Global Warming

Environmental Awareness

What is global warming?

- Climate change can be defined as a change in the earth's climate system which results in new weather pattern.
- These patterns can remain for a few decades or even for millions of years.
- Comprising 5 different interacting parts, the climate system includes the hydrosphere, atmosphere, biosphere, cryosphere and lithosphere.
- Almost all the energy of our climate system comes from the sun, a rather tiny fraction comes from the earth's interior.
- Some of the climate system's energy is lost to outer space.
- The outgoing and incoming energy determines the energy budget of the earth.
- If there is more incoming than outgoing energy, it leads to global warming.
- If there is more outgoing than incoming energy, it leads to global cooling.
- Global warming is a serious problem to humanity as well as to the whole environmental system.

Causes

- Orbital variations
- Solar radiation
- Volcanism
- Plate tectonics
- Increase in the emission of greenhouse gases
- Changes in land use
- Aerosols
- Feedback effects
- Deforestation
- Agriculture

Orbital variations

- Variations in the motion of the earth result in changes in the seasonal distribution of sunlight reaching the surface and in its distribution across the earth.

- These changes can contribute to the climate change problem.

Solar radiation

- Both short- and long term variations in solar intensity are likely to affect our climate.
- Over the last 4 billion years, the intensity of the sun increased and will continue to do so in the future.
- Thus, this increase in solar intensity is likely to also increase the earth's global temperature in the future.

Volcanism

- For volcanoes to have a notable impact on our climate for more than one year, they must emit huge amounts of SO2 and sulfate aerosols when they erupt.

- These chemicals have optical properties which scatter or absorb solar radiation and thus contribute to climate change.

Plate tectonics

- Over a time horizon of millions of years, the motion of tectonic plates reshapes ocean and land areas and thus create topography.

- This process can contribute to a change in global as well as in local climate.

Increase in the emission of greenhouse gases

- Through greenhouse gases, heat radiating from the earth to space is trapped.
- This heat gets absorbed by gases in the atmosphere and leads to the warming of the earth's surface.
- Major greenhouse gases include water vapor, carbon dioxide, methane and ozone.
- Since the industrial revolution, human activity has increased the emission of greenhouse gases to a great extent.
- Our production of greenhouse gases like methane or CO2 from the combustion of fuel play a major role in the context of climate change.
- There are additional factors which indirectly contribute to global warming, like the depletion of the ozone layer, deforestation and animal husbandry.

Changes in land use

- Changes in the land use changes the surface of the earth which in turn affects the reflection of sunlight back into space and how much heat is lost by evaporation.

- For example, changing woodland into grassland leads to a lighter surface and thus reflects more sunlight.

Aerosols

- Aerosols usually have a cooling effect on the earth's climate since they reflect incoming sunlight.
- Since the concentration of aerosols has been declining since 1990, the reflection effect of aerosols has been lowered and thus global warming has been increased.

Feedback effects

- There are several feedback effects related to global warming which makes it hard to accurately predict the future increase in temperature.
- There are negative as well as positive feedback effects related to climate change.
- Significant positive feedback effects include the ice-albedo effect, the water vapor effect and the net effect of clouds.
- Radiative cooling to space as infrared radiation increases with increasing temperature, making it the main negative feedback effect to global temperature change.

Deforestation

- Deforestation can be a significant cause for global warming.
- Since trees absorb greenhouse gases like CO2 from the air and turn it into oxygen, they are a natural greenhouse gas storage.
- However, if the forests are cut down in order to get more space for settlement or housing, large quantities of CO2 are released into the atmosphere and the global warming process will be enhanced due to this.
- A prominent example for this issue is the behavior of farmers in the Amazonian Rainforest.
- It is quite common that farmers burn down trees intentionally in order to get more farm land to grow soy or other crops since it is more profitable for them than selling wood.
- Thus, the Amazonian Rainforest is cleared with an alarming speed and one oft the biggest natural CO2 storages of our earth is destroyed.

Agriculture

- An additional cause for global warming is agriculture.
- In order to be able to meet the worldwide meat demand, large amounts of meat have to be produced on a daily basis.
- However, the cattle for this meat production emit significant amounts of methane which is a much more serious greenhouse gas than CO2.
- Moreover, farmers often use fertilizers that contain nitrous oxides, which in turn can lead to a release of nitrogen-related gases which are also known to enhance global warming.

