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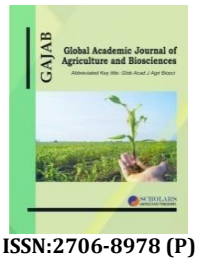

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Review Article

The Global Challenge of Climate Change and how AI might be Applied to Tackle this Challenge

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Abstract: Climate change represents one of the most urgent global crises, characterised by rising temperatures, extreme weather events, and ecosystem degradation. This paper explores the application of artificial intelligence (AI) to mitigate and adapt to climate change, focusing on agricultural greenhouses as a representative problem domain. The study presents a Business Process Model and Notation (BPMN) framework that integrates Internet of Things (IoT) devices, satellite data, and AI algorithms for real-time climate monitoring, data analysis, decision support, and policy engagement. Ethical considerations—fairness, accountability, transparency, and environmental sustainability—are critically examined to ensure the responsible deployment of AI. The paper reviews current AI applications across energy systems, precision agriculture, carbon capture, urban planning, and climate policy, highlighting benefits such as reduced energy waste, optimised resource allocation, and evidence-based policymaking. Challenges, including high energy consumption of AI models, data scarcity, and equity concerns, are discussed. The analysis reveals research gaps where fewer AI methods are applied, particularly in energy trends and public perception studies. Ultimately, responsible AI implementation—guided by ethical principles and inclusive access—offers transformative potential to advance climate action while minimising its own environmental footprint.

Keywords: Internet of Things (IoT), Cybersecurity, Artificial Intelligence, Machine Learning, Efforts to automate these environments.

1. INTRODUCTION

Climate change is one of the most critical challenges of our time, characterised by rising global temperatures, melting ice caps, extreme weather events, and ecosystem disruptions. The study showed that the architecture is feasible to monitor crops, to collaborate to maximise yield and to control the use of inputs and agrochemicals. Furthermore, it caters for culture monitoring in real-time, offering information to investigate this crisis, which requires innovative solutions that span multiple disciplines. Artificial intelligence (AI), with its ability to analyse vast amounts of data and optimise complex systems, has emerged as a powerful tool in the fight against climate change.

1.1 Background

This assignment will provide an overview of the challenges presented by the climate crisis and the scope for AI-based solutions, as well as explore the applications of AI in mitigating and adapting to climate change and the challenges that come with its

implementation. As of 2018, human activities have already caused approximately 1ºC temperature increase above preindustrial2 levels [1]. At current warming rates, and assuming business as usual continues, warming is estimated to reach 1.5ºC by 2030-2052 [1].

