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# Solutions to Climate Change: An Introduction

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## Abstract

Climate change has emerged as one of the most pressing challenges of our era, profoundly impacting ecosystems, weather patterns, and the stability of both natural and human systems. The increase in global average temperatures, primarily driven by greenhouse gas emissions from human activities, has led to alarming phenomena such as accelerated polar ice melt, sea-level rise, altered precipitation patterns, and ocean acidification. These changes exacerbate food and water insecurity, threaten biodiversity, and intensify socioeconomic inequalities worldwide. Among the various manifestations of climate change, extreme weather events—such as heatwaves, storms, floods, droughts, and wildfires—have become more frequent and severe, posing immediate threats to communities globally. We delve into the trends of extreme weather events, examine current response strategies, identify existing challenges, and explore pathways toward a more resilient and climate-adaptive future.<sup>1</sup>

## 1. Introduction

Climate change stands as one of the most pressing challenges of our time, reshaping ecosystems, altering weather patterns, and threatening the stability of both natural and human systems. The rise in global average temperatures, largely driven by the increase in greenhouse gas emissions from human activities, has triggered a range of alarming phenomena. These include the accelerated melting of polar ice caps, sea level rise, shifts in precipitation patterns, and the acidification of oceans. Moreover, climate change is

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<sup>1</sup>This abstract is generated by the prompt in A.6

exacerbating food and water insecurity, endangering biodiversity, and intensifying socioeconomic inequalities across the globe.

Addressing these multifaceted impacts is crucial not only for environmental sustainability but also for economic resilience, public health, and global security. Failure to act decisively risks irreversible damage and imposes heavy costs on future generations. Therefore, it is imperative to pursue effective and equitable climate solutions that mitigate emissions, adapt infrastructure and policies, and foster global cooperation.



Figure 1. The Left figure shows Air temperature anomalies across North America on June 27, 2021, compared to the 2014–2020 baseline. The right one shows Emergency repairs to a heat-damaged section of Interstate 5 in Shoreline, Washington.

Among the many manifestations of climate change, extreme weather events have emerged as one of the most immediate and visible threats. These include more frequent and intense heatwaves, storms, floods, droughts, and wildfires. Data from organizations such as the World Meteorological Organization (WMO) indicate a clear upward trend in the frequency and severity of such events over the past few decades. A well-known example is the 2021 North American heat dome in Fig. 1, where temperatures soared to unprecedented levels across Canada and the United States, leading to hundreds of deaths and widespread environmental damage.

In response, governments and communities have implemented various strategies, such as early warning systems, climate-resilient infrastructure, and updated disaster preparedness plans. However, significant challenges remain. These include gaps in funding, technological limitations, policy inertia, and difficulties in accurately forecasting and

Table 1. Comparison of Strategies to Address Extreme Weather Events.<sup>3</sup>

Strategy	Advantages	Disadvantages
Early Warning Systems	Enable timely alerts for evacuation and preparation, reducing casualties and economic damage.	Require advanced technology, infrastructure investment, and may not reach all vulnerable groups.
Nature-Based Solutions	Help manage floods, cool urban heat, and enhance biodiversity with long-term environmental co-benefits.	It can be slow to show results and may demand substantial land use and planning.
Infrastructure Resilience	Improves durability of critical systems (e.g., roads, energy grids), reducing service disruption.	Entails high upfront costs and ongoing maintenance challenges.
Community Engagement and Education	Promotes preparedness, local knowledge, and social networks, which can enhance adaptive capacity.	Outcomes rely heavily on consistent public participation and awareness efforts.
Urban Heat Island Mitigation	Lower temperatures reduce energy use and protect public health in dense cities.	May require significant cross-sector collaboration and investment in green spaces and materials.

managing the compound effects of multiple, overlapping disasters.

We will explore current and emerging solutions to extreme weather events as a central focus within the broader climate crisis. By examining both successes and limitations, we aim to shed light on pathways to a more resilient and climate-adaptive future.<sup>4</sup>

## 2. Solutions to Address the Extreme Weather

**Preliminaries.** We adopt the World Meteorological Organization’s formal definition<sup>5</sup>: an extreme weather event is one that is “rare at a particular place and time of year,” typically occurring at or beyond the 10th or 90th percentile of a location’s historical distribution of a given variable, e.g., temperature, precipitation.

**Current Trends in Extreme Weather.** Recent assessments by the Intergovernmental Panel on Climate Change (IPCC) reveal that many types of extremes—such as heavy precipitation, heatwaves, droughts, and tropical cyclones—have increased in frequency and intensity over the past half-century. For example, heavy precipitation events have risen by roughly 30% in many mid-latitude regions since 1950.<sup>6</sup> In the United States, the Climate Extremes Index (CEI), which aggregates temperature, precipitation, and drought indicators, shows a clear upward trend in the prevalence of extreme conditions over the last few decades.

