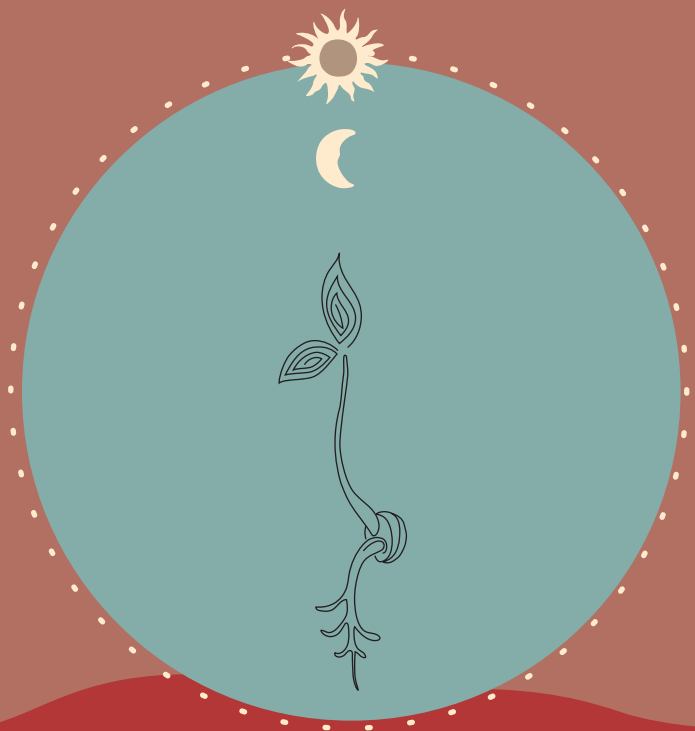

Introduction to CARBON and Climate Change

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Introduction to CARBON and Climate Change

2025

BROCHURE 1

Introduction to Carbon and Climate Change

This brochure presents the fundamentals of the carbon cycle and its relationship to climate change, addressing mitigation and adaptation strategies, as well as the socioeconomic implications of greenhouse gas emissions and their management. Its objective is to facilitate technical understanding of how carbon influences climate dynamics and, thus, understand how these emissions are managed through projects that have the potential to directly benefit Indigenous Peoples and Local Communities.

This brochure is the first volume in the series "Understanding Climate Finance," produced by Forest Trends' Communities and Territorial Governance Initiative in collaboration with Greendata and with support from the Walmart Foundation. To access the other chapters, visit the Forest Trends website.

1

Introduction to carbon and climate change

Carbon is a natural element found throughout the universe, and it is present in all living things. Beyond being an essential component of life, it also makes up the air we breathe, certain types of rocks, and the soil

It functions as a true "**building block**" of life. Through **photosynthesis**, plants absorb carbon dioxide (CO_2) from the air and, with the help of sunlight, transform it into wood, stems, leaves, and fruits. The carbon stored in these plants then becomes **food** for fungi, animals, and ultimately humans.

Carbon moves through different parts of the Earth in a natural process known as the **Carbon Cycle**. This cycle helps regulate the planet's climate, but human activities like burning fossil fuels (oil, coal, and gas), cutting down forests, and industrial production release more CO_2 into the atmosphere than the Earth can absorb, disrupting this natural balance.

