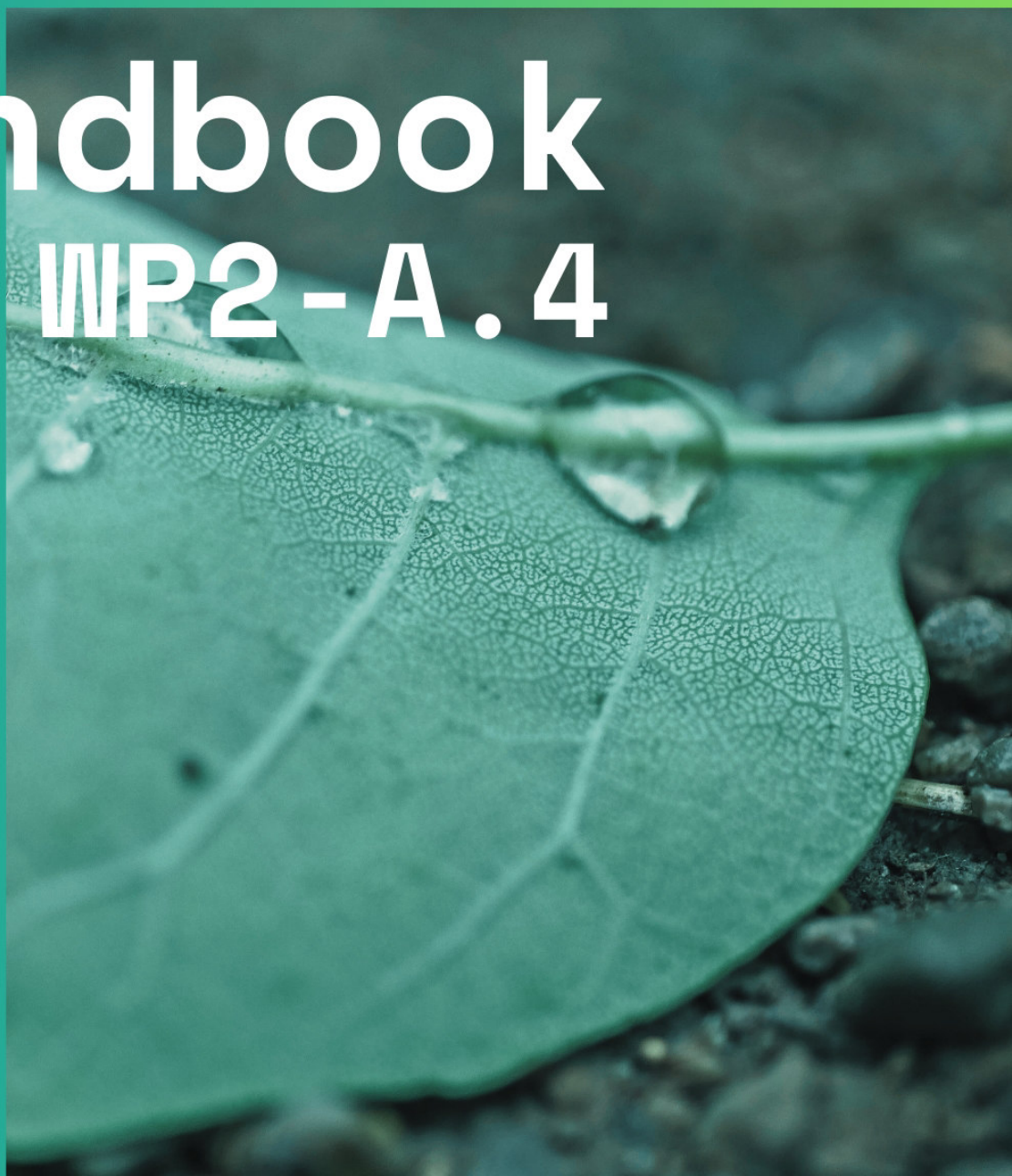
Project LEAF – ERASMUS+

Handbook

WP2-A.4



Learn biodiversity through Environmental Action For the community

Co-funded by the European Union

LEAF

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Project N°:2022-1-RO01-KA220-SCH-000086884

Consortium

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Table of Contents

LEAF – Learn biodiversity through Environmental Action
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Table of Content:

Table of Contents:

01

Introduction and Competence framework

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I. Introduction and Competence framework

This handbook was created as a unification of the joint forces of six countries gathered with the same goal, to point out the importance of plant biodiversity as the key to sustaining life on earth.

In the intricate tapestry of life on Earth, plants stand as silent architects, weaving the foundation of ecosystems that sustain all living beings. As stewards of the planet, we find ourselves at a critical juncture where the fate of plant biodiversity intersects with the destiny of our own existence. In this comprehensive exploration, we delve into the pages of our newly crafted handbook, an ode to the botanical wonders that surround us and an urgent call to action for their preservation.

Plants, with their remarkable diversity, serve as the backbone of terrestrial life, providing sustenance, shelter, and the very air we breathe. From the towering giants of the rainforests to the resilient flora of arid deserts, each species plays a unique role in the delicate balance of nature. Our textbook embarks on a journey through the vibrant realms of plant life, unravelling the intricate connections that bind ecosystems together.

As we navigate through these pages, we will uncover the profound interdependence between humans and plants, exploring the myriad ways in which our destinies are intertwined. The significance of plant biodiversity extends far beyond the aesthetic allure of a lush landscape, it is the linchpin of ecological stability, influencing climate regulation, soil fertility, and the availability of resources that sustain global communities.

In recognizing the pivotal role of plants, our handbook champions the cause of conservation, offering insights into the threats that loom over plant biodiversity and the compelling reasons to safeguard it. From the microscopic wonders of the plant kingdom to the awe inspiring giants that dominate landscapes, we invite readers to immerse themselves in the wealth of knowledge within these pages and join the collective effort to protect the irreplaceable diversity that defines our botanical tapestry.

In the pages that follow, let us embark on a journey of discovery, appreciation, and advocacy for the wondrous world of plants. Together, let us weave a narrative that celebrates the beauty of plant life and underscores the imperative to preserve the rich tapestry of plant biodiversity for generations to come.

Overall aim of the Handbook:

- Improve the teaching experience by providing a set of tools and resources that can make lessons engaging and offer more in-depth, STEAM based, systemic knowledge on local biodiversity, based on constant outdoor investigation and practical experiences in the local community.

Description

This is a conceptual framework, based on more comprehensive frameworks of the European Commission: GreenComp. The European sustainability competence framework.

LifeComp. A European competence framework for better lives in our uncertain world

European Framework for the Digital Competence of Educators: DigCompEdu

DigComp: The Digital Competence Framework for citizens

It is non-prescriptive, and it can be used as a basis for the development of Nature-oriented curricula and learning activities. The aim is to educate students and the community in the spirit of environmental values so as

to live a responsible, sustainable life, while thriving as individuals, responsible citizens and reflective lifelong learners. General competence. From an integrated, general competence perspective, our handbook contributes to developing:

Scientific Literacy:

- Understanding fundamental concepts of botany, ecology, and plant biology.
- Grasping the significance of biodiversity in ecosystems.

Critical Thinking:

- Analysing the impact of human activities on plant biodiversity.
- Evaluating the importance of conservation efforts.

Laboratory Skills:

- Developing practical skills through hands-on lab work.
- Conducting experiments and making observations related to plant life.

Environmental Awareness:

- Appreciating the role of plants in environmental sustainability.
- Recognizing the consequences of biodiversity loss on ecosystems.

Research Skills:

- Accessing and synthesising information on plant diversity.
- Formulating and testing hypotheses related to plant biology.

Problem-Solving:

- Identifying challenges and proposing solutions for the conservation of plant biodiversity.
- Applying knowledge to address real-world environmental issues.

Teamwork and Collaboration:

- Engaging in collaborative lab activities and group projects.
- Sharing ideas and perspectives on biodiversity conservation.

Ethical Awareness:

- Understanding the ethical considerations in biodiversity conservation.

- Recognizing the responsibility to protect and preserve plant life.

Lifelong Learning:

- Fostering a curiosity and enthusiasm for continued learning about plants and ecosystems.
- Developing the skills to stay informed about advancements in plant science

From a filtered, synthetic Green Competence perspective, the following apply, according to the detailed description by modules:

AREA	COMPETENCE	DESCRIPTOR
1. Embodying sustainability values	1.1 Valuing sustainability	Reflection on, identification and explanation of values related to sustainability
	1.3 Promoting nature	Acknowledging the role humans in nature and respecting the role and needs of other species and nature itself in order to restore healthy ecosystems
2. Embracing complexity in sustainability	2.1 System thinking	Contextual approach and consideration of all factors when analyzing sustainability issues
	2.2 Critical thinking	Assessment of information and arguments, challenging of assumptions and theories, consider factors that influence conclusions
	2.3 Problem framing	Formulating current and potential challenges to sustainability
3. Envisioning sustainable futures	3.1 Future literacy	Imagining alternative scenarios and identification of steps for a more sustainable future

	3.3 Exploratory thinking	Exploring and linking disciplines and linking creative ideas and methods
4. Acting for sustainability	4.2 Collective action	Acting for change in collaboration
	4.3 Individual Initiative	Identifying own potential for sustainability and contributing actively to improving the future of the planet

1. Valuing sustainability
2. Promoting nature

***Module 1*: "*Climate change and urban biodiversity*"**

Presentation of the mechanisms of climate change, the human activities at the origin but also the international political response and the commitments made by the states and local governments.

Inventory of the trajectories of emissions and the consequences on our ecosystems in terms of adaptation.

Inventory of the realities of climate change through theoretical and scientific knowledge such as the Intergovernmental Panel on Climate Change (IPCC) reports, the Sustainable Development Goals, the climate change international negotiations agenda

Analysis of the realities of biodiversity through theoretical and scientific knowledge such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) reports, the Sustainable Development Goals and the international negotiations agenda

Identification of the role of biodiversity as a cornerstone to mitigate these changes while also creating a significant number of co-benefits both in terms of adaptation and resilience with, among other, nature-based solution.

Module 2 : "Protected Natural Areas"

Overview of the protected natural areas worldwide, including the history, statistics per continent and their importance in the preservation of biodiversity.

Analysis of protected natural areas in Europe and more specifically in Greece.

	Module 3 : "Urban parks and forests" Analysis of parks and gardens as part of the European urbanizing landscapes, in a context of planning for sustainable biodiversity and relating to multifunctional land use. Analysis of the parks and forests integrated in the urban landscapes of Suceava Analysis of the landscapes' evolution monitoring the biodiversity of parks and gardens. Identification of European urban landscapes of parks and forests, from the perspective of the importance of the species persistence influencing the habitat quality, the amount and configuration of the habitat and the permeability of the landscapes. ***Module 4: "Biodiversity of aquatic plants"*** Overview of the water plant biodiversity worldwide and importance in the preservation of water plant biodiversity. Overview of Protected Natural water and Protected water in Serbia ***Module 5: "Boosting digital skills of teacher for a better communication and collaboration"*** Analysis of the importance of digital skills in the school environment ***Module 6 - "Cooperation with local community"*** Analysis of the importance of an inclusive approach and involving local community in sustainable actions Identification of ways to inform and involve relevant stakeholders in a green project/program.

2. Critical thinking, system thinking and problem framing	Urban parks and forests analyzed by applying a questionnaire and comparing the results. By social science methods, investigation of the effect of biodiversity on human health and wellbeing Assessment of actions aimed at increasing the green areas allocated to the citizens of each country in the current context of climate and geopolitical changes. *Identification by teachers and students of specific local resources*, so that, at a global level, the risks of biodiversity loss are increasingly reduced, through concrete activities, field applications. Assessment of the role of the *quality* of the natural environments, by investigating the beneficial effects of the activity in allotments or domestic gardens on health and wellbeing Evaluation of the greater positive effect of the natural environments in comparison to the built-in environments on human restoration and wellbeing. Evaluation of impact of professional practices and knowledge in the interaction through digital technologies. Assessment of how climate change is altering territories: rising sea levels, increased extreme weather events, higher temperatures, water shortage... Evaluation of how climate change is accelerating the loss of biodiversity and leading to increased degradation of ecosystems, vulnerability of food production, threat to human well-being.

	Evaluation of current challenges of urban planning to answer climate change and how climate change impact cities (soil vulnerability, urban heat islands, urban sprawl…)

3.1 Future Literacy 3.3. Exploratory thinking	Evaluation of the relationship between the stress reduction and the visual perception of the natural environments and future measures Identification of possible causal mechanisms linking species richness and wellbeing to the garden context and urban green spaces in general/possible steps Identification of a set of resources related to protected areas to include in teaching Get involved with the local community Ideas promoting 'green' attitudes in the use of digital technologies Ideas to organize and manage digital workspaces in the school Ideas on how to advocate important topics in local community and in front of decision makers Ideas on Biodiversity in the city: how to use it to regenerate the city by finding alternatives to solutions that have become obsolete; green frames, greening of urban furniture/buildings, eco pastoralism, recreating urban beehives... with adaptable examples at local, national, and international levels Understand and practice in the territory: how to observe changes as a secondary school student? To question oneself and the local actors and inhabitants to better understand the multi-systemic evolution in their community Cross-reference of the multi-systemic issues that territories face in order to rethink their planning with sustainable alternatives

2. Collective action 3. Individual Initiative	Practical implementation cases – students 'activities in Suceava's Parks, forests and gardens -Romania Practical implementation cases and students' activities on local protected natural areas to deliver in class – Greece Practical activities related to water plant biodiversity for teachers to use in the class - Serbia Let's get practical! Hands-on activities for teachers -Serbia Hands-on activities for teachers *for* Collaboration and sharing through digital resources - keeping it 'green' -Italy Plan on how to efficiently engage with local community and relevant stakeholders active in it (Croatia) Put into practice – immersion in the understanding of territorial change through interaction with local stakeholders and inhabitants and by observing the cycle of nature and the biodiversity in its immediate environment (France)

02

Climate change and urban biodiversity

Module by ENERGIES 2050

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Table of Contents, Module 2:

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II. Climate change and urban biodiversity

1. Introduction

Climate change, the origin of which is due to human activities, is characterised both by its increasingly significant increase and by its increasingly severe consequences in a growing number of countries. Since the end of the 19th century, the average temperature at the Earth's surface has been increasing. The average global temperature in 2022 was 1.15°C higher than pre-industrial levels (1850-1900). This is the eighth consecutive year that this 1°C mark has been exceeded. Since the 1980s, each decade has been warmer than the previous one.

This increase in temperature has significant consequences. The life and activities of humans are affected: increasing temperatures and rising sea levels, melting of the oceans, melting of the ice, increase in rain in some places and droughts in some others, increase in extreme weather phenomena (storms, flooding, temperatures). The evolution of human activities has led to the depletion of non-renewable natural resources and the demand for energy is constantly increasing. Moreover, the phenomenon of climate change, for which man is undeniably responsible, threatens the balance of our ecosystems and is becoming a risk for our planet and even for our life on earth.

Climate change and the loss of land due to rising sea levels, its impacts on agriculture and fisheries affecting food security, and increasingly frequent extreme weather events are forcing some populations to migrate to survive. In 2005, the term "environmental refugee" was used for the first time in a UN report. The number of "climate migrants" is estimated at 250 million people by 2050. All of this is putting pressure on available natural resources, including water, which reinforces inequalities between populations.

The fauna and flora are also sensitive to climate changes. With the acceleration and weakening of vegetative cycles, some species are forced to migrate or adapt in order not to disappear. Global warming is one of the five main causes of the erosion of biodiversity (today we speak of the sixth mass extinction). These issues are now recognized as challenges at global, European, national and local levels.

In order to adapt and fight against these changes, the international community has set itself the goal of halving greenhouse gas emissions (GHG) by 2050 on a global scale. To reach this goal, the countries of the world will have to rethink their development methods and get into gear to considerably reduce their CO_2 emissions. It is important to understand the chronology of our history and our impact on the climate to help everyone to understand the origin of the policy hierarchy in the fight against climate change. This arborescence has its basis in an international response to scientific concerns. It is also important to better capture how this has been translated into national agendas, so as to best shape the objectives to be reached, as a result of these many years of negotiations. Cities are also at the forefront both regarding the problems but also as part of the solutions.

Therefore, assimilating this evolution of the agreements, will allow us to grasp the relationship between the city policies and the national strategies. A clear understanding of this articulation of these political and territorial scales of commitment, allows us to better grasp this thread, in order to have a clearer understanding of the relationship between the city and the national strategies and their contribution to the development of the city.

This module focuses on these different levels. Climate change and the issues of preserving biodiversity are at the heart of the issues, and cities and local levels are particularly important as well as citizens' involvement. Teaching and knowledge are priority pillars. With that respect, this module involves providing teachers with informational content to enable them to enrich their teachings on these important issues. It is also about inviting learners to take into account in their daily lives the essential changes to be implemented collectively as part of the global answer.

2. Part I - International and national context versus local realities

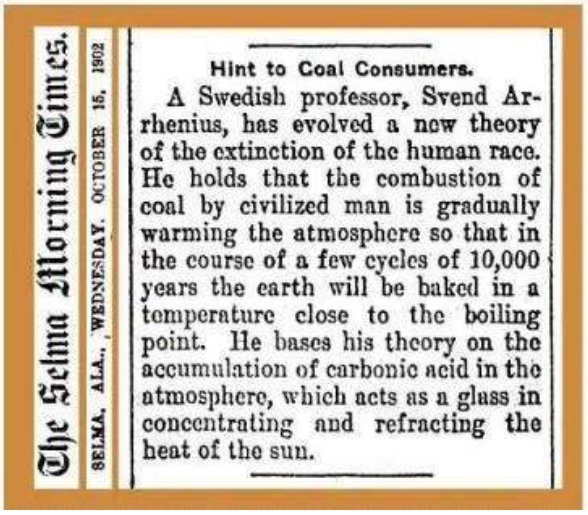
2.1.1. The Emergence of a Global Environmental Governance

The precursors: Climate change and biodiversity are two interconnected and pressing issues that are of global concern. Climate change refers to the long-term shifts in weather patterns and temperatures that are caused by the increase in GHG emissions, primarily from human activities (Prakash, S. 2021). On the other hand, biodiversity refers to the variety of plant and animal species that exist in a particular ecosystem, as well as the genetic diversity within those species (Verma, A. K. 2021). Both climate change and biodiversity have important implications for our planet and its inhabitants, including humans. The loss of biodiversity can have negative impacts on the environment, such as reduced ecosystem services, decreased resilience to climate change, and reduced food security. Climate change, for its part, can exacerbate the loss of biodiversity through changes in temperature, precipitation, and other environmental factors.

With the industrialization that began in the 19th century, human activities turned out to be responsible for an aggravation of the greenhouse effect. This aggravation is linked to the increase in the concentration of GHG naturally present in the atmosphere, among which carbon dioxide (CO_2). CO_2 is the main cause of this additional greenhouse effect, and therefore of global warming (Gupta, 2017). If certain natural phenomena such as volcanic eruptions and forest fires can increase its concentration in the atmosphere, it is human activities, with the use of fossil carbon (oil, natural gas and coal) and our modes of production and consumption such as the manufacture of cement, which essentially cause this increase (Baum, 2016).

One of the first scientists to predict humans' potential impact on climate change was the Swedish scientist and Nobel laureate Svante Arrhenius. Arrhenius, a noted chemist of the late 19th and early 20th centuries, was the first to recognize and calculate the effect of atmospheric CO2 on global temperature, now known as the greenhouse effect. The downright image is from a newspaper article from 1902, emphasising the original conclusions Arrhenius drew from his calculations. The one on the

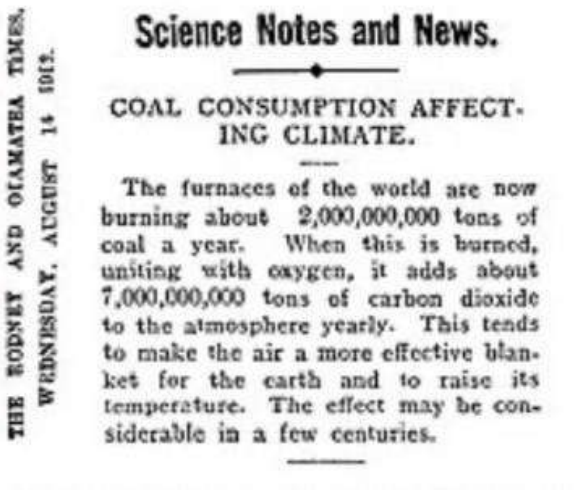
left is from a late 1912 article first published in Popular Mechanics. As you can probably guess, those early warnings didn't really materialise.



The Selma Morning Times. SELMA, ALA., WEDNESDAY. OCTOBER 15, 1902

Hint to Coal Consumers.

A Swedish professor, Svend Arrhenius, has evolved a new theory of the extinction of the human race. He holds that the combustion of coal by civilized man is gradually warming the atmosphere so that in the course of a few cycles of 10,000 years the earth will be baked in a temperature close to the boiling point. He bases his theory on the accumulation of carbonic acid in the atmosphere, which acts as a glass in concentrating and refracting the heat of the sun.



THE BODNEY AND OTAMATEA TIMES, WEDNESDAY, AUGUST 14 1912.

Science Notes and News.

COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

https://archive.nytimes.com/dotearth.blogs.nytimes.com/2016/10/21/coals-link-to-global-warming-explained-in-1912/
"Hint to Coal Consumers". The Selma Morning Times. Selma, Alabama, US. 15 October 1902. p. 4

The emergence of the modern environmental movement in the 1960s and 1970s - Through a brief introspection in time, we go back to the year 1958 when American scientist Charles Keeling observed that the increase in the concentration of carbon dioxide in the atmosphere was linked to human activity. The following year, at a special event celebrating the 100th anniversary of the U.S. oil industry in 1959, scientist Edward Teller, the father of the hydrogen bomb, had some prescient words to share with the hundreds of oil tycoons, government officials and other scientists in attendance:

“At present the carbon dioxide in the atmosphere has risen by 2 percent over normal. By 1970, it will be perhaps 4 percent, by 1980, 8 percent, by 1990, 16 percent, if we keep on with our exponential rise in the use of purely conventional fuels. By that time, there will be a serious additional impediment for the radiation leaving the earth. Our planet will get a little warmer. It is hard to say whether it will be two degrees Fahrenheit or only one or five. But when the temperature does rise by a few degrees over the whole globe, there is a possibility that the ice caps will start melting and the level of the oceans will begin to rise. Well, I don’t know whether they will cover the Empire State Building or not, but anyone can calculate it by looking at the map and noting that the ice caps over Greenland and over Antarctica are perhaps five thousand feet thick.”

There was a bit of fear in Teller's testimony. In the course of the 1960s, a slew of scientists returned to this question with fresh calculations and cautions regarding the consequences of carbon dioxide emissions on worldwide temperatures.

In this historical framework, the modern era of global environmental governance began in the 1960s and 1970s, as public concern grew about the impact of human activities on the natural world. This period saw the emergence of the modern environmental movement, as citizens, scientists, and activists mobilised to address a range of environmental issues, including pollution, deforestation, and species extinction. At the end of the 1970s, scientists mentioned CO_2 emissions as a probable cause of global warming. This awareness pushed the international community to react.

During the 1970s, the correlation between unusually cold weather and concerns about man-made pollutants like smog causing a cooling effect led to a perplexing question: were humans responsible for global warming or cooling? According to the general consensus among the scientific community, the available evidence was deemed insufficient and inconclusive, indicating a requirement for more comprehensive data. The majority of scientists did not predict global cooling despite successive frigid winters in Asia and North America, but a handful of dissenting voices were amplified by the mainstream media. Sensationalized journalism has the potential to harm the public's understanding of climate science (Jones, M. D. 2014).

Some key milestones: It was not until 1972 and the first United Nations Conference on the Environment[26] for its protection to be stated as an international priority. It was in Stockholm, Sweden, that the United Nations Environment Program (UNEP) was created. This UN-convened conference marked a turning point in the development of international environmental policy. It led to the creation of a commitment which coordinates the global efforts to promote sustainability and safeguard the natural environment. Therefore, The Conference marked a turning point in global environmental governance, as it was the first time that environmental issues had been put on the international agenda. The Conference produced the Stockholm Declaration, which affirmed the need for a global response to environmental challenges and called for sustainable development.

Climate change, however, was only a footnote at the Stockholm conference. The issue was largely seen as a scientific concern, not an urgent political "problem." But between that 1972 conference and

[26] https://www.un.org/en/conferences/environment/stockholm1972

the second half of the 1980s, some politicians took note of the fact that scientists were increasingly warning of the risks posed by rising GHG. This was recognized at the first World Climate Conference in 1979 held in Geneva from 12 to 23 February, where the knowledge of climate change and the impact of its variability was taken into consideration.

The World Commission on Environment and Development, also known as the Brundtland Commission, was established in 1983 by the United Nations. The Commission's report, *Our Common Future*", defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Verma, 2019). The report emphasised the importance of addressing environmental and development issues together, and it laid the groundwork for many of the global environmental agreements that followed. (Brundtland G.H. 1987).

The emergence of global environmental governance was driven by a recognition that environmental problems could not be solved by individual countries acting alone. Many environmental issues, such as climate change and biodiversity loss, are global by nature and require coordinated action at the international level. Global environmental governance aims to promote cooperation and coordination among countries, to ensure that environmental issues are addressed effectively and fairly. During the 1980s, a consensus emerged among scientists regarding global warming, leading to the first large-scale and coordinated efforts to protect the environment. Therefore, the regulation and ultimate prohibition of chlorofluorocarbons (CFCs) marked a significant milestone in climate change history. Initially employed as refrigerants and propellants, CFCs were eventually found to be significant contributors to the depletion of the ozone layer. Circling the earth in the upper reaches of the atmosphere, the ozone layer is composed of ozone particles. Its primary function is to shield the planet from the detrimental effects of ultraviolet radiation, which is commonly associated with sunburns and skin cancer. Even though it is only loosely linked to climate change, ozone depletion can be a significant hazard. It heightens the risk of cancer and other detrimental effects on plants and animals. The greatest perceivable indicator of ozone reduction is the ozone hole, a region of severe ozone depletion found over Antarctica. At their nadir, Antarctic ozone levels were 70 percent lower than they were before 1980. In 1987, the Montreal Protocol[27] was created and implemented in 1989. Its success in reversing

[27] https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol

the negative trend has been a monumental accomplishment in the history of international agreements. Thanks to the Protocol's decision to phase out and later prohibit the use of ozone-depleting elements such as CFCs, the ozone layer above the South Pole has started to heal. According to NASA projections, the ozone hole is predicted to recover its pre-1980 dimensions by approximately 2075 NASA (2014). The Montreal Protocol stands as a significant landmark in the global effort to combat climate change, marking the first major international achievement in this regard. The rapid implementation of the ozone hole agreement is striking.

2.2.1. The United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) was effective in 1994, and it remains one of the most important global environmental agreements. The Convention is a legally binding treaty that sets out a framework for action to address climate change. 2,500 recommendations have been established under the name of Agenda 21 during this summit. The objective of this convention[28] was to stabilise GHG at their 1990 level by the year 2000. The fight against global warming was considered only possible on a global scale with effective cooperation between all states. The objective of the UNFCCC is to stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system. The Convention recognizes that developed countries have a greater responsibility to address climate change, as they have contributed the most to GHG over time.

One of the key outcomes was the Kyoto Protocol, adopted in 1997. The Protocol established legally binding targets for reducing GHG emissions in developed countries. The Protocol also created a system of emissions trading, which allowed countries to buy and sell emissions credits. While the Kyoto Protocol was an important step forward in global efforts to address climate change, it had several limitations. For example, it only applied to developed countries, and some countries, such as the United States, did not ratify the Protocol. The development of the Kyoto Protocol faced significant challenges, particularly in achieving consensus among participating countries. Negotiations were often fraught with tension, as developed and developing countries held different views on the responsibility

[28] https://unfccc.int/resource/docs/convkp/conveng.pdf

for addressing climate change and the level of ambition required. Despite these challenges, the Kyoto Protocol represented a significant achievement in global efforts to address climate change.

The UNFCCC and its associated protocols have faced several challenges over the years. One of the biggest challenges has been ensuring that all countries take action to effectively address and respect their commitments. Among challenges include financing for climate action, technology transfer, and adaptation to the impacts of climate change. We will present the Paris Agreement later.

2.3.1. The Intergovernmental Panel on Climate Change (IPCC)

As a result of the Montreal Protocol's aftermath in 1987, the United Nations, in collaboration with the World Meteorological Organization, established the Intergovernmental Panel on Climate Change (IPCC[29]) in 1988. This intergovernmental body is based on the idea of cooperation between scientists and government representatives from each member state. Its mandate is to provide policymakers with scientific assessments of climate change, its impacts, and possible response options.

The IPCC is composed of thousands of scientists and experts from around the world who volunteer their time and expertise to assess the latest scientific information on climate change. Since its establishment, the IPCC has released a series of Assessment Reports, which provide a comprehensive overview of the state of knowledge on climate change. The reports are produced every six to seven years and are intended to inform policymakers and the public about the risks associated with climate change. Back in 1990, the IPCC published its first assessment report. It warned that "emissions from human activities are significantly increasing atmospheric concentrations of greenhouse gases. This report prompted many calls for a global treaty. The IPCC has also released several Special Reports on specific topics, such as the impacts of global warming and how to limit our emissions under 1.5°C and the role of land use in climate change mitigation and adaptation. Moreover, The IPCC's findings have been instrumental in shaping climate policy and public awareness of climate change. Its reports have provided a scientific basis for international climate negotiations and agreements, such as the UNFCCC and the Paris Agreement.

[29] https://www.ipcc.ch/

IPCC regularly carries out a review of research and knowledge on the various aspects of climate change. Even if it has had its critics; described as both “too cautious” and “too political and alarmist”, however, reports have been widely accepted as the authoritative source of information on the science and impacts of climate change. In 2007, IPCC was awarded the Nobel Peace Prize.

One of the key strengths of the IPCC is its ability to provide policymakers with clear and concise summaries of complex scientific information. The Summary for Policymakers, which is included in each Assessment Report and Special Report, is a concise summary (40-70 pages) of the main findings and recommendations of the global reports which contains thousands of pages. The Summary for Policymakers is approved line by line by representatives from all member countries, ensuring that it accurately reflects the scientific consensus and the proper endorsement. Furthermore, recently the IPCC has also increasingly focused on the regional impacts of climate change with a serie of regional reports. This has allowed policymakers and communities to better understand the specific risks and opportunities associated with climate change in their region.

In conclusion, the IPCC is playing a crucial role in providing policymakers and the public with reliable and up-to-date information on climate change. IPCC reports have provided a scientific basis for international climate policy and have helped to raise public awareness of the urgent need to address climate change.

2.4.1. The Convention on Biological Diversity (CBD) and the role of IPBES

The climate and biodiversity crises are interdependent: these two central elements of life on earth must be protected in the same way (Arya, 2019; Prakash, 2021). The biological resources of our planet play a crucial role in human economic and social progress. It is widely acknowledged that the Earth's biological diversity is an invaluable global asset for generations present and yet to come. Unfortunately, the danger to species and ecosystems has reached unprecedented levels, with human activity causing an alarming rate of extinction (Kumar and Verma, 2017).

Following a pressing call to action, the United Nations Environment Programme (UNEP)[30] took bold steps in November 1988 by gathering the Ad Hoc Working Group of Experts on Biological Diversity.

[30] https://www.unep.org/

Their mission was to assess the necessity of an international convention on biological diversity. Moving forward, the Ad Hoc Working Group of Technical and Legal Experts was established in May 1989 to prepare a legal instrument for the preservation and responsible usage of biological diversity worldwide. After that, in February 1991, the Ad Hoc Working Group underwent a name change and was now recognized as the Intergovernmental Negotiating Committee. Its efforts culminated with the Nairobi Conference on May 22, 1992, which marked the official adoption of the Agreed Text of the Convention on Biological Diversity.

The United Nations Conference on Environment and Development, also known as the Rio "Earth Summit," witnessed the signing of the Convention on 5 June 1992 at the United Nations Conference on Environment and Development (UNCED). The Convention came into effect on 29 December 1993. The inaugural Conference of the Parties was scheduled for 28 November – 9 December 1994 in the Bahamas.

At the same time, biodiversity plays an enormous role in building resilience to the inevitable impacts of climate change. So, the CBD is based on the recognition that biological diversity is a vital asset for present and future generations and that it is important to protect and conserve this diversity. The main objectives of the CBD are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources. The CBD recognizes that the conservation and sustainable use of biological diversity is of critical importance for the well-being of humanity.

The CBD is a living agreement that has evolved over time through the Conference of the Parties (COPs) and the adoption of various protocols. The COP is the decision-making body of the CBD, and it meets regularly to review the implementation of the convention, to adopt new decisions and protocols, and to plan and coordinate the work of the convention. The CBD has adopted several protocols that address specific issues related to biodiversity conservation, including the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation, which was adopted in 2010.

The Nagoya Protocol[31] aims to ensure that the benefits arising from the utilisation of genetic resources are shared fairly and equitably between the countries providing the resources and those using them. It

[31] https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf

also aims to promote the conservation of biodiversity and the sustainable use of its components. The Nagoya Protocol has been ratified by over 100 countries, and it is an important legal instrument for the implementation of the CBD (Morgera, et al 2014).

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[32] is an independent intergovernmental body established by the United Nations in 2012. The IPBES provides scientific assessments of biodiversity and ecosystem services and supports the work of the CBD. The IPBES plays an important role in providing the scientific basis for the implementation of the CBD and in helping to ensure that policy decisions are based on the best available science.

2.5.1. The Paris Agreement (2015)

The Paris Agreement, adopted in 2015, as an outcome of the UNFCCC 21st Climate Conference (COP21) represents a significant milestone in the international community's efforts to address climate change. Building on the framework established by the UNFCCC and its associated protocols, the Paris Agreement seeks to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with a goal of pursuing efforts to limit the increase to 1.5 degrees Celsius by the end of the Century. This new universal agreement commits, from 2020, all states (whether they are developing countries or industrialised countries) and particularly the largest emitters of CO_2 which are China and the United States. Each state must make commitments commensurate with its responsibilities and possibilities. It tries to establish a fair distribution of efforts between industrialised countries, emerging countries and poor countries. The former, considered to be historically responsible for global warming, have also pledged to provide 100 billion dollars a year to developing countries by 2020 to help them in their transition. This amount is set to increase in the coming years.

The Paris agreement was cautiously welcomed by governments and activists. One of the key mechanisms of the agreement is the concept of Nationally Determined Contributions (NDCs)[33]. NDCs are updated every five years, with a view to progressively increase ambition over time.

In addition to the NDCs, the Paris Agreement includes provisions for financing, capacity-building, and technology transfer to help developing countries to implement their commitments. Developed

[32] https://www.ipbes.net/history-establishment
[33] https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs

countries are expected to provide financial support to developing countries to help them meet their climate goals and adapt to the impacts of climate change. Organised in this manner, the agreement represents the "ultimate" global pact on climate change for the foreseeable future. As the initial legally binding agreement, it holds the distinction of being enforceable. Climate litigation based on breaches of the Paris Agreement has been brought against various nations and corporations, including oil giant Shell as most of them are not respecting their commitments.

The role of the IPCC and IPBES in supporting the implementation of the Paris Agreement is also significant. The IPCC's scientific assessments and special reports provide the basis for much of the discussions and decision-making under the agreement. The IPBES, on the other hand, focuses on biodiversity and ecosystem services, which are critical components of climate change mitigation and adaptation efforts. The Paris Agreement represents an umbrella agreement, set to last, with a periodic review of what has been promised and achieved. Moreover, it turns its back on the (top-down) architecture of the Kyoto Protocol, adopting a (bottom-up) approach in which countries submit voluntary reduction proposals. Depledge, J. (2022). It also replaces absolute global emission reduction targets with NDCs. While the Paris Agreement has the legal status of an international treaty that creates legal obligations for all countries that have agreed to sign and ratify it, the level of ambition of the NDCs and compliance with their contents are not legally binding (Bodansky, 2016).

There were close discussions on the question of the ambition of the text. Developing countries, including small island states, and civil society, including NGOs networks, wanted to set the absolute limit at 1.5°C of total warming. Developed countries such as the United States and oil-exporting countries, including Saudi Arabia, sought instead to maintain the 2°C limit. The final version of the text states that countries aim to keep "the increase in global average temperature well below 2°C above pre-industrial levels" while "continuing efforts to limit the increase in temperature to 1.5°C above pre-industrial levels" (art. 2.1).

Using this wording, the Paris Agreement shows that it is entirely possible that global warming above 1.5°C could already be considered a dangerous anthropogenic disturbance of the climate system. But it is not enough to mention this objective, it is also necessary to specify how to achieve it. The content of the NDCs and other national documents varies depending on the country's national circumstances, priorities, and resources. However, all NDCs must include certain key elements, such as:

- A description of the country's current and projected GHG emissions, including information on the sectors and sources that contribute most to emissions.
- A description of the country's national circumstances, such as its economic, social, and environmental conditions, that affect its ability to mitigate and adapt to climate change.
- A description of the country's mitigation goals and targets, which should be ambitious, transparent, and measurable. The goals should be set based on the best available scientific knowledge and should be consistent with the objective of the Paris Agreement to limit global warming to well below 2°C above pre-industrial levels.
- For developing countries, description of the country's adaptation goals and actions, which should address the vulnerabilities and impacts of climate change on the country's economy, society, and environment.
- For developing countries, description of the country's climate finance needs, and support received, as well as its capacity-building and technology transfer needs.

National Climate Action Plans or NDCs are key tools for ensuring effective national action on climate change. Once adopted, they must be implemented and regularly reviewed and updated to reflect progress and new opportunities for reducing emissions. National governments should also regularly report the results of their climate change action to the UN and other stakeholders to ensure transparency and accountability. Every country (Parties as signatory of the Paris Agreement) has the freedom to develop their NDCs in a self-directed and unforced manner, considering their own individual circumstances, abilities, and preferences. NDCs typically encompass strategies to lower GHG emission in sectors like agriculture, industry, transport, energy, and waste management. Additionally, they may also comprise measures to acclimate to the consequences of climate change, such as extreme weather phenomena, storms, floods, and droughts. After a country approves its NDC, it will need to develop and implement specific policies and measures to achieve its targets and goals. The policies and measures will vary depending on the country's specific circumstances and priorities (Tørstad, V. and al 2020)

Here are some examples of the types of policies and measures that countries might use:

- **Energy sector:** The field of industry is responsible for an important part of international greenhouse gas emissions. Measures to lower emissions in this sector include increasing the share of renewable energy, improving energy efficiency and decreasing dependence on fossil fuels.
- **Transportation sector:** Transport sector also constitutes an important addition to greenhouse gas emissions, particularly through the use of fossil fuels in vehicles. Policies and measures to lower emissions in the transport sector could include promoting public transport, elevating fuel efficiency standards and promoting the use of electric vehicles or phasing out fossil fuel subsidies.
- **Buildings and construction sector:** The construction field has a major role in the portion of global energy consumption and greenhouse gas emissions. Promoting energy efficiency, improving building codes and standards, and encouraging the use of low-carbon building materials is one of the policies and measures that has been taken to reduce emissions from.
- **Agronomy and forestry:** Agriculture is important for both reduction and adaptation efforts. Strategies and measures to lower agricultural emissions could include promoting sustainable land use practices, reducing deforestation, and decreasing livestock emissions and fertiliser use. Policies and measures to increase the resilience of agriculture and forestry to climate change could implicate promoting climate-friendly agriculture, improving water resource management, and reducing the risk of forest fires.
- **Industry sector:** As known the industry is responsible for a significant portion of global greenhouse gas emissions, particularly from high-emitting industries such as cement, steel, and chemicals. To reduce the emission due to this sector, the policies and measures that have been taken from the industry sector could include promoting the adoption of low-carbon technologies and practices, improving energy efficiency, and developing policies to reduce emissions from high-emitting industries.

Apart from the mentioned areas, other crucial areas of emphasis might incorporate waste management, land-use alteration, and optimal water management. It ultimately hinges on the country's specific

necessities and preferences, but all efforts will be geared towards curbing greenhouse gas emissions and enhancing the resilience of communities to the perils of climate change.

Sectors that countries prioritise will differ based on their unique circumstances, capabilities, and priorities (Crumpler, Kand all 2020). Several factors can impact a country's decision on which sectors to prioritise, including:

- **Emissions profile**[34]: Nations with significant emissions in specific fields would probably focus on those areas while devising their climate plans. As an illustration, a nation with high energy or transportation sector emissions might give priority to those sectors to achieve substantial greenhouse gas reductions.
- **Economic considerations**[35]: Countries may prioritise sectors that are critical to their economy or have the potential for significant economic growth. For example, a country with a strong renewable energy sector may prioritise policies and measures to further develop that sector.
- **Technical feasibility**[36]: Countries may prioritise sectors where there are readily available and cost-effective technologies to reduce emissions. For example, countries with abundant solar or wind resources may prioritise the development of those technologies to reduce emissions from the energy sector.
- **Social and political considerations**[37]: Countries may prioritise sectors that have significant public support or align with their political priorities. For example, a country with a strong agriculture sector may prioritise policies and measures to reduce emissions from agriculture in order to support the livelihoods of farmers and rural communities.
- **Adaptation needs**[38]: Countries may prioritise sectors that are most vulnerable to the impacts of climate change and require adaptation measures. For example, a country with a high risk of drought may prioritise water management policies and measures to ensure water availability in the face of climate change.

[34] https://ourworldindata.org/co2-and-greenhouse-gas-emissions
[35] https://www.imf.org/en/Topics/climate-change/climate-and-the-economy
[36] https://www.oecd.org/env/cc/44887764.pdf
[37] https://www.worldbank.org/en/topic/social-dimensions-of-climate-change
[38] https://climatepolicyinfohub.eu/climate-change-adaptation-needs-barriers-and-limits.html

Overall, the Paris Agreement represents a global effort to address the urgent threat of climate change. Its provisions for NDCs, financing, capacity-building, and technology transfer provide a framework for countries to work together towards a common goal. The role of the IPCC and IPBES in supporting the implementation of this agreement is critical, as their scientific assessments and policy recommendations provide a basis for informed decision-making. While challenges remain, such as the need for more ambitious targets and greater international cooperation, the Paris Agreement is an important step towards a sustainable future for our planet.

2.6.1. The Climate and Biodiversity Conferences of the Parties (COPs)

The Conference of the Parties (COPs) are the key international platforms for advancing global climate and biodiversity agendas. COPs are meetings that bring together representatives from member countries, each year, for the UNFCCC and, each two years, for the CBD, to discuss the latest developments in these fields and negotiate solutions to global environmental challenges.

The COPs have been instrumental in producing key outcomes that have shaped international climate and biodiversity policies. They had also produced number key outcomes, including, for example for the Biodiversity COP, the adoption of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation to the Convention on Biological Diversity at COP10 in 2010. However, despite the successes of the COPs, there are also several challenges facing global environmental governance.

One of the main challenges is ensuring the effective implementation of existing international agreements and commitments, particularly in light of the increasing urgency and severity of climate change consequences and biodiversity loss. Another challenge is ensuring the equitable participation of all countries in the decision-making processes of the COPs, particularly developing countries that may lack the resources and capacity to fully engage in these processes. Besides, efforts are underway to address these challenges and strengthen global environmental governance. These efforts include initiatives to enhance the transparency and accountability of countries' climate and biodiversity commitments, increase support for developing countries' adaptation and mitigation efforts, and improve the integration of scientific research and knowledge into decision-making processes. Overall,

COPs will continue to play a crucial role in advancing global climate and biodiversity governance in the years to come. For example, in the biodiversity COP15, held in Montreal in 2022, governments have committed to protecting 30% of the land and water considered important for biodiversity by 2030. Currently, only 17% of land and 10% of marine areas are protected (Juffe-Bignoli, D. and al 2018).

Under the UNFCCC, governments have made commitments to develop strategies that are ambitious enough to avoid the worst consequences of climate change. It has also to be mentioned that, noted that more and more of the international biodiversity agenda is emerging in discussions at the climate COPs. In the last UN climate change conference, governments meeting at COP 27 in Sharm el-Sheikh in November 2022 recognized the importance of nature-based solutions to face climate change. These are solutions that protect natural ecosystems and benefit people while helping to combat climate change and protect biodiversity.

Among others, UNFCCC COP28 will concentrate on:

- The endorsement of the IPCC summary of its sixth assessment report, whose outcomes are anticipated to be acknowledged by all parties involved.
- This year the 1st "global stocktake" is set to be published. The objective is to assess the measurable progress the Paris Agreement has made in the fight against climate change including whether countries are meeting their objectives or not.
- During COP16 in Cancún, a Green Climate Fund was established with the aim of providing $100 billion annually by 2020 as climate support for developing countries. Despite these objectives, the fund still falls short and has done so since its inception, prompting regular revisits to address this shortfall.
- The "loss and damage" fund was decided during the COP27 and to be designed. This concept was first introduced at the 2012 COP18, referring to the irreversible destruction triggered by climate change. A case in point would be the displacement of people as a result of the rising sea levels, rendering affected regions uninhabitable.
- The current inflation and scarcities of food and energy have triggered a heightened attention towards climate financing, especially from developing countries.

- Despite considering all the pledges and NDCs made for climate change, experts have concluded that the temperature increase will surpass the 2°C goal set by the Paris Agreement. As a result, we can anticipate more talk about how the Paris Agreement can ratchet up ambition to combat this issue.

In conclusion, the international agreements and mechanisms discussed in this handbook demonstrate the urgent need for global action to address climate change and protect biodiversity. The UNFCCC and the CBD were established in 1992 to provide a framework for international cooperation on these issues. The IPCC and the IPBES play a critical role in providing scientific assessments and informing policy decisions. Finally, the COPs has been instrumental in advancing global environmental governance, although significant challenges remain. As we move forward, continued international cooperation and action will be essential to ensure a sustainable future for our planet.

2.7.1. National context

International mobilisation was triggered by scientific concern for environmental issues, which gave rise to key events that marked the beginning of the establishment of global agendas. As a result, each country commits to implement its own contribution and develop its own agenda for action.

Climate change and biodiversity loss are pressing global issues that require a concerted effort from all nations to address. To effectively tackle these issues, countries must organise themselves at a national level to meet international agendas. In this part, we will explore the theoretical and practical considerations that countries must take into account when organising themselves to meet these agendas. This may involve setting specific emissions reduction targets or renewable energy targets, and identifying the policies and measures needed to achieve these targets.

Some steps that a country can take to build an energy transition policy in relation to its climate commitments may include:

- **Conducting a comprehensive energy and emissions analysis:** This includes identifying the sources of energy used and greenhouse gases emitted, as well as any potential opportunities to reduce emissions through energy efficiency measures or the use of renewable energy sources.

- **Setting emissions reduction targets:** The country needs to identify specific emissions reduction targets based on its international commitments and its own national circumstances. These targets should be ambitious but achievable.
- **Developing policies and measures to achieve the targets:** The country needs to identify and set up a range of policies and measures that can help achieve its emissions reduction targets. This may include renewable energy incentives, energy efficiency programs, carbon pricing, and regulations.
- **Engaging stakeholders:** The country needs to engage with stakeholders such as industry, civil society, and local governments to ensure that the energy transition policy is inclusive and effective.
- **Monitoring and reporting progress:** The country needs to establish a system for monitoring and reporting progress towards its emissions reduction targets. This involves regular tracking and reporting of emissions data, as well as the implementation and impact of policies and measures.

At the national level, countries need to align their policies and initiatives with international agendas related to climate change and biodiversity. One such mechanism is the development of national strategies and plans, such as National Biodiversity Strategies and Action Plans (NBSAPs) and National Climate Change Strategies. These plans provide a roadmap for how a country will implement policies and initiatives to address climate change and biodiversity loss. Such Plans will also help to coordinate action across different government agencies with all stakeholders.

In addition, countries can also engage with international organisations and other countries to share knowledge, resources, and best practices. Another important consideration when organising at the national level to meet international agendas is the need for effective implementation. National strategies and plans are only effective if they are implemented effectively, and this requires a range of governance mechanisms, such as regulations, incentives, and enforcement mechanisms. For example, a country may implement regulations to limit GHG from industry or provide incentives for companies to adopt more sustainable practices. Effective implementation also requires monitoring and evaluation to track progress and adjust as needed.

In other words, each country has its own way of organising itself to meet international climate agreements and to secure its pattern for development. Most countries have policies and programs in place to reduce their GHG and to adapt to the effects of climate change. Compliance with international climate agreements is implemented at the national level through the adoption of specific policies and measures to reduce GHG and limit climate change. Countries that are signatories to the agreements must develop National Climate Action Plans that describe their greenhouse gas emission reduction targets and the means they will use to achieve them. As a reminder, the Paris Agreement states that: each Party shall engage, as appropriate, in adaptation planning processes and in the implementation of measures, including the development or enhancement of plans, policies [...] and/or relevant inputs, which may include [...], monitoring and evaluation of adaptation plans, policies, programs and measures and lessons learned (decision 1/CP.21, Article 7.9)[39].

As a result of varying circumstances, capabilities, and priorities, each country will approach climate strategy development differently. Prioritisation of particular sectors allows countries to maximise their resources in achieving the most significant emissions reductions and making progress towards their climate change targets. For instance, a country with a high percentage of emissions from energy may prioritize policies and measures that foster the deployment of renewable energy technologies and enhance energy efficiency in industries and buildings. Possible actions include setting renewable energy goals, enforcing energy efficiency regulations and standards, and offering incentives to encourage the uptake of renewable energy sources and energy-efficient upgrades.

Here are some common ways countries organise themselves:

- **National Biodiversity Strategies and Action Plans (NBSAPs):** Countries are encouraged to develop NBSAPs, which are comprehensive plans that outline the steps they will take to conserve biodiversity and ensure its sustainable use. These plans are based on the CBD's 20 Aichi Biodiversity Targets and are regularly updated to reflect progress and new challenges.
- **National Climate Change Strategies:** Countries have to develop strategies and plans to mitigate GHG and adapt to climate change impacts. These plans are often based on the Paris Agreement's NDCs. Additionally, a National Adaptation Plan (NAPs) is generally also elaborated. These plans describe the steps a country will take to reduce its GHG and adapt to

[39] https://unfccc.int/sites/default/files/french_paris_agreement.pdf

the impacts of climate change. NAPs must be updated regularly and shared with international bodies to ensure greater transparency and accountability in addressing climate change. National climate action plans can include measures to reduce GHG in key sectors such as electricity production, agriculture, industry, construction and transport. They can also include measures to promote renewable energy, sustainable mobility and sustainable management of natural resources.

- **Government Agencies and Ministries:** Many countries have government agencies and ministries that are responsible for implementing policies related to climate change and biodiversity. These agencies often work together to ensure a coordinated approach to addressing these issues.
- **International Cooperation and Partnerships:** Countries may work together with international organisations and other countries to share knowledge, resources, and best practices related to climate change and biodiversity.
- **National Legislation and Regulations:** Countries develop laws and regulations to support their policies related to climate change and biodiversity.

Countries need to take a multi-faceted approach to meeting the international climate change and biodiversity agendas. A combination of policies, strategies, government agencies, international cooperation, laws, and regulations is therefore needed. Alternatively, a nation with substantial agricultural emission rates would prioritise mitigating these by encouraging sustainable land management, reducing food waste, and promoting better livestock agriculture. This sector-based approach aids in identifying and surmounting emission reduction obstacles. For instance, nations with restricted access to low-carbon technology should prioritise policies and measures that support research and development of new technologies. Other options include enhancing access via capacity building and technology transfer programs. This may implicate the country's current emissions profile, the potential for reductions in each sector, the availability of low-carbon technologies, the cost-effectiveness of different policies and measures, and the political and social feasibility of implementing them.

In conclusion, meeting international agendas related to climate change and biodiversity requires countries to organise themselves at a national level using governance mechanisms that align policies

and initiatives with international goals, engage with international organisations and other countries, and implement policies effectively. Effective governance is essential to addressing complex global issues like climate change and biodiversity loss and requires coordination and cooperation across multiple actors and levels of government. By using governance mechanisms effectively, countries can take meaningful action to address these pressing global issues and create a more sustainable future for all.

2.8.1. Acting at the local level

While international efforts are important, the impacts of climate change and loss of biodiversity are often most acutely felt at the national and local level. Local ecosystems and communities are often the first to experience the effects of these changes, such as changes in weather patterns, sea-level rise, and the loss of wildlife habitat. Therefore, it is important for action on climate change and biodiversity loss to be taken at all levels, from the international to the national and local. Local communities and governments can take steps to protect biodiversity and mitigate the impacts of climate change, such as by promoting sustainable land use practices, protecting natural habitats, and investing in renewable energy sources. At the same time, international efforts can provide support and resources to these local efforts and ensure that they are part of a broader global strategy for addressing these issues. In addition to national efforts, regional and local governments can play a crucial role in supporting the implementation of climate action plans.

Local governments can also contribute to the development and implementation of national climate action plans by providing expertise and knowledge of local challenges. National governments can work with local governments to develop greenhouse gas emission reduction strategies that reflect local needs and priorities. To meet the targets for reducing GHG set out in such agreements, local authorities must enact practical policies and measures. Regional and municipal administrations have the authority to implement measures that encourage sustainable transportation, renewable energy, and reduction of GHG across key sectors. Initiatives such as incentivizing the adoption of electric cars, advocating for wind or solar power generation, financing energy-efficient building renovations, and establishing sustainable waste management programs are a few examples. They can also encourage

citizens and businesses to reduce energy and water consumption, separate waste and use more environmentally friendly modes of transportation. Municipalities can also use their purchasing power to encourage businesses to adopt more sustainable practices and to support local suppliers of sustainable products and services.

In this respect, the contribution of local authorities is essential. Many local communities are seeking to improve their living environment through the use of Nature-based Solutions[40]. These can be promoted by providing the means for biodiversity to thrive in a highly anthropized and pressured environment. The issues of urban heat islands, runoff, flood risk, pollution and lack of access to nature are amplified by climate change and the characteristics of the urban environment (mineralization of public spaces, artificialization and waterproofing of soils, reduced air circulation between buildings, rejection of a part of the biodiversity considered as harmful...). In this context, nature in the city comes into play as a response to environmental and public health issues.

The process of translating national climate targets into local and territorial strategies for the climate varies by country but certain steps are essential:

- **Evaluating local climate risks and vulnerabilities:** Before developing local and territorial climate strategies, it is important to understand local climate risks and vulnerabilities. This may entail a risk assessment, such as identifying areas prone to flooding, drought or other climate-related hazards.
- **Engaging local stakeholders:** Regional and territorial climate strategies are most effective when they involve the participation of local stakeholders, such as community organisations, businesses, and residents. Involving these stakeholders can help ensure that strategies are tailored to local needs and priorities.
- **Develop a local climate plan:** Regional and territorial climate plans can be developed based on local climate risks and vulnerabilities and stakeholder input. They can include measures to reduce greenhouse gas emissions, such as promoting renewable energy and energy efficiency, as well as measures to adapt to the effects of climate change, such as improving water management and building climate-resilient infrastructure.

[40] https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en

- **Implementation and monitoring of local climate plans:** Once local and territorial climate plans have been developed, they need to be implemented and monitored to ensure that they are achieving their goals. This may involve establishing mechanisms to monitor progress and evaluate the effectiveness of measures over time.

As a response to the national engagement, each territory's strategies are based on the account of the specificities and capacity of each country to achieve the carbon reduction. A crucial step comes to the point in which certain realities are put on the front, we call that a diagnosis phase. A global approach review is necessary because on this global assessment the sectoral approach gives the guideline to what it called “scenarios”. Furthermore, this phase is important because each organism on the national and local scale proposes a numerous strategy that holds a different kind of scenario for each sector (Transport, Agriculture, construction) in order to aim the ecological transition. Those scenarios depend on each country's strength and weakness in which every local and territorial strategy is based on the sector that is more effective to achieve the carbon reduction.

From this point as a continuation, cities and regions take the lead in implementing bold measures to fight climate change. Their climate goals and actions often surpass those of national governments, yet their full potential in responding to climate change is yet to be unleashed. Directly responsible for reducing up to one-third of GHG emissions, local governments rely on national and state counterparts or multi-level government coordination for the remaining two-thirds of urban emission cuts. To initiate climate action measures and prioritise policy objectives, cities and regions must establish a clear rationale and evidence base. It is also essential to keep track of progress and extend ambitions periodically. National governments play a significant role in aiding and encouraging local governments' place-based initiatives to promote zero-carbon transitions and systemic resilience.

Legislation plays a critical role in supporting the development and implementation of local and territorial strategies for climate change and biodiversity conservation. In many countries, national laws and regulations provide a framework for local and territorial governments to develop and implement their climate and biodiversity plans. For example, legislation may establish targets for reducing greenhouse gas emissions or protecting biodiversity, and set out the responsibilities of different levels of government in achieving these targets. Legislation may also provide guidance on the development

of local and territorial plans, such as requiring the incorporation of specific measures or stakeholder engagement.

In addition to national laws and regulations, local and territorial governments may also have their own laws and regulations that support climate and biodiversity action. These may include zoning and land use regulations that protect natural areas, building codes that promote energy efficiency, or incentives for businesses that adopt sustainable practices. Effective legislation can provide a clear framework for local and territorial governments to take action on climate change and biodiversity conservation, and can help to ensure that efforts are aligned with national and international goals and commitments. However, legislation alone is not enough to ensure successful implementation. Effective governance structures, stakeholder engagement, and adequate financial resources are also critical for achieving local and territorial climate and biodiversity goals. It typically comes before the development of local agreements and strategies for climate change and biodiversity conservation. National laws and regulations establish the framework within which local and territorial governments operate and provide the legal basis for action on climate change and biodiversity conservation. Local agreements and strategies are then developed within this framework.

For example, a national law may establish a target for reducing greenhouse gas emissions or protecting biodiversity and set out the responsibilities of different levels of government in achieving these targets. Local and territorial governments would then develop their own plans and agreements for meeting these targets, taking into account their unique circumstances and capacities.

However, it is also important to note that local and territorial governments can play a key role in shaping national legislation and policies related to climate change and biodiversity conservation. Through engagement with national government agencies, civil society organisations, and other stakeholders, local and territorial governments can advocate for policies and legislation that support their goals and priorities.

Cities can also work with citizens and businesses to promote sustainable living and encourage the participation of all local stakeholders in the ecological transition. For example, cities can organise awareness campaigns to encourage citizens to adopt greener behaviours, such as reducing water and energy consumption, promoting public transportation and active modes of transportation, such as cycling or walking. Also, cities can encourage businesses to adopt more sustainable practices, such as

implementing energy management practices, reducing GHG and improving energy efficiency. Indeed, the impacts of climate change are often more pronounced in urban areas, particularly due to the urban heat island effect, increased risk of flooding and reduced air quality. Strategies to adapt to the impacts can be put forward by the cities, such as implementing urban drainage systems, promoting urban greening, creating cooling zones, and planning land use according to climate risks. Some cities can work together with other cities, through city networks or cooperative initiatives, to share good practices, exchange knowledge and experiences, and promote more ambitious policies at the international level. This collaboration can help strengthen the voice of cities in international climate change negotiations and promote more ambitious climate action at the global level.

Cities can also put in place climate action plans that define specific targets and measures to reduce greenhouse gas emissions. These plans can include policies to promote renewable energy, improve the energy efficiency of buildings, encourage sustainable mobility, reduce waste, and protect green spaces and natural areas. Since the way we live and interact in urban centers and neighbourhoods can significantly impact our efforts to combat climate change, reducing CO_2 emissions through energy-efficient buildings, low-carbon public transport, and promoting cycling and walking is crucial. Urban green spaces and gardens have the ability to lower CO_2 levels, cool down urban areas, and prevent flooding. Localised initiatives that prioritise climate action and resilience building can have a positive impact on communities, such as producing goods and food within proximity to reduce transportation costs and waste while also supporting local economies.

Reclaiming public space by nature transforms landscapes and can be accompanied by positive or negative reactions from users and managers. In fact, nature in the city in its diversity (fauna, flora, water, soil) produces different perceptions, depending on the actors in contact with it and its context of implementation. It is essential to anticipate and understand these relationships in order to integrate them serenely. To guarantee the effective implementation of nature and encourage its integration into public space, many organisms like the Cerema[41] in France has developed a range of tools to support territories in their development projects and the elaboration of a Nature in the City strategy.

In this respect, the contribution of local authorities is essential. Many local communities are seeking to improve their living environment through the use of Nature-based Solutions[42]. These can be promoted

[41] https://www.cerema.fr/en

[42] https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en

by providing the means for biodiversity to thrive in a highly anthropized and pressured environment. The issues of urban heat islands, runoff, flood risk, pollution and lack of access to nature are amplified by climate change and the characteristics of the urban environment (mineralization of public spaces, artificialization and waterproofing of soils, reduced air circulation between buildings, rejection of a part of the biodiversity considered as harmful...). In this context, nature in the city comes into play as a response to environmental and public health issues.

We can all agree that biodiversity is a crucial element in the fight against climate change and in the ecological transition in general. In local and territorial organisations taking biodiversity into account in cities has therefore become a central issue. Indeed, cities are often considered as "biodiversity deserts", i.e., urban environments characterised by a low diversity of animal and plant species. This is due to the fragmentation of natural habitats, pollution, soil artificialization and other factors linked to urbanisation. Yet, urban biodiversity has important impacts on the quality of life of citizens, on health, on the resilience of the city to the impacts of climate change and on the provision of ecosystem services such as the regulation of air and water quality. Thus, local and territorial seek to promote biodiversity in cities by implementing policies and projects to encourage the presence of green spaces, parks and gardens, to encourage the planting of trees and local and resilient plant species, to protect natural areas and to encourage the reintroduction of animal species. For example, cities can create ecological corridors to allow species migration, install green roofs to improve air quality and promote biodiversity, implement green space management plans to promote plant and animal species diversity, or promote the creation of shared gardens or beehives to encourage citizen participation in biodiversity preservation.

Biodiversity has become a major issue and cities are increasingly seeking to promote the presence of nature in the city to strengthen their resilience to the impacts of climate change and improve the quality of life of their citizens. The renewed emphasis on nature in the city is not only an aesthetic pursuit, but a means of providing critical ecosystem services. Mitigating global warming, reducing urban storm runoff, and purging urban air pollution top the list of such services. However, any urban public policy centred around this approach must consider the impact of urbanisation on ecological continuities and the reciprocal effects between the dense urban fabric and the surrounding natural spaces (Blanc and Clergeau, 2010; La Greca and al., 2011; Ahern, 2012; Vergnes and al., 2013;

Depietri and al., 2016). For example, cities such as New York, London, and Berlin boast a well-organised administration, which has facilitated the implementation of ecological strategies over a vast region. These efforts have given shape to genuine principles of rewilding, thereby establishing strong links between the urban fabric and the natural surroundings. This is evident from the works of the Mayor of London[43] (2008), Lovasi et al. (2013), Douglas (2014), and Connop et al. (2016).

The transportation sector's increasing contribution to GHG necessitates a targeted approach. The benefits of mitigating emissions in other sectors, such as agriculture, construction, or industry, will not suffice to offset the escalating transportation-related emissions. However, sustainable community planning holds vast potential to counter the trend of escalating emissions, given the magnitude of its immediate, near- and far-reaching impact. The enduring nature of community development shapes its identity for a generation or two. Museums, highways, or neighbourhoods take years to construct, and their situational impact and choice of materials affect their longevity. Sustainable urban planning and land-use management have broader implications as they encourage eco-friendly living habits and consequently reduce greenhouse gas emissions at the source.

Today, cities are at the dawn of a new era. In fact, if we talk about the biodiversity in the urban area, this increases interest to city dwellers and public authorities, who see many benefits in urban biodiversity: quality of life, economic, social and educational tools, solutions to global warming... However, there is still work to be done to integrate biodiversity into land-use planning policies. This work requires taking into account, protecting and developing biodiversity in the city in a sustainable way while integrating the social and economic aspects of the city. Moreover, nature in the city is not only a question of biodiversity, but it also concerns the quality of life of city dwellers and the services provided by biodiversity that contribute to the sustainability of urban life. This biodiversity, threatened by the loss of habitat in the city and the numerous disturbances linked to human activities, can nevertheless be restored, and preserved on a daily basis. In the urban context, biodiversity is often threatened by urbanisation, which leads to fragmentation of natural habitats, loss of soil and water quality, air and soil pollution, and other negative impacts on ecosystems and the animal and plant

[43] https://journals.openedition.org/vertigo/19753

species that inhabit them. However, urban biodiversity is important because it also provides ecosystem services and contributes to the quality of life of citizens.

To take biodiversity into account in cities, local and territorial organisations can rely on different theoretical approaches. Among these, we can cite:

- **The ecosystem approach**[44]**,** which aims to understand the interactions between the biotic and abiotic elements of an ecosystem. This approach makes it possible to take into account the impacts of urbanisation on ecosystems and to promote practices aimed at maintaining or restoring their functioning.
- **The ecological resilience approach**[45]**,** which considers the capacity of ecosystems to resist disturbances and adapt to environmental changes. This approach promotes practices to strengthen the resilience of urban ecosystems to the impacts of climate change.
- **The integrated natural resource management approach**[46]**,** which aims to coordinate the management of natural resources (such as water, soil, biodiversity) to ensure their sustainability. This approach promotes the coordinated management of natural resources in cities, taking into account their interdependence and their role in providing ecosystem services.

In summary, the consideration of biodiversity in cities in the organisation of the implementation of international climate agreements is based on different theoretical approaches aimed at understanding the interactions between urban ecosystems, strengthening their resilience and promoting coordinated and sustainable management of natural resources. These approaches make it possible to better take into account the challenges of biodiversity in cities and to promote practices that encourage the preservation and promotion of urban biodiversity, while contributing to the fight against climate change. In this perspective, cities and local authorities have a key role to play in the implementation of international climate agreements. They can put in place policies and measures to encourage biodiversity in cities, such as the creation of green spaces, the promotion of urban agriculture, the sustainable management of soil and water, the planting of trees and other vegetation, or the raising of citizens' awareness of the importance of biodiversity. Finally, by involving citizens and local actors in these initiatives, cities and local authorities can contribute to raising awareness of the importance of

[44] https://www.cbd.int/ecosystem/
[45] https://www.frontiersin.org/articles/10.3389/fevo.2019.00241/full
[46] https://www.cifor.org/publications/pdf_files/Books/INRM2000.pdf

biodiversity in cities and to the implementation of concrete solutions to protect and promote it. Thus, taking biodiversity in cities into account in the organisation of the implementation of international climate agreements can contribute to the construction of more sustainable, more resilient, and more environmentally friendly cities.

3. Part II – Theory

3.1.1. Introduction

Humans are an integral part of the environment and have the largest ecological footprint. With our resources, we have restructured all aspects of life on earth. This has influenced the evolution of humans, from our earliest ancestors to our contemporaries today, and we have come a long way in nearly two million years of evolution. Between the advances in man's social behaviour and the new achievements in various fields, we are always striving to provide civilization with a better standard of living. However, it is important to recognize that the consequences of our actions have significant side effects on the entire ecosystem and environment. This section presents the various human activities that impact the environment.

The ecosystems are the foundation of human activities. Its services provide social and health benefits, such as educational or recreational opportunities for example, the enjoyment we get from walking in forests or parks. The benefits of a natural ecosystem are innumerable. It produces the air we breathe; filter the water we drink and recycle the subsistence that makes everything grow. Anthropic activities have had a major effect on global warming, bringing us in line with the Anthropocene era. Humanity has become a geophysical force acting on its ecosystem with significant and potentially irreversible consequences on a planetary scale. Human activities have been damaging the environment for thousands of years. The first traces of Homo sapiens on Earth have led to many changes on the planet and around us, through the development of infrastructure, travel, urbanisation, and other trade networks. However, the change has been both positive and negative - probably for the better, but also for the worse.

There is considerable evidence that climate change is affecting biodiversity. The continued progress of climate change is having primarily negative and often irreversible effects on many ecosystems and

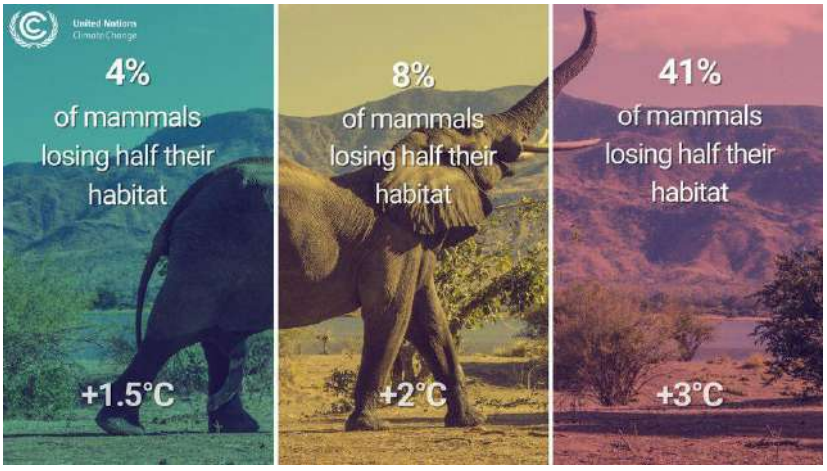
their services, with significant negative social, cultural and economic consequences. Nevertheless, the links between biodiversity and climate change go both ways. Preserving natural terrestrial, marine, and freshwater ecosystems and restoring degraded ecosystems (including their genetic and species diversity) is critical to achieving the overall goals of the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC), as ecosystems play a key role in the global carbon cycle and in adapting to climate change, while also providing a wide range of ecosystem services that are essential to human well-being and the achievement of sustainable development goals. Besides, there is growing recognition in the scientific communities that biodiversity loss and climate change are two closely related environmental challenges. Details of these links are provided in a joint analysis by the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2021 (Pörtner et al., 2021).

Land use changes, exploitation of resources such as unsustainable fishing practices, energy production and pollution often exacerbate the effects of climate change and lead to the degradation or loss of ecosystems. As a result, the interaction of feedback loops between climate change and biodiversity loss are mutually reinforcing and addressing them requires coherent policies and actions. Climate change is disrupting ecosystems and biodiversity. By disrupting natural feedback loops, loss of habitat for a wide variety of flora and fauna, anthropogenic climate change threatens the health of terrestrial and aquatic ecosystems (IPCC, 2022). The consequences of climate change on ecosystems and biodiversity also weaken their ability to provide ecosystem services, harming human lives and livelihoods, as well as efforts to eradicate poverty and hunger and provide clean water to billions of people (IPCC, 2022; IPBES, 2019).

To date, the planet has experienced an average warming of 1.19°C since the pre-industrial era, accompanied by an increase in the number and intensity of extreme weather events (cyclones, floods, droughts, etc.). Moreover, humans continue to use land, primarily for food production, as the primary driver of biodiversity loss. Indeed, human activity has already altered more than 70% of all ice-free land. When land is converted to agriculture, some plant and animal species may lose their habitat and face extinction. However, climate change is an increasingly important factor in the decline of biodiversity. Climate change has resulted in changes to marine, terrestrial, and freshwater ecosystems

around the world. It has led to the loss of local species, increased disease, and mass mortality of plants and animals, resulting in the first climate-induced extinctions.

Meanwhile, nearly half of the Earth's ecosystems are in decline, while a quarter of species are threatened with extinction. Some scientists are even considering the possibility of a sixth mass extinction. This massive destruction of our ecosystems puts the survival of all species at risk. Biodiversity and life are the foundations of human societies; this is why we must protect them. Moreover, the two crises are intimately linked. For example, increased temperatures have forced animals and plants to move to higher elevations or latitudes, with many moving toward the Earth's poles, with far-reaching consequences for ecosystems. Each degree of warming increases the risk of species extinction.



3.2.1. Current situation

3.2.2. Marine and coastal biodiversity and climate change

https://www.international-climate-initiative.com/en/topics/marine-and-coastal-biodiversity/

Covering 70% of the Earth's surface, the oceans are the largest habitat on the planet. The coastline is home to some of the world's richest and most diverse ecosystems, including mangroves, coral reefs and seagrasses. According to the IPBES, climate change is one of the major direct causes of the decline in biodiversity. This is illustrated in particular by the case of coral reefs, which are essential to the survival of marine ecosystems with nearly 98% of them being at risk of disappearing beyond 2°C of warming, the maximum temperature increase limit set out in the Paris Agreement.

Rising ocean temperatures increase the risk of irreversible loss of marine and coastal ecosystems. The number of living coral reefs, for example, has nearly halved over the past 150 years, and continued warming threatens to destroy nearly all remaining.

https://www.un.org/en/climatechange/science/climate-issues/biodiversity#:~:text=The%20risk%20of%20species%20extinction,destroy%20almost%20all%20remaining%20reefs

About half of the GHG produced by human activities remains in the atmosphere, while the other half is absorbed by land and oceans. These ecosystems -and the biodiversity they support- are natural carbon sinks, offering nature-based solutions to climate change. The Coral Reef Alliance, an environmental NGO, estimates that by 2050, 90% of the world's coral reefs could experience annual bleaching. This type of event can impact the many species that depend on reefs (up to 25% of known marine species), which can lead to long-term losses. One estimate indicates that about 50% of reefs are already degraded due to climate change and other pressures such as overfishing and pollution. Fortunately, research shows that reefs can (and will) adapt to moderate warming, given the opportunity. While reefs cover only 0.2% of the world's seabed, they are home to about 25% of marine species (Reid, 2017). Reefs can be degraded by increases in sea surface temperatures and changes in

water chemistry. As a result, as well as other existing stressors on coral reefs, the effects of climate change could lead to large-scale coral bleaching.

