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Tutorial work Handout

For the use of first-year Master's students (M1 Level)

FIELD

NATURE AND LIFE SCIENCES (NLS)

FUNDAMENTAL TEACHING UNIT

BIODIVERSITY

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Subject Title 2: Biodiversity

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Objective:

The Tutorials Work on Biodiversity, designed specifically for Master 1 students. They aim to deepen your understanding of biodiversity through hands-on experiences and critical analysis. Throughout this Tutorial, students will engage in a series of practical tasks that will enhance their skills in research, analysis, and collaboration, all while fostering a greater appreciation for the complexities of biodiversity.

Table of Program of Tutorials

T 1: Comparison of measurement methods (advantages/disadvantages)

T 2: Mini-project: inventory of a green space (simulation or field trip)

T3: Case study: analysis of the ecosystem services of a wetland

T 4: Analysis of Invasive Species Cases in Algeria

T5: Analyze the relationship between pollution levels and biodiversity indices in various ecosystems

T 6: Simulated debate between stakeholders: biodiversity vs development

T7: Comparison of protected areas (Africa, Amazon, Algeria)

T8: Design of a restoration plan for a fictional site

Preface

Biodiversity and Environment Master’s program explore the wonders of biodiversity and the vital role to play in sustaining life on Earth. Students in this academic master will delve into the intricate web of life that sustains our planet and explore the myriad ways in which human activities intersect with natural ecosystems. This tutorial is designed to provide students with a comprehensive understanding of biodiversity, its measurement, and the pressing environmental challenges we face today.

This tutorial is not just an academic exercise; it is a call to action. As future leaders in biodiversity and environmental management, students hold the responsibility to advocate for the preservation of our planet's rich biological heritage. We encourage students to approach each module with curiosity, critical thinking, and a commitment to making a positive impact on the world around you.

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Tutorial work 1: Comparison of Biodiversity Measurement Methods (advantages/disadvantages) (Example: Field survey and the use of technology information)

Objective:

Biodiversity measurement is crucial for understanding ecological health, conservation efforts, and the impacts of human activities on ecosystems. Various methods exist for measuring biodiversity, each with its own strengths and weaknesses. This tutorial aims to provide a detailed comparison of several common biodiversity measurement methods, focusing on their advantages and disadvantages according a case study of an ecosystem.

1. Biodiversity Measurement Methods

Each biodiversity measurement method has its own set of advantages and disadvantages, making them suitable for different research questions and contexts. Understanding these methods' strengths and limitations is essential for selecting the appropriate approach for biodiversity assessment. In practice, a combination of methods may provide the most comprehensive understanding of biodiversity in a given area, allowing for more effective conservation and management strategies.

Each method has its strengths and weaknesses, and the choice of method should be guided by the specific research questions and conservation goals. This directed study will equip students with the knowledge and skills to critically assess biodiversity measurement techniques and apply them in real-world contexts. Several methods can be used such as:

- Field surveys, including species inventories, quadrat sampling, and transect sampling, provide essential data for biodiversity assessments and conservation planning by cataloging species and their ecological roles. However, these methods can be time-consuming and may require careful planning to avoid errors in data collection.

- Remote sensing and genetic analysis, including DNA barcoding and metagenomics, offer significant advantages for biodiversity assessment, such as efficient species identification and comprehensive ecosystem monitoring. However, they also present challenges, including the need for advanced technology and expertise, potential data interpretation complexities, and limitations in detecting certain species or genetic variations.

- Ecological modeling, particularly through Species Distribution Models (SDMs) and biodiversity indices, offers valuable insights into species-environment relationships and

biodiversity patterns, aiding conservation efforts. However, the models depend heavily on data availability and can be limited by the complexity of ecological interactions and potential inaccuracies in predictions.

2. Exercises

Exercise 1: Measuring Biodiversity in a forest Ecosystem across to field survey

In the context of forest ecosystems, the analysis of species inventories plays a crucial role in understanding biodiversity. However, this raises an important scientific question: How do variations in species composition and abundance within these inventories reflect the overall health and resilience of the ecosystem? In this case data are collected during investigations on a forest ecosystem of Mahouna (Guelma, North East of Algeria). The list of species found is presented in the following table with Braun-Blanquet coefficient over three plots in Cork oak formation.

Table 1: Data Collected from coastal ecosystem:

Species	**Braun-Blanquet coefficient**		
	Plot 1	**Plot 2**	**Plot3**
Arborescent Layer *Quercus suber*	3	4	4
Shrub Layer *- Cistus monspeliensis:* *- Phillyrea angustifolia:* *- Calicotome spinosa:* *- Asparagus acutifolius:* *- Cistus salvifolius:* *- Daphne gnidium:* *- Crataegus monogyna:* *- Erica arborea:* *- Lavandula stoechas:* *- Cytisus triflorus:*	 2 1 1 1 1 1 1 2 1 1	 1 0 1 0 1 1 2 2 1 0	 0 0 1 0 1 0 2 2 1 2
Herbaceous Layer *- Asphodelus microcarpus:* *- Daucus carota:* *- Thymus vulgaris:* *- Cyclamen africanum:*	 0 1 0 0	 1 0 1 0	 2 1 1 1
Liana Layer *- Smilax aspera:*	1	0	0

By examining the inventory data, student can identify key species, assess ecological interactions, and evaluate the impacts of environmental changes. This inquiry not only enhances our comprehension of biodiversity patterns but also informs conservation strategies. Therefore, what methodologies can be employed to effectively analyze species inventories and their implications for forest ecosystem management?

Solution:

To analyze the species inventories provided and their implications for forest ecosystem management, we can employ several methodologies and calculate key ecological indices.

Methodologies for Analyzing Species Inventories

1. Species Richness: This is the simplest measure of biodiversity, representing the total number of different species present in the inventory. It provides a basic understanding of the diversity within the ecosystem.

2. Abundance Analysis: This involves examining the number of individuals of each species. It helps in understanding which species are dominant and which are rare, providing insights into the structure of the ecosystem.

3. Shannon-Wiener Diversity Index (H'): This index accounts for both abundance and evenness of the species present. It is calculated using the formula:

$$H' = -\sum(pi.ln(pi))$$

where pi is the proportion of each species relative to the total number of species.

4. Simpson's Diversity Index (D): This index measures the probability that two individuals randomly selected from a sample will belong to the same species. It is calculated as:

$$D = \sum(p_i^2)$$

The value of **D** ranges from 0 to 1, where 1 represents no diversity and values closer to 0 indicate higher diversity.

5. Evenness (E): This measures how evenly the individuals are distributed among the species. It can be calculated as:

$$E = \frac{H'}{\ln(S)}$$

where E is the total number of species.

6. Functional Diversity: Assessing the functional traits of species can provide insights into their roles in the ecosystem and how they respond to environmental changes.