**Strategies to Address Extreme Weather.** We focus on four

categories of interventions, each supported by authoritative guidelines and case studies:

- **Early Warning Systems and Forecasting:** Deploying advanced monitoring networks and numerical models to provide timely alerts for imminent heatwaves, storms, or floods. The WMO recommends continuous investment in such systems to reduce loss of life and property damage ([https://rcc.dwd.de/DWD-RCC/EN/overview/documents/01\\_wmo\\_guidelines.pdf](https://rcc.dwd.de/DWD-RCC/EN/overview/documents/01_wmo_guidelines.pdf)).
- **Resilient Infrastructure.** Designing and retrofitting buildings, roads, and utilities to withstand extreme loads, e.g., elevated flood barriers, heat-resistant materials, and wind-hardened structures. The UNFCCC emphasizes that context-specific adaptations (e.g., cyclone shelters, drought-tolerant water systems) are essential for community resilience (<https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/introduction>).
- **Nature-Based Solutions.** Restoring and conserving ecosystems such as mangroves, wetlands, and urban green spaces to buffer storm surges, filter floodwaters, and mitigate urban heat islands (Menéndez et al., 2020). Coastal mangroves alone store carbon equivalent to over two years of global emissions while providing natural flood protection.
- **Risk Financing and Insurance.** Establishing insurance schemes and contingency funds to spread the economic burden of extreme events. Innovative financial instruments—such as parametric insurance—can

<sup>4</sup>This section is generated with the help of the prompt in A.2.

<sup>5</sup><https://community.wmo.int/en/background>

<sup>6</sup><https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-11/>

expedite payouts after disasters, though high costs and market development remain challenges.

We summarize the corresponding advantages and disadvantages in Tab. 1.<sup>7</sup>

### 3. Conclusion

In confronting the multifaceted impacts of climate change, particularly the escalating frequency and severity of extreme weather events, it is imperative to implement comprehensive and adaptive strategies. Early warning systems, resilient infrastructure, nature-based solutions, and community engagement have demonstrated effectiveness in mitigating the adverse effects of such events. However, challenges persist, including funding limitations, technological constraints, policy inertia, and the complexities of forecasting compound disasters. Addressing these challenges requires sustained investment, cross-sector collaboration, and the integration of scientific research into policy-making. By embracing a holistic approach that combines mitigation and adaptation measures, societies can enhance their resilience, safeguard vulnerable populations, and ensure a sustainable future in the face of climate change <sup>8</sup>.

### References

Menéndez, P., Losada, I. J., Torres-Ortega, S., Narayan, S., and Beck, M. W. The global flood protection benefits of mangroves. *Scientific reports*, 10(1):4404, 2020.

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<sup>7</sup>This section is written with the help of the prompt in A.3.

<sup>8</sup>This conclusion is generated by the prompt in A.6

## A. Prompt List

### A.1. Translator Prompt

We use this template to translate the Chinese text into English: “Please translate the following text into English:  $\{Text\ Content\}$ .”.

### A.2. Introduction Prompt

We use the following prompt to organize the content of the introduction section: “I am writing an essay titled **Solutions to Climate Change: An Introduction**. In this section, I need to provide content for the introduction. First, it should give an overview of the major climate change phenomena currently affecting the world. Then, it should discuss the importance of addressing these various climate challenges. After that, the focus will shift specifically to extreme weather events, which is the central theme of the essay. This part should outline the general trends in extreme weather globally, present a classic example, introduce current response strategies, highlight the major challenges we still face, and finally, offer a brief conclusion to the section.

### A.3. Method Prompt

We use the following prompt to organize the method section: “Following the content of the introduction, we now turn to the Methods section of the essay. In this part, we will first provide a formal definition of extreme weather. Then, we will present specific and factual data to demonstrate the current trends in extreme weather events. After that, we will outline several effective strategies or measures to address extreme weather, each supported by credible references. These methods will be explained in detail. Finally, we will include a table to compare the advantages and disadvantages of each approach.”.

### A.4. Rewrite Prompt

We use the following prompt to rewrite some text copied from the website, e.g., Wikipedia: “Please rewrite this passage in English to avoid plagiarism.”.

### A.5. Table Generation Prompt

We use the following prompt to generate the  $\text{\LaTeX}$  table from the text: “Return the  $\text{\LaTeX}$  command of the given text:  $\{Text\ Content\}$  to generate the corresponding table.”.

### A.6. Abstract and Conclusion Generation Prompt

We use the following prompt to generate the conclusion and the abstract from the text we provide: “Write the conclusion section and abstract section base on the given text:  $\{Text\ Content\}$ .”