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Office for Climate Education

UNDER THE AUSPICES OF UNESCO
AND THE FOUNDATION LA MAIN À LA PÂTE

CLIMATE CHANGE AND LAND
SUMMARY FOR TEACHERS

BASED ON THE IPCC SPECIAL REPORT ON CLIMATE CHANGE AND LAND (SRCCL)

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SUMMARY FOR TEACHERS

Climate change and land

Based on the IPCC Special Report on Climate Change and Land (SRCCL).

Land is where we live.
Land is under growing human pressure.
Land is a part of the solution.
But land can't do it all.

Summary

Introduction

The Intergovernmental Panel on Climate Change (IPCC) is an international body established in 1988 by the United Nations to assess the science related to climate change. It aims to provide policymakers with regular assessments of the scientific understanding of climate change and its impacts as well as possible mitigation and adaptation options. IPCC assessments are written by hundreds of scientists from around the world and formally adopted by the governments of its 195 member countries.

Accounting for approximately 23% of all greenhouse gas emissions, land contributes to climate change, but is also vulnerable to climate change impacts. To understand this relationship further, the IPCC decided to produce a *Special Report on Climate Change and Land*. Written by more than 100 scientists from 52 countries, the report was finalised and adopted by all IPCC member governments in Switzerland in August 2019.

Since the IPCC reports are not adapted to teachers' needs, the Office for Climate Education compiles summaries for teachers, alongside activities and exercises that may serve as examples for teachers to work on the topic.

This summary for teachers is based on the IPCC *Special Report on Climate Change and Land*. Some information are also taken from other institutional reports.

1. Land is a critical resource

LAND IS FINITE

The land is where we live. **It is essential to our existence and wellbeing**, as it provides most of our **food, feed (food for livestock), fibre, timber and energy.** Today, humans work about three quarters of the global ice-free land surface (see Figure 1). How we choose to manage the land not only affects the livelihoods of billions of people but also impacts the natural ecosystems that survive on the land and help maintain **ecosystem services** like air and soil quality, flood and disease control, or pollination. Land is finite, and, as the human population increases, **we rely on the land like never before.** When damaged, the resulting losses are substantial and **difficult to restore.**

A growing global population and changing lifestyles have increased our consumption of the land's resources. **Currently, agriculture accounts for 70% of global freshwater use and food production has increased by about 30% since 1961.** Not only has the world's population grown, but diets have evolved – especially in recent decades. This has changed the way we use the land for farming. **Our diets are more energy-dense**: high in fat with a large share of vegetable oils, meat and sugar. These dietary changes have contributed to about two billion adults being overweight or obese. Yet, **around 821 million people are still undernourished, despite 25–30% of total food produced being lost or wasted.**