Calculation of Indices Using the Provided Data

First, we need to convert the Braun-Blanquet coefficients into a numerical format that can be used for calculations. The coefficients can be interpreted as follows:

- 1 = 1-5% cover

- 2 = 6-25% cover

- 3 = 26-50% cover

- 4 = 51-75% cover

- 5 = 76-100% cover

- . = Absent

1. Calculate Total Abundance and Species Richness

- Total Abundance (N): 43

Total Number of Species (S): There are 16 unique species.

Step 3:

Calculate Proportions (pi)

- For each species, calculate

- Calculate Shannon-Wiener Diversity Index (H'):

Calculating H' : **H'≃ 2.33**

- **Calculate Simpson's Diversity Index (D)**

Calculating D: D≅ 0.20

Calculate Evenness:

$$E = \frac{H'}{\ln(S)} =$$

E = 2.33/ln (16) =2.33/2.772 ≅ 0.84

Interpretation of Results

1. Species Richness: The inventory contains 16 species, indicating a relatively diverse ecosystem.
2. Abundance: The presence of dominant species (like *Quercus suber*) suggests that certain species may play a critical role in the ecosystem.

3- Shannon-Wiener Index (H'): A value of 2.33 indicates a moderate level of diversity. Higher values indicate greater diversity, suggesting a more stable and resilient ecosystem.
4- Simpson's Diversity Index (D): A value of 0.20 indicates a relatively low diversity. Lower values suggest that the ecosystem may be dominated by a few species, which could make it more vulnerable to disturbances.

5. Evenness (E): An evenness score of 0.84 suggests that the species are relatively evenly distributed, which is beneficial for ecosystem stability.

The analysis of species inventories using the Shannon-Wiener and Simpson indices provides valuable insights into the biodiversity and health of the forest ecosystem in Mahouna. The moderate Shannon index suggests a decent level of diversity, while the Simpson index indicates potential dominance by certain species. These findings can inform forest management strategies aimed at preserving and enhancing biodiversity.

Exercise 2: Mapping Vegetation Distribution Using Aerial Photos and Satellite Images

The Mahouna Forest, located in Guelma, is an important ecological area that has been studied using aerial photographs and satellite imagery. By utilizing Geographic Information System

(GIS) software, researchers have been able to create a vegetation distribution map of the forest. The data from Landsat 7, combined with aerial photographs and a digital elevation model (DEM), provides valuable insights into the forest's ecological characteristics.

Analyze the vegetation distribution in the Mahouna Forest using GIS tools and the provided data sources:

- What are the main vegetation types identified in the Mahouna Forest?
- How does the topography, as indicated by the DEM, affect the distribution of these vegetation types?
- What challenges did you encounter during the classification process, and how did you address them?

Solution:

- Import the Landsat 7 imagery and aerial photographs into the GIS software (e.g., ArcGIS, QGIS). Ensure that all layers are in the same coordinate system (e.g., UTM) for accurate alignment.

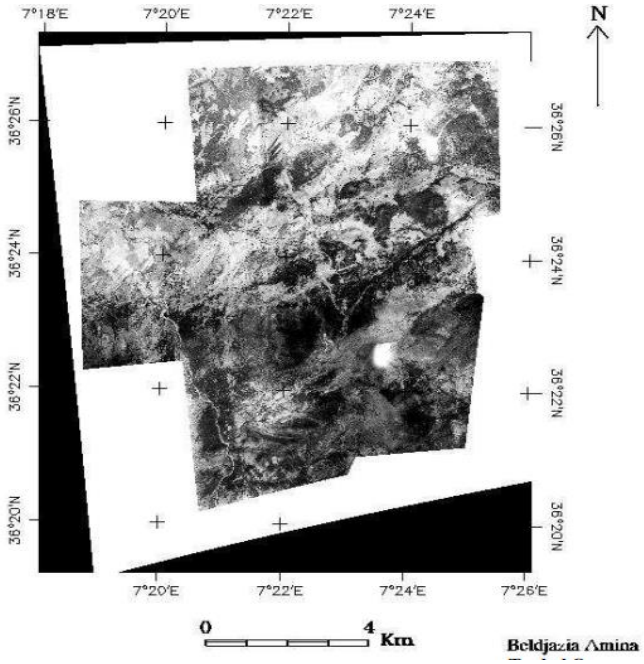


Figure 1: Aerial photographs of Mahouna forest (Guelma, North East of Algeria) (Beldjazia, 2009).

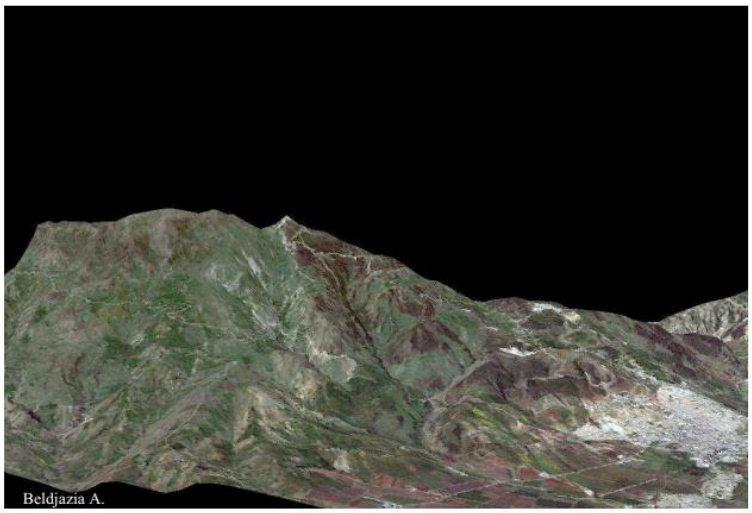


Figure 2: Satellite image of Landsat of mahouna Forest (Guelma, North East of Algeria) (Beldjazia, 2009).

- Analyze the DEM to identify high and low elevation areas. For example, higher elevations may correspond to rocky outcrops or less dense vegetation, while lower elevations may indicate areas with richer soil and denser forest cover. This analysis can be visualized using slope and aspect tools in the GIS software.

- Use the image classification tool in the GIS software to classify the Landsat 7 imagery. For supervised classification, select training samples for known vegetation types (e.g., coniferous forest, deciduous forest, grassland). For unsupervised classification, use clustering algorithms to identify distinct vegetation groups. The output will be a classified map showing different vegetation types.

- Overlay the classified vegetation map with aerial photographs. Validate the classification by comparing the classified areas with the aerial imagery. Discrepancies may arise due to factors such as seasonal changes, cloud cover in satellite images, or misclassification due to similar spectral signatures of different vegetation types. Address these by refining training samples or adjusting classification parameters.

- Create a final vegetation distribution map that includes a legend (indicating different vegetation types), scale, and north arrow. The report should summarize findings, such as the identification of coniferous forests in higher elevations and denser deciduous forests in lower areas, highlighting their ecological roles in biodiversity and habitat provision.

