

Climate change and forests

TEACHER-LED LESSON by
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Wednesday 26th September 2018

TOPIC Climate change and forests

GOALS At the end of your research you should know...

- ... the difference between weather, weather condition and climate.
- ... why there are different climate zones worldwide.
- ... how climate zones affect trees and forests.
- ... how much forest exists world wide.
- ... what we mean when we talk about climate change.
- ... what the natural greenhouse effect is.
- ... the main reasons for the human enhanced greenhouse effect.
- ... what the value of forests in climate change is.
- ... what the main threats to forests due to climate change is.
- ... the main strategies for forests in climate change.

- SOURCES**
- http://www.geo.fu-berlin.de/en/v/iwm-network/learning_content/environmental-background/basics_climategeography/definitions/index.html
 - <https://content.meteoblue.com/en/meteoscool/general-climate-zones>
 - <https://www.iucn.org/resources/issues-briefs/forests-and-climate-change#why>
 - <https://www.youtube.com/watch?v=bpazvRVh4y0&t=26s>
 - https://data.worldbank.org/indicator/AG.LND.FRST.ZS?end=2015&name_desc=false&start=1990&type=points&view=chart
 - <http://www.scotese.com/climate.htm>
 - <https://www.cbd.int/climate/intro.shtml>
 - http://www.efiatlantic.efi.int/files/attachments/efiatlantic/2012_rokfor/efi_rokfor_climate_change_a4_210113.pdf
 - <https://www.nps.gov/goga/learn/nature/climate-change-causes.htm>
 - <http://climatechange.lta.org/get-started/learn/co2-methane-greenhouse-effect/>
 - <https://www.nrcan.gc.ca/forests/climate-change/forest-carbon/13085>
 - <https://www.iucn.org/resources/issues-briefs/forests-and-climate-change#why>
 - https://www.youtube.com/watch?time_continue=1&v=nckgJWnj4Yw

What is the difference between weather, weather condition and climate?

Weather is the combination of the current meteorological components like wind, sunshine, rain, Weather is defining a short time period up to several days.

Weather condition is describing typical weather phenomena from one week to several month, like a series of thunderstorm in hot summer, a foggy month in autumn or other weather conditions which are typical for a specific region or season.

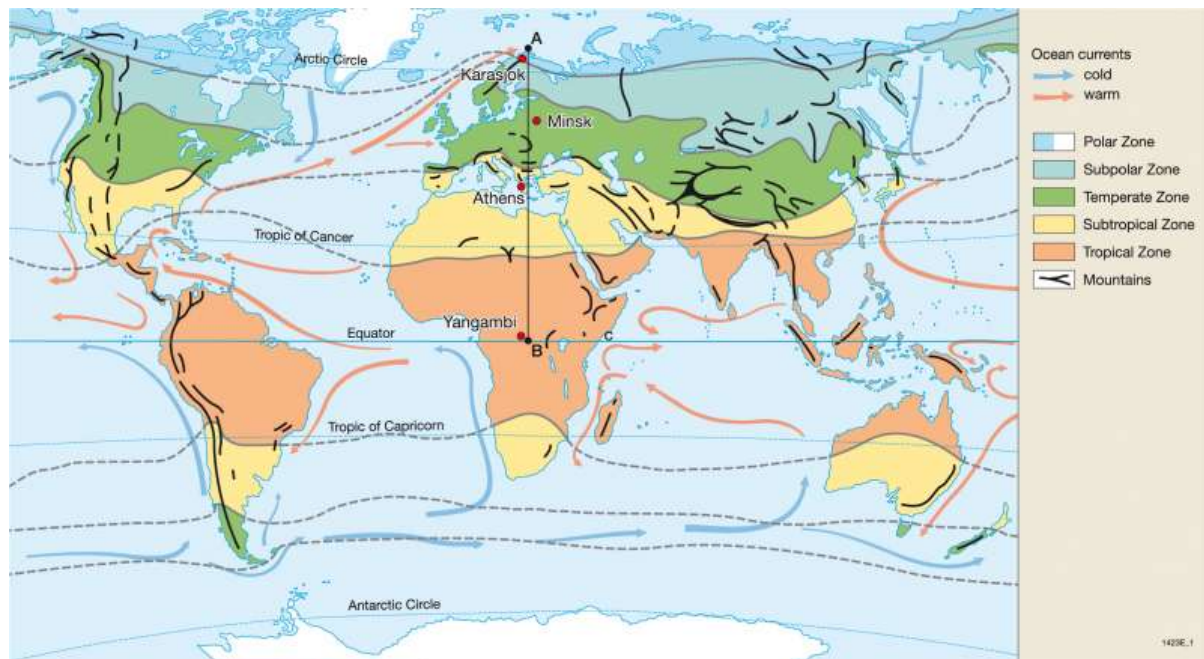
Climate is describing the long term (min 30 years) and average weather conditions for a specific region, like maritime climate, cold-dry desert climate, tropical climate.¹