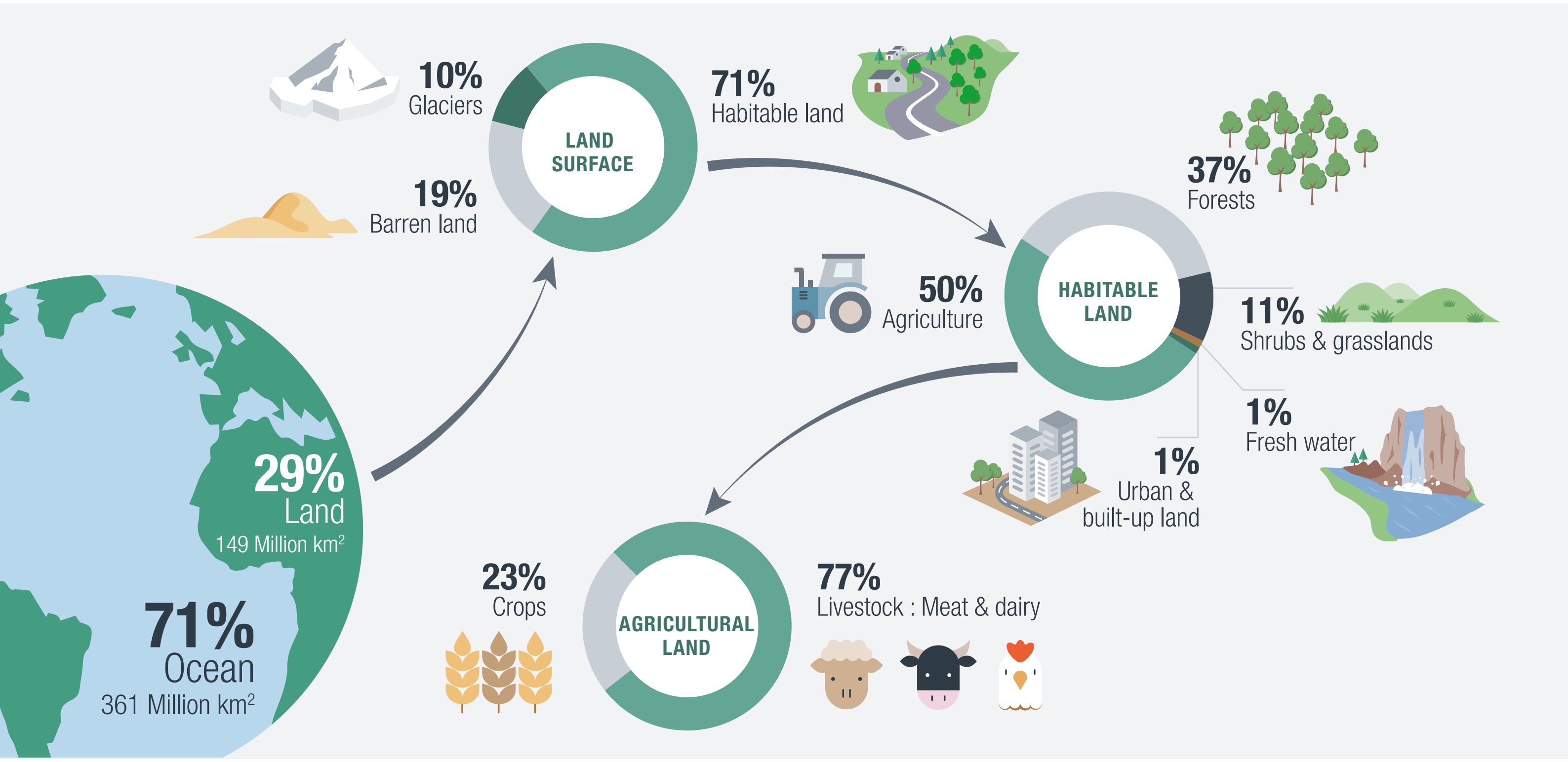

FIGURE 1 How the land is used (~2015). Although human settlements (cities, towns and villages) only take up about 1% of the total ice-free land surface, we use the land for many different purposes.

UN Food and Agriculture Organization (FAO), Licensed under CC-BY by the authors Hannah Ritchie and Max Roser in 2019. Adapted from an infographic by Azote.

LAND AS PART OF THE CLIMATE SYSTEM

Land exchanges energy, water, aerosols and greenhouse gases with the atmosphere and with the ocean – through both human and natural mechanisms. Thus, land plays a very important role in the climate system. Since the industrial revolution, humans have modified the balanced exchange of greenhouse gases at these interfaces by emitting huge amounts of greenhouse gases into the atmosphere – thus causing global warming. But land could also be the solution to mitigate climate change, since it is not only a source of greenhouse gases, but also a sink (meaning it can remove greenhouse gases from the atmosphere, primarily through photosynthesis).

CLASS ACTIVITY # TASKS AND QUESTIONS

Look up the meat consumption statistics for your country.

- How many kilograms of meat does every person in your country eat?
- Compare this consumption with other countries.
- How has meat consumption evolved in the last 10 to 50 years in your country / in the world?

Find information about percentages and sources of food loss and waste.

- Think of ways to reduce food waste.
- Check if there are apps or initiatives in your country or town to help redistribute surplus food from private households, restaurants and shops / supermarkets.
  Answer: Foodsharing, OLIO, Too Good To Go, ResQ Club, etc.

CLIMATE CHANGE ALTERS THE LAND

Human activities are the cause of global warming. Since pre-industrial times, the mean temperature on land and at sea has risen, but **the land temperature has risen much more (about 1.53°C since 1850)** than the global mean temperature (about 0.87°C since 1850). There are two main reasons for the difference between land surface temperature and ocean surface temperature. First, land is mostly made of solid constituents, so it has a lower heat capacity than the ocean, which is liquid water. Land needs less heat for its temperature to rise. Additionally, when the ocean temperature rises, there is a converse cooling effect when ocean water evaporates. On the land, there is less water, so the cooling effect of evaporation is smaller.

Amongst the most damaging impacts of climate change on land are **extreme events.** Warming has led to an **increase in the frequency and intensity of extreme events** like heatwaves, droughts, and heavy rainfall. Also, dust storms are occurring more frequently and are more intense – this is mainly due to the expansion of dry areas and desertification.

As more CO_2 is emitted into the atmosphere and the world gets warmer, the land's vegetation responds to these changes. Over the last 30 years, **vegetation greening trends** (increase in vegetation productivity) have been observed in parts of Asia, Europe, South America, central North America, and southeast Australia, due to **longer growing seasons: plants have more CO_2 to photosynthesize, plus land management has changed** (different watering mechanisms and fertilization practices are being used).

In other regions, however, such as in parts of northern Eurasia, North America, Central Asia and the Congo Basin, the opposite has been observed: **vegetation browning** (decrease in vegetation growth or death of vegetation) is largely due to water stress from climate and land use change, but also due to wildfires and climate-related droughts. In fact, in some places, **entire climate "zones" are moving location**: for example, polar climate zones are getting smaller and arid climate zones are expanding.

HUMANS ALTER THE LAND

When land loses its soil quality, vegetation, water resources or wildlife then it is said to have been degraded. In the twentieth century, land degradation accelerated partly due to increased extreme events like droughts and flooding, and also due to human land use change such as urbanization, deforestation and intensive agriculture. **Today, about one quarter of the Earth's surface is subject to human-induced land degradation. Climate-change-induced land degradation** such as coastal erosion, exacerbated by sea level rise, thawing permafrost or extreme soil erosion, **can result in forced migration, conflicts and poverty.**

Desertification is an extreme form of land degradation in arid or semi-arid areas. **Between 1980 and the 2000s, about 500 million people lived in regions which experienced desertification.** Climate change exacerbates land degradation processes, particularly in environments such as low-lying areas, river deltas, drylands and permafrost areas, which **impacts the lives of people all over the world,** particularly the populations of South-East Asia, the Sahara, North Africa and the Middle East.

Desertification contributes to global warming since the vegetation that could potentially absorb CO_2 from the atmosphere is gone. On the other hand, the decrease in vegetation cover increases the albedo (deserts are "whiter" than forests) and so reflects more light than land covered with vegetation. This leads to cooling.

