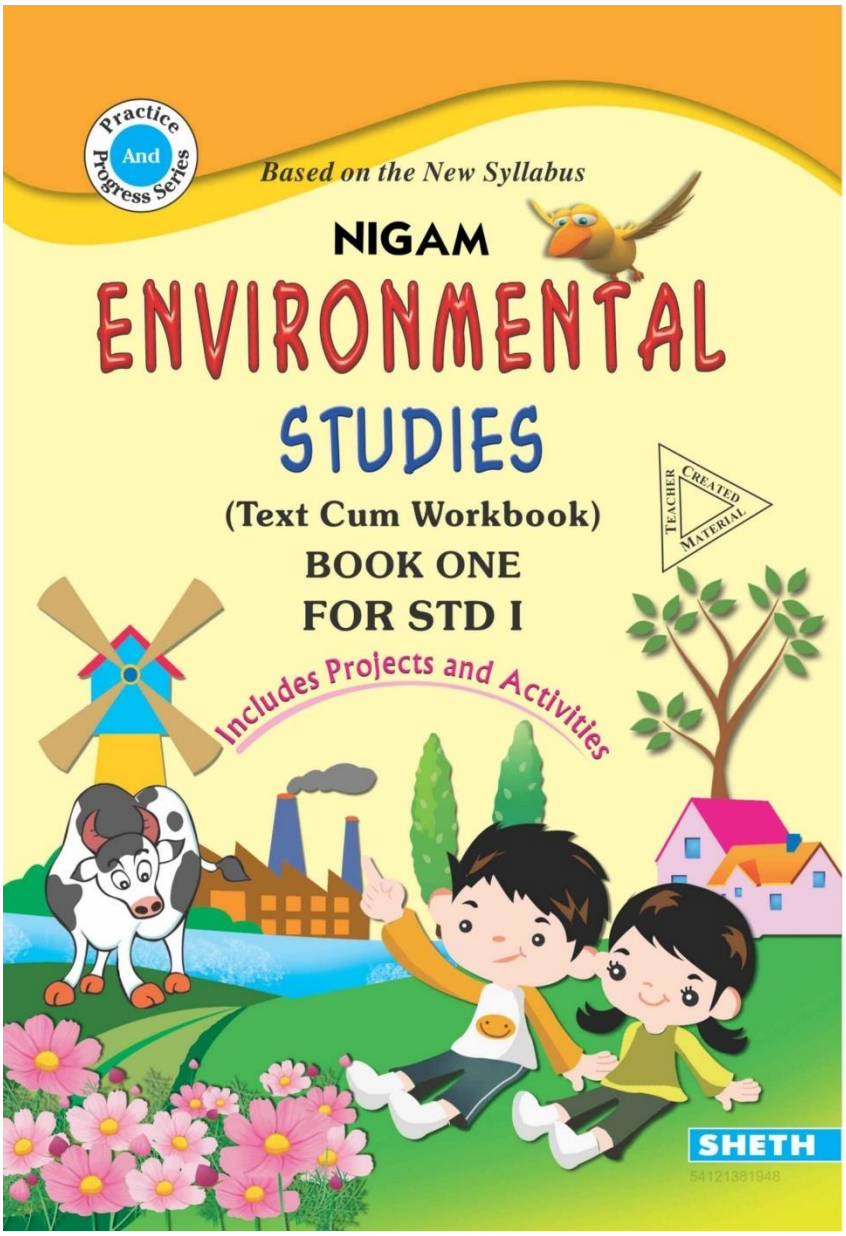


Fig.27. Student Workbook

2.7.2. Raising awareness and nature activities:

Nature activities have a cultural dimension, meaning that the environment is no longer seen simply as the relationship between man and nature, but as the relationship between man and the environment in which he lives. Generally speaking, nature activities are part of environmental education aimed at sustainable development, responding to the needs of an organisation or an individual.

The role of the nature educator is to act as an educationalist and enthusiast, able to intervene on very specific subjects, to organise and lead various activities around nature and the environment. They may also organise guided tours or courses.

Nature instructors need to have a certain amount of initiative and creativity to be able to communicate and lead a group. They must also have a very good knowledge of the land where they work, its history and heritage.

Successful events require precise knowledge of the site. These include outdoor sites, which are an excellent medium for events, and natural environments with complex ecosystems.

The event also requires the choice of a specific theme proposed by the person in charge of the educational facility or by the manager of the natural site or by the producer of the event. This choice is based on the programming of events or festivals.

The duration of the activity depends on the age of the participants and the specifications. For example, alternating learning time with discovery time throughout the day is a suitable choice for schoolchildren.

Fig.28. Nature animator

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