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MODERN ENVIRONMENTAL ISSUES

Handbook for students

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Видання “MODERN ENVIRONMENTAL ISSUES” адресоване студентам спеціальностей “біологія” та “екологія”. Мета навчально-методичного посібника – вдосконалити вміння читати оригінальну літературу англійською мовою за спеціальністю. Особливу увагу приділено спеціалізованій лексиці.

Пропонований посібник складається з дванадцяти уроків, тематично згрупованих навколо актуальних тем. Кожен із уроків містить вправи, які допоможуть засвоїти природні мовні конструкції, орієнтують читача на вибір правильного слововживання у сфері спілкування на екологічні теми.

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UNIT 1
CARBON FOOTPRINT

1. **Discuss the main environmental problems:**

climate change, deforestation, pollution (air, water, and soil), wastes, loss of biodiversity, ecosystem degradation etc.

How do we influence each of them in our daily lives? How's it possible to reduce the negative impact on the environment in our personal lives?

2. **Read the text "Human footprint" by World Wildlife Fund [32]:**

During a typical day, you might drive to work, do a load of laundry, or watch TV in an air-conditioned room. All these actions come with a price that extends beyond the one measured in dollars and cents withdrawn from a bank – this price comes in the form of natural resources withdrawn from the Earth.

By adding up all of those withdrawals, we can calculate the human footprint on the planet – a measure of how much we are using the Earth's natural resources. The withdrawals come in six categories:

- **Carbon:** A measure of carbon emissions, represented by the amount of forest land that would be needed to sequester carbon dioxide emissions, not including the fraction that is absorbed by the oceans and leads to acidification.
- **Cropland:** The amount of cropland used to grow plants for food, fiber, animal feed, and commodities including oil, soy and rubber.
- **Grazing land:** The amount of grazing land used to raise livestock for meat, dairy products, hide and wool.
- **Forests:** The extent of forests required to supply timber, pulp and fuel wood.
- **Fishing grounds:** The estimated primary production required to support the fish and seafood caught in freshwater and marine environments.
- **Built-up land:** The amount of land covered by human structures, including transportation, housing, industrial structures and reservoirs created by dams.

At the same time, we calculate the planet's total biocapacity – Earth's ability to produce natural resources, provide land for humans to build on, and absorb waste such as carbon emissions.

Put the two numbers together and the problem becomes increasingly clear. It takes a year and a half to generate the resources that the human population uses in only a year. Simply put, this is not a sustainable path for our planet's future.

Another way to look at this is to say that it would take 1.6 Earths to produce all the renewable resources we use. And worse, the human population is expected to use the equivalent of 2 Earths of renewable resources per year by 2050. The effect of this overuse is a growing scarcity of resources –2.7 billion people, for example, already face water scarcity at least one month out of the year.

Every human produces an individual ecological footprint that is determined largely by the wealth and level of development in the country they live in – more developed countries have a larger footprint on average – but the choices we make in our daily lives also contribute. Driving a car, running clothes through a dryer, turning on the air conditioning – these are activities that add up to a larger footprint.

If everyone in the world lived like the residents of the U.S., humanity's annual demand on nature would equal a whopping 4 Earths per year. Only the residents of four countries – Qatar, Kuwait, United Arab Emirates and Denmark – have larger average footprints.

The challenge of reducing our footprint grows more complex everyday. How do we decrease our resource use and at the same time create a future that provides food, water and energy for the 9 billion people that will share the planet in 2050?

To reduce humanity's footprint, WWF helps develop and implement new ways of growing crops, managing fisheries, forests and wetlands, generating energy, and dealing with waste. WWF provides recommendations that will help enable farms to feed a growing population and keep Earth habitable.

The goal is that everyone lives within the Earth's capacity to sustain people and nature – and has equitable access to, and use of, natural resources.

3. Answer the questions:

1) What is the footprint?
2) What are the six main categories for calculating the human footprint?
3) What is planet's biocapacity?
4) Which country has the largest footprint?
5) How many people will live on the planet in 2050?
6) How WWF is trying reduce humanity's footprint?

4. Analyze the diagram of carbon footprint and fill in the blanks: which forms the humanity's footprint?

Photo credit: www.siegwerk.com

Analyze contains of humans' carbon footprints and suggest: 1) What probably has more impact? 2) Which sector is more important in our lives? 3) How do different sectors of footprint influence ecosystems?

5. Problem question “Ukrainian carbon footprint”.

The skates in the photo reflect the carbon footprints of different countries. As we can see, the USA has the largest carbon footprint. Consider what the carbon footprint of Ukraine is compared to other countries. What could be probably Ukrainian footprint and why?

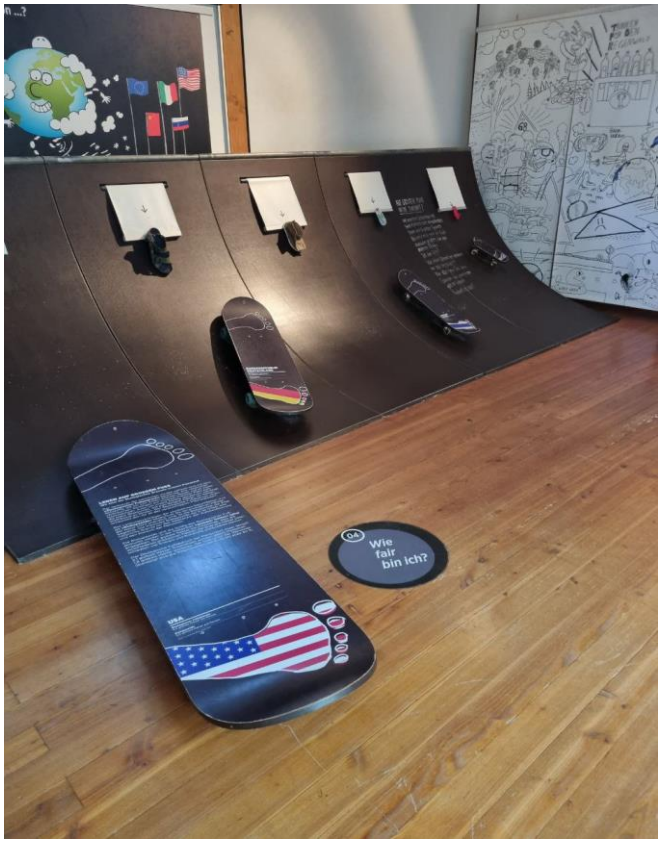


Photo credit: Uliana Semak

6. Calculation of carbon footprint in your household.

6.1. Using the QR-code, find the video “How your sandwich changes the world”. Then read the explanation how to calculate your personal the carbon footprint.

Alexandra Shimo-Barry, author of “The Environment Equation” has come up with a formula that explains how to calculate your carbon footprint at home, too! Simply follow the below steps, and voila [13].

1. *Multiply your monthly electric bill by 105*
2. *Multiply your monthly gas bill by 105*
3. *Multiply your monthly oil bill by 113*
4. *Multiply your total yearly mileage on your car by .79*
5. *Multiply the number of flights you’ve taken in the past year (4 hours or less) by 1,100*
6. *Multiply the number of flights you’ve taken in the past year (4 hours or more) by 4,400*
7. *Add 184 if you do NOT recycle newspaper*
8. *Add 166 if you do NOT recycle aluminum and tin*
9. *Add 1-8 together for your total carbon footprint*

Keep in mind that an “ideal” carbon footprint (or a “low” footprint) is anywhere from 6,000 to 15,999 pounds per year. 16,000-22,000 is considered average. Under 6,000 is considered very low. Over 22,000 – it’s high level of footprint.

7. **Watch the video “Climate changes: Your carbon footprint explained” by BBC news. Discuss the importance of the carbon footprint for global climate change processes.**

8. **Write an essay “How Can I Reduce My Carbon Footprint”?**

UNIT 2
CLIMATE CHANGES

1. **Watch the video "Causes and Effects of Climate Change" by National Geographic:**

Discuss the following questions:
Try to give the definition of climate change.
What are the reasons of climate change?
What are greenhouses gases?

2. **Read the text [40] and interpret it.**

NASA ABOUT CLIMATE CHANGE

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term.

Changes observed in Earth's climate since the mid-20th century are driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere, raising Earth's average surface temperature. Natural processes, which have been overwhelmed by human activities, can also contribute to climate change, including internal variability (e.g., cyclical ocean patterns like El Niño, La Niña and the Pacific Decadal Oscillation) and external forcings (e.g., volcanic activity, changes in the Sun's energy output, variations in Earth's orbit).

Scientists use observations from the ground, air, and space, along with computer models, to monitor and study past, present, and future climate change. Climate data records provide evidence of climate change key indicators, such as global land and ocean temperature increases; rising sea levels; ice loss at Earth's poles and in mountain glaciers; frequency and severity changes in extreme weather such as hurricanes, heatwaves, wildfires, droughts, floods, and precipitation; and cloud and vegetation cover changes.

"Climate change" and "global warming" are often used interchangeably but have distinct meanings. Similarly, the terms "weather" and "climate" are sometimes confused, though they refer to events with broadly different spatial- and timescales.

What Is Global Warming?

Global warming is the long-term heating of Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. This term is not interchangeable with the term "climate change".

Since the pre-industrial period, human activities are estimated to have increased Earth's global average temperature by about 1 degree Celsius, a number that is currently increasing by more than 0.2 degree Celsius per decade. The current warming trend is unequivocally the result of human activity since the 1950s and is proceeding at an unprecedented rate over millennia.

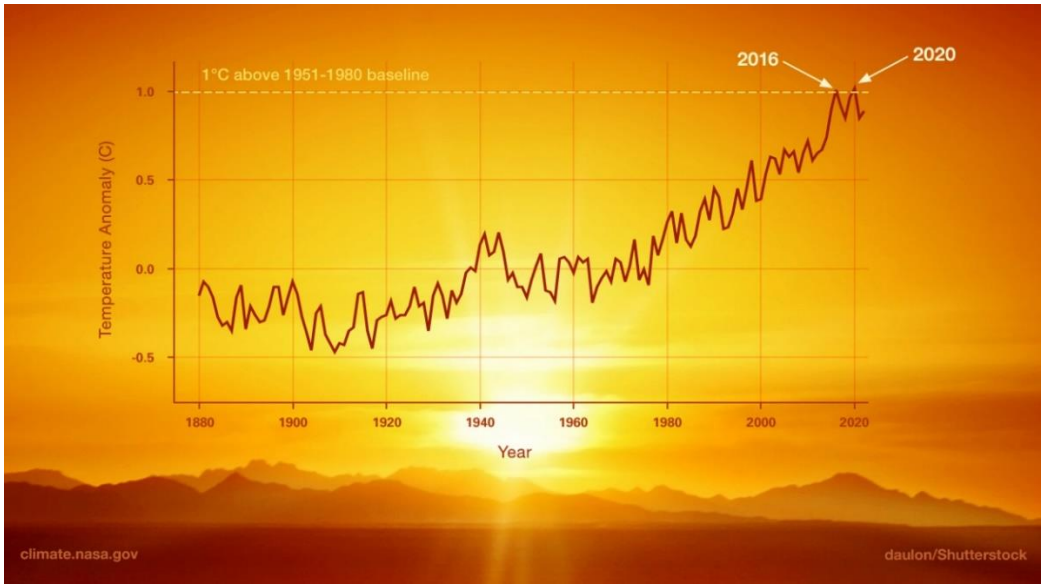


Photo credit: climate.nasa.org

3. Analyse the graph. Give the answers to the questions:

1) What does it illustrate?
2) What is the time period of change in global surface temperature?
3) What are the dynamics of average temperatures in the 2020s years?
4) In what years were temperature records set?
5) Do you have any data about surface temperature in a current year?

4. Read the text [6]:

Earth Will Continue to Warm and the Effects Will Be Profound

The potential future effects of global climate change include more frequent wildfires, longer periods of drought in some regions, and an increase in the wind intensity and rainfall from tropical cyclones. Global climate change is not a future problem. Changes to Earth's climate driven by increased human emissions of heat-trapping greenhouse gases are already having widespread effects on the environment: glaciers and ice sheets are shrinking, river and lake ice is breaking up earlier, plant and animal geographic ranges are shifting, and plants and trees are blooming sooner. Effects that scientists had long predicted would result from global climate change are now occurring, such as sea ice loss, accelerated sea level rise, and longer, more intense heat waves.

The magnitude and rate of climate change and associated risks depend strongly on near-term mitigation and adaptation actions, and projected adverse impacts and related losses and damages escalate with every increment of global warming.

Some changes (such as droughts, wildfires, and extreme rainfall) are happening faster than scientists previously assessed. In fact, according to the Intergovernmental Panel on Climate Change (IPCC) – the United Nations body established to assess the science related to climate change – modern humans have never before seen the observed changes in our global climate, and some of these changes are irreversible over the next hundreds to thousands of years.

Scientists have high confidence that global temperatures will continue to rise for many decades, mainly due to greenhouse gases produced by human activities.

The IPCC's Sixth Assessment report, published in 2021, found that human emissions of heat-trapping gases have already warmed the climate by nearly 1.1 degree Celsius since 1850-1900.[1] The global average temperature is expected to reach or exceed 1.5 degree C within the next few decades. These changes will affect all regions of the Earth.

The severity of effects caused by climate change will depend on the path of future human activities. More greenhouse gas emissions will lead to more climate extremes and widespread damaging effects across our planet. However, those future effects depend on the total amount of carbon dioxide we emit. So, if we can reduce emissions, we may avoid some of the worst effects.

The scientific evidence is that unequivocal: climate change is a threat to human wellbeing and the health of the planet. Any further delay in concerted global action will miss the brief, rapidly closing window to secure a liveable future.

5. See the diagram below and discuss what will happen with ecosystems and biodiversity in case of temperature increasing in: a) 1,5 degree C; b) 2 degrees C; c) 3 degrees C; d) 4 degrees C?

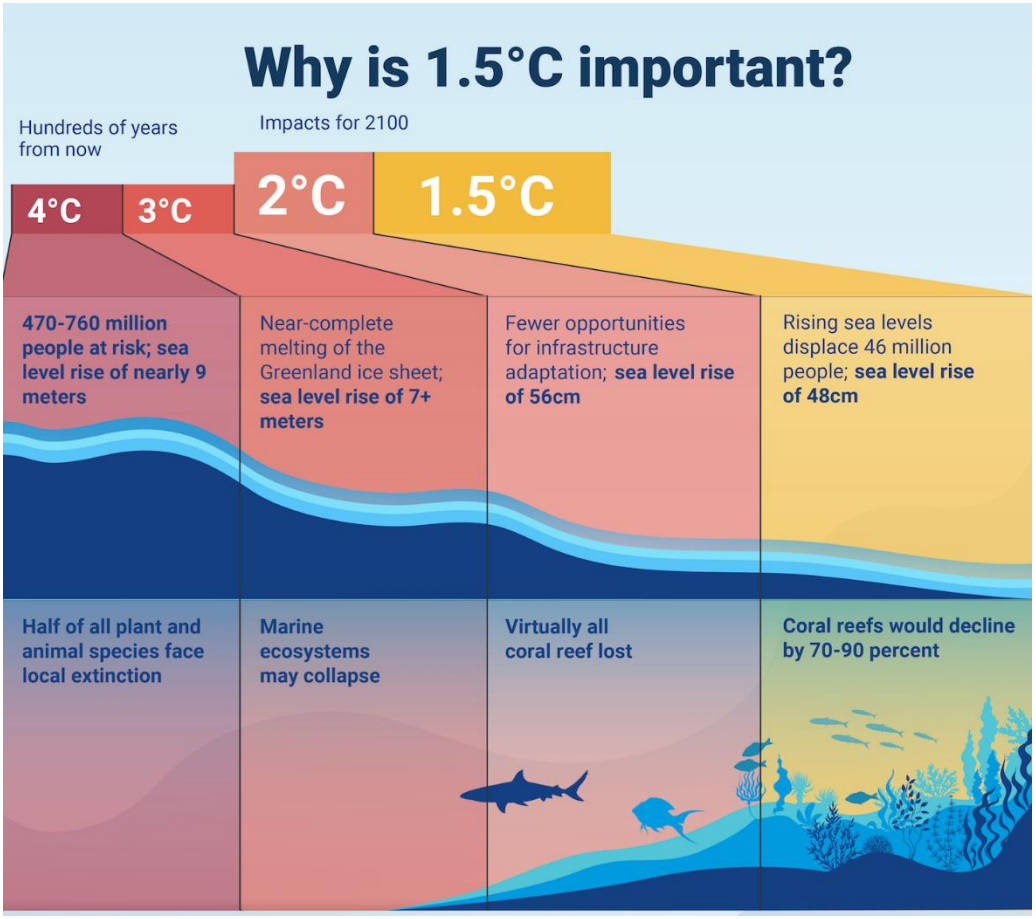


Photo credit: www.unep.org

6. Watch the video to find out more about temperature increasing:

7. Match the terms and their definitions:

1) atmosphere	a) form of oxygen that absorbs ultraviolet radiation.
2) carbon	b) greenhouse gas produced by animals during respiration and used by plants during photosynthesis. Carbon dioxide is also the byproduct of burning fossil fuels.

3) precipitation	c) all forms in which water falls to Earth from the atmosphere.
4) sea level	d) all weather conditions for a given location over a period of time.
5) carbon dioxide	e) coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
6) climate	f) chemical element with the symbol C, which forms the basis of all known life.
7) environment	g) increase in the average temperature of the Earth's air and oceans.
8) global warming	h) conditions that surround and influence an organism or community.
9) fossil fuel	i) gas in the atmosphere, such as carbon dioxide, methane, water vapor, and ozone, that absorbs solar heat reflected by the surface of the Earth, warming the atmosphere.
10) global warming	j) phenomenon where gases allow sunlight to enter Earth's atmosphere but make it difficult for heat to escape.
11) greenhouse effect	k) degree of hotness or coldness measured by a thermometer with a numerical scale.
12) greenhouse	l) building, often made of glass or other clear material, used to help plants grow
13) greenhouse gas	m) base level for measuring elevations. Sea level is determined by measurements taken over a 19-year cycle.
14) temperature	n) increase in the average temperature of the Earth's air and oceans.
15) ozone	o) layers of gases surrounding a planet or other celestial body.

8. Read the text about climate changes in Ukraine [19]:

In Ukraine, there has been some intensification of abnormal weather phenomena (hail, squalls, tornadoes in areas for which they were atypical), which previously occurred once every 50-100 years. Other adverse events include sharp pressure drops that will result in weather instability with significant temperature fluctuations over short periods of time, an increase in the number of natural disasters (hurricanes, storms, droughts, prolonged downpours, floods, especially in Prykarpattia and Zakarpattia), rising sea levels.

Economic and social risks are associated with vulnerability of human health, loss of a number of species, infrastructure, the need to increase costs to overcome the effects of natural disasters, rising costs of land reclamation, the spread of "undesirable" plant species (weeds, allergens), the increase in insurance payments (insurance of the population, agricultural risks, etc.). Energy, agriculture and water supply systems are considered Ukraine’s economy sectors that are most susceptible to climate change.

The number and duration of droughts are expected to increase, resulting in an increase in energy demand for space cooling, food storage, an increase in irrigation water, and, consequently, an increase in the amount of energy needed to meet growing water demand, treatment and transportation. It is now believed that a severe drought is an event that occurs once every hundred years. In Ukraine, droughts covering up to 30% of the country’s territory now occur every 2 to 3 years. By 2070, the frequency of droughts is expected to at least double. High temperatures are particularly difficult to tolerate in cities, and cities will continue to grow and need more and more energy. High temperatures are not necessarily the cause of droughts — they can often be caused by warm and snowless winters, which prevent the replenishment of groundwater.

Droughts can also be critical in crop areas: groundwater scarcity negatively affects soil moisture and crop yields. However, the expected global warming in Ukraine will lead to instability

of snow cover and reduced inflow of meltwater to rivers. This results in the drying up of shallow rivers, especially in the mountainous and foothill areas of the country.

Extreme weather events, such as squally wind, hurricanes, tornadoes, will contribute to the frequency of power outages, which leads to significant economic losses to the population and industry, rising social tensions and increased demands on emergency services and the Ministry of Emergencies, negatively impacting the work of wind power stations and the increase in the number of incidents at them.

Ukraine's water resources are directly affected by climate change. Ukraine already belongs to the group of countries with limited water reserves and is the least water-supplied country in Europe. Thus, declining precipitation indicates that summer river flows may be halved throughout Central Europe and Ukraine. As a result, the need for water will increase significantly, and severe droughts will become more frequent. In Ukraine, droughts are observed even in the northern and western regions, which are considered areas of sufficient moisture. For example, in 2015 there was a drought like it had never happened before.

In Ukraine, about 2.5% of the population live at an altitude of less than 10 meters above sea level, so such habitats are the most vulnerable (houses, infrastructure, arable land will suffer even more from soil erosion, especially after 2050). Rising sea levels could have negative consequences for the operation of port enterprises. Over the past 60 years, the level of the Black Sea has risen by 15 cm. The current rate of rise of the Black Sea level is 0.25 cm / year, of which 0.1 cm / year – due to subsidence of the soil, and the rest – due to the inflow of fresh water from precipitation, which arrives faster than salt water evaporates. By 2100, the water level in the Black Sea may rise by 22 to 115 cm. If the water level rises by 115 cm, 29 thousand hectares of land (including the territory of the Autonomous Republic of Crimea) will be flooded, with a corresponding loss of coastal settlements.