Deforestation releases CO_2 and eliminates one of the ways by which CO_2 is removed from the atmosphere (photosynthesis). The FAO estimates that between 1990 and 2019, about 420 million hectares of forest – corresponding to approximately half the area of the United States – have been lost worldwide due to deforestation, a large part of it due to the transformation of the Amazon rainforest into agricultural land. In 2020, another 10 million were lost.

Soils are constantly exchanging carbon between the land and the atmosphere. Today, **soils capture more carbon than they release.** However, when land and especially soils are degraded, this results in a net increase in **greenhouse gas emissions into the atmosphere.**

CLASS ACTIVITY # TASKS

— Use the information from the previous sections to create a mind map illustrating how humans transform land.

— List all the reasons that you can think of to explain why land and its biodiversity are important for a) humans, b) animals and plants, c) the Earth's climate.
Answer: regulating the water cycle, pollination, food chains, leisure, etc.

— Explain why the mean land surface air temperature has increased almost twice as much as the mean surface air temperature over land and ocean.

— List measures to fight desertification on a local scale. You may do an internet search
Answer: Planting trees and shrubs is a way to lower the temperature and increase the humidity.

— With the help of your teacher, plan and conduct an experiment to show that a surface with higher albedo heats up less than a surface with lower albedo.

— List 10 words that represent the desert.
— Write a poem with those words.

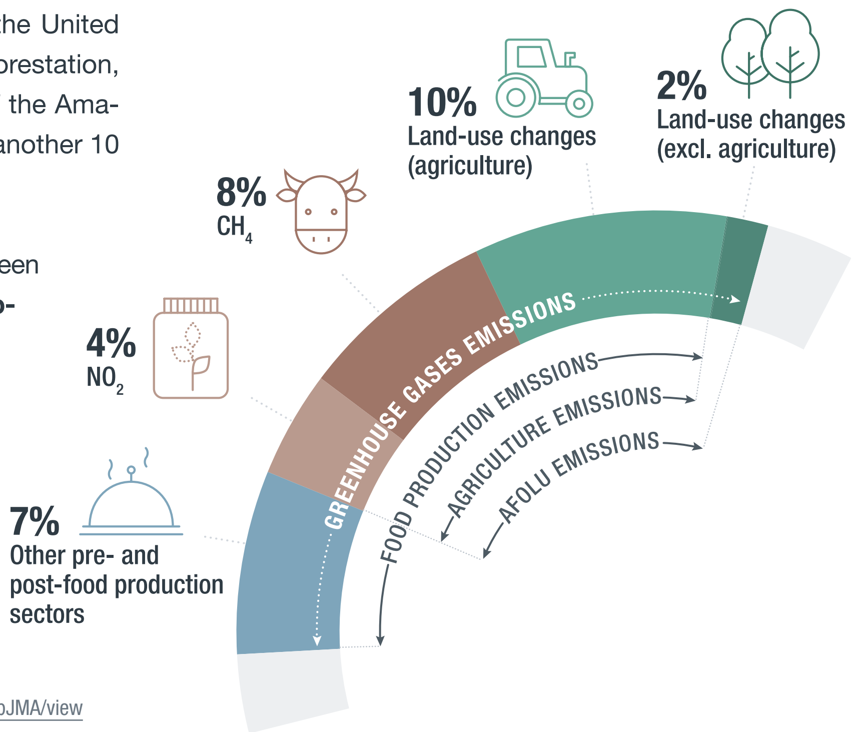

FIGURE 2 Greenhouse gases emissions linked to Agriculture, Forestry and Other Land Use (AFOLU) and food.

Citoyens pour le Climat (adaptation). Summary report based on the IPCC Climate Change and Land report.
https://drive.google.com/file/d/17H99ekMQ7j9ErgXTQUKP5s0-qQ4-pJMA/view

CLASS ACTIVITY # TASKS

Look up the global warming potentials of methane, nitrous oxide and carbon dioxide.

— Name and explain the main sources of methane in agriculture.

There is rarely a single solution.

— Discuss the pros and cons of grazing cattle and how livestock should be kept in order to have the least harmful effect on the environment and the climate. In particular, discuss and debate whether having no livestock at all would be the best solution.

For background information, you can watch the TED Talk by the Zimbabwean ecologist Allan Savory: https://www.ted.com/talks/allan_savory_how_to_fight_desertification_and_reverse_climate_change/discussion

— Find out what crops, vegetables and fruit are grown in your region / country.
— Which ones have a high / low nutrient uptake and require a lot of fertiliser?
— Which ones need irrigation?
— Find out if there are crops that have started to be grown recently (like grapes for sparkling wine in England) due to climate change.

Carbon fertilization is also known as **carbon dioxide fertilization.** This is when the increase of carbon dioxide in the atmosphere increases the rate of photosynthesis in plants.

— Explain why CO_2 fertilization is a CO_2 sink.
— Discuss the statement (a typical objection of climate sceptics) in your class: "With increasing CO_2 concentration in the atmosphere, crop yields are increasing. Global warming is good for eradicating hunger."

Hint 1: More CO_2 leads to more biomass; however, the amount of nutrients does not increase (the amount of nutrients per kilogram of biomass decreases).

Hint 2: Even if higher biomass seems like a positive effect, think of all the negative effects of higher CO_2 levels (higher temperature, sea level rise, etc.).

Imagine you are a scientist:

— How would you monitor desertification, deforestation or permafrost thawing?

Although greenhouse gas emissions from fossil fuel combustion are substantially larger, emissions from land are still significant: **all human land use activities combined contribute to around 23% of total human greenhouse gas emissions** (see Figure 2).

The three main greenhouse gases related to the land are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Methane and nitrous oxide are closely linked to agriculture and both have a higher global warming potential (see glossary) than carbon dioxide.

