



Climate Change and Global Warming



GO GREEN AGAINST CLIMATE CHANGE



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- I. Climate, climate oscillations, climate changes
- II. Climate change factors
- III. Effects of climate change on society
- IV. Climate change strategies
- V. Student activity



I. Climate, climate oscillations, climate changes

Unlike **weather**, which refers to the current situation of meteorological elements, such as: air temperature, atmospheric pressure, relative humidity, **climate** represents the average situation of the elements indicated for large areas and large time intervals (30 years reference period) for the stability of environments.

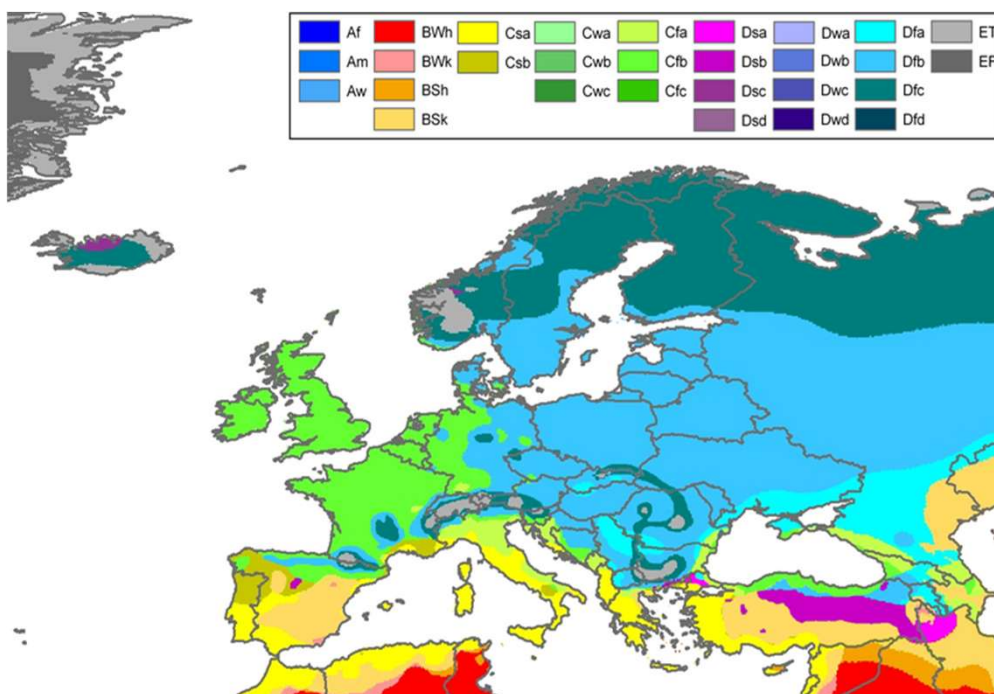


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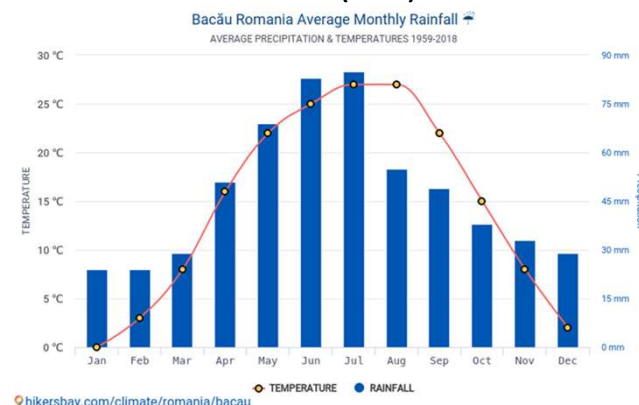


