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Challenge the Ecosystem and AI Combating Climate Change

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Abstract

Bottom cold water mass provides abundant nutrients and cool water in summer, playing a pivotal role in the productivity of marine ecosystem and sustainable aquaculture development. Located in the most densely populated region, the Yellow Sea cold water mass (YSCWM) is a unique one influencing hundreds of millions of people living in the rim of the Yellow Sea. As anthropogenic carbon emissions continue, how the YSCWM will be altered by climate change becomes a pressing issue, but remains elusive. Using an unprecedented set of climate models with high resolution and biogeochemical components, we find that the volume of the YSCWM will shrink by 48% to 2040–2050, along with the bottom temperature warming of 0.4 ± 0.1 °C dec^{-1} and the dissolved oxygen concentration declining of 0.09 ± 0.04 mg $(L\ dec)^{-1}$. The significant destruction of the YSCWM is driven by the strengthened Yellow Sea Warm Current (YSWC). The reduced land-sea thermal contrast is the cause of the circulation change, by weakening the East Asian winter monsoon. Due to the resultant profound habitat reduction for marine life, predicting the change of the YSCWM will have far-reaching influences on the future policy-making for sustainable development of offshore aquaculture.

This paper offers an in-depth exploration of different approaches to reduce greenhouse gas emissions, adapt to environmental changes, and create resilience among vulnerable populations. With their capacity to process big data, stabilize complex systems, and produce actionable insights quickly, AI technologies represent a significant force in developing ideas and solutions for the complex global system threats to climate change [1]. AI technologies pave the way for researchers and practitioners to devise more sophisticated climate modelling, optimize renewable energy systems, improve agriculture, and facilitate climate-adaptive measures and disaster response. In addition, this paper analyzes the impacts and the ethics in the context in which AI technologies can be deployed to combat climate change and adaptation. However, AI presents an impossible breakthrough in climate issues. However, at the same time, it generates problems with data protection, the prejudice of the algorithms, and the issues of social inequality [1]. Therefore, an analytical consideration of risks and tradeoffs related to AI-driven remedies is necessary to support the idea that climate solutions will be equitable and transparent and consider social values. This paper will carefully review the literature and case and provide clear ground on how AI technology is transformative in tackling the challenges associated with climate change. Moreover, the paper will navigate ethical complexities that may be inherent in deploying AI technologies globally.

Keywords- Climate Change , Artificial Intelligence, Environmental Sustainability temp trend °C $decade^{-1}$, Data Privacy.

Introduction

Climate change induced by greenhouse gases emission from human activities is projected to cause dramatic changes in temperature, circulations, and biogeochemical properties in the ocean[2-5] . The offshore regions and marginal seas are more vulnerable to climate change than the open ocean[6-8] . The response of these regions to climate change exerts profound influences on human living by impacting fishery, aquaculture, shipping, and tourism, etc. Bottom cold water mass (BCWM), trapped near the bottom of marginal seas under the strong thermocline in summer, is a widespread phenomenon observed in many shelf seas, such as the Irish Sea, Middle Atlantic Bight, North Sea, Berling Sea and Yellow Sea (YS)[9-12]. It originates from the vertically homogeneous cold water mixed by strong wind and surface heat loss in the previous winter[13-15]. As reservoirs of cool water and nutrients, the BCWMs serve as the habitat for plankton and cold-water fishes[13-16]. Since nearshore fishing and breeding are approaching their limit, developing aquaculture in the BCWM could be the future solution for the fishery of its surrounding countries [17-18]

The rising threat of climate change has been the giant alarm bell for everyone, urging them to get a sustainable solution, minimize the impact, and build resilience in vulnerable areas. Global temperature has risen by nearly 1.1 degrees Celsius since the pre-industrial era, as per the IPCC(Intergovermental Panel on Climate Change), resulting in more intense, frequent, and severe heat waves, storms, and other extreme weather [1]. Additionally, WMO(World Meterological Organization) states that there are elevated concentrations of greenhouse gases, such as carbon dioxide (CO_2) and methane (CH_4), around the world, which lead to the amplification of the global warming crisis [1]. Consequently, AI (artificial intelligence) and climate change saw a proliferation of groundbreaking AI studies in the most advanced area. As per Global AI Index, the investments in AI technologies in the recent few years have immensely grown which is majorly due to public and private sectors. Similarly, IEA(International Energy Agency) (IPCC) research indicates that AI-guided energy management systems could create 4% global emission savings by 2030, highlighting AI's ability to lead substantial improvement in climate change mitigation effectiveness [1,19].

