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A Multidisciplinary Review of Data-Driven Solutions for Environmental Sustainability: AI for Climate Action

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Abstract: It is becoming more widely acknowledged that machine learning (ML) and artificial intelligence (AI) are revolutionary instruments in the battle against climate change. Using cross-sectoral applications, policy analysis, environmental monitoring, and predictive modelling, this review summarizes the most recent research on AI-enabled solutions for environmental sustainability. By analyzing enormous datasets from meteorological, geospatial, and oceanic sources, AI-driven predictive models improve climate forecasting, risk assessment, and mitigation planning, according to the findings. In environmental monitoring artificial intelligence (AI) combined with remote sensing and the Internet of Things (IoT) allows real-time tracking of biodiversity, air and water quality, and disaster risk, giving timely intelligence for intervention. AIs impact on governance is increased by Natural Language Processing (NLP), which analyses public opinion and climate policy documents to support evidence-based and socially responsive policymaking. Additionally, AI supports the Sustainable Development Goals (SDGs) by being used in disaster relief, sustainable agriculture, and energy optimization. Despite these developments, there are still many serious issues, such as interval in data quality, black-box nature of AI model, moral dilemmas and potential socio-economic injustice. The stress has been emphasized in all reviews the same access to standardized data protocols, persuadable AI framework, and technology resources. When it comes to including AI in climate strategies, interdisciplinary cooperation is an important architect that guarantees innovations, both socially and scientifically sound. In the time of unique environmental changes, Artificial Intelligence (AI) has the ability to promote global stability and flexibility, to become a major component of climate action by creating computational capabilities with environmental science and policy.
Keywords: *Artificial Intelligence, Climate Change, Predictive Modeling, Environmental Monitoring, Sustainable Development Goals, Natural Language Processing, Explainable AI*

INTRODUCTION

Climate Change Rapid Acceleration already creates unheard problems that say for creative, data-powered and interdisciplinary solutions. The need to use state -of -the -art computational techniques to support mitigation and adaptation strategies immediately increasing global temperature, increasing frequency of extreme weather events and ongoing greenhouse gas emissions. Big data analytics, machine learning, and Artificial Intelligence (AI) have become a game-changing technology that can improve climate action by facilitating effective resource management, high precision environmental monitoring and reliable future modeling (2024 in 2024). These technologies enable focused and active interventions by processing large and diverse datasets and spotting the complex patterns remembered by traditional analytical techniques. In recent years, the convergence of various technical domains has accelerated the integration of AI into the structure of environmental stability. Integration of Big data solutions in Artificial Intelligence (AI), Internet of Things (IOT), and Smart Urban Systems enables real -time environmental sensation, energy efficiency adaptation and emissions reduction program (Bibri et al. 2023). At local, regional and international levels, these integrated approaches help to conduct sustainable growth goals by reducing data collection and practical climate policies. Technologies for data-operated sensing have created new opportunities to address various types of environmental issues outside urban settings. Evidence-based decision making is supported by the smart sensing system that uses AI algorithms to detect and analyze the environmental pollutants, biodiversity loss, and climate-inspired changes in land and water resources (Bhavani and Gajendra 2024). These skills are necessary to guarantee that environmental intervention is sensitive to reference, timely and stability goals.

In addition, data-operated innovations are being implemented in areas other than environmental science, such as policy economics and governance, highlighting the interdisciplinary nature of AI for climate action. These devices support the role

of science and technology in social change and make a lot of assistance in the achievement of Sustainable Development Goals (SDG) by creating landscape modeling, impact forecasting, and mitigation strategy evaluation (Bachman et al). Therefore, integration of environment and computational science is an important step in making futures that are low-carbons, flexible and adaptive.

In its light, the current review presents the body of research on AI-powered climate solutions with two main goals: First, to check completely how AI, machine learning, and Big data analytics are used to monitor environmental issues, assess and second, multi-related strategies, which are to involve environmental science for stability.

Objectives

1. To systematically review applications of artificial intelligence, machine learning and Big data analytics to review big data analytics in predicting and reducing environmental challenges.
2. To analyze the interdisciplinary approaches to integrate environmental science in deploying AI for stability.