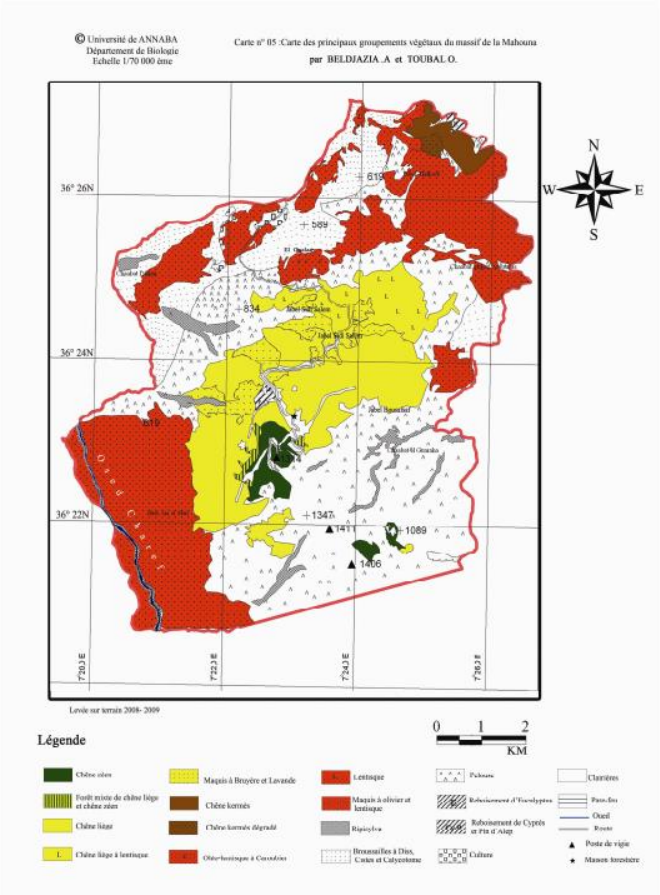


Figure 3: Vegetation distribution of Mahouna (Guelma, North East of Algeria) (Beldjazia, 2009).

1. Main Vegetation Types:

- The main vegetation types identified may include coniferous forests, deciduous forests, and grasslands, each with distinct ecological roles.

2. Topography Influence:

- The topography influences vegetation distribution by affecting soil moisture, sunlight exposure, and temperature, leading to different plant communities in high versus low elevation areas.

3. Challenges Encountered:

- Challenges may include cloud cover in satellite images, which can obscure vegetation, and the difficulty in distinguishing between similar vegetation types. These can be addressed by using additional data sources or refining classification techniques.

This exercise provides a comprehensive approach to understanding the vegetation distribution in the Mahouna Forest using modern GIS techniques and remote sensing data.

3. Home work

Students are encouraged to engage with the material actively and apply their learning through practical activities.

1. Select a Local Ecosystem: Each group will choose a local ecosystem (e.g., forest, wetland, urban area).

2. Choose Measurement Methods: Decide which biodiversity measurement methods to apply.

3. Data Collection: Conduct fieldwork or use existing data to gather information.

4. Analysis and Presentation: Analyze the data and present findings, discussing the advantages and disadvantages of the chosen methods.

Tutorial work 2: Mini-project: inventory of a green space (simulation or field trip)

Objective:

The goal of this mini-project is to conduct an inventory of a green space, which could be a park, garden, or any natural area. This inventory will help student to understand the biodiversity, ecosystem composition, and the overall health of the green space. Student can choose to simulate this project using existing data or conduct a field survey to gather real-time data.

What do mean green spaces?

Green spaces are vital for urban environments as they provide numerous benefits, including improving air quality, supporting wildlife, and offering recreational opportunities for residents. By inventorying a green space, you will gain insights into its ecological value and learn how to assess and document biodiversity.

1. Steps to Conduct the Inventory:

Step 1: Choose Your Green Space

- Select a green space for your inventory. This could be a local park, botanical garden, nature reserve, or even your backyard in the region of Sétif.

- If you are simulating, choose a specific area and gather existing data about its flora and fauna.

Step 2: Define Your Inventory Goals

- Determine what you want to achieve with your inventory. Some possible goals include:

- Identifying plant and animal species present

- Assessing the health of the ecosystem

- Understanding the impact of human activity on the green space

- Evaluating the services provided by the green space (e.g., recreation, habitat, carbon sequestration)

Step 3: Develop a Data Collection Plan

- Decide on the methods you will use to collect data. This may include:

- Visual surveys for plants and animals

- Measuring the size and health of trees

- Recording the presence of invasive species

- Noting human impacts such as litter or erosion

Step 4: Conduct the Inventory (Field survey)

- Visit the green space and begin your inventory. Follow these guidelines:

- Take notes on the different species you observe, including their common and scientific names.

- Take photographs to document your findings.

- Measure and record the size of significant plants or trees.

- Note any signs of wildlife, such as tracks, nests, or droppings.

- Be respectful of the environment; do not disturb wildlife or plants unnecessarily.

Step 5: Conduct the Inventory (Simulation)

- Use online databases to gather information about the selected green space. Look for:

- Species lists

- Historical data on biodiversity

- Maps and photographs

- Create a spreadsheet to organize your findings.

Step 6: Analyze Your Data

- Review the data you collected. Look for patterns, such as:

- The most common species

- The presence of any endangered or invasive species

- Evidence of human impact

- Consider the health of the ecosystem based on your observations.

Step 7: Present Your Findings

- Prepare a presentation to share your findings. Include:

- An introduction to the green space and its significance

- A summary of the species identified

- Any notable observations regarding ecosystem health and human impact

- Recommendations for conservation or improvement efforts

- Use visuals such as photos, charts, and maps to enhance your presentation.

Step 8: Reflect on the Experience

- After completing your project, take some time to reflect on what you learned. Consider:

- What surprised you about the green space?

- How did the experience change your perspective on biodiversity and conservation?

- What actions can you take to help protect green spaces in your community?

2. Practice Exercises

Exercise: Analysis of Green Spaces in Ain Mousse, Sétif

In order to analyze the existing tree species in the Ain Mousse neighborhood of Sétif, a field survey in this city has made focusing on their health, height, diameter, and overall contribution to urban greenery.

- Identify the most common species in the area.

- Note any species that are particularly healthy or unhealthy based on the crown condition and leaf color.

- Examine the provided data table that includes various tree species, their circumference, height, leaf color, fruiting status, and crown condition.

Solution:

1. Green spaces in Ain mousse include trees plantation in road (figure 4).



Figure 4 : Ain mousse City (Setif, North East of Algeria) (Beldjazia, 2025)

The most common species in the area are in the table below

2. Health Assessment:

Assess the health of the trees based on the following criteria: Leaf color (green is generally healthy, yellow may indicate stress). Fruiting status (presence of fruit can indicate a healthy tree).

