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ASSESSMENT OF GLOBAL ENVIRONMENTAL HEALTH THROUGH THE LENS OF CLIMATE CHANGE

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ABSTRACT

Climate Change refers to long-term alterations in temperature, precipitation, wind patterns, and other aspects of the Earth's climate system. These changes are driven largely by human activities, particularly the burning of fossil fuels, deforestation, and certain industrial processes, which release greenhouse gases. Climate Change brings impacts such as rising sea levels, more intense and frequent extreme weather events, shifting ecosystems, and threats to biodiversity. Climate Adaptation, Mitigation, and Resilience are critical strategies to address and manage the impacts of climate change and discussed in this paper with different examples. Climate Mitigation involves efforts to reduce or prevent the emission of greenhouse gases to limit the extent of climate change. Mitigation aims to slow down global warming and minimize future impacts on natural and human systems. Climate Adaptation is the process of adjusting systems, practices, and policies to withstand the current and anticipated impacts of climate change. It involves modifying infrastructure, improving water management, adopting climate-resilient agricultural methods, and planning for climate-resilient cities. Climate Resilience refers to the ability of systems—such as communities, economies, and ecosystems—to recover from and adapt to climate-related shocks and stresses. Building resilience involves strengthening institutions, improving risk assessments, implementing early warning systems, and fostering adaptive capacity. It encompasses both adaptation and mitigation efforts to create societies that can sustain themselves despite the challenges posed by climate change. This article attempts to understand how mitigation addresses the causes of Climate Change, adaptation tackles the impacts, and resilience builds the capacity to endure and recover from climate-related disruptions.

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INTRODUCTION

Climate change refers to long-term shifts and alterations in temperature and weather patterns, primarily caused by human activities (McNutt, 2013). These activities include the burning of fossil fuels, deforestation, and industrial processes, which release large amounts of greenhouse gases like carbon dioxide and methane into the atmosphere (McNutt, 2013; Oberthür, 2016). These gases trap heat, leading to a warming effect known as the greenhouse effect. The consequences of climate change include more frequent and severe weather events, rising sea levels, and disruptions to ecosystems and biodiversity Climate change has a significant global impact for

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several reasons (Oberthür, 2016). Global temperatures are increasing, leading to more frequent and severe heat waves, which can cause health problems and reduce agricultural productivity. Melting glaciers and polar ice caps contribute to rising sea levels, which can lead to coastal flooding and erosion, threatening coastal communities and ecosystems. Climate change increases the frequency and intensity of extreme weather events such as hurricanes, floods, droughts, and wildfires, causing widespread damage and displacement (Bošnjaković, 2012; McNutt, 2013).

Changes in temperature and precipitation patterns can disrupt ecosystems, leading to loss of biodiversity and altering the distribution of species, which can impact food security and livelihoods. Increased CO^2 levels are causing oceans to become more acidic, affecting marine life, particularly organisms with calcium carbonate shells or skeletons, such as corals and shellfish (McNutt, 2013). Changes in climate can alter growing seasons, reduce crop yields, and increase the prevalence of pests and diseases, threatening food security. Climate change can exacerbate health issues by increasing the spread of diseases, causing heat-related illnesses, and impacting mental health due to stress from extreme weather events and displacement (Hitz and Smith, 2004). The economic impact of climate change includes damage to infrastructure, increased insurance costs, and loss of productivity, all of which can strain economies, especially in vulnerable regions. Resource scarcity, displacement, and competition for resources can lead to social and political tensions, potentially exacerbating conflicts and leading to migration (Bošnjaković, 2012). The interconnected nature of these impacts means that climate change is a global issue that requires coordinated international efforts to mitigate and adapt to its effects.

Geopolitics of Climate Change

The geopolitics of climate change refers to how global political and economic relations are influenced by the impacts of climate change and the efforts to mitigate and adapt to it. Climate change can alter the availability and distribution of natural resources like water, arable land, and fossil fuels, leading to potential conflicts or cooperation over these resources (Bošnjaković, 2012). Countries vary in their contributions to and impacts from climate change. This can affect international relations, trade policies, and economic stability, with vulnerable countries often seeking reparations or assistance from more developed nations. Climate change can cause displacement due to extreme weather events, sea-level rise, and resource scarcity, leading to migration that can strain political and social systems in receiving areas, potentially causing conflicts (Hitz and Smith, 2004). Climate change requires coordinated global action, leading to international agreements like the Paris Agreement. These agreements can shift geopolitical alliances and power dynamics as countries negotiate their responsibilities and contributions (WHO, 2014). The move towards renewable energy and the reduction of carbon emissions can shift geopolitical power from fossil fuel-rich nations to those leading in green technologies, impacting global energy markets and political alliances. Many nations view climate change as a threat to national security, influencing defence strategies and international military cooperation. Understanding these dynamics is crucial for developing effective policies and strategies to address the multifaceted challenges posed by climate change on a global scale.

Policies associated with Climate Change at global, regional and local levels

Policies addressing climate change span global, regional, and local levels, with each level focusing on specific aspects of mitigation and adaptation strategies (Hitz and Smith, 2004; Barnett, 2007; Majra and Gur, 2009; Dalby, 2010; Bošnjaković, 2012; Hommel and Murphy, 2013; McNutt, 2013; Streck and Terhalle, 2013; Dalby, 2013, 2015; Oberthür, 2016)

Here's an overview of key policies at each level:

Global Level

Paris Agreement (2015): An international treaty under the United Nations Framework Convention on Climate Change (UNFCCC), aiming to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels.