3.2.3. Forest biodiversity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Forests cover one-third of the Earth's surface and are estimated to be home to two-thirds of all known terrestrial species. They also provide a wide range of goods and services. Over the past 8,000 years, about 45% of the Earth's original forest cover has been converted. The majority of these have been cleared in the last century. Knowing the vulnerability of forests to climate change is particularly important because even small changes in temperature and precipitation can have significant effects on forest growth. A 1-degree Celsius increase in temperature can alter the functioning and composition of forests.

Over the past decade, deforestation has been greatest in the humid tropics, mainly in Africa, followed by South America. The FAO (Food and Agriculture Organization of the United Nations)[49] estimates that about 420 million hectares of forest disappeared between 1990 and 2020 (i.e. 178 million hectares net, taking into account afforestation and natural expansion of forests). Since then, the annual rate of deforestation has slowed, but it was still 10 million hectares per year between 2015 and 2020. The most important driver of deforestation is the global demand for agricultural products: agribusinesses clear huge tracts of forest and use the land to plant high-value cash crops, such as palm oil and soybeans, as well as for livestock[50].

[47] https://efi.int/forestbiodiversity
[48] https://blogs.worldbank.org/opendata/supporting-global-biodiversity-conservation-broader-species-coverage
[49] https://www.fao.org/home/en
[50] https://www.lse.ac.uk/granthaminstitute/explainers/whats-redd-and-will-it-help-tackle-climate-change/

Land use change, particularly deforestation, accounts for 12 to 20 percent of global GHG. The process of forest degradation (changes that adversely affect the structure or function of a forest without reducing its area) and the destruction of tropical peatlands also contribute to these emissions (Pearson, 2017). As a result of deforestation and degradation, some tropical forests are now emitting more carbon than they are capturing, shifting from being a carbon "sink" to a carbon source. For example, the southeast zone of the Amazon rainforest is now considered by scientists to be a net source of carbon.

The majority of large forest-dwelling animals, half of the large primates, and nearly 9% of all known tree species are already at risk of extinction. In addition, woody tree species are less able to move poleward in response to changing climatic conditions. Wood contains 80% of all carbon stored in terrestrial vegetation and deforestation reduces greenhouse gas emissions (Houghtone, 2005). Deforestation and land clearing activities emit about 1.7 billion tons of carbon per year. Therefore, forest conservation offers significant opportunities to protect biodiversity and mitigate climate change.

3.2.4. Agricultural biodiversity & climate change


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The agricultural sector relies on natural processes and living beings to produce food, but it often alters the environment around it. Farms can be managed to minimise the damage they do to the environment, but industrial agriculture's focus on productivity means that too many farms disturb wildlife, both near

[51] https://www.earleassociates.co.uk/blog/the-impact-of-agriculture-on-biodiversity
[52] https://environment.co/agricultural-biodiversity/

and far. If environments are overly altered or polluted by industrial agriculture, vulnerable species may lose their habitat or even disappear, harming biodiversity.

In addition, industrial agriculture wreaks havoc on soil biodiversity. The habitats of insect and other invertebrate communities are disrupted when farmers plough the soil, interrupting their ability to recycle dead plants into the rich, stable organic carbon that makes soils fertile.[53] Chemicals also alter the microorganisms involved in this process: scientists have found fewer species of beneficial bacteria and fungi in soils where chemical fertilisers and pesticides are used[54]. Ultimately, these soils become less biodiverse and less healthy for crops. Such changes can also contribute to climate change: soils store more than 1.6 trillion tons of carbon dioxide worldwide, but highly disturbed soils with low biodiversity quickly lose this carbon to waterways and the atmosphere. Furthermore, the extreme weather cycles can completely alter the composition of plant and soil communities[55].

To sum up, the pressures of a warming climate favour adaptable invasive species that could displace millions of highly specialised plants, animals, and microorganisms. For researchers modelling these changes, the loss of biodiversity associated with climate change is likely to be one of the largest mass extinctions in Earth's history[56]. Globally, about 35% of agricultural production depends on pollinators such as bees, birds and bats. Therefore, it is also necessary to promote the conservation of those elements of agricultural ecosystems that provide goods and services, such as natural pest control, pollination and seed dispersal.

 [57]

[53] Tsiafouli, Maria A., et al. “Intensive Agriculture Reduces Soil Biodiversity Across Europe.” Global Change Biology, vol. 21, no. 2, 22 Sept. 2014, pp. 973–985., doi:10.1111/gcb.12752.

[54] Brussaard, Lijbert, et al. “Soil Biodiversity for Agricultural Sustainability.” Agriculture, Ecosystems & Environment, vol. 121, no. 3, 2007, pp. 233–244., doi: 10.1016/j.agee.2006.12.013.

[55] Mooney, Harold, et al. “Biodiversity, Climate Change, and Ecosystem Services.” Current Opinion in Environmental Sustainability, vol. 1, no. 1, Oct. 2009, pp. 46–54., doi:10.1016/j.cosust.2009.07.006.

[56] Bellard, Céline, et al. “Impacts of Climate Change on the Future of Biodiversity.” Ecology Letters, vol. 15, no. 4, 18 Jan. 2012, pp. 365–377., doi:10.1111/j.1461-0248.2011.01736. x.

[57] https://www.fnsea.fr/actualit%C3%A9s/lagriculture-facteur-de-biodiversite/

3.2.5. Biodiversity & urban environment

In parallel with this urban growth, the world is experiencing a major decrease in biodiversity. Since the earliest times, cities have historically settled and developed in or near ecosystems that provide abundant contributions to urban societies, including water, rich soils, and areas protected from extreme weather events. This natural layer that provides the foundation for the built environment has been increasingly deteriorated by the recent direct and indirect impacts of urbanisation.

The planet has been transformed by human interventions, two-thirds of the oceans are under severe threat, and more than 85 of the wetlands have been destroyed. It is estimated that the mean abundance of non-human species in their native regions has been reduced by more than 20% and that about one million species are in danger of imminent extinction. With this in mind, urbanisation can have significant negative impacts on global biodiversity. About 60% of the urban areas that will probably exist in 2050 have not yet been urbanised. From 1985 to 2015, coverage increased by nearly 10,000 km^2 each year (Liu et al. 2020). An additional 190,000 km^2 of natural habitat was lost to urban growth between 1992 and 2000, and an additional 290,000 km^2 will be at risk by 2030 (The Nature Conservancy 2018). The exponential growth of the built environment has proven detrimental to the natural ecosystems of cities, reducing economic opportunities and requiring a systemic transition in urban development.

The statistics are alarming: over half of the world's population resides in urban areas now, whereas only 14% did a century ago. However, this urbanisation trend has led to localised degradation of biodiversity and biological homogenization. Developed countries and their counterparts in the South have been equally affected (Pauchard et al., 2006; Mcdonald et al., 2008). The expansion of cities has adversely impacted landscape ecology, causing the destruction and fragmentation of natural vegetation (Niemelä, 1999a and b; Savard et al., 2000). Urbanisation has led to decreased net primary production, increased temperature and precipitation, degradation of air and water quality, and the sealing of surfaces (Bonan, 2000; Kühn et al., 2004).

In recent times, cities and towns have accorded utmost importance to environmental conservation. While biodiversity isn't always noticeable in our day-to-day lives, its contribution to the environment is undeniable. It plays a crucial role in maintaining ecosystem balance and diversity of food sources. Maintaining the biodiversity in urban centers holds immense significance, stressing the need to

safeguard the wildlife and vegetation. Many ecological cities have already made environmental protection and biodiversity their top-most priority.

To safeguard biodiversity in cities, a range of measures can be adopted. These include preserving plant species, establishing green spaces, and introducing eco-friendly labels. The promotion of urban biodiversity can manifest in diverse ways. A growing number of cities are implementing pro-environmental measures. These committed cities have launched multiple initiatives to protect biodiversity. Each determines their biodiversity plan on their own scale. Actions to be taken in the coming months and years build on this plan to preserve its living heritage.

Biodiversity in the city plays an important role in ensuring good air and water quality and in regulating temperature. Thus, taking into account, reintroducing and protecting nature in the city appears to be a solution for adapting cities to the impacts of climate change and the well-being of its inhabitants.

Nature is a source of ecosystem services in many areas: vital, social, economic... Indeed, in addition to its charm, nature is known for its benefits on health and physical and mental well-being. A walk in a park allows you to do a sport activity, to reduce stress, to be a source of inspiration. These green spaces are also very good air purifiers, allowing better breathing. They also allow social links: meeting places, calm, recreation, natural spaces encourage interactions and can be a means of education and appropriation of places and contribute to the dynamism of neighbourhoods. Biodiversity is a support and a supplier of goods and services on which we depend, notably in our economic activities (raw materials, food resources, water purification...). Indeed, nature contributes 23,000 billion euros to the world economy each year.

Finally, biodiversity provides regulatory services. For example, vegetation helps to reduce urban heat islands caused by concrete, which heats up the temperature of cities by 2 to 3°C. They are also carbon sinks, acoustic filters, flood regulators... All these benefits brought by nature are crucial. There is therefore a real need to create functional urban natural spaces capable of hosting biodiversity while reconciling the needs of cities.

In conclusion, achieving biodiversity in urban areas demands a collective effort from all stakeholders, including government and society. Local communities and other relevant parties must also be engaged. Favourable outcomes, like sustainable development, healthier lifestyles, and better environmental preservation, result from promoting urban biodiversity. A collaborative approach to this endeavour

will create cities that are not only liveable but also blessed with natural beauty and abundant biodiversity. Conserving and restoring nature helps to slow climate change, particularly through its function as a carbon sink. On the other hand, it is also increasing the resilience of human societies to the consequences of this disruption. disruption. Indeed, healthy, functional, restored and managed ecosystems in a sustainable and inclusive way provide many natural buffers which help societies adapt and improve their resilience to climate change. Nevertheless, putting the planet back on a 1.5°C trajectory requires substantial emissions reductions in the short term, in order to achieve carbon neutrality in 2050 at the global level, and as soon as possible in the so-called developed countries. This means a 65% reduction in emissions by 2030 in Europe. These concepts are at the origin of the approach of Biodiversity[58].

4. Part III - Practices and inspiring solutions

4.1.1. Why is it important to preserve biodiversity in cities

We are in the century of cities as more than half of humanity now lives in cities and more than 70% of the population lives in cities (Liu et al. 2020; UN DESA 2018). In addition, an estimated 60% of the urban areas that will exist in 2050 have not yet been built (United Nations 2013). The development of tomorrow's cities-and the evolution of today's-will therefore condition the health and well-being of billions of people (Ramaswami et al. 2016; Munro and Grierson 2018; Vidal et al. 2020).

But the next few decades are also predicted to see the most dramatic reduction in biodiversity since the extinction of the dinosaurs 65 million years ago (IPBES 2019a). It is primarily the rapid expansion of human populations into cities and their use of land, water, timber, and energy-often on biodiversity-rich land-that is driving these losses (Elmqvist et al. 2013). In order to ease the transition to higher climate targets, protect biodiversity as well as promote human rights, several practices can play a key role. On another hand, restoring, preserving, and enhancing terrestrial ecosystems (wetlands, grasslands, senescent forests, ...) would allow us to reduce emissions by 14.77 billion tons of tons of CO_2 by 2050. In comparison, it is emissions by 30 billion tons of tons of CO_2 per year by

[58] https://www3.weforum.org/docs/WEF_BiodiverCities_by_2030_2022.pdf

2030 (from 56 Gt to 25 Gt), to limit the temperature increase to 1.5°C by 2100 in accordance with the Paris Agreement.

Of the principles detailed in this note, we will first mention all the safeguards to preserve the rights of nature and human rights. Then, the other principles will be illustrated through good and bad practices, whether in the land, forest, agriculture or energy sectors. On another hand, preserving biodiversity is one of the other challenges that occurs while we speak about climate change. The biodiversity encompasses life's multiplicity on Earth, from varied species and ecosystems to genetic diversity. Urban regions, known for their buildings, infrastructure, and concrete surfaces, are not usually known for being biodiversity hotspots. However, cities can still offer homes for numerous flora and fauna, and their biodiversity can provide vital support for ecosystem services like water management, carbon sequestration, and pollination. Numerous initiatives have been implemented at international, national, and local levels to safeguard and boost biodiversity in urban landscapes.

Preserving biodiversity in cities is important for a number of reasons. First, cities are home to a diverse range of species, from insects to birds to mammals, and preserving their habitats is important for maintaining the health of ecosystems. Second, urban biodiversity can provide numerous benefits to humans, such as improved air and water quality, pest control, and recreational opportunities. Moreover, urban biodiversity can contribute to the resilience of cities in the face of climate change, as green spaces can help absorb excess water during floods and mitigate the urban heat island effect. In an increasingly urbanised world, preserving biodiversity is becoming more and more important as more and more people move into cities and natural habitats are lost to development. The concept of biodiversity refers to the variety of life on Earth, including all living organisms and the ecosystems in which they exist. The urban environment can offer unique opportunities for protecting and enhancing biodiversity, but it also poses challenges that must be addressed.

One theoretical approach to preserving biodiversity in urban areas is the concept of **ecosystem services**. Ecosystem services are the benefits that humans derive from natural ecosystems, such as pollination, air and water purification, and regulation of the climate. Urban areas can provide these services as well, through the preservation of green spaces and other natural habitats.

Another theoretical approach is the concept of **urban ecology**, which focuses on the study of ecosystems in cities and the interactions between humans and nature. Urban ecology recognizes that

cities are complex systems that are influenced by social, economic, and environmental factors. By understanding these factors, urban ecologists can develop strategies to enhance biodiversity in urban areas. In this section, we are going to highlight interesting projects and strategies put in practice to fight climate change and biodiversity loss in urban areas all over the world.

4.2. Some inspiring solutions all over the world

4.2.1. Urban parks and green spaces: *The High Line in New York City*


https://gocity.com/new-york/en-us/blog/guide-high-line-new-york-city

https://www.istockphoto.com/fr/photo/le-printemps-dans-la-high-line-dans-la-ville-de-new-york-gm492990892-76666523

Creating urban parks and green spaces can provide habitat for wildlife and increase biodiversity in cities. For example, the High Line in New York City is a park built on a disused elevated railway line on Manhattan's west side, which has become a haven for plants and wildlife in the midst of a bustling urban environment. The park has been praised for its innovative design, which incorporates many features that promote biodiversity and serve as a nature solution for the city.

One of the key features of the High Line that promotes biodiversity is its extensive planting of native plants and grasses. The park is home to over 500 species of plants, many of which are native to the region. These plants provide habitat and food for a wide range of insects, birds, and other wildlife, helping to support local biodiversity. In addition to its plantings, the High Line also incorporates a number of design features that serve as nature solutions for the city. For example, the park's green roofs and rain gardens help to manage stormwater runoff and reduce the urban heat island effect, while also providing habitat for birds and insects. It also features a number of elements that promote human-nature interaction, such as seating, viewing platforms and art installations that incorporate

natural materials. This feature helps to reinforce a sense of connection with the natural world and promote environmental awareness.

In the end, the High Line is an innovative example of how urban spaces can be designed to promote biodiversity and serve as nature solutions for the city. Its success has inspired similar projects in cities around the world, highlighting the potential for urban spaces to contribute to conservation efforts and support local ecosystems.

4.2.2. Green roofs and walls: The Bosco Verticale in Milan, Italy

https://www.stefanoboeriarchitetti.net/en/project/vertical-forest/
https://www.pedestal-eternoivica.com/fr/nouvelles/bosco-verticale-in-milan

Bosco Verticale, which translates to "Vertical Forest," is a pair of residential towers in Milan, Italy, that are covered in a total of 900 trees and over 20,000 plants. The towers have been designed as a nature solution for the city, providing a unique and innovative way to promote biodiversity in an urban environment. Moreover, the trees and plants on the towers help to create a microclimate, improving air quality and reducing the urban heat island effect. They also provide habitat for birds and insects, helping to support local biodiversity. Additionally, the towers include rainwater harvesting and irrigation systems, which help to conserve water and reduce the impact of the development on local ecosystems. As part of the sustainable urban development, Bosco Verticale Towers incorporates renewable energy technologies such as solar panels and wind turbines. These measures aim to reduce the environmental impact of the project and promote a more sustainable future for the city.

The towers have been recognized with numerous awards and have inspired similar projects in other cities around the world. They demonstrate the potential for nature solutions in urban areas, showing that it is possible to incorporate green space into high-density development and promote biodiversity in the city. Installing green roofs and walls can provide habitat for birds and insects, as well as reduce the urban heat island effect and improve air quality.

4.2.3. Urban agriculture: The Green Streets program in Toronto, Canada


https://www.toronto.ca/legdocs/mmis/2017/pw/bgrd/backgroundfile-107515.pdf
https://www.csla-aapc.ca/awards-atlas/toronto-green-streets-technical-guidelines

The Green Streets program in Toronto, Canada is a community-led initiative that aims to increase the city's green infrastructure and biodiversity. The program involves transforming residential streets into green spaces by planting native plants and trees and reducing impervious surfaces such as concrete and asphalt. The program was launched in 1991 and has since transformed over 1,000 residential streets in Toronto. The program is run by the non-profit organisation Green Thumbs Growing Kids, which works with local residents to plan and implement the green street projects. The program is supported by the city government, which provides funding and technical assistance.

The Green Streets program has several goals related to biodiversity and ecological health. First, by planting native plants and trees, the program aims to create habitats for pollinators, birds, and other wildlife. Second, by reducing impervious surfaces, the program helps to mitigate the urban heat island effect and reduce stormwater runoff, which can contribute to water pollution and flooding. Third, by

engaging local residents in the planning and implementation of the green street projects, the program builds community resilience and enhances social cohesion.

In fact, it can be said that the Green Streets program has achieved its goals. It has increased the abundance and diversity of pollinators and birds in participating neighbourhoods. As well, the program has reduced stormwater runoff and increased water infiltration into the soil. In addition, the program has helped to build community engagement and social capital as residents work together to create and maintain green street projects.

This program is an inspiring example of how communities can come together to promote biodiversity and ecological health in urban areas. By engaging local residents and using green infrastructure to transform residential streets, the program is helping to create more sustainable and resilient neighbourhoods.

4.2.4. Restoration of degraded urban areas: The Los Angeles River Revitalization Project, USA

https://www.wenkla.com/projects/los-angeles-river-revitalization

Restoring degraded urban areas can provide habitat for wildlife and increase biodiversity in cities. The Los Angeles River Revitalization Project is a multi-decade, multi-billion-dollar effort aimed at restoring the natural habitats and ecosystem of the Los Angeles River. The project is one of the largest and most ambitious urban river restoration efforts in the United States and is seen as a nature-based solution to combat biodiversity loss in the region. For many years, the Los Angeles River was a concrete-lined channel that served as a flood control mechanism, with little regard for the natural ecosystems and wildlife that once thrived along its banks. The river was also heavily polluted, with sewage, trash, and other pollutants contributing to poor water quality.

Moreover, this project aims to change all of that by creating a more natural and sustainable river ecosystem. The project includes a wide range of initiatives, such as removing concrete channels and restoring natural riverbanks, creating new wetlands and habitat areas, and improving water quality through green infrastructure and other measures. One of the key elements of the project is the creation of a continuous greenway and bike path along the river, which will provide access to nature and recreational opportunities for nearby residents. The project also includes the creation of new parks, gardens, and other green spaces along the river, which will provide habitat for native plants and wildlife. In 2015, work was completed on the Los Angeles River Revitalization Project, including the removal of nearly a mile of concrete from the river and the opening of new parks and recreation areas along the river. It also helped improve the river's water quality, through efforts such as installing green infrastructure to capture and treat stormwater runoff. Ultimately, the Los Angeles River Revitalization Project is an interesting example by restoring natural habitats and creating green space, the project is helping to create a more sustainable and resilient future for Los Angeles residents and wildlife.

4.2.5 Community involvement: The Urban Biodiversity and Citizen Science project in London, United Kingdoms


https://panorama.solutions/en/solution/urban-nature-project-championing-uks-urban-biodiversity-londons-natural-history-museum

Community involvement is a critical component of efforts to fight against biodiversity loss in urban areas. When local communities are engaged in conservation efforts, they can provide valuable support

for biodiversity conservation and management, as well as help to create a sense of shared ownership and responsibility for the natural areas around them. There are several ways in which community involvement can be used as a solution to fight against biodiversity loss in urban areas:

- **Citizen science:** Citizen science involves engaging members of the public in scientific research projects, such as monitoring biodiversity, tracking changes in wildlife populations, or collecting data on environmental conditions. Citizen science can be a powerful tool for engaging communities in conservation efforts, as it can help to build knowledge and awareness of local environmental issues, while also collecting important data that can be used to inform conservation management.
- **Community-led conservation projects:** Community-led conservation projects involve local residents in the planning and implementation of conservation efforts. This can include initiatives such as community gardening, urban agriculture, and the creation of green spaces and wildlife habitats. By involving local residents in conservation efforts, these projects can help to build community cohesion and create a sense of shared ownership over the natural areas around them.
- **Environmental education:** Environmental education can be used to raise awareness and promote understanding of local environmental issues, as well as to build skills and knowledge related to conservation management. By providing opportunities for people to learn about the natural areas around them, and how to protect and enhance them, environmental education can help to build a culture of conservation and promote sustainable practices.
- **Advocacy and activism:** Community involvement can also take the form of advocacy and activism, in which local residents work to influence policies and decisions that affect the natural areas around them. This can include efforts to promote more sustainable land use practices, advocate for the protection of wildlife habitats, and push for stronger environmental regulations and protections.

Community involvement is a vital component of efforts to fight against biodiversity loss in urban areas. By engaging residents in conservation efforts, it is possible to build support for conservation management, create a sense of shared responsibility for the natural areas around us, and promote a more sustainable and resilient future for our cities and communities. The Urban Biodiversity and

Citizen Science project in London, UK is a community involvement project that aims to fight against biodiversity loss in urban areas. The project uses citizen science methods to engage local residents in monitoring and mapping biodiversity across the city. Through the project, community members are trained to collect data on wildlife populations, habitat quality, and environmental conditions using a range of tools and techniques. This data is then used to inform local conservation management strategies and to build a better understanding of the biodiversity and ecological processes in urban areas. Data collection is not the only aspect of the project. The Urban Biodiversity and Citizen Science project also provides opportunities for community members to learn more about local biodiversity and conservation management. This includes workshops and educational events on topics such as plant and animal identification, habitat restoration and sustainable urban design. Moreover, the Urban Biodiversity and Citizen Science Project is an inspiring example of how community participation and citizen science methods can be used to combat biodiversity loss in urban areas. While involving residents in monitoring and mapping biodiversity, the project raises awareness of local environmental issues and encourages a sense of shared ownership and responsibility for the natural areas around us.

While urban densification is becoming a key issue in the fight against global warming, limiting the change in land use and its consequences on biodiversity, bringing nature back into the city is a solution for local authorities. On the one hand, it responds to the needs of city dwellers to have access to more nature in their daily environment, in order to improve their living environment, well-being, social ties and health. On the other hand, preserving and developing biodiversity allows cities to adapt to climate change. Nature in the city preserves continuity and strengthens ecological functionality, and also makes urban environments more resilient, by combating heat islands, preventing flooding, regulating runoff, etc. It also has many co-benefits, both for biodiversity and for city residents.

4.2.6. Inspiring policies: The urban green-blue grids for resilient cities - France

URBAN GREEN-BLUE GRIDS
for resilient cities

The green and blue grids[59] is an example of good practice. This European policy aims to preserve and restore the networks of natural environments and landscape elements landscape elements (hedges, copses, etc.) in a sufficiently fine mesh so that sufficiently fine for wild species to complete their life cycle to accomplish their life cycle and to circulate between the environments they need (ecological corridors). It is therefore a process supporting the adaptation of biodiversity to climate change. climate change. The TVB thus makes it possible to maintain and restore, everywhere in the territories natural carbon sinks (forests, wetlands, grasslands wetlands, meadows, hedges, etc.) that are essential to respect a trajectory compatible with the 1.5°C objective. It contributes to the fight against natural risks in rural, urban and peri-urban areas.

This French national program is designed to protect and enhance biodiversity by creating a network of natural and semi-natural habitats across the country. The TVB program aims to promote the connectivity and ecological functionality of ecosystems by creating corridors and stepping stones for biodiversity. The TVB program is based on the principles of ecological connectivity, which recognizes that ecosystems are interconnected, and that the fragmentation of habitats can lead to loss of biodiversity and ecosystem services. The program seeks to create a network of natural and semi-natural habitats, including forests, wetlands, rivers, and other natural areas, that are connected by green and blue corridors.

Green corridors are composed of vegetated areas, such as parks, gardens, and roadside vegetation, which provide habitats for plant and animal species. Blue corridors consist of aquatic environments, such as rivers, lakes, and wetlands, which are essential habitats for aquatic species and provide important ecosystem services, such as water purification and flood control. The TVB program involves a range of stakeholders, including local and regional authorities, NGOs, and private landowners, in the planning and implementation of the network. The program provides guidance and resources for the creation and management of green and blue corridors and supports the development of local biodiversity strategies.

In the larger scheme of things, it must be recognized that the Trame Verte et Bleue is an inspiring example of a large-scale response to biodiversity loss and climate change. By creating a network of natural and semi-natural habitats across the country, the program promotes ecological connectivity and

[59] https://www.urbangreenbluegrids.com/design-tool/

strengthens the resilience of ecosystems to climate change and other environmental stressors. With this program, an important step is taken in building more sustainable and resilient communities, better equipped to adapt to the challenges of the 21st century. Finally, policies and regulations can play an important role in preserving biodiversity in urban areas. For example, zoning regulations can require the preservation of green space or the installation of green roofs on new buildings. Incentives, such as tax credits or grants, can also be provided to encourage the preservation of biodiversity in urban areas.
In conclusion, preserving biodiversity in urban areas is an important issue that requires a theoretical approach to understand the complex interactions between humans and nature. Strategies such as green infrastructure, restoration of degraded urban areas, community involvement, and policies and regulations can help protect and enhance biodiversity in urban areas. By implementing these strategies, urban areas can become more sustainable and resilient, providing ecological services that benefit both humans and wildlife.

4.2.7. Agroecology in cities: the Parisian project called "Parisculteurs"


https://www.agritecture.com/blog/2019/3/7/city-of-paris-introduces-32-more-sites-for-urban-farming
https://www.demainlaville.com/parisculteurs-la-capitale-met-ses-toits-au-vert/

Agroecology is a sustainable farming method that promotes the use of ecological principles and practices to enhance soil fertility, biodiversity, and ecosystem services, while also supporting the livelihoods of farmers and promoting food security. Agroecology has been recognized as a promising approach to address the challenges of climate change and biodiversity loss, particularly in urban areas.
In cities, agroecology can take many forms, such as urban agriculture, rooftop gardens, and community gardens. These initiatives provide numerous benefits, including reducing food miles and

associated carbon emissions, enhancing urban biodiversity, and promoting social cohesion and community development.

One example of agroecology in cities is the Parisian project called "Parisculteurs," which aims to develop 100 hectares of green roofs and walls, urban agriculture, and shared gardens by 2020. The project seeks to promote urban agriculture as a means to reduce the city's carbon footprint, enhance biodiversity, and provide new green spaces for residents to enjoy. The project has mobilised a diverse range of stakeholders, including citizens, NGOs, and private companies, to transform underutilised urban spaces into productive and biodiverse areas. The project has already achieved significant success, with over 700 projects implemented across the city, including rooftop gardens, urban farms, and community gardens. One of the most notable projects under the Parisculteurs initiative is the "Agrocité" urban farm, located in the 19th arrondissement of Paris. The farm consists of 1,000 square meters of vegetable plots, orchards, and a greenhouse, and produces over 2 tons of vegetables and fruits each year. The farm is managed by a local association and provides training and employment opportunities for residents, while also enhancing urban biodiversity and reducing the city's carbon footprint.

On balance, the scale of the “Parisculteurs” project is an inspiring example of how cities can promote sustainable agriculture and enhance biodiversity in urban areas. By mobilising diverse stakeholders and transforming underutilised urban spaces into productive, biodiversity-rich areas, the project contributes to building more resilient and sustainable cities for the future. Around the world, other cities are adopting agroecological practices to combat climate change and biodiversity loss. Another example is the "Organoponicos" program in Havana[60] Cuba, which promotes the use of organic farming methods and urban agriculture to enhance food security and reduce the city's dependence on food imports. Thus, there is promise in using agroecology to address the challenges of climate change and biodiversity loss in urban areas. By fostering sustainable agricultural practices, enhancing urban biodiversity, and promoting social cohesion and community development, agroecological initiatives can help build more resilient and sustainable cities for the future.

[60] https://sagemagazine.org/urban-farm-fed-cities-lessons-from-cubas-organoponicos/

4.2.8. Climate change, Biodiversity & Education

https://www.yre.global/gaia-2030-biodiversity-campaign
https://oceanservice.noaa.gov/education/planet-stewards/talking-about.html

Climate change and biodiversity loss are pressing environmental issues that affect our planet in profound ways. Informing students about these issues can inspire them to take action and become environmental stewards who are committed to preserving our planet's natural resources. Integrating climate change and biodiversity education into the school curriculum can be an effective way to do this (Dalelo, A. 2012). Moreover, Climate change and biodiversity education integrated into school curricula can have a significant impact on raising awareness and promoting action to address these pressing environmental issues. In doing so, we can inspire the next generation of leaders who are committed to protecting our planet.

- First, integrating environmental and sustainability science into science, maths, and social studies classes can help students understand the scientific concepts behind climate change and biodiversity loss. In this context, they can learn about the impact of human activities on the environment, the role of greenhouse gases in global warming and the impact of habitat destruction on biodiversity. They will be inspired to take action and make positive changes in their own lives to reduce their impact on the environment.
- Second, providing opportunities for students to participate in hands-on activities can be an effective way to promote environmental stewardship. Gardening, composting, and recycling programs can teach students to reduce waste and conserve resources. Through these activities,

students can learn about the importance of sustainable practices and develop a sense of responsibility for the environment.

- Third, hosting guest speakers can be a valuable way to enhance climate change and biodiversity education. Local conservationists and scientists can share their knowledge and experience with students, helping them understand the impact of climate change and biodiversity loss on their local community. Similarly, guest speakers can provide valuable insight into actions individuals and communities can take to mitigate the effects of climate change and protect biodiversity.

In addition, encouraging students to participate in environmental clubs or after-school programs can help them develop a sense of community and purpose around environmental issues. They can collaborate on environmental projects, share ideas and concerns, and advocate for sustainable practices within their school and local community. Climate change and biodiversity education integrated into school curricula can have a significant impact on raising awareness and promoting action to address these pressing environmental issues. In doing so, we can inspire the next generation of leaders who are committed to protecting our planet.

Besides, creating international school partnerships is a valuable strategy to facilitate the sharing of ideas and knowledge regarding biodiversity conservation among schools from different countries. This collaborative approach can promote global cooperation and enhance understanding of biodiversity issues. Craft an all-encompassing biodiversity curriculum for nationwide implementation in schools. Essential topics to cover include the significance of biodiversity, its precarious position, and measures to safeguard its existence. Moreover, encouraging students to take an active role in preserving biodiversity through creative expression is one of the many benefits of hosting national biodiversity competitions. Drawing, essay, or photography contests are just a few examples of ways to engage students while promoting conservation efforts. We can cite some particularly relevant approaches:

- **Adopt Sustainable Landscaping Practices[61]:** Encourage residents and businesses to adopt sustainable landscaping practices by promoting the use of native plants, reducing the use of pesticides and herbicides, and implementing water-efficient landscaping techniques such as drip irrigation, rain gardens, and drought-tolerant plant species.

[61] https://www.fao.org/ecosystem-services-biodiversity/news-events/news-details/en/c/1038435/

- **Establish Community Gardens[62]:** Community gardens can provide a space for residents to grow their own food, as well as provide habitat for pollinators and other wildlife. In addition to providing habitat, community gardens can also help to increase social cohesion and community engagement.
- **Plant Trees[63]:** Trees provide many benefits to urban areas, such as reducing the urban heat island effect, improving air quality, and providing habitat for wildlife. Cities can encourage residents to plant trees on private property and also establish urban forestry programs to plant trees on public land.
- **Implement Green Infrastructure[64]:** Green infrastructure refers to the use of natural systems to manage stormwater and reduce the impact of development on the environment. Cities can implement green infrastructure techniques such as green roofs, rain gardens, and bioswales to provide habitat for wildlife, improve water quality, and reduce the impact of stormwater runoff.
- **Establish Wildlife Corridors[65]:** Urban areas can be fragmented, which can make it difficult for wildlife to move between habitats. Cities can establish wildlife corridors or greenways that connect natural areas to provide habitat and migration routes for wildlife.
- **Educate Residents[66]:** Educate residents about the importance of biodiversity and the role they can play in promoting it. This can be done through community events, educational programs, and outreach campaigns.
- **Partner with Local Organizations[67]:** Work with local organisations, such as conservation groups and environmental clubs, to promote and implement biodiversity initiatives. This can help to build partnerships and strengthen community support for biodiversity conservation.

It is important to have practices and solutions for climate change and biodiversity loss because these are two of the most pressing environmental challenges of our time, with far-reaching consequences for human well-being and the health of the planet. In order to address these challenges, it is critical that we develop and implement practices and solutions that help mitigate climate change and conserve

[62] https://www.weforum.org/agenda/2023/02/community-gardens-boost-well-being-biodiversity/
[63] https://alewk.com/blog/the-environmental-impact-of-planting-trees/
[64] https://environment.ec.europa.eu/topics/nature-and-biodiversity/green-infrastructure_en
[65] https://www.nccarf.jcu.edu.au/terrestrialbiodiversity/documents/Corridor_FINAL.pdf
[66] https://www.unesco.org/en/education-sustainable-development/climate-change
[67] https://www.mckinsey.com/industries/agriculture/our-insights/partnering-for-the-planet-an-ngo-success-story

biodiversity. This requires a shift towards more sustainable and equitable ways of living, including adopting renewable energy sources, promoting energy efficiency, and conserving and restoring natural habitats. Furthermore, it requires a collective effort from governments, businesses, communities, and individuals to take action and work towards a more sustainable future.

By implementing practices and solutions that address climate change and biodiversity loss, we can help to build a more resilient and sustainable future for all. This includes ensuring that future generations have access to the same natural resources and biodiversity that we enjoy today, as well as promoting more equitable and just societies.

5. Part IV - Put into practices: General approach

5.1.1. Introduction

Environmental education is a critical component of building a sustainable future for our planet. By increasing awareness and understanding of environmental issues, we can inspire individuals and communities to take action to protect and conserve the natural world. Climate change and urban biodiversity are two of the most pressing environmental challenges facing our world today. As our global climate continues to shift and human populations grow and urbanise, it is more important than ever to educate young people about these issues and empower them to take action.

Schools are ideal settings for environmental education, as they provide opportunities to reach a wide range of young people and to integrate environmental learning across disciplines. By teaching about climate change and urban biodiversity in schools, we can help students understand the impact of human activities on the environment, and the ways in which we can work to mitigate these impacts.

5.2.1. Zoom on France example

To zoom in on France, the country is recognizing the importance of environmental education, various organisations and initiatives have been implemented to promote awareness and action towards climate change and biodiversity conservation. These strategies aim to engage individuals, schools, and communities in environmental education and foster a sense of responsibility towards the environment.

One notable strategy in France is the implementation of the Éducation à l'Environnement et au Développement Durable[68] (EEDD) framework. This framework, established by the French Ministry of Education, provides guidelines and support for integrating environmental education and sustainable development into the national curriculum. The EEDD framework ensures that environmental education is woven into various subjects, enabling students to learn about the environment, sustainability, and the interconnections between human activities and the natural world.

The French government also supports organisations and initiatives that promote environmental education. For instance, the French Agency for Biodiversity (AFB)[69] plays a vital role in conserving biodiversity and raising awareness through education. The AFB collaborates with schools, universities, and other educational institutions to develop educational materials, organise workshops, and provide training for teachers. Their efforts aim to install a deep understanding of biodiversity and the importance of its conservation in the younger generation.

Furthermore, France has been actively involved in the implementation of the UNESCO Associated Schools Network[70] (Réseau des Écoles Associées à l'UNESCO). This network encourages schools to incorporate sustainable development and environmental education into their curricula, fostering a sense of global citizenship and environmental responsibility. Participating schools collaborate on projects and share best practices, creating a platform for innovation and knowledge exchange.

In addition to governmental and organisational efforts, France also emphasises hands-on learning and outdoor education. The country is home to numerous nature reserves, parks, and botanical gardens that serve as living laboratories for environmental education. These spaces provide opportunities for students to engage directly with nature, observe biodiversity, and understand the intricate relationships between different species and ecosystems.

Moreover, France hosts environmental education events and campaigns to raise awareness among the general public. For instance, the annual "Fête de la Nature"[71] celebrates biodiversity by organising various activities, workshops, and guided tours. These events aim to reconnect individuals with nature,

[68] https://www.ecologie.gouv.fr/leducation-lenvironnement-et-au-developpement-durable
[69] https://www.ofb.gouv.fr/documentation/french-biodiversity-agency-presentation#:~:text=The%20French%20Biodiversity%20Agency%20was,for%20Ecology%20and%20Agriculture%20%26%20Food.
[70] https://www.unesco.org/en/aspnet
[71] https://fetedelanature.com/fil-d-infos

inspire curiosity, and educate people about the importance of protecting biodiversity and addressing climate change.

In conclusion, France has demonstrated a strong commitment to environmental education through the implementation of frameworks, collaboration with educational institutions, and the promotion of hands-on learning. These strategies facilitate the integration of climate change and biodiversity conservation into the national curriculum, ensuring that future generations are equipped with the knowledge and skills needed to address environmental challenges. By nurturing a sense of environmental responsibility, France is paving the way for a more sustainable future and fostering a culture of environmental stewardship among its citizens.

5.3.1. School sheets

One innovative approach to teaching about climate change and urban biodiversity is through the use of dedicated school sheets. These worksheets provide students with a structured framework for collecting and analysing data on local plant and animal species, as well as climate and soil conditions. By engaging in hands-on field work and data collection, students can develop a deeper understanding of the complexity of local ecosystems and the ways in which they are impacted by climate change and human activity.

The school sheets are designed to include a range of activities, including a biodiversity checklist section, a phenology observation section, a soil and habitat analysis section, a climate data section, and a reflection section. By using these sheets, students can collect and analyse data on a range of environmental variables and use this data to develop hypotheses about the relationships between climate change, urbanisation, and biodiversity loss. They can also use the data to develop conservation strategies, such as designing green spaces or promoting sustainable urban agriculture. Furthermore, the use of school sheets can be a powerful tool for educating young people about the complex relationships between climate change, urbanisation, and biodiversity loss. By engaging in hands-on learning and data collection, students can develop a deeper understanding of these issues, and become empowered to take action to protect our planet's ecosystems. As such, integrating environmental

education and the use of school sheets into school curricula is an important step towards building a more sustainable and equitable future for all.

We also need to keep in mind that the design should be simple and easy to use, with clear instructions and prompts for students to follow. The sheet should also be visually engaging and attractive to encourage students to engage with it.

As part of this Chapter of the handbook we have selected 5 school sheets that could be completed by students during or after their field trips:

- Biodiversity Checklist
- Phenology Observation Sheet
- Soil and Habitat Analysis Sheet
- Climate Data Sheet
- Reflection Sheet

5.3.2 Biodiversity sheet

This sheet could contain a checklist of different plant species found in the local area that students can check off as they observe them during the field trip. This will help students become more familiar with the local plant biodiversity and develop their observational skills. Content of the Biodiversity Checklist section of the school sheet:

- **Species name:** The name of the plant species being observed and recorded.
- **Habitat:** The type of habitat where the plant is located, such as forest, meadow, or wetland.
- **Abundance:** The number of individual plants of that species observed in the area, such as few, some, or many.
- **Height:** The approximate height of the plant, recorded in centimetres or inches.
- **Canopy cover:** The percentage of the area covered by the plant's leaves and branches.
- **Flowering:** The time of year when the plant is flowering, recorded as either early, mid, or late season.
- **Fruit/Seed:** The time of year when the plant is producing fruit or seeds, recorded as either early, mid, or late season.

- **Notes:** Any additional notes about the plant's appearance, behaviour, or ecology that may be relevant to the study.

The Biodiversity Checklist section should be comprehensive and include all the plant species that are commonly found in the local area. It should also provide clear and concise instructions on how to record observations of each species. By documenting this information, students can gain a deeper understanding of the local plant biodiversity and how it relates to climate change. This sheet can include both flora and fauna.

This table sum up the content we can have for the biodiversity sheet:

	Species names	Habitat	Abundance			Height	Flowering season			Size	Fruit/seed	Notes
			Few	Some	Many		Early	Mid	Late			
Flora												
Fauna												

5.3.3. Phenology Observation Sheet:

Phenology is the study of the timing of seasonal events in plants and animals. This sheet contain a list of different plants and the specific phenological events to observe, such as the first flower bud or the first leaf. Students can record the date and any observations they make regarding the plants' phenology. Content of the Phenology Observation section of the school sheet:

- **Date:** The date of the observation.
- **Weather:** The current weather conditions, such as sunny, cloudy, rainy, or windy.
- **Temperature:** The current temperature, recorded in Celsius or Fahrenheit.

- **Leaf buds:** The stage of development of the plant's leaf buds, such as not yet visible, swelling, or fully expanded.
- **Flowers:** The stage of development of the plant's flowers, such as not yet visible, buds, or fully open.
- **Fruits/Seeds:** The stage of development of the plant's fruits or seeds, such as not yet visible, developing, or ripe.
- **Insects:** Any insects observed on or near the plant, recorded by species if possible.
- **Birds:** Any birds observed interacting with the plant, recorded by species if possible.
- **Other Observations:** Any other notable observations or changes in the plant or its surrounding environment.

The Phenology Observation section should be completed regularly throughout the year to track the seasonal changes in plant growth and development, as well as the behaviour of associated animals such as insects and birds. By documenting these observations, students can gain a deeper understanding of how climate change affects the timing of seasonal events, such as leaf budding and flower blooming.

This table sum up the content of the phenology sheet:

Date: _____

Weather: _____

Temperature: _____

Leaf buds	Not yet visible / Swelling / Fully expanded
Flowers	Not yet visible / Buds / Fully open
Fruits/Seeds	Not yet visible / Developing / Ripe
Insects	Species and stage of development
Birds	Species and behaviour observed
Other observations	Notable changes in the plant or its surroundings

5.3.4 Soils and habitat analysis sheet

This sheet contains a checklist of different soil types and habitat characteristics found in the local area, such as soil moisture, pH, and slope. Students can record their observations and take samples for further analysis back in the classroom. Details on the content of the Soil and Habitat Analysis section of the school sheet:

- **Location:** The location of the soil and habitat analysis, such as a specific plot or area within the larger study site.
- **Soil type:** The type of soil at the analysis location, such as sandy, clay, or loamy, as well as the colour and texture of the soil.
- **Soil pH:** The pH level of the soil, which can be measured using a soil pH test kit.
- **Soil moisture:** The moisture level of the soil, which can be assessed by feeling the soil and noting whether it is dry, moist, or wet.
- **Habitat features:** The specific features of the habitat at the analysis location, such as trees, shrubs, rocks, or bodies of water.
- **Species observed:** Any plant or animal species observed within the habitat, recorded by species if possible.
- **Other observations:** Any other notable observations about the soil or habitat, such as signs of erosion, human impacts, or the presence of invasive species.

The Soil and Habitat Analysis section should be completed at each study site to document the unique characteristics of the soil and habitat. By tracking changes in soil type, moisture, and pH level over time, students can gain a deeper understanding of how these factors affect the growth and survival of plant species. Similarly, by observing the specific features and species present in the habitat, students can gain insights into the complex interdependencies of plant and animal species in the ecosystem.

Example of a Soil and Habitat Analysis Checklist section that you can use for your project:

Location: _____

Soil Type: _____

Soil Colour: _____

Soil Texture: _____

Soil pH: _____

Soil Moisture: _____

Habitat Features: _____

Plants	Species /Names	Num observed
Animals	Species name	Num Observed

Other Observations: _____

In this example, the checklist includes a table with columns for the soil and habitat characteristics, as well as a section to record any plant or animal species observed within the habitat. For the species observed section, there are columns for the species name and the quantity or abundance observed, which can be recorded as specific numbers or a general estimate (e.g., many, few, rare).

Besides by using a Soil and Habitat Analysis Checklist, students can document the unique characteristics of each study site and gain insights into how these factors affect the growth and survival of plant and animal species. They can also identify any potential threats to the habitat, such as invasive species or human impacts, and develop strategies to protect and conserve the ecosystem.

5.3.5. Climate Data sheet

This sheet contains a list of different climate data, such as temperature, rainfall, and wind speed, and asks students to collect this data during their field trip. This will help students understand the local climate and how it may be impacting the plant biodiversity in the area. Details on the content of the Climate Data section of the school sheet:

- **Location:** The location where the climate data was recorded.
- **Date and time:** The date and time when the climate data was recorded, including the year, month, day, and time of day.
- **Temperature:** The temperature at the time of recording, measured using a thermometer or other temperature measuring device.

- **Precipitation:** The amount of precipitation that occurred during the time of recording, measured using a rain gauge or other precipitation measuring device.
- **Wind speed and direction:** The wind speed and direction at the time of recording, measured using an anemometer or other wind measuring device.
- **Humidity:** The relative humidity at the time of recording, measured using a hygrometer or other humidity measuring device.
- **Cloud cover:** The amount of cloud cover at the time of recording, measured as a percentage of the sky covered by clouds.
- **Other observations:** Any other notable observations about the weather or climate at the time of recording.

The Climate Data section should be completed at regular intervals throughout the study period, such as daily or weekly, to document the climate conditions at each study site over time. By tracking changes in temperature, precipitation, wind speed, and other climate factors, students can gain a deeper understanding of how these factors affect plant and animal species in the ecosystem. They can also identify any long-term trends or patterns in the climate data, such as changes in temperature or precipitation levels, and use this information to predict future changes and develop strategies for adaptation and mitigation.

Location: _____
Date and Time: _____
Temperature: _____
Precipitation: _____
Wind Speed and Direction: _____
Humidity: _____
Cloud Cover: _____
Other Observations: _____

By using a Climate Data Checklist, students can collect consistent and accurate data on the weather and climate conditions at each study site, which can help them identify patterns and trends over time.

They can also use this data to explore how climate factors affect plant and animal species in the ecosystem and develop hypotheses about how climate change may impact these species in the future.

5.3.6. Reflection Checklist sheets

At the end of each field trip, students could be asked to reflect on their experiences and what they have learned about plant biodiversity and climate change. This is an example of questions we can include in the reflection section of the sheets:

- What did you observe during your field trip?
- How did your observations compare to your expectations?
- What did you learn about plant biodiversity and climate change?
- How do you think climate change might affect the plants and animals in the ecosystem you studied?
- What actions can you take to help address climate change and protect plant biodiversity?
- What challenges did you encounter during your field trip, and how did you overcome them?
- How can you use the data you collected during your field trip to inform future research and action?
- What surprised you the most during the field trip?
- How can you apply what you learned to help protect plant biodiversity in your community?

By using a Reflection Checklist sheet, students can reflect on their experiences during the field trip and consolidate their learning. They can also identify areas for further research and action, such as developing conservation strategies or advocating for policy changes to address climate change. By engaging in reflective practice, students can develop a deeper understanding of the complex relationships between plant biodiversity, climate change, and human actions, and become more informed and engaged citizens in the global effort to protect our planet's ecosystems

6. Conclusion

As we conclude this module on “Climate change and urban biodiversity” it is essential to reflect on the role of environmental education and explore future perspectives in the ongoing fight against these critical environmental challenges.

The international, national, and local contexts have provided a backdrop for understanding the urgency of addressing climate change and biodiversity loss. However, it is through environmental education that we can truly empower individuals and communities to take action and pave the way for a sustainable future. Environmental education serves as a catalyst for change, equipping individuals with knowledge, skills, and a deep understanding of the interconnections between human activities, climate change, and biodiversity. By incorporating environmental education into formal and informal educational settings, cities can foster a sense of responsibility and engagement among their residents. Schools, universities, and community organisations can play a vital role in promoting environmental education initiatives that empower individuals to make informed decisions and take sustainable actions in their daily lives.

Looking ahead, it is crucial to emphasise the importance of interdisciplinary collaboration and partnerships between stakeholders involved in climate arrangements and biodiversity conservation. By working together, government agencies, educational institutions, NGOs, and community groups can create a comprehensive and coordinated approach to addressing climate change and biodiversity loss in cities. This collaboration can facilitate the sharing of best practices, resources, and expertise, maximising the impact of environmental education initiatives.

Additionally, future perspectives should include a focus on innovative approaches and technologies that integrate climate change and biodiversity education into the urban fabric. Cities can leverage advancements in digital tools, citizen science, and immersive technologies to engage individuals in meaningful ways. These technologies can provide interactive learning experiences, promote behaviour change, and enable individuals to actively participate in monitoring and conservation efforts.

Lastly, the future of environmental education lies in fostering a sense of hope, agency, and empowerment among individuals. While the challenges ahead may seem daunting, it is essential to emphasise the positive impact that collective action can have. By highlighting success stories,

showcasing sustainable urban projects, and promoting environmental champions, cities can inspire individuals to become change agents in their communities.

It is important to note that this handbook has explored the history of the international agreements and national and local strategies and initiative as a retrospective guidebook. However, environmental education has an important place because actions can enable us to initiate a transformation towards a more sustainable future. Besides, it is possible to integrate environmental education into urban planning and to involve people in a meaningful way so that cities become centres of action for climate and biodiversity conservation. Let's seize this opportunity to inspire, educate and empower people to shape resilient, vibrant cities that are harmoniously connected to nature. Together we can create a future where climate change and biodiversity loss are urgently addressed and the well-being of our planet and future generations is preserved.

Bibliographic references

- Arya S. (2021). Freshwater Biodiversity and Conservation Challenges: A Review. International Journal of Biological Innovations. 3 (1): 74-78. https://doi.org/ 10.46505/IJBI.2021.3106.
- Audu, A. R. A., Cuzzocrea, A., Leung, C. K., MacLeod, K. A., Ohin, N. I., & Pulgar-Vidal, N. C. (2020). An intelligent predictive analytics system for transportation analytics on open data towards the development of a smart city. In Complex, Intelligent, and Software Intensive Systems: Proceedings of the 13th International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS-2019) (pp. 224-236). Springer International Publishing.
- Baum R.M. (2016). Future Calculations: The first climate change believer. Distillations. 2(2): 38-39. https://www.sciencehistory.org/ distillations/future-calculations.
- Blanc, N., & Clergeau, P. (2010). Installer une trame verte dans la ville? Le point de vue des chercheurs?. Urbanisme, (36,), 55-58.
- Bonan, G. B. (2000). The microclimates of a suburban Colorado (USA) landscape and implications for planning and design. Landscape and urban planning, 49(3-4), 97-114.
- Bongaarts, J. (2019). IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.
- Bodansky, D. (2016). The Paris climate change agreement: a new hope? American Journal of International Law, 110(2), 288-319.
- Boyd, E., Corbera, E., & Estrada, M. (2008). UNFCCC negotiations (pre-Kyoto to COP-9): what the process says about the politics of CDM-sinks. International Environmental Agreements: Politics, Law and Economics, 8, 95-112.

- Brimacombe, A. M. B. (2020). Climate change and human security in small island developing states: The case of Papua New Guinea and its UN-REDD/REDD+ Program.
- Brundtland G.H. (1987). Our Common Future: The World Commission on Environment and Development, Oxford: Oxford University Press.
- Connop, S., Vandergert, P., Eisenberg, B., Collier, M. J., Nash, C., Clough, J., & Newport, D. (2016). Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure. Environmental Science & Policy, 62, 99-111.
- Crumpler, K., & Bernoux, M. (2020). Climate change adaptation in the agriculture and land use sectors: A review of nationally determined contributions (NDCs) in Pacific Small Island developing states (SIDS). Managing Climate Change Adaptation in the Pacific Region, 1-25.
- Dalelo, A. (2012). Loss of Biodiversity and Climate Change as Presented in Biology Curricula for Ethiopian Schools: Implications for Action-Oriented Environmental Education. International Journal of Environmental and Science Education, 7(4), 619-638.
- Depietri, Y., & McPhearson, T. (2017). Integrating the grey, green, and blue in cities: Nature-based solutions for climate change adaptation and risk reduction. Nature-based solutions to climate change adaptation in urban areas: Linkages between science, policy and practice, 91-109.
- Depledge, J. (2022). The "top-down" Kyoto Protocol? Exploring caricature and misrepresentation in literature on global climate change governance. International Environmental Agreements: Politics, Law and Economics, 22(4), 673-692.
- Douglas, I., & James, P. (2014). Urban ecology: an introduction. Routledge.
- Eisenman, T. S., Churkina, G., Jariwala, S. P., Kumar, P., Lovasi, G. S., Pataki, D. E., ... & Whitlow, T. H. (2019). Urban trees, air quality, and asthma: An interdisciplinary review. Landscape and urban planning, 187, 47-59.
- Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonald, R. I., ... & Wilkinson, C. (2013). Urbanization, biodiversity and ecosystem services: challenges and opportunities: a global assessment (p. 755). Springer Nature.
- Gupta P.K. (2017). Ecology and Environment, th 13 edn. Rastogi Publications, Meerut. 755p.
- Philibert, J. (2006). One and a half century of diffusion: Fick, Einstein before and beyond.
- Houghton, R. A. (2005). Tropical deforestation as a source of greenhouse gas emissions. Tropical deforestation and climate change, 13.
- IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2019b. "Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services." Edited by S. Diaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard, A. Arneth, et al. IPBES Secretariat, Bonn, Germany. Ishimatsu, K., K. Ito, Y. Mitani, Y. Tanaka, T
- IPCC, 2019: Summary for Policymakers. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.
- Juffe-Bignoli, D., Burgess, N. D., Bingham, H., Belle, E. M. S., De Lima, M. G., Deguignet, M., ... & Kingston, N. (2018). Protected Planet Report 2018. International Union for the Conservation of Nature (IUCN).

- Jones, M. D. (2014). Cultural characters and climate change: How heroes shape our perception of climate science. Social Science Quarterly, 95(1), 1-39.
- Karppinen, P., Erkinaro, J., Niemelä, E., Moen, K., & Økland, F. (2004). Return migration of one-sea-winter Atlantic salmon in the River Tana. Journal of Fish Biology, 64(5), 1179-1192.
- Kühn, I., Brandl, R., & Klotz, S. (2004). The flora of German cities is naturally species rich. Evolutionary ecology research, 6(5), 749-764.
- Kumar Ajay and Verma A.K. (2017). Biodiversity loss and its Ecological impact in India. International Journal on Biological Sciences. 8(2): 156-160.
- La Greca, P., La Rosa, D., Martinico, F., & Privitera, R. (2011). Agricultural and green infrastructures: The role of non-urbanised areas for eco-sustainable planning in a metropolitan region. Environmental Pollution, 159(8-9), 2193-2202.
- Leitão, A. B., Miller, J., Ahern, J., & McGarigal, K. (2012). Measuring landscapes: A planner's handbook. Island press.
- Liu, X., Y. Huang, X. Xu, X. Li, X. Li, P. Ciais, P. Lin, et al. 2020. “High-Spatiotemporal-Resolution Mapping of Global Urban Change from 1985 to 2015.” Nature Sustainability 3: 564– 70.
- Madre, F., Clergeau, P., Machon, N., & Vergnes, A. (2015). Building biodiversity: Vegetated façades as habitats for spider and beetle assemblages. Global Ecology and Conservation, 3, 222-233.
- McDonald, R. I., Kareiva, P., & Forman, R. T. (2008). The implications of current and future urbanization for global protected areas and biodiversity conservation. Biological conservation, 141(6), 1695-1703.
- Morgera, E., Tsioumani, E., & Buck, M. (2014). Unraveling the nagoya protocol: a commentary on the nagoya protocol on access and benefit-sharing to the convention on biological diversity (p. 444). Brill.
- Munro, K., & Grierson, D. (2018). Nature, people and place: informing the design of urban environments in harmony with Nature through the Space/Nature Syntax. Lifelong learning and education in healthy and sustainable cities, 105-125.
- NASA (2014). https://www.nasa.gov/ audience/forstudents/k-4/stories/nasaknows/what-is-climate-change-k4.html.
- Pauchard, A., & Shea, K. (2006). Integrating the study of non-native plant invasions across spatial scales. Biological invasions, 8, 399-413.
- Pearson, T. R., Brown, S., Murray, L., & Sidman, G. (2017). Greenhouse gas emissions from tropical forest degradation: an underestimated source. Carbon balance and management, 12, 1-11.
- Pörtner, H. O., Scholes, R. J., Agard, J., Archer, E., Arneth, A., Bai, X., ... & Ngo, H. (2021). Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change.
- Pörtner, Hans-Otto, Debra C. Roberts, E. S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig et al. "IPCC, 2022: Summary for policymakers." (2022): 3-33.
- Prakash, S. (2021). Impact of Climate change on Aquatic Ecosystem and its Biodiversity: An overview. International Journal of Biological Innovations, 3(2).
- Ramaswami, A., Russell, A. G., Culligan, P. J., Sharma, K. R., & Kumar, E. (2016). Meta-principles for developing smart, sustainable, and healthy cities. Science, 352(6288), 940-943.
- Reid, V. (2017). Coral reefs in our changing climate. Biodiversity, 18(1), 1-1.
- Sanders, A. K., Falcão, T., Haider, A., Jambeck, J., LaPointe, C., Vickers, C., & Ziebarth, N. (2018). World economic and social survey 2018: Frontier technologies for sustainable development.
- Savard, J. P. L., Clergeau, P., & Mennechez, G. (2000). Biodiversity concepts and urban ecosystems. Landscape and urban planning, 48(3-4), 131-142.

- Taplin, R. E. (2015). Climate Change: A Different Subjectivity? PhD diss., Griffith University, Australia.
- Tehan, M. F., Godden, L. C., Young, M. A., & Gover, K. A. (2017). The impact of climate change mitigation on indigenous and forest communities: International, national and local law perspectives on REDD+. Cambridge University Press.
- The Nature Conservancy. 2018. Nature in the Urban Century. Arlington, VA: The Nature Conservancy. https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_ NatureintheUrbanCentury_FullReport.pdf.
- Tørstad, V., Sælen, H., & Bøyum, L. S. (2020). The domestic politics of international climate commitments: which factors explain cross-country variation in NDC ambition? Environmental Research Letters, 15(2), 024021.
- UN (2015). Transforming our world: the 2030 Agenda for Sustainable Development. https://sdgs.un.org/2030agenda
- Ve r m a A. K. (2019). Sustainable Development and Environmental Ethics. International Journal on Environmental Sciences. 10 (1): 1-5.
- Verma, A. K. (2021). Influence of climate change on balanced ecosystem, biodiversity and sustainable development: An overview. International Journal of Biological Innovations.
- Zhang, X., Fu, Y., Han, Z., Overland, J. E., Rinke, A., Tang, H., ... & Wang, M. (2022). Extreme cold events from East Asia to North America in winter 2020/21: Comparisons, causes, and future implications.

03

Protected Natural Areas

Module by PLATON

LEAF - Learn biodiversity through Environmental Action
For the community
ERASMUS+ 2022-1-RO01-KA220-SCH-000086884

Co-funded by the European Union

Table of Contents, Module 3:

Co-funded by the European Union

LEAF - Learn biodiversity through Environmental Action For the community
ERASMUS+ 2022-1-RO01-KA220-SCH-000086884

III. Protected Natural Area

1. Introduction to Protected Natural Areas

1.1. Overview of Protected Natural Areas

Protected Natural Areas, commonly known as 'protected areas' or 'conservation areas,' play a fundamental role in the preservation of Earth's biodiversity. These areas are designated and managed with the primary objective of safeguarding the biological diversity, ecosystems, and natural landscapes they encompass. The fundamental philosophy behind their establishment is deeply rooted in recognizing the critical interconnections between healthy ecosystems, wildlife conservation, and human well-being.

1.1.1. Definition and Purpose

Protected Natural Areas are defined as specific geographical spaces where human activity is regulated to protect the natural environment and sustain the processes that maintain its diversity. The primary purposes include biodiversity conservation, habitat restoration, scientific research, education, and sustainable recreation. Through controlled human intervention, these areas aim to strike a balance between the conservation of natural resources and providing opportunities for people to experience and understand the value of nature.

Protected areas serve various purposes, often interrelated:

- **Biodiversity Conservation:** Preserving the variety and variability of life forms, genes, and ecosystems.
- **Ecosystem Functions:** Ensuring vital ecological processes such as nutrient cycling, pollination, and water purification are maintained.
- **Scientific Research:** Offering living laboratories for scientific study and research on natural systems and processes.
- **Education and Recreation:** Providing platforms for environmental education, interpretation, and sustainable recreation.

1.1.2. Historical Evolution

The concept of protected areas has evolved over centuries, reflecting changing societal values and attitudes towards nature. The trajectory can be traced from hunting reserves in medieval Europe to the establishment of the first national parks in the United States during the 19th century. This evolution is marked by a growing awareness of the need to conserve natural resources and the establishment of international agreements promoting conservation efforts.

The timeline includes significant milestones:

- **Ancient Times:** Prehistoric hunting zones and early conservation practices in various civilizations.
- **18th - 19th Century:** Development of parks and reserves in Europe and North America.
- **20th Century:** Rapid increase in protected area numbers, fueled by global conservation movements.
- **21st Century:** Integration of indigenous knowledge, community-based conservation, and transboundary protected areas.

1.1.3. Types of Protected Natural Areas

Protected areas encompass a wide array of categories, each designed to fulfil specific conservation goals and tailored to the ecological characteristics of the region they protect. Common types include:

- **National Parks:** Primarily for conservation and enjoyment, with strict regulations.
- **Wildlife Sanctuaries and Reserves:** Focus on the conservation of specific species.
- **Biosphere Reserves:** Integrating conservation with sustainable development.
- **Marine Protected Areas:** Protecting marine ecosystems and habitats.

1.1.4. Importance of Protected Natural Areas in Biodiversity Preservation

Protected areas are crucial tools in mitigating biodiversity loss and ecosystem degradation. They provide safe havens for diverse flora and fauna, support ecosystem resilience, aid in climate regulation, sustain essential ecological processes, and offer educational and recreational opportunities for the public. In essence, they are a cornerstone of conservation efforts, working towards a harmonious coexistence of humanity and the natural world.[1]

[1] 1. Dudley, N., et al. (2013). **"Natural Solutions: Protected Areas Helping People Cope with Climate Change."** IUCN.

2. The Importance of Protected Natural Areas in Biodiversity

2.1. Introduction

In this unit, we will explore the vital role that Protected Natural Areas play in preserving biodiversity. We will delve into the depths of what biodiversity entails, the current crisis it faces, and how these protected areas act as a shield against the ongoing biodiversity loss.

2.2. Biodiversity: A Primer

2.2.1. Definition and Significance

Biodiversity encompasses the variety of life on Earth at all levels of biological organisation, including the diversity of species, genetic variation within each species, and the variety of ecosystems. It is fundamental for ecosystem functioning, stability, and resilience, providing humans with numerous ecosystem services like clean air and water, food, medicine, and climate regulation. The importance of preserving biodiversity cannot be overstated, as it is intricately linked to our well-being and survival.

2.2.2. Current Biodiversity Crisis

The world is experiencing an unprecedented biodiversity crisis. Species are going extinct at an alarming rate, largely due to human activities such as habitat destruction, pollution, climate change, overexploitation, and the introduction of invasive species. The consequences of this crisis extend beyond the loss of individual species; it disrupts ecosystems, weakens their resilience, and impairs their ability to provide essential services. Addressing this crisis requires urgent and concerted efforts on a global scale.

2.3. The Role of Protected Natural Areas in Biodiversity Conservation

2.3.1. Biodiversity Hotspots and Endemism

Biodiversity hotspots are regions with exceptionally high levels of biodiversity and a large number of species found nowhere else. These areas are particularly crucial for conservation efforts, as they

2. Redford, K. H., & Sanjayan, M. (2003). **"Parks as Surrogate Remnants: A Reconsideration."** In R. Woodroffe et al. (Eds.), "People and Wildlife, Conflict or Coexistence?" Cambridge University Press.
3. Terborgh, J., et al. (2002). **"Ecological Meltdown in Predator-Free Forest Fragments."** Science, 294(5548), 1923-1926.
4. IUCN. (2021). **"IUCN World Database on Protected Areas."** Retrieved from https://www.protectedplanet.net/

harbour a significant portion of the world's biodiversity. By establishing protected areas within these hotspots, we can safeguard a multitude of unique species and ecosystems.

2.3.2. Conservation of Threatened and Endangered Species

Protected areas provide safe havens for endangered and threatened species, allowing them to recover and thrive. For example, the African savannas in protected areas like Serengeti National Park have been vital in preserving populations of charismatic species such as lions, elephants, and zebras. Without these protected areas, many of these species would face a heightened risk of extinction.

2.3.3. Ecosystem Services and Sustainability

Protected areas offer a wide range of ecosystem services that are invaluable to human societies. Forested protected areas, for instance, act as carbon sinks, aiding in mitigating climate change. Wetland reserves help in flood control and water purification, benefiting surrounding communities. Recognizing and valuing these services is essential for promoting sustainable development and fostering a symbiotic relationship between humans and nature.

2.4. Supporting Evidence: Case Studies and Research

2.4.1. Case Study: Yellowstone National Park, USA

Yellowstone National Park, established in 1872, is a paradigm of the positive impact of protected areas on biodiversity. The reintroduction of grey wolves in the mid-1990s led to a cascade of ecological benefits, including a reduction in elk populations, regeneration of vegetation, and improvements in riverbank stability.

2.4.2. Research Findings: Great Barrier Reef Marine Park, Australia

Research conducted in the Great Barrier Reef Marine Park demonstrates the importance of protected marine areas in conserving coral reefs and marine biodiversity. Marine protected areas within the reef have shown higher coral cover, increased fish biomass, and greater species diversity compared to adjacent areas with human activity.

2.5. Challenges and Future Outlook

2.5.1. Challenges in Biodiversity Conservation

Despite the benefits of protected areas, they face numerous challenges. Encroachment, illegal poaching, climate change, and inadequate funding are major hurdles. Additionally, effectively managing and expanding protected areas in the face of growing human populations and urbanisation remains a persistent challenge.

2.5.2. Strategies for Improvement

To enhance the effectiveness of protected areas, strategies such as involving local communities in conservation efforts, implementing stricter regulations, developing sustainable tourism, and fostering international cooperation are crucial. Integrating modern technologies like satellite monitoring and artificial intelligence can also significantly aid in better management and protection of these areas.

2.6. Conclusion

Protected Natural Areas are not just spaces of nature set aside; they are the cornerstones of biodiversity conservation. They serve as our insurance policy against the loss of the rich tapestry of life that defines our planet. Recognizing their pivotal role and investing in their preservation is not just an environmental necessity but a moral obligation for present and future generations.[2]

3. Protected Natural Areas Worldwide

3.1. Introduction

In this unit, we will embark on a journey across the continents, exploring the diversity of Protected Natural Areas worldwide. These areas serve as bulwarks in the battle to conserve our planet's biodiversity. Understanding their distribution, characteristics, and the global efforts in preserving them is essential to appreciate the scale and importance of the conservation endeavour.

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[2] Sala, O. E., et al. (2000). **"Global biodiversity scenarios for the year 2100."** Science, 287(5459), 1770-1774.
Butchart, S. H., et al. (2010). **"Global biodiversity: indicators of recent declines."** Science, 328(5982), 1164-1168.
Millennium Ecosystem Assessment. (2005). **"Ecosystems and Human Well-being: Biodiversity Synthesis."** World Resources Institute.
Dinerstein, E., et al. (2017). **"An ecoregion-based approach to protecting half the terrestrial realm."** BioScience, 67(6), 534-545.
Ripple, W. J., et al. (2014). **"Status and ecological effects of the world's largest carnivores."** Science, 343(6167), 1241484.
Hughes, T. P., et al. (2017). **"Global warming and recurrent mass bleaching of corals."** Nature, 543(7645), 373-377.

3.2. Protected Natural Areas: A Global Overview

3.2.1. Scope and Classification

Protected Natural Areas, designated to safeguard ecosystems, species, and geological formations, exhibit remarkable diversity globally. They range from expansive wilderness regions to small, carefully managed reserves. International bodies like the International Union for Conservation of Nature (IUCN) classify these areas into six categories: strict nature reserves, national parks, natural monuments, wildlife sanctuaries, protected landscapes, and managed resource protected areas.

3.2.2. Global Distribution

Protected Natural Areas are distributed across the world's biomes, from the Arctic tundra to the tropical rainforests. Each continent hosts a unique array of these areas, adapted to the specific ecological, geographical, and climatic conditions. Understanding this distribution is crucial for recognizing the global significance of these conservation efforts.

3.3. Protected Natural Areas in Continents

3.3.1. Africa

Africa boasts diverse and extensive Protected Natural Areas, including the Serengeti National Park in Tanzania, the Okavango Delta in Botswana, and Virunga National Park in the Democratic Republic of Congo. These areas are vital for conserving iconic species like elephants, lions, and rhinoceroses.

Serengeti National Park in Tanzania

Serengeti National Park, a UNESCO World Heritage Site, is renowned as a premier wildlife destination. It hosts the awe-inspiring Great Migration, a cyclic movement of millions of wildebeest and other ungulates, showcasing nature's dynamic ecosystem. The park encompasses 2,286 square kilometres, offering varied landscapes, from sunlit plains to hilly terrain. Besides the migration, the park houses an impressive predator population and iconic African wildlife like elephants. The Maasai people, with a rich cultural heritage, coexist within the park. Serengeti's history dates back to 1930 when it was designated a game reserve, evolving into a national park in 1951. Its natural wonders and vibrant biodiversity continue to captivate visitors, leaving an indelible mark on all who witness its beauty.


Okavango Delta in Botswana

The Okavango Delta in Botswana, a UNESCO World Heritage Site, is a sprawling and diverse ecosystem resulting from the Okavango River merging into the Kalahari desert. Spanning 6,000 to 15,000 square kilometres, it houses endangered wildlife and birds. Fueled by the Okavango (Kavango) River from Angola, it forms a distinctive alluvial fan. Seasonal flooding, peaking in July during Botswana's dry season, sustains the delta. The region is largely flat with slight elevation variations. Notably, Chief's Island is the largest landmass, formed on a tectonic fault line. Designated the 1000th UNESCO World Heritage Site in 2014, it's a crucial wildlife area protected by the Moremi Game Reserve and various wildlife concessions. The delta is renowned for its exceptional wildlife, drawing safari enthusiasts to premier camps like Mombo Camp, Duba Plains Camp, Vumbura Camp, and others.


https://www.okavangodelta.com/

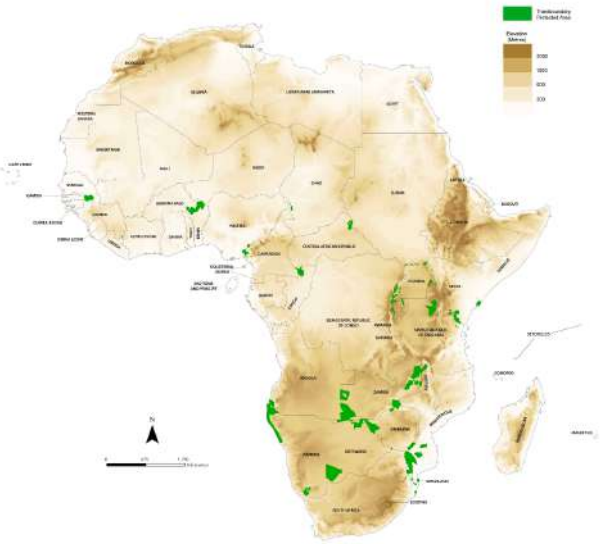
Virunga National Park in the Democratic Republic of Congo

Virunga National Park in the Democratic Republic of Congo stands as a UNESCO World Heritage Site, boasting an expansive and ecologically diverse landscape. Covering approximately 7,800 square

kilometres, the park is celebrated for its rich biodiversity, featuring a unique blend of volcanoes and lush forests. Within its bounds reside a myriad of wildlife, notably the endangered mountain gorillas, making it a critical conservation area. Established in 1925, Virunga is the oldest national park in Africa, showcasing a long history of wildlife protection and environmental stewardship. Despite facing significant challenges such as poaching and political instability, the park remains a vital sanctuary for endangered species. For those seeking a remarkable encounter with wildlife and a glimpse of awe-inspiring natural beauty, Virunga National Park stands as a prominent destination, drawing conservationists and adventurers alike.

https://virunga.org/

Here you can see a map with all the protected areas in Africa, according to UN – United Nations.



