
The Key Solutions to Climate Change

Abstract

Climate change presents an urgent threat to natural ecosystems, human societies and global stability, with greenhouse gas emissions and unsustainable land use as the main contributing factors. From extreme weather to the loss of biodiversity and lack of resources, we need comprehensive and coordinated action to mitigate climate change. This paper explores key solutions, including technological innovation and environmental restoration, and emphasises the importance of the transition to renewable energy, energy efficiency and the protection of important ecosystems such as forests and wetlands. In addition, we address the necessity of global cooperation, and by integrating science, policy and public participation, we can find a sustainable path to mitigate the severe consequences of climate change.

1 Introduction to Climate Change

Climate change refers to long-term shifts in temperatures and weather patterns. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions. But since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil and gas [1].

Burning fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat and raising temperatures. Climate change has an increasingly large impact on the environment. Deserts are expanding, while heat waves and wildfires are becoming more common. Amplified warming in the Arctic has contributed to thawing permafrost, retreat of glaciers and sea ice decline. Higher temperatures are also causing more intense storms, droughts, and other weather extremes. Rapid environmental change in mountains, coral reefs, and the Arctic is forcing many species to relocate or become extinct. Even if efforts to minimize future warming are successful, some effects will continue for centuries. These include ocean heating, ocean acidification and sea level rise.

The main greenhouse gases that are causing climate change include carbon dioxide and methane. These come from using gasoline for driving a car or coal for heating a building, for example. Clearing land and cutting down forests can also release carbon dioxide. Agriculture, oil and gas operations are major sources of methane emissions. Energy, industry, transport, buildings, agriculture and land use are among the main sectors causing greenhouse gases. Fossil fuel use can be phased out by conserving energy and switching to energy sources that do not produce significant carbon pollution. These energy sources include wind, solar, hydro, and nuclear power. Cleanly generated electricity can replace fossil fuels for powering transportation, heating buildings, and running industrial processes. Carbon can also be removed from the atmosphere, for instance by increasing forest cover and farming with methods that capture carbon in soil [2].



Figure 1: The climate changes on the Earth

2 The Impact of Climate Change

Climate change is having a profound impact on the natural environment, biological diversity, and human societies. It is contributing to extreme weather and ecosystem degradation, threatening the survival of marine and terrestrial organisms, while increasing human vulnerability in terms of health, resources and infrastructure. This chain reaction not only disrupts the balance of nature, but also poses a continuing challenge to the global society [3].

2.1 Impact on Environment and Nature

- **Rising Global Temperatures:** There will be more frequent, intense, and prolonged heatwaves stress on the earth. For example, higher temperatures lead to a warmer Arctic and melting permafrost, releasing trapped greenhouse gases (methane and carbon dioxide), which is accelerating the global warming in a feedback loop.
- **Extreme Weather Events:** Warmer oceans have contributed to stronger hurricanes, typhoons and cyclones, leading to catastrophic flooding and destruction. The frequency of extreme rainfall and flooding has significantly increased, such as the Spanish floods of 2024, seriously threaten human safety and damage ecosystems. In addition, hotter, drier conditions can worsen the severity of droughts, e.g., in the south-western United States, the Mediterranean and the Amazon, cause wildfires, destroy forests and release carbon dioxide.
- **Ocean Impacts:** Rising sea levels caused by melting ice sheets (Greenland, Antarctica) and thermal expansion of seawater threaten coastal ecosystems and human settlements. Meanwhile, the absorption of too much carbon dioxide increases the acidity of the oceans, which harms marine organisms (e.g., coral reefs, shellfish, plankton) that form the basis of the food chain.

2.2 Impact on Wildlife and Humans

- **Increased Extinction Risks:** As a result of ocean warming and acidification, coral reefs, which are critical to the diversity of marine life, are experiencing mass bleaching. Climate change has led to harmful algal blooms, disrupting the food chain and causing massive losses of marine life. Nearly half of the world's wetlands have been lost due to climate change and other human impacts. The World Conservation Union (IUCN) lists climate change as a major driver of species extinction, including amphibians and Arctic animals.
- **Shifts in Migration and Behavior:** As sea ice melts, species such as polar bears and other wildlife near the Arctic Circle are changing their migration routes. Coastal wetlands that serve as natural storm barriers are also shrinking, reducing habitat for marine life. Changes in plant climate disrupt pollination cycles, affecting insects and birds.
- **Health and Safety Risks:** Climate change exacerbates heatwaves and worsens air quality due to wildfires and pollution, increasing the risk of heatstroke, respiratory illnesses and more.