Kyoto Protocol (1997): A previous international treaty that committed its parties to reduce greenhouse gas emissions, based on the premise that global warming exists and human-made CO2 emissions have caused it.

UN Sustainable Development Goals (SDGs): Goal 13 focuses specifically on taking urgent action to combat climate change and its impacts.

Regional Level

European Green Deal (EU): A set of policy initiatives by the European Commission with the overarching aim of making Europe climate-neutral by 2050.

North American Climate, Clean Energy, and Environment Partnership (USA, Canada, Mexico): A collaboration to reduce greenhouse gas emissions, promote clean energy, and enhance environmental cooperation.

African Union Agenda 2063: Includes initiatives to address climate change and promote sustainable development in African countries.

Local Level

Climate Action Plans (CAPs): Many cities and municipalities develop CAPs to reduce local greenhouse gas emissions and adapt to climate change impacts. For example, New York City's Climate Mobilization Act.

Renewable Energy Mandates: Local governments may set requirements for renewable energy use in new buildings, such as California's Solar Mandate.

Urban Green Spaces Initiatives: Local policies promoting the creation and maintenance of green spaces to enhance resilience to climate change, like London's Green Infrastructure Plan.

Key Policy Instruments

These three policies are part of a multi-tiered approach necessary to address the complex and global nature of climate change effectively (Barnett, 2007; Dalby, 2013, 2015).

Carbon Pricing: Includes carbon taxes and cap-and-trade systems to incentivize emission reductions.

Renewable Energy Standards: Mandates or incentives for renewable energy generation.

Energy Efficiency Standards: Regulations for buildings, appliances, and industrial processes to improve energy efficiency.

Climate Resilience Planning: Strategies to enhance the resilience of infrastructure and communities to climate impacts.

Current scenario of global climate change looks and it's future directions

The current scenario of global climate change presents several concerning trends and impacts

Global temperatures have been steadily increasing, leading to heat waves, altered weather patterns, and melting polar ice caps (McNutt, 2013). There's an increase in frequency and intensity of extreme weather events such as hurricanes, floods, and droughts. Melting glaciers and thermal expansion of seawater are causing sea levels to rise, threatening coastal communities (Dalby, 2015). Habitats are changing faster than many species can adapt, leading to biodiversity loss and ecosystem disruptions. Climate change exacerbates social and economic inequalities, affecting vulnerable populations disproportionately. Future directions depend heavily on global efforts to mitigate and adapt to climate change (Majra and Gur, 2009). Reduction of greenhouse gas emissions through international agreements, technological innovations, and shifts towards renewable energy sources are urgently needed. According to Dalby (2014) developing resilience in infrastructure, agriculture, and communities to cope with the impacts that are already inevitable; hence strengthening policies and regulations at local, national, and global levels to address climate change comprehensively should be prioritized. The future will be shaped by how effectively nations collaborate and implement solutions to mitigate climate change while adapting to its unavoidable consequences (Hommel and Murphy, 2013).

Serious Lack of Political Will

The issue of Climate Change often intersects with political will, where decisions made by governments and policymakers can significantly impact efforts to mitigate its effects. Factors such as economic interests, short-term political gains, and differing priorities among nations can all influence the level of commitment towards addressing climate change on a global scale. Efforts like international agreements (e.g., the Paris Agreement) aim to foster cooperation, but challenges remain in aligning diverse political agendas with long-term environmental goals (Streck and Terhalle, 2013; Dalby, 2010). The lack of strong political will behind global climate mitigation efforts can be attributed to several factors. Addressing these challenges requires sustained public advocacy, international cooperation, technological advancements, and policy innovations to overcome inertia and prioritize effective climate action (Dalby 2013, 2015).

1. **Short-term vs. Long-term Priorities:** Politicians often prioritize issues that yield immediate benefits or are more visible to voters over long-term and often less tangible environmental concerns.
2. **Economic Considerations:** Mitigating climate change requires significant investments in

renewable energy, technology upgrades, and infrastructure changes, which can be perceived as costly and may impact short-term economic growth.

3. **Political Interests and Pressure:** Industries that contribute to greenhouse gas emissions often have significant political influence, lobbying against regulations that could affect their profitability or competitiveness.
4. **Global Coordination Challenges:** Climate change is a global issue that requires cooperation among nations, but achieving consensus on targets and actions can be challenging due to differing economic priorities, development stages, and historical responsibilities.
5. **Public Opinion and Awareness:** While awareness of climate change has grown, it may not always translate into consistent voter pressure on politicians to prioritize climate policies over other issues.
6. **Policy Uncertainty:** Changing political landscapes and short-term policy cycles can lead to uncertainty in long-term climate policy frameworks, making it harder to implement and sustain effective mitigation measures.

COP initiative and Climate Change

The COP (Conference of the Parties) initiative is the main decision-making body of the United Nations Framework Convention on Climate Change (UNFCCC). It involves annual meetings where countries come together to negotiate and assess progress in addressing climate change (Painter, 2018; De-Lara et al., 2022). These conferences aim to review the implementation of the UNFCCC, the Kyoto Protocol, and the Paris Agreement, and to promote strategies for reducing greenhouse gas emissions and adapting to climate impacts. COP meetings are crucial for setting international climate policies and targets (De-Lara et al., 2022).

Major successes and failures of COP with respect to Climate Change

The Conference of the Parties (COP) under the United Nations Framework Convention on Climate Change (UNFCCC) has had numerous successes and failures over the years (Hjerpe and B.-O. 2010). Here are some key points:

Major Successes:

Paris Agreement (COP21, 2015): A landmark agreement where 196 parties committed to limit global warming to well below 2°C, with efforts to limit it to 1.5°C. Countries agreed to submit nationally determined contributions (NDCs) and update them every five years (Mace, 2005).