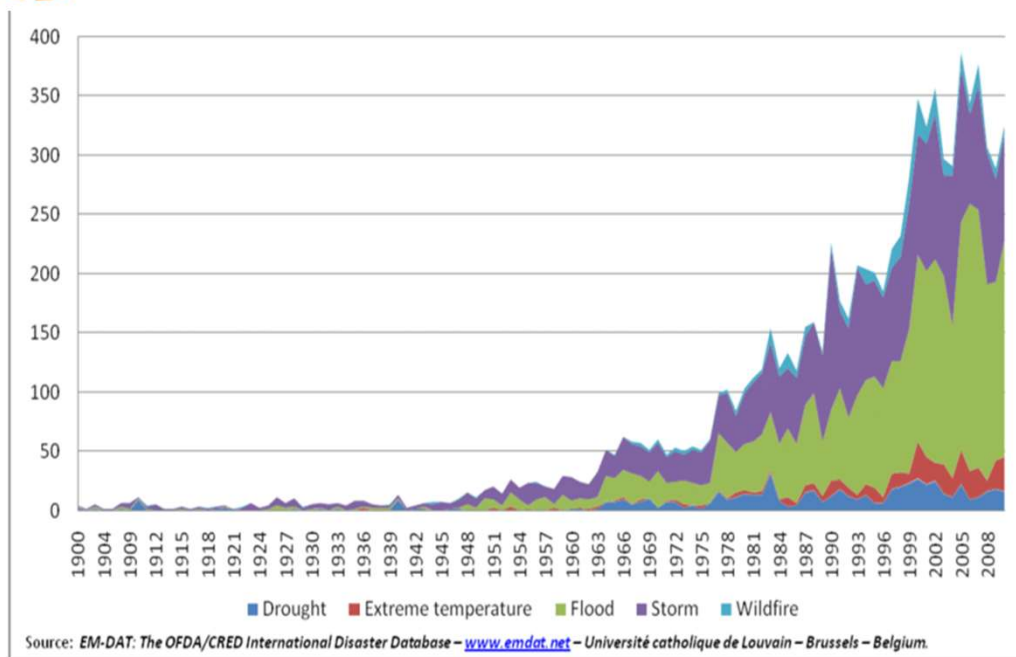
According to the Köppen-Geiger's classification, which takes into account the thermal and precipitation regime, Romania has several types of climate imposed by a diversity of factors, such as latitudinal position and on the continent, and relief.



- the dominant type of climate is temperate continental or humid continental (Dfb)
- in SW and S temperate continental with hot summers (Dfa)
- in the Carpathian arc is temperate continental cold (Dfc)

Application: identify you climate according with the map





Climate oscillations are changes in the statistical distribution of climate patterns that can last for a few years, but climate changes last decades or centuries, and their documentation uses different methods, such as: glaciology (the evolution of glaciers), dendrochronology (the study of tree rings), palynology (the study of pollen fossilized in rocks), measurement of C14 isotopes in fossils, deuterium in glaciers, etc.

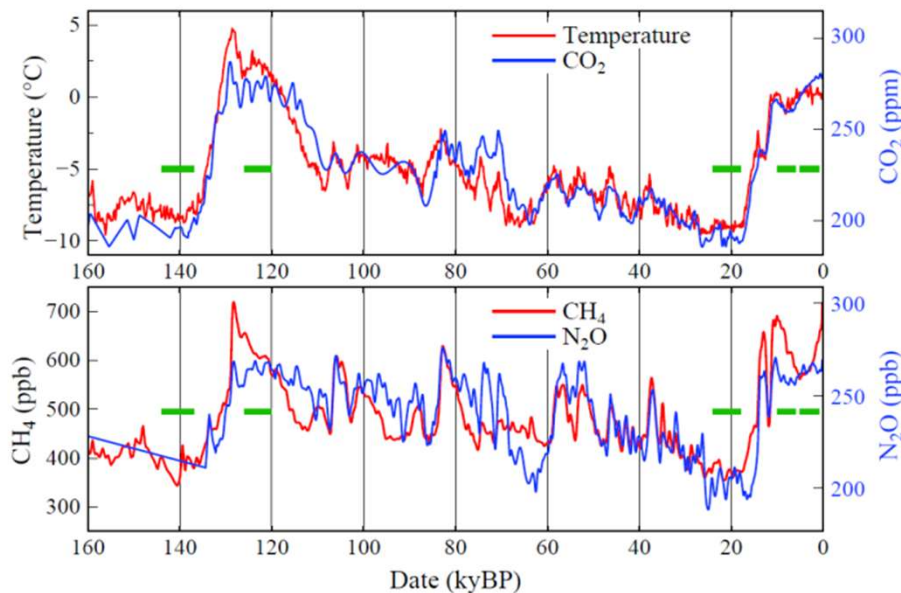


Fig. 3. Antarctic (dome C) temperature (Jouzel et al.⁴³) and multi-ice core GHG amounts (Schilt et al.).⁵⁶ Green bars (1-5, 6-10, 18-24, 120-126, 137-144 kyBP) are periods of calculations.