Agriculture is vulnerable to climate change due to changes in ecosystems, declining crop productivity. When the temperature rises by 1 C, the natural zones shift by about 160 km. From 1998 to 2008, the average temperature in Ukraine increased by 0.6 C (and in the last 100 years—by 0.8 C), so the displacement of natural areas is already occurring in Ukraine and results in the emergence of atypical species of plants and animals. Warmer winters result in the formation of ice crusts in the fields. If their distribution coincides with frosts, spring or autumn drought, the loss of crop yields can be 50-70%.

9. Read more and discuss. How the military actions affect climate in Ukraine:

10. Prepare the presentation “The possible solutions to reduce climate change”.

UNIT 3
URBANIZATION

1. **Discussion of the issues.**

Consider what the advantages and disadvantages of living in cities are? Is the quality of the environment different in contrysite, villages and cities? What are the causes of environmental change in cities?

2. **Read the text [35]:**

Human population has tended to increase over time. As more people were born, small groups of individuals found reasons to come together to form groups and, with the advent of agriculture, small sedentary communities. A small number of these settlements grew into what we now call cities. This kind of growth often corresponds with a shift from one way of organizing labor to another.

The world population has grown significantly and our economies have become more industrialized over the past few hundred years. As a result, many more people have moved into cities. This process is known as urbanization. Even after cities emerged, however, a large majority of people lived and worked in rural areas. It was not until large-scale industrialization began in the eighteenth century that cities really began to boom. Nearly half of all people now live in urban areas. They are attracted by jobs in manufacturing and the professions, as well as by increased opportunities for education and entertainment.

Urbanization is often discussed in reference to countries that are currently in the process of industrializing and urbanizing, but all industrialized nations have experienced urbanization at some point in their history. Moreover, urbanization is on the rise all over the globe.

One effect of this huge increase in people living in urban areas is the rise of the megacity, which is a city that has more than 10 million inhabitants. There are now cities with even more than that. Tokyo, Japan, for example, has nearly 40 million residents. Another effect of urbanization is urban sprawl. Urban sprawl is when the population of a city becomes dispersed over an increasingly large geographical area. This movement from higher density urban cores to lower density suburbs means that as cities expand, they often begin to take up significant tracts of land formerly used for agriculture. Sprawl also increases the need for travel infrastructure, such as roads, because people's homes are likely to be farther away from where they work and the amenities they enjoy.

As we move forward in the 21st century, the global population is likely to continue growing. Urban areas will continue to grow with the population. This continual growth presents complex challenges as we prepare for the cities of the future. How we choose to manage urbanization will have consequences for our world for many years to come.

3. **Match terms and then definition:**

1) city	a) large settlement with a high population density.
2) industrialization	b) Urban area of more than 10 million people characterized by rapid growth, unpredictable population distribution, formal and informal economies, and high levels of social fragmentation.
3) megacity	c) total number of people or organisms in a particular area.
4) population	d) growth of machine production and factories.
5) urban	e) having to do with country life, or areas with few residents.
6) urbanization	f) having to do with city life.

7) urban sprawl g) process in which there is an increase in the number of people living and working in a city or metropolitan area.

8) rural h) unplanned low-density development surrounding an urban area that often starts as rural land. Also called suburban sprawl.

4. Analyze the graph below. How did the number of people living in cities change in the period 1990-2014? What is the forecast for changes in the population of cities until 2050?

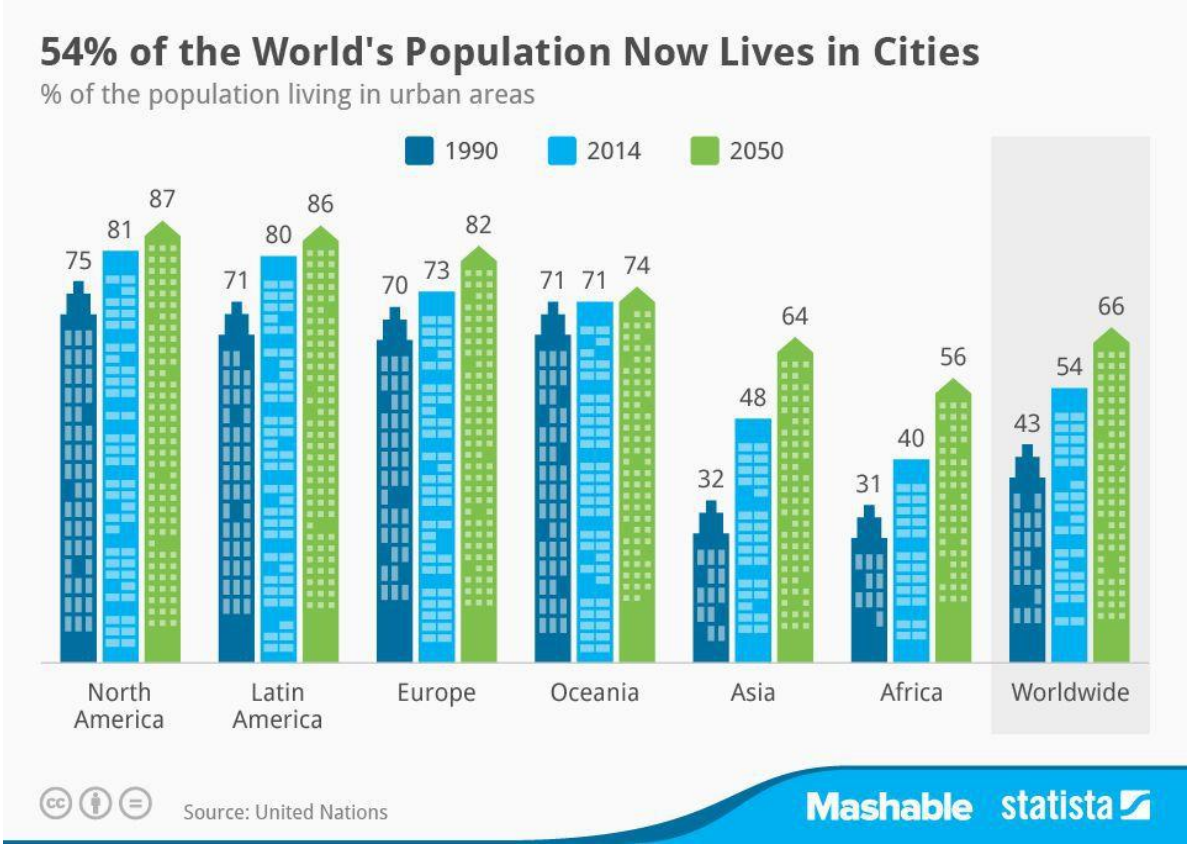


Photo credits: statista

5. Read the text "Environmental Problems of Urbanization" [11] and discuss if these environmental problems are relative to the city where you live.

It is clear that the world is becoming more and more urban. It has been predicted that by the year 2050, 70% of the human population on the Earth will live in cities. There are many environmental problems that are associated with so much urbanization on the landscape. These are issues that humanity is going to have to find solutions to if we are to both dwell in cities, yet have a livable planet for future generations.

Heavy natural resource use. The human population that lives in urban areas around the world consumes a lot of resources and energy to keep everything up and running. This means that cities exhibit a net drain on natural resources and ecosystems, and also produce a very large carbon footprint. In addition, most resources must ultimately be transported large distances to reach consumers in cities, requiring lots of energy.

The loss of natural ecosystems. Like the loss of valuable farmland, as urban areas continue to grow and sprawl across the landscape, this development process often leads to the development of previously pristine ecosystems.

Pollution. Cities can be large sources of air pollution, water pollution, land pollution, and soil pollution, waste that is littering the landscape, and are also often associated with challenging issues of sanitation that can lead to the pollution of land and water.

Waste. Cities are a large source of waste. This waste must be managed somehow, and can end up polluting the landscape and waterways. Industrial and toxic waste that is produced in cities can lead to large amounts of pollution of the urban landscape, causing many environmental and human health issues.

Urban runoff. Cities contain large amounts of impervious surfaces that do not allow water to infiltrate the ground. Much of the rainwater that does fall on the urban landscape quickly runs off into rivers and streams, bringing all of the pollutants and chemicals that were present on these surfaces with them into waterways.

Light pollution. With increased urbanization, there is a lot more light that shines at night. There are studies that indicate that all of the human-produced light at night is disrupting the natural biological rhythms of organisms that have evolved within a dependable natural night and daylight cycle. This can impact not only diurnal species, but also nocturnal species that greatly depend on it being naturally dark at nighttime.

Noise pollution. With increased global urbanization, there is also an increased level of noise, both in volume and in consistency that humans and other organisms are constantly exposed to. Because wildlife are highly dependent on sound, they can become disoriented and their behavior and communication abilities can be hampered due to the excessive noise levels that they are exposed to in and around urban areas.

Fragmentation of habitat and isolation of wildlife and plant populations. As urban development continues across the landscape, wildlife habitat is becoming increasingly fragmented and wildlife and plant populations are becoming increasingly isolated from one another. This habitat fragmentation impacts these organisms' capacity to reproduce, and reduces the genetic diversity that is present within the remaining populations. It also reduces the suitable habitat that is needed for their survival.

An increase in human-wildlife conflicts. As human development fragments habitat, and leaves wildlife with no place to go, there has been an increase in human-wildlife conflict. Wildlife are hit by vehicles, birds and insects hit windows on cars and buildings and are killed, and sometimes wildlife come into human communities looking for food and other resources that they need to survive.

Sometimes, wildlife may be killed if they exhibit aggression or prey on pets or livestock. Sadly, only a few select hardy species can ultimately adapt and survive in an urban area and in such constant proximity to humans.

Feral animals and pets. Wherever humans have dwelled, they have always brought along their animals, both for companionship and for helping with labor. In urban areas, the keeping of animals has resulted in the feralization of many different animals like cats that compete and prey on local wildlife, and pets that do the same thing as well.

Loss of connectedness to nature. As more people are living in urban areas than ever before, many of them have begun to lose the intimate connection that they once had to the land they depend on, how all living things are connected, and how nature actually works.

This global disconnection from nature has led to many unsustainable public policies and a lack of concern about nature by the public.

People will not protect that which they do not understand or do not care about.

If we really want to have stewards of our planet, we must help others to reconnect with nature so that they can learn to value and protect it.

6. Answer the gouestion:

1) What is the impact of heavy natural resource use by urban populations on ecosystems and natural resources?
2) How does the consumption of resources in urban areas contribute to a large carbon footprint?
3) How does the loss of natural ecosystems contribute to environmental degradation and biodiversity loss?
4) What pollutants and chemicals are typically carried by rainwater runoff in urban areas?

5) What are the environmental consequences of light and noise pollution resulting from increased urbanization?
6) How does habitat fragmentation and isolation of wildlife population contribute to the decline in biodiversity?
7) How does human development impact the natural movement patterns and behaviors of wildlife species?
8) What measures can be taken to mitigate human-wildlife conflicts and reduce the negative impacts of habitat fragmentation on wildlife population and biodiversity?

7. Read about Vertical Green Spaces [21]:

Vertical green spaces (VGS) is an umbrella term for both green facades and green walls. The benefits of traditional green facades - climbers led along the building face, have been well known for ages, perhaps millennia, while green walls represent a contemporary, advanced technological solution with a pre-cultivated modular-based system that grows close to the façade.

Green façades employ soil-bound plants, typically woody or herbaceous climbers that grow directly against the building wall (direct green façade) or on a support system (indirect green façade). Green walls, however, involve plant support structures attached to the building wall such as a screen, tray, vessel, planter tiles and flexible bags, and sometimes require some minor maintenance and irrigation. The plants do not root in the ground soil, which considerably increases the application possibilities and allows for a rapid, uniform coverage over a large surface.

Vertical green systems contribute to reducing the energy demands of buildings by providing shade and insulation, mitigating the urban heat island and cooling down public spaces. They also provide carbon sequestration, acoustic improvements, reduction in pollution levels and help improve biodiversity. Other less measurable, but apparent benefits include an effect on human health and social and cultural benefits.

VGS Fighting Urban Air Pollution

Air pollution caused by particle matter poses a risk to health in urban environments. Currently, as much as 84% of the global population is exposed to airborne particle pollution levels that exceed the WHO guidelines. Due to the porous nature of plants, they are ideal in acting towards airborne pollution removal and deposition, as well as influencing local air pollutant dispersion patterns. Plants act as living filters, facilitating air detoxification, particle absorption and accumulation on leaf surfaces. The vertical alignment of green walls follows existing urban surfaces and increases their potential for pollution reduction. That makes them an effective system that requires minimal adjustments to the built environment, making the adoption of this technology both efficient and desirable.

Photo credits: Uliana Semak

Green walls can be an effective greening strategy for capturing particle pollution in urban spaces since they can be applied throughout the enormous available wall area in cities. Importantly, they do not interfere with the prevailing ventilation in street canyon situations, which can be a problem with some other green infrastructure, for example in the form of tree borders of hedges, that can affect air streams. Green walls can also be placed very close to the pollutant source, making them even more efficient – a green wall located next to a busy road captures roughly 1010 to 1011 particles per square meter of leaf area.

Green Walls as Constructed Wetlands

Green infrastructure systems, green walls included, are among the most environmentally friendly technologies for cleaning water and air in urban settlements. They have the ability to act as constructed wetlands. Constructed wetlands are vegetation-based water treatment technologies that utilise the purification functions inherent to natural ecosystems to reduce water pollution. As an additional advantage, they offer an aesthetic experience and can be used for enhancing the beauty and biodiversity of the urban environment. However, most have a large land requirement, which is a major drawback. This is why green walls are emerging as an ideal solution. They possess the ability to perform the functions of constructed wetlands in wastewater treatment without occupying copious amounts of space. Due to their vertical structure, they can easily be implemented almost throughout the city environment. The implementation of green walls in such a way, therefore, offers a sustainable solution to wastewater treatment and recycling in modern architecture.

Green walls remove pollutants in wastewater through physical (via straining and sedimentation; filtration), chemical (via reaction, adsorption) as well as biological (via microbial assimilation in plant and biofilm in the substrate) and other microbial processes. This is done while water naturally drains vertically down through the substrate. The vegetation also provides a habitat for microorganisms that take up nutrients and degrade organic pollutants from the wastewater. They can be employed in greywater treatment in order to reduce environmental stress and some studies have already shown them to effectively treat wastewater for further reuse. The vertical design makes them ideal for wastewater treatment and water recovery for urban settlements with limited space.

Photo credits: Uliana Semak

8. **Watch the videos with case studies of successful greening system in the city:**

9. **Create and present smart-ideas for your city.**

UNIT 4
GREEN TECHNOLOGY

1. **Read about environmental technology [4] and try to answer the questions.**

Environmental Technology is also known as ‘green’ or ‘clean’ technology and refers to the development of new technologies which aim to conserve, monitor or reduce the negative impact of technology on the environment and the consumption of resources. Despite the negative impact of technology on environment, a recent rise in global concern for climate change has led to the development of new environmental technology aiming to help solve some of the biggest environmental concerns that we face as a society through a shift towards a more sustainable, low-carbon economy.

The positive impact of technology on the environment as a result of the development of environmental technology such as renewable energy, ‘smart technology’, electric vehicles and carbon dioxide removal.

What is environmental technology and how does it aim to address environmental challenges? 2. Can you provide examples of innovative environmental technologies that have been developed to promote sustainability? 3. How can environmental technology help in the conservation of natural resources and reduction of pollution? 4. What role does environmental technology play in sustainable development and combatting climate change? 5. How can individuals and businesses benefit from adopting environmentally friendly technologies in their everyday practices?

2. **Fill in the scheme with green technologies which you know.**

Photo credits: https://www.collidu.com/presentation-green-technologies

3. Read the text and watch the following videos "5 Sustainable Technologies and How They Affect the Environment" [25]:

The following technological innovations introduce a major leap towards a sustainable future, waste elimination and the reduction of energy consumption.

Carbon capture and storage (CCS) is an emerging technology that separates the carbon dioxide – a gas with a presence in Earth's atmosphere that is warming our planet – from other gases that industrial processes generate. It does so via post-combustion capture, pre-combustion capture and oxyfuel combustion methods. CCS transports carbon by pipelines and stores it in rock formations underground where it does not inflict any damage on the environment. The first carbon capture facility in the world was opened in Switzerland in 2017. Companies in the US and Canada are also developing their own carbon capture plants that could reverse one of the most damaging environmental trends and lead to the improvement of our planet's health.	
Solar glass is another emerging technology that may greatly improve global energy sustainability. It is a material used for making windows and other glass surfaces that captures the energy of the Sun and converts it into electricity. A scientific team at the University of Michigan developed a solar glass that generates an efficiency of 15% or more, while also letting 50% of light pass through the window. This solves one of the biggest solar glass hurdles — maintaining window transparency without sacrificing the efficiency of converting light into electricity. According to the team's estimate, there is currently enough usable window space to supply 40% of US energy needs with solar glass.	
The Smart Grids — the current power production infrastructure — is mainly centralized and very responsive to usage fluctuations. It requires a massive production of energy to work dependably, which often causes overproduction and energy waste. The grid also relies heavily on energy sources that emit pollution. Smart grids that deploy multiple energy distribution, automation, networking and sensor technologies are currently being tested around the developed world. They will enable a very localized energy production — even down to individual households — that can be sent back to the grid. Thanks to sensor technology and highly precise prediction algorithms, the production of energy can be fine-tuned to evade overproduction and waste. Improved battery technology will lead to efficient storage of energy from renewable sources. A study by Electric Power Research suggests that smart grid technology may reduce carbon emissions by 58% in 2030, compared to 2020 levels.	

Environmental networked sensors monitor the quality of air and water, keep track of acidification, identify sources of pollution and capture real-time data on other environmental factors that compromise the health of our planet. Sensor technology has advanced by leaps and bounds in recent years. Localized sensor networks keep track of energy and water usage to reduce waste, while air pollution trackers warn the public about levels of harmful elements in the atmosphere. The next breakthrough in environmental sensor technology is a wearable air quality sensor that will enable individuals to measure the levels of pollution in a city.	
Energy-efficient LED lighting technology is already replacing traditional bulbs in many homes and public spaces. It consumes much less power per unit of light emitted compared to iridescent bulbs, cutting down greenhouse emissions from power plants. Also, LEDs do not contain any hazardous materials and their carbon emissions are low. By 2030, LED bulbs will account for an 84% market share in the US. In the same year, this technology will reduce the consumption of energy by 40%, approximately saving about $26 billion in today's energy bills.	

4. Analyze the diagram. What are the components of green technologies? Do you know a specific example for each of the mentioned areas? Which of them should be implemented at the interstate or state level, and which can you implement in your life?

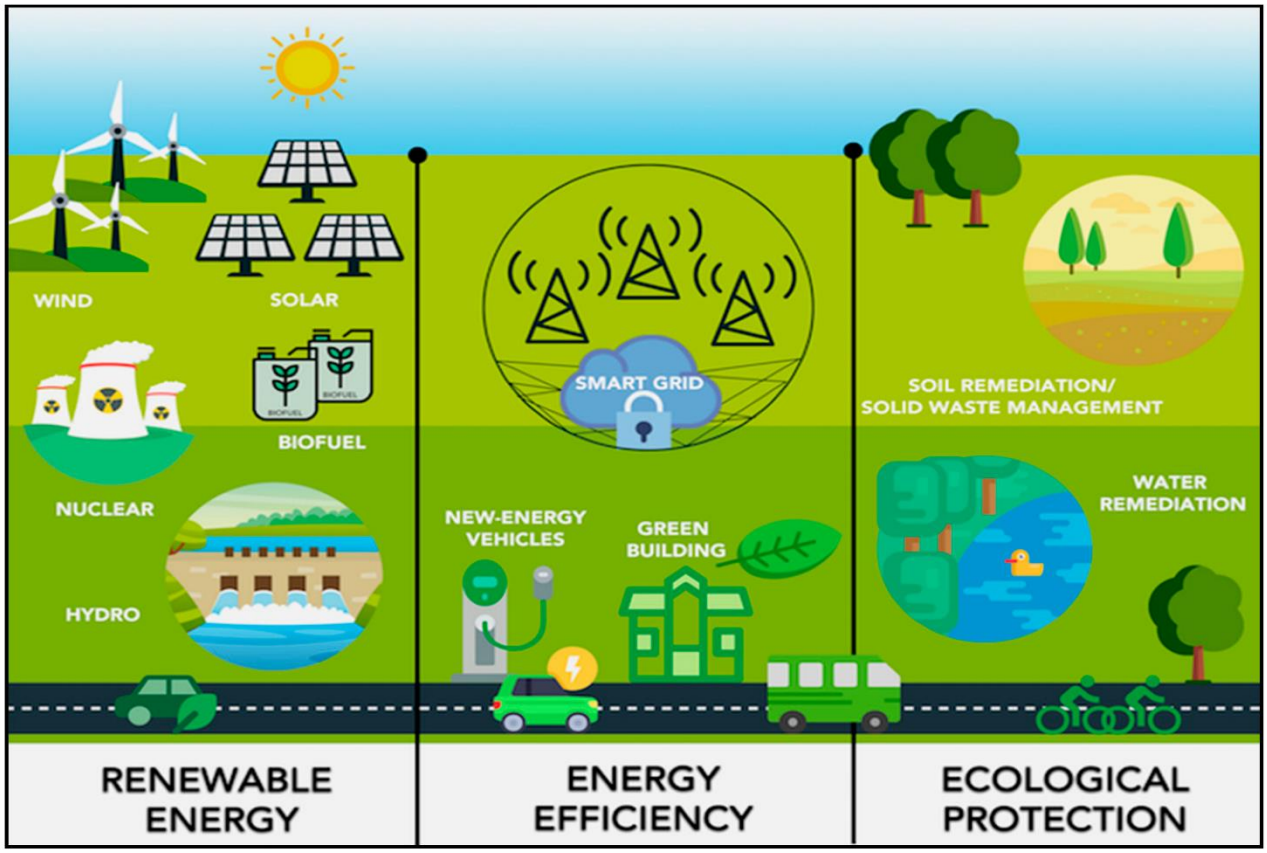


Photo credits: https://www.mdpi.com/2071-1050/12/9/3886

5. **Read the text "How Sustainable is Tesla?" [26].**

- Manufacturing process

The production of EV batteries generates far more emissions than the production process for ICE vehicles. Producing the battery alone for a Tesla generates between 5,291 and 35,273 pounds of CO_2 emissions, which is up to three times higher than the emissions to manufacture a gas-powered car.