Examples:

- *It is cold in Siberia. (C)*
- *There will be a thunderstorm this evening. (W)*
- *In recent years, October was always very mild and sunny in Middle Europe. (WC)*
- *Last year's Christmas season was incredibly frosty. (WC)*
- *It is very humid today. (W)*
- *In Middle Europe there's usually snow in winter. (C)*

Why are there different climate zones worldwide?

Different climate factors are influencing the weather and weather conditions. Together with the meteorological or climate components, climate factors are composing the climate in its variations.^{2 3}



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Climate factors

- atmosphere
- latitude
- ocean currents
- altitude
- relief
- exposition
- vegetation cover (land use)

climate factors are usually stable or only slightly changing factors, except the vegetation cover

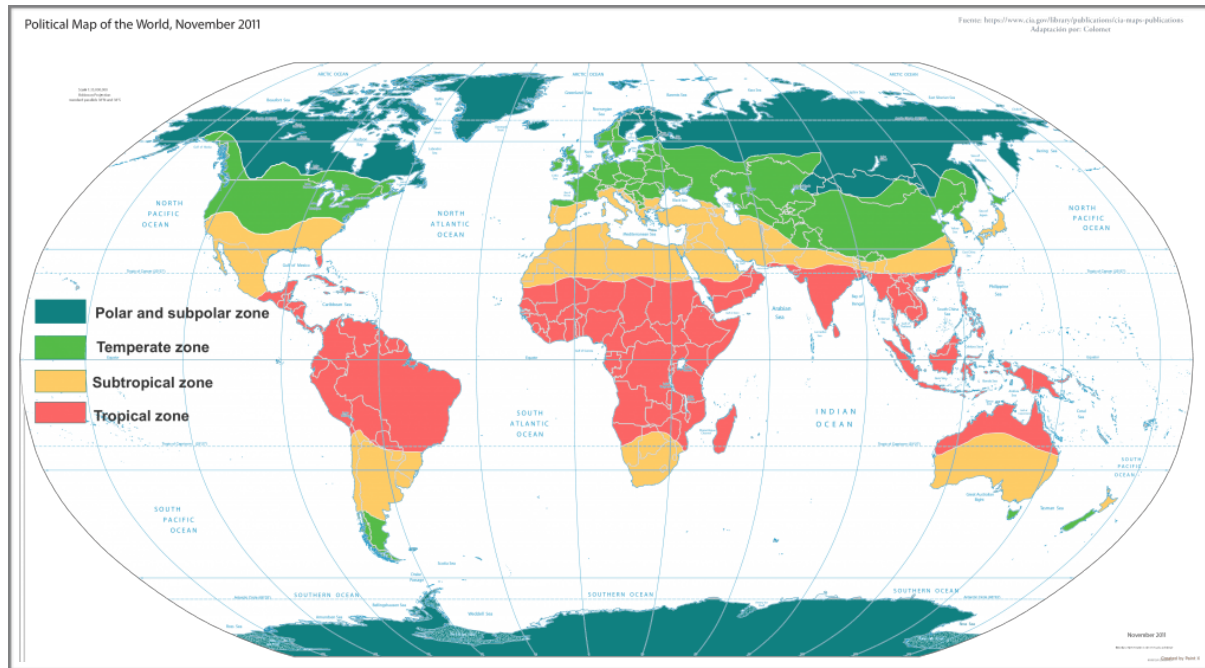
Meteorological/climate components

- temperature
- atmospheric pressure
- wind
- solar radiation
- humidity
- precipitation

Meteorological or climate components are dynamic and change permanently;

Film "Five factors that affect climate"⁵ or "Basics of Geography"

How do climate zones affect trees and forests?