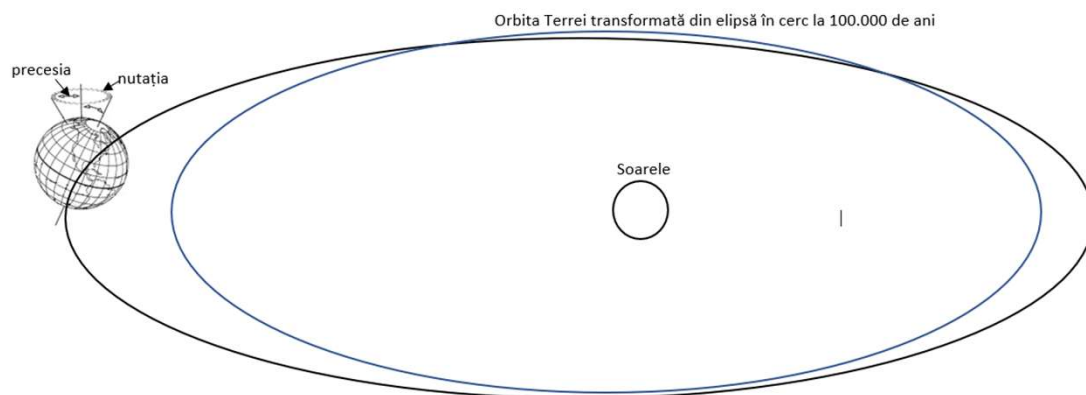
One of the methods that can reconstruct the climate evolutions of the past, is the study of the ice layers deposited over the millennia in the polar regions, where atmospheric gases, such as CO₂, CH₄, N₂O, remained captive. After the quantitative determinations, researchers including Jean Jouzel compiled variation graphs, such as the adjacent one presented in the work "Global warming in the pipeline".

Application: From the adjacent graphs, a cyclical variation of climate changes and a correlation of the temperature increase with the analyzed gases can be seen. The question thus arises: What are the causes of climate change?



II. Climate change factors

1. **Cosmic factors** represented by Milankovich's cycles that explain the variation of solar energy received by Earth with:
 - the transformation of the Earth's orbit from an ellipse to a circle once every 100,000 years requires a change of 0.4°C ;
 - the variation of the angle of the planet's rotation axis (nutation) between 22° and 24° relative to the perpendicular to the plane of the orbit (41,000 years);
 - changing the angle of the rotation axis by 46° on a cycle of 25725 years, resulting in the alternating heating of the hemispheres (currently the northern one is more heated)



Other cosmic causes can be the cycles of solar activity (11 years), the different density of matter in space, etc.



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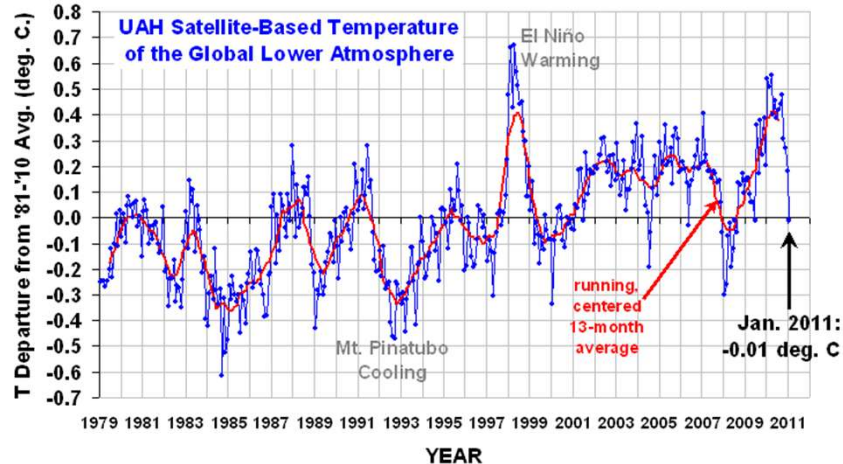
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2. Terrestrial factors of climate change