- **Economic and Food/Water Strain:** Extreme weather disrupts agriculture and supply chains, causing energy costs and food prices to rise and creating shortages. Water shortages threaten drinking water supplies and agricultural production in rural areas.
- **Damage to Infrastructure:** Frequent natural disasters caused by climate change can repeatedly destroy human infrastructure, leading to costly repairs, disruptions to services, and long-term risks to economic stability.



Figure 2: Many arctic animals rely on sea ice, which has been disappearing in a warming Arctic.

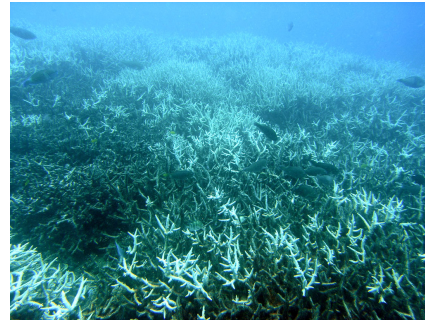


Figure 3: Coral bleaching from thermal stress has damaged the Great Barrier Reef and threatens coral reefs worldwide.

3 Key Solutions to Climate Change

Addressing climate change requires the consideration of many factors, such as the intensive development of renewable energy, the establishment of digital and smart infrastructures and the call for people to adopt green transportation. Only through cooperation among Governments, businesses, communities and individuals can we better global climate change and build a resilient and sustainable future [4][5].

3.1 Technological and Infrastructural Transformation

Technological innovation and modern infrastructure are essential for effective climate change mitigation. Transforming energy systems, transport networks, industrial operations and urban planning can significantly reduce greenhouse gas emissions while promoting sustainable growth.

- **Renewable energy:** One of the most critical changes is the global transition from fossil fuels to renewable energy such as solar, wind, and hydro. These energy sources produce few direct emissions and are becoming increasingly affordable and competitive with traditional fuels. The advances in energy storage technologies, such as high-capacity batteries and grid-scale energy storage solutions, further improve the reliability and flexibility of renewable energy.
- **Digital and Smart Infrastructure:** The integration of the most advanced technologies, such as AI, IoT, and big data, into infrastructures and energy management can make the entire systems more efficient. Smart grids, for example, can balance electricity supply and demand in real-time, integrate renewable energy more effectively, and reduce energy loss. Intelligent transportation systems can also optimize traffic flow and reduce emissions.
- **Green Transportation:** Decarbonizing the transportation sector is very important, as it remains one of the largest contributors to global emissions. Promoting the adoption of electric vehicles (EVs), expanding charging infrastructure, and investing in clean public transportation systems can significantly reduce the dependency on fuels.

3.2 Environmental Protection and Ecosystem Restoration

Protecting and restoring natural ecosystems is the foundation of climate change mitigation and adaptation. Healthy ecosystems are well resilient to extreme weather events and support bio-diversity

by storing large amounts of carbon, all of which are essential for the long-term stability of the planet and the well-being of humankind.

- **Preserving Forests and Expanding Reforestation:** Forests can absorb about over one third of global carbon dioxide emissions each year. It is essential to stop deforestation, especially in tropical regions such as the Amazon, the Congo Basin and South-East Asia. The issues of illegal logging, conversion of land to agriculture and over mining must be addressed by strengthening legislation and providing economic alternatives for local residents. At the same time, large-scale reforestation programmes like in China, could be effective in restoring ecosystems, improving the water cycle and mitigating climate change.
- **Restoring Wetlands Ecosystems:** In addition to forests, other ecosystems, such as wetlands and mangroves, play an important role in climate regulation. For example, wetlands store more carbon per unit area than most forests and provide important flood protection. Mangroves reduce erosion by providing a buffer against storms in coastal areas and support rich marine bio-diversity. Protecting and restoring these ecosystems not only fixes carbon, but also enhances resilience to climate impacts such as sea-level rise and extreme rainfall.