Tropical zone

In the regions between the equator and the tropics (equatorial region), the solar radiation reaches the ground nearly vertically at noontime during almost the entire year. Thereby, it is very warm in these regions. Through high temperatures, more water evaporates and the air is often moist. The resulting frequent and dense cloud cover reduces the effect of solar radiation on ground temperature.

=> *warm and humid: many tree species in different layers; green leaves every day of the year (jungle)*

Subtropical zone

The subtropics receive the highest radiation in summer, since the Sun's angle at noon is almost vertical to the Earth, whilst the cloud cover is relatively thin. These regions receive less moisture (see trade winds), what increases the effect of radiation. Therefore, most of the deserts in the world are situated in this zone. In winter, the radiation in these regions decreases significantly, and it can temporarily be very cool and moist.

=> *drought: only a few small trees which have to store water efficiently (desert)*

Temperate zone

In the temperate zone, the solar radiation arrives with a smaller angle, and the average temperatures here are much cooler than in the subtropics. The seasons and daylength differ significantly in the course of a year. The climate is characterised by less frequent extremes, a more regular distribution of the precipitation over the year and a longer vegetation period - therefore the name "temperate".

=> *vegetation period: trees pass through different stages every year (different seasons)*

Polar and subpolar zone

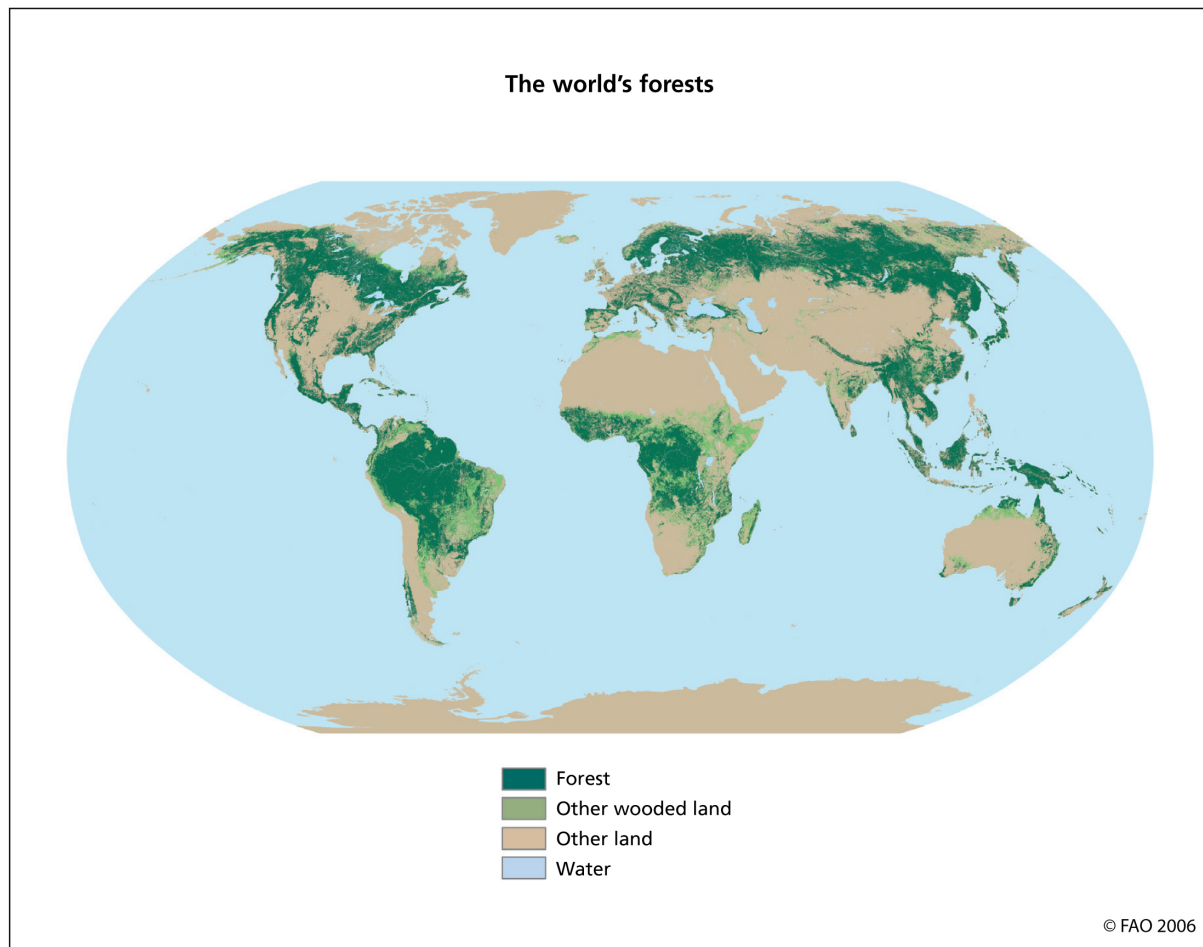
The polar areas between 60° latitude and the poles receive less heat through solar radiation, since the sun has a very flat angle toward the ground. Because of the changes of the Earth axis angle to the sun, the daylength varies most in this zone. In the summer, polar days occur. Vegetation is only possible during a few months per year and even then is often sparse. The conditions for life in these regions are very hard.