Volcanic eruptions through emitted gases, which either trap infrared radiation, as in the case of CO₂, or increase the radiation reflected from the atmosphere, as is SO₂ and volcanic ash. One such example was the 1815 eruption of the Tambora volcano in Indonesia, which caused the year "no summer" in 1816.

Cycles of chemical elements in the planetary system. Thus, carbon from the atmosphere is absorbed more slowly by the oceans if their temperature increases, so the greenhouse effect is amplified.



The 1991 eruption of Mount Pinatubo had a global climate effect.

Application: What is El Nino?



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3. **Human society** has interfered with the climate system at a rate directly proportional to numerical and technological evolution, and the activities with the greatest impact are: agriculture, industry, transport, etc. Agriculture, which at the beginning influenced the climate system through deforestation, thus reducing the carbon storage capacity through ephemeral crops, and currently by increasing the amount of greenhouse gases such as CH₄ as in rice cultivation.

The industrial revolution meant the burning of huge amounts of coal, oil and natural gas in activities such as steel industry, petrochemical industry, thermal power industry and the emission of CO₂, SO₂, NO_x, suspended and sedimentable dusts.

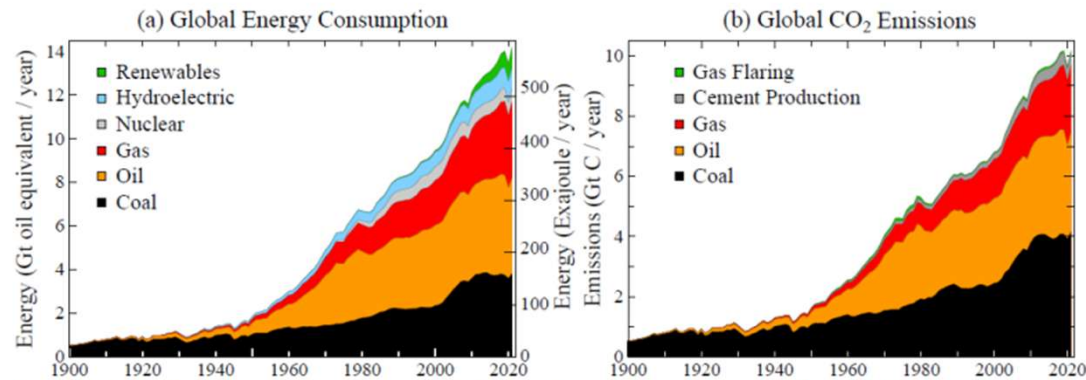


Fig. 20. Global energy consumption and CO₂ emissions (Hefner et al.¹⁴¹ and BP¹⁴²; see text).

Transportation, which has switched from external combustion engines to internal combustion engines, has become one of the biggest sources of atmospheric pollution with CO₂, SO₂, NO_x

Application: Who/what is you biggest toxic gases emitter in your country?