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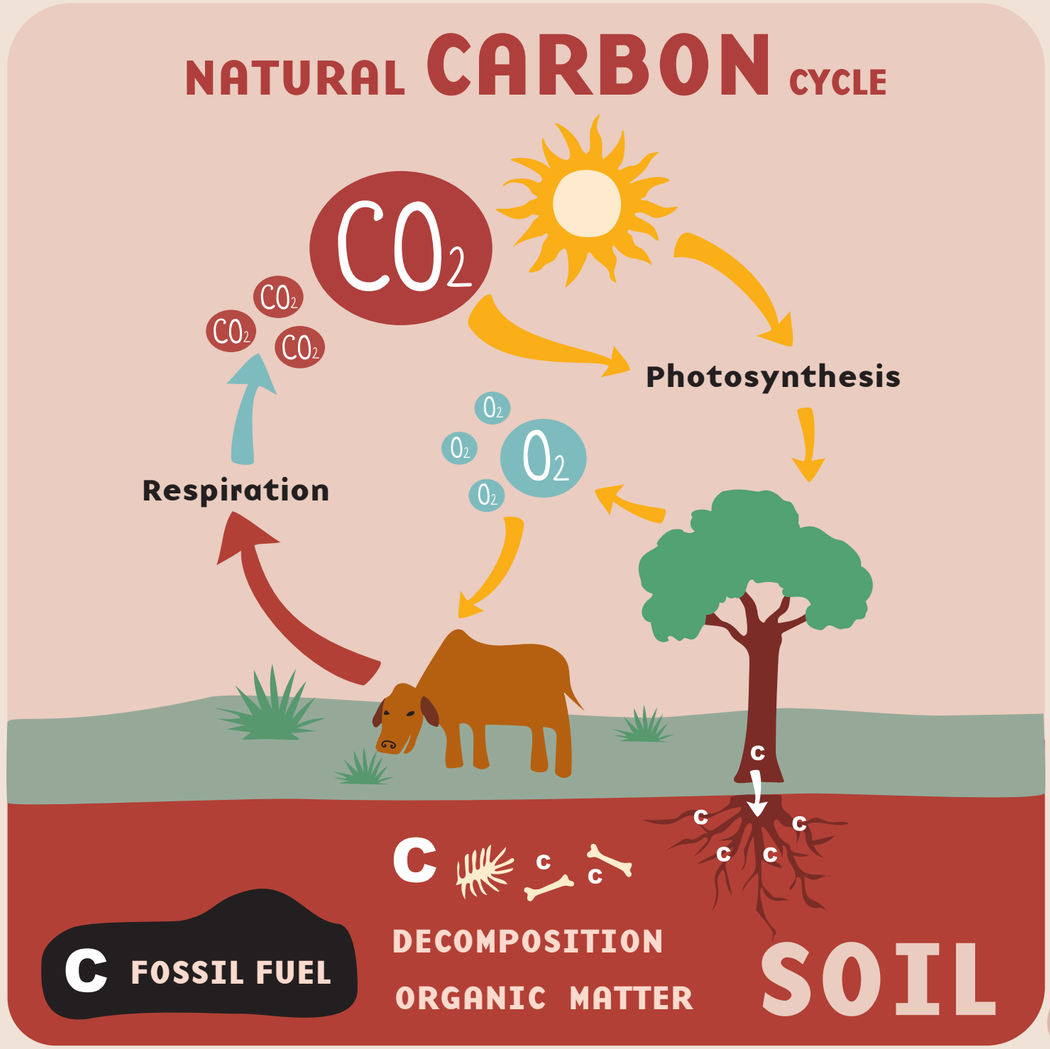
The carbon cycle is the path that carbon takes in nature. In the atmosphere, it appears as CO_2, where it is bound to oxygen and circulates among plants, animals, soil, and oceans.



What are FOSSIL FUELS?

Fossil fuels are sources of energy that were generated over millions of years from the decomposition of the remains of plants and animals, such as dinosaurs. This organic matter was transformed into coal, oil, and natural gas through natural processes involving high pressure and temperature inside the Earth.

We use these fuels for various purposes, such as generating electricity in thermoelectric plants, powering cars that run on gasoline or natural gas, and operating factories. However, when fossil fuels are burned, greenhouse gases are released, resulting in global warming and climate change.