=> *too cold, frozen soil: no trees (northpole)*

IMPORTANT: The characteristics of the climate zones change with great altitude differences within a small area, like in [mountain](#) areas, since temperatures decrease rapidly with altitude, changing the climate compared to valleys.⁶

How much forest is there on the planet?

Around 30% of the land area worldwide is covered with forests.⁷ This corresponds to an area more or less the size of a football field for every person on the planet. More than 60% of these forests areas are in very poor countries.⁸ Most of these forests are tropical rainforests.

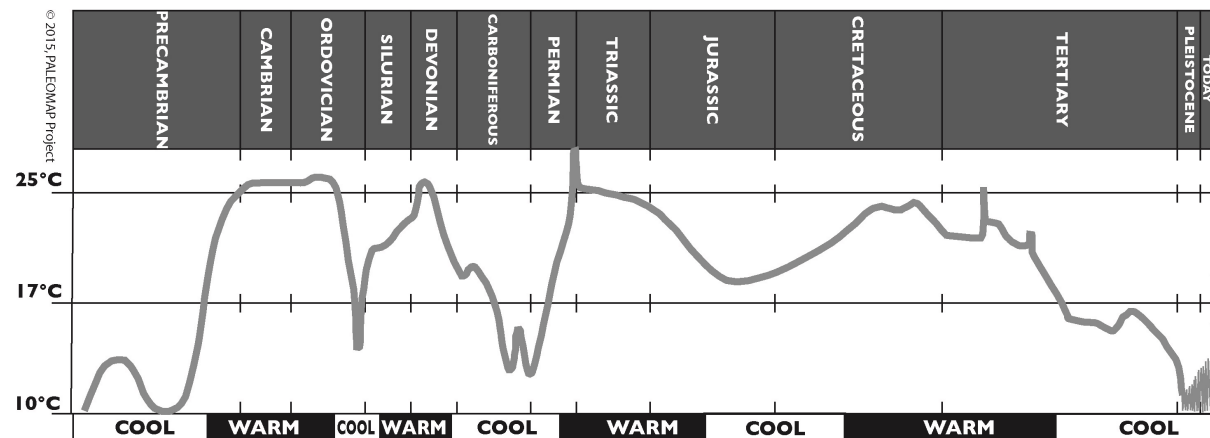


	Worldwide	30,8 %	39,991,336.2 km ²
	Spain	36,8 %	184,178.7 km ²
	Netherlands	11,2 %	3,760.0 km ²
	Italy	31,6 %	92,970.0 km ²
	Germany	32,7 %	114,190.0 km ²
	France	31,0 %	169,890.0 km ²
	Denmark	14,6 %	6,122.0 km ²

Forest in percent of land area in 2015 ⁹

What is climate change?