4 Future Development

In order to effectively ameliorate climate change, the governments should strengthen international cooperation and promote changes in the energy sector. Investments in clean energy, green infrastructure and advanced technologies should also be accelerated. It was of the most importance to protect and restore natural ecosystems. The public should also actively participate in sustainable lifestyles. Finally, climate adaptation needs to be integrated into urban planning, which can better protect against future climate risks.

References

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- [3] Kashif Abbass, Muhammad Zeeshan Qasim, Huaming Song, Muntasir Murshed, Haider Mahmood, and Ijaz Younis. A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental science and pollution research*, 29(28):42539–42559, 2022.
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A AI Use Statement

I use Deepseek-R1 to briefly introduce the current climate change and the impact it caused. I also asked Deepseek-R1 to correct my writing grammar and logic.

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Introduction to Climate Change on Earth

Climate change refers to significant, long-term alterations in Earth's climate patterns, including shifts in temperatures, weather systems, and ecosystems. Over the past century, human activities have dramatically accelerated these changes, pushing the planet into a period of unprecedented environmental transformation.

Causes of Climate Change

The primary driver of modern climate change is the increase in **greenhouse gases (GHGs)**, such as carbon dioxide (CO₂) and methane (CH₄), released by burning fossil fuels (coal, oil, gas), deforestation, and industrial agriculture. These gases trap heat in the atmosphere, intensifying the **greenhouse effect** and raising global temperatures. Since the pre-industrial era (1850–1900), human activities have caused Earth's average temperature to rise by approximately **1.1°C**, with the last decade (2013–2022) being the warmest on record.

Natural factors, like volcanic eruptions and solar cycles, also influence climate, but their impact is dwarfed by human-driven emissions.

Impacts of Climate Change

1. **Rising Temperatures:** 2023 was the hottest year globally, with heatwaves becoming more frequent and intense.
2. **Melting Ice and Rising Seas:** Polar ice sheets and glaciers are retreating, contributing to sea-level rise (3.4 mm/year since 1993), threatening coastal communities.
3. **Extreme Weather:** Hurricanes, floods, droughts, and wildfires are growing more severe and unpredictable.
4. **Ecosystem Disruption:** Coral reefs face bleaching, species are migrating or facing extinction, and Arctic ecosystems are collapsing.
5. **Human Consequences:** Food and water insecurity, displacement of communities, and health risks (e.g., heat stress, disease spread) disproportionately affect vulnerable populations.

Global Response

Efforts to combat climate change focus on **mitigation** (reducing emissions via renewable energy, reforestation, and sustainable practices) and **adaptation** (preparing for impacts like sea-level rise).

Figure 4: AI use-1



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Climate change is increasingly reshaping daily life in both subtle and profound ways, altering routines, health, economic stability, and even social interactions. Here's how it manifests:

1. Health Risks

- **Extreme Heat:** Deadly heatwaves force people to limit outdoor activities, strain energy grids (due to air conditioning demand), and exacerbate respiratory illnesses.
- **Air Quality:** Wildfire smoke and increased pollen from longer growing seasons worsen allergies and asthma.
- **Disease Spread:** Warmer temperatures expand habitats for mosquitoes and ticks, raising risks of diseases like malaria, dengue, and Lyme disease.

2. Food and Water Security

- **Crop Failures:** Droughts, floods, and unpredictable growing seasons disrupt agriculture, leading to higher food prices and shortages of staples like wheat, rice, and coffee.
- **Water Scarcity:** Dwindling freshwater supplies in regions dependent on glaciers or seasonal rains affect drinking water, hygiene, and irrigation.

3. Economic Costs

- **Higher Bills:** Energy costs rise as households rely more on heating/cooling systems. Insurance premiums spike in disaster-prone areas (e.g., flood zones).
- **Job Disruption:** Industries like farming, fishing, and tourism face instability, while climate-driven migration strains labor markets and social services.

4. Daily Routines and Infrastructure

- **Travel Disruptions:** Extreme weather cancels flights, damages roads, and disrupts supply chains, delaying goods from groceries to electronics.
- **Home Risks:** Flooding, wildfires, or storms force families to relocate or invest in costly home reinforcements (e.g., fire-resistant materials, flood barriers).

5. Mental and Social Stress

- **Climate Anxiety:** Younger generations report stress over an uncertain future, while communiti ▾

Figure 5: AI use-2