



Greenhouse Effect: The Ultimate Violation of the Principle of Sustainable Development

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Abstract

One of the most serious environmental issues that has been confronting the international community in the twenty first century is the rise of the greenhouse effect due to man-made greenhouse gas (GHG) emissions. The natural greenhouse effect is a necessary condition for life on Earth, but a reinforced greenhouse effect, which is primarily caused by the use of fossil fuels, deforestation, industrialization, and unsustainable consumption patterns, results in unprecedented global warming, climate variability and ecological destabilization. This article examines the principle of the sustainable development in the context of environmental law. The study focuses on the key legal instruments (United Nations Framework Convention on Climate Change (1992), Kyoto Protocol (1997) and Paris Agreement (2015)) and principles (Rio Declaration on Environment and Development (1992) and Brundtland Report (Our Common Future, 1987)) for the normative development of sustainability in international environmental law. The analysis reveals that the continued rise in the concentration of GHGs in the atmosphere is not only a policy failure, but also a contradiction between the prevailing economic development models and the environment limits inherent in the doctrine of 'sustainable development'. The article further argues that the greenhouse effect is a violation of the principles of sustainability, intergenerational equity, precautionary principle, polluter pays principle and intra-generational justice, because it is not distributed equally, it does affect vulnerable groups and future generations, and the environmental costs are externalized by the high emitters. It highlights the increasing importance of the role of the courts to hold people accountable for climate change through doctrinal analysis.

Keywords: Greenhouse effect, Sustainable Development, Environmental Law, Environmental Governance, Greenhouse Gases.

1. Introduction

Sustainable development is defined in the Brundtland Report (1987) as development that balances economic development with environmental care and social justice, and as development that does not compromise the needs of future generations for the needs of today's generation. (World Commission on Environment and Development [WCED], 1987). The principles are, however, at risk because of the effects of the intensification of the greenhouse effect, mainly due to increased emissions of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) by human activity.

GHG emissions have been the subject of efforts to control them in environmental law, both in multilateral treaties, national legislation and judicial measures. But the current trend towards rise of greenhouse gas levels and the resulting climate change effects challenge existing normative frameworks. The greenhouse effect is one of the biggest legal, ecological and developmental crises of the modern world. The so-called greenhouse effect is a natural phenomenon of the atmosphere that is necessary for the life on earth, but it has been intensified by human intervention, primarily through the burning of fossil fuels, deforestation, industrial production and unsustainable modes of consumption, and has seriously disrupted the global climate system.

The Sixth Assessment Report (AR6) from the Intergovernmental Panel on Climate Change (IPCC) has confirmed that humanity has indisputably warmed Earth's atmosphere, oceans, and land, leading to widespread and rapid changes in the Earth's systems. Global warming, extreme weather events, biodiversity loss, desertification and food and water security are all signs of a changing environment that undermine the very concept of sustainable development.

The concept of sustainable development was first brought in by the World Commission on Environment and Development Report *Our Common Future*, 1987, as "development that does not threaten the ability of future generations to meet their needs. Later, this principle found normative status in international environmental law, e.g. in the Rio Declaration on Environment and Development, which incorporated environmental protection into the development process, and established guiding principles like the precautionary principle and the polluter pays principle.

