1 General Introduction on Worldwide climate change

1.1 What is climate change?

Climate change is the most severe threat to life on Earth in human history. It encompasses the long-term shifts in temperature, precipitation, and other weather patterns, already resulting in widespread negative impacts, losses, and damages to both nature and human populations. The primary drivers of climate change are human activities, particularly the burning of fossil fuels, deforestation, and livestock farming, which significantly amplify the greenhouse effect.

If we keep increasing greenhouse gasses, the planet will warm to a degree beyond what many species can handle, altering or eliminating habitat, reducing food sources, causing drought and other species-harming severe weather events, and even directly killing species that simply cannot stand the heat. As warming levels increase, so do the risks of species extinction or irreversible loss of biodiversity in ecosystems including forests, coral reefs and in Arctic regions. Such catastrophic losses would irreversibly diminish biodiversity, severely disrupt ecosystems, and cause immense hardship for human societies worldwide.[1]

1.2 Climate tipping points and feedback loops

Feedback loops in climate change are processes that can either amplify (positive feedback) or diminish (negative feedback) the effects of climate change. Positive feedback loops are particularly concerning because they can accelerate warming, leading to more rapid and potentially irreversible changes in the climate system.

One of the most perilous aspects of climate change is the presence of tipping points.[2] Our climate system is a complex system, characterized by intricate interactions that are difficult or even impossible to predict precisely, often containing multiple tipping points. Tipping points can be likened to balancing on a chair: you can sway and return to your original position, but if you sway too far, the chair tips over, and you cannot simply right yourself by swaying back as you have crossed a tipping point. In our climate, the accumulation of greenhouse gases can push different systems beyond their tipping points. A notable example is the Greenland ice sheet. Once its tipping point is surpassed, the melting becomes irreversible, even if greenhouse gas levels are reduced. This irreversible change highlights the critical need to address climate change before these thresholds are crossed.

It is possible for tipping points to be abrupt. One of the most prominent climate tipping elements is the Atlantic meridional overturning circulation (AMOC), which can potentially collapse because of the input of fresh water in the North Atlantic. This collapse can be as sudden as taking place in a just a decade, while studies show that it can tip between 2025 and 2095.[3] The AMOC is a major component of the Earth's climate system, often described as a large ocean "conveyor belt" that transports warm, salty water from the tropics to the North Atlantic, where it cools, sinks, and returns southward at deeper ocean levels. This circulation plays a crucial role in regulating climate, particularly in Europe and North America. As oceanographer Wallace Broecker correctly warned: "We play Russian roulette with climate and no one knows what lies in the active chamber of the gun."

Even more dangerous is that tipping points in the climate system are often interconnected, creating a complex web of potential cascading effects.[4] When one tipping point is crossed, it can trigger changes that push other systems towards their tipping points, leading to a domino effect of rapid and potentially irreversible changes. The interconnected nature of tipping points means that the stability of the Earth's climate system is more precarious than it might appear when considering individual elements in isolation.

1.3 System change

While the need for action is clear, addressing climate change is incredibly challenging because it permeates every aspect of modern life. When scientist warned for depletion of the ozone layer in 1973, the Montreal Protocol was finalized in 1987, a global agreement to protect the stratospheric ozone layer by phasing out the production and consumption of ozone-depleting substances. Remarkably, only 14 years lapsed between the basic scientific research discovery and the first international agreement signed.[5]

While reducing CO2 and other greenhouse gases may seem straightforward, the reality is far more complex. Climate change is deeply rooted in our capitalist system, which relies on endless economic growth and the constant extraction of resources. However, infinite growth is unsustainable on a finite planet. Climate change is just one of many consequences of this system; others include biodiversity loss, declining freshwater supplies, and widespread pollution, such as plastic contamination in our oceans. Among these interconnected issues, climate change and biodiversity loss are the most urgent, as they pose direct and existential threats to life on Earth. Addressing these challenges requires a fundamental shift in how we view growth, consumption, and our relationship with the natural world.

1.4 Science communication

Science communication is extremely important to inform the public and politicians on the current threads. Organized climate denial has been a significant barrier to public understanding and action on climate change, largely driven by fossil fuel companies. For decades, major fossil fuel companies, aware of the scientific consensus on climate change, have invested heavily in misinformation campaigns to protect their financial interests. These companies funded lobby groups, think tanks, and public relations campaigns to cast doubt on the science of climate change, often using tactics similar to those previously employed by the tobacco industry.[6]

Contrarian scientists, often with ties to fossil fuel interests, were presented as credible experts in media debates, creating a false impression of balanced scientific debate when, in reality, there was overwhelming consensus within the scientific community. This deliberate strategy sowed confusion and mistrust among the public and policymakers, making it seem as though the existence and causes of climate change were still open to debate.