Transboundary protected natural areas in Africa (Source: UN – United Nations)

3.3.2. Asia

Asia houses an array of Protected Natural Areas, such as the Western Ghats in India, Bandhavgarh National Park, and the Kinabalu Park in Malaysia. These areas are critical for preserving unique biodiversity, including numerous endemic species and valuable ecosystems.

Western Ghats in India

Older than the Himalaya mountains, the mountain chain of the Western Ghats represents geomorphic features of immense importance with unique biophysical and ecological processes. The site's high montane forest ecosystems influence the Indian monsoon weather pattern. Moderating the tropical climate of the region, the site presents one of the best examples of the monsoon system on the planet. It also has an exceptionally high level of biological diversity and endemism and is recognized as one of the world's eight 'hottest hotspots' of biological diversity. The forests of the site include some of the best representatives of non-equatorial tropical evergreen forests anywhere and are home to at least 325 globally threatened flora, fauna, bird, amphibian, reptile and fish species.

https://whc.unesco.org/en/list/1342/gallery/

Bandhavgarh National Park

The diverse mix of habitats in Bandhavgarh supports a corresponding plentitude of fauna. Its luxuriantly rich ecosystem provides amply for everyone – from the tiny butterflies to the majestic tigers. The park has earned a worldwide reputation for tigers and their unusually high density here is a pleasant surprise for wildlife lovers.

According to bio-geographic classification, the park area lies in the zone 6A-Deccan peninsula, Central highlands. The important prey species consists of chital, sambhar, barking deer, nilgai, chinkara, wild pig, chowsingha, langur and rhesus macaque.
Dependent upon them are the major predators like tiger, leopard, wild dog, wolf and jackal. The lesser predators are fox, jungle cat, ratel, palm civet, and mongoose. Besides them, other mammalians present are sloth bear, porcupine, Indian Pangolin, variety of bats including the giant fruit bat, Indian tree shrew, and many other species of rodents. The avifauna is also well represented. More than 250 species of birds have been recorded with the park.

https://umaria.nic.in/en/tourist-place/bandhavgarh-national-park/

Kinabalu Park in Malaysia

In the heart of Sabah, Malaysian Borneo, lies Kinabalu Park—a UNESCO World Heritage Site covering 754 square kilometres and established in 1964. It boasts Mount Kinabalu (4,095.2 m), the region's tallest peak between the Himalayas and New Guinea. The slopes of Mount Kinabalu are a haven for diverse plant and animal species, making it a biodiversity hotspot. The park's unique botanical makeup is a blend of Himalayan, Chinese, Australian, Malay Peninsula, and pan-tropical flora, making it an ecological gem. A product of the Royal Society Kinabalu Scientific expedition (1962-1964), Kinabalu Park remains a testament to nature's beauty and a pioneering conservation effort in Malaysian Borneo.
Kinabalu Park, a biodiversity hotspot, houses an estimated 5,000 to 6,000 vascular plant species, constituting 14% of the Malesia phytogeographical region's flora and 2.5% of Earth's flora. Orchids (711 species), ferns (621 species), figs (78 species), and palms (81 species) are among its rich flora. The park also hosts a diverse fauna, including unique bird species like the Rhinoceros Hornbill, and an abundance of moths, butterflies, and mammals, such as Orangutans and Bornean Gibbons. A haven

for nature enthusiasts, Kinabalu Park's remarkable biodiversity paints a portrait of nature's marvel in Malaysian Borneo.

https://www.sabahparks.org.my/kinabalu-park

3.3.3. North America

North America boasts iconic Protected Natural Areas like Yellowstone National Park in the USA, Banff National Park in Canada, and El Vizcaíno Biosphere Reserve in Mexico. These areas are essential for biodiversity conservation and attract millions of visitors annually.

Yellowstone National Park in the USA

Yellowstone National Park is one of the most iconic and diverse natural areas in the United States. It covers an area of over 3,400 square miles, spanning three states: Wyoming, Montana and Idaho. The park is home to a variety of wildlife, such as bison, elk, wolves, bears and more. It also features geothermal features, such as geysers, hot springs, mud pots and fumaroles, that are powered by a massive volcanic system beneath the surface. Yellowstone was established as the first national park in the world in 1872 and has been designated as a UNESCO World Heritage Site since 1978. The park attracts millions of visitors every year, who come to enjoy its scenic beauty, recreational opportunities and cultural heritage.

https://www.nps.gov/yell/index.htm

Banff National Park in Canada

Banff National Park, nestled in the heart of the Canadian Rockies in Alberta, is a pristine and captivating natural haven, making it a significant subject for geography study. Established in 1885, it holds the distinction of being Canada's first national park and is part of a UNESCO World Heritage Site. The park spans approximately 6,641 square kilometres and is renowned for its towering mountain ranges, including the iconic Rocky Mountains. It features an array of breathtaking landscapes, from dense forests to pristine lakes and mighty glaciers.

This ecological wonderland is home to an impressive diversity of wildlife, including grizzly bears, elk, wolves, and numerous bird species. The park's unique geography is shaped by ancient glaciers and geological forces, contributing to its majestic scenery and abundant freshwater sources.

https://banffnationalpark.com/

El Vizcaíno Biosphere Reserve in Mexico

El Vizcaino, located in the central part of the Baja California peninsula, is an incredible region that showcases diverse ecosystems between the Gulf of California and the Pacific Ocean. Its remarkable value lies in its desert, mountain, and coastal/marine ecosystems, which connect two major bodies of water. This area is vital for wildlife, especially endangered species, and is a prime spot for studying fossils. The bay here is a favourite of the grey whale, and there are ancient ruins and intriguing rock art. This region is typical of the Sonora Desert, one of North America's four deserts, with its unique flora and fauna. The reserve is home to over 400 prehistoric sites, numerous plant species, and abundant wildlife, making it a key area for geographical study, showing the interconnectedness of geography, biology, and environmental science.

https://en.unesco.org/biosphere/lac/vizcaino

3.3.4. South America

South America is home to the Amazon Rainforest, Pantanal Conservation Area in Brazil, and Torres del Paine National Park in Chile, among others. These areas are rich in biodiversity, supporting diverse flora and fauna, and play a vital role in global climate regulation.

Amazon Rainforest

The Amazon Rainforest, a colossal tropical rainforest, blankets the Amazon River's basin and tributaries in northern South America, covering a staggering 2.3 million square miles (6 million square km). Representing about 40 percent of Brazil's total area, it's bordered by various geographical features like the Guiana Highlands to the north, the Andes Mountains to the west, the Brazilian central plateau to the south, and the Atlantic Ocean to the east. This expansive rainforest, known as Amazonia, stands as the world's largest river basin, stretching from the Atlantic Ocean to the Andean foothills. The lush forest hosts an astonishing array of life, including millions of insect, plant, and bird species, many yet to be discovered by science. It's a biodiversity hotspot, featuring a plethora of trees

and a rich tapestry of wildlife, from jaguars and manatees to capybaras and diverse monkey species. However, in recent decades, human settlement and deforestation have significantly impacted this vital ecosystem, emphasising the critical need for conservation and sustainable practices to protect this natural wonder.

https://www.britannica.com/place/Amazon-Rainforest

Pantanal Conservation Area in Brazil

The Pantanal, the world's largest freshwater wetland, is a stunning natural landscape nestled in southwestern Brazil, extending to southeastern Bolivia and northeastern Paraguay. Encompassing approximately 139,000 to 210,000 square kilometres, it's a mosaic of rivers, wetlands, lakes, and forests. The Pantanal is part of the vast Paraguay-Paraná-Rio Plata river system and is home to an extraordinary variety of wildlife, including diverse ecosystems and vegetation types. The region experiences cyclical flooding from October to April, transforming the landscape and providing rich nutrients to the soil. This unparalleled natural wonder showcases the intricate relationship between geography, hydrology, and ecology, offering a unique opportunity for students to study the Earth's diverse and interconnected systems.


https://www.roughguides.com/article/a-guide-to-visiting-brazils-pantanal/

Torres del Paine National Park in Chile

Torres del Paine National Park, located in southern Chile, is a breathtaking natural wonder that epitomises the diverse beauty of our planet. It encompasses a stunning 181,414 hectares of pristine wilderness, featuring iconic granite peaks, azure lakes, glaciers, and vast expanses of unspoiled landscapes. The park is renowned for the Paine Massif, a mesmerising mountain range with spires that seem to touch the sky. Students studying geography can delve into the remarkable geological formations, glacial activity, and the role of climate in shaping this awe-inspiring terrain. Torres del Paine is also a haven for biodiversity, housing unique flora and fauna, making it a vital area for ecological studies. It's a captivating destination that showcases the interconnectedness of natural systems and provides an educational window into the world's diverse geography.


https://www.travelandleisure.com/trip-ideas/nature-travel/torres-del-paine-patagonia-trek

3.3.5. Europe

We will discuss more detailed about Europe in the next chapter.

3.3.6. Antarctica

While not inhabited by humans in a traditional sense, Antarctica is home to numerous marine protected areas, crucial for conserving unique Antarctic marine biodiversity.

East Antarctic

The East Antarctic Marine Protected Area (MPA) holds significant scientific value as it designates vital reference zones to measure the natural fluctuations and enduring shifts in Antarctic marine biodiversity and ecosystems. These reference zones are crucial for sustainable fisheries management and accurately gauging the conservation needs of the region over the long term.

Within this area, critical sites are identified for prolonged monitoring of marine mammals, seabirds, the formation of Antarctic Bottom Water, and understanding the impacts of climate change on Southern Ocean ecosystems and processes in an undisturbed setting. The MPA's dimensions are based on the essential summer foraging habitats for marine mammals, Adélie and Emperor penguins, as well as other seabirds during crucial breeding periods. Furthermore, the size is dictated by its significance in monitoring large-scale ecosystem processes.

https://www.truthdig.com/articles/east-antarctic-ice-sheet-may-spell-trouble/

Weddell Sea

The Weddell Sea is a vast bay off the Antarctic coast, reaching deep into the Southern Ocean, with its centre at approximately 73° S 45° W. It's surrounded by the Antarctic Peninsula on the west, Coats Land on the east, and the Filchner and Ronne ice shelves to the south. Covering an area of about

1,080,000 square miles (2,800,000 square km), the Weddell Sea is usually heavily covered in ice, extending north to about 60° S during early summer, making early ship exploration quite challenging. The British explorer James Weddell played a significant role in its discovery in the early 19th century, reaching a farthest south position of 74°15′ S. The sea was named after him later. Subsequent explorations and expeditions contributed to the understanding of this icy region, including oceanographic explorations and mapping of its coasts. It has been a focus of research, particularly during the International Geophysical Year in the late 1950s, leading to the establishment of research bases along its coastlines. The Weddell Sea continues to be a fascinating area for scientists studying the Antarctic region and its unique geography.

https://www.worldatlas.com/seas/weddell-sea.html

3.4. Challenges and Achievements

3.4.1. Conservation Challenges

Protected Natural Areas face numerous challenges globally, including climate change impacts, habitat fragmentation, poaching, invasive species, and sustainable funding. Addressing these challenges is essential to ensure the long-term sustainability and effectiveness of these areas.

3.4.2. Notable Achievements

Despite the challenges, there have been significant successes in the establishment and management of Protected Natural Areas worldwide. The increase in the number and coverage of protected areas, successful reintroduction programs, and sustainable tourism initiatives are notable achievements in the realm of biodiversity conservation.

3.5. Conclusion

Protected Natural Areas worldwide are the embodiment of humanity's commitment to preserving the Earth's natural heritage. They are a testament to our understanding of the interdependence of life and the imperative to protect it. As we continue to navigate an increasingly human-dominated world, these protected areas offer hope and a roadmap for a sustainable and harmonious future.[3]

4. Protected Natural Areas in Europe

4.1. Introduction

In this unit, we will focus on the rich tapestry of Protected Natural Areas in Europe. The continent is known for its diverse landscapes, from the Arctic tundra to the Mediterranean coastlines, each hosting unique ecosystems and species. Exploring these protected areas will shed light on Europe's commitment to biodiversity conservation and sustainable environmental management.

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[3] IUCN. (2021). "IUCN World Database on Protected Areas." Retrieved from https://www.protectedplanet.net/
Mittermeier, R. A., et al. (2004). "Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions."

Conservation International.

Dudley, N., & Stolton, S. (2003). "Running Pure: The Importance of Forest Protected Areas to Drinking Water." World Bank, WWF.

Sala, O. E., et al. (2000). "Global biodiversity scenarios for the year 2100." Science, 287(5459), 1770-1774.

https://virunga.org/

https://www.serengeti.com/geology-sereng

https://www.okavangodelta.com/

https://whc.unesco.org/en/list/1342/gallery/

https://umaria.nic.in/en/tourist-place/bandhavgarh-national-park/

https://www.sabahparks.org.my/kinabalu-park

https://www.nps.gov/yell/index.htm

https://banffnationalpark.com/

https://en.unesco.org/biosphere/lac/vizcaino

https://www.britannica.com/place/Amazon-Rainforest

http://world-heritage-datasheets.unep-wcmc.org/datasheet/output/site/pantanal-conservation-area/

https://old.mpatlas.org/mpa/sites/68807533/

https://www.britannica.com/place/Weddell-Sea

4.2. Diversity of Protected Areas

4.2.1. National Parks

National Parks play a vital role in preserving biodiversity. They provide a safe haven for countless species, allowing for their conservation and often serving as centres for scientific research. Additionally, these parks offer opportunities for people to connect with nature, fostering a sense of appreciation and responsibility towards the environment.

Exploring Europe's National Parks is a remarkable journey that not only allows us to witness the beauty of our planet but also encourages us to become responsible stewards of our natural world. By protecting these areas, we ensure a sustainable future for all living beings.

Europe is home to a rich tapestry of natural wonders, many of which are preserved and celebrated in its various National Parks. These parks serve as havens for biodiversity, allowing a wide array of plant and animal species to flourish within their borders. Here is a list of some of the most important National Parks in Europe (of course there are so many more that you can discover).

1. ***Białowieża National Park, Poland and Belarus*** **Białowieża National Park,** shared by Poland and Belarus, is a UNESCO World Heritage Site and one of the last remaining primaeval forests in Europe. It is famed for its ancient trees, especially the towering oak and spruce trees, providing a unique habitat for a variety of species, including the European bison, deer, and wolves.

https://en.wikipedia.org/wiki/Bia%C5%82owie%C5%BCa_National_Park

2. **Sarek National Park in Sweden** is a rugged, mountainous wonderland and one of Europe's last true wildernesses. Here, glaciers, deep valleys, and jagged peaks dominate the landscape. The park is an important habitat for reindeer, wolverines, and golden eagles.

https://www.capturingthewild.be/en/2017/08/23/sarek-national-park-2/

3. **Plitvice Lakes National Park in Croatia** is a jewel of cascading lakes, waterfalls, and lush forests. Its pristine blue lakes are home to various species of fish and amphibians, and its woodlands host diverse birdlife.

https://whc.unesco.org/en/list/98/

4. **Snowdonia National Park in Wales** is a mountainous region with picturesque landscapes. It hosts a variety of habitats, from rivers and lakes to forests and grasslands, providing homes for otters, peregrine falcons, and a rich array of plant species.

https://www.tripsavvy.com/guide-to-snowdonia-national-park-1662552

5. **Aigüestortes i Estany de Sant Maurici National Park,** is situated in the heart of the Pyrenees, this Spanish park is characterised by its dramatic peaks, alpine lakes, and dense forests. It's a haven for chamois, marmots, and the golden eagle.

https://www.spain.info/en/nature/aiguestortes-national-park/

6. **Göreme National Park in Turkey** is renowned for its surreal landscapes and unique rock formations known as 'fairy chimneys'. The park is home to a variety of plants and animals, and its underground cities showcase human interaction with nature through centuries.

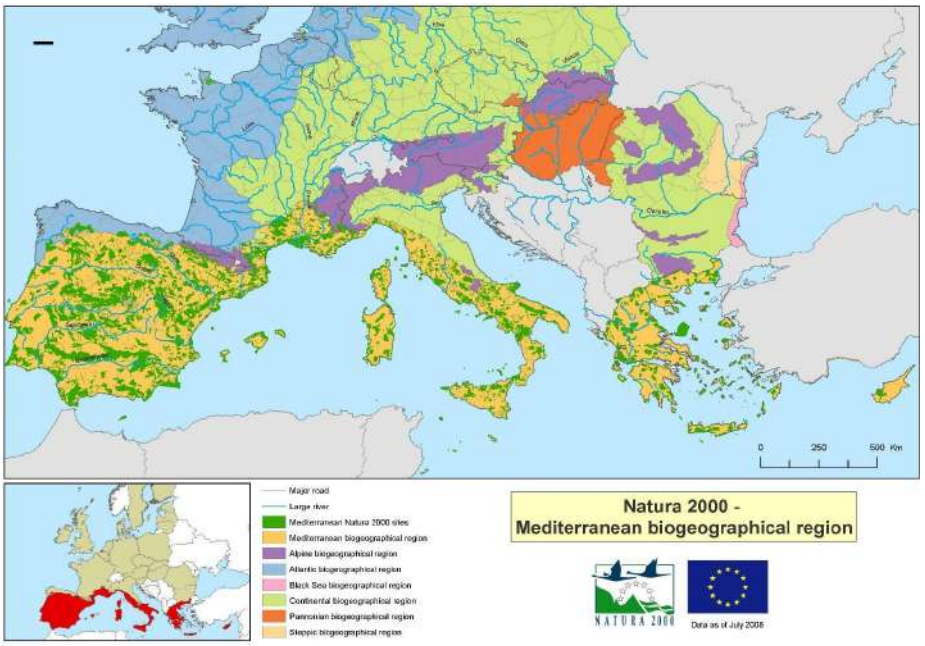
https://www.dailysabah.com/life/travel/turkeys-goreme-national-park-5th-most-popular-in-world-on-tiktok

7. **Slovenia Triglav National Park,** named after the iconic Triglav Mountain, is Slovenia's only national park. It is a realm of majestic peaks, deep valleys, and pristine rivers. The Alpine ibex, golden eagle, and brown bear find sanctuary here.

https://national-parks.org/slovenia/triglav

4.2.2. Natura 2000 Network

The Natura 2000 network is a network of key sites, both on land and at sea, that spans across all 27 EU countries and is the largest organised network of protected areas in the world. It aims to protect areas considered essential for selected species of flora and fauna or habitat types among those listed in both the European Birds Directive (79/409/EEC, as amended by Directive 2009/147/EC) and the European Habitats Directive (92/43/EEC). These include species and habitats that are considered to be of European importance because they are threatened with extinction, are vulnerable, rare or endemic, or are excellent examples of typical features of one or more of Europe's nine biogeographical regions. The whole of Greece is included in the Mediterranean biogeographical region.



https://ec.europa.eu/environment/nature/

Natura 2000 network sites include different types of ecosystems such as terrestrial, lagoon and marine ecosystems. An ecosystem can include one or more habitats and usually hosts a diverse community of plants and animals.

While the network includes strictly protected areas, to a large extent it is not a system of strict nature reserves from which all human activities are excluded. The approach to the conservation and sustainable use of Natura 2000 sites is much broader and focuses heavily on people who work with nature rather than at its expense. However, Member States must ensure that sites are managed in a sustainable way, both ecologically and economically.

The Natura 2000 network numbers more than 27.000 sites covering a total area of approximately 1.150.000 square kilometres of land and sea in all EU Member States. The total area covered by the Natura 2000 network represents about 18% of the total EU land area and 8% of its marine territory

4.2.3. UNESCO Biosphere Reserves

Europe hosts a significant number of UNESCO Biosphere Reserves, integrating biodiversity conservation with sustainable development. These reserves, like the Galloway and Southern Ayrshire Biosphere in Scotland, demonstrate the harmonious coexistence of humans and nature.

4.3. Biodiversity Hotspots

4.3.1. The Mediterranean Basin

The Mediterranean Basin, spanning Southern Europe, North Africa, and Western Asia, is a biodiversity hotspot due to its varied ecosystems and unique flora and fauna. With over 25,000 plant species and numerous endemic animals, it's a crucial area for global biodiversity. However, human activities threaten this rich biodiversity through habitat destruction, climate change, and pollution. Conservation efforts are vital to protect this region's unique ecosystems and the essential services they provide, ensuring a sustainable future for all. Protected areas like the Sierra Nevada National Park in Spain play a pivotal role in conserving this unique biodiversity.

https://www.turgranada.es/en/fichas/national-and-natural-park-of-sierra-nevada-15198/

4.3.2. The Carpathians

The Carpathian Mountains, often referred to as the Carpathians, sprawl across Central and Eastern Europe, captivating all with their sheer expanse and natural marvels. These mountain ranges transcend being merely geographical wonders; they stand as bastions of extraordinary biodiversity. Let's delve into this astonishing biodiversity within the Carpathians and understand why this region is pivotal for our planet's ecological tapestry.

The Carpathians are renowned for their diverse array of ecosystems, from ancient forests and alpine meadows to pristine rivers and expansive wetlands. Within each of these ecosystems lies a distinctive habitat, nurturing a diverse range of plant and animal species, each finely tuned to the specific environmental conditions.

Inhabiting the Carpathian Mountains is a stunning variety of flora and fauna. The forests are inhabited by captivating species like the European bison, lynx, brown bear, and grey wolf, while a rich tapestry of plant life, including diverse tree species like beech, spruce, fir, and pine, graces these slopes.

These mountains are acknowledged as a biodiversity hotspot due to their substantial biodiversity and the pressing threats they face. This designation underscores the abundance of species and emphasises the urgent need for conservation efforts to shield them from human-induced threats such as habitat destruction, climate change, pollution, and illegal logging.

Preserving the Carpathians' biodiversity necessitates concerted conservation initiatives. Collaborations involving various organisations, governments, and local communities are working tirelessly to establish protected areas, restore degraded habitats, and increase awareness about the significance of preserving the region's unique ecosystems. National parks, nature reserves, and conservation programs are pivotal in ensuring the long-term survival of the Carpathians' biodiversity.

Biodiversity stands as a linchpin for our planet's well-being and all its inhabitants. The Carpathians, with their opulent biodiversity, contribute to vital ecosystem services encompassing soil health, water purification, carbon sequestration, and tourism revenue. Safeguarding biodiversity guarantees a sustainable future, providing essential resources and upholding a thriving environment for generations to come.

https://www.worldatlas.com/mountains/carpathian-mountains.html

4.4. Conservation Challenges

4.4.1. Human Pressure and Land Use Change

Europe's densely populated regions often face intense human pressure, leading to habitat loss and fragmentation. Striking a balance between conservation and development remains a persistent challenge.

4.4.2. Climate Change

Climate change poses a severe threat to Europe's biodiversity, affecting species distribution, phenology, and ecosystem functioning. Protected areas need adaptive strategies to mitigate these impacts.

4.5. Best Practice and Success Story

Oostvaardersplassen Nature Reserve, Netherlands

Oostvaardersplassen Nature Reserve in the Netherlands stands as a beacon of success in protected natural areas, showcasing a remarkable model of ecological restoration and wildlife management. Originally a polder—a low-lying tract of land enclosed by dikes—Oostvaardersplassen has been transformed from a human-engineered landscape into a thriving wetland ecosystem over the decades, offering invaluable lessons in conservation and ecological regeneration.

The creation of Oostvaardersplassen in the 1960s was, in essence, an unintentional act of conservation. As the polder was left to naturally evolve without human interference, a remarkable transformation began to unfold. The area transitioned from barren, man-made land into a complex mosaic of wetlands, reed beds, grasslands, and water bodies, attracting an array of plant and animal species.

One of the most significant aspects of Oostvaardersplassen is its ability to support a high density and diversity of wildlife. The reserve is home to a plethora of species, including large herbivores like red deer, Konik horses, and Heck cattle. These herbivores play a vital role in shaping the landscape through their grazing activities, thereby promoting plant diversity and habitat heterogeneity.

The reserve employs a hands-off management approach, allowing natural processes to dictate the ecosystem's development. This minimal intervention strategy has been pivotal in fostering a self-regulating, balanced ecosystem. However, the reserve does incorporate adaptive management practices to maintain ecological stability and prevent population overshoots that could lead to animal welfare issues.

Additionally, Oostvaardersplassen has become a living laboratory for researchers and scientists, enabling in-depth studies on wildlife behaviour, population dynamics, and ecosystem functioning. The knowledge gained from this reserve has informed conservation strategies worldwide.

Furthermore, Oostvaardersplassen has successfully integrated ecotourism and public engagement. Visitors have the opportunity to observe wildlife in their natural habitat, fostering a greater appreciation for the natural world and the importance of conservation.

In summary, Oostvaardersplassen Nature Reserve embodies a success story in protected natural areas by demonstrating the transformative power of allowing nature to reclaim and restore landscapes. Its hands-off management approach, support of diverse wildlife, research contributions, and engagement

with the public collectively make it a shining example of effective conservation and ecological restoration.

https://www.istockphoto.com/photos/oostvaardersplassen

4.6. Conclusion

Protected Natural Areas in Europe are a testament to the continent's dedication to biodiversity conservation and sustainable environmental management. They not only preserve the natural beauty but also contribute to scientific research, education, and a harmonious relationship between humans and nature.[4]

[4]European Environment Agency. (2021). **"State of nature in the EU"**. Retrieved from https://www.eea.europa.eu/themes/biodiversity/state-of-nature-in-the-eu

European Commission. (2021). **"Natura 2000 Barometer."** Retrieved from https://ec.europa.eu/environment/nature/natura2000/barometer/index_en.htm

UNESCO. (2021). **"Biosphere Reserves in Europe."** Retrieved from https://en.unesco.org/biosphere/europa

Eurosite. (2021). **"Rewilding in Europe: Creating space for natural processes."** Retrieved from https://www.eurosite.org/publications/rewilding-in-europe-creating-space-for-natural-processes/

5. Protected Natural Areas in Greece

5.1. Introduction

In this unit, we will delve into the captivating world of Protected Natural Areas in Greece. The country, with its diverse landscapes and rich biodiversity, hosts a plethora of protected areas. These areas are not only vital for conservation but also offer a glimpse into Greece's natural heritage.

The National System of Protected Areas is comprised of all areas that are subject to a protection regime with the aim of effectively protecting biodiversity and other ecological values.

The different categories of protected areas were initially defined in art. 19 of Law No. 1650/1986 “On the Protection of the Environment”. Following successive amendments, PA categories now include:

5.2. National Parks

Large natural or semi-natural areas, either terrestrial, marine or mixed in nature, wherein large-scale ecological functions take place. They encompass typical species and natural habitats of EU and Greek interest which demand protection and conservation. National parks may be named based on their geographical characteristics and/or according to their historical or administrative identity. They may include two or more Natura 2000 sites and/or biodiversity conservation areas, particularly if they incorporate a wide range of ecosystem functions with common spatial, natural and/or abiotic characteristics.

5.2.1. Parnassos National Park

The responsibility area of Parnassos National Park’s Management Body lies within the territorial limits of Boeotia, Phocis and Fthiotida Prefectures, as well as Livadia, Amfikleia - Elateia, Delphi – Amfissa and Distomo - Arachova - Antikyra Municipalities. The human presence in the region is very important, dating back to 1500 BC. Today there are 18 settlements in the wider area whose inhabitants are engaged in agriculture, livestock, manufacturing, mining and tourism.

Parnassos Mt. consists of spectacular cliffs and rocky areas. Its geology is mostly hard limestones (76.6%). Limestone forms particularly impressive karst on Parnassus; some formations are nationally known, such as the Sinkhole of Lilaia and the Corycian Cave.

The climate is humid, with an average annual precipitation of 1468,2 mm at an altitude of 1300 meters. Winters are particularly harsh and long lasting, while summers are cool. Despite rainfall's intensity, surface runoff is low, due to the prevalence of permeable limestone, which justifies the large number of springs.

Parnassos is a complex ecosystem, with a wide variety of landscapes and habitats, resulting to a rich and rare biodiversity. The protected area is characterised by a large number of special scientific importance and significance plant taxa. There have been reported 854 taxa, 6 of which (*Centaurea musarum, Hieracium gaudryi, Eryssimum parnassi, Euphorbia orphanidis, Bupleurum capillare, Campanula ripicula*) are endemic, while, a large number are stenoendemic (endemic to Central Greece, Greece etc). Several species in the area are assigned to different risk categories according to WCMC, P.D.67/1981 , UNEP, RDB and the Berne Convention.

https://www.shinygreece.com/post/parnassos-mountain-arachova

There are three type of areas found on Parnassos, according to its vegetation:

- Low vegetation above the treeline, reaching up to the top of the mountain (Liakoura 2,457 m), consisting of shrubs, phryganic and herbaceous species.
- Arboreal vegetation, including forests of *Abies cephalonica*, *Pinus nigra* and deciduous oaks. This zone is located at an altitude of 600 reaching up to1800m, and
- Shrubby vegetation, which includes the plant formations, met below the previous zone down to the foot of Parnassos. *Quercus coccifera*, *Quercus ilex* and *Pistaccia lentiscus* are characteristic species of this zone.

Regarding the fauna of Parnassos, there are 5 species of mammals, 2 amphibians, 2 reptiles and 2 invertebrate species recorded and listed (Directive 92/43, Annex II) 38 species of birds (Directive 79/409, Annex I) and 68 additional bird species protected by international treaties. In addition, at least seven species of mammals are protected by Greek law, and several vertebrate species included in the Red Data Book of Threatened Vertebrates of Greece.

Other protected areas established within the responsibility area of Parnassos NPMB are:

- the Aesthetic Forest “Dasos Tithoreas” (PD Gov. 125/D/1979),
- the Wildlife Refuge " Asprochoma - Fine - Prontoli – Arachova” (Gov. 1043/V/1976),
- the breeding ground for prey "Amfikleia" (GG 406/V/76)

Last but not least, regardless its natural - ecological value, Parnassos is a place of enormous cultural - historical heritage, i.e. the Sanctuary of Apollo and the Oracle of Delphi. In addition, the great cultural - historical value of the area is enhanced by the ancient and modern monuments, as well as the rich history of the region.

5.2.2. Olympus National Park

Olympus, the highest mountain in Greece (the highest peak is 2,918 m. above sea level), rises on the border of Macedonia and Thessaly, between the provinces of Pieria and Larissa. Owing to its specific microclimate, which is partly due to the short distance from the sea and the steep increase in height above sea level, it stands out for its great diversity in terrain, climate and vegetation.

The shape of the massif and the majestic peaks, covered in fog and low-hanging clouds, which often bring storms, in conjunction with its diverse and changeable natural beauty, have always induced awe and admiration. In this eerie landscape, the ancient Greeks placed the residence of the Twelve Gods of

Olympus (with Zeus at their head), the Muses and the Graces. There, according to Hesiod, Zeus fought Cronus and the Titans and, after winning, settled there and became lord of all the gods, demigods and humans. The myths and traditions collected by Homer and Hesiod were passed on throughout the ancient Greek and Roman world, making Olympus the epicentre of ancient Greek mythology and a symbol of Greek civilization.


https://olympusfd.gr/en/vegetation-zones

Owing to its outstanding natural beauty, Olympus was the first area in Greece for which a special protection scheme was implemented, with its proclamation as a National Forest in 1938.

The forest itself features an anarchic succession of vegetation. As the altitude increases, the vegetation of Olympus, and particularly its distribution, presents many peculiarities. Thus, while in the neighbouring mountains of Pieria, Titaros, and Ossa there is a clear sequence of vegetation zones, on Olympus one witnesses an anarchy in zone succession due to its great variety of microclimates, which are due to the bedrock, slope, altitude above sea level, steep gradients and general terrain.

Generally speaking, there are four discernible zones of vegetation. The first, ranging from 300 to 500m, is comprised of evergreen sclerophyllous vegetation and includes shrubs and low trees such as holm oak (*Quercus ilex*), Greek strawberry tree (*Arbutus adrachne*), Kermes oak (*Quercus coccifera*), and prickly juniper (*Juniperus oxycedrus*). There are also certain characteristic deciduous species such as manna ash (*Fraxinus ornus*), smoke tree (*Cotinus coggyria*), Montpellier maple (*Acer monspessulanum*), Judas tree (*Cercis siliquastrum*), turpentine tree (*Pistacia terebinthus*) and others.

From 600 to 1400m, which is the zone of beech-fir and montane conifers, we come across black pine (*Pinus nigra var. pallasiana*) in unmixed and compact stands, or in mixed stands with beech (*Fagus sylvatica*). Beech forms small clusters, unmixed or mixed with fir, Bosnian pine or black pine, and occupies the richer and wetter soils. In small clusters and scrubs we encounter Macedonian fir (*Abies borissi-regis*), oriental hornbeam (*Carpinus orientalis*), wych elm (*Ulmus glabra*), common hazel (*Coryllus avellana*), dogwood (*Cornus mas*), yew (*Taxus baccata*), as well as a significant variety of herbaceous plants. In the gorges and ravines are found oriental plane trees (*Platanus orientalis*) and willows (*Salix eleagnos*).

From 1400 to 2500 meters the zone of boreal conifers emerges, dominated primarily by Bosnian pine (*Pinus heldreichii*), a rare species of pine, which makes its appearance at an altitude of around 1,100 meters. Gradually replacing black pine, it forms unmixed stands up to nearly 2,000 meters. The areas where Bosnian pine grows are usually dry with rocky slopes. The vegetation that grows in the region is adapted to specific local conditions and is represented by characteristic shrubs, grasses, chasmophytes, etc., while the flora includes many endemic Balkan species.

Above 2,500 meters, the highest treeline in the Balkans, we no longer find forests but a variety of sub-alpine ecosystems of low-growing vegetation with many rare wildflowers, most of which are endemic to Olympus, Greece or the Balkans.

5.2.3. Vikos-Aoos National Park

Vikos-Aoos Geopark encompasses the entire area of 3 Natura 2000 sites (Vikos – Aoos National Park, Timfi mt and Central Zagori) and a significant part of three additional Natura 2000 sites {Smolikas mt, Mitsikeli mt and Douskon / Meropi (Nemertsika) mt}.

Moreover, almost the entire area of the Vikos-Aoos Geopark is located in the Northern Pindos National Park, which is the largest mainland protected area in Greece, covering an area of 2.000 km^2. It was established in 2005 after the union of two pre-existing smaller National Parks, Vikos-Aoos National Park and Pindos (Valia Calda) National Park.

The Northern Pindos National Park consists of four distinct zones of graded protection. Among the most important zones are the Nature Protection areas and the Habitat and Species Conservation Zone, which both encompass most of the Vikos-Aoos Geopark surface.

Vikos-Aoos Geopark includes five distinct types of characteristic ecosystems, clearly distinguished by the dominant vegetation. At lower altitudes (375 m to 700 m) we encounter ecosystems of evergreen sclerophyllous shrubs and then oak forest ecosystems (700 m – 1.000 m).

In the mid altitudes (1.000 m to 1.600 m) there are coniferous and beech forests while at high altitudes (1.600 m to 2.000 m) there are bosnian pine forests and at even higher altitudes (2.000 m to 2.637 m) subalpine and alpine meadows.

These ecosystems are quite often spread over relatively large areas or form mixed sets, creating the impression of a complex mosaic where individual sections can be distinguished by the particular leaf color of the different trees.

However, beyond these five major ecosystems, there are also others which occupy smaller areas, such as rocky slopes, gorges and vertical cliffs of high mountains, as well as aquatic ecosystems (lakes, rivers) and riparian vegetation ecosystems. There are also “anthropogenic ecosystems”, which are decisively shaped by human impact as is the case of Konitsa plain.

All these ecosystems host remarkable numbers of wild fauna and flora species, the number and variety of which depends largely on their particular ecological requirements. In the wider area of the Geopark more than 1.700 plant species and subspecies have been found, while wildlife is equally rich as the wider area’s ecosystems host around 250 species of vertebrates and numerous invertebrate species.

https://vikosaoosgeopark.com

5.3. Marine Protected Areas

In Greece, less than 5% of the total marine and coastal area is under protection, while only 0.08% of these properly implement conservation and management measures (UNEP-WCMC, 2023). Here are some of them:

5.3.1. National Marine Park of Zakynthos

Zakynthos' Marine Park is located along the southern coast from the promontory of Marathia's Cape to the beach of Gerakas, including the outback of the beaches of Limni Kerì, Laganas and Kalamaki and the Strofades, two small islands 50 nautical miles southern of Zakynthos.

This area presents the main characteristics of the Mediterranean ecosystem, with sandy beaches, emerging rocks and sandy dunes, whereas in the outback there are thick pinewoods, fertile areas for agriculture and the Mediterranean landscape with spontaneous vegetation.

The Seals Monachus MonachusNational Marine Park was founded in 1999 with the main purpose of defending the particular fauna of the southern part of the island and of its integration with the local society.

The most important animal specimens to protect are the turtles Caretta-Caretta and the Mediterranean Seals Monachus-Monachus.

https://www.zanteisland.com/en

In addition to turtles and seals the park intends to protect also other animal specimen:

- **Birds**: the southern gulf of Zakynthos and the Strofades are usually visited by migrating birds, wild swans, swallows, kingfishers, and seagulls.
- **Reptiles and amphibians**: there are many frogs, tortoises, iguanas and soft water snakes.
- **Mammals**: in the outback there are many porcupines and wild rabbits, whereas in the park waters it is possible to meet dolphins with the "bottle muzzle" or Tursiops Truncatus.

5.3.2. Alonnisos Marine Park

The National Marine Park of Alonissos Northern Sporades was the first marine area of Greece that was characterised as a "Marine Park" and the largest in the Mediterranean. It was enacted by Presidential Decree (Government Gazette 519 / D '/ 1992) which was updated with the J.M.D. 23537/2003 (Government Gazette 621 / D'/ 2003). The purpose of the creation of the "National Marine Park" was the protection, conservation and management of nature and landscape, as a natural heritage and valuable national natural resource, due to its great biological, ecological, aesthetic, scientific, geomorphological and pedagogical value. In addition to the many rare species of flora, fauna and natural formations, in the Sporades area live and reproduce a significant population of the Mediterranean seal , a species that has been defined as the number 1 endangered marine mammal.

https://www.discovergreece.com/el/experiences/exploring-natures-gifts-marine-park-alonissos

5.4. Special Protection Areas (SPAs) and Natura 2000 Sites

Biodiversity Conservation Areas

Terrestrial, aquatic, marine or mixed type, natural or semi-natural areas with a recorded presence of natural habitat types and species of international, EU importance and/or Greek interest that require protection and conservation. All national sites belonging to the Natura 2000 Network are included in this category.

Protected Landscapes and Natural Formations

Functional elements of nature or individual formations (eg. points or areas of interest), which have special ecological, geological or geomorphological value or which contribute to the preservation of natural processes and the protection of natural resources. They may include trees, tree and shrub stands, protective marine vegetation, riparian and coastal vegetation, hedges, waterfalls, springs, gorges, dunes, reefs, caves, rocks, fossils, paleontological finds, coral formations and geotopes. Protected natural formations with a monumental nature are specifically designated as Protected Natural Monuments. Individual areas within National Parks, Biodiversity Conservation Areas and/or Wildlife Refuges can be characterised as Protected Natural Formations and can be included in the scalable protection zoning of these areas.

5.4.1. Lake Kerkini

In the north-west part of Serres Prefecture, just 40 Km from the town of Serres and about 100 Km from Thessaloniki, we can meet one of the most beautiful places in Greece, **Lake Kerkini**. Its unique wetland has been declared as National Park according to Ramsar Convention and it is one out of ten wetlands of International Importance of Greece.

The man's intervention caused the formation of this heaven. In 1932 the first dam was constructed in the waters of river Strymonas and gradually lake Kerkini took shape. You can read here about **Lake Kerkini's** History.

The riparian plantations consisting of riparian forests of wild willows, the suspended water-lilies expanded in a surface of thousands hectares, the fish high diversity, the buffalos swimming in lake's calm water and the great mountainous areas of Belles and Krousia give a unique grace to this land.

https://kerkini.gr/?lang=en

The lake offers the ideal conditions for bird watching. It is one of the best places in Europe for natural watching of about 300 rare and protected bird species that live and breed here. It is no coincidence that many scientists and amateurs from around the world visit us every year for their research.

5.4.2. Mount Taygetus Natura 2000 Site

Two thousand four hundred and seven vertical meters come between the seaside village of Kardamili and Profitis Ilias peak, the summit of Taygetos, the roof of the Peloponnese. This is no ordinary mountain. West Mani is blessed with a landscape so diverse that can keep you busy for a lifetime exploring it. Mountain forests and meadows, steep slopes and rocky ecosystems, early wildflowers and the strong scent of the herbs will fill your heart and senses with pure joy. Hiking, mountain biking, trekking and climbing at the mountains' hillsides or gorges, are just some of the many options you have!

Taygetos is the highest mountain range in the Peloponnese with its peak (Profitis Ilias) reaching an altitude of 2,407 meters. It is a unique environment of tremendous natural value that has been designated as a 'Special Protection Zone' at European level (officially GR2550009 'Mount Taygetos-Lagada Tripis'). Taygetos is a mountain young in age that is still developing, rising each

year by one centimeter; therefore, we do not know which will be its height over the centuries and which generation will see it taller than other mountains.

The name is one of the oldest recorded in Europe, appearing in the Odyssey. In classical mythology, it was associated with the nymph Taygete. This is also the classical Mount Taleton mentioned by Pausanias, in the second century AD and the peak was dedicated to Helios, the Sun and Zeus. Taygetus overlooks the cities of Sparti and Kalamata, whose skyline it dominates.

Golden eagle, king eagle, eagle hawk and pheasant eagle are perhaps the most well-known of the 32 protected bird species that together with endemic flora and reptile species compose the unique mosaic of Taygetos biodiversity.

Researchers have recorded, according to the latest calculations, more from 6.500 types of plants in Greece, among which 1.150 are not found elsewhere in the world. Compared to its surface, Greece has the richest flora in Europe. The 2.500 types have been recorded in the mountains of Peloponnese. In Taygetos the big alternation of biotopes has as a result the flourishing of 600 types of plants (without having completed the recording yet), among which more than 120 are Greek endemic plants, that is to say they grow in Taygetos and at least in one more Greek mountain.

https://www.2407m.com/taygetos-mountain/

Thirty-two (32) of these are mountain endemic, that is to say unique in the world. This rich flora proves the uniqueness of the mountain and of the region, while the flora is rich in aromatic plants (oregano, mint, thyme, tea, lavender, etc).

5.5. Challenges and Conservation Efforts

5.5.1. Over-Tourism and Infrastructure Development

The increase in tourism poses a challenge to many of these protected areas, necessitating sustainable tourism practices and effective visitor management strategies.

5.5.2. Land Use Changes and Urbanization

Urban expansion and agricultural activities are leading to habitat loss and fragmentation, emphasising the need for stringent land-use planning and conservation initiatives.

5.6. Conclusion

Protected Natural Areas in Greece stand as a testament to the nation's dedication to environmental conservation. They are not only critical for safeguarding biodiversity but also offer immense educational and recreational value.[5]

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[5] Ministry of Environment and Energy, Greece. (2021). **"Protected Areas."** Retrieved from https://www.ypeka.gr/en/natura2000/sites
Management Agency of Parnassos National Park. (2021). **"Parnassos National Park."** Retrieved from https://www.parnassosnp.gr/en/
Olympus National Park. (2021). **"Welcome to Olympus National Park."** Retrieved from https://olympusfd.gr/en/olympus-national-park/
Management Agency of Vikos-Aoos National Park. (2021). **"Vikos-Aoos National Park."** Retrieved from https://www.pindosnationalpark.gr/en/
National Marine Park of Zakynthos. (2021). **"About the Park."** Retrieved from https://www.nmp-zak.org/en/about-the-park/
Alonnisos Marine Park. (2021). **"Introduction."** Retrieved from https://alonissos-park.gr/en/
Management Body of Kerkini Lake National Park. (2021). **"Lake Kerkini."** Retrieved from https://www.kerkini.gr/en/
Greek Biotope/Wetland Centre. (2021). **"Greek Wetlands."** Retrieved from https://www.ekby.gr/en/projects/inland-aquatic-ecosystems/greek-wetlands.html

6. Practical Implementation Cases – Student Activities

6.1. Introduction

In this unit, we present a range of engaging and educational activities designed for secondary school teachers to implement in their classrooms. These activities aim to provide students with hands-on experiences and foster a deeper understanding of Protected Natural Areas, biodiversity, and conservation efforts.

6.2. Activities

Activity 1: Virtual Nature Tour

Objective

- Introduce students to various Protected Natural Areas worldwide using virtual tours.

Instructions

1. **Research and Selection**: Assign students different continents and have them research and select a Protected Natural Area from that continent.
2. Virtual Tour Creation: Using online tools or virtual tour platforms, have students create a virtual tour of their selected area, showcasing its biodiversity, unique features, and conservation efforts.
3. Presentation: Students present their virtual tours to the class, highlighting the importance of the area and the need for its protection.

Activity 2: Habitat Diorama

Objective

- Help students visualise and understand the diversity of habitats within a Protected Natural Area.

Instructions

1. **Selection of Protected Area**: Divide the students into groups and assign each group a different Protected Natural Area.
2. **Research and Diorama Creation**: Each group researches their designated area's habitat, flora, fauna, and geological features. They then create a diorama representing the habitat.
3. **Presentation**: Students present their dioramas to the class, explaining the habitat's characteristics and the species that inhabit it.

Activity 3: Biodiversity Scavenger Hunt

Objective

- Increase students' awareness of biodiversity by exploring and identifying various species within a local ecosystem.

Instructions

1. **Ecosystem Selection**: Select a local ecosystem such as a park, forest, or wetland.
2. **Biodiversity List**: Provide students with a list of species (plants, insects, birds, etc.) they may encounter in the chosen ecosystem.
3. **Field Trip and Scavenger Hunt**: Organise a field trip to the chosen ecosystem. Students, in groups, use the list to identify and document the species they observe.
4. **Data Analysis and Reflection**: Back in the classroom, students analyse the data, discuss their findings, and reflect on the importance of biodiversity.

Activity 4: Conservation Awareness Campaign

Objective

- Encourage students to raise awareness about conservation issues and the importance of Protected Natural Areas.

Instructions

1. **Issue Identification**: Guide students in identifying a specific conservation issue related to a Protected Natural Area (e.g., deforestation, pollution, habitat loss).

2. **Awareness Materials**: In groups, students design posters, infographics, or short videos to inform others about the issue, its impact, and how individuals can contribute to conservation.
3. **Awareness Campaign**: Display the created materials within the school premises or share them through school communication channels to educate the school community and beyond.

Activity 5: Citizen Science Project

Objective

- Involve students in citizen science initiatives to contribute real data for biodiversity monitoring.

Instructions

1. **Project Selection**: Choose a citizen science project focused on biodiversity monitoring (e.g., bird watching, plant identification, water quality testing).
2. **Participation and Data Collection**: Guide students in participating in the chosen project, either during a field trip or within their local community. They collect relevant data following the project guidelines.
3. **Data Analysis and Report**: Assist students in analysing the collected data and creating a report summarising their findings, emphasising the importance of citizen science in biodiversity conservation.

Activity 6: Eco-Debate

Objective

- Enhance critical thinking and communication skills by engaging students in a structured debate on conservation topics.

Instructions

1. **Topic Selection**: Choose conservation topics related to Protected Natural Areas (e.g., hunting in conservation areas, ecotourism impact, etc.).

2. **Team Formation**: Divide the class into teams, with each team assigned a specific stance on the topic.
3. **Research and Preparation**: Teams research their assigned stance, gather supporting evidence, and prepare arguments for the debate.
4. **Debate**: Conduct the debate, allowing each team to present their arguments and counter-arguments in a respectful and structured manner.
5. **Reflection**: After the debate, facilitate a discussion where students reflect on the arguments presented and their own perspectives.

Activity 7: Wildlife Photography Contest

Objective

- Encourage appreciation for biodiversity and wildlife by organising a photography contest.

Instructions

1. **Theme Selection**: Set a theme related to wildlife or nature (e.g., native species, habitats, biodiversity).
2. **Photography Session**: Allow students to explore nearby natural areas and capture photographs based on the chosen theme.
3. **Photo Submission and Evaluation**: Have students submit their best photographs. Organise a contest where the class votes on the most compelling and impactful photos.
4. **Exhibition and Discussion**: Display the winning photos in the classroom and host a discussion about the beauty and importance of the captured subjects.

Activity 8: Ecological Footprint Analysis

Objective

- Raise awareness about individual impact on the environment and the significance of sustainable practices.

Instructions

1. **Introduction to Ecological Footprint**: Educate students about the concept of ecological footprint and its relevance to conservation.
2. **Personal Ecological Footprint Calculation**: Guide students to calculate their ecological footprints using online calculators or worksheets.
3. **Analysis and Action Plan**: Students analyse their ecological footprints, identify areas for improvement, and create a personal action plan to reduce their footprint.
4. **Class Discussion**: Engage in a class discussion where students share their action plans and strategies to minimise their ecological footprint.

Activity 9: Nature Journaling

Objective

- Cultivate observation skills and a deeper connection to nature by keeping a nature journal.

Instructions

1. **Journal Creation**: Provide students with journals or ask them to create their own. Explain the purpose and components of a nature journal.
2. **Outdoor Observation**: Organise outdoor trips to natural areas where students can observe and document their observations, including sketches, descriptions, and reflections.
3. **Journal Sharing**: Allocate time for students to share their journal entries and discuss the diverse observations made during the outdoor trips.

Activity 10: Green School Initiative

Objective

- Empower students to lead conservation efforts within the school community.

Instructions

1. **Team Formation**: Divide interested students into groups, each responsible for a specific conservation initiative (e.g., waste reduction, energy conservation, tree planting).
2. **Planning and Implementation**: Guide each group in planning and implementing their initiative within the school premises, involving the school community.

3. **Awareness Campaign**: Encourage the groups to create awareness materials and campaigns to inform students and staff about their initiatives and how others can contribute.
4. **Progress Evaluation**: Monitor the progress of each initiative and celebrate achievements. Discuss challenges faced and strategies for improvement.

6.3. Conclusion

These activities provide valuable opportunities for students to actively engage with the concept of Protected Natural Areas, biodiversity, and conservation. Implementing such hands-on activities enriches their learning experience and nurtures a sense of responsibility towards the environment.

7. References

Activity 1: Virtual Nature Tour

1. National Park Service. (2021). **"Virtual Tours."** Retrieved from https://www.nps.gov/subjects/nature/virtual-tours.htm
2. Google Arts & Culture. (2021). **"Explore museums and play with Art Transfer, Pocket Galleries, Art Selfie, and more."** Retrieved from https://artsandculture.google.com/project/national-parks

Activity 2: Habitat Diorama

1. Gilbert, B. K. (2016). **"Creating a Habitat Diorama."** Sciencing. Retrieved from https://sciencing.com/creating-habitat-diorama-10047009.html
2. Exploring Nature Educational Resource. (2021). **"Diorama and Habitat Materials and Tips."** Retrieved from https://www.exploringnature.org/db/view/Diorama-and-Habitat-Materials-and-Tips

Activity 3: Biodiversity Scavenger Hunt

1. National Geographic Education. (2021). **"BioBlitz Field Trip Lesson Plan."** Retrieved from https://www.nationalgeographic.org/activity/bioblitz-field-trip/
2. Project Learning Tree. (2021). **"BioFinder: Outdoor Exploration and Scavenger Hunt."** Retrieved from https://www.plt.org/activities/biofinder-outdoor-exploration-and-scavenger-hunt/

Activity 4: Conservation Awareness Campaign

1. World Wildlife Fund. (2021). **"Education for Sustainable Development Toolkit."** Retrieved from https://www.worldwildlife.org/teaching-resources/toolkits/education-for-sustainable-development-toolkit
2. Green Schools National Network. (2021). **"Green Schools Resources."** Retrieved from https://greenschoolsnationalnetwork.org/resources/

Activity 5: Citizen Science Project

1. Citizen Science Association. (2021). **"Getting Started with Citizen Science."** Retrieved from https://citizenscience.org/get-involved/
2. iNaturalist. (2021). **"iNaturalist: A Community for Naturalists."** Retrieved from https://www.inaturalist.org/

Activity 6: Eco-Debate
1. IDEA - International Debate Education Association. (2021). **"IDEA Resources."** Retrieved from https://idebate.org/resources
2. National Speech & Debate Association. (2021). **"Public Forum Debate Resources."** Retrieved from https://www.speechanddebate.org/topics/

Activity 7: Wildlife Photography Contest
1. National Geographic. (2021). **"National Geographic Photography Contests."** Retrieved from https://www.nationalgeographic.com/photography/photo-contest/
2. BBC Wildlife Magazine. (2021). **"Wildlife Photography Masterclass: Top Tips from the Experts."** Retrieved from https://www.discoverwildlife.com/how-to/masterclass/

Activity 8: Ecological Footprint Analysis
1. Global Footprint Network. (2021). **"Ecological Footprint Calculator."** Retrieved from https://www.footprintcalculator.org/
2. Wackernagel, M., & Rees, W. (1996). **"Our Ecological Footprint: Reducing Human Impact on the Earth."** New Society Publishers.

Activity 9: Nature Journaling
1. Laws, J. M., & Laws, E. (2016). **"The Laws Guide to Nature Drawing and Journaling."** Heyday Books.
2. Cornell Lab of Ornithology. (2021). **"Keeping a Nature Journal."** Retrieved from https://www.birds.cornell.edu/k12/lets-go-birding/activities/keeping-a-nature-journal/

Activity 10: Green School Initiative
1. National Wildlife Federation. (2021). **"Eco-Schools USA: Greening Your School."** Retrieved from https://www.nwf.org/Eco-Schools-USA
2. The Center for Green Schools. (2021). **"Green Schools Initiative."** Retrieved from https://centerforgreenschools.org/initiative/green-schools

04

Urban parks and forests

Module by CNME

LEAF - Learn biodiversity through Environmental Action
For the community
ERASMUS+ 2022-1-RO01-KA220-SCH-000086884

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Table of Contents, Module 4:

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IV. Urban Parks and forests

CHAPTER I – GENERAL PRESENTATION OF THE TOPIC AND THEORETICAL ASPECTS

1.1. Introduction

This chapter aims to highlight a number of concepts, typologies and roles of urban forests and parks and their meanings from different perspectives.

The dominant form of urban settlement for the coming decades and rapid urbanisation will bring with it great challenges in terms of balancing the modern world, meeting people's needs and caring for the environment. Cities of the future will have to meet the demands of development without compromising the quality of the environment and the ability of future generations to prosper. One of the solutions available to today's society is the existence of forests and urban parks, whose wise management can help solve many environmental or health problems of the population.

The 2030 Agenda for Sustainable Development proposed at the UN level in 2015, through the 17 Sustainable Development Goals (SDGs) as a global action programme undertaken by the signatory states, promotes sustainable development by achieving a balance between the environment, economy and society[73]. The contribution of forests and urban parks, in relation to the 2030 Agenda and its goals, brings to the forefront the Sustainable Development Goal on Sustainable Cities and Communities (SDG 11) the roles of forests and urban parks can be linked to the achievement of the other SDGs as well, due to their complex relevance in achieving sustainable development. The conditions for cities and urban communities to respond to the challenges of today's society and development, i.e. to be "open to all", to have "smart city" status, to contribute to safety, resilience or access to quality services, to put the health of the environment and the population first, can only be met by taking into account the quality of life which is in direct proportion to the existence of a quality environment, which cannot be guaranteed without forests and urban parks[74] (annex no 1).

[73] https://dezvoltaredurabila.gov.ro/web/obiective/odd11/
[74] https://www.euractiv.ro/we-develop/ce-reprezinta-cele-17-obiective-de-dezvoltare-durabila-odd-incluse-pe-agenda-2030-6402

1.2. Defining the terminology

1.2.1. Urban forest

The concept of an **urban forest** described in many literature reviews usually refers to a forest in the vicinity of an urban environment. According to FAO (Food and Agriculture Organization of the United Nations) **urban forests** are "systems comprising forests, trees and groups of trees, located in urban and peri-urban areas", acting as the "backbone" of the "urban green infrastructure".[75]

Originally developed in North America and large European cities, the term **urban forest** differs from **the urban park** in that it has greater biodiversity and a special ecosystem functionality. In addition, **the urban forest** is also characterised by the fact that some of the ecosystems present here, are part of a natural forest heritage, therefore cores of inherited tree vegetation[76]. **Urban forests** located in or on the outskirts of towns and cities include, in principle, tree species, herbaceous plants, faunal elements specific to forest-type ecosystems, but unlike **urban parks**, they often do not have special facilities for the population (paths, well-established boundaries, facilities, etc.)[4].

Some authors mention the existence of several components of an urban forest, such as: natural areas (corresponding to natural forests in the vicinity of the city), privately owned trees (usually corresponding to residential neighbourhoods), street tree lines, park trees (the urban park).[77](*annex no.2*)[78]

.Although the concept of **urban forest** refers to the totality of trees and forest areas in or around urban areas, some authors point out that the definition of the term urban forest, which differs from one country to another, leads to a "difficult operationalisation of the concept and to a connection between urban forest and classical forest"[7].

Across the European continent there are different understandings of the terms urban forestry and urban forest[79]. Here are some of the definitions accepted in some European countries, mentioned

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[75] https://www.fao.org/documents/card/en/c/e068e0d9-0c97-41c7-a856-05556a1bd10b (*Guidelines on urban and peri-urban forestry, FAO Forestry Paper-Nr.178* (F. Salbitano, S. Borelli, M. Conigliaro and Y. Chen, 2016, Roma), FAO (Food and Agriculture Organization of the United Nations)

[76] https://en.wikipedia.org/wiki/Urban_forest

[77] https://www.uforest.eu/wp-content/uploads/2022/12/Uforest_report-3.4_ROM_final.pdf *Harnessing the potential of urban forests. Developing a local action plan for urban forestry* (Juliet Achieng Owuor, Ian Whitehead and Rik De Vreese - European Forestry Institute, 2022)

[78] https://parkboardmeetings.vancouver.ca/files/STRATEGY-UrbanForestStrategy-20180430.pdf (*City of Vancouver and Vancouver Park Board. 2018. Urban Forest Strategy: 2018 Update*. 60 pp.)

[79] http://quickurbanforest.eu/sites/default/files/documentos/konijnendijk202003_a20decade20of20uf20in20europe.pdf (*A decade of urban forestry in Europe*, Forest Policy & Economics, FOREST POLICY AND ECONOMICS · JULY 2003, Cecil Konijnendijk)

by Cecil Konijnendijk, 2003[7]: Finland (urban forests are defined as forests located in or near an urban area where the main function is recreation and they do not include artificial parks); Greece (the term urban forest includes parks, gardens, forests near cities and street trees); Germany (the urban forest corresponds largely to artificial forests on various terrains).

In conclusion, in contrast to other concepts referring to urban green spaces, the urban forest, which focuses on forest and trees, can be defined as "**the totality of trees and other forest vegetation in and around urban areas**". (Owuor, J.A., Whitehead, I. and De Vreese, R., 2022, *Unlocking the Potential of Urban Forests: Developing a Local Urban Forestry Plan. Erasmus+ Project Uforest Deliverable 3.4.*)[5]**.**

In connection with the term urban forest, it is significant to bring to attention the term **urban forestry**, which generally refers to the management and care of urban forests.

Under a different understanding, urban forestry is defined as "the art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic and aesthetic benefits that trees provide to society." (Cecil C. Konijnendijk, Robert M. Ricard, Andy Kenney , Thomas B. Randrup, 2006)[80].

The concept of urban forestry formally emerged in North America**Error! Bookmark not defined.** and has developed rapidly over the years and is now much more complex, taking into account interdisciplinarity in urban forest management actions. Although there are differences, at least between North America and Europe, in the meanings of urban forestry, the multifaceted perspective of the approach leads to many ways in which urban forest management and administration actions can be carried out internationally.

1.2.2. Urban Park

Parks are natural, semi-natural or man-made areas with multiple purposes (recreation, protection of the natural environment and habitats, conservation of biodiversity, etc.) comprising vegetation, buildings, special-purpose land under different forms of ownership, and structurally, active recreation areas and passive recreation areas[81]. The structural variety of **urban parks**, which includes

[80] https://www.sciencedirect.com/science/article/abs/pii/S1618866705000464 (*Defining urban forestry-A comparative perspective of North America and Europe,* Cecil C. Konijnendijk a, Robert M. Ricard b, Andy Kenney c, Thomas B. Randrup, 2006)

[81] https://en.wikipedia.org/wiki/Park

different components (forests, green spaces, street trees and shrubs, gardens, lakeside amenities, sports areas, etc.), is determined by the local particularities imposed by the natural and socio-economic framework. **Urban parks** serve cities and include areas of natural, historical or cultural significance, and their facilities are necessary to meet the needs of the urban community[82].

The urban park is an essential component of urban green spaces with numerous recreational, social, health-promoting and urban environmental quality functions. (Kevin Lynch, Byrne and Sipe, 2010, Rahmanov and collab., 2019, apud Kurt Konakoğlu and collab., 2021)[83]. Urban parks as "open spaces" are accessible to all residents (Dharmawan and Rachmanıyah, 2020, apud Kurt Konakoğlu and collab., 2021)[11] their role in the complexity of the urban ecosystem being "strategic in improving the quality of the urban life" (Fasihi, 2019, apud Kurt Konakoğlu and collab, 2021)[11].

Some authors define **urban parks** as "defined areas of open space, mostly dominated by vegetation and water and generally reserved for public use." (Cecil C. Konijnendijk, Matilda Annerstedt, Anders Busse Nielsen, Sreetheran Maruthaveeran, 2013)[84].

Another approach in defining the concept of **urban park** emphasises the perspective towards urban development. In this sense, **the urban park** is defined as "a landscape entity within the urban system, a functional element, a cultural factor and an eco-spatial element with a role in sustaining natural habitats"[85].

In terms of area, urban parks are usually referred to by the authorities and the population as "parks". Regardless of the name given to this type of urban green space and the differences at global or regional level (park, garden, metropolitan park, neighbourhood park, municipal park, etc.) incorporated into urban architecture, their role as recreational oases in the urban environment remains essential.

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[82] http://www.ijstr.org/final-print/nov2015/A-Brief-Review-On-Urban-Park-History-Classification-And-Function.pdf (Mohammad Mehdi Sadeghian, Zhirayr Vardanyan, INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 4, ISSUE 11, NOVEMBER 2015)

[83] https://www.researchgate.net/publication/348891351_A_Research_on_the_Usage_Reasons_of_Urban_Parks_A_Case_Study_of_Amasya_Courthouse_Urban_Park (*A Research on the Usage Reasons of Urban Parks: A Case Study of Amasya Courthouse Urban Park*- Kurt Konakoğlu et al., 2021)

[84] https://www.researchgate.net/publication/267330243_Benefits_of_Urban_Parks_A_systematic_review_-_A_Report_for_IFPRA

[85] https://dokumen.tips/download/link/breviar-curs-parcul-urban.html (conf.dr.arh. Angelica Stan-Urban park-from concept to project. Course support)

1.3. Urban Forests and Parks Typology

1.3.1. Types of urban forests

FAO in *Guidelines on urban and peri-urban forestry, FAO Forestry Paper-Nr.178* (F. Salbitano, S. Borelli, M. Conigliaro and Y. Chen, 2016), classifies the urban forests in five categories [3]:

- *Peri-urban forests and woodlands* - forests and woodlands around towns and cities that can provide goods and services such as timber, fiber, fruit, other non-timber forest products, clean water, recreation and tourism);
- *City parks and urban forests*- forests and parks larger than 0.5 ha with a variety of land cover, recreational and leisure facilities;
- -*Pocket parks and gardens with trees*– parks smaller than 0.5 ha with facilities for recreation, leisure, private gardens and green spaces;
- *Trees on streets or in public squares*- linear street tree alignments, small groups of trees and isolated trees in squares, car parks and streets, etc.
- *Other green spaces with trees*– urban farmland, sports fields, waste land, lawns, river banks, open fields, cemeteries and botanical gardens".

Among the many classifications of urban forests, we mention the one referring to their relationship and relations with primary natural vegetation, the typology in this case being as follows[86]: *urban forests as remnants of preserved natural woodland (*these have often been redeveloped, as in the case of one of the largest parks in Brussels, Bois de la Cambre, laid out in English style and with numerous facilities for recreation and relaxation)[87]; *ancient forests present before urban growth* (such as the Bois de Vincennes in Paris or the Bois de Boulogne in Lille, France, which is part of Le parc de la Citadelle, notable for its public amenities and facilities, including a nearby zoo, a real place of learning, education and awareness of biodiversity protection)[88]; *replanted or artificially created forest areas* such as urban gardens; *peri-urban forests* (located on the margins of urban areas, such as the

[86] https://ro.frwiki.wiki/wiki/For%C3%AAt_urbaine
[87] https://www.visit.brussels/en/visitors/venue-details.The-Bois-de-la-Cambre.230548
[88] https://www.lilletourism.com/parc-de-la-citadelle.html

Forêt de Soignes - a remnant of old forest in the south-eastern part of Brussels, mainly composed of beech trees -80% from plantations or natural regeneration)[89].

Another classification of urban forests, perhaps specific to France in particular, according to their age, extent, structure and composition, includes the types mentioned below [90].

- *Relict forest meadows*. This type represents forest areas ranging in size from a few hectares to hundreds of hectares, preserved in the central part of the city or on its outskirts; some of these have undergone anthropogenic changes, such as Boulogne (846 ha) and Bois de Vincennes (995 ha) in Paris; other such forest types are protected and preserved as part of the heritage, such as the forest of Neuhof-Illkirch. (945 ha) to the south of the Strasbourg urban congestion, classified as a National Nature Reserve, Natura 2000 site, with a remarkable presence of mainly forest and water areas of different typology [91].
- *Linear woody plantations* (street alignments of trees of different sizes, whether or not accompanied by buildings, alignments of trees or forests accompanying rivers running through towns).
- *Land cover plantations*, *more or less extensive and dense*. This category includes urban recreational parks (Montsouris Park in Paris) or wooded areas in cemeteries, large squares or car parks.
- *Dense wooded micropopulations*. These are plantations on small areas (tens to hundreds of thousands of m²), usually found in city squares.
- *Individual trees and groups of trees* (trees with a particular identity due to age, history or species).
- *Wooded areas*. These correspond to the results of natural, spontaneous colonisation and recolonisation by invasive or exotic species on abandoned areas of varying sizes.

Serge Muller(2022)[18] stated that all the above types can complement each other in terms of the ecological benefits they offer, but that urban forests should include native species because they are better able to adapt to environmental conditions.

[89] https://ro.frwiki.wiki/wiki/For%C3%AAt_de_Soignes
[90] https://www.lagazettedescommunes.com/821144/de-quoi-se-compose-exactement-la-foret-urbaine/
[91] https://www.grand-est.developpement-durable.gouv.fr/67-massif-forestier-de-strasbourg-neuhof-illkirch-a18081.html

1.3.2. Types of urban parks

There are regional differences in the types of urban parks around the world. They are today a result of the evolution of green spaces over time, in response to the changing needs of urban environments and urban populations.

In the USA, the following are mentioned as **types of urban parks** in terms of their evolution over time[92]:

- *Town Squares* (city squares, "city green" - these evolved with the development of the city; initially they had the main role of recreation and city events venues and were located around important city institutions);

-*City and Cultural Parks* – represent an evolution of green spaces such as 'rural' parks on the outskirts of towns; initially they were intended to reproduce rural environments and included meadows, woodland areas, water features and paths; later they were structurally enriched by facilities to meet the social and cultural needs of the inhabitants (zoos, gardens, museums, theatres, etc.) and were transformed into what are now called *cultural parks*.

- *Neighborhood Parks*– emerged at the end of the 19th century, out of the need to shorten the distance travelled to "rural" parks on the outskirts of cities; they were part of the idea of "airing out" the city, playing a significant role in maintaining the health of the population and acting as the "lungs" of cities (in Minneapolis, it was considered that "no resident should be more than six blocks from a public park").
- *Pocket Park* - according to NRPA (National Recreation and Park Association) a pocket park is a smaller outdoor space of 0.25 acres - 3 acres (1 acre equals 4046 m²) but with a high degree of accessibility and diverse functions;
- *Neighbourhood park* - typically 3-10 acres and has daily uses, offering a wide range of recreational and community activities;
- *Community Park* - ranges in size from 10 to 30-100 acres, and serves the local community, being accessible to several neighbourhoods and providing a variety of recreation and leisure opportunities;

[92] https://dp.la/exhibitions/urban-parks/types-parks/town-squares

- *District Park* - ranges in size from 30 to 150 acres and is accessible to a larger population, with multiple amenities of this type;
- *Regional Park* - is larger than 100 acres and has a wide variety of infrastructure (camping, education, water features, nature reserves, etc.).
- *Special Use Park/Facilities* (spaces that do not fit into a typical park classification) include: historical/cultural/social sites, performance parks, exhibition gardens, theatres, churches and amphitheatres, golf courses, etc.
- *Green centers/multi-use trails* - are intended to provide connections between neighbourhoods and parks. Another complex classification of urban parks, taking into account many criteria, brings to the foreground their great diversity: monument parks, central parks, elongated parks, private parks, garden parks, etc [13] (*annex no.3*).

1.4. The Role and Benefits of the urban forests and parks

Numerous studies, articles and scholarly papers mention the multiple benefits of green spaces in general and urban forests and parks in particular as central structural elements of urban space, supported by scientific evidence and a wealth of research.

The functions of urban forests and urban parks can also be brought to the foreground by direct reference to the natural forest: *anti-erosion* (they reduce the risk for soil erosion, landslides, due to too much rain landslides and other slope processes), *climatic* (role of natural filters purifying the air, reducing high temperatures in cities, producing oxygen, reducing noise pollution), *hydrological* (they contribute to increasing atmospheric humidity and have a role in reducing surface runoff and supplying groundwater, streams and plants), *biological and biodiversity* (living environment, they conserve biodiversity and have positive effects on human health), *social* (they promote social integration and reduce stress), *educational* (they constitute educational environments in themselves as outdoor laboratories), *scientific* (they provide important subjects for scientific analysis), *economic* (they provide resources and increase the value of land), *aesthetic and landscape* (they increase the aesthetic value of space).

The roles and benefits of urban forests can be grouped into three major areas [5]: *social* (they promote socialisation, they create a positive perception of the urban environment, they contribute to improving the health of the population, they facilitate movement, reduce violence and crime and have an aesthetic and landscaping role), *ecological* (they offset locally and directly certain CO2 emissions, produce oxygen and store carbon, reduce the risk of natural hazards-floods, landslides and storms, increase air quality and reduce city temperature, contribute to biodiversity conservation, reduce pollutants and noise pollution), *economic* (contribute to increase the value of nearby land, facilitate economic growth by providing new jobs, offer specific goods and products, contribute to increase income, offer shopping opportunities in a pleasant environment).

To these areas it is necessary to add the scientific value that urban forests have, in terms of the possibility of carrying out studies with multiple implications (human health, ecosystem relations, landscape value, climatic role, social role, etc.).

From a *benefits* perspective (promoting well-being), some authors (Cecil C. Konijnendijk, Matilda Annerstedt, Anders Busse Nielsen, Sreetheran Maruthaveeran, 2013)[93] mention the following categories in relation to **urban parks**: promotion of human and social well-being (beneficial impact on human health, opportunities for recreation and leisure, benefits to social relations, etc.), promotion of tourism (contributions to the local economy, promotion of tourists' well-being), preservation of biodiversity (urban parks are a living environment, play a role in promoting biodiversity and maintaining ecosystem relations), positive climate impact (reducing pollution, maintaining optimal temperatures).

Other authors mention, in relation to urban development, the roles of urban parks based on aspects concerning the ecological balance, the morphological-typological balance of the city, the restructuring of marginal areas, landscape recreation, spatial harmonisation. The functions of urban parks take into account the health of the population (health function), the socio-cultural needs of the population (social function, cultural function), landscape and representational aspects (representation function) or ecological and protective elements (preservation/protection function).[13]

On the benefits of **urban forests**, FAO (*Guidelines on urban and peri-urban forestry, FAO Forestry Paper-Nr.178, 2016*)[3] mentions their variety in nature or importance, taking into account the

[93] https://worldurbanparks.org/images/Newsletters/IfpraBenefitsOfUrbanParks.pdf (*Benefits of Urban Parks A systematic review* A Report for IFPRA By Cecil C. Konijnendijk Matilda Annerstedt Anders Busse Nielsen Sreetheran Maruthaveeran, 2013)

particularities given by the location of the urban forest, the degree of economic development of the states, the social or environmental characteristics of human communities. Otherwise, the economic function, through the need for wood, may be more representative for less economically developed countries, and the recreational function more relevant and important for cities in developed countries[3].