Kyoto Protocol (COP3, 1997): Established legally binding emission reduction targets for developed countries. Created mechanisms like carbon trading, clean development mechanism (CDM), and joint implementation (JI) (Christoff, 2008). Financial Commitments: Green Climate Fund (GCF) was established to support developing countries in adaptation and mitigation practices (COP16, 2010). Pledge to mobilize $100 billion per year by 2020 for climate action in developing countries (COP15, 2009).

Technological and Capacity Building Support: Establishment of the Technology Mechanism to enhance the development and transfer of climate technologies (COP16, 2010).

Major Failures:

Implementation Gaps: Many countries have struggled to meet their emission reduction targets, and the overall global emissions have continued to rise (Parker et al., 2012).

Lack of Ambition: Some NDCs are not ambitious enough to meet the 1.5°C or 2°C targets, leading to criticism that the Paris Agreement alone is insufficient (Ivanova, 2016).

Withdrawal and Non-Participation: The U.S. withdrawal from the Paris Agreement under the Trump administration (later rejoined under Biden) highlighted the vulnerability of international agreements to domestic politics (De-Lara et al., 2020). Insufficient Financial Contributions: The $100 billion annual climate finance target has not been fully met, and there are concerns about the transparency and effectiveness of the funds allocated (Mace, 2005).

Adaptation and Loss and Damage: Slow progress on addressing loss and damage and providing adequate support for adaptation in vulnerable countries. Despite these challenges, the COP process has been crucial in maintaining global attention on climate change and fostering international cooperation. The ongoing negotiations and commitments continue to play a vital role in addressing the climate crisis (Ivanova, 2016; De-Lara et al., 2020).

Climate Change Mitigation

Climate Change mitigation refers to efforts to reduce or prevent the emission of greenhouse gases into the atmosphere. The goal is to limit the magnitude and rate of long-term climate change (Anita et al., 2010). Mitigation strategies can be of multidimensional nature and dynamics. One the important step is reducing greenhouse gas emissions. This involves cutting down emissions from various sources like burning fossil fuels for energy, industrial processes, and deforestation (Bahadur et al., 2013; Demski et al., 2017). Secondly, enhancing the carbon sinks by increasing the capacity of forests, oceans, and soil to absorb CO from the atmosphere.

Switching to renewable energy sources (such as wind, solar, and hydroelectric power instead of fossil fuels); and improving energy efficiency by enhancing the efficiency of buildings, transportation, and industries to use less energy for the same output (McEvoy et al., 2013). By adapting to practices that can successfully reduce emissions from agriculture and forestry and increase carbon sequestration in trees and soil, it is possible to prevent Climate Change. These actions are essential to slow down global warming, reduce its impacts, and ensure a sustainable environment for future generations (Demski et al., 2017).

Climate Change Mitigation through Sustainable Approaches

Mitigating climate change involves a combination of strategies that reduce greenhouse gas emissions and enhance carbon sinks. Combining these strategies can significantly mitigate the impacts of climate change and contribute to a sustainable future (Anita et al., 2010; Bahadur et al., 2010, 2013; Gifford, 2011; McEvoy et al., 2013; Chen et al., 2017; Demski et al., 2017; Tang, 2019).

Some key strategic approaches are mentioned below:

Renewable Energy: Transitioning from fossil fuels to renewable energy sources like solar, wind, hydro, and geothermal power.

Energy Efficiency: Improving energy efficiency in buildings, transportation, and industries to reduce overall energy consumption.

Reforestation and Afforestation: Planting trees and restoring forests to absorb CO2 from the atmosphere.

Sustainable Agriculture: Implementing practices that reduce emissions from agriculture, such as improved crop rotation, reduced tillage, and better manure management.

Carbon Capture and Storage (CCS): Developing technologies to capture CO2 emissions from industrial sources and store them underground.

Transportation: Promoting electric vehicles, public transportation, cycling, and walking to reduce emissions from the transportation sector.

Policy and Regulation: Implementing policies and regulations that limit emissions, such as carbon pricing, emissions trading systems, and stricter emission standards.

Reducing Waste: Minimizing waste through recycling, composting, and reducing single-use plastics to lower methane emissions from landfills.

Behavioural Changes: Encouraging changes in individual behaviour, such as reducing meat consumption, conserving energy, and supporting sustainable products.

Research and Innovation: Investing in research and development of new technologies and methods for reducing emissions and adapting to climate impacts.

Challenges for Successful Climate Change Mitigation

Mitigating climate change involves a complex array of serious challenges that act as a wall against successful ground level implementation of Climate Change mitigation strategies (McEvoy et al., 2013). Transitioning to renewable energy and green technologies requires significant investment. Developing countries, in particular, may struggle with these costs (Bahadur et al., 2013). Achieving international consensus and cooperation is difficult. Different countries have varying interests, priorities, and levels of commitment to climate action. While renewable technologies are advancing, there are still technological hurdles to overcome, such as energy storage and grid integration for renewable resources (Demski et al., 2017). Existing infrastructure is largely built around fossil fuels. Shifting to renewable energy requires substantial changes to this infrastructure. Effective climate action often requires significant changes in consumer behaviour and lifestyle, which can be challenging to implement and sustain (Bahadur et al, 2010).