Nevertheless, the present development trends are still very carbon intensive. The world economy is still very much fossil fuel dependent and there is a structural dilemma between growth and ecology. Does the rise in GHGs that accompanies a development footstep also constitute “sustainable”? The presence of high emissions is not just a result of loopholes in the regulations, but of a clash between economy and environment. Multilateral treaty regimes have been the response of environmental law to the climate crisis. The United Nations Framework Convention on Climate Change adaptation is the first ever global effort to stabilise concentrations of GHGs at a safe level that will not cause dangerous anthropogenic interference with the climate system. This framework was reinforced by the Kyoto Protocol with binding emission reduction targets for developed countries and subsequently by the Paris Agreement with the global commitment to keep the global temperature rise well below 2°C, and to 1.5°C if possible, above pre-industrial levels. These instruments illustrate an increasing recognition of the fact that climate change is not only an environmental issue, but also a legal and ethical issue to sustainable development. However, the amount of legal frameworks has not slowed global GHG emissions and the impacts of climate change have been intensifying. There is a gap between a normative commitment and the actual environmental situation, and this gap is in the enforcement, compliance and political will. In addition, the differential vulnerability of developing countries, small island developing states and vulnerable groups to climate change is a serious question of intra-generational equity and climate justice. The greenhouse effect is therefore a threat to the integrity of the environment, but can also lead to socio-economic inequalities and thus weaken the integrative vision of sustainable development. In this way, the intensification of the greenhouse effect phenomenon may be regarded as the extreme case of the concept of sustainable development breach, which impacts on all three of its pillars: environment, economy and society. It compromises the life supporting ecological systems, imposes growing economic burdens on present and future generations and increases inequity at the global level. Furthermore, it exposes the vulnerabilities of a consent-based system of international environmental governance, which is centered on states and their national economic interests. This article thus takes a look at the greenhouse effect from an environmental law perspective and suggests that climate change is not only a scientific or policy failure, but also a structural violation of sustainable development principles as they are reflected in international environmental law. This study aims to show that transformative legal reform in the sense of reconciling development with ecological limits and holding those who cause environmental damage to account is necessary for attaining true sustainability, through analysis of treaty frameworks, normative principles and emerging climate litigation.

2. Greenhouse effect: A scientific overview

The greenhouse effect is the heating of the Earth's surface by the trapping of the sun's radiation by the gases in the atmosphere. Although GHGs are vital to maintaining comfortable temperatures, human activities, including fossil fuel combustion, deforestation, and industrial agriculture, have led to GHG levels that are higher than natural concentrations (Intergovernmental Panel on Climate Change [IPCC], 2023). The IPCC Sixth Assessment Report (2023) states that human activity has caused the recent global warming "with high confidence," as the amount of CO₂ in the atmosphere is now higher than it has been in at least 800,000 years.

The greenhouse effect is the basic thermodynamic process whereby heat energy from the earth's surface is trapped by trace gases in the earth's atmosphere by absorbing longwave infrared radiation from the earth's surface and re-radiating it in all directions. This is a natural planetary mechanism that acts as an insulating blanket, maintaining a mean temperature of the globe of about 15°C (59°F). If the atmosphere did not provide this insulation, the temperature of the earth's surface would fall to a hostile -18°C (-0.4°F) and the planet would be frozen and largely uninhabitable (National Aeronautics and Space Administration, 2024).

2.1 The Natural Greenhouse Effect

The greenhouse effect is a radiative balance system. The sun's energy that reaches the earth is in the form of shortwave radiation. Clouds, atmospheric particles and the Earth's surface reflect part of this radiation back into space, and the remainder of it is absorbed by the land and ocean. The longwave infrared radiation emitted is a re-emission of the absorbed energy. GHGs in the atmosphere absorb and re-radiate this infrared radiation, thus slowing the escape of heat from the lower atmosphere (IPCC, 2023). The main GHGs that occur naturally are: 1. Carbon dioxide (CO₂) 2. Methane (CH₄) 3. Nitrous oxide (N₂O) 4. Water vapor (H₂O) 5. Ozone (O₃). The most abundant greenhouse gas, water vapor is a feedback, meaning that its concentration is highly dependent on temperature changes and is not a direct contributor to climate change (National Aeronautics and Space Administration [NASA], 2023).

2.2 Anthropogenic (Enhanced) Greenhouse Effect

The 'enhanced greenhouse effect' is the extra GHG which are added into the atmosphere as a result of human actions. Major sources include: 1. Combustion of fossil fuels (coal, oil, and natural gas) 2. Deforestation and changes in land use. 3. Industrial processes 4. Agriculture especially livestock production The Intergovernmental Panel on Climate Change (2023) indicates that the atmospheric levels of carbon dioxide (CO₂) have increased from about 280 parts per million (ppm) during pre-industrial days to more than 420 ppm in recent years. The concentrations of methane and nitrous oxide are also higher than at any time in the past 800,000 years. CO₂ emissions from the combustion of fossil fuels for energy generation are still the main source of CO₂ emissions worldwide. Economies are constrained in carbon-intensive development paths by industrialization, transportation and electricity generation. Furthermore, deforestation decreases the Earth's ability to sequester CO₂, which further increases the amount of CO₂ in the atmosphere.