Irrespective of the consideration of the typology of functions or aspects of differentiation of their importance, the contribution of urban forests to the achievement of the Sustainable Development Goals is relevant from the perspective of environmental sustainability, development sustainability and biodiversity conservation (*anex no. 4*)[3].

CHAPTER II.
THE INTERNATIONAL AND NATIONAL CONTEXT VERSUS THE LOCAL REALITY CONTEXT

2.1. Parks in Europe

The history of parks in Europe goes back centuries, with various factors influencing their development and evolution. Here is a brief overview of the history of parks in Europe:

Medieval hunting parks: In the Middle Ages, Europe's parks originally served as hunting grounds for the aristocratic class. Various enclosed areas of land were set aside for hunting, often surrounded by walls or fences to ensure the exclusivity of the hunting activity. These parks were usually located near castles or manor houses and were considered a symbol of wealth and social status.

Renaissance gardens: During the Renaissance, gardens became synonymous with parks in Europe. Influenced by Italian garden design, Renaissance gardens were notable for their geometric layouts, symmetrical designs, various ornaments and water features such as fountains and ponds. They were designed to reflect human creativity and mastery of nature, often incorporating sculptures, French-style carved shrubs (topiary art) and geometric patterns.

A unique example of landscape gardening are *English gardens and parks*: in the 18th century, the concept of landscape gardening gained popularity in Europe, especially in England. Inspired by the naturalistic style, landscape gardens aimed to create a harmonious blend of natural and man-made design elements. These parks created spectacular landscapes, undulating lawns, winding paths with

picturesque features such as lakes, bridges and ornamental buildings. English parks, such as Hyde Park in London, have become accessible spaces for public recreation and social activities.

Today, urban parks and public spaces are commonplace: increasing industrialisation and urbanisation in the 19th century led to the creation of public parks in European cities. These parks served as green spaces in urban areas, providing residents with recreational functions and opportunities and a respite from the crowded and polluted urban environment. Examples include Berlin's Tiergarten, Paris' Bois de Boulogne and Amsterdam's Vondelpark.

National parks and conservation areas can now be found: The concept of national parks emerged in the late 19th and early 20th centuries in Europe, influenced by the conservation movement. National parks were established to protect and preserve significant natural and cultural landscapes. One of the oldest national parks in Europe is Plitvice Lakes National Park in Croatia, established in 1949. Today, there are numerous national parks across Europe, such as the Peak District National Park in the UK and Triglav National Park in Slovenia.

Parks including UNESCO World Heritage sites: In recent decades, many European parks and gardens have gained recognition as UNESCO World Heritage sites. These sites are considered to be of outstanding universal value and are intended to protect the functionality of ecosystems for future generations. Examples include the Versailles Gardens in France, the Royal Botanic Gardens in Kew, UK and the Wachau Cultural Landscape in Austria.

Throughout history, the purpose and design of Europe's parks have evolved from exclusive hunting grounds to public spaces for recreation, conservation and cultural appreciation. Today, Europe's parks serve as 'green lungs' with essential functions in urban environments, as well as protected areas that preserve the continent's natural and cultural heritage.

These are just a few examples of the many beautiful parks found throughout Europe. Each Park has its own unique features and attractions, making Europe a paradise for nature lovers and outdoor enthusiasts.

2.2. Representative parks in Europe

Europe is home to many beautiful parks and nature reserves. Here are some notable parks located in different countries across Europe:

2.2.1. Plitviče Lakes National Park

Is a famous national park located in Croatia. It is one of the oldest and largest national parks in the country and has been designated a UNESCO World Heritage Site. The Park is famous for its breathtaking natural beauty, pristine lakes, lush waterfalls and forests, and distinctive karst formations.

Here are some key features and information about Plitviče Lakes National Park:

- Location: Plitviče Lakes National Park is located in central Croatia, near the border with Bosnia and Herzegovina. It is located halfway between the capital Zagreb and Zadar on the Adriatic coast.
- Geography: The natural wonders of this park are generated by its karst system, which includes 16 interconnected terraced lakes. There are also underground and surface streams connected by a series of waterfalls. The lakes are famous for their vivid turquoise colour, which is the result of the unique combination of limestone, minerals and micro-organisms in the water.
- Waterfalls: Plitviče Lakes National Park boasts a large number of waterfalls, the most famous being Veliki Slap (Great Waterfall), Galovački Buk and Milanovac. These waterfalls offer stunning views and are a major attraction for visitors.
- Wooden walkways: To preserve the park's delicate ecosystem, a network of wooden walkways and boardwalks has been built to allow visitors to explore the park without damaging the natural environment. These walkways take you over lakes and offer close-up views of waterfalls.
- Flora and Fauna: Plitviče Lakes National Park is home to various species of plants and animals. The forests around the lakes are populated by various wildlife, including brown bears, wolves, deer, wild boar and many species of birds. The park's clear lakes also support a rich aquatic ecosystem.
- Activities: Visitors to the park can enjoy a range of activities, such as hiking along the many trails that crisscross the park, boating on the lakes or simply diving into the tranquil natural surroundings. Swimming in the lakes is generally not allowed to protect the environment.

- Visitor facilities: Plitviče Lakes National Park offers well-maintained visitor facilities including information centres, parking areas, restaurants and accommodation options. Guided tours and maps are available.

Plitviče Lakes System (photo source: https://np-plitvicka-jezera.hr/en/)

2.2.2. Lake District National Park

Is a picturesque and popular national park located in the north-west region of the United Kingdom. The Lake District National Park offers a captivating mix of natural beauty, outdoor activities, cultural heritage and a tranquil lakeside reflection setting. It is known for its stunning landscapes, serene lakes, towering mountains and charming villages.

Let's explore some key features and information about the Lake District National Park:

- Location: The Lake District National Park is located in Cumbria in the north west of the UK. It is approximately 90 miles north-west of Manchester and 90 miles south-west of Newcastle.
- Natural beauty is expressed in the unique landscape. The Park is renowned for its breathtaking scenery, which includes picturesque lakes, rolling hills, intensely fragmented mountains and wooded valleys. It is home to England's highest peak, Scafell Pike, as well as several other notable mountains such as Helvellyn and Skiddaw.
- The geography of the area includes lakes as a dominant feature: As the name suggests, the Lake District is famous for its stunning lakes. The Park is home to sixteen major lakes, including Windermere, Ullswater, Derwentwater and Coniston Water. These lakes offer opportunities for boating, kayaking, fishing and scenic cruises.

- Other morphological components are mountains and columns: The Lake District has a wide range of very old, intensely fragmented mountains that attract outdoor enthusiasts and hikers from around the world. The rugged peaks offer diverse hiking trails, including the popular Wainwright Walks, where visitors can enjoy panoramic views of the surrounding countryside.
- Wildlife: The Park is home to a variety of wildlife including red deer, roe deer, red squirrels and a variety of bird species such as peregrine falcons, golden eagles and ospreys. It also has several nature reserves that are crucial for the conservation of rare and endangered species.
- Outdoor activities: The Lake District National Park offers many outdoor activities for visitors to enjoy. As well as hiking and water-based activities, visitors can engage in cycling, climbing, horse riding and even paragliding. The park's diverse terrain offers opportunities for all levels of adventure.
- Cultural aspects: the Lake District has strong literary associations, particularly with the famous poet William Wordsworth and other Romantic poets. Wordsworth's former home, Dove Cottage, and his burial place in Grasmere are popular attractions for literary enthusiasts.
- Villages and towns: the Lake District is dotted with charming villages and towns such as Ambleside, Keswick, Bowness-on-Windermere and Grasmere. These picturesque settlements offer a range of accommodation options, quaint pubs, tea rooms and local shops.
- Visitor centres and facilities: The National Park has several visitor centres, such as the Keswick Information Centre and the Bowness Bay Information Centre, where visitors can obtain maps, guides and information about park attractions and activities. There is also ample parking, picnic areas and visitor facilities throughout the park.
- Cultural heritage is expressed through the geographical cultural landscape: the Lake District has a rich cultural heritage, with historic houses, castles and gardens to explore. Beatrix Potter's Hill Top Farm, Dalemain Mansion and Muncaster Castle are among the area's notable cultural attractions.

2.2.3. Cinque Terre National Park, Italy:

Located along the Italian Riviera, this park comprises five colourful coastal villages and offers breathtaking views of the Mediterranean Sea.

Cinque Terre National Park is a UNESCO World Heritage Site and a popular destination for its stunning coastal scenery, vibrant villages and opportunities for outdoor activities. Whether you choose to hike along the trails, relax on the beaches or indulge in the local cuisine, Cinque Terre offers an unforgettable experience.

Cinque Terre National Park is a picturesque national park located in the Liguria region of Italy. It is known for its rugged coastline, colourful cliff top villages, terraced vineyards and scenic hiking trails. Let's explore some key features and information about Cinque Terre National Park:

- Location: Cinque Terre National Park is located along the Italian Riviera on the north-west coast of Italy. It covers a stretch of about 18 kilometres between the towns of Levanto and La Spezia.
- Geography - Coastal geomorphology is imprinted in the seascape: the national park is famous for its five picturesque villages: Monterosso al Mare, Vernazza, Corniglia, Manarola and Riomaggiore. These hive-like Mediterranean villages are characterised by colourful buildings, narrow streets and beautiful harbours. Each village has its own unique charm and is worth exploring.
- Scenic coastal trails: Cinque Terre National Park offers a network of scenic hiking trails linking the five villages and offering breathtaking views of the coast. The most famous trail is the Sentiero Azzurro (Blue Trail), which winds along the cliffs and offers stunning views of the sea and villages. Other popular trails include the Via dell'Amore (Path of Love) and the Sentiero Alto (High Path).
- Vineyards and terraced landscapes: the national park is known for its terraced landscapes, where there are vineyards and plantations. The terraces are a testament to the region's centuries-old farming practices. Visitors can enjoy the scenic beauty of these terraced landscapes while exploring the hiking trails.
- Mediterranean flora and fauna: Cinque Terre National Park is home to a rich variety of flora and fauna. The park's vegetation includes various Mediterranean shrubs, especially pine and olive trees. Wildlife such as birds, reptiles and small mammals can also be found in the park.

- Marine Protected Area: The coastal waters of Cinque Terre are part of the Cinque Terre Marine Protected Area. This designation aims to preserve marine biodiversity and ensure the sustainable use of marine resources. Snorkelling and scuba diving are popular activities for exploring underwater ecosystems.
- Local cuisine: The region is famous for its delicious seafood and Ligurian cuisine. Visitors can enjoy fresh seafood dishes, pesto sauce, focaccia bread and local wines while enjoying the coastal atmosphere of the villages.
- Train and boat connections: Cinque Terre is well connected by trains running along the coast, making it easily accessible for visitors. In addition, boats operate between villages, providing a scenic and convenient way to explore the coastline.
- Visitor facilities: The villages of Cinque Terre National Park offer visitor facilities such as accommodation, restaurants, cafes and shops. The Park also has visitor centres where you can get information, maps and assistance in planning visits.

Sentiero Monterosso – Vernazza (photo source: https://www.parconazionale5terre.it/)

2.2.4. Saxon Switzerland National Park, Germany:

Located near the border with the Czech Republic, this park features unique sandstone formations, gorges and the stunning Bastei Bridge.

The Saxon Switzerland National Park, also known as the Sächsische Schweiz National Park, is a picturesque national park located in eastern Germany near the Czech border. It is famous for its unique

geological formations on sandstone rocks, deep river valleys and stunning landscapes. Here are some key facts about the Saxon Switzerland National Park:

- Location: The Saxon Switzerland National Park is located in the state of Saxony in eastern Germany. It covers an area of about 93 square kilometres and is located about 30 kilometres southeast of Dresden.
- Geography - a geological complex developed on sandstone: The Park is famous for its stunning landforms carved on sandstone rock, shaped by millions of years of erosion. These formations include towering cliffs, rock pillars, natural arches and steep cliffs, creating a dramatic and unique landscape. Another morphological element is the Elbe River Valley: The Elbe River flows through the heart of the Saxon Switzerland National Park, carving deep river valleys and adding to the picturesque beauty of the region. The Elbe River valley offers stunning views and it is a popular spot for boat cruises and scenic walks.
- Podul Bastei: One of the most iconic landmarks in the landscape of this park is the Bastei Bridge. This sandstone bridge spans a deep ravine and offers panoramic views of the surrounding rock formations and the River Elbe. It is a popular destination for visitors and photographers.
- Hiking and outdoor activities: the Saxon Switzerland National Park is a paradise for outdoor enthusiasts. The Park offers an extensive network of hiking trails catering for all levels of experience. From walks to challenging, high difficulty hikes, visitors can explore the park's natural wonders, including the famous Malerweg (Painter's Path), which is a long-distance hiking trail that winds through the park.
- Mountaineering: The sandstone cliffs in the national park offer excellent opportunities for rock climbing. Experienced climbers from all over the world visit Saxon Switzerland to tackle challenging routes and enjoy the breathtaking views from the summit.
- Flora and Fauna: The Park is home to diverse flora and fauna. The forests in the park are predominantly mixed deciduous forests, including beech, oak and pine. Wildlife such as red deer, wild boar, lynx and various bird species are found in the park.
- Accessibility: The Saxon Switzerland National Park is easily accessible by public transport, with regular train connections from Dresden and other nearby cities. The Park also has designated

parking areas for visitors arriving by car. Once in the park, there are various access points and parking areas for trails and a specific tourist infrastructure.

- Visitor centres and facilities: The Park has visitor centres where visitors can get information, maps and directions for exploring the area. There are also picnic areas, restrooms and designated campsites in the park. Some surrounding towns, such as Bad Schandau and Rathen, offer accommodation, restaurants and other facilities for visitors.

The Saxon Switzerland National Park is a haven for nature lovers, hikers, mountaineers and those who want to immerse themselves in stunning natural landscapes. Unique rock formations, tranquilriver valleys and diverse outdoor activities make this a must-visit destination in Germany.

The Saxon Switzerland National Park (photo source: https://www.passports.top)

2.2.5. Krka National Park

Is a national park located in Croatia, known for its stunning waterfalls, scenic landscapes and rich biodiversity. It is named after the Krka River, which flows through the park, creating a series of waterfalls and gorges on the rugged terrain. Here are some key facts about Krka National Park:

- Location: Krka National Park is located in the center of Dalmatia, a mountainous area of the Šibenik-Knin region of Croatia. It is located about 10 kilometers northeast of the town of Šibenik.

- Geography -Cascades and Floors: The Park is famous for its magnificent waterfalls and floors. The most famous and impressive waterfall in the park is the Skradinski Buk system, a series of waterfalls with a total drop of 46 metres. Other notable waterfalls are Roški Slap and Manojlovački Slap. These waterfalls create a picturesque landscape and offer excellent opportunities for photography and sightseeing.

  Krka River: The Krka River is a beautiful river flowing through the national park, surrounded by lush vegetation and steep cliffs. It is known for its clear turquoise waters and is a popular spot for swimming and boating.

  Visovac Island: In Krka National Park, there is a small island called Visovac. The island is home to a Franciscan monastery and a church dating back to the 15th century. Visitors can take boat trips to the island and explore its cultural and historical significance.
- Wildlife and biodiversity: Krka National Park is home to diverse flora and fauna. The park's forests, meadows and wetlands provide habitats for numerous species of birds, fish, amphibians, reptiles and mammals. It is particularly known for the large number of bird species, over 200, recorded in the park.
- Hiking and walking trails: The national park offers a network of trails and wooden paths that allow visitors to explore the natural beauty of the park. These trails provide access to viewpoints, waterfalls and scenic spots throughout the park. The most popular trail is the educational trail near Skradinski Buk, which provides information about the ecology and cultural heritage of the park.
- Cultural and historical sites: In addition to its natural beauty, Krka National Park also has cultural and historical sites. The Park contains several old water mills, including the renovated Krka Monastery, where visitors can learn about traditional milling techniques. There are also archaeological sites and ruins that offer insights into the region's history.
- Accessibility and visitor facilities: Krka National Park is easily accessible by road and public transport from nearby towns such as Šibenik and Split. The Park offers visitor facilities including parking areas, information centres, restaurants and picnic sites. Boat tours and guided excursions are available for a more in-depth experience of the park.
- Krka National Park offers a captivating mix of natural beauty, waterfalls, but also a foray into Croatian cultural heritage and opportunities for outdoor activities. Whether you want to explore

the park's trails, swim in the crystal-clear waters or simply enjoy the tranquil surroundings, Krka National Park offers an unforgettable experience in the heart of Croatia.

Krka Waterfall System (photo source: https://www.npkrka.hr/hr/)

2.2.6. Vatnajökull National Park, Iceland:

It is the largest national park in Europe, covering an area of about 14,000 square kilometres and featuring glaciers, volcanoes and breathtaking landscapes.

Vatnajökull National Park is a magnificent national park in Iceland, famous for its glacial landscape, rugged mountain terrain, volcanoes and diverse ecosystems. It is the largest national park in Europe in terms of area, covering about 14% of Iceland's total area. Here are some key facts about Vatnajökull National Park:

- Location: Vatnajökull National Park is located in the southeastern part of Iceland and spans several regions, including Austurland, Suðurland and Höfuðborgarsvæðið. It includes a significant portion of the Vatnajökull glacier, which is by volume the largest ice cap in Europe.
- Geography - Glaciers and ice caves: The Park is famous for its stunning glaciers, including the Vatnajökull Glacier, which covers an area of about 8,100 square kilometres. These glaciers offer fascinating landscapes with ice formations, deep crevasses and ice caves. Visitors can explore the ice caves during the winter months, marvelling at the unique blue ice and intricate ice formations.

The Vatnajökull glacier system is a breathtaking natural wonder in the park. It is home to several difluence glaciers, such as Svínafellsjökull and Breiðamerkurjökull, which extend from the main ice

cap. The glacier's ever-changing features and majestic beauty attract adventurers and photographers from all over the world.

Volcanoes and geothermal activity- Vatnajökull National Park includes several active volcanoes, including Grímsvötn and Bárðarbunga. These volcanoes have shaped the dramatic landscapes of the region and offer a glimpse of the Earth's geothermal activity. The Park is also home to geothermal areas, hot springs and unique geological formations.

Skaftafell Nature Reserve: Within Vatnajökull National Park, the Skaftafell area stands out as a nature reserve. It offers a wide range of activities, including hiking trails that lead to stunning viewpoints, waterfalls and panoramic landscapes. Svartifoss, a picturesque waterfall surrounded by basalt columns, is one of the reserve's highlights.

Diverse flora and fauna: Despite the harsh conditions, Vatnajökull National Park supports a surprising variety of flora and fauna. The Park is home to mosses, lichens, arctic flowers and hardy grasses. It is also a habitat for various bird species, including puffins, falcons and swans. Occasionally, seals and reindeer can be seen along the coastal areas of the park.

- Outdoor activities: The Park offers many outdoor activities for visitors. Hiking is a popular option, with trails of varying levels of difficulty suitable for both casual and experienced hikers. Glacier tours, ice climbing and guided glacier walks offer thrilling experiences for adventurers. In addition, the park offers opportunities for camping, photography, wildlife viewing and exploring unique natural landscapes.
- Visitor centres and facilities: Vatnajökull National Park has visitor centres providing information about the park's natural features, geological processes and safety rules. The visitor centres also offer exhibitions, interactive displays and educational programmes. Facilities such as parking areas, camping sites and accommodation options are available to meet visitors' needs.

Vatnajökull National Park is an exciting destination that showcases the raw power of glaciers, volcanoes and natural wonders. It offers an opportunity to immerse yourself in Iceland's stunning landscapes and experience the country's unique geological features.

Vatnajökull National Park (photo source: https://www.iceroom.fr)

2.2.7. Durmitor National Park, Montenegro:

Located in the Durmitor Mountains, this park offers majestic peaks, glacial lakes and deep canyons, including the famous Tara River Canyon.

Durmitor National Park is a spectacularly scenic national park in Montenegro, known for its rugged mountains, deep canyons, glacial lakes and diverse ecosystems. It is a UNESCO World Heritage Site and offers stunning natural beauty and outdoor activities. Here are some key facts about Durmitor National Park:

- Location: Durmitor National Park is located in the northern part of Montenegro, in the Zabljak region. It covers an area of approximately 390 square kilometres.
- Geography-Mountainous scenery: the park is dominated by the Durmitor mountain range, part of the Dinaric Alps. The mountains, including the highest peak, Bobotov Kuk 2,522 metres, offer majestic landscapes with rugged peaks, deep canyons and glacial valleys.

Tara River Canyon: One of the park's main attractions is the Tara River Canyon, the deepest canyon in Europe and the second deepest in the world after the Grand Canyon. The canyon offers breathtaking views, and the Tara River flows through it, providing rafting and kayaking opportunities.

Glacial lakes: Durmitor National Park is home to several glacial lakes that add to its scenic beauty. The most famous is Crno Jezero (Black Lake), which is located at the foot of the Durmitor Mountains and it offers a picturesque setting for hiking, picnicking and boating. Other notable lakes include Zminje Jezero (Snake Lake) and Riblje Jezero (Fish Lake).

- Flora and Fauna: The Park is known for its rich biodiversity. The diverse ecosystems of Durmitor National Park support a variety of flora, including alpine meadows, coniferous forests and endemic plant species. The Park is also home to diverse wildlife including bears, wolves, lynx, goats and numerous bird species.
- Hiking and outdoor activities: Durmitor National Park is a paradise for outdoor enthusiasts. It offers numerous hiking trails that take you through stunning scenery including high peaks, deep valleys and crystal-clear lakes. In addition to hiking, the park offers opportunities for rock climbing, mountain biking, fishing and wildlife viewing.
- Cultural heritage: The Park also has cultural significance. The region is known for its traditional mountain villages, stone houses and distinctive Montenegrin architecture. Zabljak, the main town near the park, offers accommodation, restaurants and access to various visitor facilities.
- Visitor centres and facilities: Durmitor National Park offers visitor centres where visitors can get information about park attractions, trails and safety rules. The Park also offers facilities such as parking areas, picnic sites and campsites. Guided tours and maps are available to help visitors explore the park.

Durmitor National Park is a stunning natural gem, offering magnificent scenery, outdoor adventures and opportunities to connect with nature. Whether you're looking for thrilling activities such as rafting or simply want to immerse yourself in the tranquillity of the mountains and lakes, Durmitor National Park is a must-visit destination in Montenegro.

Durmitor Mountains (photo source: https://www.gradinamea.ro/)

2.2.8. Triglav National Park, Slovenia:

Located in the Julian Alps, it is Slovenia's only national park, offering scenic alpine landscapes, lakes and the iconic Mount Triglav.

Triglav National Park corresponds to the highest peak, Mount Triglav. It is Slovenia's only national park and offers diverse landscapes, alpine beauty and outdoor activities. Here are some key facts about Triglav National Park:

- Location: Triglav National Park is located in the Julian Alps in north-western Slovenia. It covers an area of approximately 838 square kilometres and encompasses the Triglav mountain range and its surroundings.
- Geography - Mount Triglav: The Park is named after Mount Triglav, Slovenia's highest peak at 2,864 metres. Triglav holds a special place in Slovenian culture and is a popular destination for mountaineers and hikers. It offers stunning panoramic views of the surrounding peaks and valleys.

Alpine landscapes: Triglav National Park is characterised by spectacular alpine landscapes. The Park has majestic mountains, deep valleys, glacial lakes and forests. The stunning landscapes offer opportunities for hiking, climbing and skiing, depending on the season.

Triglav Lakes: The Park is home to several beautiful glacial lakes, including the famous Bohinj and Bled lakes. Lake Bohinj, Slovenia's largest lake, is surrounded by majestic mountains and offers a peaceful setting for boating, swimming and fishing. Lake Bled, with its island and iconic castle, is a popular tourist destination.

Soca River: The Soca River, famous for its clear turquoise waters, flows through Triglav National Park. It is a paradise for water sports enthusiasts, offering kayaking, rafting and canyoning opportunities. The river also forms stunning gorges and waterfalls within the park.

- Biodiversity: Triglav National Park boasts a rich biodiversity. Its diverse habitats support numerous plant and animal species, including brown bears, goats, ibex, lynx and various bird species. The Park is committed to preserving its natural heritage and promoting sustainable tourism.
- Hiking and outdoor activities: The Park offers an extensive network of hiking trails, from easy walks to challenging alpine hikes. The Triglav Lakes Valley and the Seven Lakes Valley are

popular hiking destinations. Other activities in the park include mountain biking, climbing, paragliding and skiing in the winter months.

- Cultural heritage: Triglav National Park is also rich in rural cultural traditions. Traditional alpine villages with wooden houses, churches and hayracks can be found throughout the park. Visitor centres and museums in the park provide information about the region's history, cultural traditions and natural wonders.
- Visitor facilities: Triglav National Park offers visitor centres and information points where visitors can gather information about park attractions, trails and guidelines. The Park offers facilities such as parking areas, camping sites, picnic sites and accommodation in nearby towns.

Triglav National Park is an exciting destination showcasing the natural beauty and alpine landscapes of Slovenia. It offers a wide range of activities for outdoor enthusiasts, breathtaking views and the chance to immerse yourself in the country's alpine landscape.

Triglav Lakes Valley (photo source: https://www.tnp.si/sl/)

2.2.9. The Cévennes National Park, France:

Located in the southern part of the country, it encompasses a wide range of landscapes, including mountains, plateaus and deep river valleys.

The Cévennes National Park includes diverse landscapes, rugged mountains, deep gorges and rich biodiversity. Here are some key facts about the Cévennes National Park:

- Location: The Cévennes National Park is located in the Cévennes region, which covers parts of the departments of Lozère, Gard and Ardèche in southern France. The Park covers an area of approximately 3,240 square kilometres.
- Geography - Mountainous landscapes: the park is characterised by rugged mountain ranges, including Mont Lozère and Mont Aigoual. These mountains offer breathtaking scenery resulting from hard rock sculpting, deep valleys and picturesque peaks, providing opportunities for hiking, climbing and nature exploration.

Gorges and rivers: The Cévennes National Park is crossed by several rivers and gorges. The Tarn Gorge, one of the most famous gorges in the park, offers breathtaking views and is a popular spot for canoeing and kayaking. The rivers also create beautiful waterfalls and gorges, contributing to the beauty of the park's natural landscape.

Mont Aigoual: Mont Aigoual is the highest peak in the Cévennes mountain range and is located in the national park. Visitors can enjoy panoramic views from the summit and explore the meteorological observatory, which provides information on weather monitoring and meteorological history.

- Biodiversity: The Park is renowned for its rich biodiversity and serves as a sanctuary for many species of plants and animals. It is home to various forests, including beech, oak and chestnut trees. The park's wildlife includes wild boar, deer, otters and a wide variety of bird species.
- Cultural heritage: the Cévennes National Park is full of history and cultural heritage. The Park is known for its traditional stone houses, ancient villages and terraced landscapes. The region has a long history of agriculture, especially chestnut cultivation, which has shaped local culture and cuisine.
- Hiking and Outdoor Activities: The Park offers an extensive network of hiking trails catering to all levels of experience. These trails lead visitors through forests, valleys and along ridges, offering breathtaking views of the surrounding landscape. The Park also offers opportunities for biking, horseback riding and fishing.
- Visitor centres and facilities: the Cévennes National Park has visitor centres and information points where visitors can obtain maps, guides and information about the park's routes and attractions. The Park offers facilities such as parking areas, picnic areas and camping sites. In addition, there are accommodations and restaurants available in nearby towns and villages.

The Cévennes National Park offers a mix of natural beauty, cultural heritage and outdoor activities. Whether you're interested in exploring its mountainous landscapes, discovering traditional villages or experiencing the region's biodiversity, the Cévennes National Park offers a wonderful opportunity to immerse yourself in the natural and cultural wonders of southern France.

The Cévennes National Park (photo source: https://www.cevennes-parcnational.fr/fr)

2.2.10. Samaria Gorge National Park

Is located in the region of Chania, on the island of Crete, Greece. It is famous for the spectacular gorge relief of Samaria, which is one of the longest and most famous canyons in Europe. Here are some key facts about Samaria Gorge National Park:

- Location: Samaria Gorge National Park is located in the White Mountains (Lefka Ori) in western Crete. The Park is located about 43 kilometers, southwest of the city of Chania.
- Geography - Samaria Gorge: The highlight of the national park is the Samaria Gorge, a natural wonder that stretches for about 16 kilometres from the Omalos Plateau to the coastal village of Agia Roumeli. The gorge is famous for its steep cliffs, fragmented relief and stunning natural beauty.
- Hiking: Samaria Gorge offers a popular hiking experience for nature enthusiasts. Hiking through the gorge takes you on a well-marked trail that meanders through diverse landscapes, including narrow passes, cliffs as well as through the meandering riverbed. The trail is known for its steep descents and ascents, making it a challenging but rewarding adventure.

- Flora and Fauna: Samaria Gorge National Park is home to a diverse range of flora and fauna. The gorge features diverse plant species including Cretan dittania, Cyprus tulip and Cretan ebony. Wildlife such as Cretan wild goats (kri-kri), birds and reptiles can also be seen in the park.
- Geographical landscapes: The gorge offers breathtaking scenery, with sheer cliffs, lush vegetation and the crystal-clear waters of the Samaria River. Visitors will encounter impressive natural features such as the 'Iron Gates' and the 'Gates of Heaven' as they make their way through the gorge.
- Visitor Facilities: The National Park offers visitor facilities to enhance the hiking experience. At the entrance to the park in Omalos, there are information centres, parking areas, toilets and snack bars. Along the trail, there are designated resting points with water fountains. At the end of the hike in Agia Roumeli, there are tavernas and boat services for the return to Chora Sfakion or Chania.

The Samaria Gorge is usually open to visitors from May to October, when weather conditions are more favourable. It is important to note that hiking requires a reasonable level of fitness, appropriate footwear and sufficient water and supplies. Visitors are advised to follow park regulations and heed safety warnings.

Samaria Gorge National Park offers a memorable hiking experience through an impressive natural landscape. It is a must-visit destination for outdoor enthusiasts and nature lovers, allowing them to discover the stunning beauty of the wild Crete Island.

Samaria Gorge(photo source: www.samaria.gr)

These are just a few examples of the many beautiful parks found throughout Europe. Each Park has its own unique features and attractions, making Europe a paradise for nature lovers and outdoor enthusiasts.

2.2.11. Conclusions

Europe's parks fulfil various functions and play important roles in conserving natural ecosystems, providing recreational opportunities and promoting environmental education. Here are some key functions of parks in Europe:

- Biodiversity conservation: Europe's parks often serve as protected areas for the conservation and preservation of the region's rich biodiversity. They provide habitats for a wide range of plant and animal species, including threatened and rare species. These parks play a crucial role in maintaining ecological balance and protecting natural resources.
- Leisure time and tourism: European parks offer recreational activities and opportunities for outdoor enthusiasts. Visitors can enjoy activities such as hiking, camping, cycling, bird watching and nature photography. Parks attract tourists from all over the world, support local economies and promote sustainable tourism practices.
- Education and research: Many European parks serve as living laboratories for scientific research and environmental studies. Researchers study various aspects of ecology, geology, climate and wildlife within these protected areas. The parks also offer educational programmes and interpretation centers to raise awareness of environmental conservation and sustainable practices.
- Cultural and historical importance: Some of Europe's most outstanding parks have cultural and historical significance. These may include archaeological sites, ancient ruins or cultural landscapes that provide information about the heritage and history of the region. Parks serve the function of preserving and interpreting cultural resources, allowing visitors to explore and learn about the area's traditions or past.
- Mitigating climate change: European parks contribute to reducing the impact of climate change by conserving forests and natural landscapes. Trees and vegetation in these parks absorb carbon dioxide, a greenhouse gas, helping to reduce the impact of climate change. In addition, some parks implement sustainable practices, such as renewable energy use and waste management, to minimise their environmental footprint.
- Protection of water resources: Europe's parks often include lakes, rivers and wetlands, which are vital for protecting water resources. These areas help maintain water quality, regulate water flow

and provide important habitats for aquatic species. Parks play a crucial role in the protection and sustainable management of water resources.

- Community engagement and well-being: European parks provide spaces for local communities to connect with nature, engage in physical activity and improve their well-being. They provide opportunities for relaxation, social interaction and cultural events. Parks also promote the concept of 'green spaces' within cities, improving the overall quality of life for residents.

By fulfilling these functions, European parks contribute to the conservation of nature, the promotion of sustainable development and the well-being of society and the planet.

2.3. Representative forests and parks in Romania

"True wisdom is not to depart from nature but to shape our behaviour according to its laws and patterns." Seneca

Biodiversity (biological diversity) is the variability of biological (and ecological) entities, from genes, species, ecosystems to ecosystem complexes. Biodiversity can be considered at local, regional, national and global levels. It plays an important role in the life of each society, reflected in their culture and spirituality (folklore, art, architecture, literature, land and resource use traditions and practices, and the like). The aesthetic value of biodiversity is a fundamental human need, with natural and cultural landscapes being the basis for the development of the tourism and recreation sector.

From an ethical point of view, each component of biodiversity has inestimable intrinsic value and human society has an obligation to ensure their conservation and sustainable use.

Biodiversity conservation activity in Romania has a relatively long history, developing in line with people's concerns, the first rules for nature conservation being found in ancient Romanian law since the 15th century. These evolved until the 19th century ensuring a good conservation of natural resources, being a legislation that imposed a set of strict rules and measures. Subsequently, the legislative and institutional system continued to develop until the end of the Second World War, and during the communist period it became less developed. After 1990, biodiversity conservation activities were resumed and strengthened by drafting new legislation and creating appropriate institutional structures.

A presentation of the forests, parks and gardens of the main cities in the regions of Romania will be made: Maramures, Banat, Oltenia, Muntenia, Dobrogea, Moldova and Transylvania.

2.3.1. Maramureș

2.3.1.1. Bistrița Municipal Park/ ”King Michael”Park

One of the great attractions of the municipality is the park on the right bank of the river Bistrita, in the south-eastern part of the city. As early as 1814, decorative trees were planted here, paths were created and the embankment for the Budac bridge at the southern end of the park was laid. Further arrangements and improvements are recorded in 1898 and 1928, to which are naturally added those of recent years.

The park covers an area of more than 9 ha and preserves the original shape of the alleys: part in a classical, geometric style and part in a landscape style.

The park's charm is conferred by the many species of exotic trees and shrubs from different geographical regions of the globe. Among the original North American ornamental trees are: the tree of life (*Thuja occidentalis*), the giant thuja (*Thuja gigantaea*), the catalpa (*Bignonia catalpa*), the red oak (*Quercus borealis*). Species native to Asia include: biota (*Thuja orientalis*) from China, magnolia (*Magnolia yulan*) from India, Japanese acacia (*Sophora japonica*) from Korea, jasmine shrub (*Jasminiun officinalis*) from the Caucasus, laurel (*Ilex aquifolium*) as an ornamental shrub. Alongside the exotic species there are many native secular species: mountain ash (*Acer pseudoplantanus*), oak (*Quercus robur*), lime (*Tilia cordata*), black pine (*Pinus nigra*), mountain elm (*Ulmus montana*), hornbeam (*Carpenus betulus*), juniper (*Juniperus communis*).

The visitor's attention is particularly drawn to two rare dendrological species: ginkgo (Ginkgo biloba), also called the pagoda tree, native to China, which is considered a true "living fossil", surviving as a species from the Tertiary era to the present day.

The second important species, located in the east, is the tulip tree (*Liriodendron tulipifera*), native to North America.

Only a few species of birds nest in the park (sparrows, doves, wrens, wrens, redstarts, cuckoos, siskins, robins, blackbirds), but in the green spaces between the blocks there are many more (pipits, glassbills, starlings, florins, robins, etc.).

On 3 March 1995 the Bistrița-Năsăud County Council declared the area occupied by the park as a protected area.

Bistrița Municipal Park (photo source: https://timponline.ro)

2.3.1.2. Schullerwald Forest Park (Students' Forest)

Is the only forest park in the city of Bistrița that has an area of about 30 hectares and was developed in 2014 with European funds. It is a beautiful and well-kept setting that offers visitors many opportunities to spend pleasant hours outdoors.

The biocenosis is represented by plant species such as the European ash (*Quercus petraea*), hornbeam (*Carpinus betulus*), beech (*Fagus sylvatica*), ash (*Fraxinus excelsior*), acacia (*Robinia pseudacacia*), cherry (*Prunus avium*), dogwood (*Ligustrum vulgare*), hornbeam (*Cornus mas*), hazelnut (*Corylus avellana*), elderberry (*Sambucus racemosa*), as well as animals specific to the hill area: hedgehog (Rinaceus europius), mole (*Talpa europaea*), woodlark (*Caluber longisimus*), salamander (*Salamandra salamandra*), cuckoo (*Athene noctua*), owl (*Buho buho*), woodpecker (*Picus viridis*), woodpecker (*Parus major*), jay (*Garrulus glandarius*), coot (*Motacilla alba*), magpie (*Pica pica*).
The forest is given in the care of students who carry out greening activities, marking trails, maintenance of the green space, together with the employees of the municipality.

2.3.2. Banat

Timișoara is located in western Romania and is the county town of Timiș County, Banat. This town lies at an altitude of about 90 metres above sea level and has a humid climate.

2.3.2.1. Green Forest - Timișoara

The Green Forest is located in the north-eastern part of Timisoara, covering an area of 724 ha. In the 18th century it was the "hunting forest", with a rich variety of fauna and vegetation. The main function of the Green Forest is ecological, balancing the climate of the area. The exclusion of the main felling for almost 40 years has led to the ageing of the stands, an increase in canopy volume and thus an increase in the ecological effect.

In terms of wildlife, the forest is home to various species of wild animals, such as: roe deer (*Capreolus capreolus*), hare (*Lepus europaeus*), wild boar (*Sus scrofa*), squirrel (*Sciurus vulgaris*), but also numerous birds such as sparrow (*Passer domesticus*), woodpecker (*Dendrocopos major*), quail (*Coturnix coturnix*), partridge (*Perdix perdix*) or, among the most important, pheasant (*Phasianus colchicus*).

The wood species that grow in the Green Forest are: cherry (*Quercus cerris*), ash (*Fraxinus excelsior*), ash (*Acer campestre*), hornbeam (*Cornus mas*), Tatar maple (*Acer tataricum*), pedunculate oak (*Quercus robur*), field ash (*Acer platanoides*), field elm (*Ulmus campestris*).

The predominant species is Quercus sp. 69%, followed by Fraxinus excelsior 10%. 5% of the existing trees are between 101 and 120 years old, 21% between 81 and 100 years old, with 41% of trees between 61 and 80 years old.

The area is currently undergoing a 5-year process of transformation into a park forest. The interventions are intended to be minimally invasive and to take into account biodiversity conservation, ecological restoration, urban climate improvement and accessibility for all age groups. The project aims to educate the public about the environment, improve the health of citizens and develop recreational and leisure infrastructure, encouraging leisure in nature.

Timișoara Green Forest (photo source: https://green-report.ro)

2.3.2.2. ”Queen Mary” Park– Timișoara

"Queen Mary" park is located in a bend of the Bega canal and covers an area of about 4.5 hectares. This park is known for its rich Yew (*Taxus baccata L.*) plantation, and right from the entrance we can admire the beauty of the trees that are arranged in a row and trimmed in several geometric shapes. This is reminiscent of the 'opera topiaria' method, where yews are cut into several shapes, such as cubes or cones.

"Queen Mary" Park is said to be the most beautiful during the autumn season, when the varied coloured leaves of the different trees in the park create a beautiful colour effect.

2.3.3. Oltenia

2.3.3.1. ” Nicolae Romanescu” Park – Craiova

The city of Craiova, the municipality of Dolj County, is located in the centre of the historical region of Oltenia, in a relatively low relief area of the Romanian Plain. More precisely, Craiova is located in the Oltenia Plain, and the average altitude of the city is 101 m high.

"Nicolae Romanescu" Park in Craiova is the largest and most famous park of the city, being the third largest natural park in Europe and the second largest in Romania. The total area of the park is more than 96 hectares and includes, besides ornamental plantations of trees and shrubs, a stretch of water of more than 4 hectares, formed by a series of water lily ponds linked by small waterfalls or crossed by bridges, a shelter for many species of water birds, fish, land turtles, a lake with boats for recreation and an island that can be reached on 2 bridges. The park also has a 20 ha racecourse, a velodrome, roads, alleys and paths totalling over 35 km in length, and cycle paths. It is considered the largest nature park in Eastern Europe and is the second largest in Romania, about 90 ha, after Herăstrău Park in Bucharest. The park also has an amphitheatre for open-air shows, one of the oldest zoos in the country, opened in 1906, and several restaurants.

The suspension bridge is one of the city's most famous landmarks, which unfortunately is currently closed to tourists, as it is being renovated. But the fact that we can't cross it for the time being doesn't detract from its charm, as it can be easily seen due to its size and height.

As for the park's flora, here you can find an impressive variety of trees and herbaceous plants. Among the tree species you will find common oak (*Quercus robur*), common ash (*Fraxinus excelsior*), horse chestnut (*Aesculus hippocastanum*), white poplar (*Populus alba*), horny lime (*Tilia cordata*), dwarf birch (*Betula pendula*). Among the conifers found in the park's perimeter, the following are worth mentioning: yew (*Taxus baccata*), very long-lived, reaching 300-400 years of age; the tree of life (*Thuja orientalis*), the pond cypress (*Taxodium distichum*), then the black walnut, the Japanese willow (*Salix matsudana*), the Persian lilac (*Syringa persica*), the Judas tree (*Cercis siliquastrum*), the Japanese acacia (*Sophora japonica*), yellow acacia (*Laburnum anagyroides*), small acacia (*Amorpha fructicosa*), common dock (*Cytisus leucotrichus*), pink acacia (*Robinia pseudoaccacia var viscosa*). Among the herbaceous species, golden clover (*Trifolium campestre*), small vetch (*Vicia hirsuta*). Of the Gramineae family, represented by 80 species, we can mention: Ribwort (*Sorghum halepense*), small meadow grass (*Panicum capillare*), eelgrass (*Tragus racemosus*), beggar's beard (*Melica nutans*), common meadow grass (*Bromus arvensis*), common reed (*Poa annua, P. palustris*), Craiova fescue (*Festuca valesiaca f. craiovensis*).

Herbaceous, flowering, decorative or ornamental plants are quite rare. These include: carnations (*Dianthus deserti* and especially *D. kladovanus*, which only grows in Oltenia), purple incense, waxflowers and love flowers.

In terms of wildlife, Romanescu Park is home to a variety of animals and birds. Here you can meet birds such as the summer swan (*Cygnus olor*), the wild duck (*Anas platyrhynchos*), the greylag goose (*Anser anser*), the domestic pigeon (*Columba livia*), the sturgeon (*Turdus spp.*), as well as small animals such as the red squirrel (*Sciurus vulgaris*), the hare (*Lepus europaeus*) and the newt (*Triturus spp*).

In July 2023, a project for the development of the park was completed, financed with European funds, which aimed to enhance one of the most representative monuments of landscape art in Romania, because Romanescu Park is a reference in the European heritage of historic gardens and parks and it is a reserve to be preserved and restored.

Nicolae Romanescu Park (photo source: https://www.gds.ro)

2.3.3.2. ”Constantin Brâncuși” Central Park– Târgu-Jiu

Târgu-Jiu is located in Gorj County, in the Oltenia area and it is the municipality of its residence. The name of the park comes from the river Jiu which flows through it to the north and south. It is located about 18 km south of the Carpathian mountain range, in the Târgu-Jiu Basin. This area has provided Romania with many personalities, including the sculptor Constantin Brâncuși (1876-1957).

"Constantin Brâncuși" Central Park is located in the city of Târgu-Jiu and it is one of its main attractions. Here you can find many of Constantin Brâncuși's works, such as the Table of Silence, the Infinity Column, the Alley of Chairs and the Gate of Silence.

In addition to its cultural importance, the park is also of particular ecological importance as it is the site of a number of unique plants and trees such as the redwood. Thus, the park paths shaded by the ancient trees are loved by tourists, especially in summer, when the difference between the temperature in the sun and that in the park paths can reach even 10°C. Other tree species found in the park area are lime (*Tilia sp.*), oak (*Quercus robur L.*) and willow (*Salix L.*).

The monumental ensemble is not only cultural, but also a green space that attracts tourists and residents who want to relax in nature.

2.3.3.3. Zăvoi Park- Râmnicu Vâlcea

Râmnicu Vâlcea is the municipality of Vâlcea county, located in the north-east of Oltenia.

Zăvoi Park has a history of almost 170 years, representing one of the oldest parks in Romania. What makes this park even more interesting is the planting, which is very diverse, but also for the huge size of the specimens. Right from the entrance you can see a lot of linden trees (*Tilia tomentosa*), which have grown extremely well in the park, reaching amazing heights. In Zăvoi park there are also conifer plantations, such as pine (*Pinus sylvestris L.*) and spruce (*Picea abies L.*), which together with the linden manage to shade almost the whole park by their size.

Another characteristic feature of this park are the eight pyramidal thuja (*Thuja pyramidalis Compacta*) trees, which are lined up in two rows and stand on a rectangular lawn, together with other trees such as ash (*Fraxinus excelsior*), maple (*Alnus*), elm (*Ulmus*) and many others.

Therefore, Zăvoi Park in Râmnicu Vâlcea has an extremely important role for the city, thanks to the many kinds of trees that can be found in this place and that manage to attract a lot of tourists every year.

2.3.4. Muntenia

2.3.4.1. King Michael I Park / Herăstrău Park- Bucharest

Romania's capital, Bucharest, is the country's most populous city and also its most important commercial and industrial centre. It is located in the south-east of the country, in the Romanian Plain.

Herăstrău Park covers an area of 187 ha and is located in the northern part of Bucharest. It was built in 1936 on the shores of the lake of the same name and in 1951 the park was expanded, transformed and reopened in its present form.

The park's fauna, made up of various species of birds, makes this area a real delight to the ear, the 'participants' in the enchanting sound being blackbirds, finches, coots, pigeons and pipits, the faunal landscape being joined by graceful squirrels. Not long ago, the Rose Island area began to be populated by exotic birds of rare beauty, including swans, peacocks, Carolina ducks, white-rumped geese, red-rumped geese, Nile geese, tufted ducks, Magellan geese and mandarin ducks.

Herastrau Park is a true "green lung" as it has a rich tree vegetation of poplars, maples, willows, yews and ash trees, forming an amazing landscape, despite the urban congestion. Protected tree species, such as Tagore's oak or the flowering cherry trees of the Japanese Garden, are also found in the area.

The park is home to a unique dendrological tree, a variety of Japanese acacia with weeping branches and white-stained leaves. Because it was unknown in the literature and was first described by Romanian specialists in 1960, it was given the name Sophora japonica București.

For visitors, the main attraction of the vast park is the lake that gives it its name, which divides it into two main areas, one dedicated to rest and culture and the second to fun and sport. It is the only place in Bucharest where you can take a boat ride or a ride on a boat or a hydrobike.

Herăstrău Park (photo source: https://agora.md)

2.3.4.2. Cișmigiu Park- București

The capital is home to one of the oldest public gardens in the country, Cișmigiu Park, also known as the "Cișmigiu Garden". Inaugurated in 1847, it is located in the centre of the city and is its oldest public garden, covering an area of about 14 hectares.

The landscaping of the site was begun under the guidance of Viennese architect F. Meyer. The park includes a rose garden, a French garden and three lakes. Along the paths are planted tree species such as lime (*Tilia*).

The park is home to several protected tree species such as English plane (Platanus acerifolia), kaya (Torreya nucifera), California hickory (*Torreya californica*), Japanese red pine (*Cedrus atlantica*) and spruce (*Picea excelesa inversa*).

More than 30,000 trees such as maple (*Acer platanoides*), ash (*Fraxinus*), larch (*Larix decidua*), sycamore (*Platanus occidentalis*), elm (*Ulmus*) and fir (*Abies*) can be found within the park.

Cișmigiu is home to several bird species for which habitats have been created, either artificial or natural. For example, the specially placed aviaries are home to pigeons (*Columba livia*) which are used to tourists feeding them. The three lakes are the natural habitat of several water-loving birds such as the wild duck (*Anas platyrhynchos*) or domestic duck (*Anas platyrhynchos domesticus*), swan (*Cygnus*) and geese (*Anserini*). The lakes are also populated by aquatic plants such as reed (*Pharagmites australis*) and buttercup (*Typha*).

Thus, Cișmigiu Park is not only a place of relaxation for tourists and residents of Bucharest, but also a treasure trove of biodiversity.

2.3.4.3. Plopeni – Băicoi Forest

The town of Băicoi is located in the centre of Prahova County, it stretches for 17 kilometres and is at an altitude of 406 m.

Plopeni Forest is a site of community importance designated for the protection of biodiversity and the maintenance of a favourable conservation status of wild flora and fauna, as well as natural habitats of Community interest in the protected area. The natural area is located in the central-western part of Prahova County, in the administrative territory of the town of Băicoi.

The fauna is rich, including various species such as: bear, carpathian deer, jder, deer, wild boar, a wide variety of birds (blackbird, finch, hawk, eagle), reptiles (snakes and lizards), insects.

The site represents a wooded area (secular forest consisting of a stand of oak, oak, hornbeam, poplar and occasionally beech) framed in a continental bioregion located at the northern limit of the Romanian Plain, which preserves natural habitats of the type: *sub-Atlantic and Middle-European oak or oak with hornbeam Carpinion betuli forests* and it protects several southern plants, some very rare or endemic to the region of Muntenia.

A 2010 conservation status assessment concludes that overall the habitat and species as well as the abiotic environment are in a good conservation status, forming a favourable support for biodiversity and ecological balance.

2.3.4.4. Trivale Park Forest– Pitești

Pitești is the municipality of Arges county and is located in the Getic Plateau, near Arges, at an altitude of 289 m.Trivale Forest, located in the western part of Pitesti, is the largest natural park in the country (about 7000 ha) and consists of thermophilic oaks, the diversity of vegetation and phytogeographic significance placing it among the forests of particular importance. It is considered to have an eco-protective role for adjacent areas, thus contributing to the maintenance of the quality of the environment.

In the forests of the municipality of Pitești you can find common examples of our country's fauna, some of hunting interest (fox, badger, jder, ferret, weasel, deer, wild boar, rabbit). In addition, in the Trivale forest are admired numerous species of squirrels, insectivorous mammals such as hedgehogs or moles, and in the dark appear bats. The area is also home to various frogs, including the red wood turtle, reptiles (e.g. snakes, lizards, wolverines), water and land turtles, earthworms, spiders, gastropods, etc.

The many birds, some of them songbirds, that can be found in this forest are: cuckoo, skylark, barn owl, starling, blackbird, nightingale, skylark, lark, wryneck, turtle dove, finch, mockingbird, sparrow, sparrowhawk, woodpecker, raven, crow, owl, hawk, falcon and wild pigeon. The Trivale Forest is home to a variety of tree species, including fir, Austrian pine, white pine, spruce, wild olive, palms, oaks and gall oaks, followed by a number of rare plants, the most valuable of which are *Orchis morio* (orchid species), *Alopecurus aequalis* (common grass species), *Typa minima* (pappus species) and *Campanula abietina* (bellflower species).

The rarity of the thermophilous oak forests, the diversity of the vegetation and the particular phytogeographical significance of the Trivale Forest Reserve make it a very important forest reserve. The park was declared a nature monument in 1939.

2.3.5. Dobrogea

2.3.5.1.Archaeological Park – Constanța

Constanța is the municipality of the county of the same name, in the south-eastern part of the country and it is one of the oldest documented towns in Romania. It has a humid subtropical climate with oceanic and semi-arid influences.

The Archaeological Park of Constanța is a richly vegetated area in which the spirit of the ancient fortress of Tomis is still alive. Located in an area with a rich history and great cultural value, it is a special place, a green oasis, which is not only a place for relaxation and recreation, but also an environment conducive to the development of various species of plants and animals.

The fauna in the Archaeological Park is also diverse and interesting. Numerous species of birds can be found here, both on the ground and in the air. Among the birds found in the park are the nightingale, green woodpecker, blackbird and sapsucker. Many of these birds are protected and provide an aural and visual spectacle for visitors. Reptiles such as lizards and turtles can also be seen in sunny, less vegetated areas.

The Archaeological Park of Constanța is an important place for the conservation of biodiversity and the protection of natural habitats. In addition, it provides a suitable environment for the development of insects and other invertebrates, which play an important role in the ecological balance. Colourful butterflies, dragonflies and beetles are just a few examples of the diversity of small fauna that enrich the landscape and are indispensable for plant pollination.

The flora of the Archaeological Park is impressive in its diversity. Here you will find species of trees and shrubs such as oak, ash, hornbeam, lime and elm, which provide cool shelter and pleasant shade on hot summer days. The park's meadows are decorated with wildflowers such as poppies, snowdrops, carnations and more, creating a colourful and delightful display. Wetlands and marshes are also populated by aquatic plant species such as reeds and water lilies, which contribute to the diversity of habitats in the park.

Archaeological Park-Constanța (photo source: https://www.litoralulromanesc.ro)

2.3.5.2. Tăbăcarie Park

Tăbăcarie Park from Constanța covers an area of approx. 100 ha and is located on the shore of Lake Tăbăcăriei. The lake has an area of about 99 ha and the park is, in fact, a representation of the lake fauna and flora, specific to this territory between the waters, being remarkable for the wild beauty and variety of ecosystems. The areas where the shores are unimproved carry with them an air of wilderness from the days when this river-sea border was home only to fish and other aquatic beings.

2.3.6. Moldova

2.3.6.1. Copou Park– Iași

Iași is located in the eastern part of the Moldavian region of Romania. It is the county seat of Iași county. The city lies on the Bahlui River and is geographically recognized for the seven hills that led Marco Bandini to call it A New Rome.

Copou Park, also known as Copou Garden, is the oldest park in the city. Located on the Copoului hill, it is the largest urban park in the northern and central part of the city, covering about 10 hectares.

Its landscape composition has been described as unique in Moldova. The landscape includes a triple line of yew (*Taxus baccata var. Nidiformis*), a spruce grove and lines of Californian cypress (*Chamaechyparis lawsoniana Ellwoodii*), and the central parterre is shaded by numerous specimens of Thuja giganteea. Also on the perimeter of the park, specifically on the west side, is the 'Alley of Willows'. As its name suggests, it comprises 35 willow trees (*Robina pseudoacacia*), which are said to

have been introduced into the landscape thanks to the English garden models that arrived in Iași, according to Costache Negruzzi (1808-1868).

In addition, the park area is also home to other trees such as birch (*Betula alba*), wild chestnut (*Aesculus hippocastanum*) and mulberry (*Morus*). The landscape is completed by secondary landscapes created by hedges of *Spiraea chamaedroyfolia, Deutzia scabra, Philadelphus coronarius, Acer tataricum* and more.

With predominantly arboreal vegetation, but also with balance and eco-protective value, the park contributes significantly to air quality and the maintenance of local biodiversity. The main background is composed of linden (*Tilia*), ash (*Fraxinus*) and maple (*Acer platanoides*). In addition to trees, the park's flora also consists of shrubs. The dominant species are Forsythia (*Forsythia*), Jasmine (*Jasminum polyanthum*) and Lilac (*Syringa vulgaris*).

The flora of Copou Park is diverse, with the rich vegetation providing a natural habitat for various animal species. The most common mammal is the red squirrel (*Sciurus vulgaris*) which can be easily spotted in every area of the park. The bird population is much more diverse, with the park hosting hundreds of birds, such as the house sparrow (*Passer montanus*), the house sparrow (*Passer domesticus*), the woodpecker (*Parus major*), the linnet (*Sitta europea*), the blackbird (*Turdus merula*), the wren (*Streptopelia decaocto*), the pigeon (*Columba livia domestica*) and the starling (*Sturnus vulgaris*). In addition to species common in other parts of the city, the park is also home to other species less common in the area such as the finch (*Fringilla coelebs*) and the flycatcher (*Muscicapa*), which are evidence of the biodiversity of the area.

That being said, Copou Park is a place full of natural diversity that offers tourists and residents both a place to relax and a cultural space, commemorating the history of the national poet Mihai Eminescu.

Copou Park (photo source: https://dynamic-media-cdn.tripadvisor.com)

2.3.7.Transylvania

2.3.7.1. “Simion Bărnuțiu” Central Park - Cluj-Napoca

Cluj is the municipality of Cluj-Napoca county. It is located in the north of the Transylvanian Basin and it is one of the most important cultural, economic and academic centres in Romania.

The Central Park of Cluj-Napoca is one of the largest and most popular parks in the city. With a generous area and a variety of facilities, the park attracts both locals and tourists. The park, also known as "Simion Bărnuțiu" Central Park, was inaugurated in 1827 and is one of the oldest parks in Romania. Central Park is divided into several areas, each with its own atmosphere and facilities. Here you'll find tree-lined paths, green lawns, landscaped gardens and plenty of benches for relaxing. The park also has an open-air stage, where outdoor performances and concerts take place. The park has two artificial lakes, popular for boating and fishing. In addition, there are also artesian fountains that add charm to the landscape and provide a pleasant place to cool off on hot summer days.

The flora and fauna of the Central Park in Cluj-Napoca are varied and provide a habitat for a range of plant and animal species. The Central Park is dotted with trees, including oaks (*Quercus spp.*), poplars (*Populus spp.*), lindens (*Tilia spp.*), beeches (*Fagus spp.*), chestnuts (*Aesculus spp.*), elms (*Ulmus spp.*) and many others. These trees provide shade and contribute to a pleasant environment for visitors. The park is home to a variety of shrubs and flowers. Here you can find roses (*Rosa spp.*), tulips (*Tulipa spp.*), daffodils (*Narcissus spp.*), hyacinths (*Hyacinthus spp.*), jasmine (*Jasminum spp.*), lilacs (*Syringa vulgaris*) and many more. During the flowering season, the park becomes an explosion of colours and aromas. Due to the presence of lakes and fountains, Central Park is also home to aquatic vegetation. These include water lilies (*Nymphaea spp.*), reeds (*Phragmites spp.*), papyrus (*Typha spp.*) and other wetland plants.

The place is a paradise for bird lovers. Here you can see a variety of species including sparrows (*Passer domesticus*), blackbirds (*Turdus merula*), pipits (*Parus spp.*), nightingales (*Luscinia megarhynchos*), wrens (*Streptopelia decaocto*) and many more. Due to the biodiversity of the birds in the area, the park is an ideal place for bird watching. Various mammal species can also be found in Central Park. These include rabbits (*Lepus europaeus*), squirrels (*Sciurus vulgaris*), voles (*Microtus arvalis*) and bats (*Chiroptera*). The park provides habitat for reptiles and amphibians such as lizards

(*Lacertidae*), toads (*Bufo bufo*), green frogs (*Rana esculenta*) and turtles (*Emys orbicularis*). It is important to note that the fauna and flora in the park can vary depending on the season, and some species may be less visible or may be found in certain areas of the park. Thus, the Central Park of Cluj-Napoca offers a wonderful opportunity to interact with nature and observe the diversity of local fauna and flora.

”Simion Bărnuțiu” Central Park (photo source: https://cluj.com)

2.3.7.2. Făget Forest Park

Făget Forest is a protected natural area and nature monument of national interest, which includes natural stands of gorun and beech. The protected area covers an area of 10 ha and preserves natural species and habitats of faunistic, floristic and forestry importance. It can be visited for scientific, educational and recreational purposes, offering possibilities for tourism and weekend recreation in the surroundings of Cluj. It represents a forest ecosystem, where the trees have an average age of 50-60 years, composed mainly of native species (beech, hornbeam and gorun), but also including species of foreign origin, such as the Duglas fir. Although it can be considered relatively young, the forest is also home to old-growth trees, such as mountain ash, hornbeam and beech, which have survived over time.
To all these are added many other parks and gardens, nature reserves and botanical gardens that I remember: "Dimitrie Brândză" Botanical Garden in Bucharest, "Alexandru Borza" Botanical Garden in Cluj, "Anastasie Fătu" Botanical Garden in Iasi, "Vasile Fati" Botanical Garden in Jibou, "Răsvan Angheluță" Botanical Garden in Galati, "Vasile Goldiș" West University Botanical Garden in Macea.
Romania is a country that enjoys a special biodiversity, both in urban and natural environments. Parks and gardens not only beautify cities, they also purify the air and ensure that the diversity of flora and

fauna is preserved. Parks and nature reserves also provide a solid scientific basis for biodiversity research in our country.

CHAPTER III. PRACTICAL ASPECTS AND SOLUTIONS

3.1. Aspects on biodiversity (generalities)

The biodiversity of urban forests and parks has a special significance from the perspective that they are spaces with a central role in biodiversity conservation in urban environments. Studies carried out in various countries highlight the higher biodiversity of vegetation and fauna species in urban forests and parks compared to other types of urban green spaces, the predominance of native species and the increasing share of exotic or introduced species. (Cecil C. Konijnendijk Matilda Annerstedt Anders Busse Nielsen Sreetheran Maruthaveeran, 2013)[23].

FAO (*Guidelines on urban and peri-urban forestry, FAO Forestry Paper-Nr.178, 2016*)**Error! Bookmark not defined.** says the following about the biodiversity of urban forests: "20% of the world's bird species and 5% of vascular plant species occur in cities (Aronson *et al.* , 2014), 70 percent of plant species and 94 percent of bird species found in urban areas are native to the surrounding region (Secretariat of the Convention on Biological Diversity, 2012)".

The conservation of biodiversity (which includes both ecosystem, species and genetic diversity) remains a priority for today's society. Threats to the biodiversity of urban forests and parks, mainly due to climate change, urban sprawl and pollution, have major consequences for the whole urban environment. *The main problems* facing urban forests and parks today are related to issues such as: increased pollution, reduced biodiversity, increased vulnerability to invasive species, increased anthropogenic activity including overcrowding, litter, reduced life expectancy of trees through increased parasitism, disease, biological invasions.[94]

Some authors mention as ways to improve the biodiversity of urban forests (Owuor, J.A., Whitehead, I. and De Vreese, R., 2022)[5]: maintenance of old trees, measures aimed at replanting, removal and reduction of invasive species, fall management, planting programmes, etc.

[94] https://ro.frwiki.wiki/wiki/For%C3%AAt_urbaine

In relation to the urban environment, all categories of green spaces can contribute to the conservation of biodiversity and urban forests and parks even more so. The necessary actions are aimed as a priority at maintaining native species and original natural ecosystems, habitat conservation, achievable through action strategies with multidisciplinary approaches but also by promoting environmental education.

3.2. Case studies

Many urban forests and parks are global, regional or local role models. There are many significant examples that demonstrate the multifunctionality of forest areas through planning, design, biodiversity and management. Relevant in terms of size and function, biodiversity aspects and roles in the urban environment are Tijuca National Park (Rio de Janeiro, Brazil), Banco National Park (Abidjan, Côte d'Ivoire), Vincennes Forest (Paris, France), Central Park New York (USA), Hyde Park London (UK), Seonyudo Park (Seoul, South Korea). (*annex no.5*).

3.3. Urban forests and parks worldwide. Practical aspects and solutions

Given the complexity of the topic, we propose to focus on and analyse the **Danube Delta** as a **UNESCO World Heritage Site**, representative for **EUROPE**. To this end, each member state in the project can produce a material (article, case study, questionnaire, ppt.etc.) focused on the theme of parks and forests in order to highlight the importance of the area as a **World Heritage Site**.
The practical methods and procedures that can be used in this respect can be included in the following categories: questionnaire, case study, statistical-mathematical methods, investigation, comparison and synthesis method for the production of audio-video information materials (scientific documentary films), documentary materials, use of digital applications/technology and internet.

3.3.1. Use of the statistical-mathematical method

An example of the use of the statistical-mathematical method together with the students involved in the project can be represented by an activity that aims to characterize the biodiversity of the cities

along the Danube River (in the territory of each country involved in the project) according to certain criteria: parks present in the area, forests present in the area, endemic species (present only in the area) and endangered species.

No. crt.	Country participating in the project	ROMANIA	FRANCE	CROATIA	ITALY	PORTUGAL
1.	Towns along the Danube	Sulina Tulcea Galați				
2.	Parks present in the area	Vegetation on arms and canals				
3.	Forests present in the area	Letea Forest				
4.	Endemic species	Lianas Vineyard Sea cabbage Sturgeons				
5.	Endangered species	Lianas Sturgeons				

3.3.2. Use of investigation and digital technology

Educational interactions highlighting the importance of biodiversity can also be achieved through the use of investigation, comparison and synthesis, combined with the use of digital technology. In this sense, relevant for the students involved in the project from the perspective of a constructive dynamic, resulting from the combination of digital resources, is the design and realization of an activity to obtain, as final products, documentary or video materials.

The materials can be component parts of a group portfolio or can take the form of digital resources. The topics addressed in this case can be: comparative aspects of specific urban forests in the world, analysis of urban forests at the level of continents, comparison of urban parks in different continents, leaflets/posters of representative urban parks in Europe or the country participating in the project, etc.

Highlighting the unique elements of biodiversity in different parks or urban forests around the world, through the medium of the internet and digital technology, facilitates learning in other contexts and contributes to the development and practice of key competences: learning to learn, communication in mother tongue and foreign languages, basic skills in science and technology, digital skills.

Among the multitude of digital applications, we mention a few that can be used in work with pupils: Coogle, Padlet, Powtoon, Canva, Inkscape, Crello, Imovie, etc.

3.4. Urban forests and parks in Europe. Practical issues and solutions.

Taking into account the theoretical part in our study we can apply different questionnaires to address this issue. For example we can apply the questionnaire below to assess the point of view of each participating country in this project.

3.4.1. Questionnaire - city parks and forests

1. What is the most common category of city parks found in Europe?
2. What is the most common category of city forests in Europe?
3. Which category of parks has the highest biodiversity?
4. Which category of forests has the highest biodiversity?
5. Which category of park is most valued by the population in your country?
6. Which category of forest is most valued by the population in your country?
7. Which parks preserve endemic or endangered species?
8. Which forests conserve endemic or endangered species?
9. How many ECO-BIO products from companies that promote conservation and enhancement campaigns and biodiversity enhancement products do you use?
10. In your opinion, what do you think are the forests/parks of the future?

3.4.2. Statistical methods

Statistical methods can be used to emphasise the number of city forests and parks from different states, at a European level. For example:

No. Crt.	Participating states	Romania	France	Croatia	Italy	Portugal

1	The highest number of city forests					
2	The lowest number of city forests					
3	The highest number of city parks					
4	The lowest number of city parks					

3.4.3. Case study

A practical application, in relation to urban forests and parks at European level, can be approached by each country participating in the project, by producing a material (article, report, ppt. etc.) with the most representative park/forest at European level, from its point of view.

3.4.4. The use of IT

The use of IT can be addressed at all stages of the project (documentation, implementation and presentation of activities, evaluation) by:

- The creation of a common European website to promote biodiversity;
- Publicity spots promoting biodiversity;
- Biodiversity promotion campaigns in city parks and forests through the distribution of information leaflets.

3.5. Urban forests and parks at a national level. Practical aspects and solutions.

Biodiversity conservation is one of the most important issues at international and national level as human impact on the biosphere has intensified. Thus, maintaining biodiversity is necessary both to sustain life today and for future generations because it directly meets basic human needs by providing oxygen, food and drinking water. Recently, the awareness of biodiversity degradation has encouraged

the international community to try to remedy this issue through various positive actions because a human being can also influence nature for the better by actively engaging in the environmental protection.

Environmental education is a part of education which, through a system of specific actions, ensures the formation of an environmental awareness which is the basis of environmental conduct or ethics. It is therefore necessary to teach children why and how nature should be protected, and not just in theory.

Pupils need to be actively involved in many activities that directly concern man-made environmental problems. It is only through active involvement that young people will be able to identify and understand the relationship between man and nature and the close links between environmental quality and the quality of life and health.

To this end, we want to develop students' knowledge by further informing them about the importance and protection of the environment and their active and responsible participation in environmental actions. The discovery of our country's biodiversity can be achieved through multiple **educational field trips and thematic camps** organised together with the students in different locations. The expected results are the formation of observation skills, the discovery of negative ecological aspects and the cultivation of environmental education for the protection and maintenance of a healthy environment. In this sense, we propose through this guide to carry out educational excursions in each participating country, for which we offer as a model an example made by us.

3.5.1. Educational field trip

It is a teaching activity based on interdisciplinarity and teamwork. Pupils participate in this type of activity with a lot of enthusiasm and optimism compared to classroom activities.

An example of a field trip project carried out with 8th grade students from our college in Iași county:

Field trip plan

Date and duration of the trip: one day

Trip theme: Biodiversity

Itinerary: Suceava - Iași - Suceava

Type of field trip: excursion to get to know the natural components of the geographical landscape and to identify biodiversity in urban parks and forests

Classes: "Mihai Eminescu" National College, 8th grade

Target group: 33 students from class VIII- A

Organiser: teacher Iurea Cătălina

Partner: Transport Company

Accommodation unit: - if applicable

Service package - transport

Aim: development of the spirit of observation, formation of skills (orientation in the field, discovery of the main natural objectives in the visited cities, identification of the characteristics of the studied ecosystems, connection of theory with practice).

Objectives:

- To stimulate interest in different plant and animal species;

- to develop creativity by making posters/flyers on the theme of environmental protection;

- to develop pupils' skills and inclinations in different fields;

- developing responsible behaviour towards the environment and its protection;

- preventing and combating negative attitudes of destruction, negligence, carelessness in their environmental activities;

- awareness of the consequences of their own behaviour on the environment;

- improving relations between pupils by encouraging teamwork.

Presentation of the Main Visited Objectives

- **Preparing the field trip**

  1) Announcement of the topic: one month before it is carried out.

  2) The preparation of the students for the trip was done in several project meetings with students and parents.

- **The field trip development**

Field trip- SUCEAVA- IAȘI

Departure time: 8.00

11.00: Arrival in Iași

12.00: Visiting the main parks in Iasi: Unirii Park, Copou Park and "Anastasie Fătu" Botanical Garden. During these visits, the students have to locate the parks geographically, to analyse abiotic factors, to identify the main species of plants and animals existing in the respective ecosystem; to collect natural material (leaves, flowers, seeds, fruits) which will be used in the laboratory to draw conclusions about the **biodiversity** of the studied areas.

Unirii Park: Unirii Park from Iași is one of the largest and most beautiful parks in the city. Located in the centre of Iasi, this historic park is popular with locals and tourists alike. The flora and fauna of Unirii Park from Iași are varied and provide a habitat for a range of plant and animal species. The park is adorned with a variety of trees, such as oaks, lindens, beeches, chestnuts and acacia trees. These trees provide shade and create a pleasant environment for visitors. The park is home to a variety of shrubs and herbaceous plants such as roses, lilacs, azaleas, hydrangeas and irises. Due to the presence of lakes and fountains in the park there are also species of aquatic vegetation. These can include water lilies, bulrushes, reeds and other wetland plants.

The park is also a great place for bird watching. Here you can see various species including sparrows, crows, blackbirds, robins, nightingales, thrushes and more. Birds can be found in the trees, on the lakeshore or on the park's lawns. Some species of mammals (squirrels, rabbits and field mice) can also be found in Unirii Park. The park can also be home to reptiles and amphibians such as lizards, toads, green frogs.

Copou Park: with predominantly arboreal vegetation, with eco-protective value, the park contributes significantly to air quality and the maintenance of local biodiversity. The main background is composed of linden, ash, acacia and maple. In addition to trees, the park's flora is also made up of shrubs. The dominant species are forbs, jasmine and lilac.

The flora of Copou Park is diverse, with the rich vegetation providing a natural habitat for various animal species. The most common mammal is the red squirrel, which can easily be spotted in every part of the park. The bird population is much more diverse, with the park home to hundreds of birds such as the house and field sparrow, pipit, sandpiper, blackbird, wren, pigeon and starling. As well as species common in other parts of the city, the park is also home to other species less common in the area such as finches and flycatchers, which are evidence of the biodiversity of the place.

”Anastasie Fătu” Botanical Garden: This is the oldest botanical garden in Romania, founded in 1886 by Anastasie Fătu. It covers an area of 5 hectares, on which about 2000 species of plants are systematically arranged. There are 12 greenhouses, each dealing with one aspect of the world's flora and vegetation: Mediterranean, tropical, subtropical and ornamental plants. The Botanical Garden of Iași is organised in 10 sections: systematic, phytogeographical, greenhouse complex, flora and vegetation of Romania, forest of Moldavia, biological, useful plants, dendrarium, ornamental, rosarium.

- **Systematisation of Knowledge**

1) Impressions and general feedback.

2) Put together a *Project Video / PPT Presentation* detailing the ecosystems studied. Specify the location, type of ecosystem, description of the biotope, identification of the predominant species/species, their classification and highlight their importance in the biocene.

All teaching methods will be used during the trip, **but observation, learning by discovering, questioning, demonstrating with natural material are at the forefront**.

3.5.2. “Let`s do it Romania!” National Campaign

Another way to address biodiversity in practice in relation to urban forests and parks at national level is to launch a national campaign in each member state on a specific day. The campaign focuses on planting, maintaining and promoting urban parks and forests, promoting spots on the theme in the media.