Tesla has made efforts to make its Gigafactories more efficient by completing more of the manufacturing process on-site and minimizing the distance between portions of the production line. Additionally, by its own report, Tesla has a lower water consumption for manufacturing per car, which helps increase sustainability a bit.

Lastly, all of the manufacturing for Teslas is done in the U.S. and in accordance with standards set by the Environmental Protection Agency (EPA), which helps cut down on emissions.

- Transition to Vegan Leather

In response to ethical concerns raised by customers, Tesla stopped using real leather in all of its cars in 2016 and now uses vegan leather. While this helps reduce the mistreatment of animals for products, it also means that the interior contains some potentially harmful chemicals.

The vegan leather in most Teslas is made from polyvinyl chloride (PVC) and polyurethane, which contain volatile organic compounds (VOCs). These put strain on the environment by contributing to ozone production and because they're not very biodegradable. Plus, they are considered carcinogenic during and potentially after production, so the people who work with these materials are put at risk.

The vegan leather in the Model 3 isn't quite as supple as genuine animal leather, and there have been some complaints about its durability over long periods. However, it's a morally better decision than using real leather, and the look and feel are quite nice.

- Tesla Tires

One thing many people seem to overlook when discussing emissions is how tires degrade and contribute to pollution. Over time, your tire treads wear down from friction created between the rubber and the road. An estimated 1.5 million tons of tire particles pollute water, soil, and air each year in the U.S. alone.

Unfortunately, tire wear is higher for Teslas than for most ICE cars because they are heavier. The average car comes in between 2,500 and 4,000 pounds in most cases, but the Model 3 weighs in at 4,048 pounds. That added weight creates more friction between the tires and the road, which increases emissions coming from the rubber than you'd see on most sedans.

- Brake Dust

Brake dust is another often-overlooked emission coming from vehicles. When your brake pads engage, particles are slowly scraped off of both the wheels and the pads, contributing to pollution.
Given the above-average weight of the Model S, you can expect to see more brake dust coming from the car than you would from standard ICE vehicles. Additionally, since the Tesla accelerates more quickly than most cars, there's a chance that hard braking will be more common with this EV. I can say from firsthand experience that it's difficult not to drive this like a sports car.

- EV Charging

It's easy to think that the electricity you pour into any EV to "refuel" it is more sustainable than pumping gas into an ICE car, and to some extent, you would be correct. However, it's important to consider that, while charging an EV uses electricity, that power is often produced at plants by burning fossil fuels. It's more efficient to burn coal and natural gas at a power plant than it is in your car, but it still generates emissions.

However, Tesla is different in this regard in that the company used 100% renewable energy for its superchargers in 2021—the most recent year a sustainability report is available as of this writing. Charging a Tesla at a public charging facility, at least in 2021, meant that no net emissions were generated.

- Tesla Battery Recycling

Another area where Tesla excels in sustainability is in its battery recycling program. First off, none of the scrap batteries from production are sent to a landfill, and 100% of them are recycled. Second, Tesla has a recycling program that reuses a large portion of end-of-life batteries to manufacture new ones, cutting down on long-term emissions for production. Battery recycling remains a sustainability issue for many other EV manufacturers.

6. **Find a video about Tesla sustainability:**

7. **Write an essay on one of the following topics:**
   1) "How green technologies can improve our daily lives and help save the environment"
   2) "My own experience of using green technologies"
   3) "The future in the world of green technologies"

UNIT 5
RENEWABLE ENERGY

1. **Watch the video about benefits of renewable energy and discuss the following questions:**

a) What different types of renewable energy sources do you know?
b) What are the benefits of using renewable energy compared to fossil fuels?
c) What are the main challenges in implementing renewable energy technologies?
d) How does renewable energy contribute to reducing greenhouse gas emissions?
e) What are the environmental impacts of renewable energy production and use?

2. **Read the text by the United Nations [41] regarding renewable energy:**

What is renewable energy?

Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. Renewable energy sources are plentiful and all around us.

Fossil fuels - coal, oil and gas - on the other hand, are non-renewable resources that take hundreds of millions of years to form. Fossil fuels, when burned to produce energy, cause harmful greenhouse gas emissions, such as carbon dioxide.

Generating renewable energy creates far lower emissions than burning fossil fuels. Transitioning from fossil fuels, which currently account for the lion's share of emissions, to renewable energy is a key to addressing the climate crisis.

Renewables are now cheaper in most countries, and generate three times more jobs than fossil fuels. Here are a few common sources of renewable energy:

SOLAR ENERGY

Solar energy is the most abundant of all energy resources and can even be harnessed in cloudy weather. The rate at which solar energy is intercepted by the Earth is about 10,000 times greater than the rate at which humankind consumes energy.

Solar technologies can deliver heat, cooling, natural lighting, electricity, and fuels for a host of applications. Solar technologies convert sunlight into electrical energy either through photovoltaic panels or through mirrors that concentrate solar radiation.

Although not all countries are equally endowed with solar energy, a significant contribution to the energy mix from direct solar energy is possible for every country.

The cost of manufacturing solar panels has plummeted dramatically in the last decade, making them not only affordable but often the cheapest form of electricity. Solar panels have a lifespan of roughly 30 years, and come in variety of shades depending on the type of material used in manufacturing.

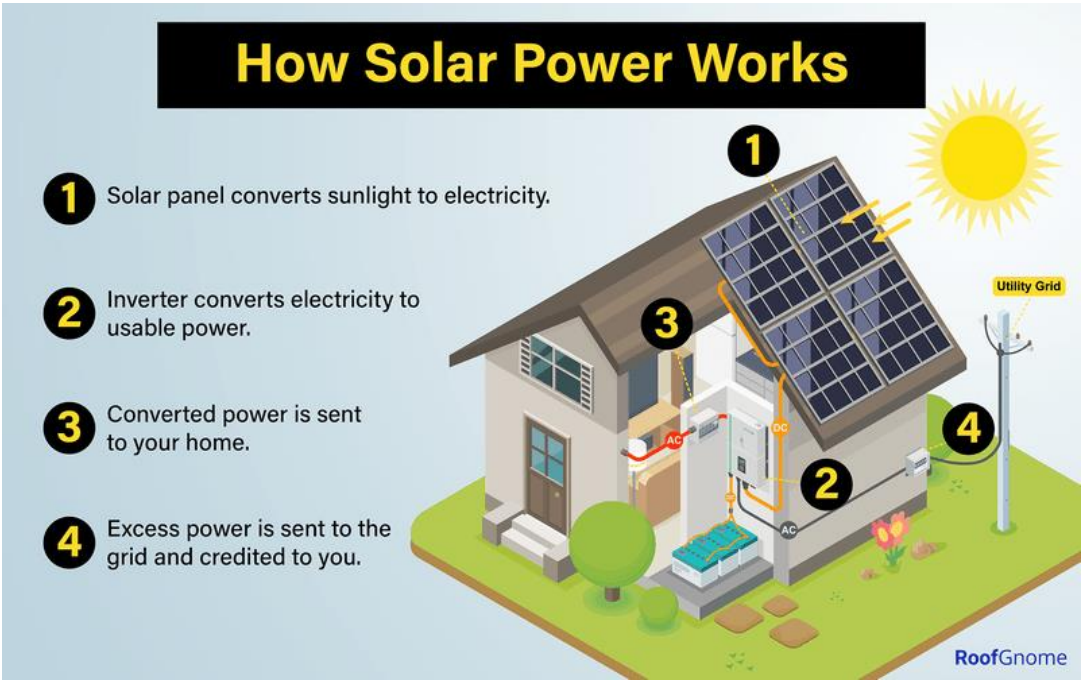


Photo credits: https://roofgnome.com/blog/solar/how-do-solar-panels-work/

WIND ENERGY

Wind energy harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea- or freshwater (offshore). Wind energy has been used for millennia, but onshore and offshore wind energy technologies have evolved over the last few years to maximize the electricity produced - with taller turbines and larger rotor diameters.

Though average wind speeds vary considerably by location, the world's technical potential for wind energy exceeds global electricity production, and ample potential exists in most regions of the world to enable significant wind energy deployment.

Many parts of the world have strong wind speeds, but the best locations for generating wind power are sometimes remote ones. Offshore wind power offers tremendous potential.

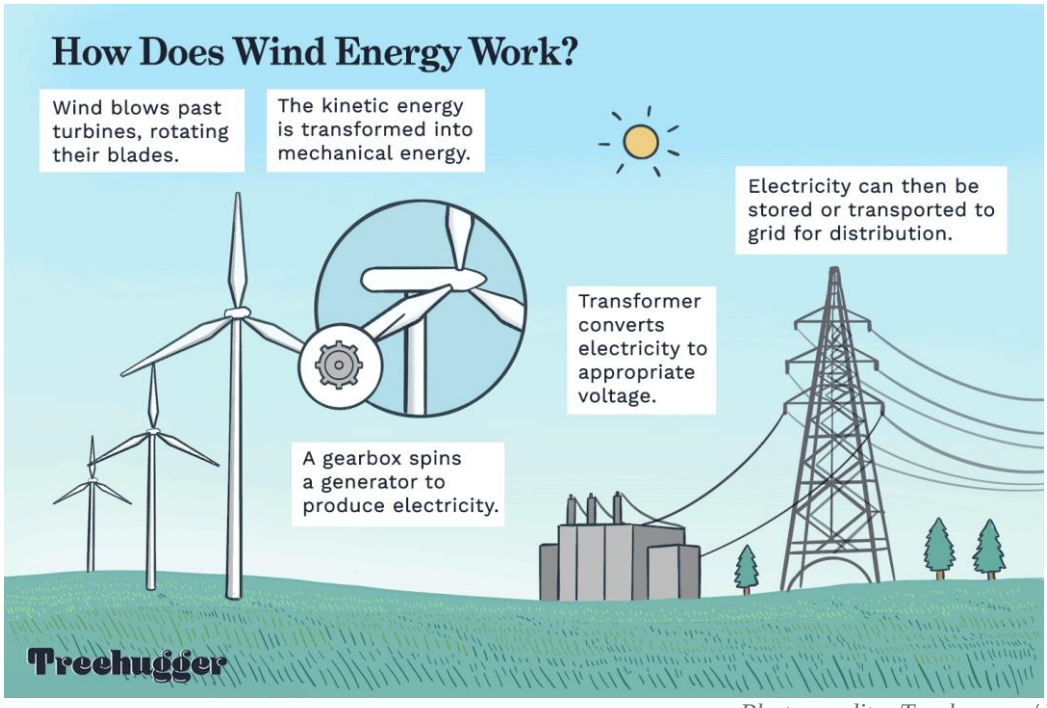


Photo credits: Treehugger / Hilary Allison

GEOTHERMAL ENERGY

Geothermal energy utilizes the accessible thermal energy from the Earth's interior. Heat is extracted from geothermal reservoirs using wells or other means.

Reservoirs that are naturally sufficiently hot and permeable are called hydrothermal reservoirs, whereas reservoirs that are sufficiently hot but that are improved with hydraulic stimulation are called enhanced geothermal systems.

Once at the surface, fluids of various temperatures can be used to generate electricity. The technology for electricity generation from hydrothermal reservoirs is mature and reliable, and has been operating for more than 100 years.

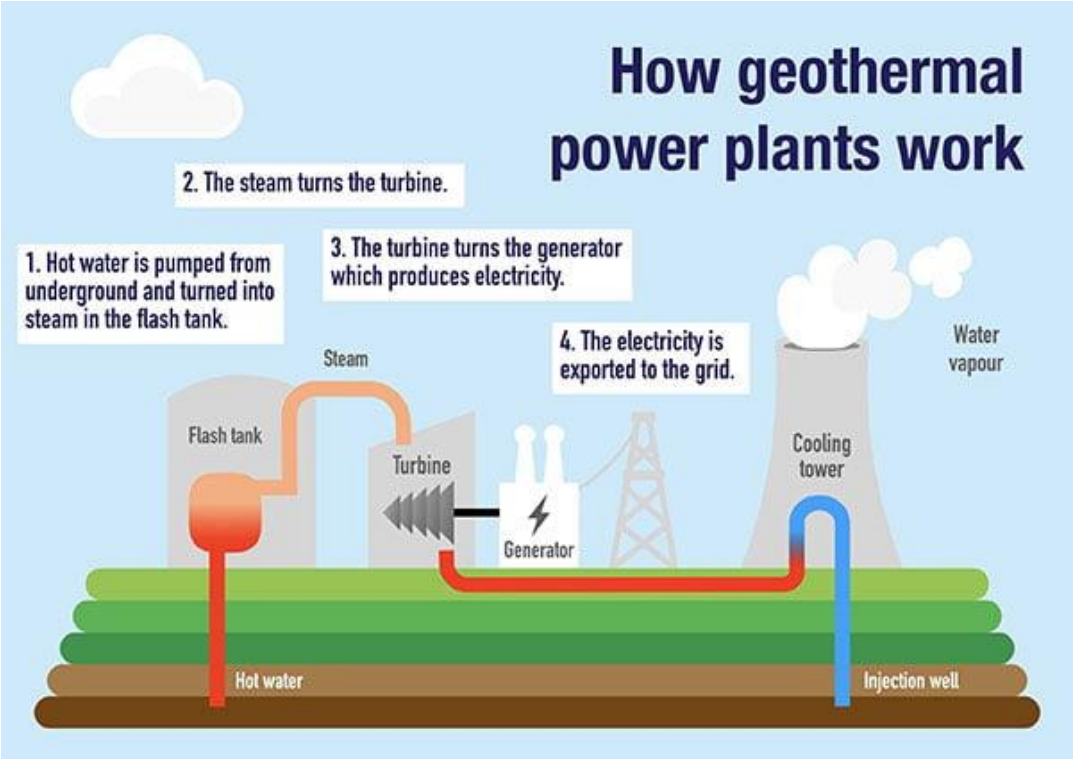


Photo credits: https://amigoenergy.com/blog/understanding-geothermal-energy/

HYDROPOWER

Hydropower harnesses the energy of water moving from higher to lower elevations. It can be generated from reservoirs and rivers. Reservoir hydropower plants rely on stored water in a reservoir, while run-of-river hydropower plants harness energy from the available flow of the river.

Hydropower reservoirs often have multiple uses – providing drinking water, water for irrigation, flood and drought control, navigation services, as well as energy supply.

Hydropower currently is the largest source of renewable energy in the electricity sector. It relies on generally stable rainfall patterns, and can be negatively impacted by climate-induced droughts or changes to ecosystems which impact rainfall patterns.

The infrastructure needed to create hydropower can also impact on ecosystems in adverse ways. For this reason, many consider small-scale hydro a more environmentally-friendly option, and especially suitable for communities in remote locations.

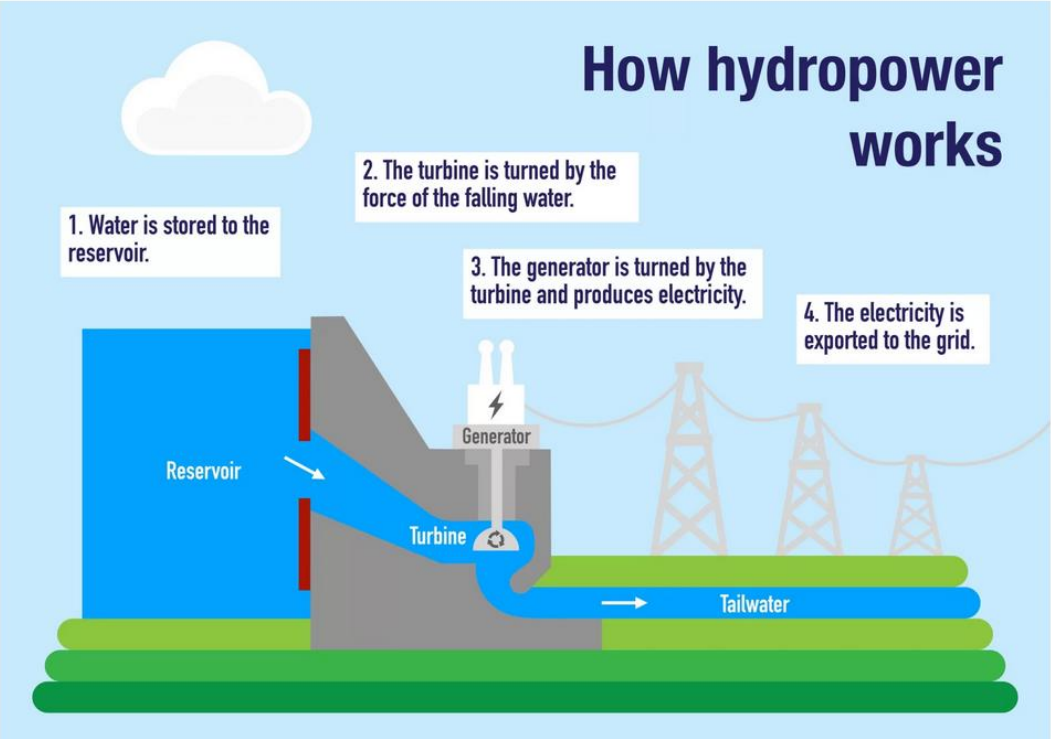


Photo credits: https://kamitelectrical.com/renewable-energy/micro-hydro-power/

OCEAN ENERGY

Ocean energy derives from technologies that use the kinetic and thermal energy of seawater – waves or currents for instance – to produce electricity or heat.

Ocean energy systems are still at an early stage of development, with a number of prototype wave and tidal current devices being explored. The theoretical potential for ocean energy easily exceeds present human energy requirements.

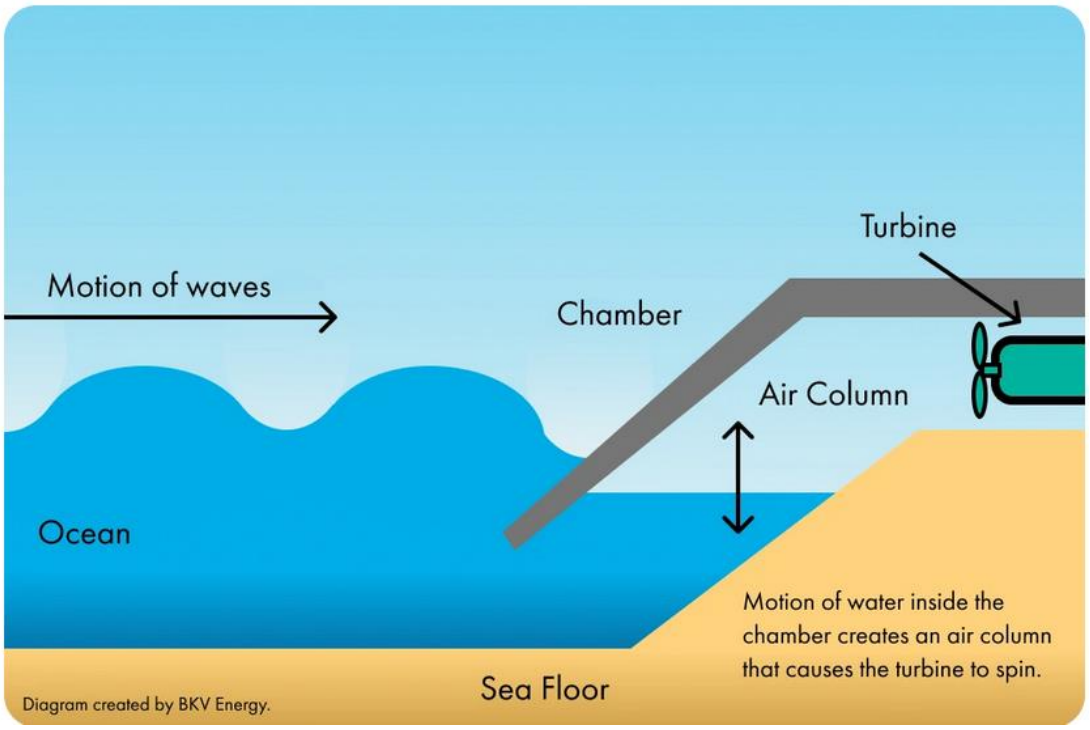


Photo credits: https://bkvenergy.com/learning-center/what-is-wave-energy/

BIOENERGY

Bioenergy is produced from a variety of organic materials, called biomass, such as wood, charcoal, dung and other manures for heat and power production, and agricultural crops for liquid biofuels. Most biomass is used in rural areas for cooking, lighting and space heating, generally by poorer populations in developing countries.