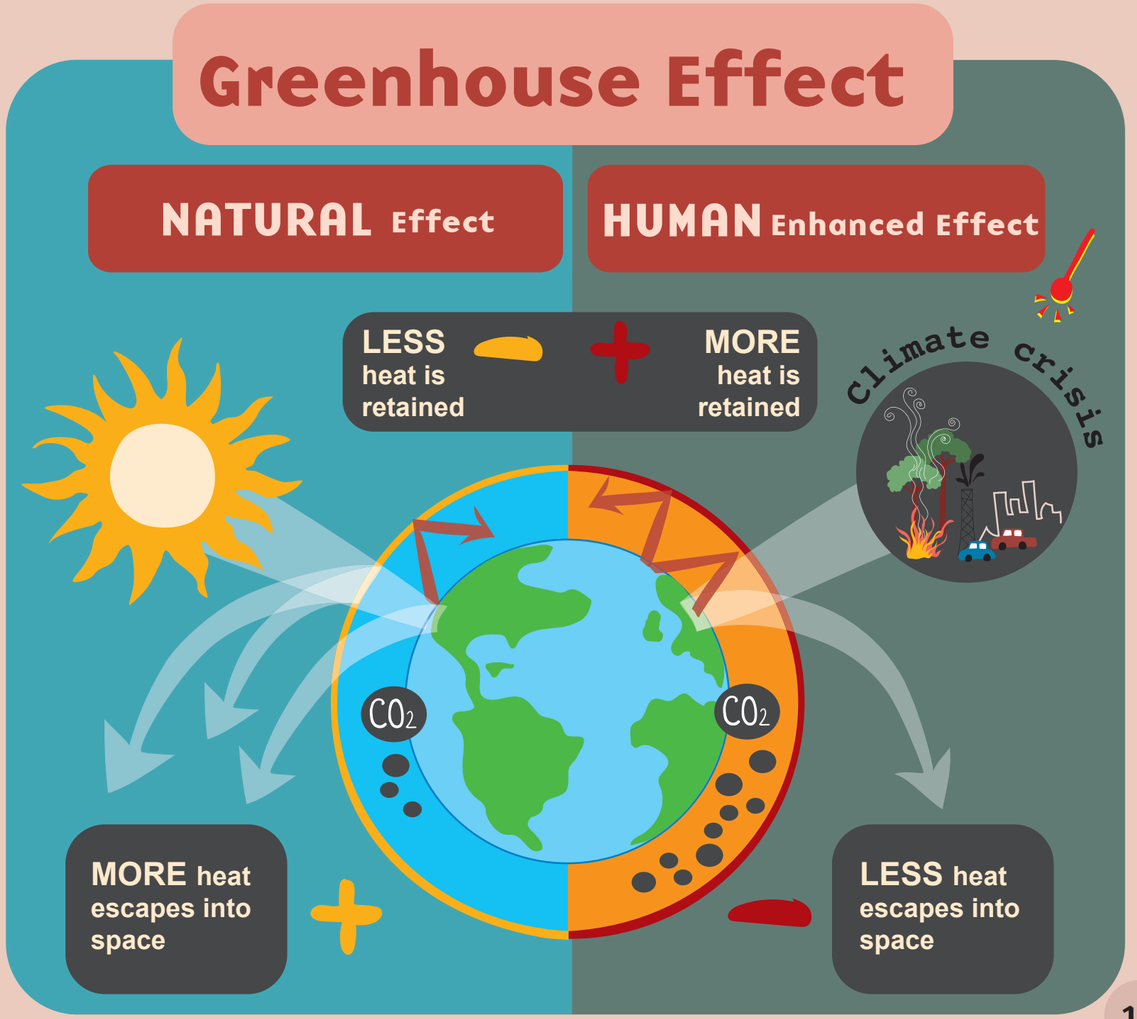
These fuel sources took many generations to form, and therefore cannot be replenished in a short period of time, which is why they are called non-renewable sources. Renewable energies, on the other hand, are sources that regenerate naturally and do not run out with use, such as solar energy, derived from the sun, and wind energy, generated by the wind. They are considered clean because they do not emit pollutants during energy production, but their large-scale installation must be carefully planned to avoid impacts on local communities and territories.

Since the beginning of the industrial Age (around the year 1750), **the amount of carbon in the air has increased by approximately 50 percent**. This has made the planet warmer and caused serious problems, such as rising sea levels, droughts, floods, and disruptions in nature's cycles, commonly known as climate change, which affects animal, plant, and human life.

Climate change is partially caused by **global warming**, which occurs when the Earth warms up more than it should due to the increase in **Greenhouse Gases (GHGs).**

These gases are present in the air and come from different sources.
For example:

- **CO_2**, which derives from the air we and plants exhale, and it is also present in car exhaust, forest fires, and factory emissions.
- **Methane (CH_4),** which comes from gases released by livestock, some crops, and decomposing waste.
- **Nitrous oxide (N_2O)**, which arises from the decomposition of organic matter and the use of artificial fertilizers in agriculture.