3.6. Practical aspects and solutions at a local level-city parks and forests

As part of the ERASMUS+ "LEAF" Project, together with the students we carried out a research activity in which we identified, classified and characterised the biodiversity of forests, parks, gardens, squares, green spaces, terraces. Thus through activities included in the biology lessons as well as through outdoor activities we made the following classification: park forests, parks for relaxation and recreation, parks of the square type, city gardens.

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3.6.1. Forests Park

3.6.1.1. Zamca Forest-Park

It is an artificial forest planted in the 1970s, as a protective curtain against noxious substances in the industrial area of Șcheia, in the north-western part of Suceava municipality, on the Șeptilici hill (384m altitude, 80 m above the Suceava valley). It is a mixed forest (coniferous and deciduous) and it includes monuments of historical value: Zamca Monastery, the ruins of the fortress of Șcheia built at the end of the 4th century by Petru I Mușat, of which only the tower on the north-west side remains today.

TYPE: SEMINATURAL ECOSYSTEM - it depends on the human management.

Until 2018 it belonged to the Pătrăuți Forestry Office and after numerous approaches it was transferred to Suceava **City Hall**.

- BIOTOPE - is represented by brown, light brown soils and chernozyom;
  - **The temperate-continental climate,** with its four seasons, has suffered in recent years due to global warming and the greenhouse effect, so that extreme weather phenomena have been recorded: snow in May, hail, heavy rains that led to the erosion of some slopes and landslides (part of the hill in front of Zamca Monastery has slipped and covered the paths and a natural spring). Climatic instability is observed**. Temperatures** vary widely from season to season and

over 24 hours. There is increasing thermal instability affecting the biorhythms of plants and animals.

- BIOCENOSIS - includes a large number of plant species and increasingly more animal species (as species have adapted from the anthropised environment and vice versa).

Here are the most important species for these ecosystems.

Zamca Forest comprises:

- ***Conifer species***: **family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea abies), **fir** (Abies alba), **larch** (Larix decidua);
- ***Deciduous species***: **Family Leguminosae - willow** (Robinia pseudoacacia), **Family Aceraceae - mountain ash** (Acer pseudoplatanus), **Family Hippocastanaceae - horse chestnut** (Aesculus hippocastanum), **Family Betulaceae - birch** (Betula pendula), **Hazel** (Corylus avellana), **Family Fagaceae - beech** (Fagus sylvatica), **oak** (Quercus robur), **Family Juglandaceae - walnut** (Juglans regia), **Family Tiliaceae - lime** (Tilia cordata), **Family Salicaceae - white poplar** (Populus alba), **hornbeam** (Salix sp.), **white wicker** (Salix alba), **willow** (Salix fragilis), **Oleaceae family - ash** (Fraxinus excelsior);
- ***Species of subterranean fungi*** that live in exomycorrhizal symbiosis with the roots of wooden plants which thus become more resistant to diseases and pests and have a richer crown with a more abundant leaf mass because these mycorrhizal fungi provide them with mineral salts and even exchange organic substances.

  These fungi are included in the **genus Elaphomyces** and we have identified the following **species**: **Elaphomyces leveillei** - prefers shallow-sloping sandy-clay soils and as biotope deciduous (beech, hornbeam, maple) and coniferous (spruce, pine, fir) mixed forests, **Elaphomyces cetaceae** - species preferring biotope with smooth-sloping sandy-clay soils and biocene of deciduous mixed forests (beech, oak, ash) and conifers (pine, spruce, fir), **Elaphomyces ness** - prefers biotopes with shallow sloping sandy-clay soils and good water run-off without stagnation. The biocenosis of deciduous and mixed forests.These species are not edible like truffles and are used to strengthen the "health" of the trees with which they are in symbiosis.They grow all year round and are perennial.

- ***Fruit tree species*** - **Family Rosaceae** – **apple** (Malus pumila), **pear** (Prunus domestica), **mountain ash** (Sorbus aucuparia), **cork tree** (Prunus cerasifera var.cerasifera), **cherry** (Cerasus avium);
- ***Shrub species***: **Family Rosaceae** – **dog rose** (Rosa canina), **hawthorn** (Crataegus monogyna) **Family Caprifoliaceae** – **elder** (Sambucus nigra), **boxwood** (Sambucus ebulus), **Family Oleaceae** – **lilac** (Syringa vulgaris), **dogwood** (Ligustrum vulgare), **bloodwood** (Cornus sanguinea)
- ***Shrub species*** - **Family Rosaceae - blackberry** (Rubus fruticosus), **raspberry** (Rubus idaeus);
- ***Herbaceous species***:
- ***Earth moss*** (Marchantia polymorpha), **common earth moss** (Polytrichum commune);
- ***Ferns*****-horse tail** (Equisetum arvense);
- ***Spring blooming plants:***

  Class Monocotyledons - Family Amaryllidaceae – snowdrop (Galanthus nivalis**), Family Liliaceae – bluebell (**Scilla bifolia**), Family Primulaceae - cuckoo's thistle (**Primula veris**);**

  Class Dicotyledons - Family Ranunculaceae – wheatgrass (Ficaria verna**), common vetch (**Hepatica transsilvanica**), common lamb's lettuce (**Coridalis solida**), Easterflower (**Anemone nemorosa**), crowberry (**Gagea sp.**), Fam. Compositae - dandelion (**Taraxacum officinale**), little chamomile (**Belis perenis**), poplar (**Tusilago farfara**), Family Violaceae - violet (**Viola odorata**), Family Scrophulariaceae – little lizard (**Veronica chamaedrys**), Family Cruciferae - shepherd's teat (**Capsella bursa-pastoris**), cow's thistle (**Lepidium draba**);**
- ***Summer blooming plants***
- **Compositae family** - **Chicory** (Cichorium intybus), **daisy** (Chrysantemum leucanthemum), **mousetail** (Achillea millefolium), **white wormwood** (Artemisia absinthium), **burdock** (Arctium lappa), **crucifer** (Senecio vulgaris), **cornflower** (Centaurea cyanus), **thistle** (Carduus natans), **Cypress** (Cirsium arvense), **fairy thistle** (Carlina acaulis), Leguminosae - **red clover** (Trifolium pratense), **white clover** (Trifolium repens), Labiatae - **field basil** (Prunella vulgaris), **sage** (Salvia officinalis), **eggplant** (Ajuga reptans), **roundwort** (Glecoma hederaceum), **thyme** (Thymus serpillum), Family Boraginaceae - **snake weed** (Echium vulgare), **wild thyme** (Myosotis ssilvatica), Family Solanaceae - **St. John's wort** (Solanum nigrum), Family Euphorbiaceae - alior

(Euphorbia cyparissias), Family Hypericaceae - **St. John's wort** (Hypericum perforatum), Family Papaveraceae - **poppy** (Papaver rhoeas), **tumbleweed** (Chelidonium majus), (Chrysantemum leucanthemum), **mousetail** (Achillea millefolium), **white wormwood** (Artemisia absinthium), **burdock** (Arctium lappa), **crossbill** (Senecio vulgaris), **cornflower** (Centaurea cyanus), **thistle** (Carduus natans), **hawthorn** (Cirsium arvense), **fairy thistle** (Carlina acaulis), Family Leguminosae - **red clover** (Trifolium pratense), **white clover** (Trifolium repens), Family Labiatae - **field basil** (Prunella vulgaris), **sage** (Salvia officinalis), **eggplant** (Ajuga reptans), **roundwort** (Glecoma hederaceum), **thyme** (Thymus serpillum), Family Boraginaceae - **snake weed** (Echium vulgare), **knotweed** (Myosotis ssilvatica), Family Solanaceae - **St. John's wort**(Solanum nigrum), **Family Euphorbiaceae – alior** (Euphorbia cyparissias), Family Hypericaceae - **St. John's wort** (Hypericum perforatum), Family Papaveraceae – **poppy** (Papaver rhoeas), **celandine** (Chelidonium majus), Family Cariyophyllaceae - **pigeon's goosefoot** (Silene vulgaris), **carnation** (Dianthus carthusianorum), **wood sorrel** (Verbascum thapssus), **linaria** (Linaria vulgaris), Family Malvaceae – **knapweed** (Malva sylvestris), Family Convolvulaceae - convolvulus(Convolvulus arvensis), **Family Asclepidiaceae – lady's bedstraw (**Galium verum**), Greater plantain (**Plantago maior**), Old-growth (**Erigeron annuus**), Sparkleweed (**Anagallis arvensis**), Family Violaceae -** pansy **- (**Viola tricolor**), Family Geraniaceae – cranefoot (**Erodium cicutarium**), snowberry (**Geranium robertianum**), Family Linaceae – flax (**Linum usitatissimum).

- **Family Gramineae - common meadow-rue (**Poa pratensis**), creeping pyrene (**Agropiron repens**), common meadow-rue (**Dactylis glomerata**), foxglove (**Alopecurus pratensis**), common meadow-rue (**Bromus inermis**), common sedge (**Lolium perene**).**

Pictures from the activities

3.6.1.2. ”Șipote” Dentrological Forest Park

It is located in the SE part of Suceava municipality and comprises 7 hectares of land in the hilly area. It was established between 1975 and 1977 as a protective fence for the Burdujeni industrial area. The land was divided into 4 vegetation sectors and was conceived as a dendrological park with: mountain vegetation (1.95 hectares), hill vegetation (2 hectares), lowland vegetation (1.35 hectares) and meadow vegetation (1.70 hectares), for the part that includes the Suceava river meadow. Initially about 95% of the area was planted with coniferous and deciduous seedlings. It is considered the zero point of Suceava and includes the Citadel of Suceava from the time of the ruler Stephen the Great, the equestrian statue of the ruler Stephen the Great, the Wood Museum, the Dendrological Park and the Tătărași Park.

TYPE: SEMINATURAL ECOSYSTEM - is managed by humans.

- BIOTOPE - - is represented by brown and light brown soils and chernozyom
- **The temperate-continental climate,** with its four seasons, has suffered in recent years due to global warming and the greenhouse effect; thus extreme weather phenomena have been recorded: snow in May, hail, heavy rains that led to the erosion of some slopes. Climatic instability is being observed. **Temperatures** vary widely from season to season and over 24 hours. There is increasing thermal instability affecting the biorhythms of plants and animals.

- BIOCOENOSIS - is rich in both wild and cultivated species**.**

The forest comprises:

- ***Conifer species***: **family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea abies), **fir** (Abies alba), larch (Larix decidua), **juniper** (Pinus cembra), **family Cupressaceae - juniper** (Juniperus communis), **family Taxaceae - yew** (Taxus baccata);
- ***Deciduous species:*** **Family Leguminosae - willow** ***(***Robinia pseudoacacia***),* **Family Acerceae - mountain ash** ***(***Acer pseudoplatanus***),* **Family Hippocastanaceae - horse chestnut** ***(***Aesculus hippocastanum***),* **Family Betulaceae - birch** ***(***Betula pendula***),* **Hazel** ***(***Corylus avellana***),* **Family Fagaceae – beech** ***(***Fagus sylvatica***),* **oak (**Quercus robur***),* **Family Juglandaceae – walnut** ***(***Juglans regia***),* **Family Tiliaceae – lime (**Tilia cordata***),* **Family Salicaceae - white poplar (**Populus alba***),* **hornbeam (**Salix sp**.), white wicker (**Salix alba**), willow (**Salix fragilis**), Oleaceae family – ash (**Fraxinus excelsior**);**
- ***Species of subterranean fungi*** that live in exomycorrhizal symbiosis with the roots of wooden plants which thus become more resistant to diseases and pests and have a richer crown with a more abundant leaf mass because these mycorrhizal fungi provide them with mineral salts and even exchange organic substances.

  These fungi are included in the **genus Elaphomyces** and we have identified the following **species**: **Elaphomyces leveillei** - prefers shallow-sloping sandy-clay soils and as biotope deciduous (beech, hornbeam, maple) and coniferous (spruce, pine, fir) mixed forests, **Elaphomyces cetaceae** - species that prefers biotope with smooth-sloping sandy-clay soils and biocenosis of deciduous mixed forests (beech, **Elaphomyces ness** - prefers biotopes with shallow sloping sandy-clay soils and good water run-off without stagnation. Biocoenosis of deciduous and mixed forests. These species are not edible like truffles and are used to enhance the 'health' of the trees with which they are in symbiosis.
- ***Fruit tree species*** - **Family Rosaceae – apple** (Malus pumila), **pear** (Prunus domestica), **mountain ash** (Sorbus aucuparia), **cork tree** (Prunus cerasifera var.cerasifera), **cherry** (Cerasus avium);
- ***Shrub species***: **Family Rosaceae** – **dog rose** (Rosa canina), **hawthorn** (Crataegus monogyna) **Family Caprifoliaceae – elderberry** (Sambucus nigra), **boxwood (**Sambucus ebulus**), Family**

Oleaceae – lilac (Syringa vulgaris), **dogwood** (Ligustrum vulgare), **bloodwood** (Cornus sanguinea);

- ***Shrub species* - Family Rosaceae - blackberry** (Rubus fruticosus), **raspberry** (Rubus idaeus).
- ***Herbaceous species***:
- **Mushroom - earth moss (**Marchantia polymorpha**), common earth moss (**Polytrichum commune**)**
- **Ferns-horse tail** (Equisetum arvense)
- ***Spring flowering plants:***

  – **Monocotyledons Class - Family Amaryllidaceae - snowdrop (**Galanthus nivalis**), Family Liliaceae - pansy (**Scilla bifolia**), Family Primulaceae - cuckoo's club (**Primula veris**)**

  Class Dicotyledons - Family Ranunculaceae - wheatgrass(Ficaria verna**), wild buckwheat (** Hepatica transsilvanica**), common cocklebur(**Coridalis solida**), Easter flower(**Anemone nemorosa**), crowberry(**Gagea sp. **), Family Compositae - dandelion (**Taraxacum officinale**), English daisy (**Belis perenis**), poplar (**Tusilago farfara**), Family Violaceae - violet (**Viola odorata**), Family Scrophulariaceae - little lizard (**Veronica chamaedrys**), Family Cruciferae - shepherd's teat (**Capsella bursa-pastoris**), cow's thistle (**Lepidium draba**);**
- **Summer blossoming plants:**

  – **Compositae family - chicory (**Cichorium intybus**), daisy (**Chrysantemum leucanthemum**), mousetail (**Achillea millefolium**), white wormwood (**Artemisia absinthium**), burdock (**Arctium lappa**), Common Crucifer (**Senecio vulgaris**), Cornflower (**Centaurea cyanus**), Thistle (**Carduus natans**), Common Cohosh (**Cirsium arvense**), Fairy thistle (**Carlina acaulis**), Leguminosae - Red clover (**Trifolium pratense**), white clover (**Trifolium repens**), Family Labiatae - field basil (**Prunella vulgaris**), sage (**Salvia officinalis**), eggplant (**Ajuga reptans**), roundwort (**Glecoma hederaceum**), thyme (**Thymus serpillum**), Family Boraginaceae - snake weed (**Echium vulgare**), knotweed (**Myosotis ssilvatica**), Family Solanaceae – skunkweed (**Solanum nigrum**), Family Euphorbiaceae - alior (**Euphorbia cyparissias**), Family Hypericaceae - St. John's wort (**Hypericum perforatum**), Family Papaveraceae - Poppy (**Papaver rhoeas**), Rhodock (**Chelidonium majus**), Family Cariyophyllaceae - Pigeon's wort (**Silene vulgaris**), Carnation (**Dianthus carthusianorum**), Wood sorrel (**Verbascum thapssus**), Linaria (**Linaria vulgaris**),**

Family Malvaceae - Mallow (Malva sylvestris**), volbura(**Convolvulus arvensis**), lady's bedstraw (**Galium verum**), pelargonium (**Plantago maior**), elderberry (**Erigeron annuus**), scintillum (**Anagallis arvensis**), Family Violaceae – pansy (**Viola tricolor**), Family Geraniaceae - crane's-tail (**Erodium cicutarium**), snowberry (**Geranium robertianum**), Family Linaceae – flax (**Linum usitatissimum**) Familia Gramineae -common meadow grass** (Poa pratensis), **rhizomes** (Agropiron repens), **cock's foot** (Dactylis glomerata), **meadow foxtail** (Alopecurus pratensis), Bromus inermis, **perennial ryegrass** (Lolium perene).


Equestrian statue of the ruler Stephen the Great. The oak tree in the inner courtyard of the Citadel


Biodiversity in the "St. John the New" Spring area in Suceava

3.6.2. Relaxation and leisure parks

They are included in the perimeter of schools, public institutions (hospital, health clinic, town hall, etc.) as well as in the most important areas of the city.

3.6.2.1. “Mihai Eminescu” National College Park - Suceava

”Mihai Eminescu” National College Park - Suceava

The park comprises the areas adjacent to the school and is organized on an area where in the past there were farms and fertile agricultural land, therefore the soil is rich in humus and the flora includes **120 species of different botanical groups**.

- ***Conifer species***: **Family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea excelsa), **fir** (Abies alba), **larch** (Larix decidua); **Family Cuptressaceae-tuya** (Tuja orientalis);
- ***Deciduous species***: **Family Leguminosae - willow** (Robinia pseudoacacia), **Family Acerceae - mountain ash** (Acer pseudoplatanus), **Family Hippocastanaceae - horse chestnut** (Aesculus hippocastanum), **Family Betulaceae - birch** (Betula pendula), **Hazel**(Corylus avellana), **Family Fagaceae – beech** (Fagus sylvatica), **oak** (Quercus robur), **Family Juglandaceae – walnut** (Juglans regia), **Family Tiliaceae – lime** (Tilia cordata), **Family Salicaceae - white poplar** (Populus alba), **hornbeam** (Salix sp.), **white wicker** (Salix alba), **willow** (Salix fragilis), **Oleaceae family – ash** (Fraxinus excelsior);
- ***Fruit tree species*** - **Family Rosaceae – apple** (Malus pumila), **pear** (Prunus domestica), **mountain ash** (Sorbus aucuparia), **cork tree** (Prunus cerasifera var.cerasifera), **cherry** (Cerasus avium);

- ***Shrub species***: **Family Rosaceae – hawthorn** (Rosa canina), **common hawthorn** (Crataegus monogyna), **bridal veil** (Spiraea vanhouttei), **Family Caprifoliaceae – elder** (Sambucus nigra), **box elder** (Sambucus ebulus), **Family Oleaceae – lilac** (Syringa vulgaris), **dogwood** (Ligustrum vulgare), **bloodwood** (Cornus sanguinea);
- ***Shrubs* - Family Rosaceae – blackberry** (Rubus fruticosus), **raspberry** (Rubus idaeus)
- ***Herbaceous species***:
- ***MOSS*- earth moss *(***Marchantia polymorpha***),* common earth moss *(***Polytrichum commune***)***
- ***FERNS*-horse tail** (Equisetum arvense)
- ***Spring blossoming plants:***
- **Class Monocotyledons - Family Amaryllidaceae - snowdrop** (Galanthus nivalis), **Family Liliaceae - snowdrop** (Scilla bifolia), **Family Primulaceae - cuckoo's thistle** (Primula veris), **Class Dicotyledons - Family Ranunculaceae – wheatgrass** (Ficaria verna), **wild buckwheat** (Hepatica transsilvanica), **Common cocklebur** (Coridalis solida), **Easterflower** (Anemone nemorosa), **Onio**n (Gagea sp.), **Fam. Compositae – dandelion** (Taraxacum officinale), **dandelion** (Belis perenis), **podberry** (Tusilago farfara), **Family Violaceae - violet** (Viola odorata), **Family Scrophulariaceae – little lizard** (Veronica chamaedrys), **Family Cruciferae - shepherd's teat** (Capsella bursa-pastoris), **cow's thistle** (Lepidium draba)
- ***Summer blossoming plants*** – **Compositae family - Chicory (**Cichorium intybus**), daisy (**Chrysantemum leucanthemum**), mousetail (**Achillea millefolium**), white wormwood (**Artemisia absinthium**), burdock (**Arctium lappa**), crossbill (**Senecio vulgaris**), cornflower (**Centaurea cyanus**), thistle (**Carduus natans**), hawthorn (**Cirsium arvense**), fairy thistle (**Carlina acaulis**), Family Leguminosae - red clover (**Trifolium pratense**), white clover (**Trifolium repens**), Family Labiatae - field basil (**Prunella vulgaris**), sage (**Salvia officinalis**), Eggplant (**Ajuga reptans**), Roundel (**Glecoma hederaceum**), Thyme (**Thymus serpillum**), Family Boraginaceae - snake weed (**Echium vulgare**), wild thyme (**Myosotis ssilvatica**), Familia Solanaceae – zârna** (Solanum nigrum), **Familia Euphorbiaceae - alior** (Euphorbia cyparissias), **Family Hypericaceae - St. John's wort (**Hypericum perforatum**), Family Papaveraceae - Poppy (**Papaver rhoeas**), celandine (**Chelidonium majus**), Family Cariyophyllaceae - Pigeon pea (**Silene vulgaris**), carnation (**Dianthus carthusianorum**), common lavender (**Verbascum thapssus**), linnet (**Linaria

vulgaris**), Malvaceae family – common mallow (**Malva sylvestris**), field bindweed (**Convolvulus arvensis**), lady's bedstraw (**Galium verum**), Greater plantain (**Plantago maior**), elderflower (**Erigeron annuus**), scarle pimpernel (**Anagallis arvensis**), Family Violaceae – pansy (**Viola tricolor**), Family Geraniaceae - crane's-tail (**Erodium cicutarium**), snowberry (**Geranium robertianum**), Family Linaceae – flax (**Linum usitatissimum**), Family Plantaginaceae - large plantain (**Plantago major**), narrow plantain (**Plantago lanceolata**); Family Gramineae - common meadow grass** (Poa pratensis), **rhizomes** (Agropiron repens) **cock's foot** (Dactylis glomerata), **meadow foxtail** (Alopecurus pratensis), **perennial grass** (Bromus inermis), **perennial ryegrass** (Lolium perene);

- ***Autumn blossoming plants:*** **Familia Asteraceae – marigold (**Tagetes erecta), chrysanthemum

3.6.2.2."Ștefan Cel Mare" University Park– Suceava

"Ștefan Cel Mare" University Park– Suceava

Type: **Anthropogenic ecosystem**

University Park is the largest park in the Areni neighbourhood and one of Suceava's largest parks. It covers 3 hectares and was established in 1963 and it is linked to the nearby university. In 2011, the park underwent a process of rehabilitation, which led to the introduction of new ornamental species.

- **Conifer species: family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea excelsa), **fir (**Abies alba**), larch** (Larix decidua); **family Cupressaceae - thuja** (Tuja orientalis);

- **Ornamental shrubs-Family Rosaceae - bridalwreath** (Spiraea vanhouttei), **Family Oleaceae-forsythia** (Forsytia europaea), **Family Caprifoliaceae- snowberry** (Symphoricarpos albus), **honeysuckle** (Lonicera caprifolium), **Subfam. Hydrangeoidae-jasmine** (Philadelphus coronarius);
- **Gramineae family - common grass** (Poa pratensis)

3.6.2.3. "Trei Bărboși" Park

TYPE: **Anthropogenic ecosystem**

- **Conifer species**: **family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea excelsa), **fir** (Abies alba), **larch** (Larix decidua); **family Cupressaceae - tuja** (Tuja orientalis), **yew** (Taxus baccata);
- ● ***Ornamental tree and shrub species***: **Family Rosaceae - ornamental plum** (Prunus cerasus), **bridalwrath** (Spiraea vanhoutei), **Family Leguminosae - wisteria** (Wistaria sinenzis), **rose** (Rosa sp.), **Subfam. Hydrageoidae - jasmine** (Philadelphus coronarius)
- **Family Gramineae - common grass** (Poa pratensis).

3.6.2.4. "Ioan Nemeș" Central Park

It is located in the centre of Suceava in the north-western part of the city since the second half of the 19th century, as a result of the city's development, on the land of former farms. It has been redeveloped several times, in 1908 it was given its present form but on 12 November 2009 it was named IOAN NEMEȘ (1924 - 2009) in memory of the remarkable professor of physics and biology.

TYPE: **Anthropogenic ecosystem** which comprises:

- **Conifer species**: **Family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea excelsa), **fir** (Abies alba), **larch** (Larix decidua); **Family Cupressaceae-tuja** (Tuja orientalis);
- **Ornamental species of Family Magnoliaceae - magnolia** (Magnolia sp.), *Family Hyppocastanaceae* - **horse chestnut** (Aesculus hippocastanum), **Family Rosaceae – bridalwreath** (Spyraea vanhoutei), **ornamental plum** (Prunus cerasifera), **rose** (Rosa sp.), **Family Solanaceae - petunias** (Petunia violacea), **Family Violaceae - pansies** (Viola sp.),

- **Family Gramineae- common meadow grass** (Poa pratensis), **Family Liliaceae – tulip** (Tulipa gesneriana), **hyacinth** (Hyacinthus orientalis);
- **Family Ericaceae –ornamental rhododendron** (Rododendron sp.);
- ***MONUMENT OF NATURE*-a red beech** (Fagus sylvatica var.atropurpuraea) with a height of 25 m and a rich and beautiful canopy.
- **3.6.2.5. "Simion Florea Marian" Park**

TYPE: **Anthropogenic ecosystem**

It is located in front of the memorial house of "Simion Florea Marian" ethnographer and folklorist (1487 - 1907). It covers a small area of land.

- **Conifer species**: **family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea excelsa), **fir** (Abies alba), **larch** (Larix decidua); **family Cupressaceae-tuya** (Tuja orientalis);
- **Deciduous species: Family Betulaceae - birch** (Betula pendula), **Family Hypocastanaceae - horse chestnut** (Aesculus hyppocastanum);
- **Family Gramineae - the common grass** (Poa pratensis).

3.6.3. Square Parks

These are **hyperanthropic ecosystems** where **the biotope** is mostly made up of concrete paths and specially landscaped beds for growing ornamental species. They usually have an artesian fountain in the centre of the square.

These parks are located at the city's most important intersections.

3.6.3.1."Mărășești" Square Park

It is located in front of the MPO Health Clinic, in the Mărășești intersection and has a rectangular shape. It has been set up as a recreational space and will undergo extensive redevelopment with European funds. It includes a central pyramid-shaped fountain.

TYPE: **Hyperanthropic ecosystem**

- The BIOTOPE - has been artificially created by laying out paved walkways and decorative paving slabs into which fertile soil has been introduced and artificially irrigated; it has a central pyramid-shaped artesian fountain;

- BIOCOENOSIS - is man-selected and includes a small number of ornamental species.
  - **Conifer species: family Pinaceae - pine** (Pinus sylvestris), **spruce** (Picea excelsa), **fir** (Abies alba), **family Cupressaceae-tuja** (Tuja orientalis), **yew** (Taxus baccata);
  - **Family Magnoliaceae - magnolia** (Magnolia sp.), **pig chestnut**;
  - **Family Rosaceae - bridalwreath** (Spyraea vanhouttei), **ornamental plum** (Prunus cerasifera), **rose** (Rosa sp.), **Family Solanaceae - petunias** (Petunia violacea), **Family Violaceae - pansies** (Viola sp.)
  - **Family Gramineae - the grass** (Poa pratensis), **Family Liliaceae - the tulip** (Tulipa gesneriana), **the hyacinth** (Hyacinthus orientalis).

The park is equipped with dumpsters for a selective collection of rubbish!


”Mărășești” Square Park

3.6.3.2. ”Vladimir Florea” Square Park

It is located in front of the Areni health Clinic, it is rectangular in shape and was established in 1962. It was named after the sculptor from Suceava Vladimir Florea (1922 - 1984) after 2000.

TYPE: **Hyperanthropogenic ecosystem**

- BIOTOPE - artificially created by paved walkways and decorative paving slabs into which fertile soil has been introduced and artificially irrigated; has a central artesian fountain;
- BIOCOENOSIS - is man-selected and includes a small number of ornamental species.

- Conifer species: family Pinaceae - pine (Pinus sylvestris)**, spruce** (Picea excelsa)**, fir** (Abies alba)**, family Cuptressaceae-tuya** (Tuja orientalis)

- Family Rosaceae - ornamental plum (Prunus cerasifera), **rose** (Rosa sp.), **Family Solanaceae – petunias** (Petunia violacea), **Family Violaceae - pansies** (Viola sp.)

- Family Gramineae - grass (Poa pratensis), **Family Liliaceae - tulip** (Tulipa gesneriana), **hyacinth** (Hiacinthus orientalis);

The park is equipped with dumpsters for a selective collection of rubbish !

3.6.4. City Gardens

3.6.4.1. Public Gardens

In the city of Suceava there are no public gardens.

3.6.4.2. Private gardens

TYPE: **Anthropogenic ecosystems**

Private gardens occupy large areas of the city's green spaces and there is a high level of biodiversity due to the citizens' commitment to growing both native and exogenous species.

- BIOTOPE - comprises carefully selected fertile soils adapted to the cultivated species. For example for roses, slightly acid soils. Abiotic factors are carefully controlled by man.
- BIOCOENOSIS

Conifers of the genera Tuja, Pinus, Abies, Juniperus as well as ornamental trees and shrubs of deciduous species of the genera Malus, Prunus, Acer, Juglans, Robinia.

Shrubs include species of the genera Magnolia, Rosa with numerous types and varieties, Syringa, lianas of the genera Vitis, Parthenocissus, plus herbaceous plants of the genera Petunia, Pelargonium, Begonia, Hydragena, Lilium, Narcissus, Paeonia.

Biodversity. Private gardens.

3.6.4.3. Green space gardens in residential areas

TYPE: **Anthropogenic ecosystems**

These spaces occupy a generous place in the cityscape because they are a thermal and anti-pollution filter for the tenants as well as recreational spaces.

The predominant coniferous species are pine, spruce, fir, juniper and deciduous - birch, chestnut, walnut, lime, acacia, maple, ornamental plum, Japanese quince and herbaceous plants of the families: Gramineae, Compositae, Solanaceae.

Anthropogenic ecosystems

3.6.4.4. Vertical Gardens

Covering balcony and terrace gardens, they are a future alternative for increasing biodiversity.

TYPE: **Hyperanthropogenic ecosystems**

- *The biotope* is entirely provided by man and is controlled by man according to the cultivated species.

Biodiversity. Vertical gardens/balcony gardens

- *The bioceonosis* comprises carefully selected ornamental species from the genera Tuia, Vitis, Partenocissus, Hedera, Begonia, Pelargonium, Asparagus, Aloe, Phalenopsis, Rosa.

3.6.5. Preliminary conclusions

Forests and urban parks play extremely important roles for the urban habitat and its neighbourhoods, through the landscape pattern of the city, their impact on the urban microclimate, population and economy, and by ensuring biodiversity and the well-being of the population.

The significant value of urban forests and parks in terms of preserving biodiversity, through the opportunities provided by their multiple functions, must also be linked to ensuring the quality of life in urban environments, which, through its multidimensional values, is directly proportional to the well-being of the population.

The major problems of the world's cities, such as population growth, air pollution, congestion and heavy traffic, and waste management, are often compounded by a reduction in the amount of green space, or its reduction in favour of land for new construction.

Although they vary worldwide due to climatic or relief conditions, the evolution of urban space over time, the involvement of local governments, or trends in landscape architecture and urban forestry, urban forests and therefore urban parks contribute to reducing air pollution, regulating temperatures and humidity, and providing the "green infrastructure" necessary for a healthy and sustainable urban environment.

The complexity of the demographic, socio-cultural, environmental and economic effects of urbanisation requires strong political, administrative, individual and community behaviour, actions and initiatives. Support through environmental education to raise awareness of the benefits of green spaces, forests and urban parks is essential.

Maintaining and preserving biological diversity, reducing the degradation of natural habitats, restricting the spread of invasive species and promoting optimal functional relationships between urban and non-urban areas must remain key priorities for contemporary cities in the context of significant environmental change.

Certainly, along with the varied understandings of concepts and typologies discussed in this material, the significant roles that urban forests and parks play will be important and will challenge the

designers of the cities of the future, or "smart cities", in achieving a balance between technology, environment and population health.

In urban environments, biodiversity is most often limited, so the need for green space of any kind, in the context of current climate change and achieving urban sustainability, is crucial to ensuring the future well-being of the population, maintaining ecological balance and preserving biodiversity.

CHAPTER IV. IMPLEMENTED SOLUTIONS

EXAMPLES OF OUTDOOR ACTIVITIES which can be carried out in biology lessons in nature as well as in extra-curricular activities.

4.1. Educational-hiking

It is an active-participatory method in which students travel to a predetermined location to study city parks and forests. Coordinators determine the route and the procedure to be followed in the field.

For example-hiking in the Zamca forest (in the Mărășești neighbourhood, where the school is located):

- Route: school - Zamca forest - school

- Activities with students:

- *Photographing the area to capture different phenotypes*
- *Articles based on field activities*
- *Species identification using determiners, atlases, on a statistical basis*
- *Green activities*
- *Planting activities*
- *Activities to set up canteens for different animals*
- *Reports on abiotic factors influencing the biocoenosis of the area*
- *Information leaflets*
- *Product fairs*
- *Green board*

4.2. Eco – photography

It is an active-participatory method through which students apply the ecological concepts studied and capture different aspects related to the interaction between biotope and biocoenosis factors. It is said that *"a picture is worth a thousand words"*.

Photo no.-1 - captures the return of the wading birds (swallows) to their nest and the rearing of the young.
Photo no.-2 - captures the first plants to bloom in spring - snowdrops.

4.3. Articles based on field data

The production of articles based on information material obtained in the field is an active-participatory method that develops students' creativity, imagination, desire for documentation and information, and ability to relate to community members.

For example:

Biodiversity conservation

Prof. Camelia Macarie

”Mihai Eminescu”National College, Suceava, Suceava County

Motto: *„Mens sana in corpore sano in loco sano.”*

In the current context, when a global trend of biodiversity reduction due to climate change is observed, in our school there is a concern to raise students' awareness of the importance of maintaining it and especially for the preservation of some truly valuable species of Romanian flora and fauna.

An easily noticeable change is the adaptation of wild species to human conditions. Recently, we have noticed more and more that animals in this category are conquering the human habitat: bears, foxes, hedgehogs, mice, rats, ravens, seed crows, wrens, pipits, coyotes, coypu, etc.

Self-education in this area is based on a passion that often arises in childhood when for various reasons we make contact with these species, connections so beautifully described by our writers in their poems and stories.

Over the years we have met many students who are passionate about nature, the valuable species of Romanian flora and fauna. We have extended this concern through national and international projects. In the framework of these projects, the students have developed in-depth studies on protected plant species from the wild flora: orchids (lady's slipper - Cypripedium calceolus, robin's blood - Nigritella nigra, cow's slipper - Orchis morio, poroinic - Orchis maculata, beehive - Pletantera bifolia), gentians: Earth glade - Gentian asclepiadaea, Yellow gentian - Gentiana lutea, Romanian peony - Paeonia peregrina var. romanica. Through these studies we have highlighted the fact that we have a flora very rich in rare species, useful for our health because of the products they naturally produce and which we exploit without disturbing their ecology. To a large extent, students are also attached to wild animals, and for some, their in-depth study has developed into a real passion. For example, a 5th grader studied

wild birds that have adapted to the human environment (the coot, jay, pipit, mockingbird, seed crow, etc.) and found that major differences in their ethology emerged.

Together with another keen 9th grade student, I produced a piece of material on a native bee species - Apis melifera carpatica. Since the time of the Dacians, bee products have been recognised as a panacea for health. This student was encouraged by his family to learn more about bee biology and to develop a business. Starting from one hive, with one family of bees, today he looks after 18 hives and tells us with great dedication about the bee products he has obtained and very importantly, in class and in school we have been able to promote these products and demonstrate their role in preventing and treating illnesses.

We have developed a passion for the preservation and promotion of wild flora species because honey is obtained from acacia, lime, rape, dandelion, various flowers - polyfloral honey, manna honey and of course from other plant species which, with the help of bees, are pollinated and therefore spread or are maintained in the area.

These pupils must be encouraged and promoted as a hope for a green future.

(Article published in the volume *PARTNERSHIP IN ENVIRONMENTAL EDUCATION,* published by *CCDG – BUCUREST)*

4.4. Species identification activities based on statistics

Statistically based species identification is an active-participatory method whereby data collected in the field are processed mathematically, statistically, and computationally. A series of sheets describing each species can be produced through the activity. The example below is an analysis sheet of the species in the local horizon, in relation to the number of individuals, age, type of soil on which the species occurs and other environmental conditions. The statistical data collected in the field can be exploited by producing statistics using different software or digital applications.

NO. CRT.	SPECIES *TREES*	NO. OF SPECIMENS	AGE	TYPE OF SOIL	TEMPERATURE	HUMIDITY	PH
1.	Fir	1	7	pale	0-20 C	high	7

2.	Spruce	5	7	pale			
3.	Pine						
4.	Thuja						
5.	Larch						
6.	Juniper						
7.	Ginkgo biloba						
8.	Magnolias						
9.	Lime						
10.	Maple						
11.	Birch						
12.	Walnut						
13.	Chestnut						
14.	Oak						
15.	Sessile oak						
16.	Mountain ash						
17.	Apple						
SHRUBS							
1.	Boxwood						
2.	Liliac						
3.	Bridalwreath						
4.	Bloodtwig						
5.	Snowberry						
6.	Jasmine						
7.	Japanese spindle						
8.	Weeping forsythia						
HERBACEOUS PLANTs							

1.	Dandelion						
2.	Tansy						
3.	Common Yarrow						
4.	Camomile						
5.	White nettle						
6.	Nettle						
7.	Prunella						

4.5. Green activities

Green activities can be active methods for students to identify the main categories of pollutants in parks and gardens and their impact on biotic factors.

Materials needed: household bags, disposable gloves, waste recovery bins.

How to work: students coordinated by teachers collect waste selectively in the parks and forests covered by the project. The waste (paper, cardboard, aluminium cans, plastics) is then handed in separately to specialised centres.

4.6. Planting activities

We see **planting activities** as a way to develop civic and aesthetic skills in students in terms of landscaping.

Necessary materials: hoes, season plants – in the spring: snowdrops (Galanthus nivalis), crocuses (Crocus sp.), hycinths (Hyacinthus orientalis), daffodils (Narcisus poeticus), lilies (Lilium candidum), tulips (Tulipa gesneriana).

How to do it: students arrange and plant ornamental plants in the established spaces/beds, thus contributing to maintaining and increasing biodiversity.

4.7. Setting up canteens for different animals

This is an active-participatory way for students to contribute to maintaining biodiversity.
Materials needed: canteens made from recyclable or non-biodegradable materials (plastic, polystyrene, aluminium, etc.), seeds, food specific to the beings in the area;
How to do it: pupils go to the field where they set up these canteens and regularly supply them with specific foodstuffs; pupils can then carry out in-depth studies on the biodiversity of the areas in terms of the type of feeding.

4.8. Reports

Reporting is an active-participatory method by which students provide scientific information and documentation for the whole school and social community.
Materials needed: camera, scientific bibliographic material needed for the documentaries.
How to do it: students capture some aspects related to climatic changes in the area and the behaviour of beings according to the proposed theme; students analyse the biodiversity of city parks from multiple perspectives (statistics, species inventory, reduction of the range of some species, presence of invasive species, etc.).

4.9. Information leaflets

Making information leaflets is an active-participatory method for students to inform the community about the importance of certain species in city parks and forests. Students make leaflets with scientific and illustrative information from the parks under consideration.
Materials needed: cameras, plant species determiners, ecology kits, colour printers.
How to do it: pupils go into the field where they capture vegetation in different phenotypes. They produce information materials to inform the whole school and local community.

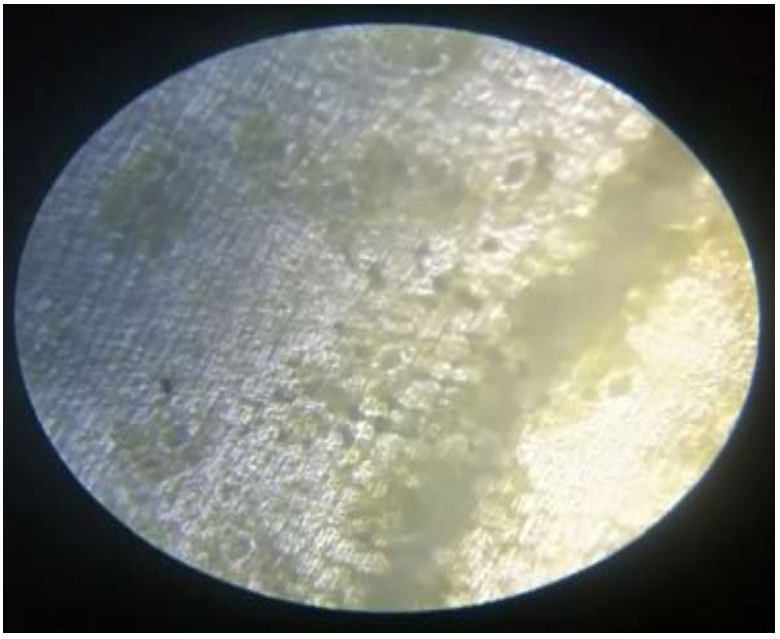
4.10. Experimental activities

Experimental activities are active-participatory methods through which students capture certain cytological aspects due to physiological changes caused by variations in environmental factors.

- ***Microscopy:***
- *Materials needed****: WE-LAB*** in which we used lenses and microscopy equipment, glass slides, water beakers, scalpel, staining reagents.

How to do it: Students analysed field samples under a microscope and carried out a comparative study of examples:

- Shape and size of pollen grains in different ornamental plants: snowdrop, tulip, lily, crocus, hyacinth, musk (harvested in March 2023);
- Biological material should be harvested from the field at full maturity so that it shows the morphological and physiological characteristics specific to these plants;
- Measured stomata number density according to species and biotope factors - conifers: fir, spruce, thuja, larch, yew (harvested in March 2023). They also analysed the leaves of spring plants: lily, musk, hyacinth, snowdrop, etc.
- These analyses have been transmitted online through the WE-LAB programme



EX.-1 - Measurement of the number of stomata in the epidermis of conifers

Ex.2- Measurement of the number of pollen grains in the flowers of different plant species in accordance with the variations in the abiotic factors.

- ***Photometry***
- *Materials needed:* WE-LAB equipped with photometric lenses and necessary cuvettes, specific reagents, pistil mill, crushed glass, 90% alcohol for cold extraction.

- *How to do it:* Students collect samples from the field conifer leaves, spring plants and wet for extraction then use the photometer to indicate the presence and concentration of chlorophyll or anthocyanin pigments, depending on the variations of environmental factors

Determination of Ph for the soil types from which we took the plant samples.

Materials needed:

- ecology kit with Ph-meter paper, reagents, analysis containers;
- Soil samples from the parks under study;

How to do it: Students go to the field where they take different soil samples and analyse them by taking the Ph with the ecology kit. The students found that the soils analysed have neutral Ph so they are optimal for life.

4.11. Products fair

The creation of a product fair can be an active - participatory method through which students can showcase the products made during the project.

Materials needed: stands, promotional leaflets, samples of organic products

How to do it: students make different handmade and organic products and promote them on these stands.

4.12. Green board

It is an active-participatory method through which students advertise the products they have made in the school community.

Materials needed: information board, photos, posters with environmental messages;

How to do it: pupils display the products they have made during the project on this board.

5. The use of we-lab in the project

1. Investigating the biodiversity of city parks and forests by analysing pollen grains for different species in different phenotypes

Investigation method: sampling the natural biological material at different flowering times during a day (morning, noon, evening) and measurement of the atmospheric air temperature at these times of the day, given the large fluctuations recorded recently due to global warming.

Pollen grains are observed, photographed and counted in the microscopic field.

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, pH meters, tweezers, scissors)
- Thermometer
- Pipette, water (H2O)
- Microscope
- Camera
- Laptop

How to do it: Students collect biological material at certain times in the morning (8-10), noon (10-14), and evening (16-20). Pollen grains are extracted with tweezers and placed on a glass slide in a drop of water for a microscopic preparation. The preparation is placed under the microscope, photographed and then the grains in the microscopic field are counted and differentiated by size, shape, colour, etc.

Preliminary conclusions:

- Spring blossoming plants (snowdrops, violets, tulips, lilies) have a higher number of mature pollen grains in the morning at temperatures of 0-8 degrees Celsius.
- Summer blossoming plants (dandelion, dandelion, mousetail, etc.) have a higher number of mature pollen grains in the afternoon at 16-25 degrees Celsius;
- Plants that bloom in the evening (night queen) have a higher number of mature pollen grains at 16 - 20 degrees Celsius in the evening.
- This aspect, analysed and investigated in this way, is very important for biodiversity as it favours the reproduction and spread of plants. The sudden temperature changes we have been experiencing lately affect plant pollination, fruiting and dissemination.

2. The study of the density of stomata number in the lower leaf epidermis of different species in accordance with temperature at different times of the day

Method of investigation: collection of biological material (leaves) from different species.

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Thermometer
- Scalpel
- Pipette, water (H2O)
- Microscope
- Camera
- Laptop

How to do it – -Students pick up the leaves of these plants and use a scalpel to remove the lower skin. A microscopic preparation is made which is analysed and photographed under a microscope. The density of the stomata and their appearance (closed or open) are counted.

Preliminary conclusions – At temperatures above 30 degrees Celsius most plants close their stomata as a form of self-protection. If the drought continues the leaves practically dry out green on the plant.

3. Concentration of chlorophyll pigments in leaves of different plant species

Investigation method – Students collect leaves of different ornamental species at different times of the day.

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Thermometer
- Scalpel
- Pestle and mortar
- Crushed glass
- Ethyl alcohol/acetone
- Pipette
- Photometer
- Camera
- Laptop

How to do it – Students pick up the leaves at different times of the day and then dip them in the pestle and mortar and add crushed glass until they obtain a fluid paste. Ethyl alcohol or acetone is then added. The resulting solution is filtered and placed in the cuvette of the photometer. The graph is recorded.

4. Variations in concentration of anthocyanin pigments in flowers of some plant species in accordance with the temperature and light intensity.

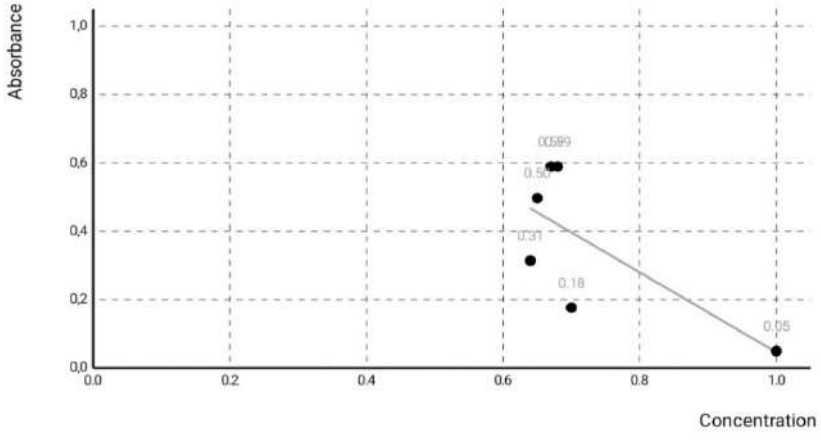
Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, pH meters, tweezers, scissors)
- Thermometer
- Scalpel
- Pestle and mortar
- Crushed glass
- Ethyl alcohol/acetone
- Pipette
- Photometer
- Camera
- Laptop

How to do it – Students pick up the flowers of these plants and analyse them photometrically.

Preliminary conclusions – the amount of pigment differs depending on the species and the time of day the sample was taken.

For example:



Thuya leaf extract

5. The study of the presence of lower plants (mosses, ferns) in the ecosystems studied in accordance with the pH of the soil following rainfall.

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Thermometer
- Scalpel
- Pipette, water (H2O)
- Microscope
- Camera
- Laptop

How to do it: Students measure the pH of the soil after each rain and then pick up lower plants and analyse them under a microscope. They observe moss and fern spores and their development. Students make microscopic preparations, take photos and compare samples.

Preliminary conclusions – if there is no rain and drought these plants do not produce spores and the spores produced do not germinate.

6. Concentration variations of chlorophyll pigments in algae found in the pools of these city parks and forests in accordance with the pH in water, especially after rainfall.

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Thermometer
- pH meter
- Scalpel
- pestle and mortar
- Crushed glass
- Ethyl alcohol/acetone
- Pipette
- Photometer
- Camera
- Laptop

How to do it: Students measure the pH of the water and collect algae. The algae are analysed and photographed under a microscope and then by grinding they obtain the solution for photometry.

Preliminary conclusions: acid rain reduces the amount of chlorophyll pigments.

7. The influence of the changing climatic factors on the biodiversity of parasitic fungi

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Thermometer
- Scalpel
- Blade, slide
- Water
- Pipette
- Microscope
- Camera
- Laptop

How to do it: Students measure temperature, pH, humidity and analyse the biodiversity of parasitic fungi (vine mange, mealybug, rust) according to the values obtained. Samples are collected and analysed under a microscope.

Preliminary conclusions: The changed climate favours the multiplication of parasitic fungi and their biodiversity.

8. The influence of the environmental factors on saprophytic fungal biodiversity

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Thermometer
- Scalpel
- Blade, slide
- Microscope
- Water
- Pipette
- Camera
- Laptop

How to do it: Students collect biological material from the field and then perform microscopic analysis of spores to illustrate biodiversity.

Preliminary conclusions: drought has reduced the number of saprophytic fungi

9. The role of mycorrhizal symbiont fungi in the resistance of some tree species to the stress caused by the variations in the environmental factors

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Hoes
- Thermometer
- termometru
- pH-meter
- scalpel
- blade, slide
- microscope
- water
- pipette
- camera
- laptop

How to do it: Students go into the field and with the help of special hoes remove the topsoil from the root level of trees that are in symbiosis with mycorrhizal fungi. Specimens of fungi are collected and analysed under a microscope**.**

Preliminary conclusions - Mycorrhizal fungi help plants with which they are in symbiosis to resist climatic stress but are also particularly affected by drought.10. Studiul biodiversității microorganismelor prezente în parcurile și pădurile citadine**.**

Necessary materials:

- Protective equipment (disposable gloves, masks)
- Ecology kit (collection containers, ph-meters, tweezers, scissors)
- Thermometer
- pH meter
- Scalpel
- Blade, slide
- Microscope
- water
- Pipette
- Camera
- laptop

How to do it: - Students take soil, water and bioderm samples from the field and analyse them under a microscope.

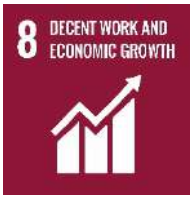
Preliminary conclusions - An increase in biodiversity due to the greenhouse effect is observed.

ANNEXES

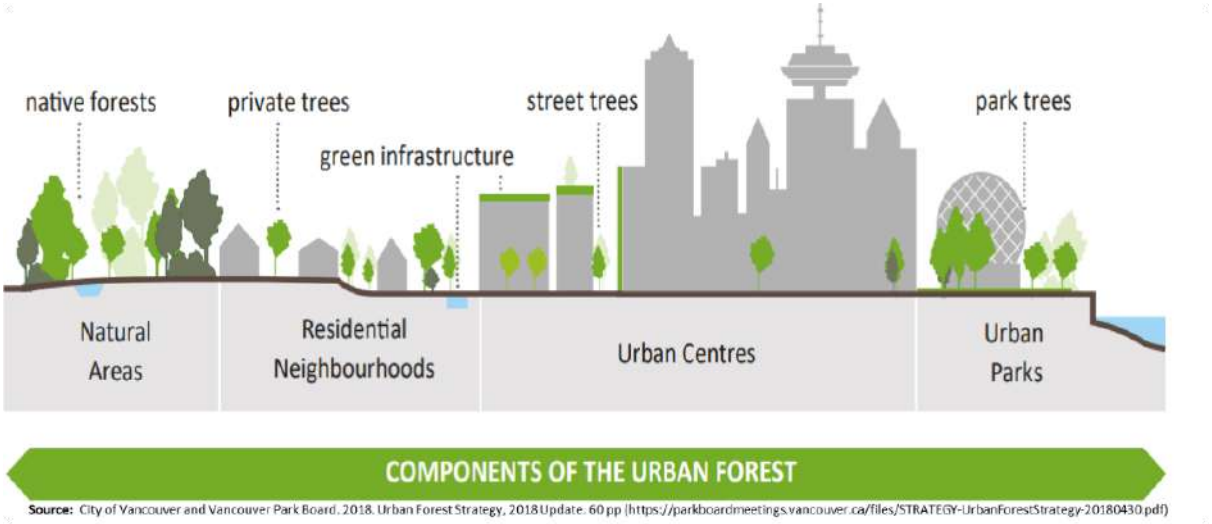
Annex no.1- The role of the urban forests[95]

Sustainable Development Goals	The role of urban forests
	Urban forests create jobs, provide a resource for entrepreneurs, reduce urban infrastructure costs, provide ecosystem services for all citizens, improve the living environment and increase property values, ultimately boosting local economies.
	Urban forests are direct sources of food (e.g. fruit, seeds, leaves, mushrooms, berries, bark extracts, sap and roots, grasses, wild meat and edible insects). Indirectly, they support healthy diets by providing affordable wood fuel, high quality water and improved soil for sustainable agricultural production.
	Forests and other green spaces in and around cities provide ideal places for many outdoor recreation and relaxation activities, helping to prevent and treat non-communicable diseases and maintain mental health. Urban forests effectively filter and remove pollutants and particulates, which also contributes to reducing the incidence of non-communicable diseases.
	Urban forests are effective regulators of urban hydrological cycles. They filter drinking water by reducing biological and chemical pollutants, reduce the risk of flooding and erosion, and reduce water losses by minimising mesoclimatic extremes through evapotranspiration processes.
	Sustainable management of urban forests can produce renewable energy for use by urban communities. This is a vital function for billions of urban and peri-urban dwellers around the world, particularly in lower-income countries where woodfuel is often the most affordable and sometimes the only source of energy available.

[95] Pictures source: https://www.un.org/sustainabledevelopment/news/communications-material/
Text: FAO. 2016. *Guidelines on urban and peri-urban forestry,* by F. Salbitano, S. Borelli, M. Conigliaro and Y. Chen. FAO Forestry Paper No._178. Rome, Food and Agriculture Organization of the United Nations, pag.7
https://www.fao.org/documents/card/en/c/e068e0d9-0c97-41c7-a856-05556a1bd10b

	Investment in urban forests and other green infrastructure contributes significantly to green economic growth, providing an attractive environment for tourism and business, improving housing values and rental rates, creating job opportunities, providing housing materials and generating savings in costs associated with energy and human health maintenance.
	Well-designed and managed urban forests contribute significantly to the environmental sustainability, economic viability and livability of cities. They contribute to mitigating climate change and natural disasters, reducing energy costs, poverty and malnutrition, and providing ecosystem services and public benefits.
	Trees and forests in and around cities contribute to climate change mitigation directly by stopping carbon and reducing greenhouse gas emissions and indirectly by saving energy, reducing the urban heat island effect and mitigating flooding.
	Urban forests contribute to creating and enhancing habitats, creating and enhancing biodiversity, significantly improving soil quality and contributing to land restoration.

Annex no.2 – Components of the urban forest[96]



[96] **(Translation-source, after:** City of Vancouver and Vancouver Park Board. 2018. Urban Forest Strategy, 2018 Update. 60 pp https://parkboardmeetings.vancouver.ca/files/STRATEGY-UrbanForestStrategy-20180430.pdf)

Annex no.3 – **Types of urban parks**

Administration	Parks managed by the Sectoral Authority	
	Parks managed by the Central Authority	
	Parks managed by the Local Authority	
Position/location in the city	**In relation to the central area**	Peri-urban parks
		Peripheral parks
		Semicentral parks
		Central parks
	In relation to the area they serve	Neighbourhood parks
		Sectorial parks
		Municipal parks
	In relation to the protected areas	Monument-parks
		Parks of environmental value
		Protected parks
Sizes	Big parks (over 7 hectares)	
	Average-sized parks (7-5 hectares)	
	Garden parks (over 15 hectares)	
Legal status	Urban parks on public space	
	Urban parks on land under concession to private companies/partnerships	
	Urban parks on private land	
Shapes and proportions	Regular, quasi-regulated compact parks	
	Elongated parks	
	Parks with very irregular shapes	
Specialisation	Totally-specialised parks-water park, zoo, botanical park etc.	
	Specialised parks for specific indoor areas(sports, entertainment, exhibitions)	
	General leisure parks-walking, resting, relaxing	
Significance	Complex cultural, thematic, museum parks (with a clear cultural purpose)	
	Experimenting, advertising, social events parks	
	Events, personality commemoration parks etc.	
	Regular social parks	

Adaptation from The Urban park-from concept to project. Coursebook, Angelica StanSource:https://dokumen.tips/download/link/breviar-curs-parcul-urban.html

***Annex no.4*- The contribution of urban forests to achieving the Sustainable Development Goals**[97]
(

				
Type of urban forest	**Significance (on a scale from 1 to 5*)**	**Significance (on a scale from 1 la 5*)**		**Significance (on a scale from 1 la 5*)**
		Mitigating climate change	Adapting to climate change	
Peri-urban forests and parks	🌳🌳🌳🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳🌳🌳
Urban parks and forests (>0,5 ha)	🌳🌳🌳🌳🌳	🌳🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳🌳
Pocket parks and tree gardens (<0,5 ha)	🌳🌳🌳🌳🌳	🌳	🌳🌳🌳🌳	🌳🌳🌳
Square/public square or street trees	🌳🌳🌳🌳🌳	🌳	🌳🌳🌳🌳	🌳🌳
Other green spaces with trees	🌳🌳🌳🌳🌳	🌳🌳	🌳🌳🌳🌳	🌳🌳🌳
***Where* 1=very low significance *and* 5= very high significance**				

[97]Ssource: Adaptation from FAO. 2016. *Guidelines on urban and peri-urban forestry,* by F. Salbitano, S. Borelli, M. Conigliaro and Y. Chen. FAO Forestry Paper No._178. Rome, Food and Agriculture Organization of the United Nations, page7
https://www.fao.org/documents/card/en/c/e068e0d9-0c97-41c7-a856-05556a1bd10b
Pictures source: https://www.un.org/sustainabledevelopment/news/communications-material/)

Type of urban forest	Significance (on a scale from 1 to 5*)	Significance (on a scale from 1 to 5*)		Significance (on a scale from 1 to 5*)
		Protection of watersheds	Resistance to floods	
Peri-urban forests and parks	🌳🌳🌳🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳	🌳🌳🌳🌳🌳
Urban parks and forests (>0,5 ha)	🌳🌳🌳🌳	🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳
Pocket parks and tree gardens (<0,5 ha)	🌳🌳🌳	Not applicable	🌳🌳🌳	🌳🌳
Square/public square or street trees	🌳🌳🌳	🌳	🌳🌳🌳	🌳
Other green spaces with trees	🌳	🌳🌳🌳🌳	🌳🌳🌳🌳	🌳🌳🌳🌳

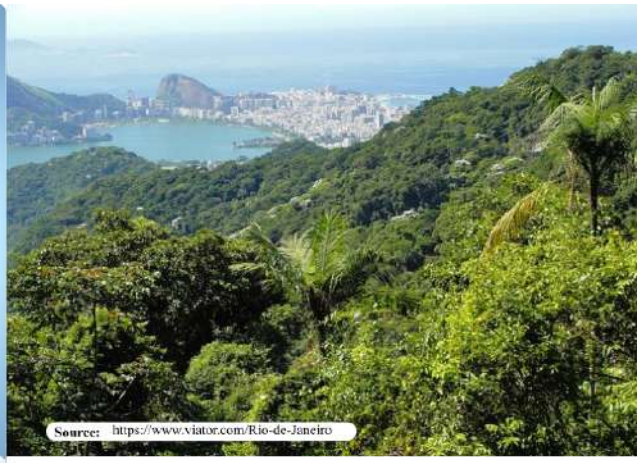
***Where* 1=very low significance *and* 5= very high significance**

Type of urban forest	Significance (on a scale from 1 to 5*)	Significance (on a scale from 1 to 5*)	Significance (on a scale from 1 to 5*)			
			Relaxation	Education	Social Cohesion	Social security and equity
Peri-urban forests and parks	🌳🌳🌳🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳🌳	🌳🌳🌳🌳🌳	🌳🌳	🌳
Urban and forest parks (>0,5 ha)	🌳🌳🌳	🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳🌳	🌳🌳🌳🌳🌳	🌳🌳🌳🌳
Pocket parks and tree gardens (<0,5 ha)	🌳🌳	🌳	🌳🌳🌳	🌳	🌳🌳🌳	🌳🌳🌳🌳
Square/public square or street trees	🌳🌳	🌳	🌳	🌳	🌳	🌳🌳🌳🌳🌳
Other green spaces with trees	🌳🌳🌳🌳	🌳🌳	🌳🌳🌳	🌳🌳🌳	🌳🌳	🌳🌳🌳
***Where* 1=very low significance *and* 5= very high significance**						

Annex no.5- Case studies- Worldwide forests and parks

TIJUCA NATIONAL PARK

It covers an area of 39.58 km² and is considered the largest urban forest in the world.
It is located in the mountainous area of Rio de Janeiro, Brazil.
It is part of the Atlantic Forest Biosphere Reserve and was declared a World Heritage Site by UNESCO in 2012.
Biogeographically, it is characterized by tropical forest up to 1000m altitude with varied species, some endangered.
Tijuca is a remnant of the former Atlantic rainforest around Rio de Janeiro.



https://en.wikipedia.org/wiki/Tijuca_National_Park
https://www.viator.com/Rio-de-Janeiro-attractions/Tijuca-National-Park/d712-a1333
https://www.google.com/maps
https://www.lonelyplanet.com/brazil/rio-de-janeiro/attractions/parque-nacional-da-tijuca/a/poi-sig/1269053/363153

BANCO NATIONAL PARK

It is located in Abidjan, Côte d'Ivoire between four municipalities (Adjamé, Attécoubé, Abobo and Yopougon).
It covers an area of 3,438 ha and it is considered the "hydraulic reservoir and green lung of Abidjan" and the second largest after Tijuca National Park.
It is noted for having 600 ha of primary forests, over 800 species of higher plants, 60 species of animals composed mainly of insects, reptiles, birds and mammals, including monkeys, herbivores, pangolins, etc.

https://fr.wikipedia.org/wiki/Parc_national_du_Banco
https://www.oipr.ci/index.php/parcs-reserves/parcs-nationaux/parc-national-du-banco
https://discover-ivorycoast.com/wp-content/uploads/2019/06/parc_national_du_banco_0.jpg
https://baab.ci/wp-content/uploads/2021/04/Nader-1.jpg
https://www.google.com/maps

VINCENNES FOREST

The forest is located in the eastern part of Paris, in the 12th Arrondissement.
It covers an area of 995 ha and it is the most important green space in Paris.
Bois de Vincennes is considered, together with Bois de Boulogne, one of the two "green lungs" of Paris.
It is noted for its mix of landscapes and facilities and the existence of 543 ha of woodland, 80 ha of gardens, 7.8 km of rivers, 20 ha of lakes.

https://www.google.com/maps
https://fr.wikipedia.org/wiki/Bois_de_Vincennes
https://www.parisinfo.com/musee-monument-paris/71314/Bois-de-Vincennes
https://www.paris.fr/lieux/bois-de-vincennes-6598
https://oppla.eu/sites/default/files/uploads/22franceupload.pdf

CENTRAL PARK

Central Park is located in New York City, United States, on 843 acres between the Upper West Side and Upper East Side neighbourhoods of Manhattan in New York City.
It is the most visited urban park in the United States, divided into three sections: the "North End", "Mid-Park", and "South End".
It is a collection of plantings, landscapes, landforms, wooded areas, meadows, special-purpose lands, etc.Central Park is biologically diverse with over 500 species.

https://www.centralparknyc.org/
https://en.wikipedia.org/wiki/Central_Park
https://www.britannica.com/place/Central-Park-New-York-City
https://eportfolios.macaulay.cuny.edu/themanhattanproject/field-lab-8/analyzing-central-park-as-a-source-of-biodiversity/
https://i.natgeofe.com/n/15ec8dec-df7c-45af-a0ae-08d4e906a134/belvedere-castle.jpg
https://www.google.com/maps

HYDE PARK

-Near Kensington Gardens, Hyde Park is the main green area of London's metropolitan life covering an area of 14o hectares (350 acres).
-Originally created for hunting purposes for the Royal Household, Hyde Park is now considered to be London's oldest park, where the conservation and protection of biodiversity occupies an important place.
It is noted for the diversity of natural habitats for different species (birds, insects, mammals, etc.) and the facilities for the population.

Sources:
https://www.google.com/maps
https://ro.wikipedia.org/wiki/Hyde_Park
https://www.londoncitybreak.com/hyde-park
https://www.dorchestercollection.com/en/moments/a-guide-to-hyde-park/

SEONYUDO PARK

Located on the island of the same name in Seoul - South Korea, Seonyudo Park with numerous facilities, is an ecological park opened in 2002, built on former industrial land.
Facilities include a botanical garden and numerous museums.

Sources:

https://www.google.com/maps
https://en.wikipedia.org/wiki/Seonyudo,_Seoul
https://english.visitseoul.net/nature/SeonyudoPark_/378
https://www.ydp.go.kr/english/contents.do?key=4311
https://www.theseoulguide.com/seonyudo-park/
https://toposmagazine.com/seonyudo-park-history-revealed/

5.1. References

1. **Amidon E. and J.Hough** – Interaction Analysis: Theory, research, and application. Reading Massachusetts (USA).Addison – Wesley, 1967;
2. **Baloche L**., – The cooperative classrom.Uppa sadle Riven, New Gersey(USA): Prentice – hall, 1998;
3. **Băncilă Gabriela, Gh.Zamfir** - Algorithm of success. Current milestones in pre-university education, Polirom Publishing House, 1999;
4. **Bâca I, Onofreiu A.** – ”Bistrița 750. Geographical and historical coordinates”, Argonaut Publishing House, 2014;
5. **Dumitru Chiriac, Cristina Humă, Mariana Stanciu** - *Green spaces - a problem of today's urbanisation* - quality of life, XX, no. 3–4, 2009, p. 249–270;
6. **Ignat Svetlana** – Method of familiarising children with nature,”Lumina” Publishing House, Chișinău, 1992;
7. **Ion I.** – Methodology of teaching biology, ”Al.I.Cuza” University Publishing House, Iași, 1995;
8. **Johnson D.,R.Johnson and E.Holubec** – Circles of learning: Cooperation in the classroom, Edina, Minnesota(USA):Interaction books, 1993;
9. **Joița Elena**- ” Pedagogy, the interactive science of education”;
10. **Kagan S.-** Cooperative learning.San Juan Capistrano, California(USA): Cagan cooperative learning, 1992;

11. **Maria Laurynowicz** – Grzyby TOM.XVIII. Ascomycetes, Elaphomycetales,Tuberales, PolskaAkademiaNauk . Institut Botaniki, 1988;
12. **Mohan Gheorghe** - Small encyclopaedia of herbs and phytotherapy, All Publishing House, 1998;
13. **Niculescu N.G.,J.D. Adumitrăcesei** – Romanian education at the crossroads, 1999;
14. **Păun C.** - Guidance in order to know nature, Didactic and Pedagogical Publishing House, Bucharest, 1981;
15. **Rădulescu St. Mihaela** – Freinet Pedagogy – an innovative approach;
16. **Rică M.** –"Parks and Gardens in Romania", Technical Publishing House, Bucharest, 1958;
17. **Toader T., Nițu C**. - ”Invitation to hiking”, Editura Ceres Publishing House, Bucharest, 1976;
18. **Ungureanu D.** – Integrated education and inclusive schooling – West Publishing House, Timișoara, 2000;
19. **Vasile Ciocîrlan** – The Illustrated Flora of Romania, Ceres Publishing House, Bucharest,1988;
20. **Vogler J.** – Assessment in pre-university education, Polirom, Iași, 2000;
21. *** Information materials produced by the Ministry of National Education and the Institute of Education Sciences;
22. https://adevarul.ro/stiri-locale/pitesti/defrisarile-din-trivale-vor-condamna-la-moarte-1107886.html
23. https://audiotravelguide.ro/parcul-tabacariei-constanta/
24. https://baab.ci/wp-content/uploads/2021/04/Nader-1.jpg
http://barnamadalin.blogspot.com/2009/06/faunavegetatia-municipiului-pitesti.html
25. https://dezvoltaredurabila.gov.ro/web/obiective/odd11/
26. https://discover-ivorycoast.com/wp-content/uploads/2019/06/parc_national_du_banco_0.jpg
27. https://discovertimis.com/places/padurea-verde-is7p3dvai2hdhg
28. https://dokumen.tips/download/link/breviar-curs-parcul-urban.html (conf.dr.arh. Angelica Stan- *Urban Park - from concept to project. Course support*).
29. https://dp.la/exhibitions/urban-parks/types-parks/town-squares
30. https://en.wikipedia.org/wiki/Central_Park
31. https://en.wikipedia.org/wiki/Million_Tree_Initiative
32. https://en.wikipedia.org/wiki/Park
33. https://en.wikipedia.org/wiki/Seonyudo,_Seoul
34. https://en.wikipedia.org/wiki/Tijuca_National_Park
35. https://en.wikipedia.org/wiki/Urban_forest
36. https://en.wikipedia.org/wiki/Urban_park
37. https://english.visitseoul.net/nature/SeonyudoPark_/378
38. https://eportfolios.macaulay.cuny.edu/themanhattanproject/field-lab-8/analyzing-central-park-as-a-source-of-biodiversity/
39. *https://ec.europa.eu/environment/nature/natura2000/index_en.htm - European Commission. (2013). Natura 2000: Protecting Europe's biodiversity. Brussels, BELGIA European Commission.*
40. https://fr.wikipedia.org/wiki/Bois_de_Vincennes
41. https://fr.wikipedia.org/wiki/Parc_national_du_Banco
42. https://gaddpr.wixsite.com/dobrogea-online/blank-c1hg9
43. http://greenly.ro/arii-protejate/parcul-poporului-un-souvenir-man-made-daruit-naturii-2
44. https://homedesigninstitute.com/read_news/459/the_different_types_of_park_designs_and_why_they_matter/
45. https://jurnaluldearges.ro/padurea-parc-trivale-locul-preferat-de-recreere-al-pitestenilor-23835/

46. https://i.natgeofe.com/n/15ec8dec-df7c-45af-a0ae-08d4e906a134/belvedere-castle.jpg
47. https://lataifas.ro/destinatii-turistice-unice/47755/parcul-herastrau-din-bucuresti/
48. https://legistarwebproduction.s3.amazonaws.com/uploads/attachment/pdf/150009/A5_Park_Classifications.pdf
49. *https://livereport.protectedplanet.net/pdf/PP_Report_2018.pdf - Dudley, N., Belokurov, A., Brierley, A., Cuttelod, A., Deinet, S., Fitzsimons, J., ... & Vasilijević, M. (2018). Protected Planet Report 2018. Gland, Switzerland: IUCN.*
50. https://nparkovi.me/en/nationalni-parkovi/durmitor - Montenegro Durmitor National Park, Montenegro.
51. https://onetreeplanted.org/blogs/stories/what-is-urban-forestry?gad=1&gclid=EAIaIQobChMI88z3_pqS_wIVCdB3Ch0obwsWEAAYASAAEgK5y_D_BwE
52. https://op.europa.eu/en/publication-detail/-/publication/440526c5-c43c-47b7-9c60-90813e6c35f2
53. https://oppla.eu/sites/default/files/uploads/22franceupload.pdf
54. https://parkboardmeetings.vancouver.ca/files/STRATEGY-UrbanForestStrategy-20180430.pdf (*City of Vancouver and Vancouver Park Board. 2018. Urban Forest Strategy: 2018 Update*. 60 pp.).
55. http://quickurbanforest.eu/sites/default/files/documentos/konijnendijk202003_a20decade20of20uf20in20europe.pdf (*A decade of urban forestry in Europe*, Forest Policy & Economics, FOREST POLICY AND ECONOMICS · JULY 2003, Cecil Konijnendijk).
56. https://ro.frwiki.wiki/wiki/For%C3%AAt_de_Soignes
57. https://ro.frwiki.wiki/wiki/For%C3%AAt_urbaine
58. https://ro.wikipedia.org/wiki/Hyde_Park
59. https://ro.wikipedia.org/wiki/P%C4%83durea_Plopeni
60. https://ro.wikipedia.org/wiki/Parcul_Nicolae_Romanescu
61. https://silkdistrict.ro/blog/ce-sunt-padurile-urbane-si-care-este-rolul-lor-in-dezvoltarea-oraselor-verzi/
62. https://sdg-tracker.org/cities
63. https://stiriletransilvaniei.ro/2022/03/18/padurea-verde-de-la-codru-secular-la-padure-parc/
64. https://treecitiesoftheworld.org/about.cfm
65. https://toposmagazine.com/seonyudo-park-history-revealed/
66. http://unyouthdelegate.ro/category/activitate2020-2021/obiective-de-dezvoltare-durabila/
67. https://visitcluj.ro/tourist_spot/fagetul-clujului/
68. https://worldurbanparks.org/images/Newsletters/IfpraBenefitsOfUrbanParks.pdf (*Benefits of Urban Parks A systematic review* A Report for IFPRA By Cecil C. Konijnendijk Matilda Annerstedt Anders Busse Nielsen Sreetheran Maruthaveeran, 2013).
69. https://www.britannica.com/place/Central-Park-New-York-City
70. https://www.brotacelul.ro/Orase/Constanta.aspx
71. https://www.canva.com/ro_ro/
72. https://www.centralparknyc.org/
73. https://www.cevennes-parcnational.fr/ - Cévennes National Park, France.
74. https://www.dorchestercollection.com/en/moments/a-guide-to-hyde-park/
75. https://www.eea.europa.eu/data-and-maps/indicators/protected-areas-in-europe - *European Environment Agency. (2018). Protected Areas in Europe* - an overview.
76. https://www.eea.europa.eu/themes/biodiversity/document-library/european-nature-information-system-eunis - *European Topic Centre on Biological Diversity. (2013). European Nature Information System (EUNIS) - Habitats Classification*.