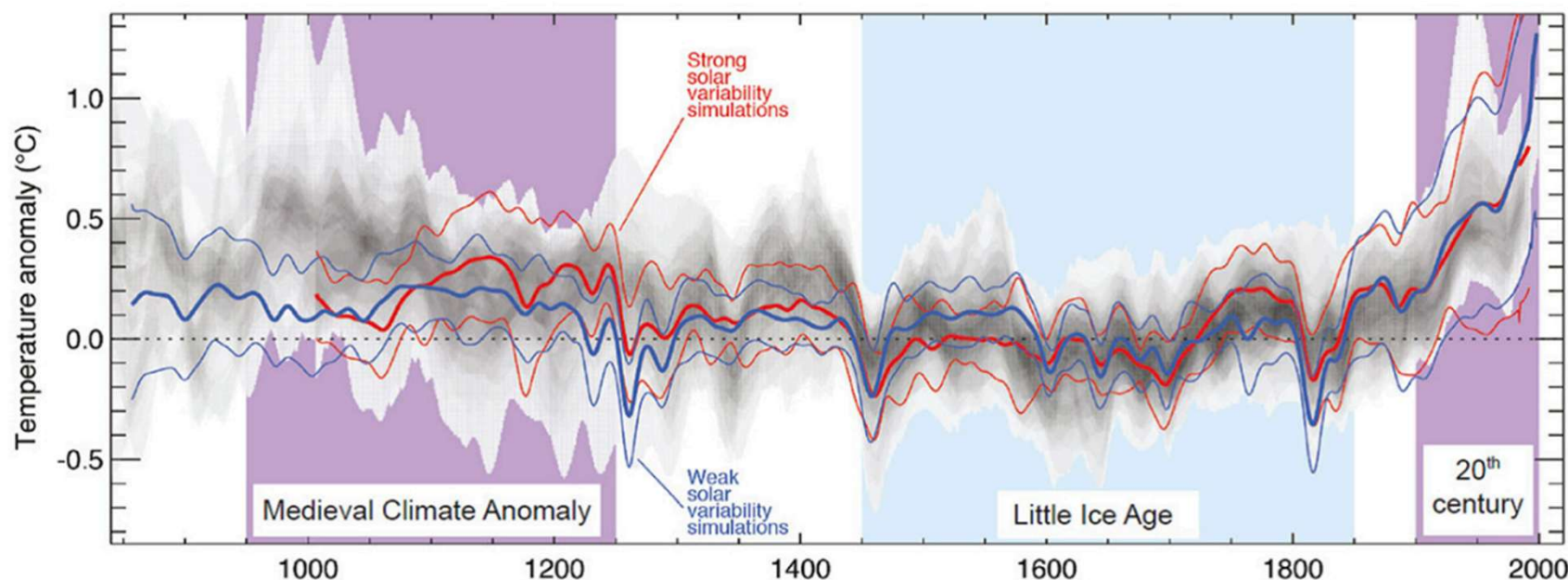


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The climate change simulation model for the last 1000 years by NOAA (2014), which takes into account the interactions between the atmosphere, ocean, ice surfaces, continental surfaces, solar and volcanic activity, highlights alternations of warmer and colder periods, but the deviations above 1°C appear from the 20th century.