Effects

- Effects on the physical environment
- Rise in sea levels
- Increase in heat waves
- Increase in average temperature
- Increase in rainfalls and wind speeds
- Effects on the Biosphere
- Social tensions
- Effects on agriculture
- Shortage of drinking water
- Human health effects
- Migration
- Change in land use

Effects on the physical environment

- Global warming changes the physical appearance of our environment.
- For example, glaciers will melt due to global warming and will eventually disappear.
- Moreover, sea levels will rise and small islands will be covered by the sea.
- In addition, weather extremes due to global warming like draughts are likely to increase in number.
- Thus, affected areas will often change from fertile land to deserted areas which will no longer be suitable for farming purposes.

Rise in sea levels

- The global sea levels are rising due to global warming which destroys the habitat for several plants, animals and humans.
- The meltdown of glaciers and ice shields in the Antarctic could account for up to 90% of the rise in sea levels and thus is the biggest source of sea level increase.
- Antarctic glaciers are melting due to an increase in ocean temperature.
- Due to the rise of sea levels, many people will lose their homes.
- People who live in countries or islands which are located just a few feet above the sea level right now will lose their livelihood since the land that they currently inhabit will just be under water in the near future.

Increase in heat waves

- Since the year 1950, heat waves and droughts have appeared more frequently.
- Moreover, extremely dry or wet periods during the monsoon season have increased.
- These increases in extreme weather conditions are likely to continue in the future.
- Making things worse, scientists estimate that heat waves will become even more likely in the future due to the global warming issue.
- These heat waves will result in many other problems, including a shortage of drinking water in many poor countries.

Increase in average temperature

- Moreover, apart from weather extremes, there will also be a significant increase in average temperature over time.
- There are many different estimates on the scale of global warming, depending on the models underlying for the estimation.
- Most scientists agree that until the year 2100, the average air temperature will increase by 0.3-1,7 degree.
- However, there are some scientists that believe that the extent of global warming may be much more severe.
- Even estimates of 4.8 degree exist in scientific discussions.
- How big the increase will eventually be will be determined by human behavior.
- If we are able and willing to take suitable measures against global warming, we may be able to confine it to a certain extent.

Increase in rainfalls and wind speeds

- Additionally, wind speed and maximum rainfalls from typhoons and hurricanes are increasing.
- Hurricanes usually get their power from the warm ocean water.
- Since trough global warming, not only air temperature, but also water temperature will increase, hurricanes and other tropical storms are likely to get stronger in the near future.
- This may have severe impacts on the coastal cities, which may be hit by enormous winds.
- These winds may be powerful enough to destroy significant infrastructure and may also cause many deaths.

Effects on the Biosphere

- Global warming has led to an expansion of drier climatic zones, e.g. the expansion of deserts in the subtropics.
- These changes in the structure and composition of ecosystems will move forward in the future if global warming cannot be mitigated.
- This effect is likely to lead to a reduction in diversity of the ecosystem and to an extinction of many species.
- This also includes species living in the ocean.
- Although the ocean heated more slowly than land, even small changes in ocean temperature can cause large adverse effects on sea animals, plants and corals.

Social tensions

- There will be severe adverse effects of global warming on humans in the future.
- Since some regions of the world will be hit much harder than others, there will be large social tensions.
- Global inequality will even rise in the future because of the effects of global warming.

Effects on agriculture

- Also agricultural production will be affected differently in different parts of the globe.
- While global warming is likely to have negative effects on crop yields in low-latitude countries, it may have positive effects on crop harvests in the northern latitudes.
- Overall, there is a severe risk of global food security if the global warming continues.

Shortage of drinking water

- Moreover, also the supply with drinking water will become an even bigger problem in low-latitude countries.
- By 2050, up to 600 million people are likely to experience increased water stress due to climate change in Africa.

Human health effects

- There are also severe impacts from global warming on human health.
- This includes effects from extreme weather leading to losses of lifes and injuries and also adverse effects from undernutrition due to crop failures.
- Moreover, there has been found evidence that increases in temperature could cause an increasing number of suicides.
- Climate change also increases the probability of conflicts driven by economic shocks and poverty.
- It also contributes to a rise in crime rate and wars.
- It can also lead to a spread of diseases and even to new human forms of diseases.

Migration

- As sea levels continue to rise, many islands will be flooded and human settlements and infrastructure will be destroyed.
- Since many people are likely to lose their livelihood and their homes, people will be forced to leave their home countries in order to find a better future.
- This will likely lead to increased migration from low-latitude to high-latitude countries since the living conditions of high-latitude countries will be much better after the adverse effects of global warming manifested.