77. https://www.euractiv.ro/we-develop/ce-reprezinta-cele-17-obiective-de-dezvoltare-durabila-odd-incluse-pe-agenda-2030-6402
78. https://www.fao.org/documents/card/en/c/e068e0d9-0c97-41c7-a856-05556a1bd10b (*Guidelines on urban and peri-urban forestry, FAO Forestry Paper-Nr.178* (F. Salbitano, S. Borelli, M. Conigliaro and Y. Chen, 2016, Roma), FAO (Food and Agriculture Organization of the United Nations).
79. https://www.globalinfo.ro/z/parcul_herastrau.htm
80. https://www.grand-est.developpement-durable.gouv.fr/67-massif-forestier-de-strasbourg-neuhof-illkirch-a18081.html
81. https://www.google.com/maps
82. https://www.icnf.pt/portal/ap/p-nac-geres - Peneda-Gerês National Park, Portugal.
83. http://www.ijstr.org/final-print/nov2015/A-Brief-Review-On-Urban-Park-History-Classification-And-Function.pdf(Mohammad Mehdi Sadeghian, Zhirayr Vardanyan, INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 4, ISSUE 11, NOVEMBER 2015).
84. https://www.iucn.org/sites/dev/files/import/downloads/iucn_green_list_standard_2016-2.pdf - *IUCN (International Union for Conservation of Nature). (2016). IUCN Green List of Protected and Conserved Areas: Standards and Guidance for Implementation. Gland, Switzerland: IUCN.*
85. https://www.lagazettedescommunes.com/821144/de-quoi-se-compose-exactement-la-foret-urbaine/
86. https://www.lakedistrict.gov.uk/ - Lake District National Park, England.
87. https://www.lilletourism.com/parc-de-la-citadelle.html
88. htttps://www.litoralulromanesc.ro/parcul_arheologic.htm
89. https://www.londoncitybreak.com/hyde-park
90. https://www.lonelyplanet.com/brazil/rio-de-janeiro/attractions/parque-nacional-da-tijuca/a/poi-sig/1269053/363153
91. https://www.nationalpark-saechsische-schweiz.de/en/ - Saxon Switzerland National Park, Germany.
92. https://www.np-krka.hr/en/ - Krka National Park, Croatia.
93. https://www.np-plitvicka-jezera.hr/en/ - Plitvice Lakes National Park, Croatia.
94. https://www.oipr.ci/index.php/parcs-reserves/parcs-nationaux/parc-national-du-banco
95. https://www.parconazionale5terre.it/ - Cinque Terre National Park, Italy.
96. https://www.paris.fr/lieux/bois-de-vincennes-6598
97. https://www.parisinfo.com/musee-monument-paris/71314/Bois-de-Vincennes
98. https://www.primariatm.ro/wpcontent/uploads/2021/02/Cadrul_Natural_Timisoara_vol.1.pdf
99. https://www.researchgate.net/publication/348891351_A_Research_on_the_Usage_Reasons_of_Urban_Parks_A_Case_Study_of_Amasya_Courthouse_Urban_Park (*A Research on the Usage Reasons of Urban Parks: A Case Study of Amasya Courthouse Urban Park*- Kurt Konakoğlu et al., 2021).
100. https://www.researchgate.net/publication/267330243_Benefits_of_Urban_Parks_A_systematic_review_-_A_Report_for_IFPRA (*Benefits of Urban Parks A systematic review A Report for IFPRA,* Cecil C. Konijnendijk, Matilda Annerstedt, Anders Busse Nielsen, Sreetheran Maruthaveeran, 2013).
101. https://www.revistacalitateavietii.ro/oldrcv/2009/CV-3-4-2009/03.pdf
102. https://www.royalparks.org.uk/parks/hyde-park/things-to-see-and-do/wildlife
103. https://www.samariagorge.gr/ - Samaria Gorge National Park, Insula Creata, Grecia.

104. https://www.sciencedirect.com/science/article/abs/pii/S1618866705000464 (*Defining urban forestry-A comparative perspective of North America and Europe,* Cecil C. Konijnendijk a, Robert M. Ricard b, Andy Kenney c, Thomas B. Randrup, 2006).
105. https://www.sciencedirect.com/science/article/abs/pii/S0169204607002174#hit7
106. (*Demand for urban forests in United States cities*, Pengyu Zhu, Yaoqi Zhang, 2008).
107. https://www.theseoulguide.com/seonyudo-park/
108. http://www.tnp.si/en/ - Triglav National Park, Slovenia.
109. https://www.turistulliber.ro/atractii-turistice/judetul-constanta/orasul-constanta/parcul-arheologic-constanta-istorie-si-natura-intr-un-singur-loc/
110. https://www.turistulliber.ro/atractii-turistice/judetul-constanta/orasul-constanta/parcul-tabacariei-peisaj-lacustru-inedit/
111. https://www.uforest.eu/wp-content/uploads/2022/12/Uforest_report-3.4_ROM_final.pdf *Harnessing the potential of urban forests. Developing a local action plan for urban forestry* (Juliet Achieng Owuor, Ian Whitehead and Rik De Vreese - European Forestry Institute, 2022).
112. https://www.vatnajokulsthjodgardur.is/ - Vatnajökull National Park, Iceland.
113. https://www.viator.com/Rio-de-Janeiro-attractions/Tijuca-National-Park/d712-a1333
114. https://www.visit.brussels/en/visitors/venue-details.The-Bois-de-la-Cambre.230548
115. https://www.ydp.go.kr/english/contents.do?key=4311

05

Biodiversity of aquatic plants

Module by Link Group

LEAF - Learn biodiversity through Environmental Action
For the community
ERASMUS+ 2022-1-RO01-KA220-SCH-000086884

Co-funded by the European Union

Table of Contents, Module 5:

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LEAF - Learn biodiversity through Environmental Action For the community
ERASMUS+ 2022-1-RO01-KA220-SCH-000086884

V. Biodiversity of aquatic plants

1.1. Introduction

Biodiversity, a term derived from "biological diversity," refers to the variety of life forms that exist on Earth. It encompasses the immense range of species, ecosystems, and genetic diversity found across the planet. Biodiversity plays a pivotal role in shaping the intricate balance and functionality of ecosystems, contributing to their stability and resilience.

Biodiversity is crucial for many scientific reasons. It sustains ecosystem functioning and services, such as pollination and nutrient cycling, ensuring ecological stability. Additionally, it provides essential resources like food, medicine, and clean water, supporting human well-being and livelihoods. Genetic diversity within species promotes adaptability and resilience to environmental changes. However, human activities threaten biodiversity, making conservation efforts vital to preserve the intricate web of life on Earth.

Aquatic biodiversity is the rich and wonderful variety of plants and animals that live in marine and freshwater environments. Aquatic biodiversity is a comprehensive term that comprises freshwater ecosystems with lakes, ponds, rivers, streams, groundwater, and wetlands. The other part of aquatic biodiversity includes marine ecosystems, which makes up an ocean, estuaries, salt marshes, coral reefs and mangroves.

Freshwater and marine ecosystems are two distinct types of ecological systems that display significant differences in their physical and biological characteristics. One of the primary distinctions lies in the salinity of the water. Freshwater ecosystems have a low salt concentration, typically less than 0.5 parts per thousand (ppt), while marine ecosystems have a much higher salt concentration, ranging from 30 to 35 ppt. Another noticeable difference is the species diversity in these ecosystems. Marine environments generally exhibit higher species diversity compared to freshwater ecosystems. This is partly due to the vastness and interconnectedness of oceans, enabling species to disperse over large

distances. Furthermore, nutrient availability varies between the two types of ecosystems. Freshwater ecosystems often have higher nutrient concentrations, such as nitrogen and phosphorus, due to runoff from the land. In contrast, marine ecosystems, especially those farther from shore, tend to be nutrient-limited. Temperature variation is another differentiating factor. Marine ecosystems generally experience less temperature fluctuation compared to freshwater ecosystems. Water's higher heat capacity allows oceans to moderate temperature changes effectively. The physical structure of the ecosystems also differs. Freshwater ecosystems encompass features like rivers, lakes, and wetlands, each with unique ecological niches. On the other hand, marine ecosystems consist of diverse habitats such as coral reefs, kelp forests, and deep-sea trenches. Additionally, the hydrological and geological processes influencing freshwater and marine ecosystems vary significantly. Freshwater ecosystems are heavily influenced by the terrestrial water cycle, including precipitation, runoff, and groundwater flow. The movement of water within river systems and the interaction with surrounding land shape the characteristics of these ecosystems. In contrast, marine ecosystems are shaped by ocean currents, tides, and coastal processes. The vastness of the oceans and the interconnectedness of marine habitats create dynamic and complex systems, affecting the distribution and movement of marine species. Both types of ecosystems play crucial roles in global biogeochemical cycles. Freshwater ecosystems act as sinks and sources of nutrients, filtering and recycling organic matter. They also play a vital role in carbon sequestration, contributing to the regulation of atmospheric carbon dioxide levels. Marine ecosystems, particularly phytoplankton, are significant contributors to global oxygen production through photosynthesis. Marine environments play a major role in carbon storage, absorbing and storing vast amounts of carbon dioxide from the atmosphere.

Different kinds of phytoplanktons, zooplanktons, aquatic plants, insects, fishes, birds and mammals are also an important part of aquatic biodiversity. From tiny plankton to large giants, all have a very important role in the aquatic ecosystem. Aquatic biodiversity is very important for the health of our planet and the well-being of human society. Aquatic biodiversity plays a critical role in supporting various aspects of human life and the environment, providing a wide array of ecosystem services and benefits. Understanding and preserving the significance of aquatic biodiversity is crucial for ensuring the well-being of our planet and its inhabitants. One key reason why aquatic biodiversity is crucial lies in its contribution to ecosystem stability. Aquatic ecosystems are intricate webs of life, where each

species plays a specific role in maintaining the overall balance and functioning of the ecosystem. Biodiversity enhances the resilience of these ecosystems, enabling them to better withstand natural disturbances and human-induced pressures, such as pollution and habitat loss. Another vital aspect of aquatic biodiversity is its role in ensuring global food security. While fish are often the first organisms that come to mind when considering food from the water, the spectrum of aquatic biodiversity encompasses a diverse range of animals, plants, and microorganisms that contribute significantly to the world's food supply. For many coastal communities and nations, aquatic resources serve as a primary source of protein and nutrition, supporting livelihoods and food security.

Moreover, aquatic biodiversity harbours significant scientific and medical potential. Many marine organisms possess unique biochemical pathways that hold great promise for medical research and drug development. Compounds extracted from marine organisms have already led to the creation of medicines for pain relief, cancer treatments, and other medical advancements. By conserving aquatic biodiversity, we preserve the potential for further scientific discoveries and medical breakthroughs that could revolutionise healthcare and improve human well-being.

Oceans, in particular, play a crucial role in regulating the Earth's climate. Marine plants, such as phytoplankton, contribute to the majority of the planet's oxygen production through photosynthesis. These tiny organisms are responsible for about half of all the oxygen we breathe. Additionally, oceans act as vital carbon sinks, absorbing a substantial amount of atmospheric carbon dioxide. This process helps mitigate the impacts of climate change, which is a pressing global concern affecting ecosystems and human societies worldwide.

Aquatic biodiversity also holds immense economic importance. It supports a range of industries, including fisheries, aquaculture, tourism, and pharmaceuticals. These industries generate significant revenue and employment opportunities for communities around the world, contributing to local and national economies. The sustainability of these industries relies heavily on maintaining healthy aquatic ecosystems and preserving biodiversity. In addition to the economic benefits, aquatic environments hold cultural and recreational significance for many communities. Coastal regions, lakes, and rivers often serve as focal points for tourism, leisure activities, and cultural practices. Preserving aquatic biodiversity ensures that these places retain their beauty and cultural value, allowing future generations to continue enjoying and appreciating them. Aquatic ecosystems provide essential services

to humanity, known as ecosystem services. These services include water purification, flood regulation, and erosion control. Billions of microorganisms, plants, algae, and animals work in concert to clean the water by filtering excess nutrients, pathogens, and pollutants. This is crucial for ensuring safe drinking water production and maintaining overall environmental health.

Aquatic biodiversity is of paramount importance for ecosystem stability, food security, scientific and medical potential, climate regulation, economic prosperity, cultural and recreational value, and the essential ecosystem services it provides. Recognizing and conserving aquatic biodiversity is imperative to ensure a sustainable and harmonious coexistence between humans and the intricate web of life that thrives in aquatic environments. Given the importance of aquatic biodiversity, it is crucial to adopt sustainable practices, protect marine and freshwater habitats, and implement conservation measures to safeguard the diverse array of life within these ecosystems for future generations.

Aquatic biodiversity is facing significant challenges due to human activities, and some companies are taking actions to address these issues. In the realm of aquatic biodiversity, both positive and negative actions by companies hold significant implications. Some companies are actively engaging in sustainable practices, striving to minimise their impact on marine ecosystems. These efforts encompass responsible fishing practices, sustainable aquaculture methods, and ecotourism promotion. Concurrently, challenges persist as industries contribute to habitat degradation, pollution, and overexploitation, threatening aquatic biodiversity. This scientific exploration delves into the multifaceted interactions between companies and aquatic biodiversity, highlighting the need for collaborative measures to safeguard our invaluable resources.

In this handbook we will explore the amazing world of aquatic biodiversity and the ways to preserve it, with special emphasis on plant biodiversity. Dive into the depths of aquatic biodiversity as we unravel the intricate webs of life thriving in oceans, lakes, rivers, and wetlands. Discover the mesmerising array of plants that contribute to the balance and stability of these aquatic environments, forming the very foundation of their sustenance and prosperity. Within these pages, you will find a plethora of engaging activities carefully crafted to deepen your understanding of aquatic biodiversity. Whether you venture into the field to explore habitats firsthand or immerse yourself in the classroom setting, these activities will captivate your curiosity and inspire a profound appreciation for the wonders of aquatic life. Through hands-on experiences, we aim to foster a sense of connection and

responsibility towards the preservation of aquatic biodiversity. Explore the significance of plant biodiversity in maintaining the health of marine and freshwater ecosystems, and grasp the essential role these plants play in providing food, shelter, and oxygen to countless aquatic species. Our empirically oriented activities offer a blend of scientific inquiry and environmental stewardship, empowering you to become an active participant in the preservation of these precious ecosystems. From conducting plant surveys to exploring the intricate relationships between aquatic organisms, each activity is designed to ignite your passion for marine conservation.

As you embark on this enriching journey, you will gain insights into the challenges faced by aquatic biodiversity and the urgent need for its preservation. The delicate balance of these ecosystems, often under threat from human activities, underscores the significance of our collective efforts in safeguarding their future.

Prepare to dive into the depths of aquatic ecosystems.

2.1. Part 1 - international context and national VS local realities

2.2. Aquatic biodiversity worldwide

Aquatic biodiversity is differently distributed across the planet due to a variety of environmental conditions and factors that influence the ecosystems in different regions. Environmental conditions that can vary throw different places are temperature, salinity, nutrient levels, water flow velocity, depth of the water column, pH levels, dissolved oxygen concentrations, turbidity, sediment composition, and exposure to sunlight. These conditions can create unique habitats and niches, resulting in varying levels of species diversity and composition. Large aquatic bodies, such as oceans and seas, located in tropical regions tend to exhibit higher species diversity compared to those found in temperate regions. Also, species richness, which refers to the number of different species present in an area, typically increases rapidly as you move from higher latitudes (closer to the poles) to lower latitudes (closer to the equator). This phenomenon is known as the latitudinal species diversity gradient. This term

describes the tendency for species diversity to be higher in tropical regions near the equator and to decrease as one moves towards the polar regions.

In general, tropical areas have a higher number of species compared to temperate and polar regions. This pattern has been observed across a wide range of taxonomic groups, including plants, animals, and marine organisms. The exact reasons for this pattern are complex and can be influenced by a variety of factors, including historical, ecological, and evolutionary processes.

Tropical regions exhibit consistent climate stability, fostering an environment where various species can coexist due to the absence of extreme fluctuations throughout the year. These areas receive a greater influx of solar energy, which boosts primary productivity and supports a more extensive array of species within the food chain. The extended periods of climate stability in tropical zones provide ample evolutionary time for speciation and the gradual accumulation of diverse species. The intricate and diverse habitats found in tropical ecosystems offer numerous ecological niches, facilitating the thriving of a wide spectrum of species. Intense resource competition in these environments drives species to specialise and diversify, thereby avoiding direct competition. The heightened diversity of predators in tropical regions compels prey species to develop a wider array of defensive strategies, thereby contributing to the overall higher species diversity. Moreover, historical events, including continental shifts, glaciations, and mass extinctions, could influence certain diversity patterns.

Not only marine systems, but many fresh-water ecosystems are also a favourable biological spot of unique species, because freshwater habitats are more isolated environments. Such kind of ecological phenomena favours the evolution of new species in different fresh-water resources. This process contributes to the high levels of endemism observed in some freshwater ecosystems. These habitats play a crucial role in supporting biodiversity and providing essential services to humans and wildlife. These environments, like rivers, lakes, and wetlands, provide us with drinking water and food, especially through fish. They offer services such as water purification, flood control, and nutrient cycling, benefiting our environment and well-being. Recreation, tourism, and cultural activities centred around these habitats contribute to local economies and enrich our lives. Scientific research, education, and even potential medicinal discoveries stem from these ecosystems. By safeguarding freshwater biodiversity, we conserve unique species and support broader global biodiversity. Therefore, these habitats play a role in climate regulation and hold economic value through various

industries. In essence, valuing and preserving these habitats ensures a balanced coexistence between humans and nature.

The distribution of aquatic biodiversity is the result of complex interactions between various environmental, ecological, and geological factors. Understanding these patterns is vital for conservation efforts and sustainable management of aquatic ecosystems worldwide.

2.3. Local biodiversity - Serbia

Serbia is a landlocked country located in southeastern Europe, bordered by several neighbouring countries, and it is not directly adjacent to any major sea or ocean. Therefore, when we discuss aquatic biodiversity in Serbia, we are primarily referring to the country's freshwater ecosystems, including rivers, lakes, and wetlands. Serbia is home to a relatively rich and diverse array of freshwater habitats, which support various plant and animal species adapted to these unique environments. Some of the notable aquatic ecosystems in Serbia include the Danube River, the Sava River, the Drina River, and several smaller rivers and streams. There are also numerous lakes and wetlands across the country, such as Lake Palić, Lake Vlasina, and the Ramsar-listed Obedska Bara wetland.

https://danube-region.eu/about/the-danube-region/

Aquatic biodiversity in Serbia is influenced by a combination of factors, including the country's geographical location, climate, hydrology, and human activities.

The Danube River, which flows through Serbia, is particularly significant for biodiversity as it serves as a migration corridor for various fish species and supports diverse aquatic and riparian habitats. Many fish species found in the Danube and its tributaries are of conservation concern and are protected under national and European legislation. The Danube supports diverse aquatic and riparian habitats along its Serbian stretch. These habitats, ranging from submerged aquatic vegetation to richly vegetated riverbanks, provide crucial shelter, breeding grounds, and feeding areas for a multitude of aquatic species. This diversity not only enriches the ecosystem but also supports fisheries, providing a vital source of sustenance and livelihood for many local communities. Many fish species found within the Danube and its tributaries in Serbia are of conservation concern. Due to factors such as habitat alteration, pollution, and overfishing, some species have faced population declines, making their protection a priority. Recognizing the ecological importance of these species, Serbia has implemented protective measures, and many of these fish species are safeguarded under both national legislation and European regulations. Preserving the health and biodiversity of the Danube in Serbia is not just a matter of environmental concern; it has social, cultural, and economic implications. The river is a symbol of natural heritage, interwoven with the country's history and culture. It offers recreational opportunities, sustains local economies through fisheries and tourism, and fosters a connection between people and the natural world. Furthermore, the Danube River's role in maintaining aquatic biodiversity has broader implications. It contributes to the overall conservation of European freshwater biodiversity, as the river is part of a larger network of waterways that traverse multiple countries. By ensuring the health of the Danube in Serbia, we are actively contributing to the preservation of a shared natural treasure.

Serbia is home to a diverse range of aquatic plants that thrive in its freshwater ecosystems. Aquatic plant biodiversity in Serbia plays a crucial role in maintaining the ecological balance of rivers, lakes, and wetlands, providing habitat and food for various aquatic organisms. Some of the common aquatic plant species found in Serbia include:

Water lilies (Nymphaea spp.) in Serbia contribute to the intricate aquatic ecology of the region. These flowering aquatic plants, known for their floating leaves and showy blossoms, are prominent features

in Serbian water bodies. As vascular hydrophytes, water lilies serve as indicators of water quality and habitat conditions. They offer valuable habitat and refuge for aquatic organisms, while their floating leaves help to provide shade and regulate water temperature. Additionally, water lilies contribute to nutrient cycling and oxygenation within aquatic ecosystems. Their presence underscores the dynamic interplay between flora and aquatic ecosystems in Serbia.

Reed (Phragmites australis) holds ecological significance within Serbia's landscapes. This tall, robust perennial grass dominates wetland areas across the region. Its structural dominance contributes to habitat diversity and stability, fostering a complex mosaic of aquatic and terrestrial life. Reed beds provide shelter and nesting sites for numerous bird species, while their rhizomes stabilise soil and help prevent erosion. Moreover, reeds assist in nutrient cycling and water purification, playing a vital role in maintaining wetland health. The presence of Phragmites australis in Serbia underscores its pivotal role in shaping the intricate dynamics of wetland ecosystems.

Watermilfoil (Myriophyllum spp.) plays a notable role within Serbia's aquatic ecosystems. These submerged aquatic plants, characterised by their feathery leaves and delicate appearance, are common inhabitants of various water bodies across the country. Watermilfoil beds contribute to habitat complexity, providing shelter for aquatic organisms and serving as nurseries for fish species. As indicator species, their presence reflects water quality and ecosystem health. Furthermore, watermilfoil plays a crucial role in nutrient uptake, aiding in the regulation of water chemistry.

Within Serbia's aquatic environments, Duckweeds (Lemna spp.) carry great ecological importance.These tiny, free-floating plants are widespread in the country's water bodies. Despite their small size, duckweeds play essential roles in the ecosystem. They contribute to nutrient cycling by absorbing excess nutrients like nitrogen and phosphorus, thus aiding in water purification. Duckweed mats provide shelter for microorganisms, insects, and small aquatic organisms. Their rapid growth rate and adaptability make them an integral part of nutrient dynamics in Serbian waters.

Water hyacinth (Eichhornia crassipes) assumes ecological significance in Serbia's aquatic settings. This invasive aquatic plant, characterised by its vibrant purple flowers and rapid growth, has been identified in various water bodies across the country. However, its prolific nature poses challenges due to its potential to form dense mats that impede water flow and limit light penetration. These mats can negatively impact native aquatic species and alter ecosystem dynamics.

Hornwort (Ceratophyllum demersum), this submerged aquatic plant, characterised by its fine, branching foliage, is a common presence in various water bodies across the country. Hornwort contributes to aquatic ecosystems by providing shelter and spawning grounds for fish and invertebrates. Its ability to rapidly uptake nutrients aids in regulating water quality, and its submerged nature offers refuge for aquatic organisms. As an indicator of ecosystem health, the presence of Ceratophyllum demersum highlights its role in shaping the balance and vitality of Serbian aquatic environments.

Cattails (Typha spp.) are tall, reed-like plants with distinctive cylindrical flower spikes that thrive in various water bodies across the country. Cattails offer valuable habitat for a diversity of wildlife, including birds, insects, and amphibians. Their dense stands provide shelter, nesting sites, and feeding grounds, contributing to the overall biodiversity of aquatic ecosystems. Additionally, cattails aid in stabilising shorelines and mitigating erosion, enhancing the resilience of wetland areas.

Water starwort (Callitriche spp.) are submerged aquatic plants, characterised by their star-shaped leaves, thrive in various water bodies across the country. Water starwort contributes to nutrient cycling and water quality by absorbing nutrients and oxygenating the water. Their presence serves as an indicator of healthy aquatic ecosystems. Additionally, water starwort provides habitat for microorganisms and small aquatic organisms, contributing to the overall biodiversity of Serbian waters. As a vital component of aquatic ecosystems, Callitriche spp. underscores their role in maintaining the delicate balance of Serbia's aquatic habitats.

These examples provide a glimpse into the richness of aquatic plant species found within Serbia. The precise composition and distribution of aquatic vegetation experience fluctuations based on factors such as the nature of the freshwater ecosystem, the quality of the water, and various environmental influences

https://www.gardenia.net/plant/nymphaea-lotus
https://www.the-scientist.com/news-opinion/genome-spotlight-common-reed-phragmites-australis-69536

2.4. Preservation of aquatic biodiversity worldwide VS in Serbia

Efforts to conserve aquatic biodiversity are a global endeavour encompassing various strategies and initiatives. Conservation organisations collaborate to establish protected marine areas and freshwater reserves, safeguarding critical habitats from degradation and overexploitation. International agreements and conventions, such as the Convention on Biological Diversity, facilitate cross-border cooperation and promote the sustainable management of aquatic ecosystems. Conservationists engage in species recovery programs, reintroducing endangered aquatic species into their native habitats and breeding them in captivity to boost their populations. Awareness campaigns, education programs, and sustainable fishing practices help raise public consciousness about the value of aquatic biodiversity and inspire responsible actions to preserve these vital ecosystems for future generations.

Serbia's efforts to safeguard aquatic biodiversity involve a combination of regulatory measures, conservation projects, and public engagement. The country designated protected areas and reserves to preserve vital aquatic habitats. Implementation of national laws and adherence to international agreements, like the Ramsar Convention, contribute to the conservation of wetlands and water-dependent ecosystems. Conservation organisations collaborate with governmental bodies to conduct research, monitor species, and restore degraded aquatic environments. Public awareness campaigns and educational programs foster a sense of responsibility among citizens, promoting sustainable fishing practices and the value of preserving Serbia's diverse aquatic life for ecological and recreational purposes.

2.5. Economic aspects of aquatic biodiversity worldwide VS in Serbia

The global fishing industry is a significant economic sector, contributing to employment, food security, and trade. It encompasses various scales, from small-scale artisanal fishing to large industrial operations. Worldwide, fishing contributes billions of dollars to economies, but it also faces challenges of overfishing, bycatch, and habitat destruction.

In Serbia, fishing plays a role in the national economy, supporting livelihoods in both commercial and recreational sectors. While not as extensive as some maritime nations, Serbia's inland waters offer opportunities for freshwater fishing. Sustainable fishing practices are important for preserving aquatic ecosystems and ensuring the long-term economic and environmental viability of this sector.

Regulatory measures, such as fishing quotas and habitat protection, aim to balance economic interests with conservation efforts, contributing to the preservation of aquatic biodiversity and the overall well-being of the nation.

3.1. Part 2 - theory

3.2. Aquatic plants

Aquatic plants are plants adapted to living in aquatic environments. They have evolved a range of characteristics that enable them to thrive in partially or fully submerged aquatic environments. They play a crucial role in aquatic ecosystems by providing habitat, shelter, food, and oxygen to various organisms, as well as helping to maintain water quality.

Aquatic plants serve as vital components within aquatic ecosystems, contributing to a range of essential ecological functions: Photosynthesis performed by these plants results in the release of oxygen into the water, creating a life-sustaining environment for aquatic organisms such as fish and invertebrates. Nutrient management is another crucial role of aquatic plants. They actively absorb nutrients, including nitrogen and phosphorus, from the water, effectively reducing excessive nutrient levels that could otherwise lead to concerns like eutrophication and the proliferation of harmful algal blooms. The root systems of these plants act as natural stabilisers, playing a pivotal role in sediment control and erosion prevention along shorelines. This function is paramount for maintaining the structural integrity of both aquatic ecosystems and adjacent land areas. Beyond their stabilising effect, aquatic plants provide invaluable habitats for an array of aquatic organisms, ranging from fish to amphibians and invertebrates. Moreover, they serve as a fundamental source of nourishment for various aquatic animals, intricately interwoven into the complex food webs within these ecosystems. These plants also assume the role of natural water filters, effectively removing pollutants and impurities from the water. This filtration process contributes not only to the enhancement of water quality but also to the improvement of water clarity, positively impacting both aquatic life and human use. In conclusion, aquatic plants transcend their visual aesthetic, playing a vital role in maintaining

the equilibrium and health of aquatic ecosystems. Their multifaceted contributions encompass the enhancement of water quality, the sustenance of diverse life forms, and the facilitation of intricate ecological interactions within aquatic realms.

Water and land ecosystems have significant differences in their physical characteristics, environmental conditions, and the types of organisms that inhabit them. In the water ecosystem the concentration of oxygen is lower compared to the atmosphere. Lack of light with depth can also be a limiting factor for development of different species. Water temperature depends on environmental conditions, and also decreases with increasing depth. All of these factors present challenges that aquatic plants must overcome in order to successfully inhabit an aquatic habitat. During the long biological evolution, aquatic plants have developed a whole series of adaptations that enable them to live in such conditions. These adaptations are essential for their survival in habitats with limited access to oxygen, light, and nutrients. Some of the key adaptations of aquatic plants include:

- **Root Systems:** Aquatic plants have specialised root systems to anchor themselves in the substrate, such as mud or sand, or to float in the water. Root structures can vary based on the type of aquatic plant. Submersed plants often have fine, feathery roots that help them absorb nutrients from the water column, while emergent plants have sturdy roots that anchor them in the substrate. Aquatic plants often possess root hairs that increase the surface area for nutrient absorption. This adaptation is crucial in nutrient-poor aquatic environments where efficient nutrient uptake is essential for growth and survival.
- **Leaves:** The leaves of aquatic plants are adapted to minimise water resistance and prevent excessive water loss. Submersed plants often have thin leaves, which provide a large surface area for nutrient absorption. Floating plants have buoyant leaves that allow them to float on the water surface, enabling them to access sunlight for photosynthesis. Many submerged aquatic plants have thin, flexible leaves that offer less resistance to water movement. This adaptation reduces the risk of damage caused by strong water currents and waves.
- **Aerenchyma**: Aerenchyma is a specialised tissue found in many aquatic plants that provides transport of gases between submerged plant parts and the atmosphere. It consists of air-filled

spaces in the stems and leaves,that allow oxygen to be transported from the aerial parts of the plant (leaves) to the submerged roots, where oxygen is needed for cellular respiration.

- **Reduced Cuticle**: The cuticle is a hydrophobic lipid outer covering found on the surface of leaves in terrestrial plants, which helps reduce water loss through evaporation, transpiration and guttation. In aquatic plants, the cuticle is often thinner or absent, as water surrounds the plants, enabling the unimpeded diffusion and exchange of water and substances responsible for regulating the amount of water in the cell.
- **Stomata**: Stomata are small pores present in the epidermis of leaves and stems responsible for controlling gas exchange and water loss due to evaporation. In many aquatic plants, stomata are located on the upper surface of leaves, allowing them to exchange gases with the air above the water's surface while still preventing excessive water loss.
- **Air Spaces in Roots**: Some aquatic plants, especially those growing in soft, muddy substrates, have developed air spaces in their roots. These spaces enhance oxygen uptake, allowing the roots to respire even when submerged in waterlogged soil.
- **Reproduction Strategies**: Aquatic plants have adapted various reproductive strategies to disperse their seeds. Some seeds that can float and be carried by water currents, while others have specialised structures that enable vegetative propagation, such as rhizomes and stolons.
- **Flowers and Pollination**: In fully submerged aquatic plants, pollination can be a challenge. To overcome this, some species have adapted their flowers to remain at or near the water's surface. This allows easier pollination by insects or wind, ensuring successful reproduction.
- **Ability to Tolerate Fluctuating Water Levels**: Some aquatic plants are adapted to tolerate changes in water levels, such as those in riverine or wetland environments that experience seasonal flooding or drying. These plants may have adaptations like rhizomes, or other specialised structures that can withstand periods of inundation and drought.

It's important to note that aquatic plants can vary widely in their adaptations, and different species have unique strategies for survival in their specific aquatic habitats.

3.3. Division of aquatic plants

Some plants are entirely submerged, while others may grow partially submerged or have a combination of submerged and emergent growth forms, depending on the water level and environmental conditions. These diverse adaptations contribute to the rich biodiversity of aquatic plant life and their important role in maintaining the functionality of aquatic ecosystems. Aquatic plants can be categorised into seven types based on their growth habits, adaptations, and habitat preferences:

Submerged Plants: These are plants that grow entirely underwater and have their roots anchored in the sediment at the bottom of the water body. Submerged plants often have thin, divided and flexible leaves to minimise resistance to water movement. This allows them to withstand water currents and reduce the risk of damage. The thin leaves also provide a large surface area for efficient nutrient and gas exchange. Examples include various species of pondweed (Potamogeton spp.) and coontail (Ceratophyllum demersum). A diverse genus of submerged plants found in a wide range of aquatic habitats. Different species have different leaf shapes and growth forms. Eelgrass (Zostera marina), a marine submerged plant commonly found in coastal areas, forming extensive underwater meadows that serve as important habitats for various marine species. A widely distributed submerged plant with finely divided leaves and a distinctive coontail-like appearance.

https://www.gardenia.net/plant/ceratophyllum-demersum

Floating Plants: These plants have no roots anchored in the sediment and instead float freely on the water surface or are loosely attached. Floating plants are typically found in freshwater environments such as ponds, lakes, slow-moving rivers, and wetlands.They are uniquely adapted to grow on the

water's surface without being anchored to the bottom. Instead, they have specialised structures that allow them to float on the water, and their roots hang down freely into the water column. Many floating plants have air-filled spaces in their tissues, providing buoyancy that keeps them afloat on the water surface. Their root systems are often reduced or modified, as they do not need to anchor into the sediment. Instead, the roots absorb nutrients and water directly from the water column. Their leaves are adapted to float on the water surface, which helps maximise their exposure to sunlight for photosynthesis. They create shade on the water's surface, reducing light penetration and helping to regulate water temperature. This can be beneficial for fish and other aquatic organisms that prefer cooler environments. Floating plants also provide essential habitat and shelter for a variety of aquatic species. Their dense growth forms create hiding places for small fish, invertebrates, and other organisms, protecting them from predators. Like other aquatic plants, floating plants help absorb excess nutrients from the water, such as nitrogen and phosphorus, which can help prevent eutrophication and algal blooms. Examples include Water Lily (Nymphaea spp.) - known for their large, round, floating leaves and striking flowers, water lilies are common floating plants found in various freshwater habitats, Duckweed (Lemna spp.) - a group of small, free-floating plants with tiny green leaves that float on the water's surface, often forming dense mats, Water Hyacinth (Eichhornia crassipes) - an invasive floating plant with large, showy flowers and thick, buoyant leaves that can form extensive mats, often causing problems in some ecosystems.

A special category is **Floating-Leaved Plants**: These plants have floating leaves, but their roots are anchored in the sediment. The leaves and flowers float on the water surface, while the stems and roots are submerged. Examples include Water Lily (Nymphaea spp.) - water lilies are perhaps the most well-known floating-leaved plants. They have large, round leaves and showy flowers that float on the water's surface. The other example is Lotus (Nelumbo spp.): lotus plants have iconic large, circular leaves and unique, fragrant flowers that are often associated with spirituality and symbolism in various cultures.

Emergent Plants: Emergent plants are a type of aquatic vegetation that grow with their roots submerged in water but have their stems, leaves, and flowers rising above the water's surface.These plants are commonly found in the shallow areas of lakes, ponds, rivers, and wetlands, where the water is not too deep to allow their stems to reach the surface. Emergent plants grow in the littoral zone of

aquatic environments, which is the area along the shoreline where the water is shallow enough to allow sunlight to reach the bottom. The roots of emergent plants are submerged in the water and anchored in the sediment, providing stability. Some emergent plant species have leaves with a waxy or hairy coating, making them water-repellent (hydrophobic). This adaptation helps keep the leaves dry and facilitates gas exchange with the atmosphere. Examples include Cattails (Typha spp.): Cattails are one of the most well-known emergent plant species, characterised by their tall, slender, cylindrical flower spikes and strap-like leaves. Bulrushes (Schoenoplectus spp.), also known as clubrushes, have solid, triangular stems and small, inconspicuous flowers, Pickerelweed (Pontederia cordata): Pickerelweed is a popular emergent plant with heart-shaped leaves and spikes of violet-blue flowers.

https://www.chesapeakebay.net/discover/field-guide/entry/cattails

Algae: Algae are a diverse group of aquatic photosynthetic organisms that can be found in both freshwater and marine environments. They can range from microscopic single-celled organisms to larger, multicellular forms. Algae play a vital role in aquatic ecosystems, contributing to oxygen production and serving as a food source for various aquatic organisms.

Saltwater Aquatic Plants: Saltwater aquatic plants, also known as marine plants or seaweeds, are a diverse group of photosynthetic organisms that inhabit marine environments, such as oceans, seas, and estuaries. These plants have adapted to thrive in the challenging conditions of saltwater habitats, where they play essential roles in marine ecosystems. These plants have developed mechanisms to cope with high salt concentrations in seawater. They have specialised cells that store excess salt or mechanisms to excrete salt from their tissues. Examples include Seagrasses like eelgrass (Zostera spp.) and turtle grass (Thalassia spp.) are important components of coastal ecosystems, providing habitat for marine life and protecting shorelines from erosion.

Bog Plants: unique group of vegetation adapted to thrive in peatlands or bogs, which are specific types of wetland ecosystems characterised by acidic, oxygen-poor soils. These environments are often waterlogged and have low nutrient availability, leading to the development of acidic peat deposits. Bogs are waterlogged, stagnant wetlands characterised by the accumulation of peat, which is partially decayed organic matter. They are typically found in cool temperate regions and often have a distinctive carpet-like appearance due to the growth of bog plants, especially sphagnum moss. Bog plants have evolved special adaptations to survive and grow in these challenging conditions. Examples are Sphagnum moss (Sphagnum spp.), one of the most iconic and abundant bog plants. It is well-adapted to the acidic and waterlogged conditions of bogs. Sphagnum moss can hold large amounts of water like a sponge, creating the characteristic waterlogged environment of bogs. As the moss grows, the lower layers die and accumulate, forming peat. Sphagnum moss also has antimicrobial properties, helping to inhibit the growth of other plants and organisms in the bog. Other examples include various carnivorous plants like sundews (Drosera spp.) and pitcher plants (Sarracenia spp.). This carnivorous plants have evolved unique strategies to obtain nutrients in the nutrient-poor bog environment. They supplement their nutrient intake by trapping and digesting insects and other small organisms. The insects are attracted to the plants by nectar or the colourful traps, and once captured, they are broken down and absorbed by the plant for their nutrient needs. Bog plants have evolved remarkable adaptations to thrive in the challenging conditions of peatlands and bogs. They play essential roles in these unique ecosystems, contributing to the formation of peat and providing habitat for specialised plant and animal species.

Aquatic mosses and **liverworts** are non-vascular plants that are well-adapted to living in aquatic environments. Unlike vascular plants, they lack true roots, stems, and leaves, but they have specialised structures that allow them to thrive in waterlogged habitats. These plants play essential roles in aquatic ecosystems and contribute to the ecological balance of various freshwater environments. Aquatic mosses and liverworts can be found in a wide range of aquatic habitats, including ponds, lakes, rivers, streams, and wetlands. They grow on submerged rocks, tree trunks, floating logs, and other submerged or partially submerged surfaces. Some species are free-floating and can form floating mats on the water's surface. They have several adaptations that enable them to survive and thrive in waterlogged conditions: These plants have rhizoids, which are root-like structures that anchor them to the substrate. Rhizoids do not absorb water or nutrients like true roots; instead, they function mainly to provide attachment. They also have thin and absorbent surfaces: The thallus (body) of aquatic mosses is typically thin and flat, maximising their surface area for efficient absorption of water and nutrients from the surrounding aquatic environment. Examples of Aquatic Mosses is Fontinalis Moss (Fontinalis spp.) also known as water moss, is a common aquatic moss found in freshwater habitats. It often forms dense mats in slow-moving streams and ponds. Riccia fluitans, also called the floating liverwort, is a free-floating liverwort that floats on the water's surface. It has a thin, ribbon-like thallus and can be found in calm, still waters. They contribute to the ecological balance of freshwater habitats, providing habitat, shelter, and nutrient cycling for a variety of aquatic organisms. Each type of aquatic plant contributes uniquely to the structure and function of aquatic ecosystems, and their diversity is crucial for maintaining the health and balance of these environments. However, it is essential to manage invasive species and prevent the spread of non-native plants that can disrupt native ecosystems and threaten biodiversity.

3.4. Dangers to aquatic ecosystems and biodiversity

Aquatic ecosystems, spanning freshwater and marine environments, face numerous threats that directly impact aquatic biodiversity, leading to substantial ecological and environmental consequences. These threats arise from anthropogenic activities and natural factors, collectively contributing to the degradation and destruction of aquatic ecosystems. Understanding these challenges is pivotal for

devising effective conservation strategies and promoting sustainable practices to preserve the intricate balance of aquatic biodiversity.

- One of the most significant threats to aquatic ecosystems is **habitat destruction and alteration**. Urbanisation, agricultural expansion, and industrial development often lead to the conversion of aquatic habitats into human settlements, farmland, or infrastructure. The modification of river courses, wetland drainage, and shoreline development disrupts critical habitats, depriving numerous aquatic species of their natural habitat.
- **Pollution**, in various forms such as nutrient runoff, chemical contaminants, and plastic waste, poses a dire threat to aquatic biodiversity. Excess nutrients from agricultural runoff and wastewater can lead to eutrophication, causing harmful algal blooms and oxygen depletion. Toxic chemicals, including pesticides and heavy metals, accumulate in aquatic organisms, disrupting their physiological functions and impairing reproduction.
- **Overfishing and unsustainable harvesting practices** result in the depletion of aquatic species, disrupting food chains and causing imbalances within ecosystems. Unregulated fishing methods, bycatch, and illegal fishing practices further exacerbate the decline of fish populations, affecting both target and non-target species.
- The introduction of non-native species into aquatic ecosystems can have catastrophic effects on indigenous species. **Invasive species** outcompete native organisms for resources, disrupt food webs, and alter ecosystem dynamics. These invasions often result in declines or extinctions of native species, leading to significant shifts in aquatic biodiversity.
- **Climate change**, driven by increased greenhouse gas emissions, poses a multifaceted threat to aquatic ecosystems. Rising temperatures, sea-level rise, ocean acidification, and altered precipitation patterns directly impact the distribution and behaviour of aquatic species. Coral bleaching events, shifting ocean currents, and disrupted breeding patterns challenge the adaptability of marine and freshwater organisms.
- **The construction of dams and water infrastructure projects** alters natural water flows, disrupts sediment transport, and affects aquatic habitats. These alterations can impede fish migration, fragment populations, and diminish nutrient cycling, ultimately impacting the overall health and functioning of aquatic ecosystems.

- The **burgeoning tourism and recreational activities** in aquatic environments can lead to habitat degradation. Increased boat traffic, coastal development, and recreational pollution disturb sensitive habitats such as coral reefs, mangroves, and coastal dunes, affecting the biodiversity they support.

In conclusion, the direct destruction of aquatic ecosystems is primarily driven by human activities that compromise the delicate balance of aquatic biodiversity. Pollution, habitat destruction, overfishing, invasive species, climate change, water infrastructure, and tourism all contribute to the decline and loss of aquatic species. Addressing these threats necessitates comprehensive conservation efforts, sustainable practices, and global cooperation to safeguard the intricate web of life within aquatic ecosystems.

3.5. Impact of natural occurrences on aquatic biodiversity

Natural occurrences can have both direct and indirect impacts on aquatic biodiversity, shaping the composition, structure, and functioning of aquatic ecosystems. Natural climate variability, such as El Niño and La Niña events, can lead to changes in temperature and precipitation patterns. These changes can affect water availability, water temperature, and nutrient cycling in aquatic ecosystems, impacting the distribution and behaviour of aquatic species. Floods can have both positive and negative impacts on aquatic biodiversity. While excessive flooding can disrupt habitats, wash away organisms, and cause population declines, moderate floods can help replenish nutrients in floodplain areas and create new habitats for various species. Droughts can reduce water availability, leading to decreased habitat quality and altered water chemistry. Aquatic organisms may experience stress due to increased temperature and reduced dissolved oxygen levels. Prolonged droughts can lead to the contraction of aquatic habitats and even local extinctions of species. Wildfires in forested areas can have downstream effects on aquatic ecosystems. The loss of vegetation can lead to increased soil erosion, sediment runoff, and nutrient loading into water bodies, potentially disrupting aquatic habitats and water quality. Volcanic eruptions can release ash, gases, and debris into the atmosphere and water bodies. Ashfall can affect water quality and aquatic habitats, while volcanic gases can alter the chemistry of water

bodies, potentially impacting aquatic organisms. Earthquakes and tsunamis can cause sudden changes in water levels, leading to habitat destruction and disturbance of aquatic organisms. Coastal habitats may be particularly vulnerable to such events.

Natural changes in seasons, such as spring runoff from melting snow, can influence water flow, temperature, and nutrient availability. These changes can trigger spawning and migration patterns in aquatic species. Some aquatic species have natural population cycles that are influenced by factors like predator-prey interactions and availability of resources. These cyclic fluctuations can impact entire food webs in aquatic ecosystems. Natural occurrences like landslides, rockfalls, and glacial retreats can alter the physical structure of aquatic habitats, creating new opportunities for colonisation by certain species and potentially displacing others. In marine ecosystems, natural occurrences like elevated sea temperatures can lead to coral bleaching, which presents a stress response that expels the symbiotic algae living within corals. This can result in the death of corals and disrupt entire reef ecosystems. It's important to note that the frequency and intensity of some natural occurrences are being influenced by human activities, such as climate change and habitat alteration. Understanding the interactions between natural occurrences and anthropogenic factors is crucial for effectively managing and conserving aquatic biodiversity.

3.6. Impact of melting glaciers on aquatic biodiversity

Glacier melting can have significant impacts on aquatic biodiversity, as it directly affects the freshwater ecosystems that depend on glacial meltwater. Glacial meltwater contributes to the flow of rivers, streams, and lakes in many regions. Changes in the timing and quantity of this meltwater can alter the flow dynamics, temperature, and nutrient levels of aquatic habitats. Species adapted to specific temperature and nutrient conditions may be negatively affected. As the temperature and chemistry of aquatic systems change due to glacial meltwater input, some species may struggle to survive or reproduce. This can lead to shifts in species composition, favouring species that are more tolerant of the changing conditions. Many aquatic species, such as fish, insects, and amphibians, rely on specific temperature and flow conditions for their reproductive cycles. Changes in these conditions can affect the timing and success of reproduction, potentially leading to population declines.

Some aquatic species are uniquely adapted to glacial habitats and cold-water environments. As glaciers shrink and meltwater decreases, these species may lose their preferred habitats, putting them at risk of extinction. Glacial meltwater can carry nutrients and minerals from the glacier's surroundings into aquatic systems. Changes in the timing and volume of meltwater can alter nutrient input, affecting the growth of aquatic plants and algae, which form the basis of many aquatic food webs. Changes in nutrient availability and species composition can ripple through aquatic food webs. Predators that rely on specific prey may face challenges if the prey populations are disrupted by changing habitat conditions. Some aquatic species, particularly fish, may migrate between different habitats for different life stages (e.g., spawning, feeding, overwintering). Changes in water flow, temperature, and habitat availability due to glacier melt can disrupt these migration patterns. Glacial meltwater creates unique ecosystems such as glacial rivers and meltwater lakes. These ecosystems often support specialised species adapted to the cold and turbulent conditions. The loss of glacial ice can lead to the disappearance of these ecosystems and the species they harbour. Glacier melting can have various effects on aquatic plants in the surrounding ecosystems. The impacts on aquatic plants depend on factors such as the rate and extent of glacier melting, changes in water temperature, nutrient availability, and sedimentation. Glacier melting can alter the physical characteristics of aquatic habitats, including water flow, temperature, and substrate composition. These changes can influence the types of aquatic plants that can thrive in a given area. Glacial meltwater is typically colder than the surrounding water bodies. Changes in water temperature due to increased glacial melt can affect the growth and distribution of aquatic plants, favouring species adapted to colder conditions.

Glacier meltwater can introduce nutrients and minerals from the glacier's surroundings into aquatic ecosystems. Increased nutrient availability can stimulate the growth of aquatic plants, potentially leading to changes in plant community composition. Changes in water flow patterns resulting from glacier melting can influence the distribution of sediment, organic matter, and nutrients. This can impact the availability of suitable substrates for aquatic plants and affect their growth. Glacier melt can increase sediment runoff into water bodies, potentially smothering aquatic plants and affecting light penetration. Reduced light availability can limit the growth of submerged aquatic plants, which rely on photosynthesis. Rapid glacial retreat and associated glacial outburst floods can cause physical disturbance to aquatic plant communities, uprooting or burying plants. Some species may be more

resilient to such disturbances than others. Changes in habitat conditions due to glacier melting can lead to shifts in plant species composition and dominance. New plant species may colonise areas that were previously ice-covered, leading to competition and changes in community structure. Some aquatic plant species are adapted to specific cold-water environments and may be more vulnerable to changes in water temperature and nutrient availability. These species could decline or be replaced by more adaptable species. Glacier-fed aquatic systems often host unique and specialised plant communities. Glacier melting and related changes can alter the biodiversity of these systems, potentially leading to the loss of rare or specialised plant species. Increased nutrient input from glacier meltwater can promote eutrophication—the excessive growth of algae and aquatic plants. While this may initially benefit some plant species, it can lead to oxygen depletion and negative impacts on overall aquatic ecosystem health. In general, the effects of glacier melting on aquatic plants can be complex and multifaceted. The interplay between various factors, including water temperature, nutrient availability, sedimentation, and competition, determines the overall response of aquatic plant communities to glacier-related changes.

3.7. Impact of volcanic eruptions on aquatic biodiversity

Volcanic eruptions can have a range of effects on aquatic biodiversity, impacting freshwater and marine ecosystems in different ways. The nature and magnitude of these effects depend on factors such as the proximity of the eruption to aquatic ecosystems, the type of volcano, the volume of material ejected, and the specific characteristics of the water bodies involved. Volcanic eruptions can introduce a variety of materials into water bodies, including ash, debris, and volcanic gases. This can lead to increased turbidity, sedimentation, and changes in water chemistry, affecting aquatic habitats and species that rely on specific water quality conditions. Eruptions can release heat and increase water temperature in nearby water bodies due to the transfer of heat from the volcanic activity. Drastic temperature changes can stress aquatic organisms that are sensitive to temperature fluctuations. Volcanic gases, such as sulphur dioxide, can dissolve in water and contribute to acidification. This can harm aquatic life, especially species like fish and invertebrates that are sensitive to changes in pH levels. Gases released during volcanic eruptions, such as sulphur dioxide and hydrogen sulphide, can be toxic to aquatic organisms, leading to mass mortality events, particularly in shallow and enclosed

water bodies. Ash and volcanic debris can settle in water bodies, increasing sediment load. This can clog gills of aquatic animals, smother benthic habitats, and reduce light penetration needed for photosynthesis by aquatic plants. The erosional force of volcanic eruptions, along with subsequent rain, can lead to soil erosion and changes in the shape of river channels and coastlines, altering aquatic habitats and stream dynamics. Volcanic eruptions can destroy riparian vegetation along riverbanks and shores, impacting habitats and organisms that rely on this vegetation for shelter and food. While volcanic eruptions can introduce new nutrients to aquatic ecosystems through ash and volcanic materials, the subsequent leaching and runoff can result in nutrient loading, potentially leading to eutrophication and algal blooms. Depending on the scale of the eruption and the proximity to aquatic ecosystems, large-scale fish and other aquatic organism die-offs can occur due to exposure to toxic substances, changes in water quality, and habitat destruction. Over time, volcanic sediments and nutrient-rich waters can create new habitats that can be colonised by pioneer species. Some species may adapt to these newly formed habitats and establish unique ecosystems. The impacts of volcanic eruptions on aquatic biodiversity can be long-lasting. Recovery of aquatic ecosystems may take years or decades, depending on the severity of the eruption and the resilience of the affected species and habitats.

https://www.ready.gov/volcanoes

Overall, the effects of volcanic eruptions on aquatic biodiversity are complex and can vary widely based on the specific characteristics of the eruption and the aquatic ecosystems involved. Monitoring and research are crucial to understanding the extent of impacts and the potential for recovery in affected aquatic environments.

3.8. Impact of landslides and rockfalls on aquatic biodiversity

Landslides and rockfalls can have significant impacts on aquatic biodiversity, particularly in areas where these events occur near or within aquatic ecosystems. These natural events can cause both direct and indirect effects on aquatic organisms and their habitats. Landslides and rockfalls can alter the physical structure of aquatic habitats, changing the shape of rivers, streams, and lakes. Debris from these events can reshape water bodies, disrupt habitats, and create new microhabitats.

Debris from landslides and rockfalls can introduce large amounts of sediment into water bodies. Increased sediment load can smother benthic habitats, clog gills of aquatic organisms, and reduce light penetration, affecting photosynthesis by aquatic plants. The introduction of sediment and debris can lead to changes in water quality, including increased turbidity and altered chemical composition. This can impact aquatic organisms that rely on clear water and specific water chemistry conditions. Landslides and rockfalls can strip vegetation from the surrounding landscape, including riparian vegetation along riverbanks and shores. This can impact habitats and organisms that depend on this vegetation for shelter, food, and stability. The force of landslides and rockfalls can cause physical disturbance to aquatic habitats, dislodging rocks, logs, and other debris. These changes can create new hiding places for aquatic organisms or expose them to new risks. Large landslides or rockfalls that directly impact water bodies can result in mass mortality events, particularly for organisms in the path of the debris. Fish, invertebrates, and other aquatic species may be crushed or buried by debris. Landslides and rockfalls can alter connectivity within aquatic ecosystems by creating barriers that prevent the movement of aquatic organisms. This fragmentation can impact migration patterns and genetic exchange among populations. These occurrences can introduce nutrients and organic matter from the terrestrial environment into water bodies. While this can temporarily increase nutrient availability and productivity, it can also lead to eutrophication and algal blooms. Over time, areas affected by landslides and rockfalls may undergo ecological succession as new plant and animal communities establish themselves. This process can influence the composition and structure of aquatic ecosystems.

The impacts of landslides and rockfalls on aquatic biodiversity can persist for years or even decades. Recovery depends on factors such as the severity of the disturbance, the resilience of the affected species, and the ability of the ecosystem to restore itself. Rockfalls can change the flow patterns of

rivers and streams, affecting water velocity, depth, and substrate composition. These changes can influence the types of aquatic species that can thrive in the altered conditions. In areas prone to landslides understanding the dynamics of these events and their potential effects on aquatic ecosystems is crucial for effective management and conservation of aquatic biodiversity.

3.9. Impact of droughts on aquatic biodiversity

Droughts can have significant impacts on aquatic plant biodiversity, disrupting the delicate balance of aquatic ecosystems and affecting the composition, structure, and functioning of plant communities. The effects of drought on aquatic plants depend on factors such as the severity and duration of the drought, the resilience of the plants, and the characteristics of the water bodies. Droughts lead to decreased water levels in rivers, lakes, ponds, and wetlands. Reduced water availability can directly stress aquatic plants by limiting their access to water for growth, photosynthesis, and reproduction. Decreased water levels can lead to changes in water temperature, dissolved oxygen levels, and nutrient concentrations. These changes can affect the quality of aquatic habitats and determine the types of plants that can thrive. Drought-induced reductions in water levels can fragment habitats, isolating aquatic plant populations and disrupting connectivity among different parts of aquatic ecosystems. In some cases, droughts can lead to higher concentrations of salts in water bodies due to evaporation. Increased salinity can negatively affect freshwater plants, particularly those adapted to low salinity conditions. Reduced water flow during droughts can lead to stagnant or slow-moving water conditions. This can impact the distribution of aquatic plant species that are adapted to specific flow velocities. As water levels drop, submerged aquatic plants may become exposed to air, potentially leading to desiccation and stress. Plants that require constant submergence can suffer when exposed to prolonged air exposure. Drought-induced changes in habitat conditions can alter interspecies interactions. Some aquatic plants may experience increased competition for limited resources, while others may be more vulnerable to herbivory due to altered predator-prey dynamics. Droughts can lead to the loss of riparian vegetation along riverbanks and shores. This vegetation plays a critical role in stabilising banks, filtering runoff, and providing habitats for various species, including aquatic plants. These conditions can affect the timing of aquatic plant reproductive cycles, such as flowering and seed

production. Reduced water availability can limit the opportunities for plant reproduction and dispersal. Even after the drought ends, the effects on aquatic plant biodiversity can persist. Some species may recover more quickly than others, potentially leading to shifts in plant community composition.

https://www.preventionweb.net/news/world-crossroads-drought-management-29-generation-and-worsening-says-un

The ability of aquatic plant communities to recover from drought events depends on their resilience and adaptive strategies. Species with drought-tolerant traits may have a better chance of surviving and recovering. Managing the impacts of droughts on aquatic plant biodiversity requires a comprehensive understanding of the specific characteristics of each ecosystem, as well as strategies for conserving water resources and promoting habitat resilience.

3.10. Impact of floods on aquatic biodiversity

Floods can have both positive and negative impacts on aquatic plant biodiversity, depending on the characteristics of the flood event, the ecosystem's natural resilience, and the specific adaptations of the aquatic plants present.

Positive impacts: Floods can bring new sediment and nutrients to aquatic ecosystems, replenishing nutrients in floodplain areas and rejuvenating habitats for aquatic plants. This can stimulate growth and create opportunities for colonisation by new plant species. Floodwaters can carry seeds from terrestrial areas into aquatic habitats, increasing the potential for plant species diversity. This can result in the establishment of new plant populations in areas that were previously devoid of vegetation. The disturbance caused by floods can expose previously buried seeds to light and moisture, promoting

germination and growth of dormant plant seeds. Floodwaters can deliver nutrients from surrounding landscapes to water bodies, temporarily increasing nutrient availability. This nutrient enrichment can stimulate the growth of aquatic plants. Floods can create new microhabitats by altering substrate composition, creating new channels, and forming temporary pools. These changes can provide niches for various aquatic plant species.

Negative impacts: Severe floods can lead to habitat destruction by uprooting, burying, or washing away aquatic plants. The physical force of flood waters can cause significant damage to plant communities. Excessive sediment deposition during floods can smother aquatic plants and disrupt their growth. Sediment can cover leaves, limiting light penetration and photosynthesis. Floods can wash away flowers, seeds, and reproductive structures of aquatic plants, disrupting their reproductive cycles and reducing their ability to reproduce.

Floods can create shifts in species composition, favouring species that are more tolerant of disturbance and rapid changes in water flow. This can lead to changes in plant community dynamics.Floodwaters can bring in pollutants, chemicals, and sediments from surrounding areas, affecting water quality and potentially stressing aquatic plants. Floods can erode and damage riparian vegetation along riverbanks and shores. The loss of this vegetation can affect the stability of banks and the availability of habitat for aquatic plants. Floodwaters can facilitate the spread of invasive plant species by transporting their seeds, fragments, or propagules to new areas. Intense flood events can create barriers and disconnect habitats, isolating plant populations and affecting gene flow among different parts of the ecosystem. Overall, the impacts of floods on aquatic plant biodiversity are complex and depend on the intensity, duration, and frequency of flood events, as well as the adaptive strategies of the plant species present. The long-term effects of floods on aquatic plants are influenced by the ability of the ecosystem to recover and the resilience of the plant communities to changing conditions.

3.11. Impact of wildfires on aquatic biodiversity

Wildfires can have a range of direct and indirect impacts on aquatic plant biodiversity, particularly in areas where fire-induced changes in the landscape can influence water quality, hydrology, and the overall functioning of aquatic ecosystems. Wildfires can remove vegetation that stabilises soil and

prevents erosion. This can lead to increased sediment runoff into water bodies, affecting water clarity and smothering aquatic plants. Ash and debris from wildfires can wash into water bodies, introducing nutrients and organic matter. While this can initially stimulate the growth of aquatic plants, it can also lead to eutrophication, algal blooms, and changes in water quality.

Wildfires can alter the chemical composition of water bodies due to the introduction of ash, organic matter, and dissolved chemicals. These changes can impact aquatic plants that are sensitive to water chemistry fluctuations. Wildfires can expose water bodies to increased sunlight and heat due to the loss of shading vegetation. This can lead to elevated water temperatures that stress aquatic plants adapted to cooler conditions. The loss of riparian vegetation along riverbanks and shores can impact aquatic habitats by reducing the availability of shelter, food, and habitat structure for aquatic plants and other organisms. These occurrences can create opportunities for invasive plant species to establish and thrive. The disturbance caused by the fire can create open spaces that invasive plants exploit. They can disrupt connectivity within aquatic ecosystems, isolating populations of aquatic plants and disrupting species interactions. Changes in soil properties and vegetation cover due to wildfires can influence water retention and flow patterns. This can affect water availability for aquatic plants and the types of species that can thrive in altered hydrological conditions.

While some aquatic plant communities may recover quickly after wildfires, others may experience long-term changes in species composition and structure due to altered conditions. Over time, areas affected by wildfires may undergo ecological succession as new plant communities establish themselves. Succession can influence which aquatic plant species become dominant in the post-fire landscape. Some aquatic plant species are more resilient to disturbance, while others may be more sensitive. Wildfires can lead to shifts in the dominance of certain species based on their ability to tolerate the post-fire conditions.

In some cases, wildfires may create opportunities for regeneration and renewal. For example, some fire-adapted aquatic plants may have seeds or propagules that require heat or fire-related cues to germinate. Overall, the effects of wildfires on aquatic plant biodiversity are complex and depend on various factors, including fire severity, ecosystem characteristics, pre-existing species composition, and the overall resilience of aquatic ecosystems to disturbance. Management strategies that consider

the interconnections between terrestrial and aquatic ecosystems are important for minimising negative impacts and promoting ecosystem recovery after wildfires.

3.12. Impact of tectonic plate movement on aquatic biodiversity

Tectonic plate movements, which include processes such as continental drift, seafloor spreading, and the formation of mountains and ocean basins, can indirectly impact aquatic plant biodiversity by influencing the geological and physical characteristics of aquatic habitats.

Tectonic plate movements can create new landforms and alter the shape and depth of aquatic habitats. For example, the formation of mountain ranges, valleys, and ocean basins can influence water flow patterns, sediment deposition, and nutrient distribution in aquatic ecosystems. Tectonic processes can create new aquatic habitats, such as freshwater lakes, rivers, and coastal areas. These new habitats can provide opportunities for the colonisation of aquatic plants and the establishment of diverse plant communities.

The movement of tectonic plates can lead to the separation of landmasses and the division of aquatic habitats. This fragmentation can impact the distribution of aquatic plant species and influence genetic connectivity among populations. Tectonic plate movements can contribute to changes in sea levels over geological timescales. Rising sea levels can inundate coastal areas and create new brackish and marine habitats, while falling sea levels can lead to the exposure of new land surfaces. These movements are often associated with volcanic activity, which can influence water chemistry, temperature, and habitat structure in aquatic ecosystems. Volcanic eruptions can introduce nutrients into water bodies and create unique hydrothermal habitats. Tectonic processes can cause the uplift of land and the subsequent erosion of rocks, leading to the deposition of sediment in aquatic environments. Sediment deposition can affect water quality and habitat structure, influencing the types of aquatic plants that can thrive.

Tectonic events can lead to changes in hydrology, affecting water flow patterns and water availability for aquatic plants. Shifts in river courses and drainage patterns can impact aquatic habitats. These movements occur over long geological timescales and can influence the evolutionary history of aquatic plants and their adaptations to changing aquatic environments. Activity, such as the movement of tectonic plates along subduction zones, can influence geothermal heat flow and hydrothermal

activity in aquatic environments. These heat sources can create unique thermal habitats that support specialised plant communities.

It's important to note that the impacts of tectonic plate movements on aquatic plant biodiversity occur over extended timescales and are influenced by a complex interplay of geological, climatic, and ecological factors. While tectonic events may not have immediate and direct impacts on aquatic plants, they can shape the physical characteristics of aquatic habitats, influencing the dynamics and distribution of plant communities over long periods of time.

3.13. Ramifications of decreased aquatic plant biodiversity

Decreased plant biodiversity can have wide-ranging and profound ramifications for ecosystems, ecological processes, and human societies. Plant biodiversity is essential for the health and functioning of ecosystems, and its decline can disrupt various ecological services and functions. Biodiverse ecosystems are often more resilient to disturbances, as different plant species have varying responses to environmental changes. Reduced plant diversity can make ecosystems more vulnerable to disturbances like pests, diseases, climate events, and habitat degradation. Plant diversity plays a crucial role in nutrient cycling within ecosystems. Different plant species have different nutrient requirements and contribute various organic materials to the soil. A decrease in plant diversity can disrupt nutrient cycling processes, affecting soil fertility and overall ecosystem productivity.

Plant diversity supports diverse trophic interactions, including herbivores, predators, and decomposers. A reduction in plant diversity can disrupt these interactions, potentially leading to imbalances in food webs and cascading effects throughout the ecosystem. Plants provide habitat and resources for a wide range of organisms, from insects and birds to mammals and fungi. A decline in plant diversity can lead to reduced habitat availability and food sources for these species. Many plant species have cultural, medicinal, and economic value. A decrease in plant diversity can limit the availability of these resources, affecting traditional practices, pharmaceutical development, and livelihoods.

Biodiverse plant communities contribute to essential ecosystem services such as carbon sequestration, water purification, erosion control, and pollination. Decreased plant diversity can weaken the capacity

of ecosystems to provide these services. Within a plant species, genetic diversity provides the raw material for adaptation to changing environmental conditions. Reduced plant diversity can result in lower genetic variation, making species more susceptible to diseases, pests, and changing climate. All of this influences carbon uptake and storage in ecosystems. A decrease in diversity can affect carbon sequestration rates, potentially exacerbating climate change impacts.

Biodiverse landscapes often have aesthetic and cultural value for communities. A loss of plant diversity can lead to less visually appealing landscapes and impact cultural connections to the land. Decreased plant diversity can impact the availability of diverse and nutritious foods. It can also reduce the potential for discovering new plant-based compounds with medicinal properties. Many natural areas are valued for their biodiversity and attract ecotourism. A decline in plant diversity can reduce the appeal of these areas for tourists and affect local economies.

Restoring ecosystems with reduced plant diversity can be more challenging, as the absence of key plant species can limit the success of restoration projects. Preserving and restoring plant biodiversity is critical for maintaining the health, resilience, and functionality of ecosystems. Conservation efforts, habitat restoration, sustainable land management practices, and raising awareness about the importance of biodiversity are all essential for mitigating the ramifications of decreased plant diversity.

3.14. Ramifications of decreasing phytoplankton biodiversity

The loss of phytoplankton, which are microscopic photosynthetic organisms that form the base of the marine food chain, can have significant and cascading effects on marine ecosystems, biodiversity, and the Earth's climate system. Phytoplankton play a crucial role in marine ecosystems and global biogeochemical cycles, so their decline can lead to a range of negative ramifications. Phytoplankton are the primary producers in marine ecosystems, providing energy and nutrients to higher trophic levels. Their decline can disrupt the entire marine food web, affecting zooplankton, fish, marine mammals, and seabirds that rely on them as a food source. Phytoplankton species diversity is a key driver of marine biodiversity. A decline in phytoplankton can lead to shifts in species composition, favouring certain species over others. This can impact the diversity and abundance of other marine organisms. These microorganisms produce a significant portion of the world's oxygen through

photosynthesis. A decline in phytoplankton can result in reduced oxygen production, potentially affecting oxygen availability in the oceans and contributing to hypoxic (low-oxygen) zones. Phytoplankton play a crucial role in the carbon cycle by sequestering carbon dioxide from the atmosphere through photosynthesis. A reduction in phytoplankton can weaken this carbon sink, potentially accelerating climate change. They play a key role in nutrient cycling by absorbing and recycling nutrients, such as nitrogen and phosphorus. A decline in phytoplankton can disrupt nutrient cycling in marine ecosystems, affecting overall productivity.

Phytoplankton contribute to water clarity by absorbing sunlight and particles. A loss of phytoplankton can result in increased water clarity, which may disrupt the light conditions that aquatic organisms have adapted to. These organisms are a critical food source for many fish species. A decline in phytoplankton can lead to decreased fish populations, affecting commercial fisheries and the livelihoods of fishing communities. Also, they play a role in the "biological pump," a process that transfers carbon from the surface ocean to deeper layers. A reduction in phytoplankton can weaken this pump, affecting the ocean's ability to sequester carbon. A decrease in phytoplankton can contribute to higher levels of carbon dioxide in the atmosphere, leading to increased ocean acidification. This can negatively impact marine organisms that rely on calcium carbonate for their shells and skeletons. The loss of phytoplankton can trigger feedback loops, where changes in one aspect of the ecosystem lead to further negative impacts. For example, reduced phytoplankton can lead to decreased food availability for zooplankton and other organisms. Phytoplankton influence the Earth's climate by regulating the exchange of heat and gases between the ocean and the atmosphere. A decline in phytoplankton can disrupt these climate-regulating mechanisms. The loss of phytoplankton is a complex issue that is linked to various factors, including nutrient pollution, climate change, and ocean warming. Protecting and restoring phytoplankton populations is crucial for maintaining the health and functioning of marine ecosystems and the global environment.

4.1 Part 4 - 10 WeLab kit exercise

4.2. Investigating Aquatic Biodiversity in Freshwater Ecosystems

Objective: The aim of this laboratory experiment is to study and compare the biodiversity of aquatic organisms in different freshwater ecosystems. Students will collect and analyse samples from various freshwater habitats to assess the diversity of aquatic life present.

Materials:

- Sampling equipment (nets, buckets, ect.)
- Water quality testing kits (pH, dissolved oxygen, temperature, etc.)
- Microscopes
- Petri dishes
- Magnifying glasses
- Identification guides or resources for aquatic organisms
- Data recording sheets

Procedure: Choose at least three different freshwater ecosystems for sampling, such as a pond, a river or stream, and a lake. Make sure the locations are accessible and safe for students to collect samples. Divide students into small groups and assign each group to one of the selected freshwater ecosystems. Provide each group with the necessary sampling equipment and data recording sheets. Instruct students to collect aquatic samples from each ecosystem using the appropriate sampling equipment. They should collect samples from both the water column and the bottom substrate to capture a wide range of organisms. Encourage students to take water quality measurements (pH, dissolved oxygen, temperature) at each sampling location.

Back in the laboratory, have students carefully examine the collected samples under microscopes and magnifying glasses. They should observe and identify various aquatic organisms present, including plankton, macroinvertebrates, and aquatic plants. Record their observations, noting the different species and their abundance. Once all groups have completed their sample analysis, compile the data from each group into a master list of observed species and their frequency of occurrence in each ecosystem. Analyse the data to compare the biodiversity among the different ecosystems. Look for differences in species richness (the number of different species) and species diversity (the relative abundance of each species).

Discussion: Have students discuss their findings as a group and present their results to the class. Encourage discussions on the factors that may influence aquatic biodiversity in each ecosystem, such as water quality, habitat complexity, and human impacts. Explore the importance of biodiversity in freshwater ecosystems and its significance for ecological balance and ecosystem health.
Summarise the results of the experiment, highlighting the differences in aquatic biodiversity between the selected freshwater ecosystems. Reinforce the importance of conserving and protecting freshwater habitats to maintain and enhance aquatic biodiversity.

4.3. Studying Aquatic Biodiversity through Phytoplankton Pigmentation

Objective: The objective of this laboratory experiment is to use a spectrophotometer for the quantitative assessment of phytoplankton presence in aquatic environments based on their pigmentation analysis.