3. Height and Diameter: results are in the table 2

Table 2: The most common species in Ain Mouss city (North East of Algeria) (April 2025)

Species	Circumference (cm)	Height (m)	Leaf Color	Fruiting
Ligustrum japonicum	***55***	***7.1***	GREEN	***PRESENT***
Ficus carica	***48***	***6.4***	GREEN	***PRESENT***
Morus alba	***47***	***7.0***	/	/
Morus alba	***30***	***6.8***	/	/
Eucalyptus	***33***	***5.5***	GREEN	/
Ziziphus	***8***	***4.2***	GREEN	***PRESENT***
Morus alba	***37***	***7.0***	/	/
Morus alba	***9***	***5.7***	/	/
Ligustrum japonicum	***58***	***7.2***	GREEN	***PRESENT***
Morus alba	***69***	***8.9***	/	/
Ficus carica	***35***	***4.6***	GREEN	***PRESENT***
Prunus lusitanica	***41***	***5.9***	YELLOW	***PRESENT***
Ligustrum japonicum	***39***	***6.0***	GREEN	***PRESENT***
Ligustrum japonicum	***20***	***4.3***	YELLOW	***PRESENT***
*Zi*ziphus	***10***	***4.0***	GREEN	***PRESENT***
Ficus carica	***23***	***4.1***	GREEN	***PRESENT***
Ligustrum japonicum	***29***	***4.1***	GREEN	***PRESENT***
Pinus halepinsus	***96***	***8.0***	GREEN	***PRESENT***
Eucalyptus	***54***	***8.2***	GREEN	***PRESENT***
Ficus carica	***49***	***6.3***	GREEN	***PRESENT***

1. Species Identification

The most common species observed are: *Ligustrum japonicum* and *Ficus carica*. 2. Health Assessment: - Healthy trees (green leaves, present fruiting) include *Ficus carica* and one tree of *Ligustrum japonicum*.

- Trees with yellow leaves (e.g., *Prunus lusitanica*) may need attention.

3. Height and Diameter Analysis:

- Average height: (7.1 + 6.4 + 7.0 + 6.8 + 5.5 + 4.2 + 7.0 + 5.7 + 7.2 + 8.9 + 4.6 + 5.9 + 6.0 + 4.3 + 4.0 + 4.1 + 4.1 + 8.0 + 8.2 + 6.3) / 20 = 6.2 m (approx).
- Average circumference: (55 + 48 + 47 + 30 + 33 + 8 + 37 + 9 + 58 + 69 + 35 + 41 + 39 + 20 + 10 + 23 + 29 + 96 + 54 + 49) / 20 =39.5 cm (approx).

4. Recommendations: This analysis provides a comprehensive overview of the green spaces in Ain Mousse, Sétif, and offers actionable insights for enhancing urban greenery.

- Increase species diversity to enhance resilience against pests and diseases.

- Implement a regular maintenance schedule to monitor tree health and address issues like yellowing leaves and low crown conditions.

- Consider planting more ornamental species that thrive in urban settings to improve aesthetic value and biodiversity.

3. Home work

Exercise 1: Identify Plants

1. Task: Identify and list at least 5 different plant species in your chosen green space. For each species, include:

- Common name
- Scientific name
- Description (height, leaf shape, flower color, etc.)

Exercise 2: Ecosystem Health Assessment

Task: Based on your observations, assess the health of the green space. Consider factors such as: - Diversity of species,

- Presence of invasive species,

- Signs of pollution or human impact

Tutorial work 3: Wetlands and Their Ecosystem Services: Case study in El Taref and Sétif, Algeria

1. Introduction to Wetlands

Wetlands are unique ecosystems characterized by the presence of water, either permanently or seasonally, which supports a diverse range of plant and animal life. They are crucial for maintaining ecological balance and provide numerous ecosystem services that benefit both the environment and human communities.

Characteristics of Wetlands

1. Hydrology: Wetlands are defined by their hydrological conditions, which include the presence of water at or near the surface for a significant part of the year. This can be in the form of freshwater, saltwater, or brackish water.

2. Soil Types: Wetland soils, known as hydric soils, are saturated with water and often exhibit unique characteristics such as anaerobic conditions, which affect nutrient availability and decomposition processes.

3. Vegetation: Wetlands support a variety of plant species, including emergent, floating, and submerged plants. Common wetland vegetation includes reeds, sedges, and various aquatic plants that are adapted to saturated conditions.

4. Biodiversity: Wetlands are among the most productive ecosystems on Earth, providing habitat for a wide range of species, including fish, amphibians, birds, and invertebrates. They serve as critical breeding and feeding grounds.

5. Water Quality: Wetlands play a vital role in filtering pollutants from water, improving water quality by trapping sediments and absorbing excess nutrients.

6. Climate Regulation: Wetlands act as carbon sinks, sequestering carbon dioxide from the atmosphere and helping to mitigate climate change.

2. Types of Wetlands (Explain this part with examples in Algeria)

Wetlands can be classified into several types, including:

1. Natural Wetlands:

- Lakes and Lagoons: These include both freshwater and saline lakes, such as Chott Chergui.

- Marshes: These are areas dominated by herbaceous plants and can be found in regions like the Mitidja Plain.

- Floodplains: Areas that are periodically inundated by river overflow, often supporting diverse ecosystems.

2. Artificial Wetlands:

- Reservoirs: Man-made lakes created for water storage, irrigation, or hydroelectric power, which can also serve as habitats for wildlife.

- Constructed Wetlands: Engineered systems designed for wastewater treatment that mimic natural wetland processes.

3. Coastal Wetlands:

- Estuaries: Where freshwater from rivers meets and mixes with saltwater from the sea, providing rich habitats for various species.

- Salt Marshes: Coastal wetlands that are flooded and drained by salt water brought in by the tides, often found along the Mediterranean coast.

4. Seasonal Wetlands:

-Temporary Ponds: These wetlands fill with water during the rainy season and dry out in the summer, supporting specific flora and fauna adapted to these conditions.

5. Peatlands:

- Areas where organic material accumulates in waterlogged conditions, though less common in Algeria compared to other regions.

3. Exercise: Ecosystem Services of Wetlands

Wetlands provide a multitude of ecosystem services, including:

1. Water Purification: Wetlands filter pollutants and sediments from water, improving overall water quality.

2. Flood Control: They act as natural buffers, absorbing excess rainfall and reducing the risk of flooding in surrounding areas.

3. Biodiversity Support: Wetlands are critical habitats for many species, contributing to regional biodiversity and ecological resilience.

4. Carbon Sequestration: By storing carbon in their soils, wetlands help mitigate climate change.

5. Recreation and Tourism : Wetlands provide opportunities for recreational activities such as birdwatching, fishing, and ecotourism, contributing to local economies.

6. Cultural Significance: Many wetlands hold cultural and historical importance for local communities, serving as sites for traditional practices and local heritage.