LITERATURE REVIEW

The convergence of environmental stability, machine learning and artificial intelligence (AI) has attracted the attention of many scholars as climate action becomes more important. In climate change research, the future modeling abilities of AI and ML applications have proved to be effective, allowing simulation of complex climatic systems to evaluate the simulation and environmental impacts (Hamdan et al. (2024). AI-operated models enable climbing patterns, extreme weather events, extreme weather incidence, extreme weather incidence, extreme weather incidents. These equipment also improves assessment of environmental impact and gives policy makers more sophisticated photographs of climate change effects.

The modeling abilities of AI's future in stability-centered areas lead their role in reducing climate change. Deep learning and reinforcement learning are two examples of AI techniques that process different types of data from sensor networks, satellite imagery and climate repository to improve risk evaluation and mitigation strategy adaptation (Pratihari 2024). Proacting carbon emissions, managing renewable energy, and predicting climate disasters are some applications that support resource-skilled and adaptable solutions in industries such as energy and agriculture.

AI has the ability to bring revolution in environmental monitoring, another important field. AI has increased the biodiversity disaster risk and real -time monitoring of air and water quality when combined with IOT and remote sensing (Alotaiibi and Nassif 2024). Wildlife monitoring, land-rover classification, and high-compatibility soil mapping is possible by developing in AI algorithms. Black-boxes of many AI models are developing framework for explain AI (XAI) to address issues of transparency brought by nature, which is necessary for adoption and trust in environmental rule. Beyond special use, AI is accepted as a cross-sector facility of climate solutions, increasing energy transport, agricultural and disaster management processes (Jordan et al. 2019). AI improves crop yield forecast and resource efficiency in agriculture, while it facilitates integration of renewable resources in the smart grid in the energy sector. Artificial intelligence-competent systems support initial warning systems in disaster management, reduce financial and human damage.

Additionally, recent progress in natural language processing (NLP) has created new opportunities for climate rule. NLP techniques are used to remove important subjects from the development of rules, forecasting public emotion, and climate policy documents and social media discourse (Ozadi et al. 2023). These methods help MLAs meet new problems, deal with false information and match laws for public needs. The accuracy of the subject modeling and emotion classification has increased with transformer-based models such as Burt and GPT, which is widely widenessing the range of relevant insights for policy. Artificial Intelligence (AI) is helping to achieve many SDGs from a stability point of view, such as biodiversity, inexpensive energy and protection of clean water (Thanwatpornul 2024). However, if resources and benefits are not distributed fairly, similar technologies run the risk of making economic inequality worse. This emphasizes the need for the framework of governance which guarantees responsible resource usage, fair access and moral deployment.

All things were considered, the literature review indicates that artificial intelligence plays a variety of roles in environmental stability, including policy analysis, cross-sectoral adaptation and future modeling monitoring. However, general issues still exist, such as model lecturers, data standardization, moral issues and policy structure integration. Climate action will require interdisciplinary cooperation to close these intervals to unlock the full potential of AI.

METHODOLOGY

The present review employs a qualitative thematic analysis methodology to integrate findings from the extant peer-reviewed literature on climate action enabled by artificial intelligence. Thematic analysis was chosen because of its propensity to find, examine, and interpret recurrent themes, ideas, and patterns in a wide range of research. The approach holds an interdisciplinary relationship with policy governance and social results, while AI, ML and Big Data Technologies have a fine understanding of methods of environmental monitoring, prediction and mitigation domains.

In order to guarantee technical and functioning relevance, with emphasis on publications for the last ten years, Sahitya Corpus was gathered from the academic database such as IEEE XPlore, Web of Scissue and Scopus. Studies that especially address the use of AI, ML, or large data analytics in dealing with climate-related issues, especially targeted by inclusive criteria, integrates the environmental attitude with focus on them. The exclusion criteria eliminated the papers that were limited to unrelated domains or which were purely theoretical, which had no evidence of application for climate-related

references. Because the synthesis of insight was directed by this thematic structure, the reviews were able to capture both technical abilities and interdisciplinary implications. Therefore, the approach guarantees the intense and analytically of AI's contribution to environmental stability.

ANALYSIS

Four major and associated topics in AI-Saksham Climate Action have been exposed by a summary of reviewed literature. A unique application field where AI, ML, and related computational technologies help in dealing with climate change, is represented by each subject, which also highlights the important issues that affect the efficacy and scalability of these technologies.