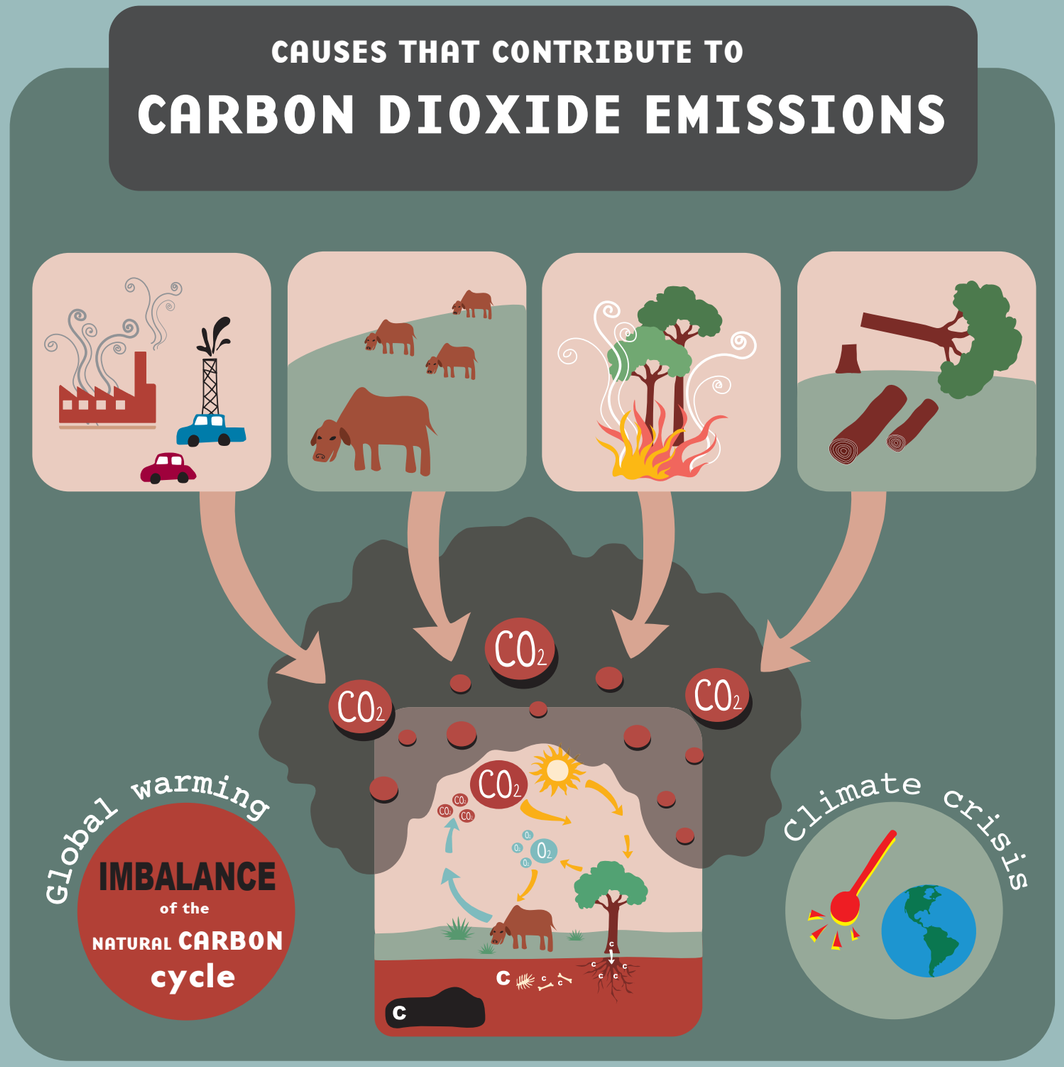
GHGs work like a blanket around the Earth. In their balanced state, they help trap heat from the Sun and keep the planet warm enough for us to live. However, when we burn large amounts of fossil fuels, such as gasoline and coal, or cut down many trees, **the amount of these gases increases** and the "blanket" becomes thicker. This causes more heat to be trapped in the air, **and the planet becomes warmer than it naturally should be.**

To understand this process, it's important to look at where carbon comes from and where it goes.

Human activities, like **burning fossil fuels and clearing forests**, are the main sources of CO_2 emissions. For their part, **forests, oceans, and soil** act as "carbon sinks," or places that can absorb some of this carbon.

Unfortunately that only works if these ecosystems are in balance; if there is more carbon than they can absorb, the sink function decreases.

