CASCADE
COMMUNITY SAFETY ACTION FOR SUPPORTING CLIMATE ADAPTATION

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Introduction to Climate Change – a Baltic Sea Region perspective

Lesson 1

Background and explanations to the slide presentation.

Content:

Basics of the causes for climate change and the major effects

- Natural greenhouse effect
- Temperature changes versus CO_2 (1880–now)
- CO_2 global emissions by sector (2014)
- CH_4 & N_2O global emissions by sector (2000–2009)
- Permafrost thawing
- Sea ice melting
- Mean sea level rise
- Extreme weather
- Climate related deaths
- Temperature scenarios (now–2100)

Climate change hazards in the Baltic Sea Region (BSR)

- Climate change weather related hazards in the BSR
- Consequences of climate related hazards for societies
- Flood events in the BSR
- Further consequences in the BSR
- Consequences for the ecosystems in the BSR
- Consequences for human health
- Transboundary impacts in the BSR

2. Learning outcomes

- Be able to explain the basics of causes for climate change: greenhouse effect, gases, emissions
- Know the major consequences of the climate change
- Be aware of drivers and risks for hazards connected with the climate change in the Baltic Sea Region

3. Basics of the causes for climate change and the major effects

4. Natural greenhouse effect – solar radiation

For human life on Earth as we know it, a certain temperature on the Earth's surface is necessary.

The natural greenhouse effect, which is caused by the naturally occurring greenhouse gases, results in an average temperature of around +14°C. The gases responsible for it are the average natural amounts of greenhouse gases before industrialization in the 19th century.
Without the natural greenhouse effect, the earth's surface would have an average temperature of around -19°C, as solar radiation is reflected on the Earth's surface and is largely reflected back into space.

Since greenhouse gases such as water vapour, carbon dioxide (CO_2), ozone (O_3), nitrous oxide (N_2O) or methane (CH_4) are present in the Earth's atmosphere, a large part of the reflected solar radiation is prevented from reaching space again and is therefore reflected back to Earth. The natural greenhouse effect leads to a temperature increase of around 33°C.

5. Natural greenhouse effects – contribution of different gases

The most important greenhouse gases are water vapour, carbon dioxide (CO_2), ozone (O_3), nitrous oxide (N_2O) and methane (CH_4). These gases have a different intense effect.

Most of the natural greenhouse effect is caused by water vapour. With over 20°C, water vapour has the greatest influence on the natural greenhouse effect. Another 7°C are caused by CO_2, 5°C by O_3, N_2O, and CH_4. This results in the natural greenhouse effect with a temperature increase of 33°C.

6. Correlation of CO_2 concentration and temperature rise since 1880

The emissions of greenhouse gases by humans lead overall to an increase in temperature, which is shown in this diagram.

In addition to the actually measured temperature increase, the calculated temperature increase is also plotted in the diagram. There is a clear correlation between the measured and calculated temperature resulting from the increased concentration of greenhouse gases in the atmosphere. This correlation confirms that the additional emission of greenhouse gases leads to man-made climate change.

7. CO_2 emissions by source and sector

Burning of fossil fuels (coal, petroleum, natural gas) causes globally the majority of carbon dioxide (CO_2) emissions. Overall, around 85 % of man-made CO_2 emissions are caused by fossil fuels (2014). Another 5 % comes from cement production and another 10 % comes from land use change. Above all, this includes the clearing of tropical forests. Tropical deforestation takes place mainly due to the development of infrastructure, such as roads. To enable areas as pastureland or for plantations for oil palms, soy, bananas or coffee are other reasons for the clearcutting. In addition, most of the clearing is done for direct wood production.

Contribution of coal, oil and gas to fossil fuel emissions:
44 % of the CO_2 emissions from fossil fuels arise from the combustion of coal, 35 % from mineral oil and 21 % from natural gas.

The resulting energy is used differently within the various sectors. Of the CO_2 emissions 37 % originate from industry. Other drivers of CO_2 emissions are transport with 23 % and the service sector with 11 %. Private households generate a further 12 % of CO_2 emissions. The rest – other sectors – accounts for 17 %. The emissions generated by transport are mainly caused by road traffic. Air transportation and shipping also have a large share.

8. Methane (CH_4) & Nitrous Oxide (N_2O) emissions

In addition to carbon dioxide (CO_2) emissions, methane (CH_4) and nitrous oxide (N_2O) emissions are relevant for man-made climate change.

Fossil fuels are essential for methane emissions. In addition, emissions from livestock farming (principally from digestive emissions of cattle), landfills or rice cultivation are important. Methane is also released into the atmosphere through burning biomass (*e.g.* wildfires and bushfires) and the manufacturing of biofuel.

Agriculture is the main driver of nitrous oxide emissions (59 %). In addition, a smaller proportion of man-made nitrous oxide emissions arise from combustion of biomass and biofuel (10%). Fossil fuels within industry cause 10 % of all nitrous oxide emissions.
Nitrogen compounds from fertilizers from agriculture or wastewater accumulate in rivers. Bacteria break down these compounds and nitrous oxide is released in the process, contributing to about 9 % of emissions. In addition, the share from other sources is about 12 %. (2000-2009).

