From Data to Action: Exploring Technological Interventions in Climate Change Mitigation

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ABSTRACT

This research paper critically examines innovative approaches to climate change mitigation by integrating big data and technological interventions. Emphasizing the pivotal role of system-of-systems thinking, the study underscores its significance in addressing the complexities of mitigation challenges. By integrating diverse disciplines, data, and tools, system-of-systems thinking promotes a comprehensive understanding and necessitates deeper collaboration between industry initiatives and scientific research. Big data emerges as a powerful tool, contributing to climate change research and decision-making by modeling scenarios, transforming energy practices, and enhancing food and water security. The utilization of initiatives like the Intergovernmental Panel on Climate Change and the Global Ocean Observing System fills crucial gaps in scientific, technical, and socio-economic data, enabling researchers to gain valuable insights into the effectiveness of various mitigation strategies. This study explores the application of big data and technological interventions across three primary domains of climate change mitigation: agriculture, cleaner production, and climate resilience.

It categorizes emerging climate change mitigation technologies. In conclusion, the integration of system-of-systems thinking, big data, and emerging technologies offers a holistic and effective approach to addressing climate change mitigation challenges, empowering researchers and policymakers to devise comprehensive strategies for a sustainable future.

Keywords: Climate Change, Innovative Approaches, Big Data, Carbon Capture, Storage

INTRODUCTION

Climate change is a pressing global issue that requires innovative solutions and data-driven approaches to mitigate its impacts. This research paper aims to explore the use of big data and technological interventions in climate change mitigation, focusing on the following aspects:

- The importance of system-of-systems thinking in addressing climate change mitigation challenges.
- The application of big data in various climate change mitigation domains, such as agriculture, cleaner production, and climate resilience.
- The role of emerging climate change mitigation technologies in reducing greenhouse gas emissions and adapting to climate change (Airehrour *et al*., 2019).

Today, climate change stands as a critical concern, and comprehending its complexity necessitates advanced models and decision-support techniques rooted in data. This paper seeks to unveil the relevance of data-based methodologies, specifically exploring the application of Big Data and data science in addressing sustainability challenges related to climate issues. The focus is on how these techniques can seamlessly integrate into scientific research and decision sciences, providing a holistic and comprehensive approach to understanding and tackling the intricate facets of climate-related problems (Alder & Hostetler, 2015; Stocker, 2014).

The Importance of System-of-Systems Thinking

System-of-systems thinking is crucial in addressing climate change mitigation challenges, as it integrates various disciplines, systems, data, and tools related to climate change (Airehrour et al., 2019). This approach helps to identify potential solutions and highlights the need for deeper integration between industry initiatives

and scientific research. By adopting a system-of-systems perspective, researchers can better understand the complexities of climate change and develop more comprehensive strategies for mitigation.

Summary of Key Observations

The following are the key findings of this study.

Big Data in Climate Change Mitigation

Big data plays a significant role in climate change research and decision-making. It can be used to model and test different scenarios, sustainably transform energy production and consumption, improve food and water security, and eradicate poverty. Initiatives such as the Intergovernmental Panel on Climate Change and the Global Ocean Observing System can help fill gaps in scientific, technical, and socio-economic data. By analyzing big data, researchers can gain insights into the effectiveness of various climate change mitigation strategies and identify areas for improvement (Ciccarelli & Marotta, 2023).

Domains of Climate Change Mitigation

This research paper examines the application of big data and technological interventions in three main domains of climate change mitigation:

- *Agriculture:* Big data can be used to develop more sustainable agricultural practices, improve food security, and adapt to changing climate conditions.
- *Cleaner Production:* Technological interventions can help industries reduce their greenhouse gas emissions, improve energy efficiency, and adopt more sustainable production processes (Alder & Hostetler, 2015).
- *Climate Resilience:* Big data can be used to identify vulnerable areas and populations, enabling the development of targeted adaptation strategies and improving climate resilience (Ciccarelli & Marotta, 2023).

EMERGING CLIMATE CHANGE MITIGATION TECHNOLOGIES

Emerging technologies play a crucial role in reducing greenhouse gas emissions and adapting to climate change. These technologies can be categorized into three main groups (Irfan et al., 2022) Carbon Capture and Storage (CCS): Technologies that remove carbon dioxide from the atmosphere or prevent its release, such as carbon capture and storage systems or bioenergy with carbon capture and storage (BECCS) (Regmi & Bhandari, 2013). Electrification and Energy Efficiency: Technologies that improve energy efficiency, reduce energy consumption, and increase the use of renewable energy sources, such as solar, wind, and hydroelectric power (Sethi et al.,2020). Climate-Resilient Agriculture and Ecosystems: Technologies that enhance the resilience of agriculture and ecosystems to climate change, such as drought-tolerant crops, soil conservation practices, and restored degraded lands (Panepinto *et al.,* 2021).

CONCLUSION

Technologies and information resources are among the factors that influence exposure and vulnerability to climate change along with financial resources, infrastructure, managerial ability, institutional environment, political forces, and societal values.

This research paper highlights the importance of system-of-systems thinking, big data, and emerging technologies in addressing climate change mitigation challenges. By integrating these approaches, researchers and policymakers can develop more comprehensive and effective strategies for combating climate change and ensuring a sustainable future for all.

However, technology alone cannot ensure the enhancement of a country's and community's adaptive capacity since the factors mentioned above influence the effectiveness of adaptation measures in a complex way. Developing countries need to adopt modern technologies based on their criteria and consider full knowledge of consequences that can likely occur.

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