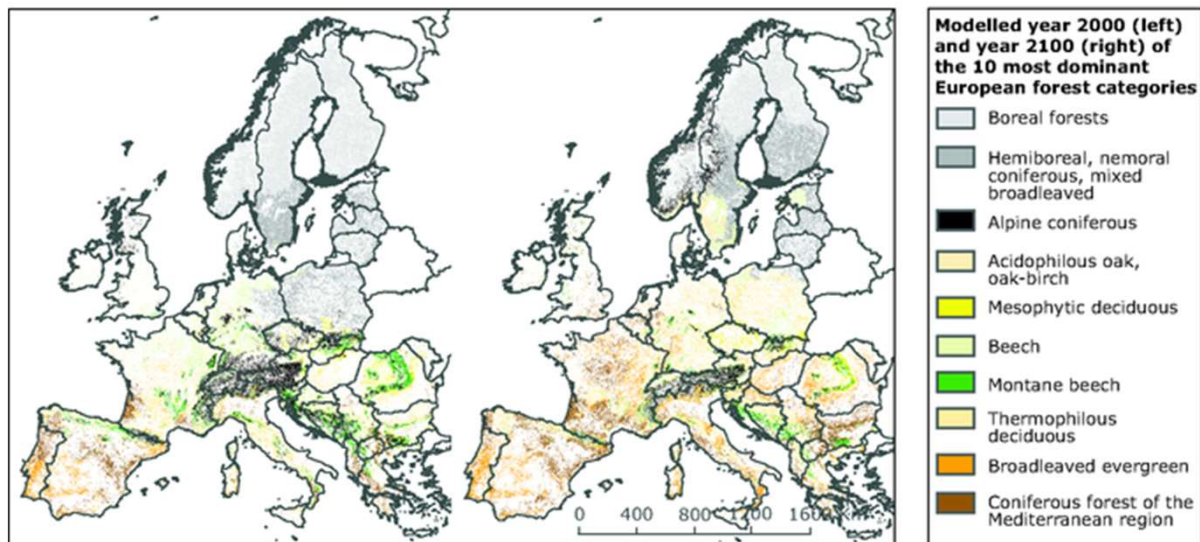


We can appreciate that the positive deviations cover the whole planet with a few exceptions, so an additional amount of energy enters the climate system causing an excessive regime, both thermal and pluviometric with effects on all geospheres.



III. Effects of climate change on humans society

1. Changing ecosystem ranges in the sense of the advance to higher latitudes and higher altitudes of warmer climate species.



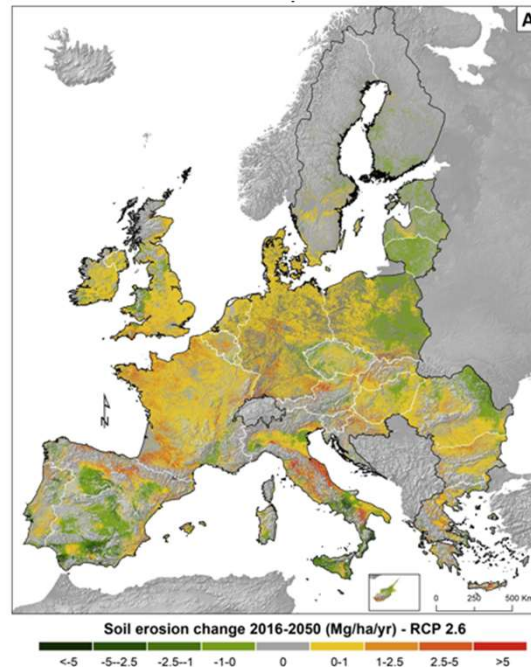
Modelled to evaluate the change of habitat suitability coverage of the ten most dominant European Forest Categories (EEA, 2006), used IPCC SRES A1B scenario and NCAR CCM3 model.



ACTIVITY: Identify for your country two changes in the distribution of plant formations between the two maps.



2. The changes in the quality and type of soils due to the change in pedogenetic factors. The rainfall regime takes on a torrential character, accelerating the erosion of the fertile horizon, and the lack of water exposes the soil to wind erosion, especially in the case of irrational agriculture.



Projections of soil loss by water erosion in Europe by 2050

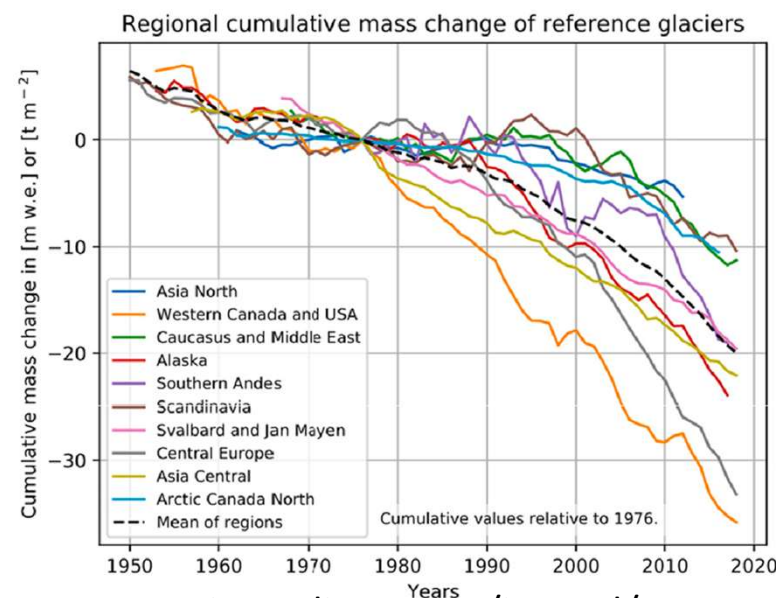
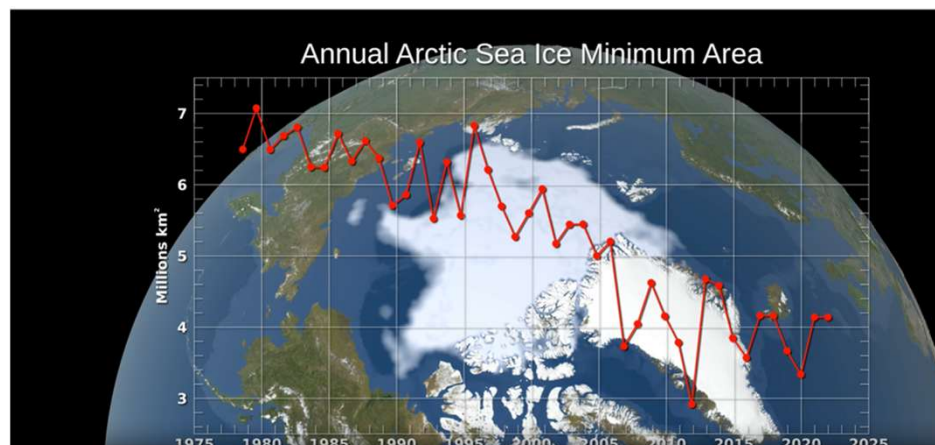