Theme 1: Climate Forecasting and Predictive Modelling

In the study of climate change, the forecast modeling continues as the most developed and large -scale used area of AI application. Compared to traditional statistical techniques, researchers have capable of predicting complex climatic phenomena with much accuracy using machine learning algorithms such as nerve networks, random forests and artists such as artists (Hamdan et al. 2024). To repeat complex interactions controlling atmospheric and ocean systems, these models use datasets from many sources, such as weather records, geophysical imagination and ocean parameters. For example, the forecast models operated by AI can predict sea-level growth scenarios under various routes of greenhouse gas concentrations, which is an essential skill to plan coastal adaptation. Similarly, deep learning architecture is used to identify non -pattern patterns in climate data by the prediction model of extreme weather occurrence, which allows first and more accurate warnings for disasters such as drought, floods and storms. In addition to supporting preparations for disasters, this capacity indicates concentrated mitigation strategies such as allocating funds for strengthening of infrastructure in areas that are at risk. By fusing the data of satellites with records of energy use, Pratihari (2024) highlights the importance of AI in predicting carbon emissions. These models aid policy makers in assessing the potential effects of various mitigation scenarios and ease the emission budget. However, issues continue to modelling the future despite these developments with the generality of data quality, model lecturers, and results in geographical contexts. A permanent issue is excessive dependence on the high-resolution dataset, which may not be accessible in developing countries, which may lead to an imbalance to the global north and south prediction. Framework for international data sharing and data infrastructure investment will be necessary to stop this difference.

Theme 2: Intelligent Sensing and Environmental Monitoring

AI, Internet of Things (IOT), and remote sensing systems have all technically integrated to change the environmental monitoring of real -time. To track changes in air and water quality, identify changes in biodiversity, and evaluate the dynamics of land-utilization, Alotbi and Nasif (2024) show how AI-in-operated monitoring platform sensor can analyze the continuous streams of data. In addition to detecting discrepancies, by predicting future trends, these systems allow for active environmental management. Smart sensing technologies, especially for monitoring toxic algal blooms in coastal water, are useful for identifying the incidence of pollution such as sudden increase in particulate matter in urban air. Raw sensors or satellite data are processed by machine learning algorithms, which then remove the noise and provide useful insight to appropriate authorities. This method reduces the ecological and economic effects of environmental hazards, while the response also reduces time. Wildlife monitoring is another area where remote sensing is used. AI-run image recognition model uses camera trap data to identify model species and count population. The conservation of biodiversity will be greatly impacted by this, particularly in regions where habitat shifts brought on by climate change are occurring. Similar to this, land-cover classification models and soil mapping help identify regions that are vulnerable to deforestation or desertification, enabling focused reforestation or soil restoration initiatives. However, a significant drawback of environmental monitoring is that many AI algorithms are black-box, meaning that stakeholders find it challenging to completely comprehend the decision-making process underlying system outputs. A remedy that provides transparency in model reasoning without compromising performance is explainable AI (XAI) techniques. Gaining the confidence of the public conservation organizations and legislators depends on this development.

Theme 3: Public Engagement and Policy Analysis.

AI has an impact on governance through Natural Language Processing (NLP) applications, which go beyond environmental science. Ojadi et al. NLP can handle enormous volumes of unstructured textual data from news sources, social media, and government reports, as 2023 demonstrates. Subject modeling, emotion analysis, and designated unit recognition are some methods used by the NLP tool to identify important subjects, monitor the development of policies and gauge public support for climate action. NLPs can be used practically in climate policy to identify discrepancies between declared regulatory goals and public priorities. For example, emotion analysis enables more inclusive and responsible policy -making by suggesting whether the proposed policies come with opposition or conform to social expectations. In addition, NLP systems play an important role in identifying false information about climate change, a growing issue in the digital age. These systems can support the conservation of integrity of public discourse and identify false narratives and protect the validity of policy

recommendations on the basis of science. By recognizing subtleties in the context of the text, transformer-based architecture such as Burt and GPT has improved the accuracy of natural language processing models. More complex policy analysis is now possible for this advancement, including the forecast on how the public will respond to the proposed climate law or spot new trends in the global climate dialogue. Adopting NLP in policy making is not without its difficulties, though. Data bias, linguistic diversity, and privacy and monitoring morality should all be noted that these devices are properly used. Converting NLP insight into a practical strategy that actually attach to the public, also requires interdisciplinary cooperation among AI developers, policy analysts and communication experts.