In the history of the earth the climate has been changing constantly, between "frigid house" (like today) and a "steaming house" (area of dinosaurs).¹⁰ During this process, animals and plants had the opportunity to adapt slowly to the temperature changes. In the past, climate change has been driven mostly by geological factors, such as shifts in the Earth's axis, volcanic eruptions, etc.



However, when we talk about today's climate change or global warming, we mean the human influence on the climate since industrialization. Within the last century the average temperature has risen about almost 1°C, in some regions it can be up to 2°C. But climate change is not only a change of temperature. It's accompanied by many other changes like in precipitation patterns (rain, snow, etc.), wind regimes and an increased sea level due to melting glaciers.¹¹

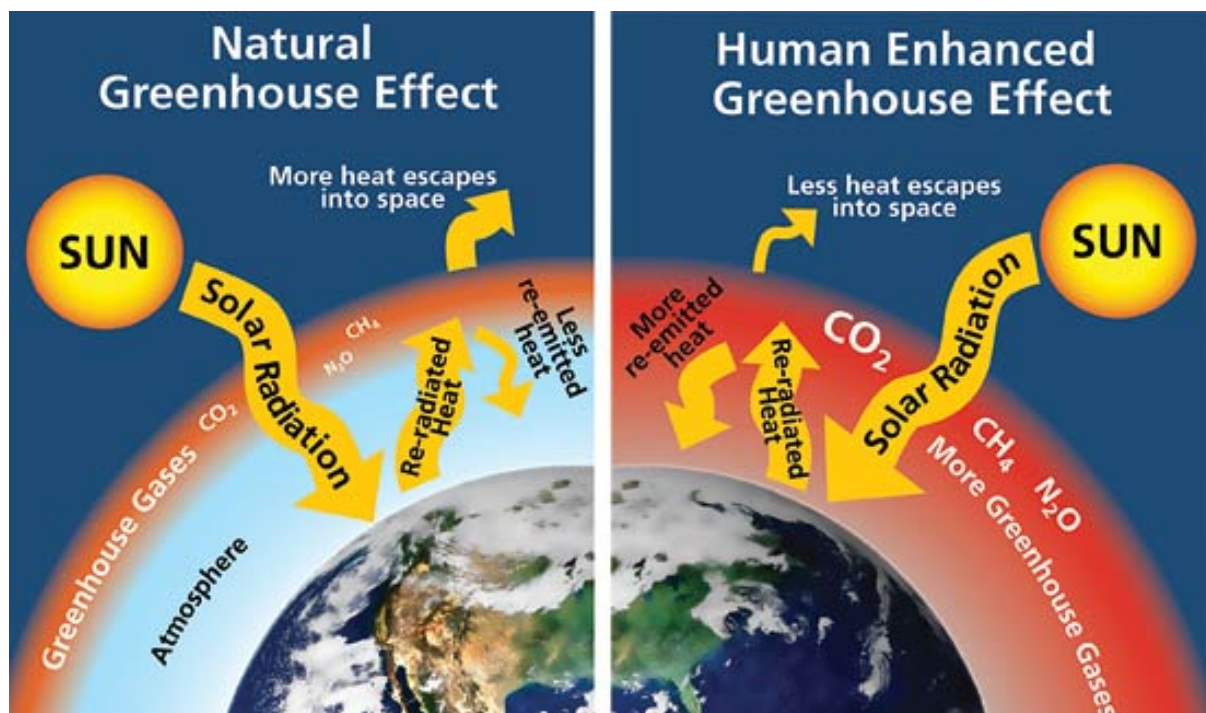
Most scientists are certain that this unusual climate change unique in speed is mostly caused by the human enhanced greenhouse effect.¹²

What is the natural greenhouse effect?