Activity: Identify two geographic regions in your country most likely to be degraded by rain-fed soil erosion, one cause and one solution.



3. Changes to oceanic and continental waters

The oceans and seas store 90% of the Earth's heat, and the excess energy helps change the direction and strength of ocean currents and storms. Inland waters such as lakes, rivers and groundwater experience changes in volume levels. Also polar and mountain glaciers show surface and volume changes with effects on the biosphere and anthroposphere.



www.ciedirect.com/journal/water-security

What is the meaning of the evolution of glaciers?

Can you guess the cause? But a consequence



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4. Consequences on human society - They are varied and complex because humanity depends on climate stability in all areas: agriculture, housing, transport, etc.



Humanity's experience accumulated over millennia of agriculture helps to obtain productions that meet the growing demand for food for a demographically exploding population, but climate change, to which agriculture also contributes, is causing increasing losses.

The quality of life in settlements, especially in cities, suffers due to the increase in heatwave durations amplified by the specific thermal characteristics of construction materials (concrete, metals, glass).

Transportation, which is an important cause of climate change, can suffer through the destruction of infrastructure due to the intensity of storms or droughts.



IV. Climate Change Strategy

Action strategies against climate change have diversified with the establishment of increasingly ambitious objectives, the emergence of new evidence and the involvement of state, regional and global actors, such as the UN, the EU, etc.



The unitary nature of the climate system requires a global approach to strategies, so the beginning of solving the problem of climate change corresponds to the signing of the United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992 in Rio de Janeiro, establishing the general objective: "stabilization of gas concentrations with a greenhouse effect in the atmosphere at a level that would prevent dangerous anthropogenic disturbance of the climate system", and as a specific objective to limit global warming below the limit of 2°C refers to the pre-industrial period. Among the proposed strategies we mention:

- emissions monitoring (national inventories with GHG emissions)
- the development of national programs to reduce GHG emissions
- the integration of the issue of climate change into economic, social development and environmental protection policies and actions

The European Union, then the European Economic Community, contributed to the drafting of the Convention, but many other initiatives had to be adopted later, and the states developed national strategies.



The Paris Agreement, as the treaty under the United Nations Framework Convention on Climate Change (UNFCCC) is called, entered into force in October 2016. The central objective became limiting global warming to below 1.5°C relative to the pre-industrial period, and the associated targets were to reduce greenhouse gas emissions by 40% by 2030 compared to 1990. Subsequent United Nations climate change conferences set more ambitious targets, such as the 55% reduction and climate neutrality in 2050. To achieve the objective, the EU provides transition financing of \$20 billion in 2017



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I am convinced that climate change and what we do about it will define us, define our era, and ultimately define the legacy we leave to future generations. Today, the moment of doubt has passed.