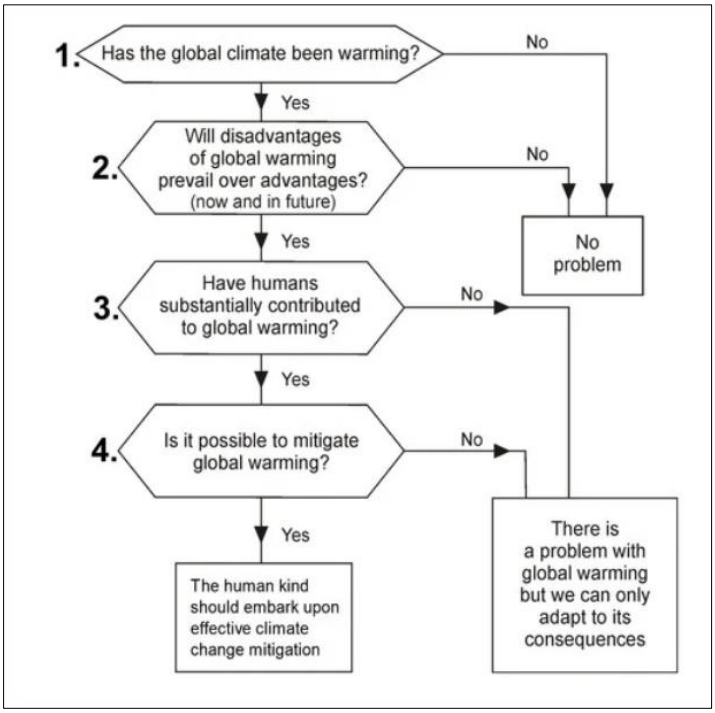

Fig. 1: Shows how global climate change warning and warnings

2. Problem Domain

Agricultural greenhouses have improved productivity in the cultivation of specific crops. Efforts towards the automation of these environments have been carried out with the application of different technologies [2]. However, the absence of a solution that comprises a complete chain of the automation process has been noted. The Internet of Things (IoT) is a technology that can offer solutions for the modernisation of agricultural environments, making it possible to automate processes, predict situations, and improve production activities. Moreover, IoT solutions and business processes should be integrated into a common framework to provide a more efficient production process control since business rules are often dynamic and might vary according to agricultural practices.

3. BPMN to Model the Processes

PMN Diagram:

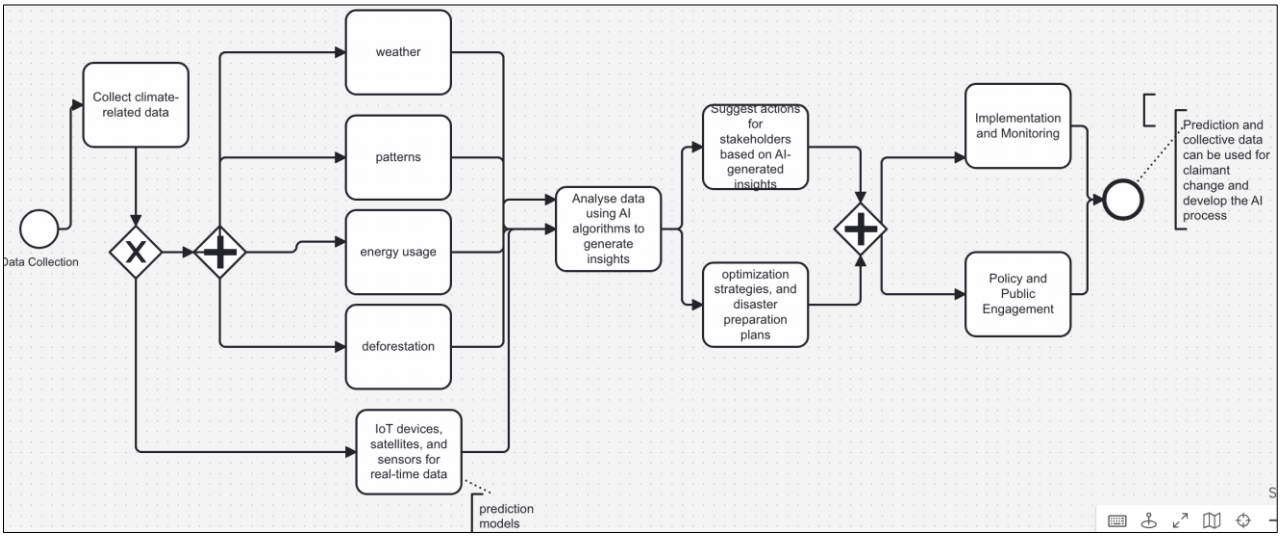

Fig. 2: Shows the process of climate data and AI in the development

Link BPMN Design [14]:
https://modeler.camunda.io/share/a229f23c-4e5c-454c-a55f-a9536e413d5d

1. Data Collection
- Collect climate-related data (weather patterns, energy usage, deforestation, etc.).
- Use IoT devices, satellites, and sensors for real-time data.

2. Data Processing and Analysis
- Analyse data using AI algorithms to generate insights (e.g., prediction models, carbon monitoring).
- Develop reports or visualization tools for stakeholders.

3. Decision Support
- Suggest actions for stakeholders based on AI-generated insights (e.g., energy optimization strategies, and disaster preparation plans).

4. Implementation and Monitoring
- Implement strategies (e.g., smart grids, precision agriculture techniques).
- Continuously monitor outcomes using AI-powered feedback loops.