Our atmosphere consists of 5 layers of gases surrounding the earth. It protects the earth from solar ultraviolet radiation, solar wind and cosmic rays. It consists of 78% nitrogen, 21% oxygen, 0,9% argon with Carbon dioxide (CO₂) and other trace gases like Methane (CH₄), Nitrous oxide (N₂O) and Water Vapor (H₂O). These trace gases are also known as greenhouse gases.¹³ They act like the glass roof of a greenhouse by trapping heat and warming the planet. The earth temperature is mainly driven by this natural greenhouse effect. Without it, the average temperature on the earth wouldn't be around 15° C, but much lower than that.¹⁴ (Film: "How Do Greenhouse Gases Actually Work?")

What is the human enhanced greenhouse effect?

The natural levels of the greenhouse gases are being supplemented by emissions from human activities, such as the burning of fossil fuels, farming activities and land-use changes. As a result, the Earth's surface and lower atmosphere are warming more rapidly than usually.



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Film: "Climate Science in a Nutshell #5 Where Does Carbon Dioxide"

Where do the additional greenhouse gases that cause global warming come from?

Carbon dioxide

- whenever coal, oil, natural gases or wood are burned
- largest contributor to climate change

Methane

- decomposition of plant matter, land fills and cattle farms
- 25x more effective than CO₂

Nitrous oxide

- modern agricultural practices (tilling and soil cultivation, livestock waste management, and the use of nitrogen-rich fertilizers)
- 298x more effective than CO₂¹⁶

Film: <https://www.youtube.com/watch?v=bpazvRVh4y0&t=26s>

What is the value of forests in climate change?

Carbon dioxide sink

Beside our oceans, forests absorb huge amounts of carbon dioxide (one of the greenhouse gases) from the atmosphere through photosynthesis producing oxygen. Within this process, carbon becomes deposited in forest biomass like trunks, branches, roots, leaves and the soil. Forest carbon is released when trees burn or when they decay after dying (fire, old age, insects or other disturbances). That means, a forest acts only as *carbon sink* if it absorbs more carbon from the atmosphere than it releases.¹⁷ If you use wood as building material (furniture, buildings, etc.) the carbon stays inside as well.

Air condition

Forests store water and release it slowly through evaporation. By doing this, forests act like some sort of air condition by cooling down the air.

Biological diversity

Forests offer various habitats and therefore increase biodiversity. This also helps to remove carbon dioxide from the atmosphere.

Water storage

Forests can cope better with heavy rainfall by acting like sponges. This protects the soil from water erosion

Windbreaker

Forests slow down winds and lower the risks of windthrow. This also protects the soil from wind erosion. A healthy soil is important for water storage and thus vegetation to grow.

Safety Belt

Forests help to stabilize land slopes and reduce the risk of mudslides and avalanches which are more likely due to more frequent extreme weather conditions.

Reflector

Forests and their huge crowns reflect solar radiation.

What are the main threats to forests in climate change?