Modern biomass systems include dedicated crops or trees, residues from agriculture and forestry, and various organic waste streams.

Energy created by burning biomass creates greenhouse gas emissions, but at lower levels than burning fossil fuels like coal, oil or gas. However, bioenergy should only be used in limited applications, given potential negative environmental impacts related to large-scale increases in forest and bioenergy plantations, and resulting deforestation and land-use change.

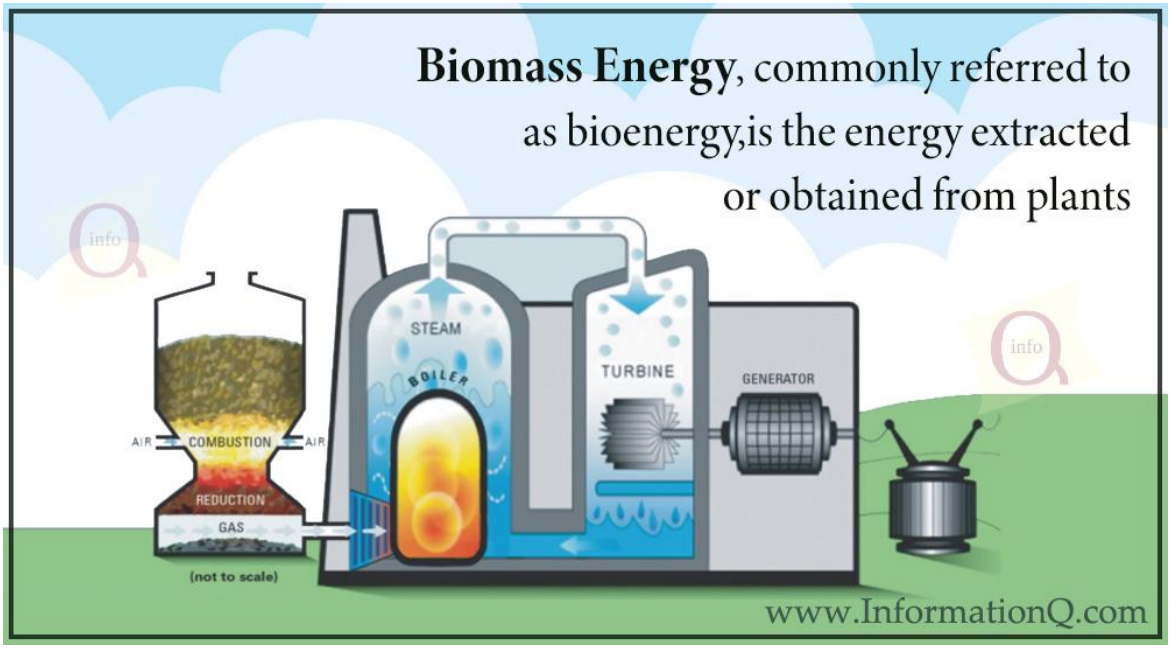


Photo credits: https://informationq.com/about-the-biomass-energy/

3. Match the terms and its definition:

1) renewable energy	a) energy generated by moving water converted to electricity. Also known as hydroelectricity.
2) geothermal energy	b) energy obtained from sources that are virtually inexhaustible and replenish naturally over small time scales relative to the human life span.
3) hydroelectric energy	c) heat energy generated within the Earth.
4) wave energy	d) renewable energy derived from living or recently living organisms, mostly plants.
5) biomass energy	e) energy produced by ocean waves.
6) wind farm	f) energy from the sun that is increased by the use of electricity or other mechanical equipment.
7) passive solar energy	g) area with a large group of wind turbines, used to generate electric power.
8) active solar energy	h) power from the sun that requires no other energy or mechanical system.

4. Read the facts about renewable energy [37]. Determine which describe the advantages (+) and which are the disadvantages (-) of renewable energy:

1) Renewable energy source is sustainable, meaning it will not run out soon. For example, the sun is expected to shine every morning for at least 4.5 - 5.5 billion years to come, so we can

consider it a renewable energy source. This might be the most important difference between renewables and fossil fuels.

2) Renewable energy sources are natural forces that are strongly dependent on the weather conditions. Therefore, when you have bad weather conditions, renewable energy technologies such as solar cells will be of less use.

3) Each type of energy requires a specific technology so that we can convert it into electricity. The efficiency of energy conversion devices is very important when prioritizing energy sources. Unfortunately, the efficiency of renewable technologies is not that high compared with traditional energy conversion devices.

4) Renewable energy sources are natural ways of energy generation and, therefore, can be considered clean. Although renewable energy technologies can cause some emissions, overall, minimum carbon and GHG will be emitted to the environment. When you compare them with fossil fuels, the difference is significant. Therefore, catastrophic environmental issues like global warming, climate change, and low air quality can be omitted if we go for renewable energy.

5) Despite fossil fuels, which are always subject to disputes and wars between countries, we can easily and peacefully gain control of renewable energy sources. In other words, trade laws, political instabilities, territorial claims, and market turmoil cannot impact the use of renewable energy sources.

6) To harness nature's energies, we need a lot of space. This will cause many problems for renewable energy sites. Compared with traditional power stations, we must use more land to establish renewable energy farms.

7) We'll have healthier air and soil by reducing greenhouse emissions and other polluting substances. This will improve public health, and people will have happier lives. Additionally, having a healthier population will cause a significant reduction in the health budget people and governments should set aside each year.

8) Besides the environmental impact of using renewable technologies, they can benefit the economy. This is especially important in some unprivileged regions. This new and stable job market has recently emerged and can empower people in poor areas.

9) Considering the energy we can get from renewable technologies, their initial cost is high and sometimes unaffordable. Renewable energy devices manufacturing and installation processes, like PV panels, are relatively expensive. Also heat pump costs can be quite high for some households. Governments are setting aside considerable budgets, such as solar panel grants and heat pump grants, to help these technologies grow.

10) If you usually follow the news, you must have heard of daily ups and downs in oil prices. Renewable energy can greatly help in this regard, reducing this turmoil and stabilising the global energy market. Because using renewable energy only demands an initial investment and doesn't require any fuel, as for instance with an air source heat pump.

11) Countries with no fossil fuel resources can reduce their energy dependence with a distributed network of renewable energy technologies. In fact, local people can generate electricity using renewable technologies and help governments reduce oil imports. This will decrease the risk of an energy crisis and benefit the countries' sustainable development.

12) Generating electricity from renewable energy sources produces way lower levels of pollution. However, renewable devices are subject to some concerns because manufacturing them and their disposal process might emit pollution. For example, solar cells will fail to perform well after a while, so we need to throw them away. However, these devices might be toxic, so we need to think of a recycling process for them.

5. **Answer the question: Can 100% renewable energy power the world? Watch the video and divide into two groups and hold a debate "Yes or no to transition to 100% renewable energy".**

6. **Analyzing case study. What are some successful examples of renewable energy projects around the world? Find and explain one of the successful examples of implementation of renewable energy.**

UNIT 6
WASTE MANAGEMENT

1. **Discuss one of the modern environmental problems – waste material. Give examples of management of waste material and your own experience in waste management practice.**

2. **Read the text "How Our Trash Impacts the Environment" [12]:**

Over two billion metric tons of unsustainable, human-generated waste are thrown away globally every year, entering our environment and polluting every ecosystem around the world. If we continue practicing waste management strategies as we do today, the total waste generation for 2050 is projected to be around 3.78 billion metric tons, representing a 1.66 billion metric ton increase in waste since 2020. In other words, we are creating more trash than ever!

Sixty-two percent of global waste is collected in controlled municipal facilities, with the remaining 38% dumped, burned, or discarded. Of the total municipal waste that is collected, 19% is recycled and 30% ends up in sanitary landfills. Sanitary landfills essentially try to keep the trash "out" of the environment, away from water sources, for example. They also use landfill gas collection systems to keep greenhouse gasses (GHGs), created by decomposing trash, from being released directly into the atmosphere.

The most common type of landfill, accounting for 31% globally, is an 'open' system. These landfill systems allow different types of waste, such as microplastics and toxic chemicals, to leak out of the trash and into the soil, groundwater, and nearby waterways.

These open landfill sites also allow greenhouse gasses, like carbon dioxide and methane, to be released directly into the atmosphere. Researchers have discovered that 20% of the total methane emissions from human-related sources are produced from open waste landfill sites. Methane is one of the largest contributors to climate change with a warming potential over 80 times greater than carbon dioxide.

This means that even though innovative climate mitigation strategies, including the development of various climate-resilient policies, are trying to tackle the problem of climate change, our poor waste management is undermining these efforts.

A recent Harvard study showed that greenhouse gas emissions (GHG) across seventy U.S. landfills were on average 77% higher than estimates by the Environmental Protection Agency (EPA). This crucial lack of reliable government data is deeply concerning and may mean we are vastly underestimating how much landfills sites are contributing to GHG emissions and therefore impacting climate change.

Increasingly we are treating our oceans as a dumping ground too and the vast majority of the trash we are dumping is made of plastics. All kinds of marine species, from fish to mammals, birds and crustaceans, consume fragments of this plastic or solid waste as it degrades into smaller and smaller pieces. Wildlife is often unable to distinguish between food and plastic waste and in some cases they are even attracted to it by its smell.

Researchers have found that an estimated 19 to 23 million tons of plastic waste are dumped in our oceans annually, with 1,500 different species having been found to have consumed toxic plastics and microplastics, primarily whales, sea turtles, and seabirds. For example, a krill-obligate blue whale is said to ingest 10 million pieces of microplastic every single day. Plastic pollution is even becoming the daily diet for most sea-birds, as a staggering 90% of them consume plastics and many of them get sick and die as a result. Even if these creatures don't consume plastics in one form or another, plastic trash often injures and maims them.

Some of this ocean plastic is entering the human food chain when we eat the crustaceans and fish that have consumed microplastics. Our waste problem is severely plaguing the health of the world's species, including our own.

3. Answer the following discussion questions:

1) What are the most pressing environmental issues caused by our current waste management practices?
2) How can individuals and communities reduce their waste footprint?
3) How can technological innovations help mitigate the negative impacts of waste on the environment?
4) What are the potential long-term consequences if current waste management practices do not improve?

4.1. Read the warning about waste consequence on human health [12, 23]. What are the health risks associated with exposure to hazardous waste and chemicals in landfills?

Over 1,000 chemicals used in the manufacturing of millions of different plastic products on the market today are classified as endocrine-disrupting and carcinogenic. They have been associated with some cancers, infertility, Alzheimer's, develop mental issues and more.

PFAS, also known as 'forever chemicals', have been in existence since the 1940s and are used on items to repel oil and water, which makes them useful in products like nonstick cookware, stain resistant clothing, and firefighting foam. When these items are dumped in landfills, it creates another pathway for these dangerous chemicals to enter the environment, where they can ultimately poison us and all other living creatures.

Toxic components such as Persistent Organic Pollutants (POPs) pose particularly significant risks to human health and the environment as they bioaccumulate through the food chain. Animals eating contaminated plants have higher doses of contaminants than if they were directly exposed. For humans, contaminants they are exposed to via food chain or air emissions may have effects on the nervous system, damage the kidneys and cause mental disorders and cancers. As an example, health impacts of improperly managed e-waste are described on picture.

4.2. Analyze the picture below. What kind of e-waste material could be a sources of the dangerous elements?

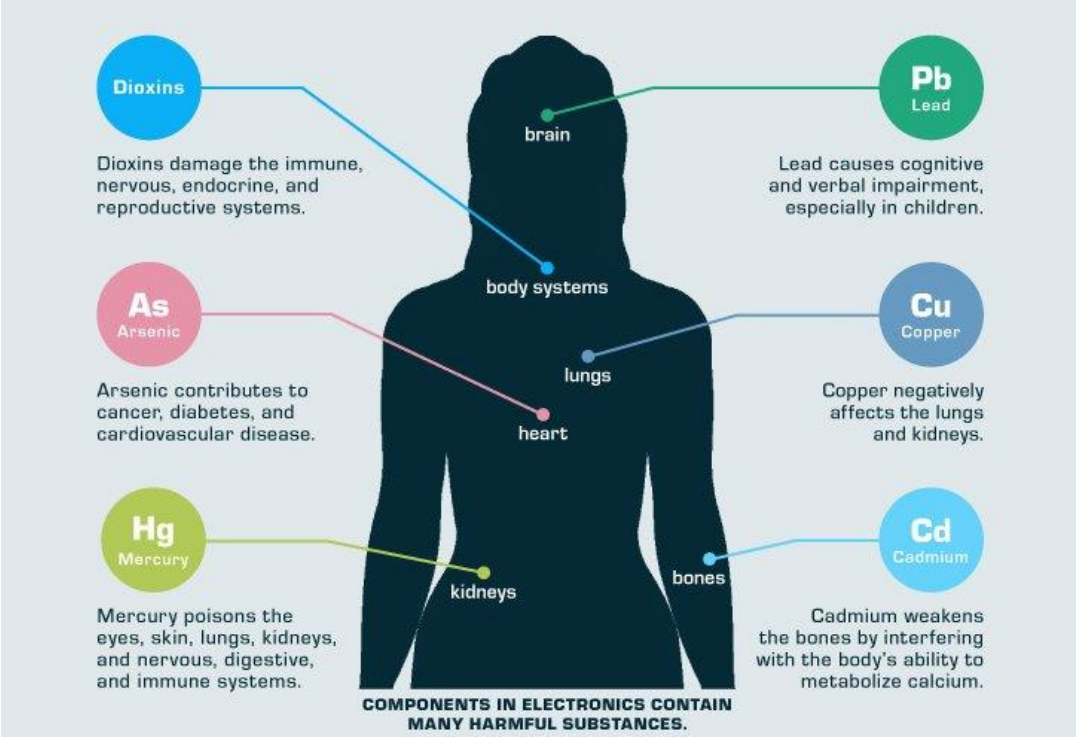


Photo credits: https://www.greenit.co.in/impacts-of-e-waste-on-health.html

5. **Watch the video "What is recycling? Save Our Planet and Environment!"**

6. **Read more about recycling [24]. There are missed words - insert appropriate words from the box below**

saves	composting	benefits	harmful	conserves	landfills	recycling	reduces	solid

Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. Recycling can benefit your community, the economy, and the environment.

- **Environment:** Recycling provides many……to our environment. By……. our materials, we create a healthier planet for ourselves and future generations.
- **Conserve natural resources:** Recycling……. the need to extract resources such as timber, water, and minerals for new products.
- **Climate change:** The recycling and…….. of municipal ……. waste (MSW or trash) saved over 193 million metric tons of carbon dioxide equivalent in 2018.
- **Energy savings:** Recycling…….. energy. For example, recycling just 10 plastic bottles……. enough energy to power a laptop for more than 25 hours.
- **Waste and pollution reduction:** Recycling diverts waste away from…….and incinerators, which reduces the…… effects of pollution and emissions.

7. **Have you known that different colours of containers are used for different types of waste? Paint the containers in different colours according to the type of waste**

Photo credits: https://logisticsuk.org/please-place-plastic-and-glass-containers-in-separate-bins/

8. **Products should only be recycled if they cannot be reduced or reused. Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, and Recycle" waste hierarchy. It promotes environmental sustainability by removing raw material input and redirecting waste output in the economic system.**

Photo credit: https://www.dvidshub.net/video/864376/reduce-reuse-recycle

Photo credit: Uliana Semak

What else can you do to reuse/reduce/recycle? Fill up the table

Reuse	Reduce	Recycle

9. **Find more. Watch the videos "What really happens to the plastic you throw away" and "The life cycle of a T-shirt". Discuss the trend of consumerism and its effects on wastes.**

10. **Municipal government in the city of Beaverton (Oregon, USA), created for citizens a recycling guide you can see below (turn the page). Try to offer a similar guide for the city in which you live / for students of our department.**

Photo credit: https://www.beavertonoregon.gov/499/Recycling-What-Goes-In

UNIT 7
ENVIRONMENTAL DEGRADATION

1. **Watch the video "One Earth - Environmental Short Film" and try to answer the following questions:**

a) What is environmental degradation, and how is it defined?
b) How has environmental degradation evolved over the past century?
c) How does environmental degradation contribute to climate change and vice versa?
d) What are the social and economic impacts of environmental degradation on communities?
e) How can individuals contribute to reducing environmental degradation in their daily lives?

2. **Read the text "Impact of Ecosystem Destruction" [34, 38]:**

Everything relies on everything else…

An ecosystem is a community of plants, animals and other living organisms that share the benefits of a particular space or environment such as air, food, water and soil. It's not different from our human community where every citizen of a city relies on his own resources and interacts with his environment.

In an ecosystem, each organism has its role and purpose. Disturbing the balance of an ecosystem can be disastrous for all the living things relying on it. An example of an ecosystem is Coral Reefs but there are much smaller ecosystems. Each ecosystem differs in size and components, but the important thing to remember is that no matter the size, it's a symbiotic community.

Our Earth is also considered as an ecosystem on a much larger scale. When we introduce external factors such as too much carbon dioxide or methane, it destroys the balance of the ecosystem which in turn affects those who live in it. The result is global warming, water shortage, extinction of species, etc. This impacts every living thing on the planet, which includes us. The impact of ecosystem destruction will be felt by everything eventually.

What can destroy an Ecosystem?

When an ecosystem is stable and healthy, we call it *Sustainable*. This means that it is capable of sustaining itself and reproducing. Sustainable ecosystems have biodiversity. There's a variety of species and organisms living there and contributing.

Ecosystem destruction is already happening. 25% of our coral reefs have disappeared and it is expected that 60% more will be gone in 30 years. This is due to ocean acidification, water pollution and illegal fishing. If all the corals go, what will happen to our marine life?

Deforestation is caused by Illegal logging and human need and progress. More than 4.6 million hectares of forest have been burned or cut down. How many species have become extinct due to this? How many homes have been destroyed?

Habitat loss is endangering our animal species. Even our apex predators are being affected – the lion, tiger, polar bear and even the majestic mountain gorillas are all being threatened by habitat loss.

Humans destroy ecosystems. Our lifestyle creates pollution and we overuse our natural resources. Today, we are using the resources of 1 and ½ planet Earths, even though we only have one. We build roads, hunt animals, cut down trees destroying forests and just litter the planet like crazy. We waste resources that are not infinite and will soon run out, if we continue our practice.

We need to stop now…

In the past 60 years, 60% of the Earth's ecosystem has been degraded. Today, we have extracted approximately 23 billion tons of resources from the Earth. That's this year alone. It's a continuous practice in spite of our best efforts to change.

Our natural ecosystems are finding it hard to cope with the different pressures and are unable to adjust. If we continue depleting resources and destroying our environment, soon it will be too late for them to recover, even with our help.

How does that affect you and me?

When we've mined what we can from our planet, when all animals have died, when there are no more fish in the sea, when the Earth is barren and devoid of trees… what will happen to us?

Like I mentioned, everything relies on everything else around it. Our planet is alive and interconnected and we are a part of that web.

The impacts of ecosystem destruction are the following:

- Increased flooding due to the erosion of soil and lack of trees
- Rising of the sea levels due to the melting of the glaciers, caused by Global Warming
- Disruption of the food chain when the apex predators become extinct
- Water shortage – we only have a finite supply of fresh drinking water
- Food shortage as the lands become barren and the oceans become fishless
- Loss of biodiversity as the whole species of living things disappear due to deforestation
- Pollution will eventually become unmanageable and affect our health.
- Rising temperatures may be too much for all living things on the planet

The Domino Effect

This may sound like an exaggeration but we're well on our way to our own destruction, slowly and surely. But the great thing about us humans, is that we learn from our mistakes. Efforts are being made to address these global concerns. People are becoming more aware that the little things you do everyday do have an effect – whether negatively or positively is up to them.

Every aspect of our ecosystem is important – because when one goes, the rest will follow.

Imagine this scenario… When the global temperature continues to rise, the glaciers will melt. The sea levels will rise and coastal cities will be inundated, killing millions of people. Economies will stop and will be severely burdened in trying to sustain everyone. Farms will be flooded, there will be no food.