Enacting and enforcing policies that reduce greenhouse gas emissions can be politically and administratively challenging. Climate Change disproportionately affects vulnerable populations; hence, ensuring that mitigation efforts are fair and adds complexity to the issue (Duarte et al., 2013). Scientific and technical uncertainties like predicting the precise impacts of climate change and the effectiveness of various mitigation strategies involves uncertainties. Industrial Resistance: Industries reliant on fossil fuels often resist change due to potential economic losses. Gaining widespread public support and understanding of climate change and necessary actions is a continuous challenge (Anita et al., 2010).

Net Zero

"Net Zero" refers to achieving a balance between the amount of greenhouse gases produced and the amount removed from the atmosphere (Davis et al., 2018). Specifically, it means reducing greenhouse gas emissions to as close to zero as possible and balancing any remaining emissions by offsetting them with an equivalent amount of carbon removal or offsetting measures, such as reforestation or carbon capture technologies (Rogelj et al., 2021).

Net Zero is important in the context of addressing climate change because greenhouse gases like carbon dioxide (CO2) contribute to global warming and climate disruption (Deutch, 2020). By aiming for Net Zero emissions, countries, businesses, and organizations commit to mitigating their environmental impact and transitioning towards more sustainable practices (Bataill, 2020). Many governments and businesses have set Net Zero targets to combat climate change and limit global temperature rise to less than 2 degrees Celsius above pre-industrial levels, as outlined in international agreements like the Paris Agreement (Fankhauser et al., 2022).

Net Zero: Opportunities and Limitations

Net zero refers to achieving a balance between the amount of greenhouse gases produced and removed from the atmosphere, typically through reductions in emissions and the offsetting of remaining emissions by activities like carbon capture and storage (Voss and Musall, 2012; Davis et al., 2018; Deutch, 2020; Bataill, 2020; Rogelj et al., 2021; Fankhauser et al., 2022). Here are some opportunities and limitations associated with net zero:

Opportunities:

Climate Mitigation: Net zero aims to mitigate climate change by significantly reducing greenhouse gas emissions, thereby slowing down global warming.

Technological Innovation: It drives innovation in clean energy technologies, such as renewable energy sources, energy-efficient technologies, and carbon capture and storage.

Economic Benefits: Transitioning to net zero can create new jobs and economic opportunities in renewable energy sectors and sustainable practices.

Health Benefits: Reductions in air pollution associated with fossil fuel combustion can lead to improved public health outcomes.

Global Cooperation: Promotes international cooperation and agreements to tackle climate change collectively.

Limitations:

Technological Readiness: Some technologies required for achieving net zero, like large-scale carbon capture and storage, are not yet commercially viable or widespread.

Cost: Transitioning to net zero can be costly, especially for industries heavily reliant on fossil fuels. The financial burden may disproportionately affect certain sectors or regions.

Social Equity: The costs and benefits of transitioning to net zero may not be equally distributed across society, potentially exacerbating inequalities.

Behavioural Change: Achieving net zero requires significant changes in consumption patterns and behaviours, which can be challenging to implement on a global scale.

Natural Carbon Sinks: Relying on natural carbon sinks (such as forests and oceans) to offset emissions raises concerns about their capacity and long-term viability.

Overall, while net zero offers a pathway towards addressing climate change, it involves overcoming technological, economic, and social challenges to achieve widespread success (Voss and Musall, 2012).

Can Net Zero be achieved realistically?

Achieving Net Zero is certainly challenging but not impossible. It requires significant changes across industries, technology advancements, policy frameworks, and global cooperation (Rogelj et al., 2021). Many experts believe it's realistically achievable with concerted efforts and innovation, although the exact timeline and feasibility vary depending on the strategies and commitments of different countries and sectors (Deutch, 2020).

The concept of achieving net zero emissions is crucial in the fight against climate change. While it's challenging and requires significant effort globally, it's not inherently a failed objective (Bataill, 2020). Many countries and organizations are actively working towards this goal, setting targets to reduce emissions and offset remaining emissions through various means like reforestation and carbon capture technologies. Success will depend on global cooperation, technological advancements, and policy frameworks that support sustainable practices (Fankhauser et al. 2022).

Green Infrastructure

Green infrastructure refers to natural or nature-based systems designed to provide multiple environmental, social, and economic benefits (Lennon, 2015). It involves integrating natural features and processes into urban planning and development to manage storm water, reduce heat islands, improve air quality, enhance biodiversity, and provide recreational spaces. Examples include green roofs, rain gardens, urban forests, and permeable pavements. Green infrastructure refers to the strategically planned and managed networks of natural lands, green spaces, and other green features designed to provide ecosystem services and support healthy urban environments (Mell, 2008, 2015).

Green infrastructure helps improve air and water quality, reduces urban heat island effects, and supports biodiversity conservation. Access to green spaces promotes physical activity, reduces stress, and enhances mental health among urban residents. It can increase property values, reduce energy costs (e.g., through shading and cooling effects), and lower infrastructure maintenance costs (e.g., by managing storm water naturally). Green spaces serve as gathering places, fostering community interaction and social cohesion (Kambites and Owen, 2006).

Establishing and maintaining green infrastructure can be expensive, especially in densely built urban areas where land is at a premium. Competing land use priorities may hinder the allocation of space for green infrastructure, especially in rapidly growing cities. Green infrastructure requires ongoing care and management to ensure its effectiveness, which can strain municipal budgets and resources. Ensuring the longevity and resilience of green infrastructure in the face of climate change and urban development pressures requires careful planning and adaptation. Addressing these challenges requires integrated planning, stakeholder collaboration, and innovative financing mechanisms to fully realize the benefits of green infrastructure in urban environments (Lennon, 2015).

Can green infrastructure be successfully implemented in poorer countries?