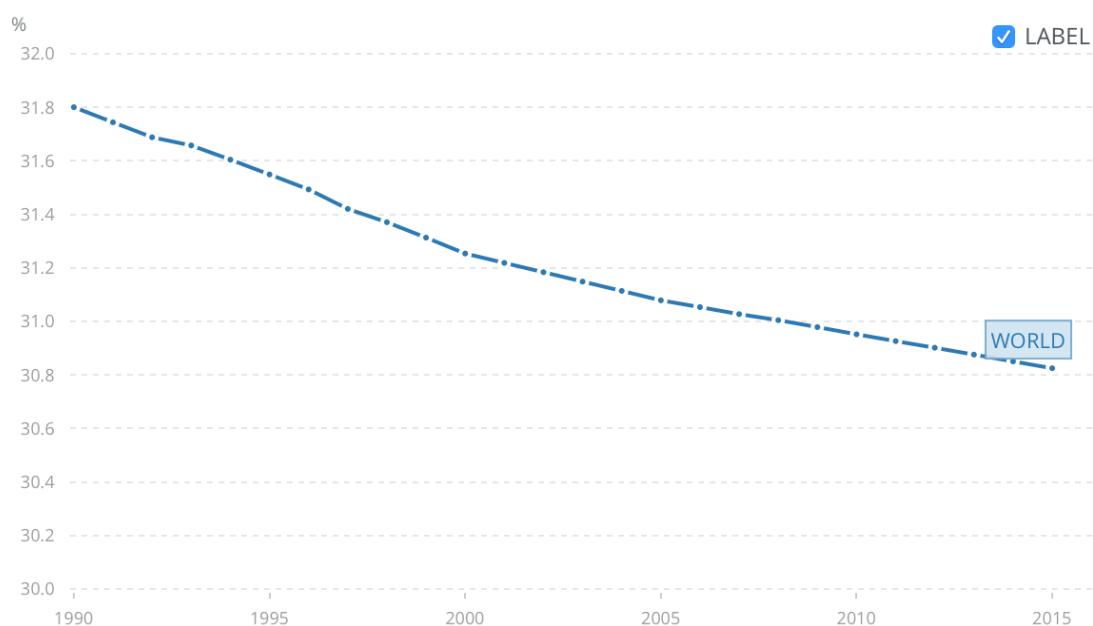
Forests in climate change are directly endangered due to the rapidly increasing temperatures, changing mean precipitation, natural catastrophes, diseases and infestation.

- intense drought causes water stress
- forest damaging insects benefit from rising temperature and drought
- extension of range and increase in mass outbreaks of pests
- more frequent fires during long lasting heatwaves
- increased windthrow damage through heavier storms
- flooding and soil erosion through intense rainfall
- higher risk of early frost damages (buds, leaves, flowers) because of weather extremes
- reduction of genetic diversity through dieback
- decrease in number of tree species through dieback

Forest strategies in climate change

Forests are on the one hand endangered through climate change, on the other hand they are part of the solution to reduce global warming and the impact of climate change consequences. In the last 8000 years about 45% of the Earth's original forest cover has disappeared, most of which was cleared during the past century.¹⁸ This trend still continues worldwide.

Around 13 million hectares of forest were converted to other uses or lost through natural causes each year between 2000 and 2010. The world has an estimated 850 million hectares of degraded forests, which could potentially be restored and rehabilitated to bring back lost biodiversity and ecosystem services, and, at the same time, contribute to climate change mitigation and adaptation.¹⁹