The main sources of methane in agriculture are paddy rice farming and livestock, whereas nitrous oxide is primarily emitted by the extensive use of manure and synthetic fertilizers. Between 2007 and 2016, **the land sector accounted for around 13% of carbon dioxide, 44% of methane, and 81% of nitrous oxide emissions caused by human activities.**

Closely linked to agriculture is **the food system** which encompasses food production, transportation, manufacturing, retailing, consumption, and food waste. **The global food system is responsible for 21-37% of the total net anthropogenic greenhouse gas emissions,** with future emissions projected to increase due to population, income growth and changes in consumption patterns and lifestyles.

Climate change has a particular impact on humans through **food security**. Changing rainfall patterns, more frequent extreme events, and warming in general are **reducing crop yields (of maize and wheat, for example) in lower latitude regions.** In Africa, climate change has lowered animal growth rates and productivity in pastoral systems. However, **in some higher latitude regions, some crop yields have increased (such as maize, wheat, and sugar beets).**

FUTURE IMPACTS OF CLIMATE CHANGE ON THE LAND

As **a critical resource for the world, land is already under pressure due to competing demands.** Climate change is making a challenging situation worse. Together with projected population growth and changes in consumption patterns, climate change will result in increased demand for food, feed, and water. These changes have huge implications, for example on biodiversity, ecosystem services and thus food security and drinking water availability.

Impacts on people will be different depending on regions. With increased warming, the frequency, intensity and duration of **heat-related extreme events** will increase, particularly in the Mediterranean region and Southern Africa. North America, South America, the Mediterranean, southern Africa and central Asia **may be increasingly affected by wildfires.** In tropical regions, warming could create unprecedented climatic conditions by the 21st century, making some areas uninhabitable.

In drylands, climate change and desertification will cause overall **reductions in crop and livestock productivity**, modify the plant species mix and reduce biodiversity. Asia and Africa are projected to have the highest number of people vulnerable to increased desertification. The tropics and subtropics are projected to be most vulnerable to crop yield decline.

Finally, climate change can **amplify environmentally induced migration** (from lack of food, water, land degradation, etc.), within countries and across borders, and this increased displacement could exacerbate stresses for future conflicts.

Women, the young, elderly and poor people are most at risk from negative climate change impacts.

TO SUM UP

Land provides us with food, freshwater, livelihoods, wellbeing, biodiversity.
Humans use more than 70% of the global ice-free land surface.
Land plays an important role in regulating the climate.
Since the pre-industrial period, the average land surface temperature has risen nearly twice as much as the average land-ocean surface temperature.
Changes in land use have contributed to growing net greenhouse gases emissions and the loss of natural ecosystems.
Climate change impacts food security, terrestrial ecosystems, biodiversity and contributes to desertification and land degradation.

2. Land is part of the problem but it is also part of the solution

Land can make a valuable contribution to reducing climate change and mitigating its effects, while simultaneously meeting human needs in a sustainable way.

TIME SCALE OF RESPONSE OPTIONS

There are two options to tackle climate change: **adapt to climate change and / or mitigate** greenhouse gas emissions. Land can help respond to the impacts of climate change by **combating desertification and land degradation,** and by **improving food security and sustainable development.**

The timescales of the various response options are very different. **Some have immediate effects**: for example, the conservation of high-carbon ecosystems, like peatlands, wetlands, mangroves and forests. **Others have long-term effects**: for example, afforestation, reforestation or the restoration of degraded soils.

LAND CONVERSION

Land conversion is the transformation of land for a different purpose. Although **most land-related response options to climate change do not involve competing for available land, some can increase demand for land.** This is a problem, since the amount of land surface that can be used for growing crops for food, feed, fibers or biofuels, as well as harvest timber or keep livestock is limited.

Some options to respond to climate change, such as improved management of cropland and grazing land, improved sustainable forest management, or increasing soil organic carbon content **do not require changes of land use.** Grassland conversion to croplands and the restoration of peatlands or coastal wetlands are examples of land conversion that require little or no additional land.

Afforestation and biofuel crops are two examples of land conversion that increase land demand. This increased demand may counteract measures to combat food security.

LAND USE CHANGE AND SUSTAINABLE DEVELOPMENT

There are a number of adaptation options in agriculture in the form of policy, planning, governance and institutions. For example, institutions might develop new capacities to take climate change into account as they develop quality products, promote better diets for healthier lifestyles, support the improvement of livelihoods in communities, etc. Other adaptation policies include property rights and land tenure security to ensure access to land that could stimulate adaptation to climate change.

One major solution to tackle climate change is to increase the use of **clean renewable energy sources, such as wind, solar and waterpower.** These energy sources do not, or only slightly, compete for agricultural land: wind turbines can be installed on extensive agricultural lands such as rangeland, for example, and solar panels can be installed on roofs or on arid land. Clean renewables reduce the use of traditional biomass such as firewood, and thus contribute to improved air quality. Reducing the use of firewood also has the co-benefit of saving (mostly women's) time spent collecting firewood. The sustainable development goals that are met are: good health and wellbeing, affordable and clean energy, reduced inequalities and climate action.

CLASS ACTIVITY # TASK

— Identify which Sustainable Development Goals are met if we make climate-friendly dietary choices, reduce post-harvest losses, reduce food waste and improve risk management.

CARBON SEQUESTRATION

Carbon sequestration is the process by which the soil or vegetation **absorb atmospheric CO_2. Vegetation cannot, however, sequester carbon indefinitely.** When the soil or vegetation matures, typically after a few decades, it reaches saturation and can no longer remove CO_2 from the atmosphere. The carbon stocks are, however, maintained. The situation is different for peatlands: they can sequester carbon for centuries.