Green infrastructure can be successfully implemented in poorer countries. While it may present challenges such as funding constraints and varying levels of technical expertise, there are several reasons why it can work. Green infrastructure often offers long-term cost savings through reduced energy consumption, improved public health outcomes, and lower maintenance costs compared to traditional infrastructure. Many green technologies can be adapted to local conditions and needs, making them suitable for diverse geographical and economic contexts. There are international initiatives and funding mechanisms aimed at supporting green infrastructure projects in developing countries, enhancing their feasibility (Kambites and Owen, 2006).

Green infrastructure can provide direct benefits to communities, such as cleaner air and water, improved sanitation, and job creation through local implementation and maintenance. It can also contribute to climate resilience by mitigating the impact of extreme weather events and reducing greenhouse gas emissions (Mell, 2008, 2015).. Successful implementation often involves a combination of policy support, capacity building, and collaboration between governments, communities, and international organizations.

Green infrastructure refers to systems and practices that mimic natural processes to manage various environmental issues sustainably. One notable global success in green infrastructure is the city of Copenhagen, Denmark (Mell, 2008, 2015). It has implemented extensive green roofs, rain gardens, and permeable pavements to manage storm water effectively. This approach not only reduces flooding risks but also improves air quality and enhances urban biodiversity. Copenhagen's efforts are a significant example of how integrating green infrastructure into urban planning can create more sustainable and resilient cities (Sinnett et al., 2015).

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Major green infrastructure achievements achieved in third world countries

Third-world countries have made significant strides in green infrastructure despite facing numerous challenges (Sinnett et al., 2015). Many countries have invested in solar, wind, and hydroelectric power to diversify their energy mix and reduce reliance on fossil fuels. Initiatives to plant trees and restore degraded lands have been undertaken to combat deforestation and enhance biodiversity (Lennon, 2015). Implementing sustainable water management practices such as rainwater harvesting, water recycling, and efficient irrigation systems to conserve water resources (Monteiro et al., 2020).

Construction of eco-friendly buildings that utilize energy-efficient designs, materials, and technologies to reduce carbon foot print; along with the improvement in waste management systems through recycling, composting, and waste-to-energy projects to minimize environmental impact can help (Mell, 2008, 2015). Promotion of public transportation, cycling infrastructure, and electric vehicles to reduce air pollution and greenhouse gas emissions are urgent needs (Sinnett et al., 2015). . The development and implementation of policies, regulations and incentives to support green infrastructure investments and sustainable development goals are important points to be considered. These achievements highlight the proactive efforts of third-world countries to address environmental challenges and promote sustainable development despite facing economic constraints (Mell, 2008, 2015).

Mitigating Climate Change

Green infrastructure plays a crucial role in mitigating climate change for several reasons. Plants absorb carbon dioxide (CO_2) during photosynthesis, reducing the concentration of greenhouse gases in the atmosphere (Lennon, 2015). Green infrastructure, such as parks and green roofs, can help lower local temperatures in urban areas by providing shade and evaporative cooling, thus reducing energy consumption for cooling buildings. Vegetation and permeable surfaces can absorb rainwater, reducing runoff and alleviating pressure on drainage systems during heavy rainfall events, which are becoming more frequent due to climate change (Van Oijstaeijen et al., 2020).

Green spaces support diverse ecosystems, preserving habitats for plants and animals that are increasingly threatened by climate change (Lennon, 2015). Trees and plants can filter pollutants from the air, improving overall air quality in urban environments. Overall, integrating green infrastructure into urban planning and landscapes not only helps mitigate climate change by reducing greenhouse gas emissions and energy use but also enhances resilience to its impacts (Wilker et al., 2016).

Climate Change Resilience

Climate resilience refers to the ability of systems, communities, and societies to anticipate, prepare for, respond to, and recover from the impacts of climate change (Thompson et al., 2009). It encompasses a wide range of measures and strategies aimed at reducing vulnerability to climate impacts and enhancing adaptive capacity. Climate resilience is crucial because it helps societies withstand and bounce back from climate-related shocks and stresses, such as extreme weather events, sea-level rise, droughts, and disruptions to ecosystems and economies (Côté and Darling, 2010. By building resilience, communities can better protect lives and livelihoods, ensure food and water security, preserve infrastructure, and maintain economic stability in the face of a changing climate (Cannon and Müller-Mahn, 2010).

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Opportunities and limitations of Climate Change resilience

Climate change resilience presents several opportunities and some limitations (Nyong et al., 2007; Davoudi et al., 2009; Laukkonen et al., 2009; Anita et al., 2010; Gifford, 2011; Chen et al., 2017; Tang, 2019).

Opportunities:

Enhanced Adaptation: Resilience efforts encourage adaptive strategies that can help communities cope with and recover from climate impacts more effectively.

Innovation and Technology: Resilience initiatives drive innovation in technologies, infrastructure, and practices that can mitigate climate risks and improve response capabilities.

Economic Benefits: Investing in resilience can lead to cost savings over time by reducing damage from climate disasters and lowering insurance premiums.

Community Empowerment: Building resilience often involves community engagement and empowerment, fostering social cohesion and capacity building.

Long-Term Sustainability: Resilience measures promote sustainable development practices that benefit both current and future generations.

Limitations:

Resource Constraints: Implementing comprehensive resilience strategies requires substantial financial resources, which may be limited in some regions or communities.

Complexity and Interdependencies: Climate resilience involves interconnected systems, making it challenging to predict and manage all potential impacts and interactions.

Equity Concerns: Vulnerable populations, including low-income communities and marginalized groups, may have limited access to resources and face greater challenges in building resilience.