The impact of these efforts has been profound. Organized climate denial has significantly delayed policy action, hindered public understanding development, and reduced the sense of urgency needed to address the climate crisis. Many people, influenced by misinformation, continue to underestimate the severity of climate change or deny it altogether, despite overwhelming evidence. This erosion of trust in scientific consensus has made it more challenging to mobilize the collective action required to mitigate the impacts of climate change, prolonging the use of fossil fuels and increasing the scale of environmental and societal harm.

Therefore, there is a continuous need for scientists to accurately inform the public and actively collaborate with the media and policymakers. Effective science communication is crucial to counteract misinformation, build public trust, and foster informed decision-making. Here something about the role of artists?

1.5 Building a better future

While climate change is driving an increase in eco-anxiety,[7] which can often lead to feelings of paralysis and helplessness, it is crucial to stay motivated and committed to reducing our impact on the planet, as every fraction of a degree of warming matters. As UN Secretary-General António Guterres emphasized, "In short, our world needs climate action on all fronts - everything, everywhere, all at once." Transforming our world into a sustainable one, where future generations can live healthy and fulfilling lives, must become the top priority in every decision made by individuals, communities, and leaders around the world.

By envisioning better futures and taking concrete steps towards them, we can turn our concerns into action and drive the change needed to secure a livable planet for all.

2 Climate change in Belgium

2.1 Current trends

Climate change already has profound effects on Belgium. First, the current warming trend in Belgium and Europe is about twice the global average. This accelerated warming can be partially explained by the differential heating rates of land and ocean. Land areas, including Belgium and much of Europe, warm more rapidly than oceans, which have a higher heat capacity and warm more slowly. This trend is illustrated in Figure 1.

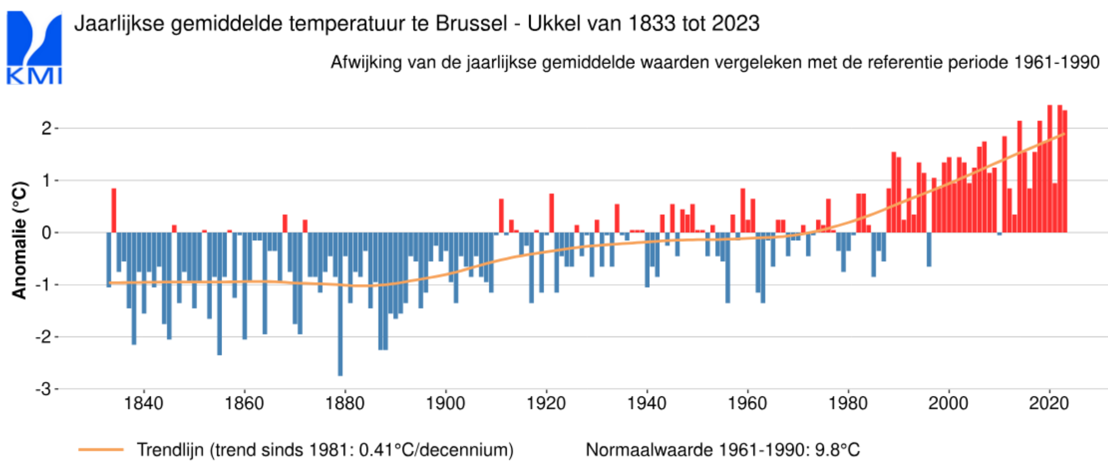

Figure 1: Change in temperature Belgium

Related to this, the highest recorded temperatures during summer are steadily increasing, and nights are becoming warmer as well. In addition, the frequency and duration of heat waves are increasing, posing significant health risks to the population. Secondly, heavy rain events occur more frequently, leading to an increased number of floods that cause substantial local damage to buildings and infrastructure. Third, the maximum snow height has already decreased significantly in regions of Belgium that typically see snowfall during winter.

In addition, there is a notable increase in drought periods. Extended periods with little or no precipitation can have serious consequences for various sectors. For example, a precipitation deficit in winter disrupts proper groundwater replenishment, while in spring and summer, insufficient water availability can lead to reduced agricultural yields. Prolonged dry spells in spring also increase the risk of forest fires, as observed in the High Fens and other areas. The persistent drought during spring 2020, caused by a stubborn and blocked atmospheric pattern, serves as an example of such extreme events. The probability of experiencing these extreme weather conditions, such as the spring 2020 drought, is increasing due to climate change.

Although we may be able to adapt to some of these changes, which are expected to intensify over time, tipping points represent the greatest threat, even for Belgium. These critical thresholds could trigger abrupt irreversible changes that far exceed our ability to adapt, highlighting the urgency of addressing the root causes of climate change before it is too late.