2.3 The Radiative Forcing and Climate Sensitivity.

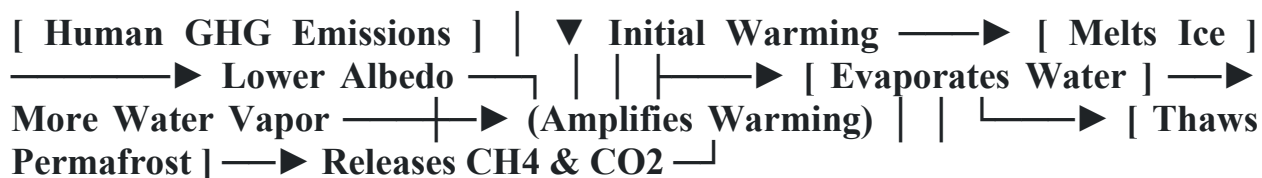
Radiative forcing is the difference between the amount of energy received from the sun that is absorbed by Earth and the amount of energy emitted by the Earth to space, expressed in watts per square meter (W/m²). Climate sensitivity is the change in global mean temperature at the end of a climate change, due to a given change in radiative forcing (University of Helsinki Institute for Atmospheric and Earth System Research, n.d.). Positive forcing means more energy is coming in than is going out which causes warming. The accumulation of greenhouse gasses (such as CO₂),

for example, will cause more outgoing infrared heat to be trapped, causing a positive forcing. However, aerosols can produce a negative forcing by reflecting sunlight back into space.

Radiative forcing refers to the imbalance in the flow of energy as a result of the increase in greenhouse gases in the Earth's atmosphere. Warming is associated with positive radiative forcing. Since 1750, the anthropogenic greenhouse gases have been the main drivers of positive radiative forcing (IPCC, 2023). Climate sensitivity is the amount of warming that is linked to a doubling of CO₂ levels. Estimates from science suggest that the equilibrium climate sensitivity is probably in the range of 2.5°C to 4°C per CO₂ doubling (IPCC, 2023). This shows that future emissions have a high risk of a substantial long-term warming.

2.4 Feedback Mechanisms

Feedback can increase or decrease warming in climate systems. Positive feedbacks, such as the melting of ice and a corresponding reduction in surface albedo (reflectivity) can accelerate warming. The methane is released due to thawing of the permafrost, which further raises the concentration of greenhouse gases. Warming creates more water vapor in the air, which increases warming. These feedback loops make it more likely that the environment will cross tipping points thresholds, after which the changes may be unstoppable (Lenton et al., 2019).



Just because the amplifying positive feedbacks erase the negative ones, the greenhouse effect triggers a compounding cycle, making timely reduction of human emissions critical to avoiding tipping points where these feedbacks become self-sustaining.

2.5 Observed Impacts of the Enhanced Greenhouse Effect

There is scientific consensus that the increased greenhouse effect has already had significant impacts, these are:

1. A rise in global average temperatures of ~1.1°C above pre-industrial levels (IPCC, 2023).
2. Sea level rise from thermal expansion and glacier melt.
3. More frequent and more severe extreme events like heat-waves, floods, droughts and hurricanes.
4. Ocean Acidification due to the absorption of CO₂. According to the National Aeronautics and Space Administration (2023), the past 10 years were the warmest in recorded history, indicating the continued trend of global warming.

2.6 Scientific Consensus and Attribution

The study of attribution has made great strides and now it is possible to quantify the contribution of anthropogenic greenhouse gas emissions to specific climatic events. The IPCC (2023) clearly declares that warming of the atmosphere, ocean and land has occurred due to human influence. This scientific certainty is the evidentiary basis of international climate governance and environmental law. To sum up, the anthropogenic-induced greenhouse effect disturbs radiative balance of the Earth and induces systemic climatic changes. Scientific evidence shows that these greenhouse gas emissions will continue to increase warming and related effects and thus decrease ecological stability and threaten sustainable development.

This section discusses the principles and legal framework for sustainable development. Sustainable development combines three pillars:

1. Environmental protection
2. Economic development
3. Social equity

The Rio Declaration on Environment and Development (1992) incorporates sustainability in international law, which includes principles like the precautionary principle, polluter pays principle, intergenerational equity (United Nations Conference on Environment and Development [UNCED], 1992). The United Nations Framework Convention on Climate Change (UNFCCC) also promotes the concept of sustainable development by stating that “the protection of the climate system for the benefit of present and future generations” (UNFCCC, 1992) is one of its goals.