Combatting deforestation and forest degradation²⁰

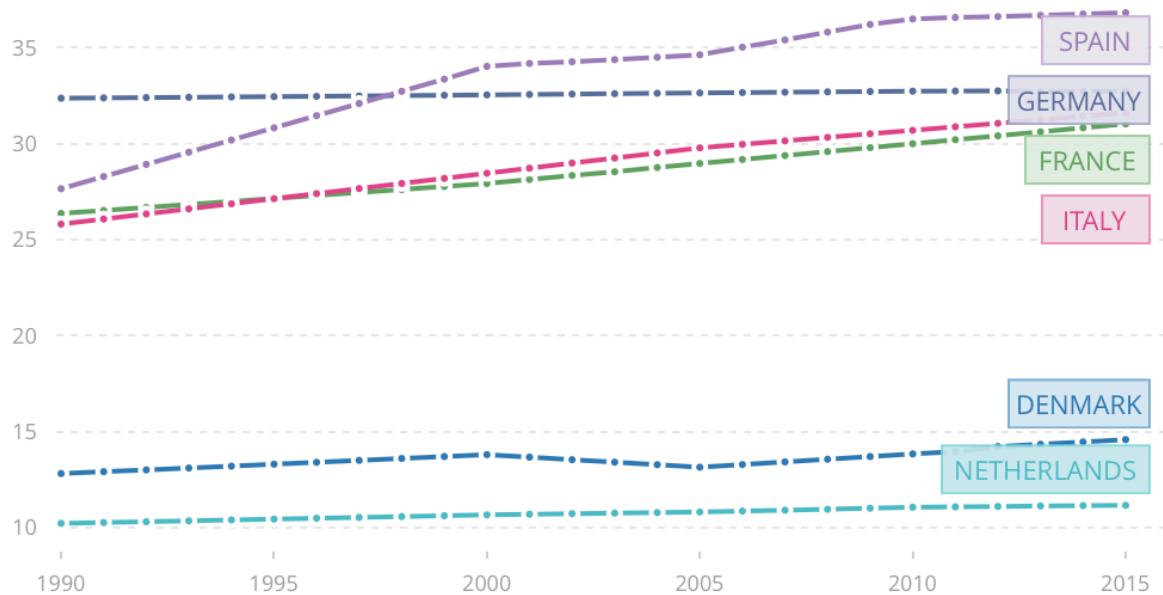
Restoring forest landscapes

Sustainable forest management

Research in alternative tree species

Conservation of genetic resources

Forest development in Europe



Film: European Forests

https://www.youtube.com/watch?time_continue=48&v=9UXrdWVQSL0

Film: European Forests in climate change

https://www.youtube.com/watch?time_continue=1&v=nckgJWnj4Yw

Film: How to conserve forest genetic resources in the context of climate change?

https://www.youtube.com/watch?time_continue=27&v=k98GSawxXj0

Film: Afforesting Island

<https://www.youtube.com/watch?v=-hgAf8awLmQ>

- > worst example of deforestation
- > land needed for cattle and sheep
- > once the trees are gone the soil is exposed to erosion
- > soil is gone, it doesn't come back easily; you need pioneer trees that restore humus

Literature

- ¹ http://www.geo.fu-berlin.de/en/v/iwm-network/learning_content/environmental-background/basics_climategeography/definitions/index.html
- ² http://www.geo.fu-berlin.de/en/v/iwm-network/learning_content/environmental-background/basics_climategeography/Climate-factors/index.html
- ³ http://www.geo.fu-berlin.de/en/v/iwm-network/learning_content/environmental-background/basics_climategeography/climate-components/index.html
- ⁴ http://media.diercke.net/omeda/800/11423E_1_Erde_Klimazonen_Geb.jpg
- ⁵ <https://www.youtube.com/watch?v=E7DLLxrrBV8>
- ⁶ <https://content.meteoblue.com/en/meteoscool/general-climate-zones>
- ⁷ https://data.worldbank.org/indicator/AG.LND.FRST.ZS?end=2015&name_desc=false&start=1990&type=points&view=chart
- ⁸ <https://www.greenfacts.org/en/forests/index.htm#1>
- ⁹ https://data.worldbank.org/indicator/AG.LND.FRST.ZS?end=2015&locations=DK-FR-DE-IT-NL-ES&name_desc=false&start=1990&view=chart
- ¹⁰ <http://www.scotese.com/climate.htm>
- ¹¹ <https://www.cbd.int/climate/intro.shtml>
- ¹² http://www.efiatlantic.efi.int/files/attachments/efiatlantic/2012_rokfor/efi_rokfor_climate_change_a4_210113.pdf
- ¹³ <https://en.wikipedia.org/wiki/Atmosphere>
- ¹⁴ http://www.efiatlantic.efi.int/files/attachments/efiatlantic/2012_rokfor/efi_rokfor_climate_change_a4_210113.pdf
- ¹⁵ <https://www.nps.gov/goga/learn/nature/climate-change-causes.htm>
- ¹⁶ <http://climatechange.lta.org/get-started/learn/co2-methane-greenhouse-effect/>
- ¹⁷ <https://www.nrcan.gc.ca/forests/climate-change/forest-carbon/13085>
- ¹⁸ <https://www.cbd.int/forest/problem.shtml>
- ¹⁹ <http://www.fao.org/docrep/013/i1960e/i1960e00.pdf>
- ²⁰ <https://www.iucn.org/resources/issues-briefs/forests-and-climate-change#why>