Today, peatlands are the largest natural terrestrial carbon sink. Worldwide, **the remaining area of natural peatland contains 42% of all soil carbon,** exceeding the carbon stored in all other vegetation types, including the world's forests [1].

When carbon is transferred to harvested wood products, **they can store carbon over the long term. Wood can substitute construction materials like concrete or steel, reducing greenhouse gas emissions.** However, when biomass (such as wood for example) is used as an energy source, as a mitigation strategy, the carbon is released back into the atmosphere.

CLASS ACTIVITY # TASKS

— Which ecosystem should we protect the most among the following: Peatlands, wetlands, rangelands, mangroves, and temperate forest.

— Explain why each ecosystem is important, drawing on carbon sequestration and tree absorption to support your argument.

— Do you know how much carbon a tree can absorb in a year? And throughout its lifetime? Find the answer on the web.

— Try to name the different types of wood in your home and find out where the corresponding trees grow.

Students will find out that the amount of carbon stored by a tree during its lifetime depends on the species and where it grows... but an order of magnitude is 1 ton for a temperate forest tree.

COMBATING DESERTIFICATION AND WIND EROSION

Solutions to help adapt to and mitigate climate change while combating desertification include water harvesting and micro-irrigation, restoring degraded land using drought-resilient, ecologically appropriate plants and other agroecological and ecosystem-based adaptation practices, such as agroforestry or permaculture. The latter have the co-benefit to enrich the soils' carbon content in the long term.

Windbreaks in the form of "green walls" using tree species with low water needs avert wind erosion and reduce sandstorms. On top of sequestering carbon, these green walls improve air quality (less dust) and human health.

COUNTERING LAND DEGRADATION

The main response options to mitigate and adapt to climate change in agriculture include increasing soil organic matter, controlling erosion, improving fertilizer management and using species that are heat and drought tolerant.

Whereas conventional agricultural practices are largely responsible for land degradation, certain practices reduce both soil erosion and nutrient loss. Examples include reduced or no tillage, the cultivation of green manures (legumes that store soil nutrients and make them available to other plants) or mulching (which ensures that the ground is always covered and fertilised).

As for livestock, response options include better grazing land management, improved manure management, higher-quality feed and use of genetically improved breeds.

Diversifying the food systems reduces the risks from climate change (like promoting the diversity and availability of seeds or heterogeneous diets). Additionally, diets mainly based on plants, such as grains, legumes, fruits and vegetables, nuts and seeds, contribute to climate mitigation, and at the same time promote good health and wellbeing. By 2050, dietary changes could free several million square kilometers of land by decreasing demand for animal-based food, leaving land free for other uses, such as afforestation.

Currently, 25-30% of total food produced is lost or wasted. Reducing food loss and waste can lower greenhouse gas emissions and contribute to climate change mitigation since it reduces the land area needed for food production. **Between 2010 and 2016, global food loss and waste represented 8-10% of total greenhouse gas emissions from human activities.**

1 IUCN – https://www.iucn.org/resources/issues-briefs/peatlands-and-climate-change

CLASS ACTIVITY # TASKS

"No-till farming" has become more and more popular in agriculture.

— Draw a cartoon to show the pros *(preservation of micro-organisms in the soil, soils store more carbon, etc.)* and cons *(more weeds, more diseases and/or pests from previous crops, etc.)* of "no-till farming".

— Name and explain some of the main characteristics of permaculture (mulching, agroforestry, Hügelkultur, etc.).

— Find unusual permaculture projects on the internet and present them to your classmates.

— Put together a menu with a low CO_2 footprint.
https://www.bbc.com/news/science-environment-46459714
http://www.foodemissions.com/foodemissions/Calculator
https://www.oce.global/en/resources/multimedia-activities/impact-our-food

The total mitigation potential in the food sector – from production to consumption, including food loss and waste – is estimated as between 2.3 and 9.6 Gt CO_2 eq/year by 2050. The total mitigation potential of dietary changes is estimated as 0.7 to 8 Gt CO_2 eq/year by 2050.
For comparison: The total greenhouse gas emissions on our planet reached 53.6 Gt CO_2 eq in 2017.
https://www.ipcc.ch/site/assets/uploads/2018/12/UNEP-1.pdf

— Discuss with your class: Is it worth changing diets?

You can organize the classroom into different groups representing farmers, scientists, and politicians, and after a short internet search, start a debate where each community presents their context and gives their perspectives.

MITIGATION SCENARIOS AND PATHWAYS

In the IPCC Special Report, a set of modelled scenarios, also **called pathways, are explored**. Each pathway involves different decisions. In all of the pathways aimed at limiting warming to 1.5°C, **land use mitigation and land use change are required**.

Most of them include different combinations of reforestation, afforestation, reduced deforestation and significant development of bioenergy technologies.

The modelled scenarios limiting warming to 1.5°C without relying too much on bioenergy and other carbon dioxide removal (CDR) options require rapid and far-reaching transitions in energy, land, urban systems and infrastructure and in behavioral and lifestyle changes compared to other 1.5°C pathways.

TO SUM UP

There are two kinds of options to tackle climate change: adapt to climate change and/or mitigate greenhouse gas emissions.
Land can respond to climate change by combating desertification and land degradation, improving food security and sustainable development.
Some responses have immediate impacts, while others have long-term impacts. And some do not require changes of land use or land demand.
Carbon sequestration is a way to mitigate climate change. Peatlands can store more carbon than forests and for a longer period of time.
A change of practices in agriculture can reduce soil erosion and nutrient loss.