Ban Ki-moon, Secretary-General, United Nations



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V. Students activity

The **Climate Change Game** is a simulation where students act as world leaders or policymakers in a global community. Their goal is to implement strategies that slow down or reverse climate change while balancing economic, social, and environmental concerns. Players must make decisions about energy use, emissions reduction, resource management, and climate adaptation while facing challenges and events (e.g., natural disasters, political shifts, new technologies).

Objective:

To achieve the most sustainable future by addressing the causes and effects of climate change through informed decision-making.



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Materials needed:

- Game board (optional) with categories like energy, economy, climate effects, policies, etc.;
- Decision cards or scenario cards;
- Resource tokens (e.g., money, energy, carbon credits);
- Environmental impact tracker (could be a simple graph or chart to track climate changes like CO2 levels, global temperatures, etc.);
- Markers or chips to represent countries or regions (if playing in teams);
- Dice or random event cards to introduce uncertainty (e.g., natural disasters or technological breakthroughs);
- Rulebook or instructions.

Note: the Cards can be made using different education platforms:

- <https://www.teacherspayteachers.com/>
- <https://www.climaterealityproject.org/>
- <https://envirothon.org/>
- <https://drawdown.org/>



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Setup:

1. Players: The game can be played by individual students or in teams. Each player/team represents a country or group of countries.

2. Starting Scenario: At the beginning of the game, the world is at a critical point in terms of climate change, with certain global thresholds approaching (e.g., 2°C temperature rise, significant biodiversity loss). Players will need to make decisions on policies and actions to reduce their emissions and adapt to changing climates.

3. Game Board/Areas:

Energy Sector: Renewable and non-renewable energy options.

Agriculture: Sustainable farming, food security, and land use.

Industry: Emissions from factories, transportation, and manufacturing.

Social and Economic Development: Balancing economic growth with sustainability.

Climate Impact: Rising temperatures, extreme weather, sea-level rise, etc.

4. Starting Resources: Each player starts with a set amount of resources (money, technology, carbon credits, etc.) to use throughout the game.





Game Phases:

Decision Phase (Turns): On each turn, players have to make key decisions on how to use their resources. The decisions might include:

- Investing in renewable energy
- Implementing carbon taxes or cap-and-trade policies
- Developing new green technologies
- Funding reforestation or sustainable agriculture
- Improving waste management or building resilient infrastructure
- Mitigating social and environmental impacts (e.g., climate adaptation measures like coastal defences)

These decisions will affect various categories on the game board and will impact the environmental and economic metrics (e.g., carbon levels, GDP, life expectancy, ecosystem health).



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Game Phases:

Event Phase (Random Events): After every round, the game introduces random events that can either help or hinder players' progress. For example:

Extreme Weather Event: A natural disaster (floods, droughts, wildfires) occurs, affecting resources and causing damage.

Technological Breakthrough: A new clean technology emerges that significantly reduces carbon emissions or increases energy efficiency.

Political Change: A new leader is elected with policies that either help or hurt climate action.

Global Agreement: International cooperation on climate action results in a global emissions reduction.





Game Phases:

Impact Tracker: After each round, players assess their progress using the impact tracker. They will measure the following:

Global Temperature Change: Players' actions will either increase or decrease global temperatures. If global temperatures rise by more than a certain threshold (e.g., 2°C), the game ends in disaster.

Resource Depletion: Non-sustainable actions may deplete natural resources, which will affect future turns.

Carbon Levels: The overall CO₂ concentration in the atmosphere will be tracked, and players must work to reduce these levels through their decisions.

Economic and Social Health: Players must balance economic growth and social equity. Overusing resources or creating inequalities could result in social unrest or economic collapse.





Winning the Game:

The game can have multiple winning conditions, depending on the scenario:

Sustainable Future: If players manage to keep global temperature rise below 2°C, reduce carbon emissions to sustainable levels, and ensure a healthy economy and society, they win the game.

Most Sustainable Country/Region: If playing as countries or regions, the player/team that achieves the most sustainable balance of economic growth, social development, and environmental protection wins.

Global Cooperation Victory: If all players work together to achieve global emissions reductions and adapt to climate change, everyone can win.





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