The Earth's natural systems can only regulate the **carbon cycle** when they are in



balance. If more carbon is released than they can absorb, the balance breaks down, triggering cascading effects such as **global warming** and **climate change.**

For example:

- the clearing of forests, especially through forest fire, results in the release of carbon dioxide into the atmosphere. This carbon leads to **rising global temperatures**, and forests that were once consistently humid begin to experience longer periods of **drought**.

- With prolonged drought, forests that previously did not burn naturally start to suffer from fires and wildfires, which further increase carbon emissions, contributing to the imbalance of this cycle and the growing negative consequences for nature and society.

Given this situation and the need to reduce emissions, several countries signed the **Paris Agreement** in an effort to curb carbon emissions into the atmosphere and limit global warming.

What is the PARIS AGREEMENT?

The Paris Agreement is a commitment signed by almost every country in the world to tackle climate change. It was created in 2015 during a conference of the United Nations (UN), an organization that brings together countries from around the world to promote peace and solve global problems. This conference, known as the Conference of the Parties (COP), is a UN event held every year to discuss measures against climate change, such as reducing pollution and protecting the planet. The Paris Agreement was signed at COP 21 in Paris, France, hence its name.

In this agreement, countries commit to:

- Reducing their emissions of greenhouse gases, such as carbon, which cause global warming;
- Protecting nature and seeking ways to develop their economies without destroying the planet;
- Helping the most vulnerable countries adapt to the effects of climate change, such as droughts, floods, and territory loss

One of the main objectives of the Paris Agreement is to limit global temperature rise to a maximum of 2°C, while striving to stay close to 1.5°C, in order to avoid more serious damage to the planet and to people.

Each country must submit its targets (Nationally Determined Contributions) and update them every five years. To fulfill their commitments, countries can use different instruments, such as protecting forests, investing in renewable energy, or creating carbon markets.

The Paris Agreement also recognizes the importance of climate justice, human rights, and the rights of Indigenous Peoples (IPs) and Local Communities (LCs) as an essential part of the fight against climate change.

What are NDCs?

Nationally Determined Contributions (NDCs) are the commitments that each country makes within the Paris Agreement to help address climate change.

Each country defines its own targets. For example:

- Reducing the amount of carbon it emits.
- Restoring forests and protecting ecosystems.
- Changing the way energy or food is produced.

These targets must be clear, transparent, and possible to track, and each country must present reports on its progress. NDCs must be updated every 5 years with more ambitious goals.

Brazil's NDCs set an ambitious commitment to cutting emissions by more than 50 percent and reaching climate neutrality by 2050. This goal requires both reducing greenhouse gas emissions and removing those that remain from the atmosphere, using things like the carbon-absorbing capacity of forests. Brazil, along with other tropical forest countries, emphasizes efforts to curb deforestation, protect ecosystems, and enhance international cooperation.

NDCs are important because they show what each country is doing to fulfill the Paris Agreement, and they hold governments accountable for concrete actions. For Indigenous Peoples and Traditional Communities, understanding NDCs is essential to defending their rights, since many climate projects and policies can directly affect their territories.

2

Mitigation and adaptation strategies

To address the challenges of climate change, there are two main strategies: **mitigation and adaptation.**

Mitigation seeks to contain the problem at its source by reducing greenhouse gas emissions or by increasing their absorption by nature. There are several ways to achieve this goal.

One way is to **transition to renewable energy sources**, such as solar and wind, which reduce dependence on fossil fuels. In 2024, renewable energies already accounted for about 30 percent of global electricity generation, but their expansion still requires major investments, including in energy storage technologies.

Another approach is to **increase energy efficiency**, that is, to use less energy to perform the same activities. This includes energy-efficient buildings, LED light bulbs, electric vehicles, and the promotion of public transportation or bicycles instead of cars.

There are also technologies to **Carbon Capture and Storage (CCS)**. These remove carbon from the air or directly from factories and power plants, and then store this gas underground in geological formations, like rocks, mountains, and caves formed over thousands of years. Projects like Sleipner in Norway show that the technique is viable, but costs are high and there are still challenges for its large-scale adoption.

Nature-based Solutions (NbS), such as reforestation, agroforestry systems, and the restoration of degraded areas, are fundamental. They help capture carbon while protecting biodiversity, improving soil and water, and generating benefits for local communities.