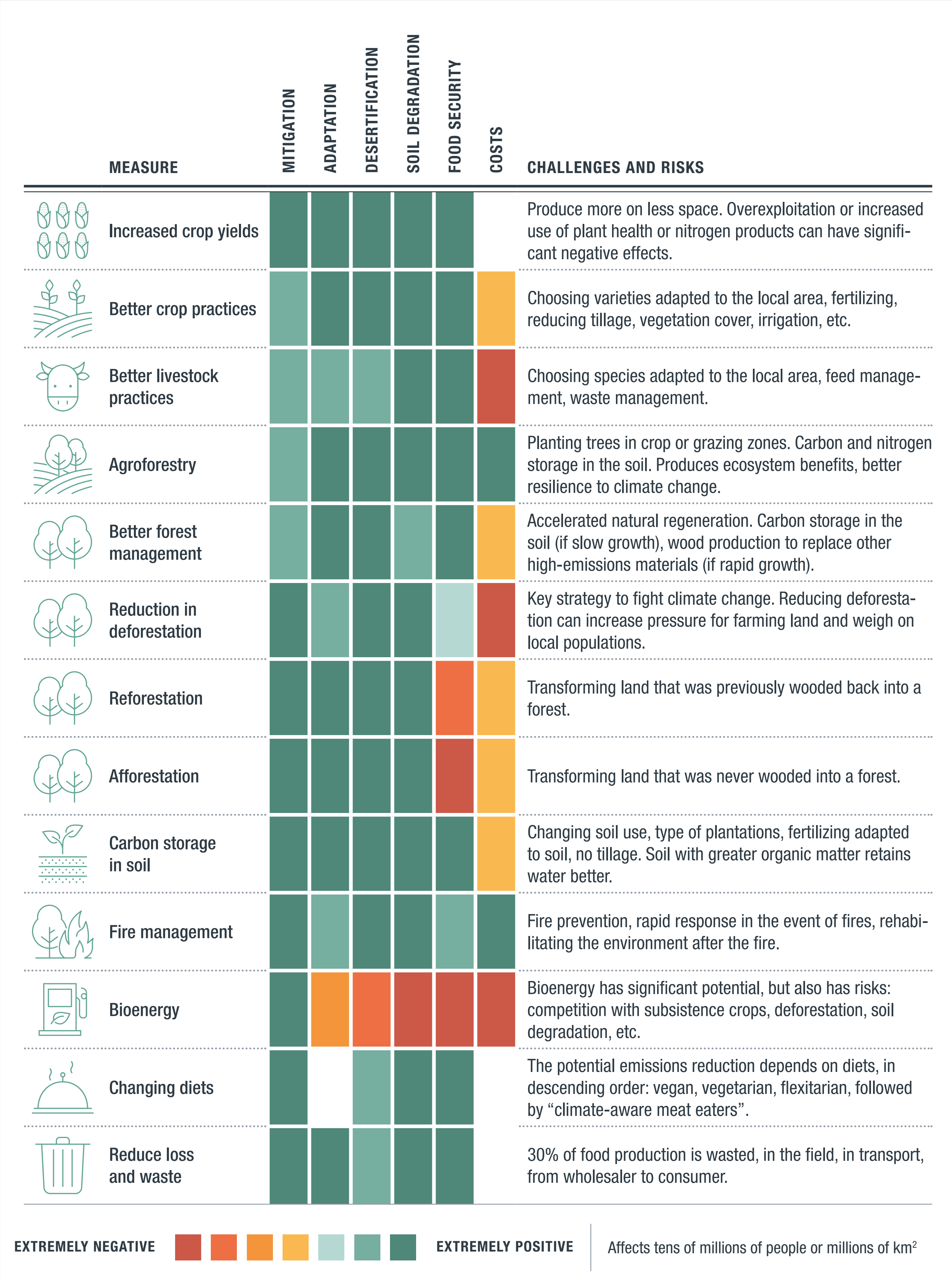

FIGURE 3 **Potential of greenhouse gases emission reduction measures linked to land-management options.**

Citoyens pour le Climat (adaptation). Summary report based on the IPCC Climate Change and Land report.
https://drive.google.com/file/d/17H99ekMQ7j9ErgXTQUKP5s0-qQ4-pJMA/view

3. Land is part of the solution but land can't do it all

IMPLEMENTING POLICIES

While various sustainable land management practices already exist, a number of **barriers prevent their widespread adoption. This is mainly due to a lack of knowledge and practical experience as well as a lack of access to resources and agricultural advisory services.**

Another barrier is **land access and ownership of land (land tenure).** Insecure land tenure means people, communities and organisations are less able to make changes to the land.

Land management decisions are made from farm level to a national scale. Adequate coordination is required, since both climate and land policies often span multiple sectors, departments and agencies, concern environment, water, energy and infrastructure, but also public health and transportation.

HUMAN-CENTRED APPROACH

Thanks to their close contact to their environment and their knowledge of the land, **indigenous and local peoples can use their agricultural practices to help overcome the combined challenges of climate change, food security, biodiversity conservation and hence combat desertification and land degradation.**

The intersections between climate change, gender and climate adaptation takes place at multiple levels: household, national and international. Capacities for adaptation are shaped through power and knowledge. **That is why women play a key role in sustainability but are also especially vulnerable to climate change impacts.** Empowering women can bring synergies and co-benefits to households. Policies that can address land rights and barriers to women's participation in sustainable land management include financial transfer to women, spending on health, education, training and capacity building.