3. The Greenhouse Effect as a Violation of Sustainable Development

3.1 Environmental Integrity

The enhanced greenhouse effect leads to global warming, sea level rise, loss of biodiversity and extreme weather events. These effects are reducing ecosystem services, biodiversity protection and ecological balance, which are in conflict with the environmental dimension of sustainable development (Rockstrom et al. 2009). The Environmental Integrity Project (EIP) is a non-profit watchdog that holds polluters accountable to enforce clean air and water laws. EIP works on understanding the largest sources of greenhouse gas emissions, such as measuring methane emissions from city landfills, mapping oil, gas and petrochemical facilities.

3.2 Economic Sustainability

Economics sustainability in the context of the greenhouse effect is a balance between strong climate protection and economic growth over the long-term. It involves moving beyond fossil fuels and towards renewable energy, carbon pricing, and avoiding the devastating economic losses associated with climate change (Halim et al., 2019).

Economic growth depends on fossil fuel driven development, but the Green House effect poses a threat to economic growth due to climate damages, loss of productivity and costs of disaster recovery. These results reveal the disconnect between growth and sustainable economic growth. The issue of social equity and vulnerability is addressed. Marginalized and low-income people are disproportionately impacted by climate change, which aggravates the situation of poverty, displacement and food insecurity. This unequal distribution of harm is in opposition to social justice, one of the core principles of sustainable development (Adger et al., 2014).

Instruments like **carbon taxes** and **cap-and-trade systems** force industries to internalize the cost of their emissions. This financial penalty promotes sustainability by incentivizing energy-efficient processes and investments in low-carbon technologies (Nordhaus, 1991).

The transition to solar, wind, and hydro power has achieved cost parity with fossil fuels in many regions. Sustainable development in major economies is now frequently driven by the long-term cost predictability and job creation associated with the renewable energy sector (Wang et al., 2021).

In heavily agricultural areas (such as the Rajshahi and broader South Asian regions), adapting to the greenhouse effect means transitioning to climate-resilient crops and sustainable water management. These steps mitigate the severe economic losses associated with erratic rainfall and prolonged droughts (Singh et al., 2025).

Corporations are increasingly required to disclose their environmental impact using standardized frameworks like the UN Climate Change guidelines. Additionally, ESG (Environmental, Social, and Governance) mandates and World Bank green bonds help channel global capital directly into sustainable infrastructure (Halim et al., 2019).

4. Environmental Law Responses

4.1 International Frameworks

1. UNFCCC (1992): Provides a worldwide framework to stabilize GHG concentrations. Prevent "dangerous" anthropogenic interference with the climate system. While all countries have a role to play in climate action, the responsibility of the developed countries is greater because of the greater level of emissions.

2. Kyoto Protocol (1997): Introduced binding emission reduction targets for developed countries. The treaty was designed to reduce global warming by focusing on six key GHGs: carbon dioxide, methane, nitrous oxide, HFCs, PFCs, and sulfur hexafluoride. It was based on the principle of 'common but differentiated responsibilities' with greater responsibility being put on developed countries, which have historically contributed more to the high levels of greenhouse gases in the atmosphere.

3. Paris Agreement (2015): Agrees to limit global warming to well below 2°C, and to 1.5°C if possible, by means of Nationally Determined Contributions (NDCs) (UNFCCC, 2015). These treaties represent legal advances, but they are based on voluntary undertakings, and enforcement measures are weak.

4.2 National Environmental Legislation A number of countries have enacted climate change mitigation and adaptation legislation (climate action laws, renewable energy statutes). But, there

are often gaps in implementation, gaps in compliance and political resistance that reduce the effectiveness of the judicial remedies and litigation and law (Voigt, 2014). For example New Zealand has specific national standards for greenhouse gas emissions from industrial heating named The Resource Management (National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat) Regulations 2023 and The United States of America has Clean Air Act (CAA) which calls upon EPA to control emissions that pose a risk to public health and welfare, including greenhouse gases.

4.3 Environmental lawsuits: Environmental lawsuits are becoming a potent weapon against state and corporate inaction on climate change. For instance, in several jurisdictions, courts have directed governments to take measures to enhance their climate policies in order to safeguard the rights of citizens (Setzer & Byrnes, 2020).