The conventional approaches to climate change usually include mitigation and adaptation solutions, which are often facing the problems of scale, complexity, and efficiency. Hence, more sophisticated strategies must be used to grapple with the multifaceted challenges of the climate crisis. So far, there is a tremendous potential of AI in such spheres as climate science, regulations, and practice in the processing of huge amounts of data, allocation of resources and evidence-based decision-making. On the other hand, among the AI applications strengths, there are of course the ethical, social and environmental problems related to their use in climate change solutions. For instance, some of the issues related to data protection and AI algorithmic bias can trigger doubts as well as inequality and unfairness in the provision of AI based solutions for climate action [19,20]. Hence, a deep understanding of the technological advancements driving AI-enabled climate solutions and the ethical questions that are a prerequisite for their implementation is required for moving towards the desirable future that is green and just. This paper will outline the viability of using AI to combat climate change and analyze the ethical, societal, and environmental drawbacks of AI in these strategies [21].

RESEARCH PROBLEM

The main research problem in this study is the analysis of climate change mitigation strategies using artificial intelligence. Integrated AI systems as a valuable contributing factor to the acceleration of both climate change adaptation and mitigation rates have a potential likelihood of playing a defining role in decision-making at the top, particularly on the topics of scalability and consequences unseen. Thus, this study centers on AI capabilities in overcoming complex climate change problems such as processing of environmental data in huge amounts and optimizing the allocation of resources, decision-making support [20]. The findings from this research questions will give the insights on how to utilize AI to mitigate climate change while minimizing the adverse ethics implications of its operation. The application of AI methods like machine learning algorithms, and neural networks to increase the accuracy of climate modeling and predictive abilities is considered [22]. Through AI-supported models, it assesses the degree to which climate change can be simulated more accurately than the past; it prognosticates future climate scenarios, and it assesses risks and vulnerabilities focusing on climate.

LITERATURE REVIEW A. ROLE OF AI IN CLIMATE MODELING

AI-driven climate models offer one of the advantages of better representation of the complex climate systems of the globe. By teaching machine learning algorithms with historical climate data, they can create cleaner models of the interaction between the atmosphere, oceans, land surface, and biosphere [23]. The AIscaled models of these processes can provide a form of intellect to understand the complexities of weather extremes, ocean circulation, and carbon cycle patterns, allowing scientists to make clairvoyant conclusions and predictions on the Earth's climate system changes. On the other hand, AI-augmented climate models are believed to enhance future climate prediction. Machine learning algorithms can adjust existing climate models for the best climate projection of different greenhouse gas levels. Using machine learning abilities in climate change models is very important because it can assess climate risks and vulnerabilities. AI algorithms can now analyze the climate data for the entire world and combine it with the socioeconomic factors, infrastructural vulnerabilities, and information on ecosystem dynamics to identify the areas and regions exposed most to the various climate impacts and prioritize the adaptation efforts [23]. AI techniques, including ensemble modeling and probabilistic forecasting, have much to offer regarding their value in providing information about the possibility and degree of extreme weather phenomena that can help in risk management and other such strategies. Applying AI approaches in climate modeling is an essential innovation in comprehending, forecasting, and coping with climate change effects. The combination of machine learning and neural networks is given to researchers that can be used to develop more precise and complete models of climate on Earth, which, in turn, will enable better decision-making and more effective climate action strategies. Nevertheless, data availability, model validation, and computational ability are still among the major problems that need to be fully resolved and call for additional research and cooperation with the scientific communities [24].

CONCLUSION

AI for fighting climate change, we have to deal with technological problems, promote AI-related transparency, and ensure that AI-driven solutions are accessible to all. While AI could be the ultimate solution to our complex structural challenge, it is not a panacea but a powerful tool that must be used responsibly and ethically. AI catalyzes this process while maintaining the fundamental values of equity, transparency, and accountability. This allows us to embrace new chances for innovation, collaboration, and developing a resilient and sustainable environment for everyone.

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