2.2 AMOC

One of the most dangerous events that could occur globally, with significant consequences for life in Belgium, is the tipping of the AMOC. The AMOC has already weakened by 15%, which has not occurred in the past 1000 years.[8] Already, heatwaves are already increasing three to four times faster in Europe (including Belgium) than in other regions of the Northern Hemisphere.[9]

A full collapse of the AMOC would have devastating consequences for humanity and numerous marine and terrestrial ecosystems. Alarmingly, models suggest that we are approaching a critical tipping point, beyond which these impacts could become unavoidable.

Figure 2 illustrates the model of Liu et al.[10] depicting the scenario after an AMOC collapse. In this model, cold air temperatures extend across Iceland, Britain and Scandinavia, significantly increasing the temperature contrast between northern and southern Europe by up to 4 °C. This pronounced shift is likely to have substantial impacts on weather patterns, including unprecedented storms, which could result in a severe reduction in crop yields and pasture availability.[11]

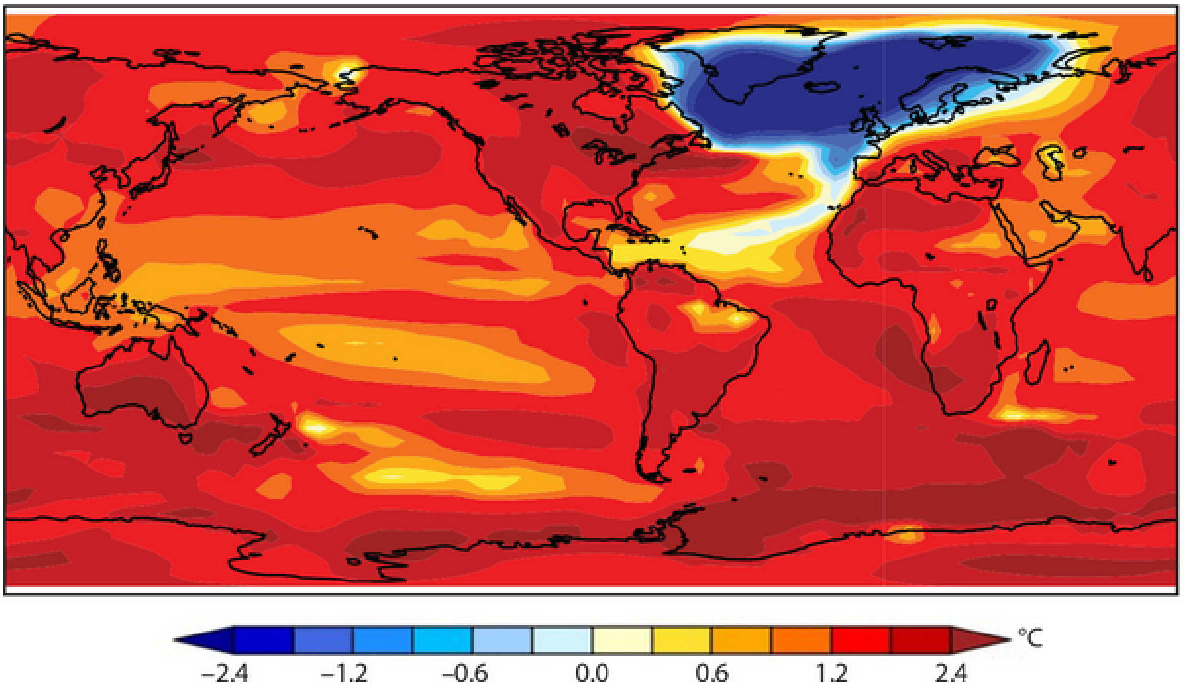

Figure 2: Annual-mean near-surface air temperature change resulting from a CO_2 doubling and AMOC breakdown. While Earth is much warmer, the northern Atlantic region has become colder. In winter, the cooling there is much stronger. From Liu et al.[10]

In addition, there would be massive changes in precipitation patterns. Major precipitation shifts in the tropics would likely cause drought problems in the northern tropics of America as well as Asia. Seasonal changes will be even greater than these annual mean changes. In our regions, we would experience a decrease in rainfall, along with the potential for sea level rise of up to one meter in coastal areas of Europe. These changes would significantly impact water availability, agriculture, and coastal communities, further stressing the need for immediate action to avoid this collapse.

A full AMOC collapse would be a massive, planetary-scale disaster. We really want to prevent this from happening. In other words, this is not about being 100% or even just 50% sure that the AMOC will pass its tipping point this century. We want to be 100% sure that it will not pass the tipping point.

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