It goes on and none of it is a pretty picture. So while we still can, let's do our share to stop degrading our ecosystems. Our lives depend on all of us interacting in a sustainable environment. No contribution is too small. In everything you do, think of how it's affecting those around you.

3. Give the answers:

1) What defines an ecosystem according to the text?
2) What roles do organisms play within an ecosystem?
3) Why is it important to maintain the balance of an ecosystem?
4) What makes an ecosystem sustainable?
5) How does biodiversity contribute to the sustainability of an ecosystem?
6) What can be done to prevent further destruction of coral reefs and forests?
7) How does the text suggest humans can learn from their mistakes regarding environmental issues?
8) What actions are being taken to address global environmental concerns?

4. **Analyze the diagram, add the missed phrases according to environmental degradation [28]:**

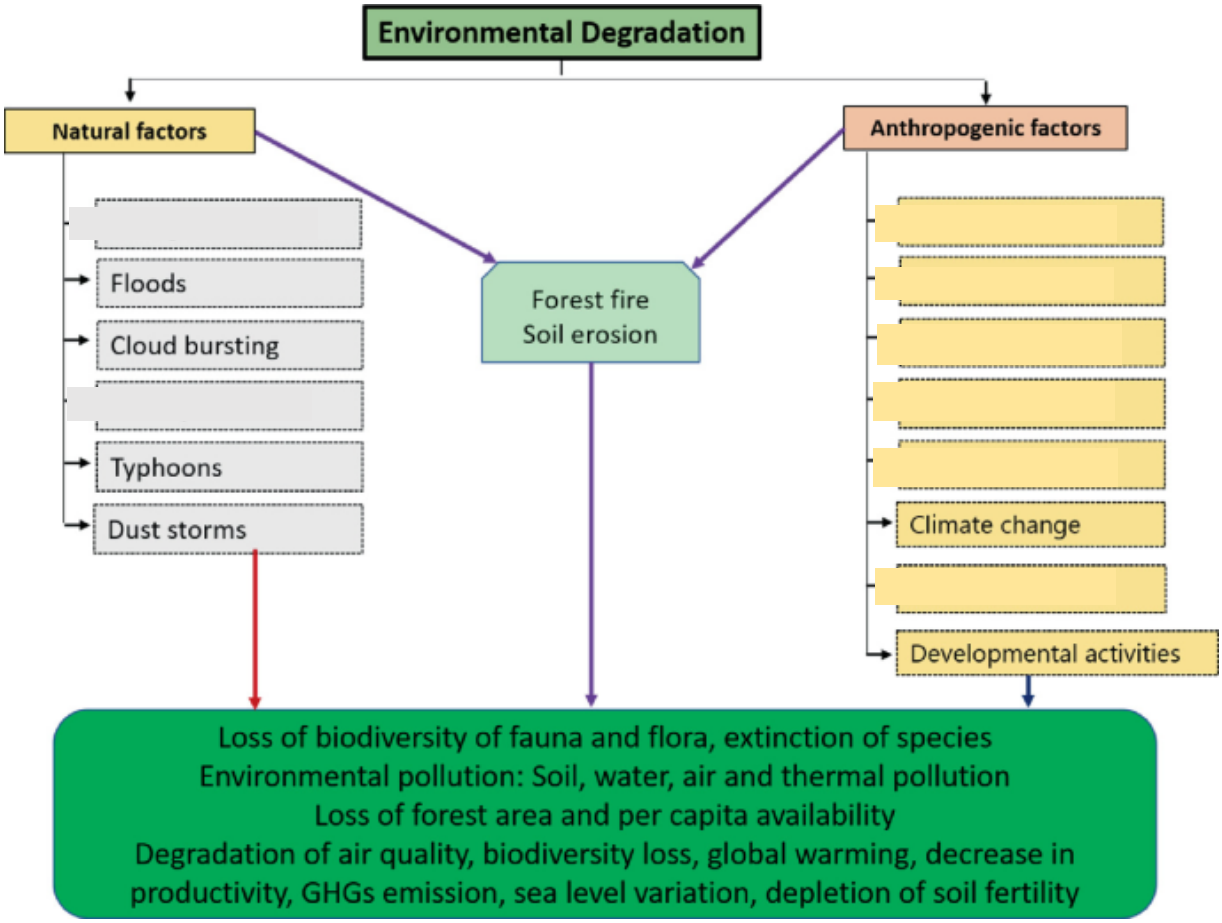


Photo credit: Vijay P. Singh, Shalini Yadav, Krishna Kumar Yadav & Ram Narayan Yadava

5. **Watch the video "What is ecosystem restoration?"**

6. **Read the information about UN Decade on Ecosystem Restoration.**

The UN Decade on Ecosystem Restoration is a global initiative launched by the United Nations to address the pressing need for large-scale restoration of degraded and destroyed ecosystems. Spanning from 2021 to 2030, this decade aims to restore the planet's ecosystems to combat climate change, prevent biodiversity loss, and improve human well-being. Here are the key aspects of the initiative [29]:

Objectives:

1. Prevent, Halt, and Reverse Ecosystem Degradation: Restore degraded and destroyed ecosystems. Halt further degradation and conserve existing ecosystems.
2. Combat Climate Change: Enhance carbon sequestration through restored

ecosystems. Increase resilience to climate change impacts. Improve Biodiversity: Restore habitats for endangered species. Increase biodiversity to support healthy ecosystems.

3. Enhance Human Well-being: Provide clean air and water. Support livelihoods through sustainable ecosystem management.

Key Areas of Focus:

1. Forests:
    - Reforestation and afforestation efforts.
    - Restoration of degraded forest lands.
2. Oceans and Coasts:
    - Coral reef restoration.
    - Mangrove replanting and protection.
3. Urban Areas:
    - Creation and maintenance of green urban spaces.
    - Restoration of urban wetlands and rivers.
4. Farmlands:
    - Promotion of sustainable agricultural practices.
    - Restoration of soil health.
5. Grasslands and Savannas:
    - Restoration of native vegetation.
    - Prevention of desertification.

Strategies and Actions:

1. Global and Local Collaboration:
    - Partnering with governments, NGOs, businesses, and communities.
    - Sharing knowledge and best practices across regions.
2. Funding and Resources:
    - Mobilizing financial resources for restoration projects.
    - Investing in innovative technologies and practices.
3. Policy and Governance:
    - Strengthening policies and regulations to support restoration. Ensuring governance frameworks that facilitate restoration efforts.
4. Public Awareness and Education: Raising awareness about the importance of ecosystem restoration. Educating the public on how they can contribute to restoration efforts.
5. **Monitoring and Research:**
    - Implementing systems to monitor progress and outcomes.
    - Supporting research to identify effective restoration techniques.

Expected Outcomes:

1. Environmental Benefits:
    - Increased biodiversity and ecosystem services.
    - Enhanced resilience to climate change.
2. Social and Economic Benefits:
    - Improved livelihoods for communities dependent on natural resources.
    - Enhanced food and water security.
3. Health Benefits:
    - Improved air and water quality.
    - Enhanced mental and physical well-being from restored natural spaces.

Challenges:

1. Financial and Technical Resources:
    - Securing adequate funding and technical expertise.
2. Political Will and Policy Support:
    - Gaining commitment from governments and policymakers.
3. Coordination and Collaboration:
    - Ensuring effective coordination among diverse stakeholders.
4. Long-term Commitment:
    - Sustaining efforts and monitoring over the long term.

Call to Action:

The UN Decade on Ecosystem Restoration calls on everyone — governments, businesses, communities, and individuals — to contribute to the restoration of ecosystems. It emphasizes the need for urgent and sustained efforts to ensure a healthier, more sustainable planet for future generations.

For more detailed information and to get involved, you can visit the official UN Decade on Ecosystem Restoration website here: https://www.decadeonrestoration.org/

5. **Analyze the information. On particular example describe what should be changed to gain ecosystem restoration:**

Photo credit: Damini Sharma's Lab

6. **Read more about successful examples of ecosystem restoration from the text "What can we do about ecosystem degradation?" by United Nations [24].**

7. **Choose a degraded ecosystem in your region and propose solutions to the problem. Prepare a presentation or essay.**

UNIT 8
BIODIVERSITY LOSS

1. **What is biodiversity, and why is it important for ecosystems? Watch a video and try to answer the question.**

2. **Read the text "Biodiversity loss: what is causing it and why is it a concern?" [17]:**

What Is Biodiversity Loss?

The definition of biodiversity loss is described as the loss of life on Earth at various levels, ranging from reductions in the genetic diversity to the collapse of entire ecosystems. In addition to its intrinsic value, biodiversity underpins ecosystem services, providing the backbone of the global economy.

The rate of loss has rapidly increased in recent years, to the point where many scientists believe that the world is currently experiencing a sixth mass extinction. Previous mass extinction events saw the existence of dinosaurs wiped out completely as well as the disappearance of more than 95% of all species living at the time.

Biodiversity loss not only results in species extinction, but it also affects humans by depriving humanity from accessing services that natural ecosystems provide, whether it be the wealth of oxygen that we breathe or the benefits of pollination provided by animals in ensuring global food security.

4 Causes of Biodiversity Loss

While biodiversity loss can occur naturally from more permanent ecological changes in ecosystems, landscapes, and the global biosphere, the current rapid rate of loss is a direct result of rampant human activity since the Industrial Revolution.

1. Habitat Loss

The single biggest contributor of global biodiversity loss is undoubtedly land and forest clearing to make way for urban and agricultural development. The latter of which has caused the loss of millions of hectares of trees to support the growing cattle and livestock industries, as well as mining activities. These ever-expanding industries are driven by global meat consumption, demand for commodities like paper and wood, and resources such as gold and other valuable minerals.

Decades of persistent land clearing means that we have lost significant amounts of natural habitats. Since forests especially are home to more than 80% of all terrestrial species of animals, plants and insects on the planet, millions of species have lost critical habitats to find shelter from prey and for reproduction, as well as increased food competition, causing population decline for many animals (and plants).

2. Wildlife Trading

Animal poaching, wildlife and exotic pet trading have cost the lives of millions of animals from thousands of species across the world, causing nearly 30,000 species to become extinct every single year. Rare and vulnerable animal species are frequently targeted, caught and killed for food, as trophies, status symbols – for instance, elephant ivories and rhino horns,

tourist ornaments, as well as allegedly medicinal purposes – many bears and tigers are killed for parts believed to be medicinal cures and even aphrodisiacs.

3. Overfishing

Aside from habitat loss from deforestation, another contributing factor in biodiversity loss is overfishing prompted by the commercial fishing industry. Today, we fish at a much higher and faster rate than fish stocks are able to replenish, pushing many fish species to the brink of extinction. While there are a number of regulations and fishing quotas in place to reduce the risk of overfishing – a few commercially-fished tuna species have recently been reported to show signs of population recovery – many other marine species including sharks and manta rays are in decline. This partly can be attributed to bycatching, where unwanted sea animals are captured during commercial fishing. About 38.5 million tonnes of bycatch result from unsustainable fishing practises every year.

4. Climate Change

Our dependence on fossil fuels and the resulting greenhouse gas emissions from it have created the phenomenon that is climate change. But today's climate is changing faster than species can move or adapt, and rising global temperatures are driving many animals to habitats they are not suited for. According to a 2004 study, scientists estimated that millions of species worldwide could face extinction as a result of climate changes predicted to occur in the next 50 years.

3. Find the definition of each drivers:

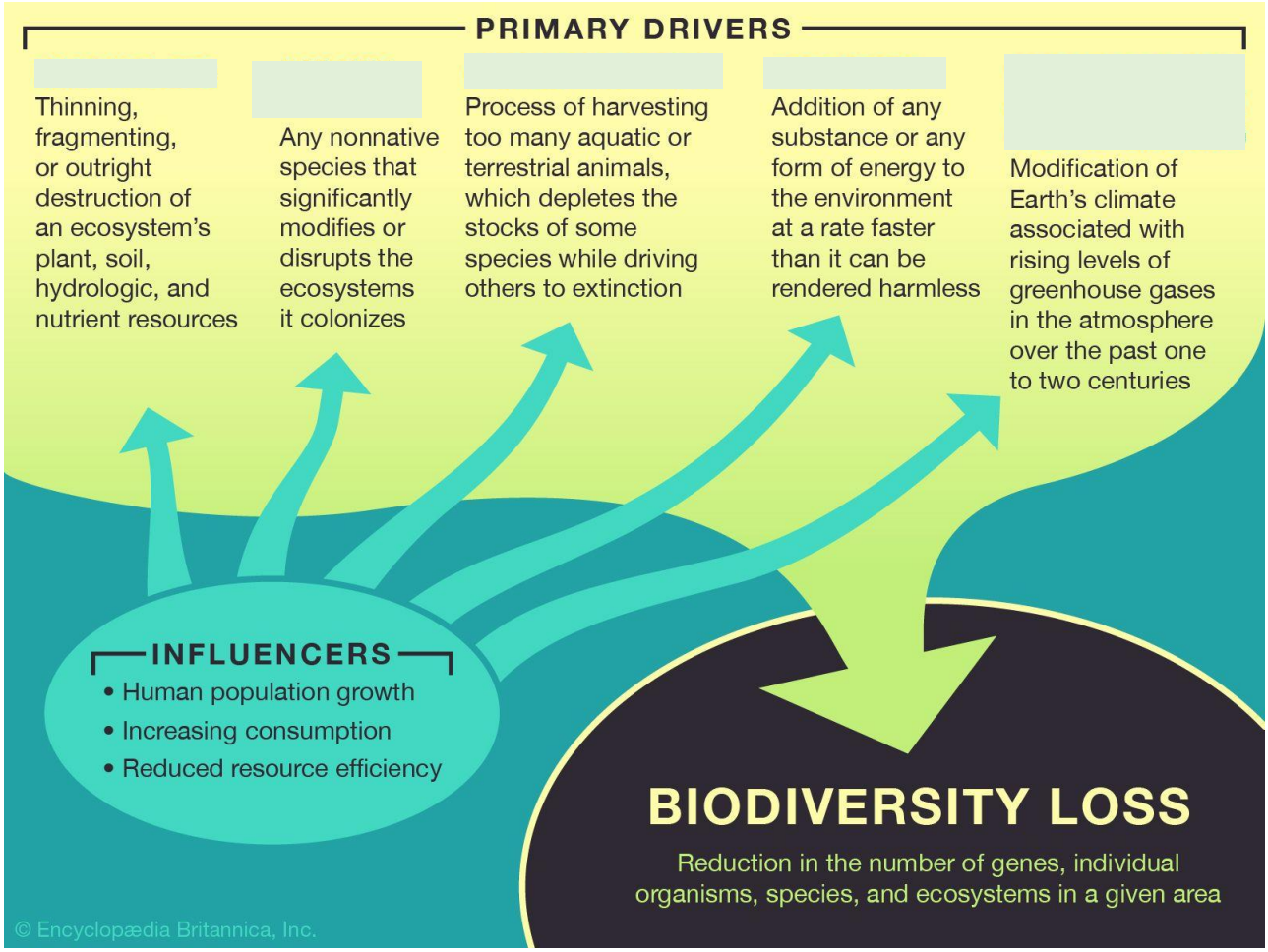


Photo credit: https://www.britannica.com/science/biodiversity

4. Match the term and definition:

1) biodiversity	a) number of ecosystems present in a specific area.
2) ecosystem	b) formula that calculates the total number of specific species in an area compared with the number of all species.
3) ecosystem diversity	c) process of complete disappearance of a species from the Earth.
4) species	d) native to a specific geographic space
5) species diversity	e) difference or variety of units of inheritance (genes) in a species.
6) organism	f) organism threatened with extinction.
7) genetic diversity	g) management of a natural resource to prevent exploitation, destruction, or neglect.
8) extinction	h) community and interactions of living and nonliving things in an area.
9) endemic	i) living or once-living thing.
10) endangered species	j) all the different kinds of living organisms within a given area.
11) conservation	k) group of similar organisms that can reproduce with each other.

5. Measuring biodiversity [5]:

Although examining counts of species is perhaps the most common method used to compare the biodiversity of various places, in practice biodiversity is weighted differently for different species, the reason being that some species are deemed more valuable or more interesting than others. One way this "value" or "interest" is assessed is by examining the diversity that exists above the species level, in the genera, families, orders, classes, and phyla to which species belong (see taxonomy). For example, the count of animal species that live on land is much higher than the count of those that live in the oceans because there are huge numbers of terrestrial insect species; insects comprise many orders and families, and they constitute the largest class of arthropods, which themselves constitute the largest animal phylum. In contrast, there are fewer animal phyla in terrestrial environments than in the oceans. No animal phylum is restricted to the land, but brachiopods (see lamp shell), pogonophorans (see beardworm), and other animal phyla occur exclusively or predominantly in marine habitats.

Some species have no close relatives and exist alone in their genus, whereas others occur in genera made up of hundreds of species. Given this, one can ask whether it is a species belonging to the former or latter category that is more important. On one hand, a taxonomically distinct species—the only one in its genus or family, for example—may be more likely to be distinct biochemically and so be a valuable source for medicines simply because there is nothing else quite like it. On the other hand, although the only species in a genus carries more genetic novelty, a species belonging to a large genus might possess something of the evolutionary vitality that has led its genus to be so diverse.

A second way to weight species biodiversity is to recognize the unique biodiversity of those environments that contain few species but unusual ones. Dramatic examples come from extreme environments such as the summits of active Antarctic volcanoes (e.g., Mt. Erebus [see Ross Island] and Mt. Melbourne in the Ross Sea region), hot springs (e.g., Yellowstone National Park in the western United States), or deep-sea hydrothermal vents (see marine ecosystem: Organisms of the deep-sea vents). The numbers of species found in these places may be smaller than almost anywhere else, yet the species are quite distinctive. One such species is the bacterium Thermus aquaticus, found in the hot springs of Yellowstone. From this organism was

isolated Taq polymerase, a heat-resistant enzyme crucial for a DNA-amplification technique widely used in research and medical diagnostics (see polymerase chain reaction).

More generally, areas differ in the biodiversity of species found only there. Species having relatively small ranges are called endemic species. On remote oceanic islands, almost all the native species are endemic. The Hawaiian Islands, for example, have about 1,000 plant species, a small number compared with those at the same latitude in continental Central America. Almost all the Hawaiian species, however, are found only there, whereas the species on continents may be much more widespread. Endemic species are much more vulnerable to human activity than more widely distributed species, because it is easier to destroy all the habitats in a small geographic range than in a large one.

In addition to diversity among species, the concept of biodiversity includes the genetic diversity within species. One example is our own species, for we differ in a wide variety of characteristics that are partly or wholly genetically determined, including height, weight, skin and eye colour, behavioral traits, and resistance to various diseases. Likewise, genetic variety within a plant species may include the differences in individual plants that confer resistance to different diseases. For plants that are domesticated, such as rice, these differences may be of considerable economic importance, for they are the source of new disease-resistant domestic varieties.

The idea of biodiversity also encompasses the range of ecological communities that are species forms. A common approach to quantifying this type of diversity is to record the variety of ecological communities an area may contain. It is generally accepted that an area having, say, both forests and prairies are more diverse than one with forests alone, because each of these assemblages is expected to house different species. This conclusion, however, is indirect—i.e., it is likely based on differences in vegetation structure or appearance rather than directly on lists of species.

6. **Overview of how scientists measure biodiversity. Which method do you think is the most accurate and why?**

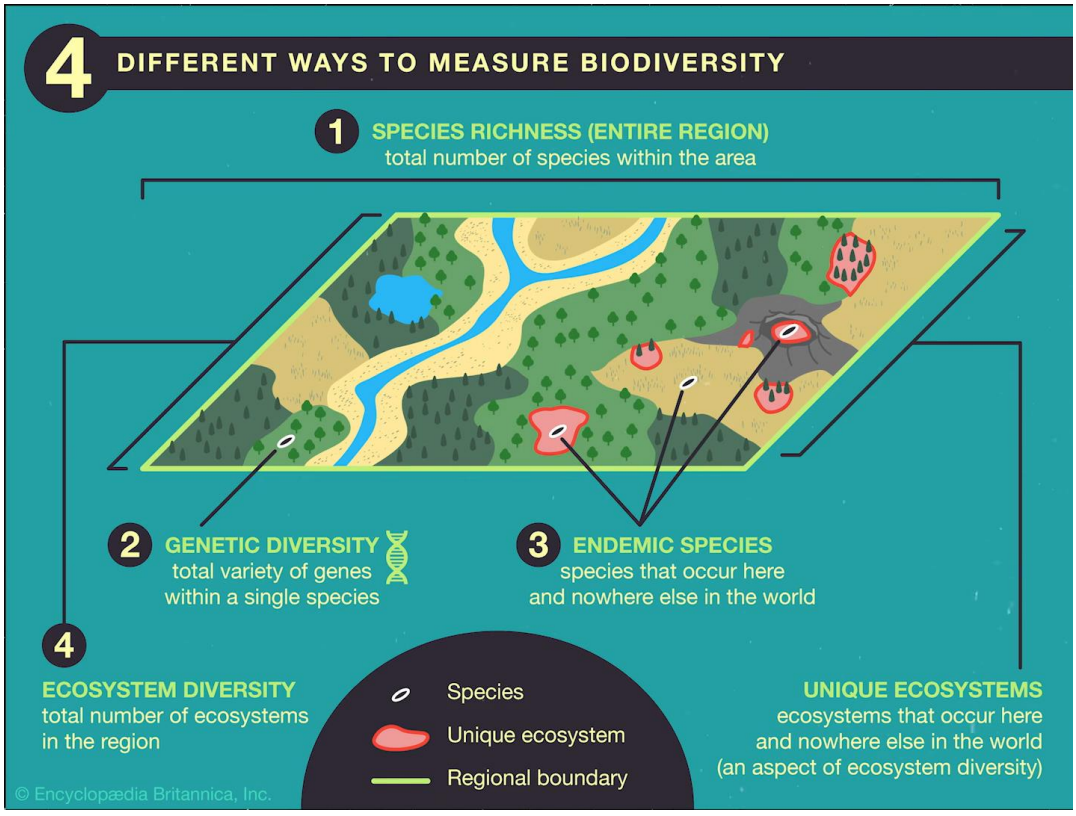


Photo credit: https://www.britannica.com/science/biodiversity

7. **Read and discuss information about the Red List of Threatened Species [33] in the context of biodiversity conservation.**

The IUCN Red List of Threatened Species is the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species. Open to all, it is used by governmental bodies, non-profit organisations, businesses and individuals.