Political and Institutional Barriers: Lack of political will, institutional capacity, and coordination can hinder effective implementation of resilience measures.

Uncertainty and Changing Conditions: Climate change projections and impacts are subject to uncertainties, making it difficult to accurately assess future risks and plan accordingly.

Overall, while climate resilience offers significant benefits in terms of adaptation and sustainability, addressing its limitations requires concerted efforts at multiple levels, from policy-making to community engagement and international cooperation.

Climate Change Economics

Climate change economics refers to the study of the economic impacts of climate change and the economic aspects of policies and measures to mitigate or adapt to it (Berrang-Ford et al., 2011). It involves understanding how climate change affects economic systems, sectors, and resources, as well as assessing the costs and benefits of various actions to address climate change (Kerr, 2007). This field examines issues such as carbon pricing, investments in renewable energy, adaptation strategies for vulnerable communities and industries, and the economic consequences of climate-related events like extreme weather and sea-level rise (Dinar, 1998; Nordhaus and Boyer, 2003).

Importance of Climate Change Economics

Climate change economics is crucial for several reasons. It helps in efficiently allocating resources to mitigate and adapt to climate change impact (Patz and Olson, 2006). This includes investments in renewable energy, infrastructure resilience, and sustainable practices. Economic analysis informs policymakers on the costs and benefits of different climate policies (Aggarwal, 2003). This includes carbon pricing mechanisms, subsidies for green technologies, and regulations on emissions (Byjesh et al., 2010). It assesses the economic risks associated with climate change, such as damage to infrastructure, agriculture, and health, helping businesses and governments prepare and manage these risks (Soora et al., 2013). Economic incentives drive innovation in clean technologies and practices, accelerating the transition to a low-carbon economy (Byjesh et al., 2010). Understanding the economic impacts of climate change fosters international cooperation in tackling global issues like reducing greenhouse gas emissions and supporting vulnerable populations (Srivastava et al., 2010). It supports long-term planning by businesses and governments, ensuring sustainable development pathways that account for climate risks and opportunities (Aggarwal, 2003). Overall, integrating economics into climate change action is essential for achieving environmental sustainability while promoting economic growth and societal well-being (Ravindranath et al., 2006).

Limitations of Climate Change economics and its drawbacks

Climate change economics faces several limitations and drawbacks. Climate change is a highly complex and uncertain phenomenon, making economic modelling challenging. Uncertainties in future emissions, technological advancements, and climate impacts complicate cost-benefit analysis. Effective climate action requires global cooperation, yet international agreements like the Paris Agreement face challenges in enforcement and commitment (Ravindranath et al., 2006). Economic models often discount future costs and benefits, potentially undervaluing long-term impacts of climate change mitigation and adaptation (Schelling, 1992). Climate policies can have uneven distributional impacts across different regions, industries, and socio-economic groups, leading to concerns about fairness and social equity (Srinivasan, 2012). Economic models may not adequately account for human behaviour, political dynamics, and institutional barriers that influence policy adoption and effectiveness (Kumar and Parikh, 2001).

Traditional economic approaches assume perfect markets, but climate change involves significant market failures like externalities (e.g., carbon emissions) that are not adequately priced. Transitioning to a low-carbon economy requires substantial technological innovation and infrastructure investment, which may not be fully captured in economic models. (Guiteras, R. 2009). Economic analyses often overlook the full value of ecosystem services threatened by climate change, such as biodiversity and natural resources. Addressing these limitations requires interdisciplinary approaches, improved modelling techniques, and policies that integrate social, environmental, and economic objectives effectively Dinar, 1998; Nordhaus and Boyer, 2003).

Food for Thought

The future of climate change is concerning and depends heavily on global action, as well as local and individual efforts. Here's an overview of the major trends and projections if we continue on our current path:

1. Rising Temperatures

Average global temperatures are projected to rise by 1.5°C to 4°C above pre-industrial levels by the end of the century, depending on emission scenarios.

The 1.5°C threshold is critical. Exceeding it may trigger feedback loops (such as melting permafrost releasing methane) that accelerate warming even further.

2. Extreme Weather Events

More intense and frequent weather events, like hurricanes, droughts, floods, and heatwaves, are expected as the climate continues to warm.

Regions that already experience high temperatures could see more heatwaves, and rainfall patterns are likely to shift, causing some areas to become wetter and others drier.

3. Rising Sea Levels

Sea levels are expected to rise due to both melting polar ice and the thermal expansion of oceans as they warm.

By 2100, sea levels could rise between 0.6 and 1.1 meters (2-3 feet) under high-emission scenarios, significantly impacting coastal communities and small island nations.

4. Impact on Ecosystems and Biodiversity

Many species face a high risk of extinction as they struggle to adapt to rapidly changing temperatures and shifting habitats.

Coral reefs, crucial for marine biodiversity, are especially vulnerable, with nearly all reefs projected to experience annual bleaching by the end of the century if emissions aren't curbed.

5. Food and Water Security Challenges

Climate change is expected to disrupt agricultural productivity due to heat stress, changing precipitation patterns, and extreme weather.

Water scarcity will likely worsen in certain regions, particularly areas dependent on glaciers for freshwater or prone to drought.

6. Health Risks

Heat-related illnesses, respiratory issues from air pollution, and the spread of infectious diseases are anticipated to increase.

Vulnerable populations, especially those in low-income areas, will face disproportionate impacts on health.

7. Economic Implications

The economic impacts of climate change are profound, potentially costing the global economy trillions of dollars due to damages from extreme weather, loss of biodiversity, health expenses, and productivity declines.