Exploring Ecosystem Services of Wetlands

Students will identify and categorize the various ecosystem services provided by wetlands, enhancing their understanding of the ecological, economic, and social benefits of these vital ecosystems. Provide students with images or videos of wetlands. Ask them to observe and note down the visible features and any information provided (Figure 5, 6).

- Divide the class into small groups of 3-4 students.

- Each group will present their findings to the class, explaining the ecosystem services they identified and providing examples.

- Facilitate a class discussion on the importance of these services and how they impact human life and the environment.

- Ask students to write a short reflection on what they learned about wetland ecosystem services and why they think it’s important to protect these ecosystems.



Figure 5: Natural wetland in el Taref (North East of Algeria) (Beldjazia, 2025)



Figure 6: Artificial Wetland in Ain Zada reservoir (North East of Algeria) (Beldjazia, 2025).

Solution:

Wetlands, whether natural or artificial, provide a wide range of ecosystem services that can be categorized into four main groups: provisioning, regulating, cultural, and supporting services. Here's an overview of these services, particularly in the context of the wetlands in El Taref and Ain Zada reservoir in North East Algeria:

1. Provisioning Services

These services involve the direct products obtained from ecosystems.

- Water Supply: Wetlands act as natural reservoirs, providing fresh water for drinking, irrigation, and industrial use.

- Fisheries: Both natural and artificial wetlands support diverse fish populations, contributing to local fisheries and food security.

- Wildlife Habitat: Wetlands provide habitat for a variety of species, including birds, amphibians, and aquatic life, which can be harvested sustainably.

- Plant Resources: Wetlands can be sources of reeds, sedges, and other plants used for construction, crafts, and traditional medicine.

2. Regulating Services

These services help regulate environmental conditions and maintain ecosystem balance.

- Water Quality Improvement: Wetlands filter pollutants and sediments from water, improving water quality and reducing the impact of runoff.

- Flood Regulation: Wetlands absorb excess rainwater and runoff, reducing the risk of flooding in surrounding areas.

- Climate Regulation: Wetlands sequester carbon dioxide, helping to mitigate climate change by acting as carbon sinks.

- Erosion Control: The vegetation in wetlands stabilizes soil and reduces erosion along shorelines and riverbanks.

3. Cultural Services

These services provide non-material benefits that contribute to the cultural, aesthetic, and recreational value of ecosystems.

- Recreation and Tourism: Wetlands attract visitors for birdwatching, fishing, hiking, and photography, contributing to local economies.

- Cultural Heritage: Many communities have cultural ties to wetlands, which can be important for traditional practices and local identity.

- Education and Research: Wetlands serve as natural laboratories for scientific research and environmental education, enhancing public awareness of ecological issues.

4. Supporting Services

These services are necessary for the production of all other ecosystem services.

- Biodiversity Support: Wetlands are rich in biodiversity, providing habitat for numerous species and maintaining genetic diversity.

- Nutrient Cycling: Wetlands play a crucial role in nutrient cycling, supporting the productivity of both aquatic and terrestrial ecosystems.

- Soil Formation: The accumulation of organic matter in wetlands contributes to soil formation and fertility.

Conclusion

The wetlands in El Taref and Ain Zada reservoir exemplify the critical ecological, economic, and social benefits provided by these ecosystems. Understanding and valuing these services is essential for their conservation and sustainable management, ensuring that they continue to support both local communities and biodiversity for future generations.

Tutorial work 4: Analysis of Invasive Species Cases in Algeria

Definition of Invasive species

Invasive species pose significant threats to biodiversity, agriculture, and ecosystems. Biological invasions pose a great threat to native species and their habitats. Non-native invasive species are organisms that are introduced from outside of their historical range to novel ecosystems and cause great harm to the environment, the economy, and/or human and wildlife health. Non-native invasive species have the ability to alter both the structure and function of environmental systems from genes to ecosystems (Meyerson et al., 2009). In Algeria, several invasive species have been identified, impacting local flora and fauna.

Exercise 1: Impact Assessment of the Common Reed (*Phragmites australis*)

Case Description:

Phragmites australis, commonly known as common reed, has invaded wetlands in Algeria, leading to a decline in native plant species (fig. 7).



Figure 7: Phragmites australis

The non-native invasive *Phragmites australis* also known as the “common reed” currently dominates many wetland areas leaving less habitat availability for other native species such as cattails (Typha) to live and thrive. *Phragmites australis* is a grass species that invades and forms monocultures in wetland habitats in New York state. This particular non-

native invasive common reed forms thick stands that easily shade out native wetland species such as cattails. The non-native invasive common reed also clogs waterways and negatively impacts the expansion of wetland habitats. *Phragmites australis* are a tall wetland grass that can grow up to 15 or so feet. The alternate leaves of the non-native invasive *Phragmites australis* are elongate (Kavanaugh, 2009). Fluffy seed heads sit at the top of *Phragmites australis* stalks and are golden or purple in color. Native common reed is generally more scattered and grows in random patches, often has spots on culms (from a native fungus that hasn't adapted to the exotic common reed), flower plumes are sparse and may not continue on the plant through winter (Swearingen et al., 2012), and the non-native invasive *Phragmites australis* forms very dense monospecific masses (Kaufamn & Kaufman, 2012). Phragmites australis is a perennial grass that mainly produces via vegetative growth (Saltonstall, 2001). It has a worldwide distribution and is endemic to North America.

Task:

In Algeria, the common reed (*Phragmites australis*) has both positive and negative impacts. It is used for phytoremediation to clean wastewater in locations like the Seybouse River (Guelma, North East of Algeria), where it effectively removes pollutants like heavy metals, nutrients, and pathogens. However, its aggressive growth can negatively affect biodiversity, and its rapid spread has led to concerns about it replacing other native aquatic vegetation. Managing the reed beds through techniques like harvesting is important to balance its benefits and drawbacks.

In order to survey the biomass of this species, a field survey in wetland has done and the biomass has been calculated.

1. Calculate the percentage of area covered by *Phragmites australis* in a wetland if it covers 150 hectares out of a total wetland area of 500 hectares.

2. If the native plant species cover 200 hectares before the invasion, what is the new area covered by native species after the invasion?

Formulas:

- Percentage of area covered = (Area covered by invasive species / Total area) × 100
- New area of native species = Original area of native species - Area covered by invasive species

1. Percentage of area covered:

$$\text{Percentage} = \left(\frac{150}{500}\right) \times 100 = 30\%$$

2. New area of native species:

$$\text{New area} = 200 - 150 = 50 \text{ hectares}$$

Exercise 2: Economic Impact of Invasive Species on Agriculture

Case Description:

The invasion of the Red Palm Weevil (*Rhynchophorus ferrugineus*) (fig. 8) has caused significant damage to date palms in Algeria.