ACTING NOW

Rapid action is needed in the land sector to prevent or at least reduce risks and losses. This is because the potential of certain response options to combat climate change is declining as climate change intensifies. For example, one option to reduce greenhouse gas emissions is to increase the organic carbon content of soils. However, soils have a reduced capacity to act as sinks for carbon sequestration when temperatures rise.

Delaying action will have irreversible effects on many ecosystems, negatively impacting food production and human health.

CAPACITY BUILDING

Knowledge and technology transfer are key to success. This includes raising awareness and climate change education. Providing **information** on climate-related risks can **improve the capacity of land managers to respond to impacts and enable timely decision making.**

The establishment of early warning systems for extreme weather and climate events can help people to respond to climatic conditions and protect lives, property and livelihoods. Seasonal forecasts and early warning systems are essential for food security and monitoring biodiversity, including pests and diseases.

INVESTMENTS AND ECONOMICS

Cost is often a barrier to sustainable land management practices. However, **investments in land restoration can bring overall benefits, making these investments viable in the very short term.** For example, certain measures can improve crop yields and the economic value of grazing land. Land restoration measures improve livelihoods and offer both positive economic returns in the short term as well as diverse benefits in the longer term such as biodiversity conservation and functioning ecosystem services.

Government support and improved access to credit can help overcome barriers to adoption, particularly those faced by poor smallholder farmers.

TO SUM UP

Access to resources, information and advisory services is key for improving land management practices.

Land management decisions have to be made from farm level to a national scale.

Delaying climate mitigation and adaptation responses will lead to increasingly negative impacts on land and reduce the prospects of sustainable development.

Near-term actions to address desertification, land degradation and food security can bring social, ecological and economic co-benefits, contributing to poverty eradication and more resilient livelihoods for those who are vulnerable.

Conclusion

Land provides food, feed, fibre, fuel and freshwater without which human society and its economy could not exist. But this provision is under threat, a consequence of unprecedented rates of land and freshwater exploitation in recent decades and exacerbated by rising global temperatures.

Land plays an important role in the global cycle of greenhouse gases, especially in agriculture, and can result in enhanced emissions of such greenhouse gases into the atmosphere. However, properly managing the use of land can contribute significantly to mitigating and adapting to climate change, including through the promotion of sustainable management of forests and ecosystems.

Land can be conserved, restored and used sustainably while other global societal goals are simultaneously met through urgent and concerted efforts fostering transformative change.

Glossary

You can find some more definitions on the OCE website
https://www.oce.global/en/resources/climate-science/glossary

ADAPTATION The process of adjusting to current or expected climate change impacts. In human systems, the aim of adaptation is to reduce risks, increase resilience or seize on beneficial opportunities. In natural systems, human intervention may facilitate adjustments to expected climate change impacts.

AFFORESTATION The establishment of a forest through tree planting or seeding on land that has lacked forest cover for a very long time or has never been forested.

AFOLU Agriculture, Forestry and Other Land Use.

AGROFORESTRY A method of using agricultural land combining trees and crops or animal husbandry.

ALBEDO Meaning “whiteness”, albedo is the reflective power of an object or surface. For instance, ice and fresh snow have a high albedo, ranging from 40% to 80%. This means that they reflect 40% to 80% of the incoming sunlight. Trees are much darker and their albedo ranges from 9% for coniferous trees to 18% for deciduous trees.

BIODIVERSITY Biodiversity refers to the variety of species (flora and fauna) that live on Earth or in a particular ecosystem.

BIOMASS Organic matter used as a fuel, especially in a power station for the generation of electricity.

BROWNING Browning is a systematic decrease in vegetation growth or the death of vegetation that results in a loss of productivity over a period of time.

CARBON FERTILIZATION Carbon fertilization is also known as carbon dioxide fertilization. It is the phenomenon by which the increase of carbon dioxide in the atmosphere increases the rate of photosynthesis in plants.

CARBON SINK Natural reservoir that stores carbon-containing chemical compounds accumulated over time. Carbon sinks help reduce the amount of atmospheric CO_2. Natural sinks are soil – the largest carbon store – and part of the biosphere via photosynthesis by terrestrial plants and marine phytoplankton and algae, a process that incorporates atmospheric CO_2 into long carbon chain macromolecules using solar energy.

CLIMATE ZONES Areas with distinct climates, that can be classified using different parameters such as temperature, precipitation, etc.

DEFORESTATION Destruction of a forest, often with the aim of turning it into agricultural land.

DESERTIFICATION Land degradation in arid or semi-arid areas by human or climatic actions.

DUST STORMS Masses of sand and dust raised by the wind in very dry areas such as deserts.

DRYLAND Drylands are ecosystems characterised by a lack of water. They include cultivated lands, scrublands, shrublands, grasslands, savannas, semi-deserts and true deserts.

ECOSYSTEM An ecosystem is the totality of living beings in a given environment plus the environment itself. In an ecosystem, there is a functional interdependent relationship between the living beings and their environment.

ECOSYSTEM SERVICES Humans can directly or indirectly benefit from ecosystems, providing them services. They are grouped into four categories: provisioning, regulating, supporting and cultural. For example, ecosystems produce oxygen (through photosynthesis) and food, and they provide us with raw materials. Ecosystems also preserve soil fertility, fertilise plants and protect coasts

EVAPOTRANSPIRATION The process by which water is transferred from the land to the atmosphere by evaporation, either from the soil and other surfaces, or by transpiration from plants.