5. Policy and Public Engagement
- Generate policy recommendations.
- Use AI tools to engage the public and raise awareness.

4. Ethical Reflection

AI has immense potential to address climate change, but its application must prioritise ethical considerations such as fairness, accountability, and transparency. Ensuring fairness involves using diverse datasets, designing inclusive tools, and prioritising vulnerable populations disproportionately affected by climate change. Accountability requires clear governance frameworks, regular audits of AI systems for biases, and community involvement to ensure decisions reflect ethical and equitable values. Transparency is achieved by using explainable AI, sharing open data and models, and documenting processes to build trust. Additionally, mitigating the environmental impact of AI through energy-efficient practices and renewable-powered infrastructure is essential to avoid exacerbating the problem it aims to solve. Balancing these principles ensures AI solutions are socially responsible, equitable, and effective in combating the global challenge of climate change.

When developing AI-based climate solutions, it is important to consider the possible ethical and social implications seriously. This may include the ethics of methods such as such as the privacy of personal data, national-scale manipulation, and the impacts of the backlash against such methods [13].

AI has immense potential to combat climate change, but ethical principles must guide its implementation. AI solutions can drive meaningful and equitable progress toward addressing one of our time's most pressing global challenges by ensuring fairness, accountability, and transparency alongside efforts to minimise environmental costs [11].

5. Data and Model Sharing

In Table 1 we see a wide range of AI tasks and methods being applied to the 9 climate research areas that we extract from our climate and AI RC dataset. For example, we identify six AI tasks and methods being used in studies of climate impacts, including causal interference, computer vision, natural language processing, neural networks, robots and time [12], series. Studies involving climate modelling are using at least five AI tasks and methods, including computer vision, graphs, neural networks, robots and time series.

Table 1: Mapping AI tasks and methods within climate change research subfields

	Causal Interference	Computer Vision	Graphs	Methodology	Natural Language Processing	Neural Networks	Reinforcement Learning	Robots	Time Series
Climate Impacts	✓	✓			✓	✓		✓	✓
Climate Modeling		✓	✓			✓		✓	✓
Emissions Trends						✓		✓	✓
Energy Efficiency		✓				✓		✓	
Energy Technologies		✓		✓	✓		✓		
Energy Trends				✓					
Land Use Change		✓				✓	✓		
Public Perception					✓				
Transportation				✓		✓			

This analysis also reveals some areas of climate research that are using fewer AI tasks and methods. While energy technologies research uses multiple methods (examples include computer vision, AI methodology, natural language processing, and reinforcement learning), we see other areas of energy research such as energy trends studies and public perception studies using fewer methods. As a result, there appear to be gaps in certain climate research areas where AI tasks and methods are not being used as widely and where there may be useful applications. Exploring these gaps identified in Table 1 is an area for future research.