Potentially Positive Future Scenarios:

If countries adhere to significant emission reduction commitments, such as achieving net-zero carbon emissions by mid-century, warming could be limited to around 1.5°C to 2°C.

Green technologies and renewable energy sources are advancing rapidly, making it increasingly feasible to transition away from fossil fuels.

Adaptation strategies, like building resilient infrastructure and sustainable agriculture, can help mitigate some impacts.

The outcome largely depends on immediate global action to reduce emissions and increase sustainable practices.

REFERENCES

1. **Aggarwal, P. K.** 2003. Impact of climate change on Indian agriculture. *Journal of Plant Biology-new Delhi*. 30(2): 189-198.
2. **Anita, W., Dominic, M., and Neil, A.** 2010. Climate change and agriculture impacts, adaptation and Mitigation: Impacts, adaptation and Mitigation. OECD publishing.
3. **Barnett, J.** 2007. The geopolitics of climate change. *Geography Compass*. 1(6): 1361-1375.
4. **Bahadur, A., Ibrahim, M., and Tanner, T.** 2010. The resilience renaissance? Unpacking of resilience for tackling climate change and disasters. Strengthening Climate Resilience Discussion Paper 1. Institute of Development Studies.
5. **Bahadur, A. V., Ibrahim, M., Tanner, T.** 2013.

Characterising resilience: unpacking the concept for tackling climate change and development. Climate and Development 5(1): 55-65.

6. **Bataill, C. G. F.** 2020. Physical and policy pathways to net-zero emissions industry. Wiley Interdisciplinary Reviews: Climate Change 11(2): e633.

7. **Berrang-Ford, L., Ford, J. D. and Paterson, J.** 2011. Are we adapting to climate change? *Global Environmental Change*. 21(1): 25-33.

8. **Bošnjaković, B.** 2012. Geopolitics of climate change: a review. *Thermal Science*. 16 (3): 629-654.

9. **Byjesh, K., Kumar, N. S., and Aggarwal, P. K.** 2010. Simulating impacts, potential adaptation and vulnerability of maize to climate change in India. *Mitigation and Adaptation Strategies for Global Change*. 15: 413-431.

10. **Cannon, T., and Müller-Mahn, D.** 2010. Vulnerability, resilience and development discourses in context of climate change. Natural Hazards. 55: 621-635.

11. **Chen, W.-Y., Suzuki, T., Lackner, M.** 2017. Handbook of climate change mitigation and adaptation. Springer International Publishing.

12. **Christoff, P.** 2008. The Bali roadmap: Climate change, COP 13 and beyond. *Environmental Politics*. 17(3): 466-472.

13. **Côté, I. M., and Darling, E. S.** 2010. Rethinking ecosystem resilience in the face of climate change. PLoS biology 8 (7): e1000438.

14. **Dalby, S.** 2013. The geopolitics of climate change. Political Geography 37: 38-47.

15. **Dalby, S.** 2014. Rethinking geopolitics: Climate security in the Anthropocene. Global Policy 5 (1): 1-9

16. **Dalby, S.** 2015. Climate geopolitics: Securing the global economy. *International Politics*. 52: 426-44.

17. **Davis, J., Lewis, N. S. Shaner, M., Aggarwal, S.** et al. 2018. Net-zero emissions energy systems. *Science*. 360 (6396), eaas9793.

18. **Davoudi, S., Crawford, J., and Mehmood, A.** 2009. Planning for climate change: strategies for mitigation and adaptation for spatial planners. Earthscan.

19. **Dinar, A.** 1998. Measuring the impact of climate change on Indian agriculture. World Bank Publications.

20. **De-Lara, A., Erviti, M.-C., and León, B.** 2022. Communication strategies in the climate change debate on Facebook. Discourse on the Madrid Climate Summit (COP 25). *Profesional de la información* 31(2).

21. **Demski, C., Capstick, S., Pidgeon, N., Sposato, R. G., Spence, A.** 2017. Experience of extreme weather affects climate change mitigation and adaptation responses. *Climatic Change*. 140: 149-164.

22. **Deutch, J.** 2020. Is net zero carbon 2050 possible? Joule 4(11): 2237-2240.

23. **Duarte, C. M., Losada, I. J., Hendriks, I. E., Mazarrasa, I., Marbà, N.** 2013. The role of coastal plant communities for climate change mitigation and adaptation. *Nature Climate Change*. 3(11): 961-968.

24. **Fankhauser, S., Allen, M., Axelsson, K., Hale, T.** et al. 2022. The meaning of net zero and how to get it right. *Nature Climate Change*. 12(1):15-21.

25. **Gifford, R.** 2011. The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. *American psychologist*. 66 (4): 290.

26. **Guiteras, R.** 2009. The impact of climate change on Indian agriculture. Manuscript, Department of Economics, University of Maryland, College Park, Maryland, pp.1-54.

27. **Hitz, S. and Smith, J.** 2004. Estimating global impacts from climate change. *Global Environmental Change*. 14 (3): 201-218.

28. **Hjerpe, H. and Linnér, B.-O.** 2010. Functions of COP side-events in climate-change governance. *Climate Policy*. 10(2): 167-18.

29. **Hommel, D. and Murphy, A. B.** 2013. Rethinking geopolitics in an era of climate change. *Geo Journal*. 78: 507-524.

30. **Ivanova, M.** 2016. Good COP, Bad COP: Climate Change after Paris. New York, NY: Future United Nations Development System, Briefing 40: 1-4.

31. **Kambites, C., and Owen, S.** 2006. Renewed prospects for green infrastructure planning in the UK. Planning, Practice & Research 21(4): 483-496.