Figure 8: Rhynchophorus ferrugineus

Task:

The red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier), is a coleoptera that consumes the palm trunks. This behavior destroys the meristem, which eventually kills the palm tree after high infestation degree. Originating in Southeast Asia, it spread to the Arabian Peninsula *via* infested material in the 1980s, crossing the Red Sea to North Africa in the 1990s to reach countries such as Tunisia, Algeria and Morocco and then Europe, including Italy, France, and Spain. In order survey the impact of this species, a field inventories has done in an area of date palms formation.

1. If the average yield of date palms is 1000 kg per tree and 20% of the trees are affected by the weevil, calculate the total loss in yield for a plantation of 500 trees.

2. If the market price of dates is 2 DA per kg, calculate the economic loss due to the infestation.

Formulas:

- Total yield loss = (Number of affected trees × Average yield per tree) × Percentage affected
- Economic loss = Total yield loss × Market price per kg

1. Total yield loss:

$$\text{Affected trees} = 500 \times 0.20 = 100 \text{ trees}$$

$$\text{Total yield loss} = 100 \times 1000 = 100,000 \text{ kg}$$

2. Economic loss:

Economic loss = 100,000 x 2 = 200,000 DA

Home work:

Identification and Impact Assessment of *Acacia saligna* (Golden Wattle)

1. Identification: Research the characteristics of *Acacia saligna*. What are its physical traits, habitat preferences, and reproductive strategies?

2. Impact Analysis:

- Discuss how *Acacia saligna* affects local biodiversity in Algeria. What native species are threatened by its presence?

- What are the primary reasons for the successful invasion of *Acacia saligna* in Algeria?

Tutorial work 5: Analyze the relationship between pollution levels and biodiversity indices in various ecosystems

Objective:

Human activities drive a wide range of environmental pressures, including habitat change, pollution and climate change, resulting in unprecedented effects on biodiversity. Pollution levels in a study area are consistently and inversely related to biodiversity indices; higher pollution leads to lower species richness and evenness. Specific impacts vary by pollutant and ecosystem type. In this tutorial we aims to identify indices used in order to analyze the relationship between pollution levels and biodiversity in an ecosystem.

1. Defining Key Concepts

- Pollution Levels: This can include metrics such as concentrations of pollutants (e.g., heavy metals, nitrogen compounds, particulate matter) in air, water, and soil.

- **Biodiversity Indices**: Common indices include species richness (the number of different species), Shannon-Wiener Index (which accounts for both abundance and evenness of species), and Simpson's Diversity Index.

2. Structured approach

Analyzing the relationship between pollution levels and biodiversity indices in various ecosystems involves examining how different types of pollution (air, water, soil) impact the variety and abundance of species within those ecosystems. Here's a structured approach to understanding this relationship:

1. Study Area Selection

Choose diverse ecosystems for analysis, such as:

-Aquatic Ecosystems: Rivers, lakes, and coastal areas.

-Terrestrial Ecosystems: Forests, grasslands, and urban areas.

- Agricultural Systems: Farmlands with varying levels of pesticide and fertilizer use.

2. Data Collection

-Pollution Data: Collect data on pollution levels from environmental monitoring stations, government reports, and scientific studies.

- Biodiversity Data: Conduct field surveys to assess species presence and abundance, or use existing databases (e.g., local biodiversity records).

3. Analysis Methods

- Statistical Analysis: Use correlation and regression analyses to explore relationships between pollution levels and biodiversity indices.

- Multivariate Analysis: Employ techniques like Principal Component Analysis (PCA) to understand how multiple pollutants interact and affect biodiversity.

- Spatial Analysis: Use Geographic Information Systems (GIS) to visualize pollution hotspots and biodiversity patterns.

4. Expected Relationships

- Negative Correlation: Generally, higher pollution levels are expected to correlate with lower biodiversity indices. For example:

* In aquatic ecosystems, increased nutrient runoff (eutrophication) can lead to algal blooms, which deplete oxygen and harm aquatic life.

* In terrestrial ecosystems, air pollution can lead to acid rain, which negatively affects plant health and, consequently, the species that depend on those plants.

-Threshold Effects: There may be threshold levels of pollution beyond which biodiversity declines sharply. For instance, certain pollutants may have sub-lethal effects on species until they reach a critical concentration.

- Ecosystem Resilience: Some ecosystems may show resilience to pollution due to high species richness, while others may be more vulnerable. For example, diverse coral reefs may withstand certain levels of pollution better than less diverse systems.

Exercise:

Data collected from environmental monitoring agencies of Pollution Levels, including:

- Air Quality Index (AQI)

- Water Quality Index (WQI)
- Soil contamination levels (heavy metals, pesticides)

Data collected from ecological studies of Biodiversity Indices, including:

- Species Richness (number of different species)
- Shannon-Wiener Diversity Index (H')
- Simpson's Diversity Index (D)

Table 3: Data collected values

Location	AQI (µg/m³)	WQI (0-100)	Soil Contamination (mg/kg)	Species Richness	Shannon-Wiener Index (H')	Simpson's Index (D)
Urban Area A	150	45	120	30	2.5	0.7
Urban Area B	200	30	200	20	1.8	0.5
Rural Area A	50	80	30	50	3.5	0.9
Rural Area B	40	85	20	55	3.7	0.92
Industrial Area	300	20	500	10	1.2	0.3

1. Calculate mean, median, and standard deviation for pollution levels and biodiversity indices.

2. Use Pearson correlation coefficient to assess the relationship between pollution levels (AQI, WQI, Soil Contamination) and biodiversity indices (Species Richness, H', D).
3. Perform linear regression to predict biodiversity indices based on pollution levels.

Solution

1. Descriptive Statistics:

- Mean AQI: 158 µg/m³
- Mean WQI: 52
- Mean Soil Contamination: 174 mg/kg

- Mean Species Richness: 33
- Mean Shannon-Wiener Index: 2.54
- Mean Simpson's Index: 0.66

2. Correlation Coefficients:
- AQI vs. Species Richness: r = -0.85 (strong negative correlation)
- WQI vs. Species Richness: r = 0.78 (strong positive correlation)
- Soil Contamination vs. Species Richness: r = -0.90 (strong negative correlation)

3. Regression Analysis:
- The regression model indicates that for every 10 $\mu g/m^3$ increase in AQI, species richness decreases by approximately 2.5 species ($p < 0.01$).
- WQI shows a positive relationship, where every unit increase in WQI corresponds to an increase of 1.5 species ($p < 0.05$).

Interpretation:

- Negative Impact of Pollution: The analysis indicates a strong negative correlation between pollution levels (AQI and Soil Contamination) and biodiversity indices. Higher pollution levels are associated with lower species richness and diversity.
- Positive Impact of Water Quality: Conversely, better water quality (higher WQI) is associated with increased biodiversity, suggesting that clean water is crucial for maintaining healthy ecosystems.
- Policy Implications: The findings highlight the need for stricter pollution control measures in urban and industrial areas to protect biodiversity. Conservation efforts should focus on improving water quality and reducing air and soil pollution to enhance ecosystem health.