9. Permafrost thawing

When the permafrost ground thaws, methane and CO_2 are released. The further warming caused by climate change can thaw deeper layers of the permafrost. This increases the amount of methane and CO_2 released to the atmosphere, which in turn intensify climate change.

This self-reinforcing process alone induces the defrosting of deeper layers of the permafrost ground, which is called permafrost carbon feedback (PCF).

10. Sea ice melting

For the entire context of the ice melt, it should be noted that when floating ice melts, roughly the same amount of water is generated as already displaced by the ice. This means that floating sea ice does not result in a rise in sea level.

Only the ice masses onshore are relevant for sea level rise. When meltwater from onshore ice flows into the sea, thereby causing the sea level to rise.

11. Sea level rise

The average sea level has risen steadily over the past 2000 years, by 0.2 mm per year. In the 20th century, the sea level increased by 1.7 mm annually. In recent years, between 2002 and 2016, the average sea level has already risen by 3.5 mm per year.

Various influencing factors contribute to the average sea level rise. The largest share results from the warming of the water and the associated expansion of seawater (31 %). Both the melting ice from glaciers and the ice on Greenland contribute 26 % each to the total sea level rise. The melting of Antarctic ice and ice reservoirs onshore causes the remainder of the sea level rise.

12. Extreme weather

Severe storms are examples of extreme weather causing damage. Climate change is causing the temperature of the sea surface to rise. Consequently this leads to an increase in evaporation, thus feeding more energy to the storms. A cascading effect when the risk of more severe storms will occur.

Further possible scenarios with negative effects are extreme weather such as heavy rains, thunderstorms and flooding. The same is true for an increase in major fire events, such as forest fire or bushfire, due to drought conditions.

13. Additional climate related deaths

There will be additional deaths due to climate change in the years to come. It is estimated that in 2010 there were already 225 000 additional deaths due to malnutrition. Another 85 000 deaths from diarrhoea and 35 000 deaths from heat or cold.

The numbers of deaths will also increase due to various diseases, such as meningitis or diseases that can be transmitted by for example mosquitoes. The flood events resulted in 2 750 additional deaths. The increasing strength of storms resulted in 2 500 additional deaths.

NB: the estimation of additional deaths resulting from climate changes are extremely hard to accomplish, as other factors also may have an impact on the results.

14. Scenario of temperature rise with and without climate protective actions

What happens if no measures are taken to combat climate change?

Two possibilities are plotted in this diagram:
1) The blue line shows the temperature increase if the measures against man-made climate change are initiated and the temperature increase can thus be kept at 1°C.
2) If any measures are carried out, the temperature will continue to rise, which is shown with the red line.

15. Climate change weather related hazards in the Baltic Sea Region

16. Climate change weather related hazards in the Baltic Sea Region (BSR)

Heavy precipitation events are likely to become more frequent, especially in Scandinavia and northern Europe, during the winter. A large amount of snowfall is problematic. Two types of hazardous rainfall have been identified as risk: Intense, long-lasting rainfall and heavy, torrential rainfall over a shorter period (Polish national risk assessment).

Two types of wind related hazards are relevant to the BSR: windstorms, as well as convective wind gusts and tornados. It is estimated that the risk of severe winter storms will increase. Example: the cyclone “Gudrun” in 2005 in Denmark with winds in gusts 46 m/s (causing forest losses, power cuts, coastal flooding; damages for 1–1.5 billion euros). Hurricanes and strong storms are included in the National Risk Profile of Denmark.

Extreme temperatures, especially heat waves, are seen as a main risk, especially in cities where they can influence the transportation system, telecommunication systems, electricity supply, risk of droughts, forest fires, and affect human health.

It is estimated that winters will be on average warmer in Northern and Central Europe. This can cause the impact of extreme cold on mortality, especially if the human population is not prepared for such circumstances.

Black ice and freezing rain on the ground causing dangers for traffic and pedestrians.

17. Consequences of climate related hazards for societies

Climate related hazards have both direct and secondary consequences. Hazards can have direct effects such as loss of life or property, asset damage, infrastructure damage, or traffic blockages caused by a hazard event such as a storm. Primary hazard events can also create secondary hazard events, which follow, such as a landslide, mudslide or flood.

For example, the direct effects of a storm can further create a chain of cascade effects, such as the power disruption creating short-term but critical disruptions for telecommunications networks, heating, or rescue services which society relies on.

18. Flood events in the BSR

Fluvial floods or flooding of river and surface water floods, take place when the water-course at a certain location is not able to absorb the heavy precipitation, snow, frazil ice or glacier meltwater from sources within the river basin upstream.

Pluvial floods/flash floods/surface floods from heavy rains, take place when local drainage capacities are exceeded. This can result from low surface permeability (*e.g.* surface sealing in urban areas) which keeps precipitation from being able to be absorbed into the ground causing excessive surface run-off.