Change in land use

- Many areas of land which are currently not suitable for agriculture since it is too cold right now will become suitable for farming purposes due to global warming in the future.
- Thus, global warming will have an upside for countries with large areas of land in cold climate zones.
- Due to global warming, they will be able to farm these areas of land and to harvest significant amounts of crop yields.

Solutions

- Reduction of greenhouse gases
- Climate engineering
- Political measures
- Change in daily consumption behavior
- Education
- Convince others
- Adaption

Reduction of greenhouse gases

- The main reasons for an increase in greenhouse gases in the last decades of the 20th century have been population growth as well an increasing GDP per capita.
- This in turn has led to an increase in consumption and thus to an increased combustion of fossil fuels which finally leads to an increase in greenhouse gases.
- The global warming issue can be mitigated by a reduction in greenhouse gases.
- A reduction in greenhouse gases can be accomplish by energy conservation, an increase in energy efficiency and the switch from fossil to renewable energies.

Climate engineering

- Climate engineering is an additional way to mitigate the global warming issue.
- It can be defined as a deliberate modification of the climate.
- Techniques that could be applied may include CO2-removal and solar radiation management.
- However, recent studies show that these measures are either ineffective or even have severe side effects.

Political measures

- There is a big responsibility for governments all over the world to unite and fight global warming.
- First steps in this direction have been made through the UNFCCC.
- In this framework, governments all over the world try to prevent adverse human interference with the climate system.
- This includes a reduction in the greenhouse gas emissions in conjunction with sustained economic development and the security of food production.
- This framework also requires developing countries to be aware of the greenhouse gas problem.
- Although per capita are relatively low in developing countries, this may change dramatically since development countries strive to higher living standards and thus the emission of greenhouse gases is likely to increase dramatically.
- In 2015, the Paris Agreement has been ratified in order to prevent the rise in temperature from exceeding two degrees.
- This should also be accomplished by supporting developing countries financially in order to reduce their greenhouse gas emissions.

Change in daily consumption behavior

- Greenhouse gases are also produced for our daily consumption of things.
- By reducing our consumption behavior, each of us can contribute to the mitigation of climate change.
- This can mean avoiding to use your car and use public transport instead.
- It can also mean turning off your lights when you do not need them in order to save energy.

Education

- Education is a crucial measure to mitigate the global warming issue.
- Global warming can only be stopped or at least slowed down if people behave in an environmentally friendly way.
- Therefore, it is quite important to educate people about the adverse negative consequences of global warming and to show them how their daily life behavior contributes to climate change.
- This education should start in a quite young age.
- On the one hand, children can convince their parents to behave in a way that slows down global warming.
- On the other hand, when these children become adults, they are more likely to behave in an environmentally friendly way.
- Thus, education is key in order to be able to fight the global warming issue.

Convince others

- Your contribution to the reduction in greenhouse gases matters, that’s for sure!
- However, also convincing other people to follow your behavior will even have a bigger impact on the mitigation of global warming.
- By convincing many people to change their consumption behavior and also change other peoples minds, everyone of us can make a big difference in our daily lifes.

Adaption

- It is likely that we will not be able to fully stop global warming.
- Thus, it is crucial that humanity is able to adapt on these new temperature conditions.
- This means that governments and industries have to take the necessary steps in order to prepare our global society for our new environment.
- This includes a solution to the migration problem that will result from global warming.
- Many people will lose their home and their sources of income and will try to find a better future in other countries.
- This will be especially true for low-latitude countries which will be affected by global warming the most.
- We are talking about many million people.
- Constructing a world in which we can all live together without wars and other adverse occurrences will be a huge challenge to humanity as a whole.

Conclusion

- Global warming is one of the biggest challenges humanity faces today and in the future.
- If we are not able to stop global warming, our planet will be impacted dramatically. Many species of animals and plants will die out.
- Moreover, many people will lose their homes and their belongings.
- Global warming will lead to an increasing number of migrants which will strive to find a better future in countries in northern latitudes.
- Thus, these countries will face enormous challenges how to deal with migration in the future.
- Humanity as a whole has to take measures in order to secure a livable environment in the future.
- This also includes the adaption on a higher earth temperature.
- We can limit the global warming to a certain extent, but we will not be able to fully stop global warming.
- However, everyone can contribute their part by a reduction in their daily consumption behavior.
- Through the reduction of our consumption behavior and by convincing others to also change their daily consumption behavior, everyone can make a huge impact to mitigate the global warming issue.

Sources

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