Suing Corporations for Damages or Inaction Tort Claims: Plaintiffs allege that the major fossil fuel companies have long been aware of the effects of their carbon emissions, yet they have continued to emit carbon, and they want to be held liable for the climate adaptation and damages.

Corporate Accountability: Landmark cases, including those filed by the environmental movement in the Netherlands, are successfully obligating multinationals energy companies to reduce their global carbon footprint by a certain percentage over a certain period to achieve the goals of the Paris Agreement.

5. The Law and Sustainable Development:

Although there have been legal advances, the greenhouse effect still continues to be a contravention of sustainable development because of:

1. **Intergenerational Debt (Violation of Equity):** Sustainable development is development that meets the needs of the present without the ability to meet the needs of future generations. The greenhouse effect is in contravention of this because greenhouse gases (such as CO₂) stay in the atmosphere for centuries. We are using cheap fossil fuels today, and burdening future generations with the catastrophic consequences of sea level rise, extreme weather and ruined agricultural land. Within the current generation, development must be equitable (Global Inequality Gap / Intragenerational Inequity).
2. **The Greenhouse Effect is a Serious Moral Dilemma:** The developed countries and mega corporations that in the past have produced the overwhelming majority of emissions are the ones that are least affected by the worst effects of climate change (droughts, floods, food insecurity).
3. **Consuming the Ecological Capital Base:** True sustainability is one in which the environment is considered to be finite and must be maintained. This natural capital is being systematically lost due to the greenhouse effect. It permanently erodes the biodiversity and ecosystem services on which human economies depend for their survival, through ocean acidification, the destruction of coral reefs, melting glaciers and changing climate zones faster than species can adapt. The world economy is still a "free sink" for the dumping of waste into the atmosphere. The current market system has not adequately and universally internalized the true cost of carbon, which encourages short-term gains at the expense of long-term ecological health and stability, and so actively works against the economic leg of sustainable development.

4. Weak enforcement of international commitments .
5. NDCs not ambitious enough .
6. Poor incorporation of climate objectives into development policy.
7. Power imbalances that marginalise vulnerable countries. These gaps highlight the limits of law to reconcile developmental aspirations with ecological boundaries.

6. Approaches to Enhance Legal Systems

In order to improve the environmental law in line with sustainable development, the following measures are required:

1. Increase legal responsibility for climate commitments.
2. Incorporate sustainability into economic planning and investments.
3. Ensure legal safeguards for vulnerable groups for climate justice and equity.
4. Use rights-based approaches, including legal rights of nature and future generations.
5. Legally require action before science is certain in order to avoid irreparable damage to the environment.
6. Make constitutional rights to resource availability a reality. Implement strict "polluter pays" policies and make them legally binding to ensure that companies pay for full lifecycle clean-up.
7. Grant legal personhood to ecosystems to allow enforcement of their protection in court.
8. Tighten up fines to a percentage of the global corporate revenue.
9. Give people and other organisations the right to take polluters to court without having to demonstrate personal harm.
10. Provide speedy adjudication through the establishment of Specialized Green Courts; have technically trained judges.
11. Ensure environmental impact assessments are carried out by independent parties, not influenced by corporate interests.

7. How is it that Greenhouse Emissions and Sustainable Development are incompatible?

The contradiction between greenhouse gas (GHG) emissions and sustainable development is obvious, as emissions disrupt the environment directly, which is the essence of sustainable development: economic stability, social equity, and environmental health. Traditional industrial development has been based on fossil fuel usage, which leads to emissions, whereas sustainable development must meet present needs without jeopardizing the future generation's ability to meet their own needs. The main reasons why they cannot coexist in their present form are: Environmental Degradation: Increase in GHG emissions results in global warming, extreme weather events, sea-level rise and biodiversity loss, which irretrievably affects the natural systems that support life.

Economic Setbacks: Climate change effects like damaged flood infrastructure or lower crop yields due to droughts generate significant economic losses, which slow down long-term economic development.

Social Inequity: Emissions exacerbate poverty and hunger, affecting the most vulnerable populations who have the least capacity to adapt and thus preventing social sustainability goals from being achieved.