Conclusion:

The analysis demonstrates a clear relationship between pollution levels and biodiversity indices. Effective environmental policies aimed at reducing pollution can significantly benefit biodiversity conservation efforts.

Tutorial work 6: Simulated debate between stakeholders: biodiversity vs development

Objective:

The goal of this exercise is to engage students in a structured debate that explores the complex relationship between biodiversity conservation and economic development. Participants will assume the roles of various stakeholders, presenting their arguments and negotiating potential solutions.

I- Important concepts

1. Importance of Biodiversity

- Definition: Biodiversity refers to the variety of life on Earth, including the diversity of species, ecosystems, and genetic diversity.

- Ecosystem Services:Biodiversity provides essential services such as pollination, water purification, climate regulation, and soil fertility.

- Cultural Significance: Many cultures have deep connections to their local biodiversity, which shapes their identity and traditions.

2. Economic Development

- Definition: Economic development involves the improvement of economic well-being and quality of life through various means, including infrastructure development, industrial growth, and urbanization.

- Job Creation: Development projects can create jobs and stimulate local economies.

- Infrastructure Needs: Development often requires land use changes that can threaten local ecosystems.

3. Ethical Considerations

- Intergenerational Equity: The debate raises questions about the rights of future generations to inherit a healthy environment.

- Indigenous Rights : Indigenous communities often have a unique relationship with their land and biodiversity, which must be respected in development plans.

4. Long-term vs. Short-term Impacts

- Short-term Gains: Development projects may provide immediate economic benefits but can lead to long-term ecological damage.

- Sustainable Development: The concept of sustainable development seeks to balance economic growth with environmental protection, ensuring that resources are available for future generations.

II. Structure of the Debate

This simulated debate will help students understand the complexities of biodiversity conservation and economic development, fostering critical thinking, negotiation skills, and an appreciation for diverse perspectives in environmental issues.

1. Preparation Phase

- Stakeholder Assignment: Divide students into groups representing different stakeholders. Each group will research their assigned perspective.

Stakeholders:

- Environmental NGOs (e.g., Greenpeace, WWF)
- Government representatives (local and national)
- Business representatives (e.g., real estate developers, agricultural companies)
- Indigenous communities
- Scientists/Researchers
- General public (citizens concerned about environmental issues)

- Research Guidelines: Each group should prepare a brief presentation outlining their stakeholder's position, key arguments, and potential solutions.

They should consider:

- The importance of biodiversity
- Economic benefits of development

- Ethical considerations

- Long-term vs. short-term impacts

2. Debate Phase

- Opening Statements : Each group presents their position. Allow 5 minutes for each group to present their arguments.

- Cross-Examination : After all opening statements, groups will have the opportunity to ask questions of each other. This encourages critical thinking and deeper understanding of opposing viewpoints.

- Open Debate: Allow for a more free-form discussion where groups can respond to each other's arguments, propose compromises, and negotiate solutions.

- Reflection and Discussion : Facilitate a class discussion on what was learned, the challenges of balancing biodiversity and development, and the importance of stakeholder engagement in environmental decision-making.

Tutorial work 7: Comparison of protected areas (Africa, Amazon, Algeria)

Objective:

To analyze and compare the effectiveness of protected areas in Africa, the Amazon, and Algeria in terms of biodiversity conservation, management practices, and socio-economic impacts.

Part 1: Overview of Protected Areas

In order to understand the similarities and differences in protected areas across Africa, the Amazon, and Algeria, students will listen to the presentation focused on the comparison of protected areas in Africa, the Amazon, and Algeria. Below is a structured outline for a comprehensive approach to understanding the complexities of biodiversity conservation in different global contexts, encouraging critical thinking and collaborative learning among students.

1. Define what a protected area is.

A protected area is a clearly defined geographical space recognized, dedicated, and managed to achieve the long-term conservation of nature, ecosystem services, and cultural values.

2. List the main objectives of establishing protected areas.

- Conservation of biodiversity
- Protection of ecosystems
- Sustainable use of natural resources
- Preservation of cultural heritage

3. Identify protected areas and provide examples from Africa, the Amazon, and Algeria.

A/ Protected area of Africa

Africa has a vast network of protected areas, including national parks, nature reserves, and other conservation zones that safeguard its unique biodiversity and ecosystems. Examples range from large transfrontier parks like the Kgalagadi Transfrontier Park between South Africa and Botswana to extensive reserves such as the Aïr and Ténéré Natural Reserves in Niger, which is one of the continent's largest protected areas. These areas are crucial for protecting threatened species, supporting livelihoods, and providing water resources to millions of people. They house an incredible variety of biodiversity, including many endemic species. Home to iconic species such as elephants, lions, and rhinoceroses. The Serengeti hosts the Great Migration, showcasing a rich array of wildlife.

Example: Serengeti National Park, Tanzania (fig. 9).

- Size: 14763 km²

- Biodiversity: Home to large populations of mammals, including the "Big Five." (Fig. 10).

- Management: Community-based conservation, ecotourism.

- Challenges: Poaching, human-wildlife conflict.



Figure 9: Map location of Serengeti National Park, Tanzania



Figure 10: Mammals of Serengeti National Park, Tanzania

B/ Protected area of Amazon

Amazon protected areas vary but are characterized by their large size, diverse ecosystems like varzea and igapó forests, and significant biodiversity, including jaguars, harpy eagles, and numerous species of fish and plants. Key characteristics include the

protection of unique habitats such as the Amazon's complex aquatic systems, which support a high diversity of aquatic species, and the conservation of threatened species like giant river otters and Amazonian manatees. Many of these areas are also crucial for maintaining the cultural and social values of Indigenous communities who play a vital role in their stewardship. Known for its unparalleled biodiversity, including millions of species of plants, insects, birds, and mammals, such as jaguars and river dolphins.

Example: Yasuni National Park, Ecuador (Fig. 11).

- Surface: 10 227 km^2

- Biodiversity: One of the most biodiverse places on Earth, home to numerous endemic species (Fig. 12).

- Management: Indigenous territories, conservation initiatives.

- Challenges: Oil extraction, deforestation, illegal logging.