Materials:

- Water samples from different aquatic ecosystems (lakes, rivers, streams)
- Spectrophotometer
- Quartz cuvette for the spectrophotometer
- Distilled water
- Micropipette and pipette tips
- Acetone
- Ethanol
- NaOH solution
- MgCO3 solution

Procedure: Prepare water samples from different aquatic ecosystems that you wish to study. Take the samples in sterile test tubes and label them according to their origin. Next is the procedure of Isolation of Phytoplankton Pigments: Phytoplankton pigment isolation is conducted using the acetone/ethanol method. This method allows for the extraction of pigments from phytoplankton for spectrophotometric analysis. Add a few drops of each reagent into each test tube containing the water samples. The reagents to be added are:

- Acetone (4 mL)
- Ethanol (1 mL)
- NaOH solution (0.1 mL)
- MgCO3 solution (0.1 mL)
- Distilled water (fill to the top of the test tube)

Carefully mix the test tubes to ensure proper mixing of the reagents with the water samples. Leave the test tubes in a dark room to allow for proper isolation of phytoplankton pigments. Let them stand for 24 hours.

Measurement of Phytoplankton Pigment Absorbance: After 24 hours, retrieve the extracts from the test tubes and transfer them into the quartz cuvette for the spectrophotometer. Set the spectrophotometer to the appropriate wavelength for measuring the absorbance of phytoplankton pigments (typically around 440 nm, 662 nm, and 750 nm). Measure the absorbance of each extract at the respective wavelengths.

Data Analysis: Based on the spectrophotometric measurements, compare the absorbance of phytoplankton pigments from different water samples. Discuss the results and their correlation with the phytoplankton biodiversity in different aquatic ecosystems.

Summarise the findings related to studying aquatic biodiversity through phytoplankton pigmentation and its significance for ecological analyses of water ecosystems.

***Note**: Before conducting this experiment, ensure to observe and follow all safety measures and guidelines for handling chemicals and equipment. Also, ensure that the quartz cuvette for the spectrophotometer is clean and free from dust to obtain accurate results. Additionally, make sure that water samples are collected appropriately and safely and that they are disposed of properly after analysis.*

4.4. Microscopic Examination of Clean Stream Water and Dirty Pond Water

Introduction: Microscopic analysis of water samples can reveal a wide range of microorganisms and particles present in aquatic environments. In this lab exercise, we will use a microscope to compare and contrast the microorganisms and particles found in a sample of clean stream water and a sample of dirty pond water.

Materials:

- Microscope
- Microscope slides
- Coverslips
- Droppers
- Clean stream water sample
- Dirty pond water sample
- Pipettes

Procedure: Place a drop of clean stream water on one microscope slide using a dropper, and place a drop of dirty pond water on another microscope slide using a dropper. Gently place a coverslip over each water droplet to create a wet mount. Begin with the lowest magnification objective lens (10x) and focus on the samples. Observe the samples for any visible microorganisms, particles, or debris. Gradually increase the magnification to higher levels (40x, 100x) to observe the samples in more detail.

Sketch and label any microorganisms or particles you observe in both the clean stream water and dirty pond water samples. Document the size, shape, and any distinctive characteristics of the microorganisms. Record and compare the presence of particles, sediment, and other visible materials in the two samples.

Discussion: Analyze and contrast the microorganisms and particles detected in the clean stream water and dirty pond water samples. Discuss potential factors contributing to the observed differences, such as pollution, nutrient levels, and habitat conditions.

Microscopic examination of both clean stream water and dirty pond water emphasises the diverse microorganisms and particles present in different aquatic environments. This exercise underscores the significance of using microscopy to delve into the microscopic world and its relevance to assessing the quality and health of aquatic systems.

4.5. Water Quality Analysis of Different Water Sources for Drinking Water Production

Introduction: Analysing the quality of water samples from various sources is crucial for determining their suitability for producing safe drinking water. In this lab exercise, students will assess water samples collected from different water surfaces, including a river, lake, sea, pond, and stream. The goal is for students to evaluate key water quality factors, such as pH, presence of microorganisms, salinity, amount of electrolytes, and general purity, to decide which water source is the most suitable for drinking water production and to justify their findings based on their analyses.

Materials:

- Water samples from a river, lake, sea, pond, and stream
- pH testing kit
- Microscope
- Microscope slides and coverslips
- Microbial staining materials (if available)
- Salinity testing equipment
- Electrolyte testing kit
- Water purity testing strips
- Laboratory glassware and equipment
- Safety goggles and gloves

Procedure: Collect water samples from the designated water surfaces using sterile containers. Label each container appropriately to identify the source.

pH Analysis: Measure the pH of each water sample using a pH testing kit. Record the results. Discuss the significance of pH in drinking water and its effects on human health.

Microorganism Presence: Prepare microscope slides of water samples for microbial examination. Observe each sample for the presence of microorganisms. Optionally, perform staining techniques to enhance microbial visibility. Record observations and discuss the implications of microbial presence in drinking water.

Salinity Measurement: Measure the salinity of each water sample using appropriate testing equipment. Record the salinity levels. Discuss the impact of salinity on drinking water suitability and human consumption.

Electrolyte Assessment: Perform electrolyte testing on each water sample using the provided kit. Record the results. Discuss the potential influence of electrolyte content on water's suitability for consumption.

Water Purity Testing: Use water purity testing strips to assess the general purity of each water sample. Record and compare the results. Discuss the role of water purity in ensuring safe drinking water.

Based on the collected data and observations, have students analyse and compare the water quality factors of each sample. In a written report or discussion session, ask students to determine which water source is the most suitable for drinking water production and to explain their reasoning based on their findings.

Presentation and Discussion: Have students present their findings to the class, discussing their analysis of each water sample's quality factors and explaining their chosen source for drinking water production.

This lab exercise provides students with hands-on experience in analysing key water quality factors to determine the most suitable water source for producing safe drinking water. By considering factors such as pH, microorganism presence, salinity, electrolyte content, and general purity, students develop critical thinking skills and gain insights into the complexities of water quality assessment and its implications for human health.

4.6. Absorption Spectrum Analysis of Chlorophyll Pigments in River Grass and Sea Grass

Introduction: Chlorophyll pigments play a pivotal role in photosynthesis, capturing light energy for conversion into chemical energy. In this lab exercise, students will employ a photometer to measure the absorption spectrum of chlorophyll pigments in river grass and sea grass. By comparing the absorption profiles of these plant types, students will uncover how diverse environments impact pigment adaptations and light absorption efficiency.

Materials:

- River grass sample
- Sea grass sample

- Spectrophotometer or photometer
- Cuvettes
- Filter paper
- Scissors
- Mortar and pestle
- Extraction solvent (acetone or ethanol)
- Microcentrifuge tubes
- Distilled water
- Safety goggles and gloves

Procedure: Collect fresh river grass and sea grass samples. Cut comparable segments from each grass type. Grind the segments with extraction solvent (acetone/ethanol). Calibrate the photometer using distilled water as the reference. Set the wavelength range to encompass the visible light spectrum (400 nm to 700 nm). Fill a cuvette with the extraction solvent (acetone/ethanol) as a blank reference. Set the photometer to measure blank cuvette absorbance at each visible light wavelength. Insert cuvettes with river grass and sea grass extracts, measuring their absorbance spectra.

Data Collection and Analysis: Record absorbance values for each visible light wavelength in both grass extracts. Plot absorption spectra for river grass and sea grass on a shared graph for comparison.

Discussion and Interpretation: Analyse absorption spectra of river grass and sea grass extracts. Discuss significance of peaks and troughs, considering different chlorophyll pigments. Interpret absorption pattern differences in relation to ecological adaptations of river grass and sea grass.

Summarise findings of absorption spectrum analysis, highlighting chlorophyll pigment absorption variations between river grass and sea grass. Discuss implications of these variations on light utilisation, adaptation, and ecological niches. This lab provides hands-on experience using a photometer to measure chlorophyll pigment absorption spectra in diverse grass types. Comparing river grass and sea grass absorption profiles unveils their adaptation to environments and the resultant light absorption efficiency differences. Students gain insights into the intricate interplay between plant adaptations, pigment absorption, and ecological niches.

4.7. Dissection and Microscopy of Sea Grass and River Grass Structures

Objective: To dissect and examine the anatomical structures of sea grass and river grass using microscopy, and to compare their similarities and differences.

Materials:

- Sea grass sample (eelgrass, Zostera spp.)
- River grass sample (common reed, Phragmites australis)
- Dissection tools (scissors, forceps, scalpel)
- Microscope
- Microscope slides and coverslips
- Dropper
- Distilled water
- Staining solution (iodine solution)
- Disposable gloves
- Safety goggles
- Lab apron

Procedure: Put on the safety goggles and lab apron. Wear disposable gloves to handle the plant samples and other materials.

Dissection: Place the seagrass sample and river grass sample side by side for easy comparison. Observe the external features of both sea grass and river grass. Note any differences in colour, size, and overall morphology. Using scissors, carefully cut small sections (about 5-10 cm in length) from both the sea grass and river grass samples. Place the sections on a dissection tray.

Microscopy: Prepare a microscope slide for each type of grass: Place a small drop of distilled water on the center of a microscope slide. Gently place a small section of sea grass on one slide and a section of river grass on another slide. If necessary, use a dropper to add a few drops of staining solution (iodine solution) to one of the grass sections. This can help enhance certain cellular structures. Place a coverslip over each grass section and gently press down to spread the material. Place each slide on the microscope stage and secure it in place. Begin with the lowest magnification objective lens (10x) and focus on the tissue's overall structure and arrangement of cells. Switch to higher magnification objective lenses (40x or 100x) to observe more detailed cellular structures.

Observations and Comparisons: Observe the following features under the microscope for both sea grass and river grass: Leaf anatomy: Look for epidermal cells, stomata (if present), and any specialised structures. Vascular bundles: Examine the arrangement of xylem and phloem. Root structure (if available): Observe root hairs, root cap, and other root tissues. Record your observations in a detailed manner, noting any similarities and differences between the two grass types.

Discussion: Compare the anatomical structures of sea grass and river grass based on your observations. Discuss the potential adaptations these grasses might have for their respective aquatic environments. Consider the differences in their cellular structures and how they might relate to their growth habits and nutrient requirements. Summarise the key findings of the dissection and microscopic examination, highlighting the similarities and differences between seagrass and river grass structures, and the potential significance of these observations in understanding their ecological roles.

Cleanup: Dispose of the plant materials properly according to your institution's guidelines. Clean and store the dissection tools and microscope properly.

Note: This laboratory exercise is a general guideline and can be adapted based on the specific plant species available and the equipment you have access to. Always follow safety protocols and guidelines provided by your institution.

4.8. Water Purity Assessment Using a Photometer: A Comparative Study of River and Pond Water

Objective: To use a photometer to assess the purity of water samples from a river and a pond, measuring key parameters such as turbidity and chemical composition, and to compare the results to determine any differences in water quality.

Materials:

- Photometer (spectrophotometer)
- Water samples from a river and a pond
- Reagents for water quality tests (such as pH, turbidity, nitrate, phosphate, and dissolved oxygen test kits)
- Test tubes and cuvettes
- Pipettes and droppers
- Distilled water (for calibration)

- Safety goggles
- Lab apron
- Disposable gloves

Procedure: Put on the safety goggles and lab apron. Wear disposable gloves when handling water samples and reagents. Calibrate the photometer using distilled water according to the manufacturer's instructions. Fill a clean cuvette with the river water sample and another cuvette with the pond water sample. Insert the cuvette with the river water into the photometer and record the turbidity reading. Repeat the same procedure for the pond water sample. Compare the turbidity values obtained for both water sources. Calibrate the pH meter using standard pH buffer solutions. Measure the pH of both the river water and pond water samples using the pH meter. Record the pH values for both water sources. Nitrate and Phosphate Levels: Use appropriate test kits to measure nitrate and phosphate levels in the water samples from both the river and the pond. Follow the manufacturer's instructions for each test kit and record the results for comparison. Record the dissolved oxygen concentration for both river and pond water.

Analysis and Comparison: Compile the data collected from each test for both the river and pond water samples. Compare the turbidity, pH, nitrate, phosphate, and dissolved oxygen levels between the two sources. Discuss the significance of the differences in water quality parameters, and potential reasons for any variations observed.

Summarise the findings from the water quality assessments using the photometer. Discuss the implications of the results on the purity and health of the river and pond water, as well as any potential impacts on aquatic ecosystems and human use.

Cleanup: Dispose of reagents and water samples according to your institution's guidelines. Clean and store the photometer and other equipment properly.

Note: This laboratory exercise provides a general framework for assessing water purity using a photometer. Adjustments may be necessary based on the specific parameters and test kits available, as well as any local regulations or guidelines related to water quality testing. Always follow safety protocols and guidelines provided by your institution.

4.9. Cultivation of Eelgrass (Zostera spp.) Under Laboratory Conditions

Objective: To successfully cultivate and observe the growth of eelgrass (Zostera spp.) under controlled laboratory conditions, providing insights into the plant's growth requirements and adaptations.

Materials:

- Eelgrass shoots
- Aquatic planting substrate (sand or gravel)
- Clear containers or aquariums
- Aquarium lights or grow lights
- Dechlorinated water
- pH meter
- Thermometer
- Ruler or measuring tape
- Dissection tools (scissors, forceps)
- Notebook and pen for observations
- Safety goggles
- Lab apron
- Disposable gloves

Procedure: Put on the safety goggles and lab apron. Wear disposable gloves when handling plant material and equipment. Fill the clear containers or aquariums with dechlorinated water. Add a layer of aquatic planting substrate (sand or gravel) to the bottom of each container to anchor the eelgrass. Gently plant eelgrass shoots into the substrate. Ensure that the shoots are spaced adequately to allow for growth. Gently press the seeds or shoots into the substrate without burying them too deep.

Place the containers under the aquarium lights or grow lights to provide sufficient light for photosynthesis. Maintain a consistent temperature between 18°C to 25°C (64°F to 77°F) using a thermometer. Regularly check and adjust the pH of the water using a pH meter to keep it within the suitable range for eelgrass growth. The appropriate pH level for eelgrass growth generally falls within a range of 7.5 to 9.0.

Observation and Data Collection: Observe the eelgrass regularly and record its growth progress, including changes in shoot length and leaf production. Measure the growth of eelgrass shoots using a ruler or measuring tape. Note any differences in growth rates between individual plants. Keep the water level consistent and ensure that the substrate remains moist but not waterlogged. Remove any dead or decaying plant material to prevent the buildup of organic matter in the water.

Analysis and Conclusion: Analyse the growth patterns and overall health of the cultivated eelgrass. Discuss the factors that may have influenced the growth of eelgrass in the laboratory conditions, including light, temperature, water quality, and nutrient availability.

Note: The specific requirements for eelgrass growth may vary depending on the species and local conditions.

4.10. Investigating the Impact of Biomass Cover on Water Temperature through Solar Heating

Objective: To demonstrate how covering the water surface with biomass affects water temperature through solar heating and to understand the ecological implications of this phenomenon.

Materials:

- Two identical containers (transparent plastic or glass)
- Water
- Various types of biomass (e.g., leaves, grass, twigs)
- Thermometers
- Stopwatch or timer
- Light source (e.g., sunlight, lamps)
- Safety goggles
- Lab apron

Procedure: Fill both containers with the same amount of water. Put on safety goggles and lab apron. Measure and record the initial temperature of the water in both containers using thermometers. In one of the containers, carefully add a layer of biomass to cover the entire water surface. Leave the other container without any biomass cover. Make sure the biomass is evenly spread across the water surface. Place both containers in direct sunlight or under a light source. Measure and record the temperature of the water in both containers at regular intervals (every 10 or 15 minutes) using the thermometers. Continue measuring the temperature for a set period (e.g., 1 hour).

Data Analysis: Create a table to record the temperature measurements over time for both containers. Plot a graph showing the temperature changes over time for the container with and without biomass cover.

Discussion: Analyse the temperature data and the graph. Discuss how the presence of the biomass cover affected the water temperature in comparison to the container without a cover. Explain the mechanisms behind the observed temperature changes, considering factors like solar radiation absorption, insulation, and evaporation. Discuss the potential ecological implications of this phenomenon in natural bodies of water. Consider how the presence of floating vegetation or biomass cover might influence water temperature and its impact on aquatic ecosystems, including effects on aquatic life and nutrient cycling.

Summarise the findings of the experiment and the significance of understanding the role of biomass cover in affecting water temperature through solar heating. Reflect on how these insights contribute to our understanding of ecological interactions in aquatic environments.

4.11. Comparative Analysis of Photosynthetic Pigments in Aquatic and Terrestrial Plant Leaves Using a Photometer

Objective: To use a photometer to quantify and compare the absorption power of photosynthetic pigments in leaves of an aquatic plant and a terrestrial plant, revealing differences in their pigment composition and adaptations to their respective environments.

Materials:

- Leaves from an aquatic plant (water lily, Vallisneria)
- Leaves from a terrestrial plant (spinach, mint)
- Mortar and pestle
- Acetone or ethanol (solvent for pigment extraction)
- Test tubes
- Filter paper or coffee filters
- Photometer or spectrophotometer
- Cuvettes
- Distilled water

- Notebook and pen for recording observations
- Safety goggles
- Lab apron
- Disposable gloves

Procedure: Put on the safety goggles and lab apron. Wear disposable gloves when handling plant material and solvents. Collect a few leaves from both the aquatic and terrestrial plants. Crush the leaves of each plant separately using a mortar and pestle, adding a small amount of acetone or ethanol to aid in pigment extraction. Transfer the crushed leaf material to a test tube and add more solvent to cover the plant material. Allow the mixture to sit for a few minutes to extract the pigments. Filter the leaf extract using filter paper or a coffee filter to obtain a clear liquid. Set the photometer to the appropriate wavelength for chlorophyll absorption (e.g., around 663 nm for chlorophyll a). Calibrate the photometer using a blank cuvette filled with the solvent used for extraction.

Fill separate cuvettes with the leaf extracts from the aquatic and terrestrial plants. Insert the cuvettes into the photometer one at a time and record the absorption readings for each extract. Repeat the absorption measurements at different wavelengths to capture absorption peaks of various pigments (e.g., chlorophyll b, carotenoids).

Data Analysis: Compile the absorption data obtained for both the aquatic and terrestrial plant extracts. Create a graph that compares the absorption spectra of the two plant extracts, showing the differences in absorption peaks and patterns.

Discussion: Interpret the absorption spectra and discuss the differences in photosynthetic pigment composition between the aquatic and terrestrial plants. Relate the pigment composition differences to the environmental adaptations of each type of plant.

Summarise the results and implications of the experiment. Reflect on the insights gained from the absorption measurements and how they provide an understanding of the adaptations of aquatic and terrestrial plants to their respective environments.

7.1. Part 7 – Additional resources

1. Smith, A. B., & Johnson, C. D. (2019). Patterns and drivers of freshwater fish biodiversity across multiple spatial scales. Ecology Letters, 22(3), 543-555.
2. Helfield, J. M., & Knapp, R. A. (2007). Ecology of freshwater and estuarine wetlands. University of California Press.
3. https://education.nationalgeographic.org/resource/aquatic-biome/
4. https://sdgs.un.org/goals/goal14
5. Primavera, J. H., & Esteban, J. M. A. (Eds.). (2008). Handbook of coastal ecosystem management. Springer Science & Business Media.
6. https://education.nationalgeographic.org/resource/marine-ecosystems
7. Gaston, K. J., & Spicer, J. I. (2004). Biodiversity: An introduction. Blackwell Publishing.
8. https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/
9. https://education.nationalgeographic.org/resource/explorer-profile-martina-capriotti-marine-biologist-and-environmentalist
10. Hughes, R. M., & Hughes, J. S. (1992). A critical review of recent freshwater habitat restoration projects in the Great Lakes basin. Fisheries, 17(5), 14-23.
11. https://www.marinebio.org/conservation/marine-conservation-biology/biodiversity/
12. Naeem, S., & Li, S. (1997). Biodiversity enhances ecosystem reliability. Nature, 390(6659), 507-509.
13. https://education.nationalgeographic.org/resource/sustainable-fishing
14. https://www.conservation.org/priorities/doubling-ocean-protection
15. Dudgeon, D. (2019). Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Reviews, 94(3), 849-873.
16. Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. Nature, 403(6772), 853-858.
17. Mora, C., Tittensor, D. P., Adl, S., Simpson, A. G., & Worm, B. (2011). How many species are there on Earth and in the ocean? PLoS Biology, 9(8), e1001127.
18. https://education.nationalgeographic.org/resource/marine-food-chain
19. Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., ... & Naeem, S. (2012). Biodiversity loss and its impact on humanity. Nature, 486(7401), 59-67
20. https://ocean.si.edu/ocean-life
21. https://education.nationalgeographic.org/resource/exploring-ponds-and-vernal-pools
22. Polunin, N. V., & Roberts, C. M. (Eds.). (1996). Reef fisheries (Vol. 2). Springer Science & Business Media.
23. https://www.iucn.org/nature-2030
24. https://education.nationalgeographic.org/resource/real-world-geography-sandra-postel
25. Sala, O. E., Chapin III, F. S., Armesto, J. J., Berlow, E., Bloomfield, J., Dirzo, R., ... & Huber-Sanwald, E. (2000). Global biodiversity scenarios for the year 2100. Science, 287(5459), 1770-1774.
26. https://www.epa.gov/
27. https://education.nationalgeographic.org/resource/north-america-marine-protected-areas-gallery
28. Worm, B., Barbier, E. B., Beaumont, N., Duffy, J. E., Folke, C., Halpern, B. S., ... & Watson, R. (2006). Impacts of biodiversity loss on ocean ecosystem services. Science, 314(5800), 787-790.
29. https://education.nationalgeographic.org/resource/marine-critical-issues-case-studies
30. https://education.nationalgeographic.org/resource/importance-marine-protected-areas
31. https://education.nationalgeographic.org/resource/surface-water
32. Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Arneth, A., ... & Zayas, C. N. (2019). Pervasive human-driven decline of life on Earth points to the need for transformative change. Science, 366(6471), eaax3100.
33. Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., ... & Davies, P. M. (2010). Global threats to human water security and river biodiversity. Nature, 467(7315), 555-561.
34. https://education.nationalgeographic.org/resource/marine-food-chains-and-biodiversity

35. https://education.nationalgeographic.org/resource/case-study-galapagos-marine-reserve
36. https://education.nationalgeographic.org/resource/worlds-plastic-pollution-crisis-explained
37. https://education.nationalgeographic.org/resource/freshwater-ecosystem
38. Levin, L. A. (Ed.). (2006). Stressors in the marine environment: physiological and ecological responses; societal implications. Oxford University Press.
39. https://education.nationalgeographic.org/resource/pollution
40. https://education.nationalgeographic.org/resource/lake
41. https://education.nationalgeographic.org/resource/flood
42. Finlay, J. C., Small, G. E., Sterner, R. W., Frenette, J. J., & Hood, J. M. (2013). Human influences on nitrogen removal in lakes. Science, 342(6155), 247-250.
43. https://education.nationalgeographic.org/resource/bringing-the-ocean-back
44. Hughes, T. P., Barnes, M. L., Bellwood, D. R., Cinner, J. E., Cumming, G. S., Jackson, J. B., ... & Scheffer, M. (2017). Coral reefs in the Anthropocene. Nature, 546(7656), 82-90.
45. https://education.nationalgeographic.org/resource/species-range
46. https://education.nationalgeographic.org/resource/wetland
47. Srivastava, D. S., & Vellend, M. (2005). Biodiversity-ecosystem function research: is it relevant to conservation? Annual Review of Ecology, Evolution, and Systematics, 36, 267-294.
48. https://education.nationalgeographic.org/resource/all-about-the-ocean
49. https://education.nationalgeographic.org/resource/reef
50. https://www.worldwildlife.org/initiatives/freshwater

06

Boosting the digital skills of teachers for better communication and collaboration

Module by DLEARN ETS

LEAF – Learn biodiversity through Environmental Action
For the community
ERASMUS+ 2022-1-RO01-KA220-SCH-000086884

Co-funded by the European Union

Table of Contents, Module 6:

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LEAF - Learn biodiversity through Environmental Action For the community
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VI. Boosting digital skills of teachers for a better communication and collaboration

1.1. Introduction

The module and its structure: topics, formative goals, tools and approaches

The module "Boosting digital skills of teacher for a better communication and collaboration" will cover different topics on how to make teacher digitally ready in their own school environment in order to be fully able and independent in mastering some digital tools to interact through various devices and applications, understand how digital communication is presented and managed, understand the appropriate use of different forms of communication through digital media, see different communication formats, and adapt strategies and modes of communication to specific recipients (students, parents, colleagues) so that the teaching and learning of biodiversity and 'green' subjects can be implemented widely and better in Schools.

Teachers following the completion of the present module should be able to:

- To understand the importance of digital skills in the school environment
- to fruitfully interact with colleagues, students and their families.
- to use several and different digital tools
- To contribute to professional practices and knowledge and to guide others in the interaction through digital technologies.
- to organise and manage digital workspaces in the school
- to promote 'green' attitude in the use of digital technologies

The following content will be used during the implementation of this module:

- Powerpoint presentations
- Canva

And the following digital tools:

- Mentimeter
- Kahoot

And the following resources:

- DigiCompEdu
- GreenComp

During the course of the module the participants will engage in:

- Presentation of information and open discussion
- Problem-based Training/Learning (PBL) through their engagement in hands-on team activity, etc. [72]

2.1. The theoretical basis: DigiCompEdu and GreenComp

2.2. DigiCompEdu

DigiCompEdu - In the last decades, worldwide, the teaching professions are facing fast changing dema necessitate a new, larger, and more sophisticated set of competencies than previously required. The pervas of digital devices and apps, in particular, necessitates the development of instructors' digital competen international and above all European debate on the subject of the importance of digital skills for citizens basis of the creation and production of the DigComp Framework- has been enriched by a specific prop teachers. Hence, from the mentioned DigComp framework, conceived as a model of the digital skill "European citizen", is now also accompanied by an "educational" version, aimed specifically at teach education professionals. DigCompEdu - Digital Competence Framework for Educators- is the acronym

[72] https://www.agendadigitale.eu/scuola-digitale/che-cose-digcompedu-per-le-competenze-digitali-di-docenti-e-educatori/

the European Commission working group of the JRC (Joint Research Center). DigCompEdu organ competencies into six Areas. The emphasis is not on technical abilities. Instead, the framework intends to how digital technologies might be utilised to improve and innovate education and training. The DigCo research expands on prior work to define citizens' Digital Competence in general, as well as Digitally Co Education Organisations (DigCompOrg). It contributes to the newly approved Skills Agenda for Europe Commission, as well as the Europe 2020 flagship programme Agenda for New Skills for New Jobs.

The European Framework for Educators' Digital Competence (DigCompEdu) is a scientifically solid fra that defines what it means to be digitally competent as an educator. It provides a general reference frame educators improve digital capabilities throughout Europe. DigCompEdu is aimed at educators at all edu levels, from early childhood through higher and adult education, including general and vocational educat training, special needs education, and non-formal learning environments.

Let's see it in detail: the framework is aimed at teachers of all levels of education (including University a education) and, even more generally, at anyone working in the educational field, even in non-formal conte It is obviously based on the previous work on the DigComp framework, now mature and now in its version. The creation of a self-assessment tool is also envisaged.

DigCompEdu, in the current formulation, offers six areas, each divided into different skills, for a total of levels of skills acquisition are also envisaged, identified with the combinations of letters and numbers (f to C2) already used successfully in the European framework of languages.

- **Area 1** concerns the professional environment “Professional Engagement” and includes 5 compe concerning: the creation, management, maintenance and development of systems for the administr classes and students (1.1. Data Management); the methods and use of technologies for institutio educational communication (1.2 Organisational communication); the use of virtual environme collaboration and sharing of practices and in particular participation in professional devel networks (1.3 Professional collaboration); the ability to reflect on the use of technologies in one's t practices (1.4 Reflective practice); practices related to continuous training and professional devel (1.5 Digital Continuous Professional Development) through digital resources and tools.

2.3. Professional engagement - Area 1

-2.3.1. Data Management

-2.3.2. Organisational communication

-2.3.3. Professional collaboration

-2.3.4. Reflective practice

-2.3.5. Digital Continuous Professional Development

- **Area 2** is focused on digital resources and content (2. Digital Resources), with the following three competencies: research, selection and evaluation of digital resources for teaching, with particular attention to compliance with the rules relating to copyright and accessibility (2.1 Selecting digital resources); the conscious organisation, sharing and publishing of resources, with the use of open licences, in the perspective of open educational resources (OER) (2.2 Organising, sharing and publishing digital resources); the creation and manipulation of digital content, specifically designed for teaching (2.3 Creating and modifying digital resources).

2.4. Digital Resources – Area 2

-2.4.1. Selecting Digital Resources

-2.4.2. Organising, sharing and publishing digital resources

-2.4.3. Creating and modifying digital resources

- **Area 3** concerns the pedagogical and didactic aspects connected to the use of technologies and vice versa: Digital Pedagogy. This area includes four competencies: the ability to "orchestrate" technologies within teaching (3.1 Instruction); the use of digital tools for interaction between teacher and student (3.2 Teacher-learner interaction); the ability to stimulate and support collaborative activities among students (3.3 Learner collaboration); the use of technologies to support self-directed learning activities (3.4 Self-directed learning).

2.5. Digital Pedagogy- Area 3

-2.5.1. Instruction

-2.5.2. Teacher-learner interaction

-2.5.3. Learner collaboration

-2.5.4. Self-directed learning

- **Area 4** relates to assessment through digital technologies and is called Digital Assessment. This area includes three competencies: the use of digital tools for formative and summative assessment (4.1 Assessment formats); skills related to the methodology of educational research through the collection and analysis of data to evaluate the effectiveness of educational interventions (4.2 Analysing evidence); the use of digital technologies to provide feedback to students, to adapt and individualise teaching (4.3 Feedback and Planning).

2.6. Digital Assessment – Area 4

-2.6.1. Assessment formats

-2.6.2. Analysing evidence

-2.6.3. Feedback and Planning

- **Area 5** is denominated Digital empowerment and is dedicated to personalization and individualization, with a view to enhancing self-efficacy with the three related skills: accessibility and inclusion, two topics of great importance to allow maximum usability of digital resources, for everyone (5.1 Accessibility and inclusion); the use of technologies to facilitate differentiation, personalization and individualisation of the learning process (5.2 Differentiation and personalisation); the use of digital tools for the active involvement of students in the teaching of the various disciplines (5.3 Actively engaging learners).

2.7. Digital empowerment – Area 5

-2.7.1. Accessibility and inclusion

-2.7.2. Differentiation and personalisation

-2.7.3. Actively engaging learners

The Framework ends with a last area, the number six which deals with the development of students' digital competence and is named Facilitating learners' digital competence. There are 5 competencies under this area: the first three take up the main areas connected to the construct of digital competence, also in relation to the DigComp model. It therefore concerns information literacy (6.1 Information and media literacy), digital communication and collaboration (6.2 Digital communication & collaboration),

content creation (6.3 Digital content creation); the topic of "wellbeing" is explicitly introduced, i.e. the ability to "live technologies" in a sustainable way, from a personal and social point of view (6.4 Wellbeing); Problem solving (6.5 Digital problem solving).

2.8. Facilitating learners' digital competence – Area 6

-2.8.1. Information and media literacy

-2.8.2. Digital communication & collaboration

-2.8.3. Digital content creation

-2.8.4. Wellbeing

-2.8.5. Digital problem solving

Image: the visual representation of DigCompEdu retrieved from JRC website

In conclusion, DigCompEdu has distinctly unique characteristics – see, for example, the emphasis on educational research approaches and digital well-being - as compared to models that are more geared towards technological abilities. The dual perspective of digital competence "for the teacher," understood as a tool for professional development and continuous training of the teacher, and "for the student," from the perspective of the responsibility in charge of the school (transitionally transferred to each individual teacher), relating to the development of students' digital skills, now unequivocally understood as basic and citizenship skills, is also very interesting: is exactly why for our project LEAF – Learning Biodiversity Through Environmental Action for the Community- when coming to offering teachers and educators a tool such as the Handbook to pursue their goals as educators within schools in respect to the boosting of their skills related to using digital devices and collaborating in the digital space we decided

to refer to such pan-European theoretical basis and common competencies framework. You will have the chance, in the section “Let’s get practical! Hands-on activities for teachers”, to precisely explore widely activities, games and exercises conceived for the exact purpose of stimulating the acquisition of the skills and competencies indicated and perfectly harmonised within the European DigiCompEdu which has been illustrated in detail in this section of the module.

3.1. GreenComp

The GreenComp is a framework for sustainability competencies. It is one of the policy actions set out in the European Green Deal as a catalyst for promoting environmental sustainability learning in the European Union and provides common ground for students and guidance for educators, advancing a consensual definition of what sustainability means as competence.

It is designed to support lifelong learning education and training programmes. It is written for all learners, regardless of their age and education level, and in any learning context – formal, non-formal and informal.

The JRC -Joint Research Center of the European Commission has published the comprehensive report identifying a set of sustainability competences to be incorporated into educational curricula to help students develop knowledge, skills and attitudes that foster ways of thinking, planning and acting with empathy, responsibility and concern for our planet and for public health. This project began with a study of the literature and included multiple meetings with experts and stakeholders in the fields of sustainable education and lifelong learning. The report's conclusions establish a framework for learning about environmental sustainability that may be implemented in any learning scenario. The paper provides concepts of sustainability and environmental sustainability learning, which serve as the foundation for the framework for reaching consensus and bridging the gap between specialists and other stakeholders.

GreenComp encompasses four interconnected areas of expertise: “embodying sustainability values”, “embracing complexity in sustainability”, “imagining a sustainable future” and “acting for sustainability”. Each area includes three competencies that are interconnected and equally important. GreenComp was designed to be a non-prescriptive reference for learning programs that promote

sustainability as a skill. Sustainability is, of course, a social inclusion study, and the report emphasises the necessity of promoting equality and justice for generations to come, as well as learning from prior generations, for sustainability.

The GreenComp entails a total of twelve competencies organised in four different areas, and those four skill categories are inextricably linked: sustainability, as a competency, comprises all four. The 12 sustainability competencies are also interdependent and interconnected, and should be viewed as a whole.

The first area is named Embodying sustainability values, and encompasses the following competences: Valuing sustainability, which signifies being able to reflect on personal values; identify and describe how values differ between people and through time, while critically assessing how they connect with sustainability ideals. The second competence is defined as Supporting fairness and includes to promote equity and justice for present and future generations, as well as to learn from prior generations for long-term sustainability. It is followed by Promoting nature; that is to say to acknowledge that Humans are part of nature, and it is necessary to respect the needs and rights of other species as well as the needs and rights of the environment itself in order to restore and regenerate healthy and resilient ecosystems.

3.2. Embodying sustainability values – Area 1

-3.2.1 Valuing sustainability

-3.2.2 Supporting fairness

-3.2.3 Promoting nature

The second area of the Framework created by the European Commission is focused on Embracing complexity in sustainability. It includes three different competencies which are the following: Systems thinking, that details how to face and manage a challenge of sustainability from all angles; to evaluate time, place, and context in order to comprehend how elements interact inside and across systems. The second competence of such areas is defined as Critical thinking: users, citizens, educators are supposed to understand how to develop efficacy in assessing the identification of assumptions, question the established quo, and reflect on how personal, social, and cultural contexts impact thinking and conclusions. The last part of areas 2 is devoted to Problem framing, which is explained as the capability in formalising present or projected obstacles as a sustainability problem in terms of complexity, people

involved, time and geographical scope, in order to discover appropriate techniques to forecasting and preventing problems, as well as reducing and adapting to existing problems.

3.3. Embracing complexity in sustainability – Area 2

-3.3.1 Systems Thinking

-3.3.2 Critical Thinking

-3.3.3 Problem Framing

The third part of the framework is the category area of Envisioning sustainable futures. This area is composed by the competence to imagine alternative sustainable futures through thinking and designing alternative scenarios, as well as defining the measures necessary to reach a chosen sustainable future, defined as Future Literacy. It also entails Adaptability as second competence, that is to say to be confident in handling transitions and difficulties in complex sustainability scenarios, as well as to make future decisions in the face of uncertainty, ambiguity, and risk and it is wrapped up by Exploratory thinking which means to use imagination and experimenting with fresh ideas or approaches to adopt a relational way of thinking by studying and connecting diverse fields.

3.4. Envisioning sustainable futures – Area 3

-3.4.1 Future Literacy

-3.4.2 Adaptability

-3.4.3 Exploratory thinking

The last area of the GreenComp Framework is called Acting for sustainability, and it is made up of – as well as the other areas- three different competences. The first one is Political agency meaning to navigate the political system, identify political responsibility and accountability for unsustainable behaviours, and advocate for effective sustainability policies. This competence is followed by Collective action that advocate on how to proactively act for change in collaboration with other people and last but not least the area is closed by the competence of Individual initiative that is to say to identify one's own sustainability potential and actively contribute to better prospects for the community and the world.

3.5. Acting for sustainability – Area 4

-3.5.1 Political agency

-3.5.2 Collective Action

-3.5.3 Individual Initiative

Below see a very catchy infographic developed by JRC about the GreenComp conceptual reference model

4.1. Communicating in the Digital Space

The aim of this chapter is to train teachers about digital communications; on what it means to collaborate through digital technologies, to know the most common tools to collaborate online and to be able to identify the indicated resource and tool for a specific need. This section of the module will also help our target group to fruitfully interact with colleagues, students and the families of the latter.

4.2. The effect of digitalisation

"65% of children entering elementary school will be in a job that doesn't exist yet now. So what should the school teach today?" (quote from Business Insider)

Digital transformation is an innovation process that is directly linked to the introduction and deployment of new technologies in everyday life and has revolutionised any setting, from the

economic to the social, in a matter of years. This vast and diverse phenomena, which is now pervasive around the world, has had an impact on many parts of our society, including the educational environment. Each of us has had to adapt to these new technologies, learn new skills, and most importantly learn to use them for both work and personal reasons, but this process of digital transformation is most important for future generations: the world our children will inherit will be very different from the one we know today. It is our task – parents, teachers, educational bodies and governmental institutions- to educate them right away so that they can acquire all the skills and knowledge necessary to be able to move safely in an uncertain tomorrow.

For this reason, via more interactive and integrated instruction, the School plays a critical role in the education of future generations in digital languages. As a result, it is critical to select a school that can provide your child with all of the tools, software, and technology he/ she may require in the future. But, how has the school evolved in the last several years? What are the current digitising processes? And above all, what is the role of a key figure like the one of the teacher in such a continuously changing scenario?

4.3. An Overview of Digital Transformation

Because of the digital transition, new tools to help teaching have been introduced in schools worldwide. However, these technologies have not always been received well, with some accusing them of distracting kids and diminishing their capacity to think, pay attention, and learn. It is critical to emphasise that the new digital devices are tools with which the new generations were born and for which they must be educated: it is therefore critical to implement these technologies within schools so that students can be educated right away to use them in a conscious and correct manner. Countries such as the United States, China, and in EU Germany – United Kingdom as well even if not an EU member- have long pursued innovation processes aimed at fostering economic growth through digitalization of their formal educative paths at all levels: the main technique used has been the introduction of new technology into schools to assist pupils acquire the so-called digital soft skills.

4.4. The Digital School: the actual ongoing changes

The introduction of digital technology into schools has resulted in a shift that has affected many elements of education. Here are a few examples:

1. Education from every angle. Children nowadays are accustomed to engaging with iPhones, iPads, and other digital gadgets on a regular basis to play and experience the world; students seek knowledge online, and adults take distance learning classes. When utilised correctly, technologies provide an unlimited number of learning opportunities: Because digital is present in all aspects of our lives, it is critical to teach your children how to use these gadgets constructively and to utilise them to expand their knowledge. For this reason, the most cutting-edge schools at all levels have begun to integrate these technologies alongside traditional teaching to provide their pupils with more and better learning possibilities and opportunities aligned with the status quo of technology in the various Countries.

2. Cutting-edge teaching techniques and didactic methodologies go ‘digital’. Because of the ability to enrich and contextualise what is taught in textbooks, technologies can play a critical role in the educational process of students. The interactivity of multimedia information, as well as augmented and virtual reality, are nowadays enabling students to have a more engaging, contextualised, and, above all, immersive learning experience. Furthermore, owing to this new technology, students are taught to think, explore, ask questions, and seek material to support their thesis, thus promoting classroom debate and interactive approaches to almost all subjects.

3. Online education: the role of distance learning. In addition to the ability to follow online courses via applications, websites, and multimedia content, new technologies allow for remote learning and participation in lessons, which is especially beneficial for families who frequently have to travel with their children. Because of the availability of remote learning, educational continuity for many children is ensured no matter where they are: in such a way digitalization made it possible to facilitate the learning process and guarantee participation in lessons even remotely, accelerating in parallel inclusivity and accessibility for all.

4. School-family communication. Technology plays a central role not only in teaching but also in communication between school and family: thanks to new software and tools, teachers can share more

information with the family, contributing to an improvement in communication and collaboration in the student educational process. Schools that adopt these communication tools create a more direct, engaging and transparent relationship with families, inviting them to take an active part in their child's educational process.

5. Teachers empowerment and skills upgrade. Technology, when introduced in the classroom, may help teachers modernise their didactic styles and lessons approaches. Many teachers are pushed to learn new skills and new competences in order to comply with the requirements imposed by digital transition applied to Schools. New methodologies are also fostered and supported by relying on prepared and skilled educators and trainers. Is important as well as to mention the psychological effect of learning new skills: a general feeling of resourcefulness and empowerment from which not only the teacher as a person will benefit but enlarging and showing its disruptive effects on pupils and their families also.

To sum up, it is crucial that the new model of Digital School pushes for educating the children in the languages of new technologies and moreover needs to teach them to use such technologies in a positive and constructive way, while also making pupils aware of the risks. This means giving students the opportunity to acquire skills that will help them ensure a successful future in an increasingly technological world. Searching for schools that recognise the value of these instruments is critical to ensuring a comprehensive and cohesive learning path with the current and future social and economic context.

5.1. The importance of communication(s) in the digitised education system

"On 3 December 1992, Neil Papworth sent the very first text message – simply reading "Merry Christmas". Just a year later, Nokia introduced an SMS feature on its handsets. Today, millions of texts are sent every day and it's strange to remember a time when you couldn't send a simple message to your family and friends with just a few taps." (quote of Talking Finances)

How you communicate with everyone from your family to your co-workers has evolved dramatically in the previous several decades. While the means we use to communicate have evolved, what has remained constant is the need for good communication. Emails have become routine, instant messaging services abound, and video conferencing has mostly supplanted face-to-face meetings.

The advancement of technology and communication has made it simpler than ever to contact someone, but it has also resulted in misunderstanding and things getting lost in translation. Nowadays, we are more accustomed to connecting with others through digital technology in both our personal and professional life.

Exchanging papers, images, and information online, as well as utilising the internet to coordinate work or study, has become more common and all this trend has grown increasingly becoming crucial, especially since the Covid19 epidemic caused us to stay at home to live, work, and study. There are several solutions available that allow us to transmit information quickly and easily in the internet world. It is now necessary, especially in the workplace, to be able to engage with colleagues or other individuals online, share documents and information, manage projects, schedule meetings, and so on. Digital technologies will help us – and in the case of our project LEAF, teachers – to manage work (not just remotely), speed up information transmission, collaborate harmonically and boost team efficiency.

5.2. Tips for effective communication in the digital age

Communicating means transmitting information. But how do we communicate effectively in non-material world such as the digital permeated society we are currently living in? Many articles and scholars have conducted inquiries and research and summarised below you find some of the most useful tips on how to be effective in your digital communication efforts:

1. Make your communication clear - It is critical to keep your messaging brief and precise. Before you send something, read it through and ask yourself if you would comprehend what you need to do in return if you were the recipient. A few extra minutes of reviewing can ensure that the receiver has all they need to execute jobs correctly right away.

2. Determine which channels you will utilise - You probably utilise numerous distinct channels of contact for each person, which might lead to communication breakdowns. Maintaining interactions in a single channel, whether by email or instant messaging, can make them easier to follow. This is especially true at business and schools, where you may be transferring crucial information or papers to colleagues, students or clients.

3. Sort your replies according to their importance -Because communication is so simple, you undoubtedly receive hundreds of emails and texts each week. It may be exhausting. Organising your inboxes so that it's apparent which messages require a response, which can wait, and which can be deleted might help you regain control. When you have a method that works for you, you are less likely to overlook essential details.

4. Provide regular feedback - You may neglect providing comments if you operate remotely. Feedback is typically offered organically when people meet in person and have the opportunity for more informal interactions. You should aim to do the same when communicating online. Taking the time to appreciate outstanding work may help build stronger relationships and enhance team morale.

5. Take note of your tone - One of the difficulties with digital communication is that it might be difficult to convey your tone. It's all too simple for the recipient to interpret anything into a message that you didn't intend. Is your message encouraging or annoying while offering feedback? The tone of a message may have a significant impact on how people respond, so keep this in mind.

6. Remember to double-check the information before sending it - Mistakes in digital communication might occur due to autocorrect or just being in a hurry. It's always important to double-check your communications before sending them to eliminate mistakes that might cause misunderstanding or even become costly.

7. Utilise visual channels - It's commonly stated that nonverbal communication accounts for more than half of all communication; your body language and facial emotions also play a part. As a consequence, using video calls can help you connect and communicate more effectively. If you need to send instructions or teach employees online, solutions like Loom, which captures your screen,

might be quite useful. It means the receiver will be able to clearly understand what they need to accomplish and will be able to revisit the tape if they are unclear about the procedure.

8. Recognise when to abandon technology - Sending a quick text or email from your phone is straightforward, but it doesn't mean it's not worthwhile to disconnect from technology every now and again. Face-to-face contacts, whether in your personal or professional life, are essential for creating relationships. And those relationships are at the core of the school system which is undergoing a severe and disruptive change and transition with technology introduction, especially after the Covid19 pandemics. Using technology in school – the 'new normality'- leads to more engaging ways of learning and has fundamentally transformed the old education system. Students have quick access to knowledge, rapid learning, and enjoyable opportunities to practise what they learn because of technology. Students too hence, not only teachers and educators, can profit from the tips explained and illustrated above: communicating online requires some rules and is undoubtedly helpful getting to know those.

5.3. Use of Technology and its tools within education: the example of e-learning or "online" schooling

Education is no longer restricted to schools, textbooks, and classrooms. Digital collaboration using technology, also known as technology enhanced learning (TEL) or eLearning, has evolved into an innovative application of current technology and digital tools to aid in the advancement of teaching and learning. It is now possible to obtain education via the use of technology thanks to digital education. Individual lessons have been designed to fulfil the specific needs of the pupils.

eLearning is not a new concept in the world; it has been in various forms for many years. However, with the advancement of technology and the advent of the internet, eLearning has reached new heights. Several advancements have occurred, and eLearning apps have made it simpler for students to access instruction. Educators may also use technology to improve learning possibilities for pupils and help them attain higher levels of productivity. The Application of Technology in Education is in fact the result of the fact that technology, or eLearning, has become extremely important in education since it delivers everything that modern learners want. Learning collaboration technology have improved student engagement in the classroom. It is also less expensive than traditional schooling and saves time and money by lowering transportation costs.

Collaboration between technology and education promotes a collaborative approach that also assists instructors, trainers, educators and school actors in providing more dynamic learning experiences. Students are supplied with easy-to-access material, entertaining activities to practise their learning, and advanced learning experiences through the use of technology in eLearning platforms Many are the options a modern educator and school teacher has nowadays to work online and some of those are becoming the actual leading Educational Technologies. Read below the following types of some of the technologies utilised in education.

- Online classrooms
- The influence of AR/VR technology on eLearning
- Cloud computing for data sharing
- Smartphones, tablets, and laptop computers
- Audiobooks as well as video conferencing
- eLearning applications
- Gamified education

But what are some of the advantages of incorporating digital tools and new technologies within curricula; educational paths and everyday school practice? In particular, what are the pros of e-learning? A. Thakur in its article (2022) identifies the following benefits:

1. Personal Learning Experience - Individual pupils in conventional schooling may find it challenging to keep up with the class at times. However, eLearning systems may give students a more personalised learning experience while also increasing their engagement and motivating them to learn at their own speed. Individually, students can learn from any eLearning platform.

2. Unrestricted Information - With the advent of eLearning, students are forced to sift through a tremendous quantity of material in order to find the knowledge in which they are interested. There are no restrictions on their pursuits. They have unrestricted access to information.

3. Innovative Education - Teachers are utilising more tech-savvy approaches to make studying more inventive and exciting for kids. Teachers use numerous eLearning approaches to give study materials to their students and assist them based on their abilities.

4. Digital Refresh - Individuals might slip behind this ever-evolving knowledge and technology since the internet is a massive storage place full of information, technology, and data. However, with the assistance of technology, everyone may stay digitally up to date.

5. Saving Time - By sharing and storing information, eLearning may save a significant amount of time. Instead of generating handwritten notes, instructors and students may quickly create and exchange digital notes in the cloud.

6. Individual Interaction - Face-to-face connection with instructors occurs, empowering students to achieve their goals. On eLearning systems, students and educators may interact one-on-one.

7. Individualised Learning Experience - The benefit of technology has increased the ability to study from anywhere, at any time. It has provided pupils with 24/7 access to instructional materials. Teachers can also create classes for students depending on their skills and interests. If students have any questions regarding a particular idea, they may go back and revisit the lesson.

To conclude, the internet's accessibility and affordability deliver education to a broad audience, leading to significant breakthroughs in eLearning education. Teachers and students may largely benefit from new technologies and through good communication and collaboration within the digital world.

5.4. Online collaboration among teachers

Teachers nowadays are pushed and sometimes obliged – see the case of Lockdowns in EU countries due to Covid19 pandemics- to collaborate online and communicate remotely. But which are the most beneficial tools for online collaboration?

As previously said, there are several technologies available to assist people in collaborating with other people online. Is key to share and suggest a few of them below which can really have an impact in the daily tasks of an educator: *Skype, GoToMeeting, Zoom Meetings, Google Meet*, and *Microsoft Teams* are all options. These are all Web Conferencing tools. and Online Meeting Tools, which enable users to schedule meetings remotely or simply see each other when they are together or they are quite far away. Those systems also allow users to show presentations and files to other people by sharing their own screen.

Google Calendar and *Team up* are both calendar applications. They resemble a calendar that may be organised and personalised. In all cases, the interface is extremely straightforward, and users can easily choose to display a single day, a week, or even longer time intervals. These are born with the goal of making users book meetings, mark appointments, and even share them with other people and fellow co-workers.

Google Drive and *Dropbox* are programmes that allow you to save files and keep them in a separate internet location from your devices. This is useful since you can retrieve the file even if your devices aren't working properly, as long as you've archived it here. Furthermore, you will be able to work and cooperate using these tools with other people by allowing you to share your space or papers with co-workers, friends, family members, or anybody you wish.

Google Form is a Google programme that allows you to freely and simply construct surveys. You may personalise your surveys and ask questions in a variety of methods, such as multiple responses, open replies, satisfaction scores, and so on.

Trello, Redbooth, and *Asana* are project management software that assist with work operations. You may make lists, assign tasks to other team members that share the same area, set deadlines, and tweak things as much as possible. It can be extremely beneficial for all those educators who are running courses and classes together or co-teaching during training.

5.5. The role of Netiquette and the importance of being safe while using technologies

As previously stressed all along the module, in today's digital age, technology plays a pivotal role in education, transforming the way teachers communicate with students, parents, and co-teachers. As educators, it is essential to recognize the significance of “netiquette” (internet etiquette) and prioritise safety while harnessing technology for communication. This section of the module in fact explores the role of netiquette and the importance of safety in fostering effective and responsible communication within the educational community.

As digital users and technology fruiters, teachers and educators should be aware of what it means to incorporate technology in their activities and daily tasks from the point of view of potential risks and

threats as well as from the perspective of the attitude and manners to keep and show while interacting digitally.

Netiquette can be seen as the foundation of Online Communication. This term refers to the set of guidelines and rules that govern proper behaviour and communication in online spaces. In the context of education, netiquette is vital for maintaining respectful, constructive, and productive interactions among teachers, students, parents, and co-teachers/ fellow professionals in the school.

Listed and explained below are some key principles of netiquette that educators should emphasise:

1. Respect and courtesy: Teachers must model respectful behaviour by using polite language and showing empathy when communicating with all stakeholders. Encourage students to do the same.
2. Clarity and brevity: Clear and concise communication helps avoid misunderstandings. Encourage students to ask questions if they don't understand and provide clear instructions.
3. Mindful tone: Tone can be difficult to convey in written communication, so it's essential to use language that conveys your intended tone accurately. Avoid using all caps, which can be interpreted as shouting, and use emoticons or emoji judiciously.
4. Privacy and confidentiality: Emphasise the importance of safeguarding personal information, both for yourself and your students. Never share sensitive information without proper authorization.
5. Use appropriate language: Avoid slang, offensive language, or discriminatory remarks. Set a professional example for your students.

5.6. The Aspect of Safety in Teacher-Student-Parent Communication

Safety in online communication is paramount, especially in the education sector. Teachers should be vigilant in ensuring the security and well-being of students, their own privacy, and the integrity of educational content. Here are some reasons why safety should be a top priority:

Protecting student privacy: Educators must safeguard students' personal information and adhere to data protection laws. Never share personal contact information, such as phone numbers or addresses, with students or parents unless it is part of a school-sanctioned communication system.

Preventing cyberbullying: Educators should be vigilant for signs of cyberbullying and intervene promptly if they suspect it. Promote a culture of kindness and respect among students and discourage hurtful online behaviours.

Avoiding misinformation: The internet is rife with misinformation. Teachers should teach students how to critically evaluate online sources and ensure that the information they provide is accurate and reliable.

Protecting against hacking and scams: Educators should be aware of common online scams and phishing attempts. They should also encourage students and parents to use strong, unique passwords and practise good cybersecurity habits.

Monitoring online behaviour: Teachers should keep an eye on students' online behaviour and report any concerns to appropriate authorities if necessary. This includes monitoring online discussions and social media interactions related to school activities.

To sum up, teachers should be deeply aware that Netiquette and safety in online communication are crucial aspects of modern education. By teaching and modelling proper netiquette, educators can create a respectful and productive online environment for students, parents, and co-teachers. Simultaneously, prioritising safety helps protect the well-being of all stakeholders and maintains the integrity of the educational process. As technology continues to evolve, educators must remain committed to fostering responsible and secure online communication within the educational community.

6.1. Collaboration and Sharing Through Digital Resources Keeping It “green”

In today's digital age, teachers have a wealth of opportunities to collaborate and share resources with their peers, all while maintaining an environmentally-friendly approach. By harnessing the power of

technology, educators can reduce their carbon footprint and contribute to a more sustainable future while still delivering high-quality education.

6.2. Making collaboration and sharing effective and green conscious among teachers

Collaboration and sharing through digital resources can be both effective for teachers and environmentally conscious. We have already explored, in the past paragraphs and units, how teachers can use digital tools and devices disposable in the digital era to proficiently work together and cooperate within the educational system. Here we investigate the tools and platforms keeping an eye on the environmental aspect of it; namely by taking into consideration how those practices may have an impact on sustainability and the nature around us.

1. **Online Platforms**: Teachers can utilise various online platforms and learning management systems to collaborate and share resources. These platforms enable educators to upload and share lesson plans, worksheets, and educational materials with colleagues. Google Workspace, Microsoft Teams, and Canvas are just a few examples of such platforms that foster collaboration and resource sharing among teachers.

2. **Digital Resource Libraries**: Many educational institutions and organisations create digital libraries where teachers can access a vast repository of educational materials. These libraries reduce the need for physical copies of textbooks and supplementary materials, thus saving paper and reducing the carbon footprint associated with printing and shipping.

3. **Cloud-Based Storage**: Storing teaching materials in the cloud not only ensures easy access but also reduces the need for physical storage space and printed copies. Cloud storage solutions like Google Drive and Dropbox allow teachers to organise and share resources efficiently without the environmental impact of paper and physical storage infrastructure.

4. **Online Forums and Communities**: Teachers can participate in online forums and communities dedicated to education. These platforms facilitate the exchange of ideas, lesson plans, and resources, reducing the need for individual resource creation. Websites like Teachers Pay Teachers also enable educators to share and sell their teaching materials, promoting resource sharing while allowing teachers to earn income.

5. **Webinars and Virtual Workshops**: Instead of travelling to attend conferences or workshops, teachers can participate in webinars and virtual workshops. This not only saves travel-related emissions but also provides access to professional development opportunities from the comfort of their own homes.

6. **Digital Collaboration Tools**: Collaborative tools such as Google Docs and Microsoft Teams enable real-time editing and feedback on shared documents. Teachers can work together on lesson plans, share insights, and provide peer reviews without the need for paper copies or in-person meetings.

7. **Online Professional Learning Networks**: Teachers can join online professional learning networks (PLNs) to connect with educators worldwide. These networks provide a platform for sharing resources, discussing best practices, and collaborating on innovative teaching strategies, all without the need for physical travel.

8. **Digital Assessment and Feedback**: Teachers can use digital assessment tools and platforms to grade assignments and provide feedback to students. This reduces the use of paper and allows for efficient online grading and record-keeping.

9. **Sustainable Procurement**: When purchasing digital resources, teachers and educational institutions can prioritise eco-friendly options and support companies that adhere to sustainable practices.

10. **Environmental Education**: Incorporating environmental education into the curriculum can raise awareness among students about the importance of sustainability. Teachers can use digital resources to teach topics related to environmental conservation and responsible digital usage.

In conclusion, collaboration and sharing through digital resources provide numerous benefits for teachers while promoting a 'green' approach to education. By embracing technology and utilising online platforms, educators can reduce their environmental impact, conserve resources, and set a positive example for their students. Students are the future of the community and educated trainers translates into educated citizens of the future: in other words, this approach not only enhances the

quality of education but also contributes to a more sustainable future for all, with a specific outlook, following the mission of our LEAF Erasmus+ project, on biodiversity.

6.3. Promoting a "green" attitude in the use of digital technologies

Promoting a "green" attitude in the use of digital technologies is not only crucial for the environment but also for our collective future. As our reliance on digital technologies continues to grow, it's imperative that we adopt sustainable practices to minimise our carbon footprint and protect the planet. Here are some key ways to promote a green attitude in the use of digital technologies:

1. **Raise Awareness**: Education is the first step towards change. Start by raising awareness about the environmental impact of digital technologies. Share information about the energy consumption of data centres, the e-waste problem, and the carbon footprint of digital devices.
2. **Reduce, Reuse, Recycle**: Apply the classic environmental mantra to digital technologies. Encourage people to reduce their digital consumption by being mindful of screen time and unnecessary data usage. Promote the reuse of electronic devices and components, and ensure proper recycling of old gadgets.
3. **Energy Efficiency**: Advocate for energy-efficient technology use. Encourage individuals and businesses to use energy-saving settings on their devices, turn off unused equipment, and invest in energy-efficient hardware. Consider renewable energy sources for charging and powering devices.
4. **Eco-Friendly Products**: Support and promote the development and use of eco-friendly digital products. These could include devices made from sustainable materials, energy-efficient appliances, and electronics designed for easy recycling.
5. **Digital Minimalism**: Embrace the concept of digital minimalism. Encourage people to declutter their digital lives by deleting unnecessary files, unsubscribing from irrelevant emails, and reducing the number of digital accounts and apps they use.

6. **Paperless Initiatives**: Encourage organisations to go paperless by using digital documents and processes whenever possible. This not only saves trees but also reduces the carbon emissions associated with paper production and transportation.

7. **Eco-friendly Apps**: Promote and use apps that focus on environmental sustainability. Apps that help users track and reduce their energy consumption, calculate their carbon footprint, or find eco-friendly products and services can make a significant impact.

8. **Telecommuting**: Advocate for remote work and telecommuting options. This reduces the need for commuting, leading to lower emissions from transportation and less energy consumption in office spaces.

9. **E-Waste Awareness**: Raise awareness about electronic waste (e-waste) and the importance of recycling old devices responsibly. Many components in electronics can be recycled, reducing the need for new raw materials and cutting down on pollution.

10. **Collaboration and Partnerships**: Encourage collaboration between tech companies, environmental organisations, and government agencies to develop and promote green technology solutions. Joint initiatives can drive innovation in sustainable tech: in the case of schools this translates into working closely with the local community in those activities aiming at stimulating green choices.

11. **Community Engagement**: Organise local community events and workshops to educate people about green tech practices and provide hands-on experience with eco-friendly gadgets and applications.

By promoting a "green" attitude in the use of digital technologies, we can significantly reduce the environmental impact of our digital lives and contribute to a more sustainable future for generations to come. It's a collective effort that requires awareness, education, and a commitment to making eco-conscious choices in our daily tech-related activities: teachers are at the frontline of such challenges and that is exactly the reason why their role within the educational system and beyond it is a game changer.

7.1. Let's get practical! Hands-on activities for teachers

The following activities provide insights and tips for educators using the LEAF handbook for what concerns collaboration and sharing in the digital space as well as maintaining a green attitude when working with online tools. Some exercises foresee the presence and active role of an instructor or facilitator while some others are dedicated to singular individuals to train on their own. However, it is advisable to carry out the activities in groups so that project based learning and collaboration are furthermore enhanced.

As already detailed in the previous section, the theoretical basis for the following hands-on exercises and activities are the DigiCompEdu and GreenComp Frameworks produced by the JRC of the European Commission.

The activities proposed here are therefore built starting from the areas of competencies explored in the relative unit and are aiming at empowering users– teachers, educators, trainers and other education professionals- for an upskilling and boosting of digital and green skills very useful – if not mandatory- in the education realm.

The activities target all teachers but specifically the ones of subjects dealing with biodiversity and environmental preservation: STEAM matters *in primis*.

7.2. Activity 1 - Create a workspace on Redbooth

Redbooth is a simple online workplace collaboration solution designed to help high-performing teams with project management chores. Simplify meeting scheduling and deadline monitoring, and assist the whole team of teachers with work organisation while guaranteeing clear communication between them.

1. Create an account at https://redbooth.com/.
2. Verify your account by clicking the verification link in the email that was issued to you.
3. Establish a collaborative workspace.

After you've made your account, you should investigate Reedbooth's unique features at https://redbooth.com/features and put your new digital collaboration environment to the test: this is a way to collaborate with fellow teachers and schedule your classes.

7.3. Activity 2 - Create a workspace on and thread on Slack

Slack is an internet application for communicating with coworkers and colleagues. The application is especially handy for organising chats, sharing files and papers, trading movies, and a variety of other tasks. Slack is based on virtual areas called "channels," which may be readily customised using "#" hashtags. This tool allows the entire work team to simply stay up to date on various communications and subjects.

Slack is therefore beneficial not just as a communication platform, but also and most importantly as a co-working area to carry out a shared project, as could be for teachers who implement co-teaching in their classes. Learning how to use Slack and take use of its many features may significantly increase your productivity and make managing your task simpler.

1. Go to slack.com/create
2. Enter your email address, then click Next. Check your email for a six-digit confirmation code.
3. Enter the code, give your space a name and click Next.
4. Create a new channel for your workspace. Channels organise conversations about anything, like a project your team is working on.
5. Add colleagues' email addresses if you're ready to invite others. Otherwise, select Skip for now.
6. Click View your channel in Slack to visit your workspace.
7. Select Done Registration at the top of the screen. Enter your name and password, then click Next.
8. Review the workspace name and URL, then click Finish to save.

7.3. Activity 3 - The box of tools

The instructor provides a list of tools that might be recommended to the students. All of the digital tools we recommend are open-source. The educator may include as many tools as he or she wants (at least one for each student). We recommend Google Drive, Trello, Dropbox, Google Calendar, Google Forms, and so on.

The instructor writes the tool's name on a piece of paper and places it in the box. It is now the learners' turn: one at a time, they grab a piece of paper from the box and speak aloud the name of the tool that they have discovered. The instructor offers the following questions to the student and the class:

1. What is the purpose of this tool?
2. Have you used this tool before?
3. Do you understand how it works?
4. Do you know of any other tools that function in a similar way?
5. Do you believe this tool can help encourage collaboration?

The educator will moderate the debate but will aim to spark discussion among the students. When all of the notes in the jar have been completed, the educator will write all of the tool names on a whiteboard.

7.4. Activity 4 - Using Dropbox with fellow educators

Dropbox is the ideal online storage solution for all file kinds, including documents, presentations, excel files, photos, and so on, that are widely used in businesses and schools as well as other organisations with several collaborators to collaborate on shared work.Because it is a phone app, you may find it useful for always having your work with you and remaining in touch with your colleagues remotely: however, if you are at school, you can use it on your computer as well as. Let’s see how to install the Dropbox app on your smartphone:

1. Access your Dropbox account.
2. At the bottom of the screen, tap Files.
3. Tap the... (ellipsis) icon next to the file or folder you wish to share.
4. Type the email, name or group of the person(s) you want to share with.
5. Tap Share. The collaborators will receive an email with a link to the file or folder. Note: The amount of free space you get on Dropbox is limited.

7.5. Activity 5 -Netiquette: which behaviours are OK?

The instructor draws on a board various online behaviours related to netiquette, some positive and some bad instances. In this first assignment, learners must determine which elements in a group have

nothing to do with the others. All of those are Netiquette examples, both good and poor. The exercise's goal is to find undesirable behaviours hidden among good ones. The facilitator will then call one participant to the chalkboard at a time and ask them to circle terrible instances of netiquette. Finally, the instructor will correct the answers submitted by the attendees. The instructor encourages learners to reflect on their online behaviour at the end of this exercise, stimulating an open discussion around the topic. For this activity, a tool such as jamboard (https://jamboard.google.com/) can be used to carry it out online/remotely or directly face to face using a chalkboard or post-its.

7.6. Activity 6 - Mentimiter/ Kahoot challenge

The teacher can run this very fun exercise with its pupils. First of all, the instructor should choose a topic explained and treated within its subject and the school curriculum. This exercise can also be done before actually explaining the topic, in order to understand the level of awareness and knowledge of the general subjects that will be covered already present in students' heads. Let's imagine teachers decide to explore the topic 'fluvial biodiversity': they will prepare a series of question and quizzes about it using Kahoot (www.kahoot.com) or Mentimeter (www.mentimeter.com): those edu-games allows to create challenges and contests among users which will simply use a numerical code generated automatically by the platforms to enter the game. Such activity enables a positive attitude among pupils who see the topic as more interesting and fun as well as engaging since it is introduced through a fun game involving the whole classroom. Little prizes can also be foreseen to support even more the uprising of enthusiasm and interest among the students.

7.7. Activity 7 - Powerpoint presentation/ Canva infographic: green practices in the classroom

Teachers of two different subjects gather the pupils and divide them into working groups. Each group is now a team supposed to create a PowerPoint presentation and share the final product on slide share (www.slideshare.com) to the whole classroom. Presentations should be built around the concept of 'green' attitudes to be adopted in schools and should favour a constructive dialogue about those. The teachers then choose the most complete presentation and upload it on the school website and/or social media channels.

As an alternative the same activity can be proposed on Canva (www.canva.com): the best infographic about eco-friendly attitudes at school will have the chance to be broadcasted on official school channels!

7.8. Activity 8 - Instal eco-consciousness

This activity is conceived to boost collaboration among teachers and communication towards school pupils and their families. At least 3 teachers cooperate in the following tasks organised within their group of learners and at the end of all four described tasks, the main findings are gathered into a compiled report written on a Shared Google file and saved into the School Dropbox or Cloud. The aim of this exercise is hence double: on one side it is dedicated to teachers to upskill their collaboration and communication competencies while on the other hand it also strengthens students' consciousness about environmental action.

Waste Audit: Conduct a waste audit with your students. Have them collect and categorise classroom waste for a week. Discuss the findings and brainstorm ways to reduce waste.

Recycling Relay: Organise a recycling relay race where students compete to correctly sort recyclables from non-recyclables. This can be a fun and educational way to reinforce recycling habits.

Indoor Gardening: Set up a small indoor garden with potted plants or a windowsill herb garden. This can teach students about the benefits of plants and the importance of green spaces.

Guest Speaker: Invite an environmental expert or a representative from a local environmental organisation to speak to the class about the importance of green choices and conservation efforts.

7.9. Activity 9 - Environmental Debate

The teacher organises debates with its students on topics like climate change, renewable energy, or conservation. This can help students develop critical thinking skills and gain a deeper understanding of environmental issues. The main findings and considerations and written down on a paperless resource – computer, shared file, online jam board by each student. The second step of this activity foresees a reflection, triggered by the instructor, about which skills are necessary to try to accomplish the insights, goals and consideration arisen during the debate. Students keep using their devices to not

down the skills: the last part of the activity will see the students and the teachers working together to cluster the skills individually following the GreenCompEdu areas of competencies Framework.

8.1 References

1. https://elearningindustry.com/digital-collaboration-of-technology-in-educational-sector
2. https://talkingfinances.co.uk/news/8-useful-tips-for-communicating-effectively-in-the-digital-age/
3. https://blog.worldinternationalschool.com/la-digitalizzazione-delle-scuole-una-visione-di-insieme
4. https://www.weareteachers.com/green-school-tips/
5. https://www.oecd.org/education/professional-collaboration-as-a-key-support-for-teachers-working-in-challenging-environments-c699389b-en.htm
6. https://www.forbes.com/sites/vickiphillips/2022/10/13/stronger-together-the-power-of-teacher-collaboration/
7. https://www.schooleducationgateway.eu/is/pub/latest/news/teacher_collaboration_still_no.htm
8. https://www.the-guild.eu/publications/insight-papers/the-guild_insight-paper_transnational-collaboration_june-2023.pdf
9. https://joint-research-centre.ec.europa.eu/greencomp-european-sustainability-competence-framework_en
10. https://education.ec.europa.eu/it/focus-topics/green-education/learning-for-the-green-transition
11. https://www.ey.com/en_vn/consulting/digital-transformation-the-key-to-sustainable-development
12. https://www.digitaldictionary.it/blog/virtual-communication-comunicazione-efficace
13. https://www.no1behind.org/portal-adrne/uploads/2021/11/NO-ONE-BEHIND-IO2-Handbook.pdf
14. https://www.its-ictpiemonte.it/news/cose-la-green-technology-e-che-ruolo-ha-il-digitale-nellecosostenibilita/
15. https://www.agendadigitale.eu/scuola-digitale/formazione-digitali-degli-insegnanti-una-strada-in-salita/
16. https://www.unidprofessional.com/tecnologia-green-come-ridurre-le-emissioni-co2/
17. https://www.tandfonline.com/doi/full/10.1080/02619768.2021.1938535

07

Cooperation with the local community

Module by Parents' Association Step by Step

LEAF - Learn biodiversity through Environmental Action
For the community
ERASMUS+ 2022-1-RO01-KA220-SCH-000086884

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Table of Contents, Module 7:

VII. Cooperation with local community

1. Introduction

In this module, we will focus on the comprehensive approach to different topics with, of course, the topic of the project *learning biodiversity through environmental action for community* in the main focus. The cooperation with the local community implies all relevant stakeholders in the community, not just the cooperation between various organisations and the local governments, but rather also relevant/important institutions such as schools for example, NGO sector, local government of course and most importantly, people that are a part of that particular community.

The system must work together to resolve any issue or event and to prevent various difficulties and major problems from happening. Working together means that all parties are open for a dialogue, at any time over any sort of issues that are at hand at the moment. It means that they are willing to add on to each other, to work together, to stick together through thick and thin and work towards success. Due to the major global initiatives and campaigns that go along with it, it's often overlooked how even the smallest wheel in this circle largely contributes to a common purpose. The most appropriate saying and the one that most of us are familiar with, and that goes perfectly along with this, is "Think globally, act locally". These small local actions, local showcase of togetherness, local belief in changes is what makes the world go around, what starts and what makes the change. There is always someone who is that first light, that first spark that ignites the fire. A lot of the time, that comes from an individual, an organisation, or an institution and that is where the need to advocate something arises. The idea itself is not doing the work, so these, let's call them stakeholders, have to put in the additional effort to make it happen. And to start, what you need is a partner in crime. It's about a team that you

put together and it's about the diversity of that team, well we might just say another form of biodiversity. You need to understand the importance of a diverse team, a team where every single member covers their part of work – the action, the activities, the legal action, financials, and, for example, take care of the visibility and reach of what we 're trying to do. In this way, not only that you will get admirers from all over your local community as well as a much higher level, you will get your idea through to the masses, you will engage them, you will make them feel like they have a say in this, you will make them feel a part of the team, you will make them join the cause.

Right about now you're starting to get where we're going with this and you're starting to see how it's all intertwined and how the previously mentioned activities start building bridges, start creating synergies, start the change. In the next couple of units in this module you will get to experience all of it and hopefully, you will be ready for the change in the real world.

1.1. Introduction to the module through an international and national context

There are lots and lots of examples that provide us with either good, positive, motivating contexts or, unfortunately, the bad, not so successful outcomes. And it's not only the case of the whole community working together, all stakeholders, relevant to the topic and maybe not so relevant, as this might often cause confusion, conflicts of interest, and other difficulties. It's important to note that partnerships in the local community and wider are also a form of cooperation, and that's a good one we dare say. All kinds of partnerships are included here, such as a one-time action in the community (rebuilding, cleaning, educating...), project and program partnerships and others.