Finally, **public policies and international agreements** also play an important role. Many countries are creating carbon markets or applying pollution taxes to encourage companies to reduce their emissions. The higher the cost of releasing carbon, the greater the incentive to avoid it. One example is the European Union Emissions Trading System, which has reduced emissions in participating sectors by about 35 percent since 2005.

Adaptation, on the other hand, refers to how people, communities, and ecosystems prepare for the effects of climate change that are already occurring, such as droughts, floods, disruptions in natural cycles, and agricultural losses. This involves, **actions that strengthen resilience,** such as the use of more resistant seeds, sustainable water management, and the valuing of traditional knowledge.

While mitigation addresses the causes of the problem, adaptation helps deal with its consequences, ensuring that populations can live with more safety and dignity in a changing climate. In many cases, **the two strategies go hand in hand,** especially when they involve **nature as an ally.**

This brochure focuses on **mitigation** measures, as they act directly to reduce carbon emissions, which is essential for slowing global warming and extreme weather events. Although adaptation is also important, mitigation is the foundation for preventing impacts from worsening, and it is directly related to the implementation of carbon markets, which will be discussed throughout this series of booklets.

	MITIGATION	ADAPTATION
What it is	Strategies aimed at reducing GHG emissions and increasing the capacity of carbon sinks, such as forests and soils.	Strategies aimed at strengthening human and natural systems against the already existing or inevitable impacts of climate change, increasing the resilience of territories and communities.
Objective	Contain and minimize global warming and climate change.	Reduce vulnerabilities and increase the capacity to withstand, respond to, and recover from extreme climate events.
Examples	• Substitution of fossil fuels with renewable energy and energy efficiency in transportation, industry, and buildings. • Reforestation, ecological restoration, and sustainable forest management. • Low-carbon agriculture.	• Adjustment of agricultural calendars. • Early warning systems and disaster prevention. • Construction of more resilient housing and infrastructure.
Territorial and community actions	• Community monitoring and surveillance for territorial protection, reducing illegal activities that cause emissions. • Traditional agroforestry systems. • Sustainable management of native species (such as Brazil nut, açaí, copaiba, etc.), generating income without degradation.	• Recovery, exchange, and use of more resistant traditional seeds. • Productive diversification for food security and income. • Preservation and recovery of traditional knowledge.

3

Implementation in practice

Putting carbon mitigation strategies into practice is no easy task. There are many challenges—technical, financial, and social—that must be taken into account for measures to really work.

The **infrastructure needed** for renewable energy involves adapting electricity grids, investing in energy storage systems (such as lithium-ion batteries), and ensuring that these technologies reach all regions. In many developing countries, the **funds and technical support** to make this happen are lacking.

To help with this transition, the UN created the Green Climate Fund in 2010 to allocate approximately USD $12 billion to support vulnerable countries until 2024. However, this amount is far from sufficient to address the scale of the problem.

In the case of carbon capture, tests have already proven that the **technology works, but the costs remain high.** Since capture also involves storing carbon underground for many years, constant monitoring and environmental safety must be ensured, which also makes projects more expensive.

NbS, such as reforestation, are more **accessible** and offer many **benefits**. However, they must be well planned to **avoid conflicts with local communities**, agricultural activities, or other land uses. In addition, projects must ensure that carbon is actually captured and that there will be no future deforestation that negates the benefits.

For this reason, many mitigation projects require **certification and monitoring.** This is done, for example, through the generation of carbon credits, which can only be sold if they follow clear rules, with **transparency and independent verification.** In the past, there have been cases of fraud in poorly executed projects, which is why greater care and participation by the communities involved is now required.

The process of including and involving **Indigenous Peoples and Traditional Populations and Communitie**s is essential. They must be involved from the outset of projects, with respect for their rights, territories, and forms of organization and self determination. **Fair distribution of benefits** is central to a successful and legitimate project.

Finally, **education and public awareness** are essential to broadening support for mitigation measures. Information and mobilization campaigns, such as those promoted by the UN, help to show that we can all contribute by reducing meat consumption, using public transportation, saving energy, or supporting environmental policies.