The IUCN Red List is a critical indicator of the health of the world's biodiversity. It is a powerful tool to inform conservation action and policy. It provides information about species' range, population size, habitats and ecology, use and trade, threats, and conservation actions that help inform conservation decisions.

Species are classified into one of nine Red List Categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient and Not Evaluated. Vulnerable, Endangered and Critically Endangered species are considered to be threatened with extinction.

The IUCN Red List will be updated with thousands of new species assessments and reassessments on Tuesday 22 October 2024.

The IUCN Red List includes the IUCN Green Status of Species, which assesses the recovery of species' populations and measures their conservation success.

There are eight Green Status Categories: Extinct in the Wild, Critically Depleted, Largely Depleted, Moderately Depleted, Slightly Depleted, Fully Recovered, Non-Depleted and Indeterminate.

A Green Status assessment looks at how conservation actions have affected the current Red List status, what we might expect if conservation actions were halted and how a species' status might be improved in future with conservation action. This is reflected in a set of conservation metrics.

8. **What video to find more about IUCN Red List:**

9. **Find the Red Book of Ukraine on the website https://redbook-ua.org/. What are the differences between the International Red List and the Red Book of Ukraine?**

10. **Explore IUCN Red List website (or website of Red Book of Ukraine) and choose one of the species. Prepare a presentation about this species: why we need to safe this species and what we can do?**

UNIT 9
REFORESTATION AND SUSTAINABLE FOREST MANAGEMENT

1. **What are the roles of forests for the environment? Why is it important to preserve forest ecosystems? Watch a video and try to answer:**

2. **Read the text about deforestation by Natural Geographic [7]:**

Deforestation is the purposeful clearing of forested land. Throughout history and into modern times, forests have been razed to make space for agriculture and animal grazing, and to obtain wood for fuel, manufacturing, and construction.

Deforestation has greatly altered landscapes around the world. About 2,000 years ago, 80 percent of Western Europe was forested; today the figure is 34 percent. In North America, about half of the forests in the eastern part of the continent were cut down from the 1600s to the 1870s for timber and agriculture. China has lost great expanses of its forests over the past 4,000 years and now just over 20 percent of it is forested. Much of Earth's farmland was once forests.

Today, the greatest amount of deforestation is occurring in tropical rainforests, aided by extensive road construction into regions that were once almost inaccessible. Building or upgrading roads into forests makes them more accessible for exploitation. Slash-and-burn agriculture is a big contributor to deforestation in the tropics. With this agricultural method, farmers burn large swaths of forest, allowing the ash to fertilize the land for crops. The land is only fertile for a few years, however, after which the farmers move on to repeat the process elsewhere. Tropical forests are also cleared to make way for logging, cattle ranching, and oil palm and rubber tree plantations.

Deforestation can result in more carbon dioxide being released into the atmosphere. That is because trees take in carbon dioxide from the air for photosynthesis, and carbon is locked chemically in their wood. When trees are burned, this carbon returns to the atmosphere as carbon dioxide. With fewer trees around to take in the carbon dioxide, this greenhouse gas accumulates in the atmosphere and accelerates global warming.

Deforestation also threatens the world's biodiversity. Tropical forests are home to great numbers of animal and plant species. When forests are logged or burned, it can drive many of those species into extinction. Some scientists say we are already in the midst of a mass-extinction episode.

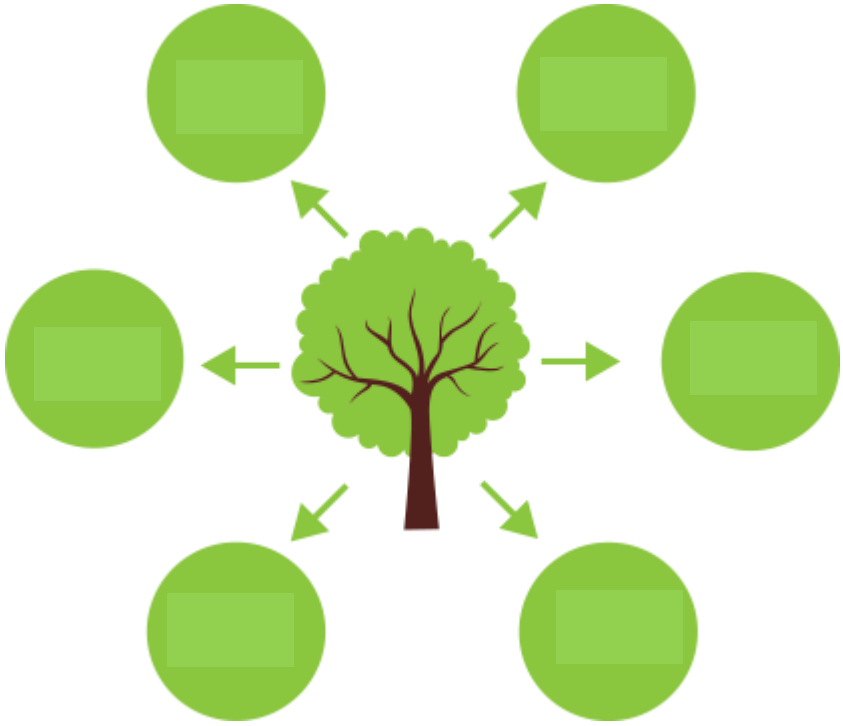
More immediately, the loss of trees from a forest can leave soil more prone to erosion. This causes the remaining plants to become more vulnerable to fire as the forest shifts from being a closed, moist environment to an open, dry one.

While deforestation can be permanent, this is not always the case. In North America, for example, forests in many areas are returning thanks to conservation efforts.

3. Match the term and definition:

1) deforestation	a) management of a natural resource to prevent exploitation, destruction, or neglect.
2) photosynthesis	b) method of agriculture where trees and shrubs are cleared and burned to create cropland.
3) conservation	c) destruction or removal of forests and their undergrowth.
4) slash-and-burn	d) process of cutting down all the vegetation in an area, usually as part of an economic industry.
5) clearcutting	e) process by which plants turn water, sunlight, and carbon dioxide into water, oxygen, and simple sugars.
6) Raze	f) completely destroy or decimate a specific area.

4. What ecosystem functions have forests? Fill up the scheme and several addition functions.



5. Read the part of text and add messed words from box:

transmitted heat habitats temperature deforestation diseases forest

There are some 250 million people who live in_____ and savannah areas and depend on them for subsistence and income — many of them among the world's rural poor.

Eighty percent of Earth's land animals and plants live in forests, and _____threatens species including the orangutan, Sumatran tiger, and many species of birds. Removing trees deprives the forest of portions of its canopy, which blocks the sun's rays during the day and retains _____ at night. That disruption leads to more extreme _____ swings that can be harmful to plants and animals.

With wild_____ destroyed and human life ever expanding, the line between animal and human areas blurs, opening the door to zoonotic diseases. In 2014, for example, the Ebola virus killed over 11,000 people in West Africa after fruit bats_____the disease to a toddler who was playing near trees where bats were spread.

6. Afforestation versus reforestation – What's the difference? [1]:

The terms afforestation and reforestation both refer to the act of planting trees in order to create a forested area. The key difference is that afforestation describes the process of growing trees in an area that was previously not covered by trees, creating a new forest.

On the other hand, reforestation refers to planting and growing trees in a forest that has seen a decrease in tree numbers or in an area that has had many of its trees removed in the recent past. When examining afforestation versus reforestation, both practices are often rather beneficial towards local ecosystems and in terms of reducing atmospheric carbon dioxide concentrations, but they can also come with disadvantages.

Two of the most effective natural options for increasing biodiversity are reforestation and afforestation. These two methods are crucial for commercial foresters and landowners to follow in order to grow wood for wood products and consistently satisfy demand in a sustainable manner.

Reforestation is essential in halting or preventing deforestation. Reforestation can help wildlife habitats and increase a forest's capacity to absorb carbon dioxide (CO_2). Afforestation can aid in preventing desertification, the process through which productive land becomes a desert due to drought or intense farming.

When planting trees in a new area, one has to be careful that other important ecosystems are not being destroyed – for example, a grassland area may already have an ecosystem related to that specific biome, which planting trees will likely alter. To mitigate this, introducing trees at a slow rate will allow a steady change in the wildlife occupying the area. Furthermore, successful afforestation requires planting a mixture of different tree species, albeit ones that are native to the climate they are being planted in. This avoids creating a monoculture of species that will attract relatively little wildlife when compared with a natural forest.

Reforestation, on the other hand, can be used as a practical way of replenishing existing forests, primarily to increase the number of trees and the range of species within a woodland, but also to improve their biodiversity. It can be used in conjunction with sustainable forestry, where only a limited number of trees within a forest are cut down, leaving significant proportions of the forest untouched. Nevertheless, if too much of the forest has already been cut down, reforestation can also have its disadvantages.

If much of the forest has been recently removed, even if the trees are quickly replanted, it is rather difficult to recreate the ecosystem exactly as it was before. A forest has a complex ecosystem, much of which relies on a certain mixture of tree species and often includes trees that are hundreds of years old. Therefore, it realistically takes many years to re-create an old forest and to bring back the rich biodiversity that was previously harboured within the biome. This shows that, when weighing up afforestation versus re-forestation, it is important to avoid large-scale deforestation in the first place.

7. Project task. Developing a plan of reforestation/afforestation:

Reforestation is a complex and longterm process. It requires careful planning, commitment, and getting the right resources. Choose some area and try to propose action plan of deforestation. Watch a video "How we get tree planting wrong".

Include in your plan such information:

1. Goals and Perspective
2. Healthy Forests
3. Planting with native species
4. Collaborating with experts
5. Site prescriptions
6. Planning

8. Forest management, or forest resource management, refers to any planned human intervention in a forest ecosystem to achieve specific goals and objectives, which can typically be grouped as environmental, economic, and social. Forest management can include anything from low intensity to high intensity interventions using different practices, tools, and techniques. Sustainable forest management is a "dynamic and evolving concept, which aims to maintain and enhance the economic, social, and environmental values of all types of forests, for the benefit of present and future generations," explains United Nations Forum on Forests.

Read the text about Goals and objectives of forest management [7]:

The definition, benefits and practices of forest management depend on the main management goals identified for each forest enterprise, or the main reasons people are actively intervening in the forest system. These goals are interrelated and interdependent, and forest managers often value one or more equally. In some cases, certain objectives would take preference over others.

For example, intensively managing a forest to increase the yield of one tree species and its wood would compromise the forest's overall biodiversity. In such a case, to protect the ecosystem, certain areas could be set aside for conservation, meaning that the area managed for yield will reduce. Similarly, a tree that is tapped for resin can also be used for its timber but tapping too much resin reduces the timber value. Defining and balancing the goals for forest management and considering how different aspects of forest management influence each other, is therefore key.

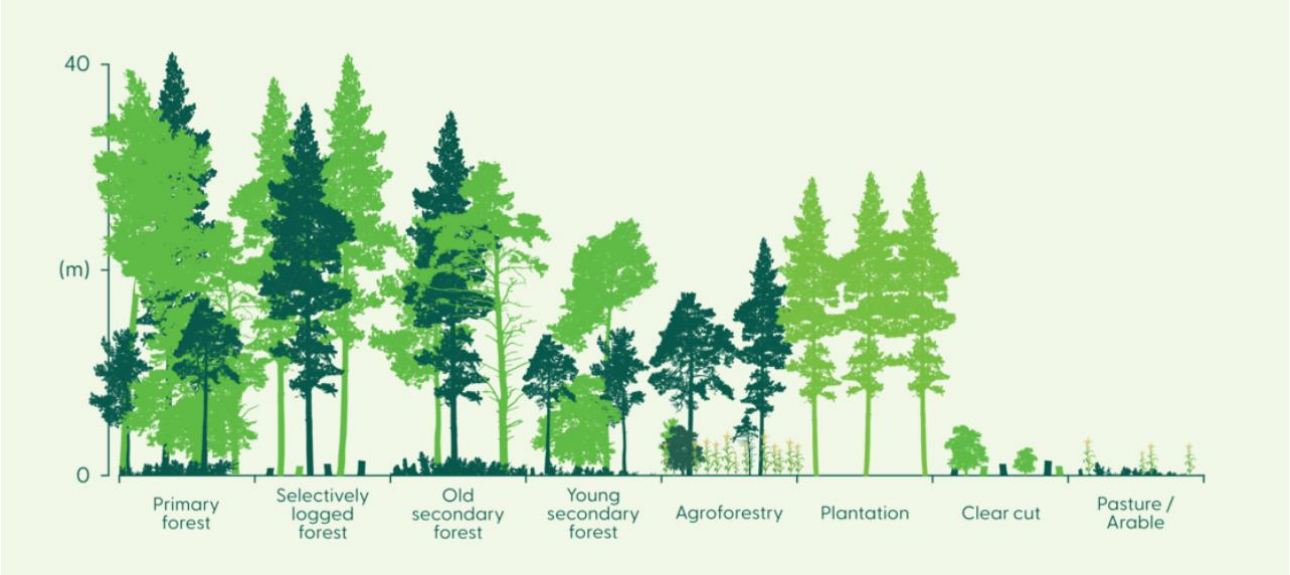


Photo credit: https://fsc.org/en/forest-management

Figure shows how forest management goals can be seen on a spectrum, with an intensively managed (often monocrop) operation on the one side and forest management with the main aim to conserve biodiversity on the other. The conservation value of the forest will increase or decrease accordingly.

Forest management for conservation

Ecological forest management, or forest management for conservation aims to conserve and protect the forest into the future. The forest is managed in a way that will ensure no species goes extinct and the species balance and gene pool is maintained. Activities focus on protecting and restoring biodiversity to allow the continued existence of all the trees, plants and animals that were there before. Climate change could cause certain species to disappear or flourish at unexpected rates. Forest management strategies can aim to mitigate these effects and adapt to the changing climate, but this is a continued challenge due to the unpredictability of climate change.

Forest management for economic goals

Forest management for economic goals aims to ensure a steady supply of forest products and optimize economic return. The forest is managed so that it can continue to deliver materials and products for the market in the long term. Sustainable forest management in this context refers to sustainable yield. For existing or natural forests, where the objectives also include conserving the forest and the life within, this will involve a great deal of environmental activities, as forest managers value the forest's overall health and resilience. In the case of plantation systems where the main objective is often to maximize economic return, forest management practices for economic gain involve fertilizers, pesticides, and other environmentally harmful practices that will ensure the plantation monoculture continues to yield forest materials.

Forest management for social gains

Forest management for social gains benefits the people that depend on forests for various social and cultural reasons. This includes the Indigenous groups and local communities who manage one-quarter of the world's land. Globally about 300 million people live in and around forests and depend on them for food, fuel, medicine, and their livelihoods. Forest management for social gains considers these people and aims to protect their rights to continue using forests. People beyond the communities that live in and around forests can also benefit from forests and be considered as a part of the social goals for forest management. This typically includes managing, and setting areas aside, for recreation, tourism, education, and conservation sites with cultural or spiritual importance (often referred to as High Conservation Values). People who work for the companies extracting forest-based products and materials are also considered as a part of social goals for forest management. Here the important considerations are the wellbeing of a forest worker and ensuring they are paid and treated fairly. Social objectives will also include banning child or forced labour and discrimination in the workplace.

9. What is Sustainable Forest Management?

10. Sustainable Forest Management Practices [30]. Forest conservation in modern forestry utilizes multiple techniques:

1) Afforestation and reforestation enlarge forest areas on our planet.
2) The ability to distinguish and treat tree diseases or pest infestations empowers forestry managers to save their farms and mitigate losses.
3) Replanting forests after harvesting contributes to ecologically sustainable forestry.
4) Selective logging and thinning prevent from felling the entire stand.
5) Pruning saves from logging the whole trees for wood and stops pathogens' spreading.
6) Clear-cutting or removal of mature trees contributes to forest health and stimulates offspring growth.
7) Controlled burn naturally revives forests – on condition the process does not go beyond control.
8) Specific training boosts foresters' proficiency in sustainable forestry techniques.
9) Weighted planning facilitates the solutions for more sustainable forestry.

10) Satellite monitoring enables remote control of the forest state and timely response to deviations.

11. **Analyze the picture "Forest growth cycle". Which sustainable forest management practices could be applied on each stage?**

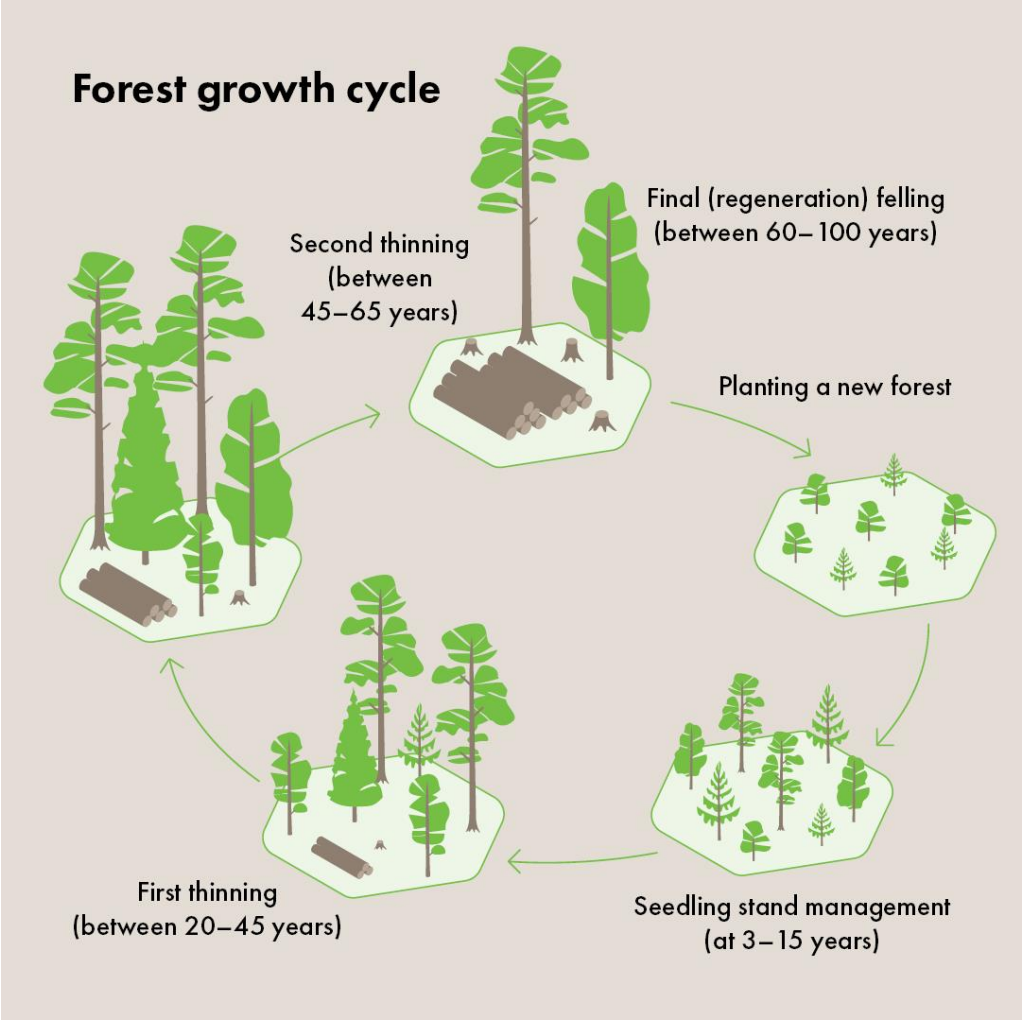


Photo credit: UPM - The Biofore Company

12. **Watch more about sustainable forest management: "Forestry for the Future: Lessons in Sustainable Management from Maine"**

UNIT 10
SUSTAINABLE AGRICULTURE

1.1. What environmental problems are caused by agriculture? Discuss environmental impact of agriculture and possible solution of them.