Coastal flooding, or storm surges, happens when the coast is flooded by seawater, *e.g.* due to storm winds and waves. Densely built areas with high levels of impermeable surfaces are at risk for flooding.

Sea level rise is expected to impact infrastructure more in the southern Baltic Sea and coastal cities.

In the Baltic Sea Region, cities have identified extreme weather such as river floods, coastal floods, and flash/surface floods as among their most significant climate hazards.

19. Further climate change related consequences in the BSR

Considerably increasing drought frequencies are expected in spring and autumn for all of the BSR countries.

Increasing meteorological drought conditions especially in spring and autumn may result in increasing fire risks. During spring, the expected large temperature rise results in an earlier melting of the snow

cover in the Northern BSR, resulting in – in combination with higher evaporation – earlier soil drying and therefore an earlier risk of forest fires.

Coastal erosion is expected to increase due to the sea level rise, combined with the increased storminess and increased wave height, means that with climate change, coastal erosion is expected to increase. High erosion of soft cliffs may lead to cliff retreat and landslides. Coastal erosion is a particularly severe problem in Germany (75 % of sandy coasts are at risk to be eroded) as well as in the Baltic States and Poland.

20. Consequences for the ecosystems

With climate change, new plant species will be able to spread into new areas. These plants can act as a host for new plant hazards. In many regions of the BSR, the winters are estimated to be milder, which will allow plant hazards to survive over the winter.

Climate change may increase the spread of infectious vector-borne transmissible diseases affecting animals. The highest current risk for the EU includes classical swine fever, African swine fever, foot and mouth disease and avian influenza. There is also a risk for spread of these diseases to the human populations, *i.e.* zoonosis.

Climate change drives biodiversity loss and ecosystem change.
Coastal birds and seabirds may be affected by climate change due to alteration of water salinity, temperature and acidity. Changing weather conditions, especially rain and wind, may also have an impact.

The reduction of the sea ice – both the extent and the duration – causes changes in marine ecosystems. Ice-dependent species are at special risk, *e.g.* due to habitat loss and altered nutrient dynamics within and under the sea ice.

21. Consequences for human health

Infectious diseases, *e.g.* influenza, can spread directly from human to human – a phenomenon called anthroponoses. Other risks are zoonosis – spreading from animal to human – like the avian flu. The spreading via a vector, such as a mosquito or tick, is also possible.

Climate conditions – temperature and precipitation – alters the possible habitats for bacteria, insects as well as the seasonal patterns of larger animals, which can carry insects to new areas. Together with additional pressures, such as habitat loss and modification, agricultural development, pollution and overexploitation of species globally, climate change also heightens the risk of pandemics related to zoonotic diseases.

The elderly, children, those with medical conditions, the homeless or those who labour outside are the most vulnerable to the effects of extreme temperatures.

Freezing drizzle and black ice have impacts on human health due to the increased risk of traffic accidents, as well as pedestrian accidents, such as slipping and falling. It can cause more accidents with vehicles than wet roads and snowy roads, because it is difficult for a road user to notice a thin ice layer. Black ice also damages road infrastructure, which requires higher maintenance.

22. Transboundary impacts

The Baltic Sea Region has relatively high vulnerability for transnational climate impacts, which influence international trade systems and business markets.

Climate change has been estimated to impact food production globally due to extreme weather events, plants or animal diseases. Extreme weather can influence infrastructure, transports, and cause changes in supplies in specific commodities produced abroad.

Climate change effects can make some areas uninhabitable or impact negatively on agricultural production, thus causing migration.

Climate change can cause disruptions in global supply chains, damage production infrastructure, causing supply losses and business disruptions.

23. Key messages

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Material in this Lesson 1 is based on the following sources in the CASCADE project:
CASCADE – Community Safety Action for Supporting Climate Adaptation and Development, funded by the European Union Civil Protection and Humanitarian Aid 1.1.2019-30.6.2021

(http://www.cascade-bsr.eu/).

Slides 3-14
Based on a presentation of M.Sc. Julian Blumenstock, Hamburg Fire and Rescue Service, at the Cascade Train the Trainer event, February 2021. (Contact: juergen.krempin.feuerwehr@hamburg.de). The presentation is based on the publication (with permission from the publisher):
Nelles David, Serrer Christian. 2021. Small Gases, Big Effect. This Is Climate Change. Penguin Random House. 131 p
(https://www.penguin.co.uk/books/319/319259/small-gases--big-effect/9780241461884.html)

Slides 15-22
Overview of climate risk drivers, hazards and consequences, climate risk drivers, hazards and consequences. October 2020. Authors: Tuhkanen Heidi & Piirsalu Evelin (SEI). Contributors: Hoy Andreas (SEI Tallinn), Lahtvee Valdur (CBSS). 71 p.
https://www.cascade-bsr.eu/sites/cascade-bsr/files/outputs/cascade_overview_of_climate_drivers_and_hazards_final_version.pdf

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