Theme 4: Integration across sectors and sustainable development

AI's cross-sectoral applications, including energy, agriculture and disaster management, demonstrate their ability to promote sustainable growth. Jordan & Company (2019) shows how AI can control energy storage, forecast energy demand and balance supply to customize renewable energy systems. National Energy Infrastructure requires these capabilities to integrate variables such as solar and winds such as variable energy sources. In agriculture, AI applications are made possible by accurate farming methods, which improve climate flexibility. ML models estimate crop yields, suggest flexible planting techniques, and optimize the irrigation program to reduce the effects of climate change. These applications increase resource efficiency by increasing food security and low agricultural emissions. Another area in which AI is required is disaster management. The plans to withdraw resources, allocate resources and develop post -disaster recovery plans are affected by all future models and real -time monitoring systems. For example, flood sensitivity can overcome AI-operated mapping, high-risk areas and direct infrastructure development from susceptible people. From a perspective of stability, Thanwatpornkul (2024) forms a direct connection between AI progress and attainment of sustainable development goals (SDG), especially related to clean water, renewable energy, biodiversity conservation and climate action. However, socio -economic issues are also brought in these areas using AI. A growing division between technically advanced and resource-developed areas can result in uneven access to AI technologies and related infrastructure. Thus, capacity-making programs, inclusive innovation rules, and moral AI regime are necessary to guarantee that the advantages of AI-managed stability are distributed worldwide.

There are many recurrent problems between these subjects. First, since confidence and accountability is important in high-day areas such as environmental rule and climate adaptation, there is a universal requirement of transparent and detected AI models. The second barrier to the difference between models and dataset from different regions or areas is still data standardization. Third, interdisciplinary cooperation contributes to continuous success. Cooperation between technologists, environmental scientists, policy makers and community stakeholders produce the most important AI applications. To guarantee that AI's contribution to climate action is both social and scientifically sound, moral issues such as privacy bias and justified access should be taken into consideration.

DISCUSSION

Although it also attracts attention to the ongoing structural and moral issues, thematic analysis emphasizes how adaptable AI is in combating climate change. The most developed application is predictive modeling, which enables stakeholders and policy makers to remove climate risks and create concentrated intervention. These models, however, mainly depend on the quality and availability of data, which differ geographically, especially in developing countries. Monitoring the environment supported by AI and IOT integration provides real -time status awareness that is essential for ecosystem protection and disaster management. Explanation and lecturer are important fields of research, because despite their ability, the black-box nature of many AI systems still prevents trust and adoption. NLP-based policy analysis is a relatively new but hurry-growing area that provides better understanding of public spirit and improves the accountability of climate policies. The integration of environmental rule and computational linguistics may be necessary for inclusive climate policies.

CONCLUSION

This analysis shows how AI and ML have developed in the equipment required to reduce and adapt climate change. These technologies provide creative ways to deal with climate change pressure issues through cross-sectoral applications, environmental monitoring, policy analysis and future modeling. Literature emphasizes AIS ability to constantly analyze large, diverse datasets, finding complex patterns and producing useful insights to make long -term decisions. While the AI-competent monitoring systems offer real-time environmental intelligence, the future analytics improves risk evaluation and climate forecast. By enabling policy alignment with social needs and increasing the public trust, NLP applications expanded the role of AI to governance. In addition, AI's contribution to disaster relief, agriculture and energy adaptation supports its role in advancing SDG. However, there are important obstacles that come up with the transformational capacity of AI, such as the difference in data quality, problems with model transparency, moral concerns, and ability to deteriorate the ability to socio -economic inequality. Standardized data protocols, equitable access procedures, and explaining AI framework should be installed to remove these concerns. Finally, a cooperative interdisciplinary strategy that combines technological advancement and environmental policy is essential for the future of AI applied to climate action. AI can be used as a major component to strengthen climate flexibility and promote sustainable development globally by establishing cooperation between scientists, technologists, policy makers and communities.

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