32. **Kerr, R. A.** 2007. Global warming is changing the world. Science. 316(5822): 188-190.

33. K**umar, K., and Parikh, J.** 2001. Socio-economic impacts of climate change on Indian agriculture. *International Review for Environmental Strategies.* 2(2).

34. **Laukkonen, J., Blanco, P. K. Lenhart, J., Keiner, M., Cavric, B., and Kinuthia-Njenga. C.** 2009. Combining climate change adaptation and mitigation measures at the local level. *Habitat International*. 33(3): 287-292.

35. **Leichenko, R.** 2011. Climate change and urban resilience. *Current Opinion in Environmental Sustainability*. 3(3):164-168.

36. **Lennon, M.** 2015. Green infrastructure and planning policy: a critical assessment. *Local Environment*. 20(8): 957-980.

37. **Mace, M. J.** 2005. Funding for adaptation to climate change: UNFCCC and GEF developments since COP-7. *Rev. Eur. Comp. & Int'l Envtl. L.* 14: 225.

38. **Majra, J. P. and Gur, A.** 2009. Climate change and health: Why should India be concerned? Indian *Journal of Occupational and Environmental Medicine*. 13 (1): 11-16.

39. **McEvoy, D., Fünfgeld, H., and Bosomworth, K.** 2013. Resilience and climate change adaptation: the importance of framing. *Planning Practice & Research*. 28(3): 280-293.

40. **McNutt, M.** 2013. Climate change impacts. *Science*. 341 (6145): 435-435.

41. **Mell, I. C.** 2008. Green infrastructure: concepts and planning. *FORUM ejournal*. 8(1): 69-80, 2008.

42. **Mell, I. C**. 2015. Green infrastructure planning: policy and objectives. Handbook on green infrastructure, pp. 105-123.

43. **Monteiro, R., Ferreira, J. C., and Antunes, P.** 2020. Green infrastructure planning principles: An integrated literature review. *Land*. 9(12): 525.

44. **Nordhaus, W. D., and Boyer, J.** 2003. Warming the world: economic models of global warming. MIT Press.

45. **Nyong. A., Adesina, F., and Elasha, B. O.** 2007. The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. Mitigation and Adaptation strategies for global Change. 12: 787-797.

46. **Oberthür, S.** 2016. Where to go from Paris? The European Union in climate geopolitics. *Global Affairs*. 2(2): 119-130.

47. **Painter, J., Kristiansen, S., and Schäfer, M. S.** 2018. How 'digital-born' media cover climate change in comparison to legacy media: A case study of the COP 21 summit in Paris. Global Environmental Change. 48: 1-10.

48. **Parker, C. F. Karlsson, C., Hjerpe, M., and Linnér, B.-O.** 2012. Fragmented climate change leadership: making sense of the ambiguous outcome of COP-15 *Environmental Politics*. 21(2): 268-286.

49. **Patz, J. A., and Olson, S. H.** 2006. Climate change and health: global to local influences on disease risk. *Annals of Tropical Medicine & Parasitology* 100 (5-6): 535-549.

50. **Ravindranath, N. H., Joshi, N. V., Sukumar, R., and Saxena, A.** 2006. Impact of climate change on forests in India. *Current Science*. 354-361.

51. **Rogelj, J., Geden, O., Cowie, A., and Reisinger, A.** 2021. Three ways to improve net-zero emissions targets. *Nature*. 591(7850): 365-368.

52. **Tang, K. H. D.** 2019. Climate change in Malaysia: Trends, contributors, impacts, mitigation and adaptations. *Science of the Total Environment.* 650: 1858-1871.

53. **Thompson, I., Mackey, B., McNulty, S., and Mosseler. A.** 2009. Forest resilience, biodiversity, and climate change. A synthesis of the biodiversity/resilience/stability relationship in forest ecosystems. Secretariat of the Convention on Biological Diversity, Montreal. Technical Series 43.

54. **Schelling, T. C.** 1992. Some economics of global warming. *The American Economic Review*. 82 (1), 1-14, 1992.

55. **Sinnett, D., Smith, N., and Burgess, S.** 2015. Handbook on green infrastructure: Planning, design and implementation/ Edward Elgar Publishing.

56. **Soora, N. K., Aggarwal, P. K., Saxena, R., Rani, S., Jain, J., and Chauhan, N.** 2013. An assessment of regional vulnerability of rice to climate change in India. *Climatic Change*. 118: 683-699.

57. **Srinivasan, J.** 2012. Impacts of climate change on India. Handbook of Climate Change and India, 29-40.

58. **Srivastava, A., Kumar, S. N., Aggarwal, P. K.** 2010. Assessment on vulnerability of sorghum to climate change in India. *Agriculture, Ecosystems and Environment*. 138(3-4): 160-169.

59. **Streck, C., and Terhalle, M.** 2013. The changing geopolitics of climate change. *Climate Policy*. 13 (5): 533-537.

60. **Van Oijstaeijen, W., Van Passel, V., and Cools, J.** 2020. Urban green infrastructure: A review on

valuation toolkits from an urban planning perspective. *Journal of Environmental Management*. 267: 110603.

61. **Voss, K. and Musall, E.** 2012. Net zero energy buildings. EnOB, München, pp192.

62. **Wilker, J., Rusche, K., and Rymsa-Fitschen, C.** 2016. Improving participation in green infrastructure planning. *Planning Practice & Research*. 31(3): 229-249.

63. **World Health Organization** (WHO). 2014. Gender, climate change and health. World Health Organization, 2014.