Development Trade-offs: Many low-income countries are facing a "trap" in which their need to develop quickly is in tension with global sustainability goals, and the current energy pathways in these countries have high emissions. (Yang, W., Feng, L., & Fan, X. 2023.)

8. Summary of Findings

Sustainable development has its roots in the concept of development in the Brundtland Report of 1987, which is development that meets the needs of the present without jeopardizing the needs of future generations. Traditional unsustainability is about the use of resources (such as fossil fuels). The greenhouse effect turns this around instead of leaving behind less, we are actively leaving behind more, and worse. There are some findings of this research, which are as follows:

Irreversible Liability: Future generations are being made liable for the high atmospheric, ecological and financial price of past industrialization without being consulted. Economically and systematically, that is the root cause of this violation, for more than a century global industrialization and intensive agriculture considered the Earth's atmosphere as an infinite and free carbon sink.

Market Failure: Technological evolution was distorted since the environment was not appreciated as a finite, composite asset. The technology developed for cheap, high emission outputs, rather than building sustainable systems early on.

Systematic Destabilization of Natural Assets: Sustainable development is based on the balance of social, economic and environmental assets. The study highlights how the strengthening of the greenhouse effect is systematically destroying the ecological baseline essential to human lives

Asset Destruction: Sea-level rise, extreme coastal flooding and accelerated soil erosion directly destroy real estate and farm land.

Loss of Biodiversity: At risk ecosystems (coral reefs, glaciers, tropical wetlands) are threatened with extinction. The loss of these natural resources means the loss of the economic development which is sustainable (Sathiendrakumar, 2003).

Greenhouse effect is the ultimate violation of sustainability as it is an existential theft from the future. Today's economic models have turned the atmosphere into the free dumping ground of the real costs of modern life, leaving an incalculable ecological debt to future generations, with no democratic means of rejecting it.

9. Suggestions

Redefine National Accounting: Make governments include gross ecosystem product (GEP) in their economic growth measurements, so as to subtract climate degradation.

Implement Strict Liability: Shift the international climate change policy from voluntary targets to legally binding measures based on the principle “polluter pays”.

Focus on Regenerative Development: Move away from “sustainability” (business as usual) and towards actively restoring carbon sinks such as peatlands, mangroves and forests.

Institutionalise Future Representation: Make independent legal proxies or ombudsmen on behalf of unborn generations in climate negotiations.

Carbon Budgets: National carbon limits to ensure resources for future generations.

Legal Frameworks: Provide legal rights to ecosystems to stop ecocide and long-term degradation.

Climate Litigation: Endorse youth climate lawsuits against states for not meeting emission targets.

True Cost Pricing: heavily tax carbon to account for the true environmental damage of fossil fuels.

Circular Economies: Require designs which minimize waste and emissions throughout the product life-cycle. Resource & Energy Governance Invest in local solar & wind microgrids to increase community resilience.

AI for Smart Grids: Modernize the power grid with AI systems to optimize renewable energy distribution.

Global & Social Equity Technology transfer: Make green technologies available to other countries without patents.

Loss and Damage Funds: Make huge transfers of money from the historic emitters of greenhouse gases to vulnerable regions a reality.

Just Transition Plans: Train fossil fuel workers to take up high-paying jobs in the green economy.

10. Conclusion

The increased greenhouse effect poses a serious challenge to the world in the form of a blatant contradiction of sustainable development principles. International and national laws have acknowledged the need to act on climate change, but their scope, implementation, and targets are not yet ambitious enough. Legal changes that fully recognize ecological constraints, that equitably implement climate action, and that hold actors responsible for environmental damage will be needed to facilitate the transition towards sustainable development. The Greenhouse Effect, if aggravated by human intervention, is the greatest example of the violation of the concept of

sustainable development as it affects the three pillars of sustainable development, which are environmental integrity, economic stability and social equity. When we emit more than we need to, we are "borrowing" from the future to power the present by trapping heat. This forms a vicious circle, in which: Tipping points are exceeded, resulting in irreversible loss of biodiversity in environmental systems. Rising economic catastrophe and resource depletion due to climate change cancel out economic development. Social justice is undermined as the most vulnerable populations who contribute the least to emissions suffer the most severe consequences. Finally, the greenhouse effect is not only an environmental decision but is a decision for human survival. In order to realign our global development with the Earth, the only way is to switch to renewable energy and sustainable land use.

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