GLOBAL WARMING POTENTIAL (GPW) By definition, CO_2 has a global warming potential of 1 regardless of the time period used. CO_2 remains in the atmosphere for a very long time up to thousands of years. CH_4 is estimated to have a GWP of 28-36 over 100 years. CH_4 emitted today remains in the atmosphere about a decade on average, which is much less time than CO_2. But CH_4 also absorbs much more energy than CO_2. The net effect of the shorter lifetime and higher energy absorption is reflected in the GWP. N_2O has a GWP 265-298 times that of CO_2 for a 100-year timescale. N_2O emitted today remains in the atmosphere for more than 100 years on average.

GREENING Vegetation can be characterized as greening if there is an observed increase in vegetation productivity over a certain period of time. Trees, shrubs, herbaceous plants and ground cover vegetation are taken into account.

HEAT CAPACITY The heat capacity of a material is the heat required to raise the temperature of a substance to one degree.

HEAT ISLAND EFFECT An urban area having a higher average temperature than its rural surroundings owing to the greater absorption, retention, and generation of heat by its buildings, pavements, and human activities.

LAND DEGRADATION Temporary or permanent decline in quality of soil, vegetation, water resources or wildlife – or the deterioration of the economic productivity of the land, such as the ability to farm the land.

MITIGATION Human intervention to reduce global warming by reducing greenhouse gas emissions or enhancing greenhouse gas sinks.

PEATLANDS Wetlands where the soil is highly organic because is it formed mostly from incompletely decomposed plants. This soil is called peat and its presence is what defines peatlands.

PERMAFROST Permafrost is a permanently frozen layer at variable depth below surface.

REFORESTATION Planting of forest on lands that have previously contained forest but have since been converted for some other use.

SOIL DEGRADATION Soil degradation means the loss of arable land, and can be a consequence of water erosion, coastal erosion, wind erosion, salinity, loss of organic matter, fertility decline, soil acidity, etc.

Resources

SCIENTIFIC DOCUMENTATION ON CLIMATE CHANGE AND LAND

IPCC – Special Report *Climate Change and Land*
https://www.ipcc.ch/srccl/

Food and Agriculture Organisation of the United Nations (FAO) – The state of food and agriculture (2016)
https://www.uncclearn.org/wp-content/uploads/library/a-i6030e.pdf

Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) – Assessment Report on Land Degradation and Restoration
https://ipbes.net/assessment-reports/ldr

IPBES – Global Assessment Report on Biodiversity and Ecosystem Services
https://ipbes.net/global-assessment

Global Land Outlook of the UN Convention to Combat Desertification (UNCCD)
https://www.unccd.int/sites/default/files/documents/2017-09/GLO_Full_Report_low_res.pdf

OCE EDUCATIONAL RESOURCES

IPCC summaries for teachers
https://www.oce.global/en/resources/climate-science

Climate Change and Land – Summary for teachers, advanced version
In press

The climate in our hands – Ocean and Cryosphere
https://www.oce.global/en/resources/class-activities/climate-our-hands-ocean-and-cryosphere

Multimedia activities:
- Carbon Cycle: https://www.oce.global/en/resources/multimedia-activities/carbon-cycle
- Land food webs: https://www.oce.global/en/resources/multimedia-activities/land-food-webs
- The impact of our food: https://www.oce.global/en/resources/multimedia-activities/impact-our-food
- Carbon footprint: https://www.oce.global/en/resources/multimedia-activities/carbon-footprint
- How can we act? https://www.oce.global/en/resources/multimedia-activities/how-can-we-act

OTHER EDUCATIONAL RESOURCES

Agritopia: roleplay game to think about the impacts of agricultural choices on climate
https://www.climateinteractive.org/programs/climate-smart-agriculture/agritopia/

California Academy of Sciences – Natural Resources Bingo
https://www.calacademy.org/educators/lesson-plans/natural-resources-bingo

Office for Climate Education

"Parties should take measures [...] to enhance climate education", states Art.12 of the Paris Agreement. *"Educating the present and future generations about climate change, and teaching them to act with a critical mind and a hopeful heart, is essential for the future of humanity. Science education must meet the challenge [...]"*, recommend the 113 science academies of the world in their recent Statement on Climate Change and Education.

Replying to these urgent calls, climate scientists and educators established an **Office for Climate Education.** Teachers are key for implementing these recommendations, especially in primary and secondary schools. Hence, the office produces for them educational resources, based on active pedagogies, such as inquiry-based science education and project-based learning. As IPCC produces "assessment reports" and "summaries for policymakers", the Office produces "resources and tools for teachers", focusing on the issues of adaptation and attenuation. It pays special attention to developing countries.

Working closely with climate scientists, involving social scientists and educators, the Office for Climate Education has an executive secretariat in Paris and a global network of local or regional partners in over 20 countries already. The teaching resources are conceived in a global frame, then are locally tested and adapted to particular situations. The numerous initiatives already taken in the same direction are documented and publicised by the Office.

The Office for Climate Education was launched in 2018 with the support of public and private funds provided by French and German partners. It amplifies its action in proportion with its resources and develops partnerships, especially with IPCC and IAP for Science – the global federation of science academies.

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UNDER THE AUSPICES OF

United Nations Educational, Scientific and Cultural Organization

Under the auspices of **UNESCO**

FONDATION La main à la pâte POUR L'ÉDUCATION À LA SCIENCE

Commissioned in 2018 by the *La main à la pâte* foundation and the climate science community, the Office for Climate Education (OCE) promotes climate change education and associated teacher support worldwide. The OCE has been a centre under the auspices of UNESCO since 2020.

FOUNDING MEMBERS

METEO FRANCE · IRD Institut de Recherche pour le Développement FRANCE · météo et climat Société météorologique de France · SORBONNE UNIVERSITÉ

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