And we don't have to look much further to find a great example of "Think globally, act locally" agenda and also a great longstanding and existing example of partnership with the community. We are, of course, referring to an Erasmus+ program, which is one of the leading examples of how a cooperation can spread all across Europe involving a number of different organisations (different profiles, different backgrounds, agenda, people, etc.) and still make them act locally. How do they act locally? They start forming partnerships with local governments, local institutions such as schools (primary or secondary) and building on these bridges they start effectively involving them in the project, for example, about

biodiversity. Educating the participants, getting them trained and ready to take on the topic of the project, spreading the knowledge, starting actions, advocating for changes – involving all these relevant stakeholders in all of the stages of the project. There is an incredible number of incredible projects out there that have been implemented throughout the years of the Erasmus+ program and it's still counting, following the constant changes in the form of improvements of course, innovation of the program. The program is always being evaluated and validated, the end users are being listened to and their recommendations and ideas are being recognized. And there, once again, you can see that cooperation, on some level. It's everywhere around us and sometimes it's only important to recognize it, add value to it, continue to practise it, improve it, innovate it, use it as much as possible and, of course, take it onto a higher level.

Organisations in our community like schools, churches, businesses and non-profit groups can play a key role in making or breaking the efforts of your group to reach its goals. They may bring real resources like money or skills to your efforts if they are partners, or they can become obstacles to your success if they are not. [6] It's about how you involve these organisations, that is if you are the one in charge of a specific action. It's important to bear in mind that it's absolutely necessary to do your homework, to do the important and relevant research as well as planning. It's not only about having a great idea, it's about the way you work on that idea. You have to be serious, you have to show credibility, you have to be reliable, resourceful and organised. It's important to be on top of the situation to be able to, first of all, involve a larger scale of stakeholders as well as the public and then, after that, control the efforts, create those necessary synergies and keep the productivity of those efforts on a high level.

This is why it's important to note that whilst working with local communities is hugely rewarding, it is important to manage expectations about what you can do together. [7]

To delve a bit deeper into this topic and to try to explain it further, let's take a look at some of the good examples of cooperation with the local community, or should we say cooperation within the local community (intersectoral cooperation). We will focus on the examples of schools and

[6] How to Partner with Local Community Organizations, Yes we can! https://www.issuelab.org/resources/9757/9757.pdf
[7] Working with Local Communities (Archive content – 2017), National Co-ordinating Centre for Public Engagement, https://www.publicengagement.ac.uk/sites/default/files/publication/working_with_local_communities.pdf

kindergartens as one of our (the author of this chapter's) biggest areas of work, but these examples can be used as a sort of template for cooperation on other levels.
First, let's take a look at the examples in Croatia as a part of the national overview.

1.1.1. The inclusive mobile team of the City of Sisak

Based on the suggestion of the members of the Sisak Colourful Inclusion project committee, the mayor Kristina Ikić Baničeк passed the Decision on the establishment of the Inclusive Mobile Team of the City of Sisak, which will carry out activities that strengthen **cooperation between the social, educational and health systems, which is needed by** socially vulnerable groups of children and parents, and will inform them about the rights and opportunities provided by the institutions and associations of the City of Sisak.

Through joint field visits by experts from different sectors, parents are educated about inclusion in the preschool program and encouraging parenting workshops, about information important for starting elementary school, about the importance of vaccination and about the use of legal and social services, etc.

The inclusive mobile team of the City of Sisak consists of experts from:

1. City of Sisak
2. "Brača Bobetko" elementary school
3. Elementary school Galdovo/District school Hrastelnica
4. Kindergarten Sisak Novi
5. Kindergarten Sisak Stari
6. Center for social welfare, Family Center branch
7. Centre for Social Welfare
8. Health center Sisak
9. General Hospital "Dr. Ivo Pedišić" Sisak
10. Sisak civil rights project
11. Sisak Association for Early Intervention in Childhood
12. Sisak colourful inclusion project.

1.1.2. Local Action Team of the Play Center and Toy Library 'Let's Go Together'

Local Action Teams (LATs) of the 'Idemo zajedno (*Let's go together*)' Game Centers are local management bodies that coordinate the process of designing, leading and monitoring activities in the

Game Centers and ensure good coordination, information sharing and local management. LATs are formed with sustainability in mind: it is a group of stakeholders who represent different institutions and communities (e.g. include representatives of minority communities) and who are educated to cooperate with each other, initiate and support care for children and their education and social cohesion in the whole local community (see below). In each local community where the Game Center is located, one LAT was formed as the main governing body of the Center. The average number of LAT members is 12, but the number of members, as well as the composition of the LAT, varies from location to location. LAT meetings initially take place once a month, and later once every three months. During these meetings, LAT plans the activities that will be organised in the Center, different ways of ensuring equal accessibility and availability of the Center for all children and families regardless of where and under what circumstances they live, and the quality of the Center's work is evaluated and the necessary changes are planned

1.1.3. Example: Medjimurje County Info Point

In order to start combating the problem of exclusion, Medjimurje County decided in September 2014 to establish the first Information Center (called 'Info-punkt') for Roma people, as a system that will enable the Roma community to have easier access to information and concrete support when exercising their rights, through direct support and development of human capacities from the Roma community (*empowerment*). The establishment of the Info-point ('Info-punkt') was **one of the recommendations of the National Strategy of the Republic of Croatia for the** inclusion of Roma people for the period from 2013 to 2020 and one of the measures of the Medjimurje County Action Plan for the inclusion of Roma people (which was developed in cooperation with the Office for Human Rights and the Rights of National minority, UNDP and OSCE). The role of the Medjimurje County Info Point is as follows:

- Provide direct assistance in exercising social rights (especially for young and elderly people).
- Help with filling out forms related to the realisation of the right to: one-time financial assistance, child allowance, pension, health insurance, obtaining free school textbooks, etc.
- Help with writing job applications and resumes.

- Identify existing problems (needs assessment) in 12 Roma settlements of Medjimurje County and attempt to influence their resolution by informing competent institutions at the local or national level about the extent of these problems.
- Identify positive initiatives in 12 Roma settlements of Medjimurje County, support and inform competent institutions at the local or national level about these initiatives.
- Organise workshops for Roma non-governmental organisations, small Roma entrepreneurs, young unemployed Roma people, etc.
- Collect data and report on the development indicators of Medjimurje County and 12 Roma settlements (categorised into geographic, demographic, educational, socioeconomic, infrastructural, traffic, financial and functional data structures) collected from institutions and organisations dealing with Roma issues in Medjimurje County.
- Provide systematic help and support regarding the establishment and development of cooperatives or other types of self-employment (connection).

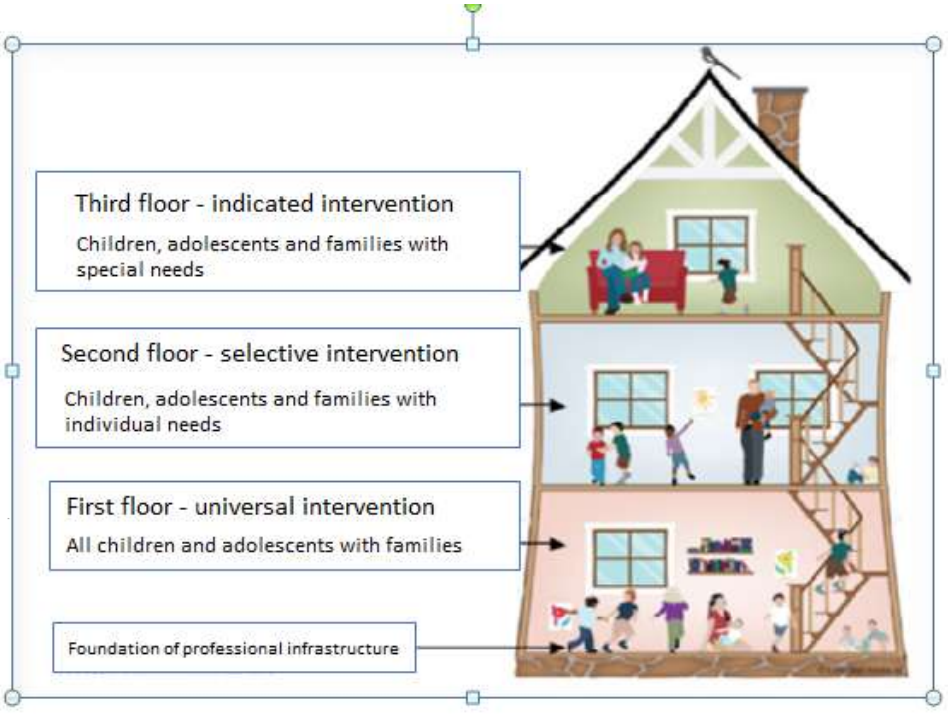
In 2014, through this project, two young Roma people were employed in the newly established Info Point (through the public works measure implemented by the Employment Agency). Unfortunately, due to a lack of funds, the project was not continued.

In the following section, we will focus more on the examples of good practices on a European, international level, to see how it compares to the Croatian (national level) ones and where one might see opportunities for improvement. This is also an important part of our learning process – learning from example, learning from one another. It might add great value to the way one person might think, act or behave, how we see different problems, how we think about solutions. In the best case scenario, it might serve to inspire.

1.1.4. Family centers in Sweden

In Sweden, as in other Scandinavian countries, Family Centers are recognized for providing integrated services for families with children. From the very moment of pregnancy, a lot of information as well as preventive health services are available to parents. The family center is a physical place (*'where it*

smells like coffee'), where all families can call, use a certain service, and meet other parents. The family center is not only intended for mothers, it is often visited by fathers as well.



The center offers various services that can be categorised into four basic services:

- prenatal care and advice;
- preventive health care;
- basic educational support;
- an open preschool institution that is considered the "heart" of the center.

An open preschool is not a school as such; it is a meeting place where parents can come with their children to engage in informal educational activities. In addition to these basic services, which are offered to parents because they have children and not because of any particular problem, other differentiated services can be offered, whenever there is a need for more (such as care for children and young people, issues related to mental health, etc.).[8]

[8] More at: www.diva-portal.org/smash/get/diva2:700870/FULLTEXT01.pdf (Family center in the Nordic countries - a meeting place for children and families)

1.1.5. Example: 'The House of the Child' in Flanders, Belgium

Flanders provides a wide range of services in the field of family support, but it was noted that many services are not available as they should be for all families and that they are not all closely connected or integrated. For this reason, in 2014, legislation introduced the concept of family centers, 'Huis van het Kind' (House of the Child), which are established throughout the Flemish part of Belgium. The goal of these houses is to encourage intersectoral cooperation between local participants in order to provide a range of family support services in an integrated and accessible way and in accordance with local needs. The aforementioned legislative decree outlines some principles and goals, but at the same time leaves some freedom to partners at the local level to design their own 'Children's House' that best suits the local context and the needs of the end users. In the framework of continuous agreement and dialogue between professionals and partners, it is researched and agreed how their 'Huis van het Kind' should function to respond to the needs of the family: at the municipal level by offering a set of services in one place (all services under the same roof) or at more places and/or in combination with other services.

'Huis van het Kind' basically offers preventive health care, parenting support and activities that facilitate meetings and social cohesion, which refers to the belief in the added value of social support as a protective factor in parenting and family functioning. The intention is also to create cohesion between families regardless of socioeconomic and ethnic-cultural boundaries and to contribute to the fight against mechanisms of social exclusion. Preventive health care is a part of health care that takes on preventive tasks related to the health of pregnant women, children and their families. Activities include, among others, vaccination, early detection of risks and health problems, and health promotion.

Support for parents consists of support for persons responsible for raising children and young people. Efforts are made to offer parental support in an accessible, empowering and non-stigmatizing way, based on the idea that it is normal to have questions when raising children. Activities include, among other things, providing information on parenting (individual or group), pedagogical advice, encouraging meetings between parents and children, practical support, etc. The Children's House can combine all kinds of services for families with children, from material and non-material support, child

care, education to preventive and mental health, leisure, libraries, etc. Depending on the local context, a number of 'Huizen van het Kind' have been developed in recent years. For example, in Antwerp an entire cooperation network was established and in 2016 there were eight physical family centers in different city districts. In Brussels there was a similar network of cooperation, but for example the locality was not set up as an actual family center in the form of a physical building.[9]

1.1.6. Example: Family centers in Finland

In the past decade, Finland has initiated a fundamental reform and shift towards the family center model. This allowed this model to grow at its own pace and be designed and developed by experts and professionals working with families with children, taking into account the local context. Here are two valuable practices that show how each center could be developed according to the local context.

Family house 'Pargasa' (western Finland) combines the services of the health, social, early education and non-governmental organisations. Professional experts are workers in health services, family counselling centers, speech therapy work, upbringing and education, and workers in special pedagogy. The main goal is to promote the general well-being of children and families, prevent exclusion and marginalisation, improve the cooperation of professionals, combine the resources of different services and develop cooperation structures for multiprofessional teams and networks for the benefit of families and children. There are activities where families can participate in the planning, implementation and evaluation of services.

In the Kainuu region (Northern Finland) the model works a little differently. This center integrates primary health care services and early preventive social services for families and children. It consists of eight smaller family stations, each of which is located in different municipalities of the region. There is one central family center located in the city of Kajaani. Each station has its own coordinator, who is responsible for the coordination of services, teamwork and network meetings, as well as for cooperation with non-governmental organisations and local actors and volunteers. The coordinators are supported by the management group at the family center. This family center pays great attention to the service path from primary care to special services by integrating professionals from special health

[9] More information: www.eurochild.org

care to primary care, arranging joint ways of care. Professionals use evidence-based observation, evaluation and monitoring methods and learn about each other's working practices.

All work begins with the family itself: professionals meet with all family members, and resources from the peer group are used. Instructing and 'walking' users is avoided by working in meetings and working together in pairs. The integration works on three levels:

- regional network of social and health services;
- team integration of services (family center teams combine experts from different service sectors);
- family integration of services (packages of services are adapted to each individual family).[10]

1.1.7. Example: Primokiz in Switzerland

The Swiss Jacobs Foundation has established a program to support early development, encouraging the creation of networks based on comprehensiveness. The program focuses on children from 0 to 4 years old and their learning environment, both at home and outside the family. This program and its local projects aim to promote equal opportunities for all young children while providing guidance on how to manage the process of co-creating a local early development strategy. It brings together experts from different sectors – education, health, social services – to systematically review and improve existing local programs. This is carried out by the following procedure: analysis of the current situation, definition of a common goal and strategies, with regular updating of the necessary data. The strategies are strongly embedded in the local context. The review of twenty-one local projects showed positive results in terms of improving networking and cooperation at the horizontal level, and the program is gaining increasing political support.[11]

1.1.8.. Example: Children's centers in Great Britain

'Sure Start' Children's Centers in the UK have a core purpose of 'improving outcomes for young children and their families and reducing inequalities, particularly for those families who need support'. These centers were developed at the local level and include all possible actors who work for and with

[10] For more information: https://uit.no/Content/341685/Kekkonen_Marjatta.pdf
[11] For more information: http://jacobsfoundation.org/project/primokiz2/

families, as well as the families themselves. This explains the different types of 'Sure Start' centers in the UK.

The 'Pen Green' center in Great Britain (Corby) is another example of working in a fully integrated way, offering all kinds of services to families. When it started in 1983, 'Pen Green' had six employees and worked with 50 children; today it is a designated children's center (June 2004) with over 110 staff, including teachers, nurses, social workers, midwives, health workers and support staff, working with over 1200 families. One of the main characteristics of 'Pen Green' is that it works for the family, but also with the family. Parents are partners in the development and evaluation of services and practices, as participants in training modules, as staff, as partners in appointment procedures, that is, as paraprofessionals. When staff characteristics are mentioned, words like 'vibrant' and 'engaged' are used. The staff at 'Pen Green' are aware that they work as partners in an equal relationship with families, and that they do not work *for* them, but collaborate **with** them. Pen Green pays tribute to the philosophy that everyone is a leader, and instead of hierarchy, they have developed the concept of horizontal management (eng. *sidearchy*) within the leadership team where everyone contributes their ideas and actions. The basic idea is that everyone is constantly part of the leadership and that they are constantly learning from each other.

'While working in an environment where social conditions are very challenging and oppressive, you actually see that only integration makes a difference. Under these conditions, there is no possibility for people to be passive.' (Margy Whalley)

Even though these previous examples are not fully related to the topic of this project and this handbook, they show real, concrete, positive examples of community partnerships and how they can create the basis for a better, well, first of all community, then the region, then a country, then the world. It's really easy to see how these partnerships correspond to any synergies created at local levels, with any greater cause in mind. And it's interesting to also give it a look from a different perspective where we keep in mind that through these examples, we see excellent showcase of learning how to lead, how to communicate, how to be active, how to raise your voice, how to advocate, how to build partnerships, how to help those in need. Ring a bell? Yes, exactly, these are all the basics of a successful cooperation with (in) the local community.

In the next two examples, let's focus more on the topic of the environment, on the topic a little bit closer to the topic of biodiversity.

1.1.9. The Hurricane Matthew Disaster Recovery and Resilience Initiative

The Hurricane Matthew Disaster Recovery and Resilience Initiative engages faculty and students from the University of North Carolina at Chapel Hill and North Carolina State University as well as professional planning experts in addressing community and state-level needs associated with recovery from Hurricane Matthew. North Carolina Policy Collaboratory, North Carolina Division of Emergency management, North Carolina State Legislature, and the US Department of Homeland Security, Science and Technology Directorate are organisations that support the Initiative's work through funding, staff support, data, office space, and other resources .

The Initiative provides sustained levels of assistance to six communities: Fair Bluff; Kinston; Lumberton; Princeville; Seven Springs; and Windsor. For example, due to floodwaters from Hurricane Matthew, the nearby Lumber River rose approximately 15 feet, damaging Fair Bluff homes and infrastructure. Through the Initiative, the North Carolina State University College of Design proposed multiple housing types for relocation, elevation, and further protection of future town infrastructure, as well as green space designation. The Initiative has provided Fair Bluff multiple levels of support through recovery plans, flood retrofitting reports, and land and economic analyses.

Community partnerships can help localities become more resilient and more effectively manage future environmental challenges. Responses to natural disasters require more than immediate relief; in order to better handle future climate-related adversity, localities must be more resilient. [12]

1.1.10. Fresno Transformative Climate Communities Collaborative

Fresno has faced long-standing environmental, health, and economic disparities. More than 100 square miles in the city have been consumed by suburban sprawl, including areas that have valuable agricultural land. As a result, the urban center and historic neighbourhoods, such as Southwest Fresno and Chinatown, have some of the highest concentrations of poverty nationwide. At the same time,

[12] Maurrasse, David, Bortfeld, Victoria (2021), How Community Partnerships Are Helping to Address Environmental Concerns, State of planet, https://news.climate.columbia.edu/2021/05/26/community-partnerships-environmental-concerns/

these communities struggle with high levels of air pollution and also lack access to green space and healthy foods. Through the Fresno Transformative Climate Communities Collaborative, the city is working to address local environmental, health, economic, and social equity concerns.

The Fresno Transformative Climate Communities Collaborative, formed by residents and other community stakeholders, employed a participatory process to identify a series of projects to implement in the Downtown, Chinatown, and Southwest Fresno Areas. The approved project, Transform Fresno, is a community-driven initiative to transform the 4.9-square-mile project area through multiple projects and plans that will reduce greenhouse gas emissions while also providing local environmental, health, and economic and social equity benefits. The California Strategic Growth Council awarded Transform Fresno with a grant of $66.5 million in November 2016 to start this project. The suite of projects enveloped in Transform Fresno involved multiple different types of partners. For example, its Displacement Avoidance Plan involves the city, Fresno Anti Displacement Task Force, Central Valley Business Diversity Partnership, Wells Fargo, and Fresno Regional Workforce Development Board. Another project, the Clean Shared Mobility Network, involves Fresno Metro Black Chamber of Commerce, San Joaquin Valley Latino Environmental Advancement and Policy, Inspiration Transportation, Shared Use Mobility Center, and Bethel Temple Early Readers Preschool.

Community partnerships have been emerging as important pathways to various types of local solutions. They seem to have particular relevance regarding environmental challenges, which can only be sufficiently addressed through multi-stakeholder, cross-sector collective action. With each passing year, we are reminded of the urgency of present and future environmental challenges. This is particularly the case for the most vulnerable populations. It is not only important to create, maintain, and strengthen local environmental community partnerships, but these initiatives must also intentionally bring an equity and racial equity lens.[13]

[13] Maurrasse, David, Bortfeld, Victoria (2021), How Community Partnerships Are Helping to Address Environmental Concerns, State of planet, https://news.climate.columbia.edu/2021/05/26/community-partnerships-environmental-concerns/

2. Visibility and the importance of information in the local community

First and one of the most important things to do, fortunately or unfortunately, is taking care of the visibility within the local community and wider of course. Now you're probably wondering why we mentioned 'unfortunately', right? Let us explain. Every now and then, often nowadays even, you will encounter people, institutions, organisations, political parties, local governments, only sharing information to get attention, nothing else. The information is shared whether they are true or false, whether that is right or wrong, with one goal in mind – personal promotion. It gets likes, it gets hearts, it gets shared, it gets popularity, it gets money. And alright, to be positive, it's not all that wrong in some cases. Sometimes, even though somebody is doing it for the wrong reasons, we might argue that the message is okay to be shared, to get through to wider audiences, to maybe trigger some actions.

But, on the other hand, as we also mentioned a moment ago, we have to keep an eye on the message. What is being said, what is the meaning behind it, what (re)action does it imply/require? Sometimes even the source of a certain message is not that important and that is where the critical thinking comes in. If the message inspires you to do something, if it triggers you, if it makes you take a stand, take action (of course, for a good cause), it doesn't matter where it comes from right? It's about how you look at it and what you want to take out of it. On the other hand, if we are looking into facts, we are going to want to get an insight from another source, double check our information, think about them thoroughly, and then take action. But okay, maybe we strayed away a little bit on this one. Let's go back and focus on why visibility and information is important, and why it's good to share in our example. The answer is simple – because it will spread the message, it will inform people, it will make people think, it will make people aware that something is done and that it is possible to get on the way, it will motivate and inspire. Another way of looking at this is that it will get you partnership requests, it will get you recognized, it will even get you valued. Your work is out there, your message is out there and it is easier than ever. With all these means at our disposal provided to us by digitalization, nothing seems impossible anymore.

And of course, with all these FREE online tools at our disposal, it's never been easier to reach targeted audiences, to make our work seen, to make our voice heard. Even though it's not only about

the online world and there are also many ways to boost your visibility offline, it's often going to cost you money. In the next couple of sections we explore the ways in which you can take care and boost your visibility in your local community.

First, let's see what offline and online assets can ensure reach and conversion when we're talking about online visibility.

The classic, offline assets are the following:

- shops
- galleries
- cafes
- libraries
- stands
- organisation premises

The online assets would be the following (or some of them):

- Websites
- Facebook profiles, pages and groups
- Instagram profiles
- YouTube channels
- LinkedIn profile and/or page
- Pinterest
- Reddit
- TikTok
- Other online platforms

Let's focus first on the oldest ones, at least the oldest ones still in function and still with a lot to give to potential users, if used correctly and efficiently, of course.

Facebook and Instagram are old social networks with the largest reach and large database. With them, it is much easier to achieve a large reach, especially with the use of databases. As we mentioned before, although recently TikTok has been largely "stealing" the attention of the audience, Facebook and Instagram are still very high in terms of popularity among social networks. Of course, it is extremely important to know who you are addressing, that is, who your target group is. Young people will certainly make different choices compared to older generations, and this generational gap is visible even at significantly younger ages. Although this may sound strange at first, if you are currently in your late 20s or early 30s, ask yourself how familiar you are with TikTok as a social

network, have you ever used it, have you ever seen a TikTok video, etc. For most of you, the answer will most likely be *no*. With the rapid development of technology, this gap has also decreased. Not so long ago, kids at the age of 15 just started discovering Facebook, while their parents, 20-30 years older than them, didn't even know what social networks were, let alone how to use them. Today we can say that the older population is increasingly present on Facebook, while the younger ones turn to TikTok, Instagram, Snapchat, etc.

And for this, as well as for many other related reasons, in addition to paid promotions, relevant organic (free) reach is possible if the capabilities of the Facebook and Instagram platforms are used wisely and correctly.

Let's look at Facebook for example, Facebook offers many possibilities which sometimes, as well as their functions, we are not even aware of, regardless of how long we have been using it. Let's look at the various effective options that Facebook offers to increase our visibility, that is, the visibility of our projects, and along the way we will also see instructions on how to set up certain content.

2.1. Visibility tools

2.1.1. Facebook groups

A great way to gather like-minded people as well as directly inform those you want your message to reach. Unlike, for example, a Facebook page, group members (unless they disable it) receive notifications that content has been published in the group. In most cases, they themselves will be able to share their opinions, participate in discussions, create polls, etc. Below we present **18 simple steps** on how to create and delete a Facebook group:

1. On the main page of the Facebook wall, click on "Groups"
2. Click on create group (top left)
3. Enter a group name
4. Enter the email addresses of the people you want to invite to the group immediately
5. Determine whether the group is public or private
6. Set group visibility
7. Go to Manage settings ("Edit group settings")
8. Specify the group type
9. Create a clear description of the group with short and clear instructions for use (less is more)

10. Link business page (if available)
11. Edit group web address (no spaces)
12. Set your privacy settings (public or private)
13. Specify who can approve new members
    a) Administrators or;
    b) Members
14. Ask questions as a prerequisite for membership - Basic questions:
    a) How did you find out about us?
    b) Why do you want to become a member?
    c) Would you like to leave an email address?
15. Specify who can post in the group (All members or only admins)
16. Set the authorization of posts (Post approval)
17. Set inappropriate words for which Facebook will alert you
18. Save the settings - click "Save"

So, already from this you can see how many possibilities are offered - for posting, for discussion, for controlling the discussion, but also the most important, for reaching the relevant audience, since it can be selected/targeted.

But it's important to remember that, as per the Entrepreneur portal: "Growth doesn't come from stagnation, it comes from movement so in order for any of this to happen, you need to step out of your comfort zone and actively source for opportunities that could elevate your branding. You need to offer incredibly valuable content that can serve your target market and resolve their concerns. If you don't know where to start in terms of content, start by processing your authenticity and sharing parts of your story. Your struggles, your pain points, how you overcame stumbling blocks, even though all of this may be deeply personal, people see their real vulnerable selves in your experiences and can truly connect with you. This is where people start to take notice, when they feel they can invest in you to invest in their own happiness and success.“[14]

Now that you know how to create a Facebook group, let's give you some tips on how to manage that group to get the best possible outcome. We have 22 steps and even though it may seem like a lot to take, it's actually a series of small tips that are easy to remember and even easier to apply.

[14]Periasami, Gaayathri (2019), The Importance of Being Visible, Entrepreneur, https://www.entrepreneur.com/en-au/starting-a-business/what-visibility-means-in-business-and-why-you-shouldnt/329962

Let's start:

- Step by step – use every opportunity you have to invite potential members to your group. You can share posts about the group anywhere you have the chance, send email invitations, use every communication channel available.
- Insert an invitation in your email – for example, in your e-signature.
- Insert the web address of the group in your other channels, such as websites for example.
- Connect more groups – ideally groups with similar goals.
- Promote your members - active members should be praised and mentioned throughout the group and other media that you use. Rewards always motivate new members to join or existing members to get even more (pro)active.
- Create relationships with members - thank them for their cooperation.
- Show behind the scenes content – people like to see it and you also show transparency.
- Give power to your members - allow them to help in making decisions.
- Instant value – use your knowledge, skills and experience to share them and provide tips & tricks to your group members as an added value.
- Create questionnaires – as one more way to include members in the decision making process.
- Create quizzes – to entertain but also educate members. People like to play games and have fun and this is a great way to combine learning, having fun and getting valuable data.
- Start a debate - it motivates members to write longer paragraphs and you also see and are able to analyse their way of thinking and the possibility of including them into higher roles of your projects.
- Live video – from your activities or as an introduction to the activities planned. Shows readiness, motivation and the human side of the people that are addressing members.
- Control the content - so the group is not spammed. Of course, you will have to be careful choosing which type of content is to be excluded as you might offend members.
- Notifications – remind members to keep their group notifications ON.
- Be authentic and honest - communicate as an equal to your group members.
- Group insights - use whenever possible. As in the Facebook page, this feature shows great days of the members and engagement.

- Organise events - online or offline. Great way to attract more interest as well as get more opportunities to share your ideas.
- Seek volunteers - to join your cause, but most importantly, get your message through to them first.
- Ask for opinion - through already mentioned surveys, comments or any other way.
- Set some questions as a condition to join the group - it can play a great role in surrounding yourself with people who are in on the cause and not just someone who wants to promote something, without any touch with the main topic of interest.
- Create mailing lists - one of the most valuable communication channels.

2.1.2. Canva

Let's have a quick break from social media and immediately insert one of the best tools out there to create the content, whether that's pictures/visuals (mostly used) or recently added option to create and/or edit videos. We are, of course, talking about *Canva*, but there are lots of other free tools out there, especially nowadays and with the rise of AI. It's important to be aware of those as they can be used by anyone and you can easily teach yourself to create simple designs that can boost your visibility as they will attract more attention and generate reach.

Canva (https://www.canva.com/), as we already mentioned, is a free online design tool that can be used by anyone completely free of charge (for the basic version). They also offer the full pro version free of charge to NGOs and other organisations/institutions, but before you apply it is important to check this information on their page.

At the main page of Canva you can choose tons of free already set to be used templates where you can play with colours, edit text, etc. You can even choose the type of content that you need, such as for example:

- Instagram post
- Instagram (Facebook) story
- Facebook post, cover, ad
- Presentation
- Infographic
- Video
- Others

This is important because you can immediately get preset dimensions so you don't have to worry about the scaling of the photos once you publish/upload them. Here's just a quick breakdown of the procedure of editing designs with Canva:

1. Upload the photo you wish to edit
    a. You can upload your own photos
    b. You can use photos that Canva offers
2. Create, insert and edit text
3. Edit the colour and font via Canva tools
4. Add various elements to your photo such as stickers, gifs, or others.
5. You're all set, click share and then download at the top right corner and choose the format in which you want to save your designs (.jpeg or .png are recommended for most designs).

2.1.3. Facebook Ads

Let's get back to Facebook now and focus on more ways how you can engage your target audience. One of the most popular and, of course, most effective ways to do that are **Facebook Ads**. And yes, you will need money for that, but it's not as much as you might think. You can set your daily/weekly/monthly budget and Facebook will already present to you the expected reach for that particular budget so you can take this into consideration before making a decision.

Let's walk you through a couple of steps to make sure you make the right decision when using Facebook Ads for the promotion of your cause:

1. Open your Ads manager (https://www.facebook.com/adsmanager)
2. Choose your goal – in general and in the ads manager as well. Before starting, it's always good to know what you want to achieve and then set up your whole campaign around it.
3. Define the audience – if you skipped this step, return to it immediately. You have to know it before you get into the ads management and Facebook offers a great tracking tool to do this. You can choose your audience based on age, based on their location, or even based on their interests. In that way, you can target really specific audiences and get your message through.

4. Placement – you choose a platform where you want your ad to be seen, for example, as Facebook and Instagram are under the same ownership since a couple of years ago, you can choose your ad to show up on Facebook and Instagram.
5. Choose your budget - you choose your budget based on the possibilities and capacities that you have. As mentioned before, Facebook will immediately show you what kind of reach you can expect based on the parameters that you've put in.
6. Choose your weapon – now you choose what you want to promote – create a video, an infographic, a leaflet, a picture, and of course a post to go along with it and promote it in a matter of seconds.
7. That's all folks – you're ready. First you will have to wait for Facebook to approve your ad (they check if it's in accordance with their community guidelines). It's also important to keep track of the numbers that you reach so that you can adjust your campaign to that and gain more success.

2.1.4. Facebook Events

Easy to make and proven to have a major reach as it's showing on people's news feeds more often than not. This is especially because it requires a response and you can also invite your Facebook friends to participate in an event (and most importantly, click that they are either coming, they are interested, or they are not coming to your event). An event can be anything you would like, it doesn't necessarily have to be an actual event, but it's recommended to be honest with your audiences so that you don't lose them due to false or misguided information.

The procedure to set up a Facebook event is simple:

1. Open your Facebook page (of course)
2. Navigate to options and then create event (it can be done via your own personal profile or from a Facebook page profile that you administer)
3. Fill in a couple of basic information about your event (title, theme, description, date and time, location – you can also add online as the location of event) and a cover picture (which you can easily create or adjust with Canva)

4. Publish an event and invite your friends to participate. This is really important as here you start to generate reach. For local levels and events that are organised in local communities, events are often a better and more successful option compared to a simple post.

2.1.5. Facebook page

To better emphasise the importance and the role that Facebook page can play, we call upon the source of *copyblogger.com* and their article *5 Great Reasons to Start Your Facebook Page Right Now* which perfectly summed it up.

1.Connection - The posts travel directly to your followers (people who liked your page) and especially subscribers to your page and often show in their news feed. That's why it's also suggested to post daily in order to build continuity and not to lose the attention of your followers.

2. Authority - You set yourself up as an expert in a particular field, or as a starter and a fighter for some cause where you need to surround yourself with others who think alike. In this way, you become a source of valuable information in your local community.

3. Branding - Of course, it provides a platform where you can start branding whatever it is you're trying to brand. Either that is your organisation, institution, business or just a cause, action or activity. As it says on the *copyblogger.com*, the small guys can now look big [15] – and that is exactly what you are trying to do while also keeping open for people and potential partners to join you.

4. Visibility - You can like other page's posts, you can comment as a page. This is an extremely great innovation of late and a possibility for you to make your presence felt. Of course, you should use this feature wisely – with great power comes great responsibility. Make sure not to just spam other pages in the search for attention, your comments are still content that should be of great value to you and others who you are trying to share it with.

5. Share-ability - Your content is easy to be shared around. As it is with likes and anyone can like your post, anyone can comment and anyone can share their posts as a part of their Facebook profiles or even pages. This helps your posts travel throughout Facebook and reach more and more people with each like, comment or share. It's also important to mention that people have a habit of tagging their

[15] Vahl, Andrea (2011), 5 Great Reasons to Start Your Facebook Page Right Now, coppyblogger, https://copyblogger.com/start-facebook-page/

friends in the posts which leads them directly to your post and more often than not makes them interact with these posts, as it serves as a sort of recommendation from a friend.

2.1.6. Instagram

We are going to focus only on Facebook and Instagram as still one of the most popular social networks but in any case, any channel or any social network that you would like to use (such as TikTok) the principle is almost the same post regularly and create consistency, communicate with your followers and try to engage and reward them, create interesting and valuable content.

There are also different tools that you can use depending on a different social network. Here, we will provide for principles or should we call it a tactic to manage your Instagram profiles with a high success rate in the end:

1. Hashtags - Try to put between 10 - 20 different # (hashtags) on each of your photos or videos. You don't want to choose just the biggest and most popular #'s, you want to choose between 3 - 5 large #'s, 5 - 10 medium sized #'s and 3 - 5 small #'s. If the number when you type # is over 1,000,000, then it is a large #, if the number is below 1,000,000 but greater than 100,000, then it is a medium #, and if the number is below 100,000, then it is a small #. Make sure that the small # has at least 1000 posts. The number of posts with that specific # will appear as you type, in the # suggestion field.

2. Content - It is essential that you create content that your followers will love. Content that they will want to share with their friends, that they will want to comment on or at least like. Make sure the content is consistent. Build a story from one video or photo to another and try to make everything connected together, that is, the moment people see you or your photos, they immediately return to that story and want to know more.

3. Story - Create a story that your audience will connect with, a story that will matter to them and because of which they will send you messages to find out more. We all have interesting experiences that we can turn into stories. The more open you are with your story and the more you share, the easier it will be for your audience to connect with you and follow you / comment on your content and join you in certain activities.

4. Engagement - Go to the # you use in your photos. Look at the top photos and write a good comment, then navigate to new photos and write a good comment there too. Try to do this between 15 - 90 times a day on 5 - 10 hashtags - choose 2 - 3 large, 3 - 5 medium and 2 - 3 small. If you have an interesting comment, chances are high that the person you commented to will look at your profile and, if they like your content, follow you and thus subscribe for more of the same or similar content.

2.2. Sales funnel

A sales funnel is the marketing term for the journey potential customers go through on the way to purchase. There are several steps to a sales funnel, usually known as the top, middle, and bottom of the funnel, although these steps may vary depending on a company's sales model. [16]

Last but not least, a sales funnel is something that helps you understand the way things work and it helps you to always keep track of what you're doing. It helps you understand the basic concept of sales and, well, this is exactly what you're trying to do. You're trying to sell something to create synergies throughout the local community and for the people, organisations, institutions and even local governments as well as businesses to join your cause, to support it, to provide their expertise and create a positive result that will benefit the whole community but, for some reasons, the world as well. Small changes all across the globe can make that happen and small changes are actually what's driving the world forward.

Not to dwell too much on this, let's see the basic concept of sales funnel and what we have to keep in mind while addressing the local community with the goal of creating cooperation, synergies, and teamwork. We have different actors that we have to recognize and, according to which, we will change/adjust our approach:

- Those who don't know about a problem – in this step, it's your goal to educate actors in the local community about the problem and how it can affect them, as well as the whole community that they are a part of.

[16] What is a Sales Funnel?, keap, https://keap.com/product/sales-funnel#:~:text=A%20sales%20funnel%20is%20the,on%20a%20company's%20sales%20model

- Those who have the problem (but don't know the solution) - it's your goal here to provide people with the solution and promote it as a unique and most relevant solution to their/your problem.
- Those who know the problem and solution (but not our solution) – this is where it gets interesting and where your solution is promoted as the most successful one. Of course, before that you have to do your research and prepare your arguments, but this can also be the opportunity to try and combine the two solutions which gives you the kind of synergies we're talking about from the beginning. This is a sales concept but, as you see from this particular example, it can be adjusted to suit our needs which is not just to sell the idea but to work together on the idea, on the problem and on the solution.
- LMR & LMF – so called "Last Minute Regret" or "Last Minute Fear". These are the people who know everything previously mentioned but, well, have LMF or LMR. They feel discomfort and fear about their decision and they are not sure that it is the right one. It's your goal to encourage them and minimise the fear and steps that are needed for them to adopt what you're trying to offer. And now you can also see why communication, why using everything that is at our disposal is of vast importance in this situation. Because all of your efforts are going to minimise the fear, minimise the regret, motivate and encourage target audiences and make them believe in these ideas and stand strong beside you.

This chapter is here to show you some requirements of how to reach and how to engage your target audiences and by audiences we mean all potential partners, relevant stakeholders and the general public. Not only to engage, to get them on your side, but also to inform them about the issues that exist in their local communities and solutions that are or that are planned to be applied. If you are in on something and if you believe that it's the right thing to do, it's you who will have to make the first step to see that necessary change become a reality. Sometimes you will also join the others, but here we are talking from our perspective and from your perspective as a reader. Now that we have covered the basics of it, in the next chapter we delve deeper into the topic of cooperation with the local community.

3. Get involved with the local community – how to cooperate and create synergies

In the next two sections we will start to get more practical and instead of just the plain theory, we will try to give you some simple tools that can kick-start your cooperation within the local community. As in this project, we are mostly institutions and organisations, we will focus on intersectoral cooperation because it includes, as its name already suggests, various different sectors collaborating on a common issue or more of them.

First of all, let's find out what intersectoral collaboration really means. Let's look at the definition of Arctic Institute of Community-based research:

Intersectoral collaboration is the coming together of different people, organisations and sectors to work together to understand and solve complex issues. These partnerships are mutually beneficial relationships that bring together different perspectives, knowledge and skills for increased effectiveness, efficiency, quality and sustainability. With an enhanced capacity to resolve complex health and social issues, inter-sectoral collaboration can result in significant and sustainable change.[17]

This kind of collaboration would also be considered *horizontal* as the *vertical* collaboration is focused on the same field of work, only different level institutions, organisations, companies. In the *horizontal* collaboration, we are talking about connecting and creating networks between different fields, different sectors. *Horizontal* collaboration might include:

- cooperation based on the proximity (eg, Social welfare center and family center in the same building):
- collaboration related to information sharing, joint education, creation of organisation networks;
- collaboration which sits at the highest level of integrated service provision in the sense that professionals share information and work together to deliver various services (Adapted from OECD, Integrating Social Services for Vulnerable Groups: Bridging Sectors for Better Service Delivery, 2015).

[17]Intersectoral collaboration, Arctic Institute of Community-Based Research - For Northern Health and Well-Being, https://www.aicbr.ca/capacity-building

Some benefits of inter-sectoral collaboration may be:

- Sharing of resources, knowledge and expertise
- Reduced duplication of effort, coordination and a unified voice
- Innovation to address complex issues
- Building positive relationships for the long-term
- Potential for greater impact
- With the involvement of more partners there is greater credibility and a broader base of support

Factors for successful collaboration may include:

- Appropriate partners who work well together
- Commitment
- Effective communication
- Common goals, vision, and values
- Clear objectives for action
- Inclusive approach with the engagement of key partners at the beginning
- Each partner has a sense of ownership and accountability
- Effective leadership, structures, linkages and processes
- Adequate resources
- Good teamwork, relationships and communication
- Flexibility and time given to the process [18]

Let's look at the levels in which intersectoral collaboration is forming:

Autonomous work

- The institution acts only in accordance with its own vision and values
- There are no protocols or other documents that would enable cooperation between institutions, all cooperation depends on the goodwill and acquaintances of those who work in the institution
- Separate financing

Outcome - institutions focused on work but not on the bigger goal and needs of the community.

Cooperation between institutions

- Cooperation depends on circumstances and acquaintances

[18] Intersectoral collaboration, Arctic Institute of Community-Based Research - For Northern Health and Well-Being, https://www.aicbr.ca/capacity-building

- Occasionally, some activities are implemented together, but each institution during this cooperation acts only in accordance with its own vision and values.
- Joint planning of activities is missing
- Separate financing

Outcome – greater availability, customised action.

Coordinated work of institutions

- Oriented towards the needs of the community
- Institutions want to act together, have an open dialogue
- There are some protocols and planning of joint work
- Joint financing of some programs or services

Outcome – greater coordination and synergy which affects the well-being of the community itself.

Integrated work of institutions

- Agreed philosophy and vision of cooperation focused on the community/users
- Formalised cooperation through strategies/policies/protocols
- A focus on sharing responsibility with a focus on the outcome
- The partnership is supportive, nurtures reflective practice
- Consolidated financing

Outcome – fully coordinated, integrated work of institutions that respond to the needs of the community and that work with one, common goal.

Advantages of an integrated approach (adapted from OECD, Integrating Social Services for Vulnerable Groups: Bridging Sectors for Better Service Delivery, 2015)

- Integrated services/actions can potentially reduce the cost of duplicating such actions
- Integrating services/actions can lead to early identification of other potential difficulties and problems as well as reactions to them.
- Integration improves access.
- Integration facilitates the exchange of information and knowledge between professionals.

- More integrated models increase cooperation between institutions, which leads to improvements in the quality of work which provides better results and satisfaction.

Benefits of intersectoral cooperation:

- greater accessibility, it is easier to find what a person needs;
- services/actions are better related to the needs and variety of issues/problems that need to be addressed;
- more cohesion in the community;
- easier transitions from one action to another;
- better partnerships and sharing of responsibilities in and between sectors.

Benefits of intersectoral cooperation for professionals and institutions/organisations:

- combining strengths and capacities in dealing with challenges;
- joint learning and professional development;
- greater efficiency.

Benefits of cross-sectoral cooperation for the policy level:

- less overlap and fragmentation;
- better, rational use of already scarce resources.

Now you're probably wondering where you should start. It's okay to feel lost at the beginning, but the most important thing is that you have defined your goal and different roles that have to be played in order to achieve it. This will be your main focus throughout this process.

Well first, as we were saying, you will define a goal, a change that is needed in the community as your starting point and you will start to think about what you can offer and what you will need to make the desired changes happen!

Here's a little cheat sheet that you can use to put it in writing, so it's easier for you to understand it and start elaborating the idea.

- Our vision of change is:

_____

- In the best interest of the community, our organisation is ready to achieve:

_____

- In order to encourage change and create synergy in the community, we need:

_____

To be aware of what and who can help you with the cause, you might want to learn what kind of services there are and who is providing them, just so you can start thinking and combining what you need with who can provide it. This is the way you kick-start the process of collaboration.

Services, as they are provided, are often fragmented (Geinger et. al., 2015), and this can affect the quality of service for the end user as well as outcomes.

Fragmentation can occur in different ways:

- Traditional sectoral division: each sector provides its services independently and focuses only on its area of activity;
- Age division: services are provided separately by age and gender;
- Division by target groups: some services refer only to selected groups of users;
- Division by levels of administration/policies: services can be managed and financed at different levels (local, regional, national);
- Organisational division: services are provided by the state, NGOs or private sector, and it is difficult to find a way for different public and private partners to start working together.

Now that you know all of that, you have the problem, you know what you want to do/achieve, you know what you need and you started thinking about the resources in the local community, about potential partners in crime that can help you achieve the changes you set your mind to, you are ready to move on to the next step.

The next step is not going to be easy as it is going to require some time spent on research. You are going to do something called *eco mapping* . Eco-mapping is a process of creating visual diagrams that

represent the connections between people or organisations within a social network and the interactions or attributes they share at a certain time point. [19]

To put it somehow more in a perspective of our topic - Ecomap is a graphic representation of the relationship of an individual/institution with its environment, and it can be a powerful tool for discovering hitherto undiscovered support systems, but also point out the need to strengthen certain relationships.

On the next page, check out 7 simple steps that lead you through the process of eco mapping.

3.1. Eco mapping

1. Take a blank sheet of paper
2. Draw a circle in the middle and write your name in it.
3. Next to the circle, draw a rectangle in the middle. Write the name of your organisation in it.
4. Draw circles on the outside. In them, illustrate your colleagues with whom you work.
5. Draw squares or rectangles on the outside in which you will write the institutions you cooperate with.
6. Next to each name, write your connection to that person/institution. Display:

   R = your relationship, for example a colleague, supervisor, friend, etc.
   S = support provided by that person, for example emotional, financial, practical help.
   F = frequency of support, for example every day, week or just a few days.

7. Draw arrows between these smaller circles and your own circle to see if both parties in a relationship benefit from it.

In this way, with these 7 simple steps, not only will you do your homework and research all the potential of your local community, you will also make connections and try to see what common points you have and how this cooperation can benefit both of the parties involved. Saying "both", we mean all of the parties involved as usually it will not be only about two parties, but rather, in the best case scenario, much more involved.

[19] Eco – Mapping: A facilitation guide, The National Council for Mental Wellbeing, https://www.thenationalcouncil.org/wp-content/uploads/2021/09/Eco-Mapping-A-Facilitation-Guide.pdf

3.2. Action plan and SWOT analysis

Now that you have analysed your local community, you know what you want to do, what you need to achieve it and **who** you might need to achieve it, you will need an action plan. In this way, you will ensure that the planning and tracking of the progress and the work done in the local community is done together.

Such a plan is an instrument that enables mutual planning of the implementation and monitoring of the integration process in order to achieve the agreed set goals.

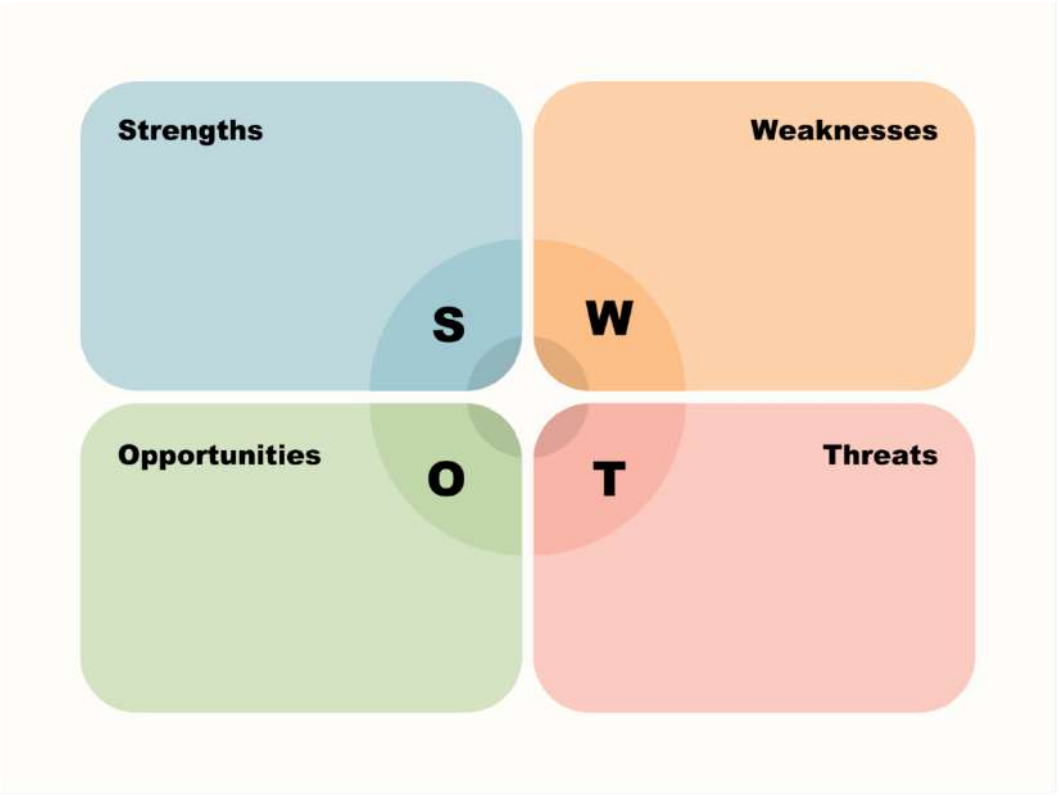
In order for the services and thus the outcomes for the users to be as efficient as possible, it is necessary that the plans are based on realistic, identified needs and problems in the community (or wider). According to these needs, the members of the intersectoral team will decide in which areas there are greater needs or opportunities for further integration in solving problems.

In addition to **the established needs in the community**, it is recommended to make plans using the findings of the so-called **SWOT analysis:** *Strengths*, *Weaknesses*, *Opportunities*, *Threats*.

It's one of the simplest yet so helpful tools that is one common thing, let's dare to say, for all sectors, regardless of the field of work the organisations are into. This tool helps you figure out where you are, where other partners that you gathered around you are, and where the community is at the present moment. This tool is about you and how honest you want to be in the assessment. You see your (of your team and other resources you have at your disposal) strengths and weaknesses, and you see what kind of opportunities or threats arise from within or outside your local community.

In general, it helps you stay more direct and more focused on the real issue as well as to stay grounded while planning your next steps.

Here is a simple picture/template of **SWOT analysis** that you can use:



Picture 2. SWOT analysis, Source: BNI, 3 Easy Steps to Create a SWOT Analysis, https://www.bni.com/the-latest/blog-news/3-easy-steps-to-conduct-a-swot-analysis

On the other hand, the action plan considers both processes/procedures and results, that is, it considers both the process of achieving the results and the results themselves. Since the focus is on the process of strengthening integration, relevant actors/stakeholders can initially focus on strengthening those processes that contribute to strengthening cooperation and coordination in order to achieve goals and implement activities, and the goal of activities is to overcome obstacles and provide services through joint planning, joint coordinated decision-making and joint/coordinated delivery.

Additionally, it is important to deal with building the leadership, but also the capacities and the introduction of new practices at all levels of management (vertical - horizontal management) and to analyze policies and legal frameworks that facilitate the development of integrated action.

3.3. Integrative negotiation

The last piece of the puzzle in this context, after you have gone through all of the steps before, is the integrative negotiation.

Integrative negotiation - also called integrative bargaining, interest-based bargaining or win-win bargaining - is a negotiation strategy in which the involved parties work together to find a solution that satisfies the needs and concerns of each. [20]

Integrative negotiation often involves a greater degree of trust than traditional negotiation. It can also include creative problem solving so that both parties benefit, which is why it is sometimes called *win - win* negotiation.

The steps of negotiation according to the ' *Win-win'* model of integrative negotiation are as follows:

- **Step 1: Define opposite models of solutions to the same problem.** Define the problem that needs to be solved, e.g. healthy eating habits.
- **Step 2: Explore the models.** Discuss and describe in detail both models - what they imply, what it looks like in practice, what's happening. It is important that they try to identify all advantages of both models or solutions.
- **Step 3: Analyse different perspectives.** For each of the models, determine the key target groups that would be covered with that model or solution - all those who could have some consequences, benefit from or be interested in the problem.
- **Step 4: Define the reasons.** For each of the models, divide *the flip-chart* paper into as many columns as there are groups whose viewpoints/perspectives you are analysing, and for each of the groups determine at least three reasons why that model is good for them - what benefits they have or can have, so that the application of that model can positively influence them.
- **Step 5: Define the connection between the models.** The groups jointly analyse the models and benefits for the groups, trying to find common needs that are addressed in different ways

[20] Indeed editorial team (2023), Integrative Negotiation: Definition, Tips and Examples, Indeed, https://www.indeed.com/career-advice/career-development/integrative-negotiation#:~:text=What%20is%20integrative%20negotiation%3F,needs%20and%20concerns%20of%20each

and to notice other similarities and interesting points between the groups. Summarise all the benefits and advantages of the model in one word - a noun.

- **Step 6: Reframe the problem.** Set up the problem again but in a way that includes both keywords from the model. If the keywords, for example, are climate change and overexploitation, we will ask ourselves a question „What strategies can be employed to combat the dual threats of climate change and overexploitation in order to safeguard global biodiversity?“.
- **Step 7: Find a new solution.** Try to find a new creative solution to the problem that will satisfy both parties. Analyse all solutions and try to propose one comprehensive solution. Think about the steps and any assumptions needed to make your model work. Create an action plan.

And this is the perfect moment, a perfect introduction that moves us on to the last part of this module – advocacy. Here we found out how we can work together and how we can break down problems and solutions among the team that we have put up during the previous phase and that was the first step of our work together. This is where our action plan gets finalised and we are ready to move on.
But, this also gave us an insight of how we can communicate our strategies and our activities and actions within the local community, with special focus on the decision makers. We are ready and we are showing it and owning it! The advocacy is the last part and it will not be so much different than what you just saw, it will only build on this internal action and communication and direct its focus on the relevant actors that we need to engage if we want to complete our quest .
Bare with us and you're almost good to go!

4. Advocacy - start the change within your local community

And at the last stage – at last! After going through all the previous efforts there is nothing left for you to do than to advocate these efforts among relevant stakeholders which, in most cases, will mean local governments or the representatives of relevant institutions in the local community. Each step that you went through before has prepared you for this one and it's important to remember that the visibility

part of this module is also here to help you with the advocacy as you will be able to inform the public as well as relevant stakeholders on the topic and also the progress of your activities.

Let's go deeper into this topic and investigate the steps you will need to take in order to get your advocacy campaign going. But, just to start ourselves off, let's first look at the definition of advocacy, to really know what this process is all about. First, we look at it from a perspective from which it might be the most recognizable to us - advocacy means getting support from another person to help you express your views and wishes, and help you stand up for your rights. Someone who helps you in this way is called your advocate (© *Mind. This information is published in full at mind.org.uk*). Simple as that. Now you might first be thinking, for example, about a lawyer – and yes, you would be completely right. You have a person who is your advocate, who is trying to prove a point and make a change in your case, for better or for worse. But here, of course, we're not talking about this level of advocacy. As per the Human rights careers portal, there are different types of advocacy and the one closest to what we are talking about is the Systems advocacy. Self-advocacy and individual advocacy focus on the needs of one or a few people, but systems advocacy zooms out. It seeks to change things on a local, state, or national level through laws and/or policies. Because it wants to change systems for the long term, this kind of advocacy can be complex. Multiple organisations often work together to research, raise awareness, and pressure legislators. [21] We are explaining this process in this way just to give you a bit bigger perspective, but something that is in line with what we're trying to achieve and what we will be doing while going through with the process of advocacy is this - Advocacy means taking action to create change. Advocates organise themselves to take steps to tackle an issue. They help to give people ways to speak out about things that negatively affect them. Advocacy has been described as "speaking truth to power". [22]

Advocacy includes many different types of activities. It can mean researching new solutions, creating coalitions of like-minded people, public campaigning to raise awareness and much more. The aim of advocacy is to create change.

If you follow these simple steps you are on a good path to success:

[21] Human Rights Careers, Advocacy 101: Types, Examples, and Principles, https://www.humanrightscareers.com/issues/advocacy-types-examples-principles/

[22] Their World, What is advocacy? https://theirworld.org/resources/what-is-advocacy/

1. Build evidence on what needs to change and how that change can happen – this you will do through research and investigating before taking action.
2. Raise attention about important issues and give voice to those affected - give the visibility section one more look. Also, you will provide a platform to all those who think and feel the same way you do to start, to take their first step on the way to change.
3. Influence those in power to provide leadership, take action and invest resources – this is where advocacy fully steps in and where you get those in power on your side of the team.
4. Create a positive change towards greater social justice and equality. [23]

4.1. Coping with different ways of functioning in teams and groups

Any group meeting around a common purpose can struggle with differences in how each individual - adult or child - deals with the information and tasks they encounter. Each person will take their contribution and express themselves in the way that means the most to them. This is something that will often occur because of various reasons, e.g. because of the difference in power, position, way of thinking, way of communicating, etc. These can all be challenges and setbacks and can influence the way that your campaign is going but fortunately, this can also be improved and it has to be improved so that you can easily and quickly find common ground and start acting upon it, in your best interest and in the best interest of the local community.

Below are some examples that can help groups and teams working together to resolve such differences to transform them into complementarities rather than barriers and guarantee greater clarity and engagement for all involved.

Such practices are based on the principle that the procedure and outcome of each meeting is owned by all present. Practices are designed in a way that allows greater balance between the individual and the collective.

[23] Their World, What is advocacy? https://theirworld.org/resources/what-is-advocacy/

How to start?

At the beginning, ask the participants what they need to feel ready to begin. In other words, what would enable them to be fully engaged? Most of the answers could surface needs, such as better understanding of the context and where your proposal comes from, or wanting to know the clear purpose of the meeting, or even if there will be a break and at what time the meeting ends. If the needs are explicitly stated, the facilitator will be able to adjust the process to meet some of the needs to ensure greater engagement. Even in the cases where not all of these needs can be met, the participants are allowed to relax instead of focusing on their unmet needs, thus losing the focus of the meeting.

Tip for facilitators: first understand the needs without immediately trying to solve them or convince the participants that their needs will be met.

1. **What do you want from the meeting?**

   One way to ask this at the beginning is to ask, „What needs to happen before I can finally say that this was a successful meeting?“. Asking this question and even writing down the answers in front of the group will encourage everyone to take ownership of what they need to do to leave the meeting feeling like it was a success. It will also help group focus and can ultimately be used as a form of self-assessment by quickly checking whether expectations are being met.

2. **Stop in the middle (process check)**

   There are many ways to check the process, that is, the course of the meeting. A simple way is to stop in the middle of the meeting and ask everyone to give feedback in a way that can increase the quality of the meeting. You can simply ask - „What's necessary to improve our meeting?“, or focus the question on critical aspects of each meeting such as engagement, everyone's participation, or achieving goals. You can also ask how each participant can fully contribute.

3. **Check the common meaning of the critical words**

   Words mean different things to different people. When certain words are used extensively in a meeting, they are often key to the purpose of the meeting and the decisions that needs to be made. Regardless of the quality of the discussion, if you hear a word or two that many participants use frequently, ask individuals to think about what that word means to them. This

will often require them to define the word by offering a specific example in a shared context. Listen for subtle nuances of potential differences in the use of some words or phrases, for example: What does 'planning', 'clear communication' or 'involvement' mean to different people?

4. **Introduce moments of silence**

   Moments of silence can be used for different purposes throughout the meeting. You can start or end the meeting with a moment of silence. Silence can be used as a way to transition between different discussion topics, it can help participants integrate information and change mood. Silence can also be used to spontaneously check the process whenever ground rules are not followed or if a meeting goes in the wrong direction. Everyone at the meeting should have access to a bell or a cymbal and ring it to initiate a moment of silence. It might seem funny but, during this time, participants can consider whether they are acting in the best interest and to fulfill the purpose of the meeting before starting the discussion (O'Toole, 2018).

4.2. Problem tree

Now let's rewind it a bit backwards. Before you actually go through with this activity, there is one important thing that you will need to keep in mind. It might sound simple and funny in a way, but you will have to be extremely careful. Before you go into a meeting with, let's take them as an example, representatives of the local government, you have to have a topic and facts about the topic of your advocacy process firmly set and investigated. You can't get to a meeting unprepared in a way that you are trying to find a way through, that you are right now, at that moment, trying to find a solution, that you don't have an answer to basic questions, or something similar. It can seem and be valued as extremely unprofessional and not serious enough to go through with it. This can cause terrible and unpleasant results for you.

This is why we're suggesting that, together with your assembled team, use the problem tree scheme to analyse and map your topic to the tiniest detail. Let's show you what we're talking about.

Problem tree analysis (also called Situational analysis or just Problem analysis) helps to find solutions by mapping out the anatomy of cause and effect around an issue in a similar way to a Mind map, but with more structure. Therefore, there are two easy steps that you should consider (and go through)

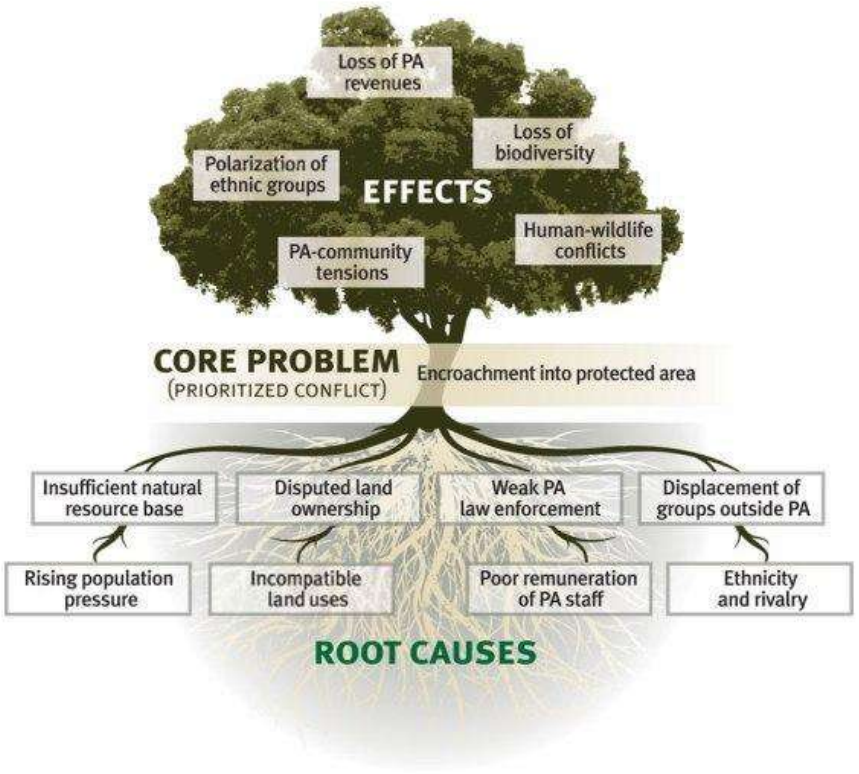
when working on a problem tree analysis. If you want the best possible outcome of this particular learning process, imagine a problem that you have had in the past week/month in your own personal life and do the following:

- Step 1: Discuss and agree the problem or issue to be analysed. The problem can be broad, as the problem tree will help break it down. The problem or issue is written in the center of the flip chart (or any other means at your disposal) and becomes the 'trunk' of the tree. This becomes the 'focal problem'. The problem should be an actual issue everyone feels passionate about, described in general, key wording.

- Step 2: Identify the causes of the focal problem – these become the roots – and then the consequences, which become the branches. These causes and consequences can be created on post-it notes or cards, perhaps individually or in pairs, so that they can be arranged in a cause-and-effect logic. [24]

Here you can see what you will eventually end up with in just a simple visual representation.

[24] Wageningen University and Research, Problem Tree https://mspguide.org/2022/03/18/problem-tree/



Picture 3. Problem tree, Source: Wageningen University and Research, Problem Tree https://mspguide.org/2022/03/18/problem-tree/

When working with your team on this analysis you can ask yourselves some of the following questions:

- Does this represent reality? Are the economic, political and socio-cultural dimensions to the problem considered?
- Which causes and consequences are getting better, which are getting worse and which are staying the same?
- What are the most serious consequences? Which are of most concern? What criteria are important to us in thinking about a way forward?
- Which causes are easiest / most difficult to address? What possible solutions or options might there be? Where could a policy change help address a cause or consequence, or create a solution?
- What decisions have we made, and what actions have we agreed on? [25]

[25] Wageningen University and Research, Problem Tree https://mspguide.org/2022/03/18/problem-tree/

And push it deeper with some of the following questions:

- Which national policies or documents address these issues?
- Are there specific political decisions that directly relate to these issues and their resolution?
- Which of these political decisions are not implemented, or not implemented correctly?
- Which of these issues can you address through advocacy, and for which does your organisation have the capacity?
- How will these policies be developed and implemented?

4.3. Plan your meetings

After you went through previous steps it will, in most cases (as it should), get you to the meetings with relevant stakeholders. Apart from what is previously mentioned for facilitating communication among strong characters that will, for sure, take part in this meeting, what you will want to do is to plan the meeting that you will have with the relevant stakeholders and plan it in detail. Try not to let anything pass you by to be as prepared as possible.

Given that we want all meetings to be accessible and to include members of the expert and professional community as well and in most cases citizens, it is important to think about the conditions that will make this possible. What must we keep in mind if we want the participants to feel relaxed, motivated and welcome?

1. **Organising the meeting.**

    a) How will we motivate people to come? What messages will we send them?

    b) Have we organised a meeting room, refreshments, technical equipment, working materials?

    c) Should the administration of the meeting be ensured (signature list, note-taking, permissions for data collection, etc.)?

    d) Are the lecturers/facilitators/moderators prepared?

2. Relationship building.

    a) How will we welcome the participants at the meeting? How will we enable them to meet each other and how will we introduce new people?

    b) Is there enough time for people to get to know each other?

    c) Should we meet the participants before the meeting and should we stay after the meetings to talk with them to understand their stories and what they have to offer?

d) What can we do to create community among participants?

e) Representatives of vulnerable groups are included.

3. Building common direction and management

a) How do we support sensitization and leadership development (e.g., director/head/mayor) among local community representatives?

b) What can we do to create participation and joint decision-making with leadership?

c) Can experts from the community be facilitators/initiators of some topics and meetings?

4. Partnership

a) How can we show partnership in this process?

b) Do we have partners representing different services and sectors? Do we treat all partners with respect and consider their perspective?

5. Change in the center of things

a) Do we communicate clearly and consistently for the purpose of the network/group meeting?

b) How can we show that the problem/change is at the center of the process and that our actions are carried out with the community's welfare in mind?

4.4. Action plan

And at the end, we just wanted to give you a simple table that you can use to create an action plan. It's recommended that you already, at this meeting that is a focal point of your advocacy process, have a draft version of an action plan prepared and then, at this meeting(s) you can fill in the gaps and start preparing the future steps.

This entire module is based on the planning process. The more thorough you are in these steps, the more success you will attract, the more desired outcomes you will generate.

The following is the example of a simple template for the action plan:

Content	Planned activities	Who is responsible?	Who is involved?	When will it take place?	What resources do we need?	Expected outcomes?

Common understanding of needs and community participation through dialogue						
Key policies and documents and necessary changes						
Organisational capacity building and introduction of new practices at different levels: - employees - leadership - management - community						
Leadership and management						
Integration: - joint planning - joint delivery - joint monitoring and evaluation						
Communication and information sharing						
Allocated resources (time, human resources, financial, material)						
Monitoring and evaluation of outcomes						

5. Conclusion

To conclude, let's just say that the cooperation with local community is something that doesn't come overnight and it's something that takes a lot of effort, facilitation, nurturing and adjusting, but in the end, it yields the results that are affecting the whole local community. It is also something that involves a lot of different actors, a lot of different stakeholders that are absolutely necessary in this

process. Also, it involves a large chunk of the public which is an important 'stakeholder' to have on your side.

Given in this module are not all of the tools neither all of the possible advice that one might take into consideration when cooperation with local community is concerned, but the basis is covered and if you give it a go, at least for the small causes for the beginning of your journey, you will see that it can take you to positive outcomes in the end. As you have seen throughout this module, one of the focal points in this cooperation is the planning – planning of your next steps (based on the research), planning cooperation, planning visibility driven actions, planning the meetings, planning the advocacy process and with special focus on that last bit there. You have to be ready to take on such challenging and comprehensive tasks, especially the last one that is advocacy where your ideas and all your work so far will depend on how you sell it, how you present it to those in power. This one step that depends on all the previous steps undertaken correctly, can determine the outcome of your whole, often long story. That's why it's of vast importance to pay attention to detail and to plan ahead. In this way, in each step of the way, you will know where you are currently at and compare it to where you wanted to be in the first place, as well as adjust and get yourself on the right track for the future.

It's also recommended to use all of the resources used throughout this module to get more information and to broaden your approach to this topic. Each of the resources used covers more and gives you more information on any particular topic that makes this module and you can always do your own research for more – it can be of great practice and great value for you as well, especially if you are a beginner!

6. Resources

1. How to Partner with Local Community Organizations, *Yes we can!,* https://www.issuelab.org/resources/9757/9757.pdf
2. Working with Local Communities (Archive content – 2017), *National Co-ordinating Centre for Public Engagement*, https://www.publicengagement.ac.uk/sites/default/files/publication/working_with_local_communities.pdf
3. Kekkonen, Marjatta, Montonen, Mia, Viitala Riitta (2012) Family centre in the Nordic countries – a meeting point for children and families, *Nordic Council of Ministers,* http://www.diva-portal.org/smash/get/diva2:700870/FULLTEXT01.pdf
4. Eurochild, https://www.eurochild.org/
5. Kekkonen, Marjatta (2013), Family centres in Finland, *National Institute for Health and Welfare Finland*, https://uit.no/Content/341685/Kekkonen_Marjatta.pdf
6. Primokiz2 – For an Early Childhood Policy, *Jacobs Foundation*, https://jacobsfoundation.org/activity/primokiz2/

7. Maurrasse, David, Bortfeld, Victoria (2021), How Community Partnerships Are Helping to Address Environmental Concerns, *State of planet*, https://news.climate.columbia.edu/2021/05/26/community-partnerships-environmental-concerns/
8. Periasami, Gaayathri (2019), The Importance of Being Visible, *Entrepreneur*, https://www.entrepreneur.com/en-au/starting-a-business/what-visibility-means-in-business-and-why-you-shouldnt/329962
9. Vahl, Andrea (2011), 5 Great Reasons to Start Your Facebook Page Right Now, *coppyblogger*, https://copyblogger.com/start-facebook-page/
10. What is a Sales Funnel?, *keap*, https://keap.com/product/sales-funnel#:~:text=A%20sales%20funnel%20is%20the,on%20a%20company's%20sales%20model
11. OECD (2015), Integrating Social Services for Vulnerable Groups: Bridging Sectors for Better Service Delivery, *OECD Publishing*, Paris, https://read.oecd-ilibrary.org/social-issues-migration-health/integrating-the-delivery-of-social-services-for-vulnerable-groups_9789264233775-en#page1
12. Intersectoral collaboration, *Arctic Institute of Community-Based Research - For Northern Health and Well-Being*, https://www.aicbr.ca/capacity-building
13. Geinger, Freya, Van Haute, Dorien, Roets, Griet, Vandenbroeck, Michel (2015.), Integration and alignment of services including poor and migrant families with young children
14. Eco – Mapping: A facilitation guide, *The National Council for Mental Wellbeing*, https://www.thenationalcouncil.org/wp-content/uploads/2021/09/Eco-Mapping-A-Facilitation-Guide.pdf
15. Tannuzzo, Steve (2023), 3 Easy Steps to Create a SWOT Analysis, *BNI*, https://www.bni.com/the-latest/blog-news/3-easy-steps-to-conduct-a-swot-analysis
16. Indeed editorial team (2023), Integrative Negotiation: Definition, Tips and Examples, *Indeed*, https://www.indeed.com/career-advice/career-development/integrative-negotiation#:~:text=What%20is%20integrative%20negotiation%3F,needs%20and%20concerns%20of%20each
17. Mind (2018), Advocacy in mental health, https://www.mind.org.uk/information-support/guides-to-support-and-services/advocacy/what-is-advocacy/
18. Human Rights Careers, Advocacy 101: Types, Examples, and Principles, https://www.humanrightscareers.com/issues/advocacy-types-examples-principles/
19. Their World, What is advocacy? https://theirworld.org/resources/what-is-advocacy/
20. O´Toole, Linda (2018), Learning for Well-being Foundation, https://www.learningforwellbeing.org/
21. Wageningen University and Research, Problem Tree https://mspguide.org/2022/03/18/problem-tree/

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