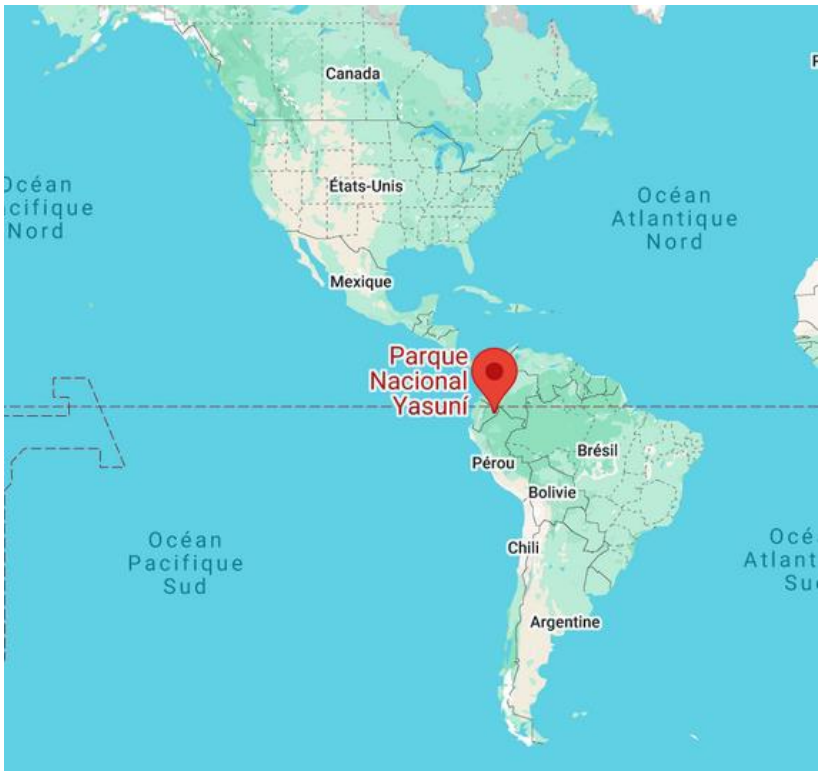


Figure 11: Map location of Yasuni National Park, Ecuador



Figure 12: Birds in Yasuni National Park, Ecuador

C/ Protected area of Algeria

Algeria's protected areas are characterized by diverse landscapes, from Mediterranean coastlines and Tell Atlas mountains to steppe and Sahara desert zones, resulting in rich biodiversity. Notable areas include Tassili n'Ajjer National Park (a UNESCO World Heritage Site) and El-Kala National Park, which is especially noted for its biological richness and unique Mediterranean conditions. The country is expanding its network of protected areas to combat threats like habitat degradation and climate change. Features unique species adapted to desert environments, including the Barbary macaque and various endemic plants in the Saharan regions.

Example: Tassili n'Ajjer National Park (Fig. 13).

- Surface: 138 000 km²
- Biodiversity: Unique Saharan flora and fauna, including endemic species (Fig. 14)
- Management: Limited resources, focus on protecting cultural heritage.
- Challenges: Desertification, climate change, limited funding.



Figure 13 : Map location of Tassili n'Ajjer National Park (Algeria).



Figure 14: Tassili n'Ajjer National Park (Algeria)

Part 2: Group Activity

Divide students into small groups (4-5 members). Each group discusses the following questions:

- analyze and compare the effectiveness, biodiversity, and threats of protected areas in Africa, the Amazon, and Algeria.

Solution:

Student will present their work according to these points

Table 4: Example of Overview of Protected Areas

Region	Name of Protected Area	Size (sq km)	Year Established	Key Biodiversity
Africa	Serengeti National Park	14,763	1951	Large mammals (e.g., lions, elephants), diverse ecosystems
Amazon	Yasuni National Park	10 227	1979	High plant diversity, endemic species, diverse fauna
Algeria	Tassili n'Ajjer	138 000	1972	Unique rock formations, endemic flora and fauna

Table 5: Example of Biodiversity Assessment

Region	Key Species	Endemic Species	Threats to Biodiversity
Africa	African elephant, Lions, Baobab Trees	Over 3000	Habitat loss, climate change
Amazon	Jaguar, Amazon river dolphin, Brazil Nut Trees	Over 2500	Deforestation, pollution
Algeria	Barbary macaque, Saharan silver antelope, Atlas Cedar	Over 200	Overgrazing, urbanization

Home work: Research and summarize the biodiversity found in protected areas in Africa, the Amazon, and Algeria.

Tutorial work 8: Design of a restoration plan of biodiversity for a fictional site

Objective:

The objective of this work is to develop a comprehensive restoration plan aimed at enhancing biodiversity in a fictional. This project will help students apply theoretical knowledge to practical scenarios, fostering critical thinking and problem-solving skills in biodiversity conservation.

1- Biodiversity restoration plan

A biodiversity restoration plan for a fictional site should follow a five-component process: **assessment**, **planning and design**, **implementation**, **ongoing management**, and **monitoring and evaluation**. This involves conducting a baseline biodiversity survey, defining clear objectives, developing a detailed timeline for implementation that includes site preparation and planting, establishing long-term maintenance and management, and setting up monitoring to track progress and make necessary adjustments.

1. Assessment

- **Site Survey:** Conduct a survey of the current biodiversity, including plants, animals, and their habitats.
- **Baseline Data:** Collect baseline data to understand the site's current state.
- **Identify Influences:** Analyze current and potential future factors affecting biodiversity, such as pollution, invasive species, or habitat fragmentation.
- **Expert Input:** Seek input from experts to help identify species and understand ecological relationships.

2. Planning and Design

- **Set Objectives:** Define clear, measurable goals for the restoration project. Examples include re-establishing a specific habitat type or increasing the population of a key native species.
- **Create a Map:** Develop or obtain base maps that show the site's main features.
- **Design Strategy:** Develop a strategy that may include reforestation, habitat rehabilitation, and invasive species control.
- **Collaborative Approach:** Involve stakeholders and experts in the design process to ensure a robust and effective plan.

3. Implementation

- **Site Preparation:** Prepare the site by removing invasive species and addressing any soil degradation.
- **Planting:** Establish a diverse range of native plant species, including seasonal flowering plants to support pollinators and other wildlife.
- **Habitat Creation:** Create or enhance specific habitats, such as wetlands, bird nesting islands, or fish passages in streams, as part of the plan.
- **Timetable:** Follow a proposed timetable for all implementation activities.

4. Ongoing Management

- **Maintenance Plan:** Outline long-term maintenance needs to ensure the restoration's success, such as continued invasive species control or supplemental planting.
- **Management Strategy:** Detail how the site will be managed to support the restored ecosystem and prevent future degradation.

5. Monitoring and Evaluation

- **Monitor Progress:** Regularly monitor the site to track the effectiveness of the restoration activities against the established objectives.
- **Adapt and Adjust:** Evaluate the results and make adjustments to the plan as needed to ensure long-term success

2- Design of a Restoration Plan for Biodiversity at the Fictional Site of Green Valley

Green Valley is a fictional area that has experienced significant ecological degradation due to urbanization, invasive species, and climate change. The site originally supported a diverse range of flora and fauna, including several endemic species. The goal of this project is to restore the ecological integrity of Green Valley, promoting biodiversity and ecosystem services.

This project will provide students with hands-on experience in biodiversity restoration planning, emphasizing the importance of a holistic approach that considers ecological, social, and economic factors. By working on the fictional site of Green Valley, students will develop skills that are directly applicable to real-world biodiversity conservation challenges.

In this case students will works in groups to prepare and present a project of restoration plan for biodiversity at this site or other sites. Their work will be presented in the form of model.

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