4

Challenges in carbon management

Despite the many possible avenues, reducing carbon emissions and tackling climate change is no easy task. One of the biggest challenges is the heavy reliance on fossil fuels, which continue to generate much of the world's energy. Changing this situation involves transforming entire systems, such as transportation, food production, construction, and industry, which can be expensive, slow, and politically sensitive.

Another major challenge is the lack of climate justice. This means that the countries and populations that have contributed least to the problem are generally those that suffer most from its effects. Indigenous peoples, traditional communities, and people living in rural and peripheral areas face flooding, drought, loss of production, and threats to their livelihoods, despite having a much smaller carbon footprint than urban and industrialized populations.

What is a CARBON FOOTPRINT?

A carbon footprint is the amount of greenhouse gases, mainly CO_2, that are emitted into the atmosphere as a result of human activities, such as traveling by car, using electricity, or producing food. It measures the impact our actions have on global warming and climate change. The larger the carbon footprint, the greater the negative contribution to global warming.

In addition, there are technical, economic, and political barriers. Some technologies, such as CCS, are still in the development phase or have high costs. Many countries lack laws, incentives, or regulatory structures capable of controlling emissions and protecting the most vulnerable territories. On the international stage, conflicts of interest continue between rich and developing countries, mainly over who should pay the bill for the climate crisis and how solutions should be financed.

Given this situation, it is essential that actions aimed at carbon management and combating the climate crisis are built with transparency, social participation, and respect for cultural and territorial diversity. The inclusion of Indigenous Peoples and Traditional Populations and Communities, the strengthening of their rights, and the valorization of traditional knowledge are fundamental to this process.

Dialogue between governments, scientists, businesses, and communities is the best way to find solutions that are fair, effective, and adapted to each reality. Only then will it be possible to transform carbon management into a real opportunity to protect the climate, territories, and ways of life.

5

Practical cases

Case studies show that climate change mitigation is not just theory, it is already being put into practice in many parts of the world. These experiences help us understand what works, what the challenges are, and how different contexts require different solutions.

In Denmark, the Ørsted **wind energy project** has made the country a global leader in renewable energy. By 2024, offshore wind turbines, which produce energy from wind and are located in the middle of the sea, were already supplying half of the country's electricity. This result was only possible thanks to **long-term planning, government support, and public participation.** Denmark shows that it is possible to reduce dependence on fossil fuels while ensuring energy security.

In the Brazilian Amazon, the Bolsa Floresta program **supports communities** that commit to conserving the forest. In return, they receive benefits such as support for sustainable activities, improvements in health and education, and incentives for community organization. The program shows how it is possible to **reconcile environmental protection and the well-being of local populations,** generating positive results for both the climate and the forest.

These examples reinforce the importance of land-based solutions that respect communities' ways of life, knowledge, and priorities. There is no one-size-fits-all formula. Each region has its own challenges, and mitigation strategies must be tailored to each reality.

Furthermore, when communities participate in decisions and share the benefits, the results are **longer lasting**. This applies to energy projects as well as initiatives in protected areas or indigenous and traditional territories.

6

Future prospects

Tackling climate change is an **urgent** challenge, but also an opportunity to build a more just, secure, and sustainable future. This will require a combination of **technology, international cooperation, behavioral changes, and valuing local knowledge.**

Several new technologies are being developed to address the climate crisis. **Green hydrogen and bioenergy with carbon capture (BECCS)**, for example, can help further reduce emissions and even generate what are known as negative emissions, i.e., removing more carbon than is emitted. Although still in the early stages, these solutions have great potential for the coming years.

It is also essential to strengthen international agreements and create fairer conditions for all countries to participate in the climate transition. **Climate finance** must increase and become more accessible to projects led by communities and countries that have historically contributed less to the problem but face the greatest impacts.

Carbon markets must also evolve, ensuring transparency, environmental integrity, and social inclusion. When well structured, these mechanisms can generate resources for forest protection, sustainable land management, and recognition of the rights of Indigenous Peoples and Traditional Populations and Communities.

On the other hand, no technology or policy will be sufficient if people are not involved. Climate education, youth mobilization, the strengthening of grassroots organizations, and the valorization of ancestral knowledge will be decisive in building **lasting solutions.**

The future of the climate depends on the decisions we make **now.** And those decisions must be made collectively, respectfully, and based on climate justice. With action, care, and unity, it is still possible to change the course of history.

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