1.2. Watch the video:

2. Read the text about sustainable agriculture [20, 27]:

Sustainable agriculture means different things to different people, but the basic goals of sustainable agriculture are environmental health, economic profitability, and social and economic equity (sometimes referred to as the "three legs" of the sustainability stool). Legally, sustainable agriculture is defined in U.S. Code Title 7, Section 3103 to mean an integrated system of plant and animal production practices having a site-specific application that will be over the long term (1) satisfy human food and fiber needs, (2) enhance environmental quality and the natural resource base on which the agricultural economy depends, (3) make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls, (4) sustain the economic viability of farm operations, and (5) enhance the quality of life for farmers and society as a whole.

Why sustainable agriculture is so important?

Sustainable agriculture is a broadbased concept rather than a specific methodology. It encompasses advances in agricultural management practices and technology, and the growing recognition indicates that the conventional agriculture that developed post World War-II, will not be able to meet the needs of the growing population in the 21st century.

Conventional agriculture is facing either reduced production or increased costs, or both. Farming monocultures, such as wheat fields, repeated on the same land results in the depletion of topsoil, soil vitality, groundwater purity and beneficial microbe, insect life, making the crop plants vulnerable to parasites and pathogens. An everincreasing amount of fertilizers and pesticides as well as the energy requirements for tilling to aerate soils and increasing irrigation costs are of prime concern. While conventional methods enabled large increases in crop yields, thus high profits only initially, have failed to be considered as the ideal approach for future.

The steady increase in corporate farming based conventional methods in the last few decades, primarily profit driven, has increased the destabilization of rural communities as well as speeded up the detrimental effects on both the farmland ecology and neighboring natural environments.

The expansion of urban population and business and industrial complexes has reduced the available farmland. The location of much of the world's primary and best quality farmland is in areas that are steadily becoming prime real estate for top end residential assets. In economic terms, farming simply cannot compete. The profits from transforming the farmland into

residential sub-divisions are astronomically higher than those achievable from farming it by any method.

The challenge for agriculture in the coming decades will be to increase productivity to meet the increasing demands for food and fiber while addressing risk and variability, and eco-efficiency will undoubtedly be a major challenge. Yield per unit land area is the simplest and most widely used eco-efficiency measure for field crops. However, there are multiple efficiency measures at play simultaneously, such as water use efficiency (crop yield per unit of water used, e.g., rainfall, stored soil moisture, and/or irrigation), nutrient use efficiency (crop yield per unit nutrient uptake or nutrient supplied), radiation use efficiency (crop biomass produced per unit radiation intercepted), labor efficiency (crop production per unit labor invested), and return on capital (profit as a fraction of capital invested).

3. Read the part of text and add messed words from box:

health risks dramatic shift drawbacks well-being mass extinction extensified farming generations food needs crop diversity ecosystem health

Sustainable agriculture, a system of_____that strives to provide the resources necessary for present human populations while conserving the planet's ability to sustain future_____. In the wake of World War II, the nature of agriculture both intensified, with more product harvested per unit area, and _____, with farms taking up a larger area. Subsequently, fewer and larger farms were able to meet the _____ of an increasing human population, constituting a _____from the numerous smaller farms of the past. Despite its efficiency, modern industrial agriculture has a number of _____, including the degradation of ecosystems and the related biodiversity loss, a loss of _____, numerous animal welfare concerns, and human _____. Sustainable agriculture seeks to address these issues and prioritizes "planetary health," the idea that the stability of the planet determines human _____. Its basic tenets include promoting socioeconomic equity, earning profit, and maintainin _____. Because modern agriculture has played a substantial role in precipitating a _____ of plant and animal species on Earth, sustainable agriculture actively endeavours to protect and support biodiversity.

4. Agroforestry has been referred to as one of the most powerful ways we can prevent desertification. Read the text about agroforestry and discuss about this practice – is it sutable to the agriculture in your region? [2, 9].

Agroforestry, cultivation and use of trees and shrubs with crops and livestock in sustainable agricultural systems. Agroforestry seeks positive interactions between its components, aiming to achieve a more ecologically diverse and socially productive output from the land than is possible through conventional agriculture. Agroforestry is a practical and low-cost means of implementing many forms of integrated land management (which seeks to reduce human impacts on land), and it contributes to a green economy by promoting long-term, sustainable, and renewable forest management, especially for small-scale producers. Although the modern concept of agroforestry emerged in the early 20th century, the use of woody perennials in agricultural systems is ancient, with written descriptions of the practice dating back to Roman times (*see* perennial agriculture). Indeed, integrating trees with crops and animals is a long-standing tradition throughout the world. In 2004 the World Bank estimated that agroforestry practices were being used by 1.2 billion people.

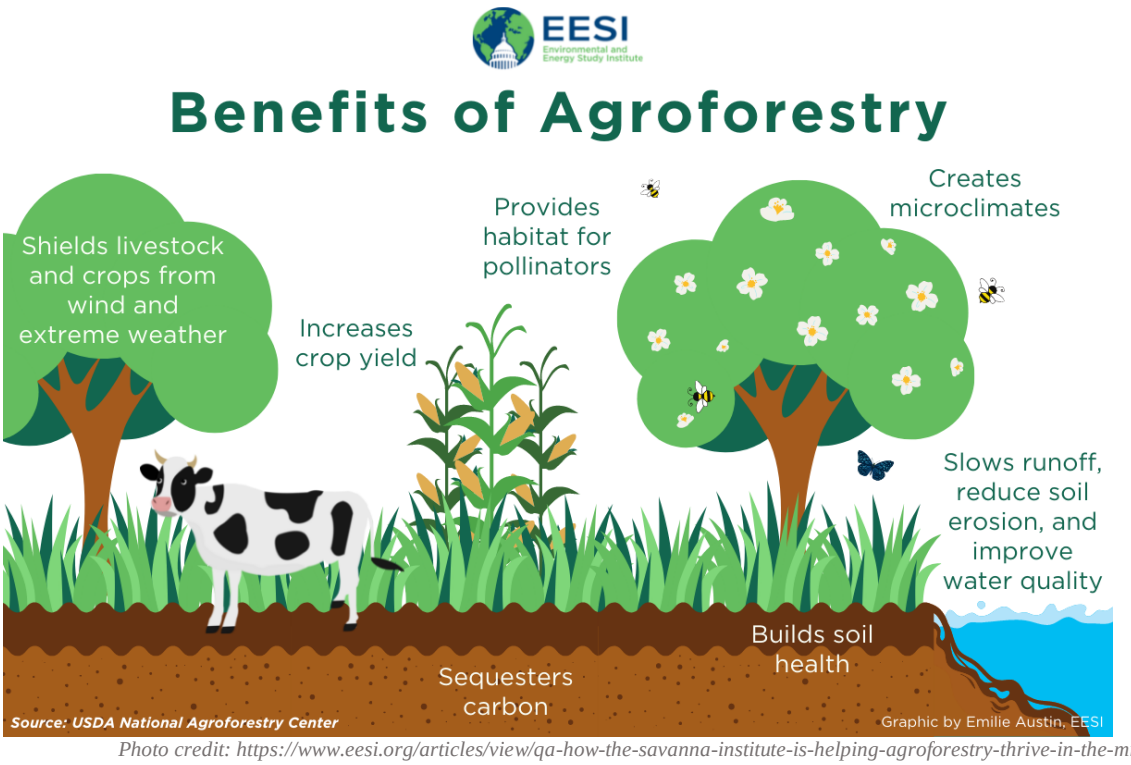


Photo credit: https://www.eesi.org/articles/view/qa-how-the-savanna-institute-is-helping-agroforestry-thrive-in-the-midwest

Agroforestry can occur at a variety of spatial scales (e.g., field or woodlot, farm, watershed) in different ecosystems and cultures. When properly applied, agroforestry can improve livelihoods through enhanced health and nutrition, increased economic growth, and strengthened environmental resilience and ecosystem sustainability. In turn, such improvements can contribute to increased social sustainability in which human needs are satisfied in a way that fosters environmental health. Farm diversification is a growing strategy for economic competitiveness, especially throughout the industrialized temperate zone, and agroforestry offers great promise for the sustainable production of specialty nut and fruit crops, high-value medicinals, dairy and beef cattle, sheep, goats, and biomass for biofuel. Agroforestry systems also yield proven strategies for long-term carbon sequestration, soil enrichment, biodiversity conservation, and air- and water-quality improvements, benefiting both the landowners and society.

The benefits of agroforestry derive from the interactions between trees and shrubs and crops and livestock. Agroforestry seeks to optimize positive interactions, such as mutualism and commensalism, and to minimize predation on crops and livestock and competition within and between species. Positive interactions may reduce stress to plants and animals, enhance yields, retain soil, and capture water. For example, the moist shaded microclimate under certain crop trees is beneficial for shade-tolerant crops such as turmeric or pineapple. Negative interactions, by contrast, can result in resource competition, more pests, excessive shading, and allelopathy (the release of biochemicals by one plant to suppress the growth of another). Black walnut and various eucalyptus trees, for example, are known to allelopathically inhibit the growth of certain annual crops planted near them.

Agroforestry systems are intensively managed to maintain their productive and protective functions through cultivation, fertilization, irrigation, pruning, and thinning. Ideally, components are structurally and functionally combined and actively managed to optimize the positive biophysical interactions between them. In some systems, for example, the trees are regularly coppiced (severely cut back), and the cuttings are applied as mulch to the soil. Such management not only encourages new tree growth but also augments the light levels reaching shaded crops, reduces weeds, and helps to maintain soil moisture.

Although American and Canadian temperate-zone agroforestry nomenclature differs from that used in the tropics and Europe, five temperate-zone agroforestry practices are generally recognized worldwide.

- Riparian and upland buffers: strips of permanent vegetation, consisting of trees, shrubs, grasses, and forbs planted and managed together
- Windbreaks: trees or shrubs planted and managed as barriers to reduce wind speed as a part of a crop or livestock operation
- Alley cropping (known as silvoarable agroforestry in Europe): trees planted in multiple rows combined with crops cultivated in the alleyways between the tree rows
- Silvopasture (also known as agrosilvopastoral agroforestry): trees combined with forage (pasture) and livestock production
- Forest farming: cultivation of high-value specialty crops under the protection of a forest overstory that provides an appropriate microclimate

5. Analyze the scheme below: what are main parts of agroforestery system?

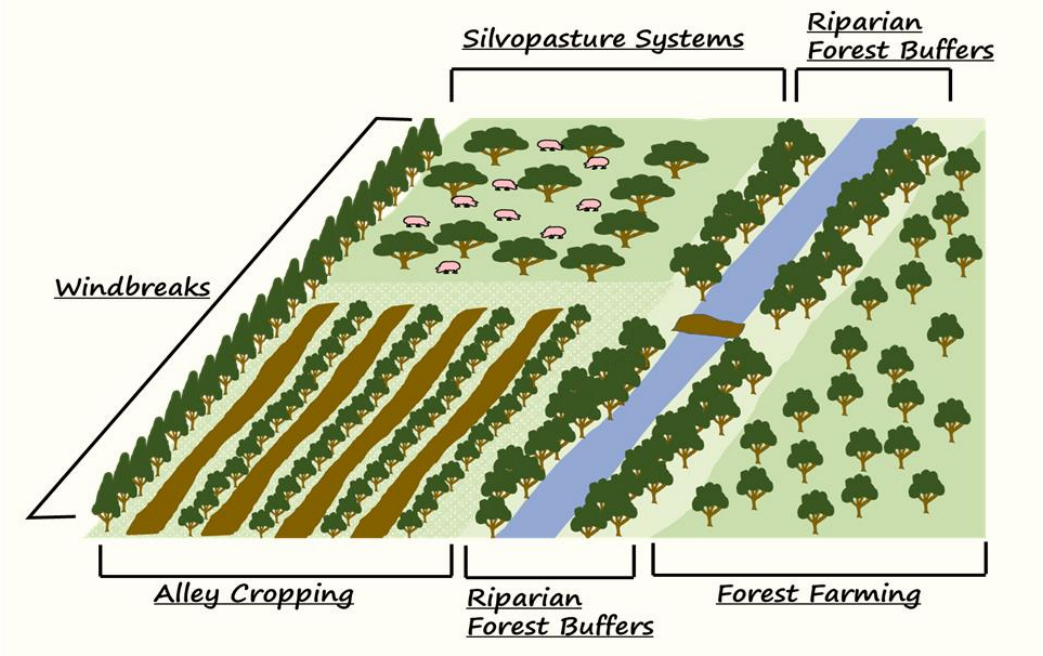


*Photo credit: https://miro.medium.com/v2/resize:fit:1400/format:png/1*ck8sFvhzmFgfB2CNG1m1Hg.png*

6. Watch the video with a successful example of agroforestry system

7. Prepare presentation about one of the sustainable agricultural practices:

1) Natural Pest Management; 2) Hydroponics and Aquaponics; 3) Crop Rotation; 4) Polycultures; 5) Permaculture; 6) Biodynamic Farming; 7) Urban Agriculture.

UNIT 11
ECOSYSTEMS RESTORATION

1.1. What are the causes of ecosystem degradation? What possible recovery measures do you know?

1.2. Watch the video "What is ecosystem restoration?"

2. Did you know that the United Nations has declared 2021-2030 as the "UN Decade on Ecosystem Restoration"? Read the text about ecosystem restoration [39]:

Ecosystem restoration means assisting in the recovery of ecosystems that have been degraded or destroyed, as well as conserving the ecosystems that are still intact. Healthier ecosystems, with richer biodiversity, yield greater benefits such as more fertile soils, bigger yields of timber and fish, and larger stores of greenhouse gases.

Restoration can happen in many ways – for example through actively planting or by removing pressures so that nature can recover on its own. It is not always possible – or desirable – to return an ecosystem to its original state. We still need farmland and infrastructure on land that was once forest, for instance, and ecosystems, like societies, need to adapt to a changing climate.

Between now and 2030, the restoration of 350 million hectares of degraded terrestrial and aquatic ecosystems could generate US$9 trillion in ecosystem services. Restoration could also remove 13 to 26 gigatons of greenhouse gases from the atmosphere. The economic benefits of such interventions exceed nine times the cost of investment, whereas inaction is at least three times more costly than ecosystem restoration.

All kinds of ecosystems can be restored, including forests, farmlands, cities, wetlands and oceans. Restoration initiatives can be launched by almost anyone, from governments and development agencies to businesses, communities and individuals. That is because the causes of degradation are many and varied, and can have an impact at different scales.

For instance, degradation may result from harmful policies such as subsidies for intensive farming or weak tenure laws that encourage deforestation. Lakes and coastlines can become polluted because of poor waste management or an industrial accident. Commercial pressures can leave towns and cities with too much asphalt and too few green spaces.

Restoring ecosystems large and small protects and improves the livelihoods of people who depend on them. It also helps to regulate disease and reduce the risk of natural disasters. In fact, restoration can help us achieve all of the Sustainable Development Goals.

3. **Before beginning an ecosystem restoration project, several critical steps must be taken to ensure its success. Analyze scheme below. Which steps are there? Describe in several sentences each stage.**

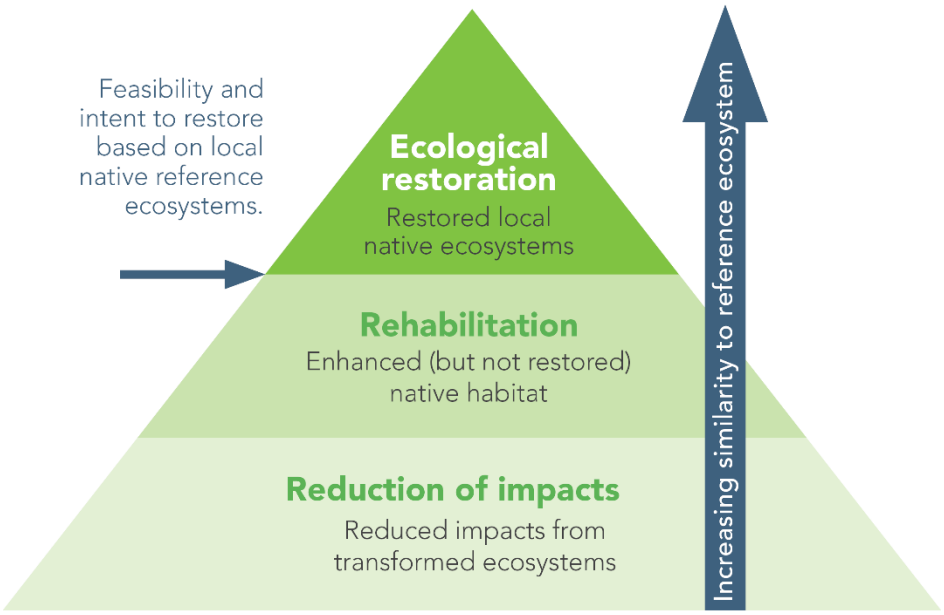


Photo credit: https://seraustralasia.com/standards/appendix1.html

4. **Restoration case: Grassland restoration [10, 18].**

Grassland ecosystem restoration revolves around reinstating the natural processes that maintain healthy, dynamic grassland ecosystems. This involves a combination of strategies including removing invasive species, reseeding native plants, managing fire regimes, and sometimes reintroducing wildlife species that were once part of the ecosystem. Each restoration project is unique, tailored to the specific conditions and ecological goals of the area in question.

Integrating livestock grazing into grassland restoration can be a powerful tool if managed properly. Controlled grazing encourages the growth of native species, reduces the dominance of any single species, and can help maintain the open structure characteristic of healthy grasslands. This mimicry of natural grazing patterns by wildlife promotes a more diversified plant community and addresses one of the key challenges in grassland restoration.

Grasslands are more than just vast expanses of open land; they are ecosystems that provide invaluable services. They act as carbon sinks, capture rainwater, mitigate flooding, and support a diversity of plant and animal species. Restoration efforts in these areas are essential to restore their ecological balance. The benefits of restoring grasslands extend beyond environmental health, influencing economic stability and social wellbeing through enhanced ecosystem services.

Example of Grassland Restoration: the reintroduction of bison to grasslands can significantly impact their ecosystem. Bison grazing patterns help in seed dispersal and breaking compacted soil, which facilitates the growth of native plants and the restoration of biodiversity.

Primary steps in grassland restoration and management:

The primary steps in grassland restoration and management involve several key activities designed to recover these ecosystems to a healthy and sustainable state. A structured approach ensures the restoration efforts are both efficient and effective.

- Site assessment to understand the current conditions and define the restoration goals.
- Removal or control of invasive species that threaten native biodiversity.
- Reintroduction of native plant species through seeding or planting.
- Soil enrichment and stabilization techniques to improve fertility and prevent erosion.

- Adaptive management practices, including controlled burns and grazing, to maintain ecosystem health.

5. Analyze the table "Steps of restoration" [8]. Explain each restoration technique. Try to find more in literature and Internet resources.

No.	Restoration technique	Details
1	Protection	Total protection from cutting of vegetation, cattle and fire is the first step. The same can be achieved with dry fence and live hedge. Identification and protection of safe sites.  
2	Soil and moisture conservation	Erosion-prone areas or slopes needs to be worked on with the help of local materials like stones and boulders to arrest soil and reduce water velocity.   
3	Vegetation management	Protection to existing flora, stage wise natives plantation (initially hardy plants and then desired plants), removal of invasive non-natives etc.  
4	Habitat creation	Creation of rock piles, log piles, wetlands, plantation of larval host plants, shrub clusters etc.  
5	Plantation (Native plants)	Selecting appropriate native plants as per the current status of the soil and land.
6	Seed dispersal (Native plants)	One of the easiest ways to introduce native plants and test regenerating capacity of the soil.

6. Restoration case: Rewilding [42].

Rewilding is a progressive approach to conservation. It's about letting nature take care of itself, enabling natural processes to shape land and sea, repair damaged ecosystems and restore degraded landscapes. Through rewilding, wildlife's natural rhythms create wilder, more biodiverse habitats.

Rewilding occurs in three key ways:

1) Habitat Restoration. We return degraded or fragmented habitats to their natural state by removing barriers, such as dams or fences, and letting the wild shape the landscape. Habitat

restoration may also involve reestablishing natural water flows, reforestation, and restoring wetlands or grasslands.

2) Species Reintroduction. We restore balance to the wild by returning native species to ecosystems where populations have either disappeared or been severely reduced. Species reintroductions are often supported by conservation breeding programs.

3) Ecological Management. Active land management supports ecosystems in various stages of recovery and helps ensure the successful reintroduction of species. Human beings are a part of the wild, and critical to its protection.

7. Rewilding should be central to the restoration efforts to overcome the biodiversity crisis while also enhancing the biosphere's capacity to mitigate human-induced climate change in a resilient manner [31]. Based on the picture below explain how the rewilding could help to restore ecosystems in a global scope.

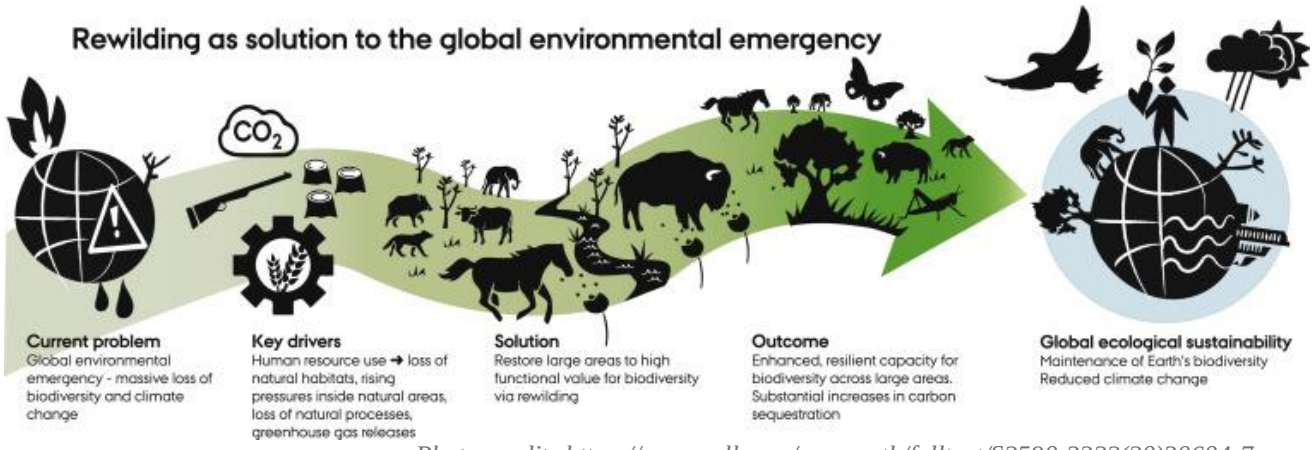


Photo credit: https://www.cell.com/one-earth/fulltext/S2590-3322(20)30604-7

8. Find examples of successful restoration and rewilding projects via qr-codes:

9. Students' Research. Using the different restoration database (e.g. NOAA Restoration Atlas) choose a restoration project and research it.

Following the research, present your findings. Include in the presentation answers to the following questions:

1) What caused damage to natural resources?
2) What economic and social consequences resulted from this damage?
3) What restoration activities were undertaken?
4) Who undertook these activities?
5) What ecological, economic and social benefits have been achieved through restoration activities?

UNIT 12
INTERNATIONAL ENVIRONMENTAL POLICY AND REGULATIONS

1.1. Discussion. Why is legislation in the field of environment and ecology necessary? What environmental problems require legislative regulation?

1.2. Analyze the diagram. What are the main objectives of environmental policy.

Photo credit: https://depositphotos.com/photo/diagram-of-sustainable-development-75332431.html

2. Read the text about environmental policy [22]:

What is an Environmental Policy?

Policy refers to a set of principles or plans agreed upon by a government or an organization to be carried out in a particular situation. Environmental policy is defined as "any action deliberately taken to manage human activities with a view to prevent, reduce, or mitigate harmful effects on nature and natural resources, and to ensure that man-made changes to the environment do not have harmful effects on human or the environment".

Environmental policy usually covers air and water pollution, waste management, ecosystem management, biodiversity protection, and the protection of natural resources, wildlife and endangered species. Proper policies and legislations at the national and the international levels can reduce the venomous pollution and help protect biodiversity and natural resources.

What is an Environmental Legislation?

Environmental legislation is a set of laws and regulations which aim at protecting the environment from harmful actions.

Legislation may take many forms, including regulation of emissions that may lead to environmental pollution, taxation of environment- and health-damaging activities, and establishing the legal framework for trading schemes, for example, carbon emissions. Other actions may rely on voluntary agreements. Among major current legislative frameworks are those relating to environmental permitting, and those mandating environment and health impact assessments.

3. Read the text and look at the diagram below. Describe the timeframe of environmental legislation development [15].

The United Nations first convened countries to address the global environment at the 1972 UN Conference on the Human Environment in Stockholm. The Stockholm conference highlighted the international aspects of emerging environmental challenges and legitimized the environment as an area for international cooperation. The Stockholm conference also created the United Nations Environment Programme (UNEP)— an institutional home for environmental protection in the United Nations. Headquartered in Nairobi, Kenya, UNEP continues today to be a leading catalyst for global environmental cooperation.

Since the 1972 Stockholm Conference, the world has met regularly in a series of major summits aimed at shifting the world generally toward a path of sustainability. The most important by far has been the 1992 UN Conference on Environment and Development (UNCED), also known as the Rio "Earth Summit". Virtually every world leader attended the Earth Summit, where they agreed to three major treaties (addressing climate change, biological diversity and desertification), and a 500-page blueprint for sustainable development (known as Agenda 21).

Sustainable development was also the organizing framework for major environment and development summits in Johannesburg in 2002 and Rio again in 2012 (the Rio+20 Summit). These summits are big affairs, attended not only by governments but also by thousands of civil society and private sector representatives. Reflecting this wider audience, the recent UN-sponsored Summits have promoted public-private Partnerships for Sustainable Development and more recently led to adoption of the Sustainable Development Goals (SDGs). These non-binding goals serve as a strategic plan for coordinating the global community toward achieving concrete, measurable goals by 2030.

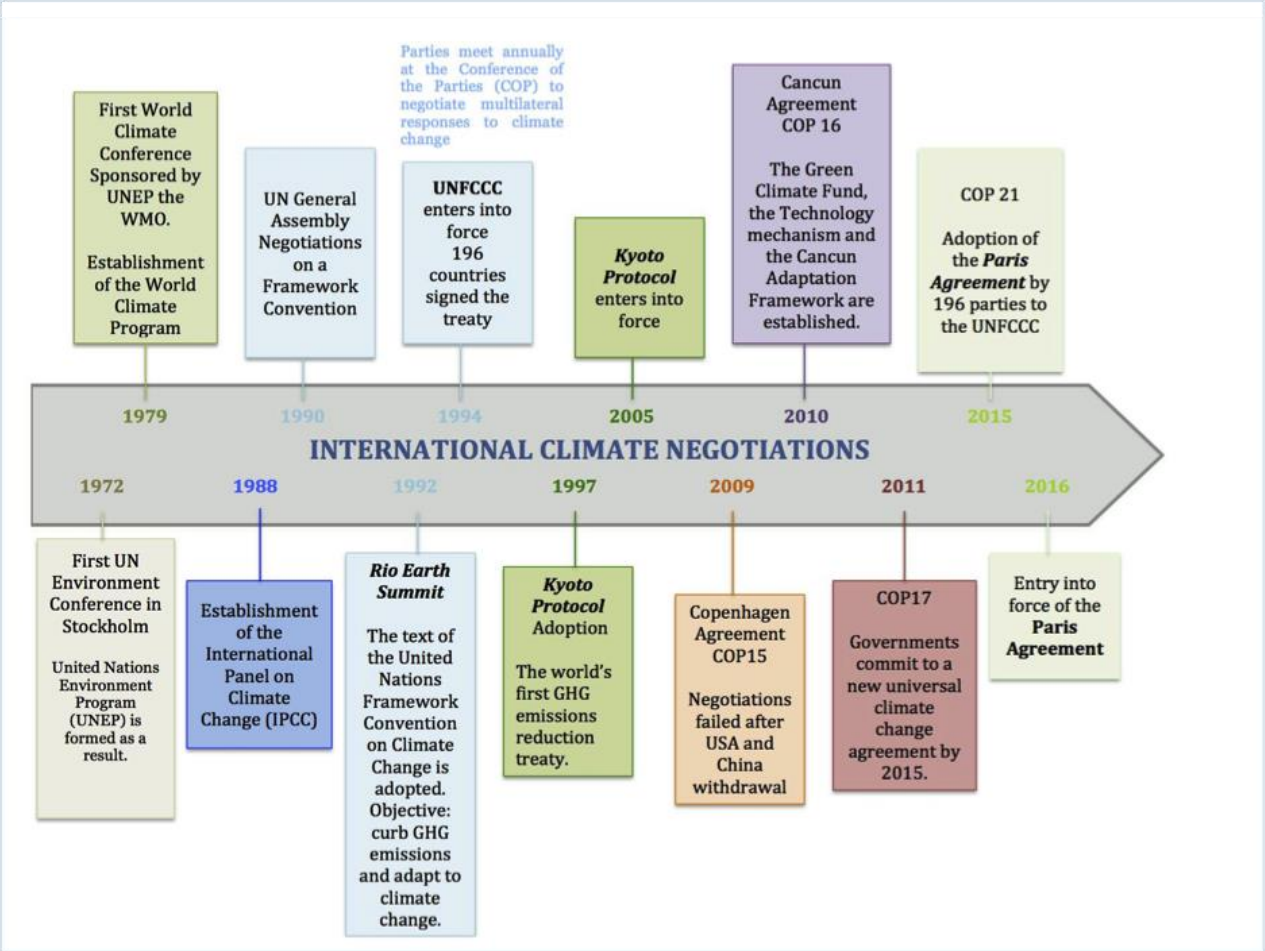


Photo credit: https://studentclimates.wordpress.com/2017/05/02/international-climate-negotiations-where-we-at/

4. **Choose one of the International environmental laws and prepare a presentation or poster with the analysis of the main provisions of it.**

5. **One of the biggest environmental problems on a planetary scale is climate change. That is why most laws and regulatory documents have been developed in the field of climate change. Read the text and study the infographics in the text [15]. Evaluate the effectiveness of climate policy. Does it work in Ukraine?**

At least since the 1980s, scientists have warned that increasing concentrations of carbon dioxide and other greenhouse gases would warm the earth's atmosphere and change our climate. Today, climate change is the most serious environmental challenge of our time, and we are already seeing its impacts: increased global temperatures; melting glaciers; reduced Arctic sea ice; increased tidal and storm surges; and increased heat waves and droughts.

Avoiding the most dangerous impacts from climate change has been a major focus of international environment law since the 1992 United Nations Framework Convention on Climate Change (the UNFCCC), which recognized climate change as "a common concern of humankind" and set out a framework for global action to avoid harmful impacts. The Convention set an informal goal to reduce emission levels of greenhouse gases to 1990 levels by the year 2000, but it did not impose any binding targets or timetables on any country.

Thirty-eight industrialized countries subsequently agreed in the 1997 Kyoto Protocol to reduce their overall emissions to approximately 5 percent below 1990 levels by the year 2012. Having agreed to cap emissions, the countries also established elaborate procedures for trading the rights to pollute under the cap. The Kyoto Protocol's "cap-and-trade" approach thus envisioned a global market for reducing carbon dioxide and other greenhouse oases. The United States first signed the Protocol in 1998 but rejected it three years later after President Bush took office. The Kyoto Protocol would catalyze Europe's reduction in GHG emissions and create a market for GHG emission credits--but the departure of the United States from the Protocol and the need to include China and other major emitting countries would lead to a search for a different approach. That approach would (finally) come in the form of the 2015 Paris Agreement on Climate Change.

The Paris Agreement, which sits within the framework established by the 1992 UNFCCC, significantly advanced the world's effort to address climate change. For the first time, all countries, including the two largest emitters (China and the United States), pledged to take serious — if not binding — commitments. The governments endorsed a specific global average temperature goal— of "well below" 2°C increase over pre-industrial levels —as the temperature that would give the world a reasonable chance of avoiding the worst climate impacts. The Parties also signaled that if necessary, they will "*pursue* efforts" to limit the temperature increase to 1.5 °C.

Most significantly, the Paris Agreement signaled a long-term shift from fossil fuels as Parties agreed to reach a "global peaking" of GHG emissions "as soon as possible" and "to undertake rapid reductions thereafter" to achieve a balance between net GHG emissions and removals in the "second half of this century. Achieving this post-2050 goal does not necessarily require the elimination of fossil fuels, because efforts could also increase GHG removals from the atmosphere, for example by growing more trees or by developing effective carbon capture technology.

Having set long-term shared goals, the Paris Agreement deemphasized the cap-and-trade approach of prior negotiations in favor of a "pledge-and-review" approach, relying primarily on each country's commitment or "nationally determined contribution" (NDC) to reduce climate change. By the end of the Paris negotiations, 186 countries would announce an NDC. The United States, for example, agreed to reduce by 2020 its overall GHG emissions 26-28% from 2005 levels, and China agreed among other things to peak their emissions and improve their GHG

efficiency by 60-65% by 2030. Each party's implementation of their pledge would be subject to some form of monitoring, reporting and verification.

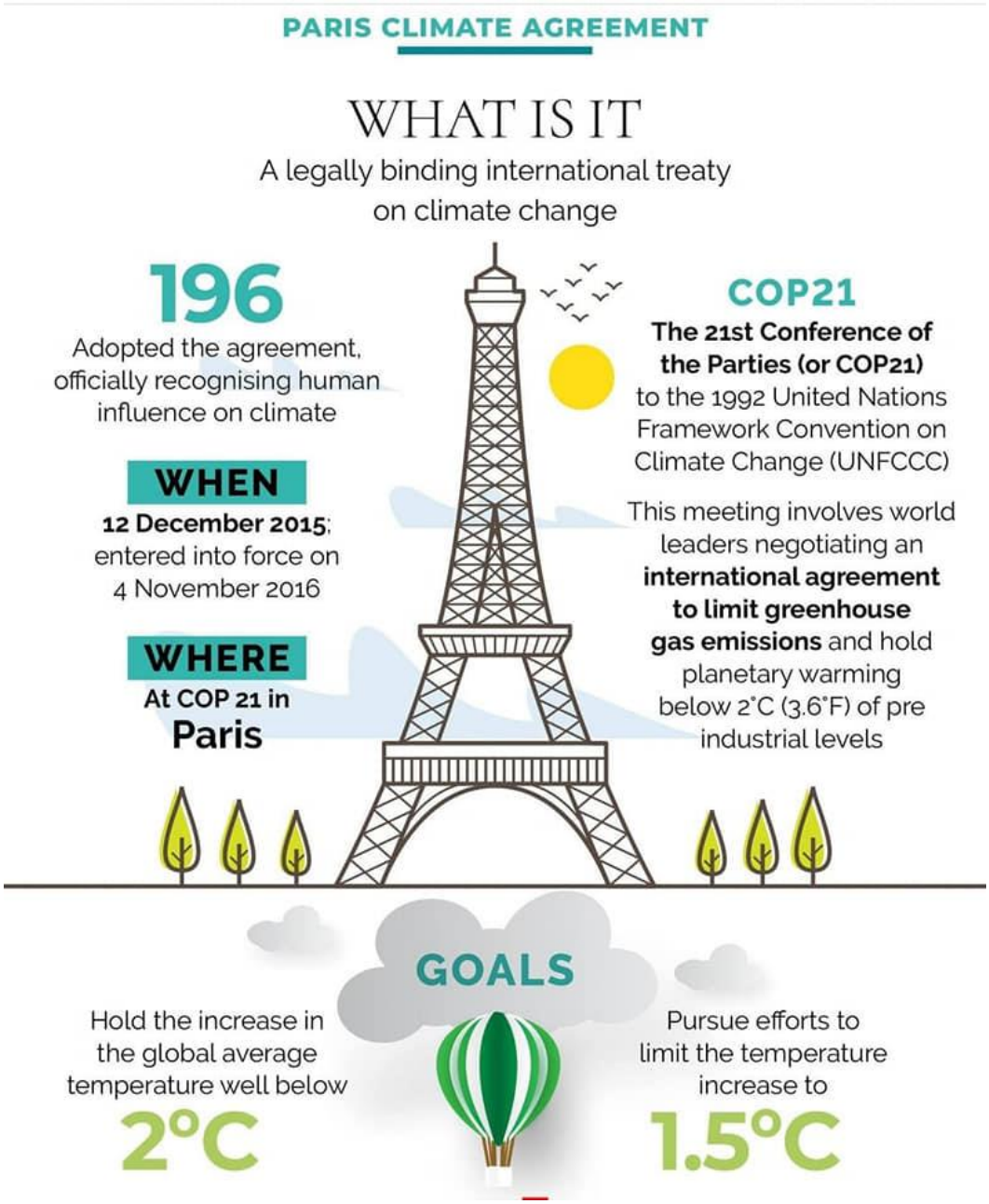


Photo credit: https://wri.org.cn/en/data/cop21-major-outcomes

The primary weakness of the Paris Agreement's approach is that an "ambition gap" exists between the countries' cumulative pledges and what is scientifically necessary to avoid the worst climate impacts. Indeed, current commitments are estimated to allow an increase in global average temperatures somewhere between 2.5 and 3.7 °C, well above safe levels. The parties acknowledged the need for reviewing their NDCs every five years, beginning in 2020. Successive commitments are supposed to build on previous commitments, taking into account each country's particular circumstances.

The Paris Agreement not only aimed at reducing GHG emissions but also at maintaining forests, improving land-use, expanding financial and technical resources for developing countries, supporting adaptation to unavoidable climate change impacts and compensating those who suffer loss and damage from climate change. Both in the large number of countries making commitments and of issues addressed, the Paris Agreement was most comprehensive effort yet

to address climate change. Nonetheless, the Trump Administration has renounced Paris Agreement, leaving the United States once again isolated globally with respect to fighting climate change.

Climate change currently dominates all other environmental issues, but other multilateral environmental agreements address other critical environmental challenges.

6. Read the text "Where do we stand" and add missing words from box:

awareness-raising affairs planet policies crisis initiatives damage increasingly generations

After reviewing the most important milestones related to global efforts to address the serious environmental _____ we are experiencing, it is inevitable that we will be plunged into deep concern.

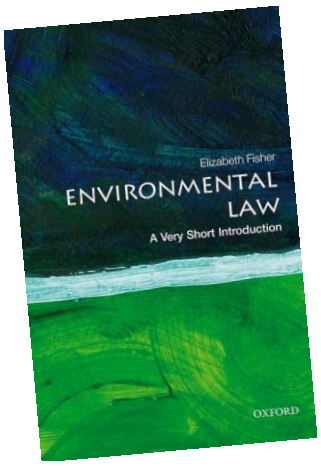
Global _____ have not succeeded in motivating the change of direction we need for our planet to begin to regain its health. As it stands, no one can ensure that future _____ will be able to meet their needs as past and present generations have done.

Despite _____ are discussed and where IEL (international environmental laws) takes shape. Although these initiatives have not yet been able to stop the environmental crisis, they have strengthened IEL as an instrument to defend our causes.

Likewise, world conferences often become platforms for large-scale protests and _____ campaigns directed by global civil society, which has become _____ alert and determined to defend our environment.

Today, much of the hope for change lies in the strength of civil society, especially in the young people who have awakened and come to the defense of the _____. This force finds in IEL a point of support to demand what we need: a resounding change in the model of development that still guides the _____ of the planet, and which is causing so much _____.

7. Find video with Elizabeth Fisher, the author of Environmental Law: A Very Short Introduction gives her top 10 things you should know about Environmental Law. Professor Elizabeth Fisher is a Professor of Environmental Law in the Faculty of Law and at Corpus Christi College, University of Oxford. She has won awards for both her teaching and her scholarship, and she is a General Editor of the Journal of Environmental Law.



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BONUS

The best 20 Ecology books

1. “The Hidden Falter” by Bill McKibben
2. “Changes in the Land” by William Cronon
3. “Life of Trees” by Peter Wohlleben
4. “The Forest Unseen” by David George Haskell
5. “The Sixth Extinction” by Elizabeth Kolbert
6. “Silent Spring” by Rachel Carson
7. “Zero Waste Home” by Bea Johnson
8. “The New Climate War” by Michael E. Mann
9. “The Uninhabitable Earth: Life After Warming” by David Wallace-Wells
10. “The World Is Blue” by Sylvia A. Earle
11. “Cadillac Desert” by Marc Reisner
12. “The Diversity of Life” by Edward O. Wilson
13. “The Song of the Dodo” by David Quammen
14. “The Death and Life of the Great Lakes” by Dan Egan
15. “Gathering Moss” by Robin Wall Kimmerer
16. “Lab Girl” by Hope Jahren
17. “Prodigal Summer” by Barbara Kingsolver
18. “World as Lover, World as Self” by Joanna Macy
19. “The End of Nature” by Bill McKibben
20. “No Impact Man” by Colin Beavan

The best 20 environmental films

1. The Human Element (2019)
2. Before the Flood (2016)
3. Eyes of the Orangutan (2021)
4. 2040 (2019)
5. An Inconvenient Truth (2006)
6. RiverBlue (2017)
7. Artifishal (2019)
8. Chasing Coral (2017)
9. David Attenborough: A Life on Our Planet (2020)
10. My Octopus Teacher (2020)
11. The Ivory Game (2016)
12. Racing Extinction (2015)
13. Cowspiracy: The Sustainability Secret (2014)
14. Virunga (2014)
15. No Impact Man (2009)
16. Food Inc. (2008)
17. Catching the Sun (2015)
18. Just Eat it! A Food Waste Story (2019)
19. Extinction: The Facts (2020)
20. The Day After Tomorrow (2004)

NOTES

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