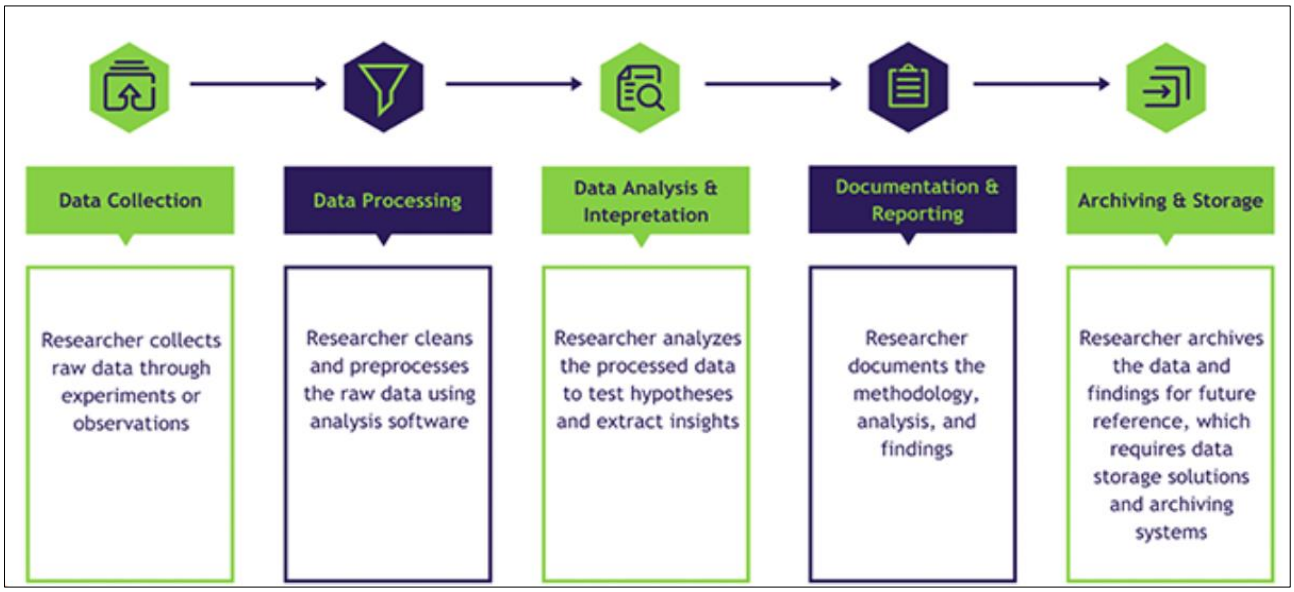

Fig. 3: Shows the data workflow

Challenges in Applying AI to Climate Change

While AI holds immense potential, its application comes with challenges:

1. **Energy Consumption of AI Systems:** Training large AI models requires substantial computational power, potentially offsetting environmental gains.
2. **Data Availability:** High-quality, standardized datasets are necessary for accurate AI models, but such data is often incomplete or inaccessible.
3. **Equity Concerns:** The benefits of AI may not reach all communities equally, especially in developing countries with limited technological infrastructure.
4. **Ethical Considerations:** Transparency and accountability in AI decision-making processes are critical to building trust

6. AI Application Developments

Opportunities for AI Application Developments in ML and AI have fuelled breakthroughs with far-reaching societal consequences. Driven both by rapid advances in high-throughput hardware, as well as an explosion of available and accessible data sources made possible by high-bandwidth internet connections and the sensor connectivity provided by the internet of things, the rising economic value of AI, predicted at as much as $16 trillion by 3 Artificial Intelligence & Climate Change: Supplementary Impact Report 2030 [9], has turned it into a powerful agent of change. AI can transform public perception and, for example, form an important part of the UK's post-Brexit industrial strategy [10]. Global media activity surrounding prestigious breakthroughs, such as DeepMind's AlphaZero winning against Go-champion Lee Sedol in December 2017 [11], has certainly contributed to the rapid growth of the AI community and its popularity far beyond the gaming scene.

Here's a chart summarising the key applications of AI in tackling climate change:

Category	AI Applications	Benefits	Examples
Monitoring & Prediction	Climate data analysis and extreme weather prediction	Better preparedness, resource allocation	IBM Weather Prediction AI
Energy Systems	Smart grids, renewable energy forecasting	Reduced energy waste, efficient integration of renewables	Google DeepMind (data centre energy)
Agriculture	Precision farming, crop monitoring, deforestation detection	Resource optimization, reduced emissions, biodiversity conservation	Global Forest Watch
Carbon Capture	Identifying storage sites, optimizing sequestration processes	Increased efficiency of carbon capture technologies	AI-powered carbon capture models
Urban Planning	Traffic management, public transport optimization	Reduced emissions, improved urban mobility	AI-driven traffic flow optimization
Policy & Awareness	Climate simulators, public engagement tools	Evidence-based policymaking, increased public participation in climate action	AI-based climate policy simulations

As there is increasing use of machine learning (ML) approaches to better understand different aspects of natural hazards, XAI is an important catalyst in advancing our comprehension of ML uses in this field. Often, ML models can lead to incorrect conclusions, as the underlying mechanism is not very well-studied. Broadly, the use of ML models in natural hazard modelling involves selecting multiple factors (also known as controlling factors), which are fed into the model for regression or prediction purposes (fig. 4).

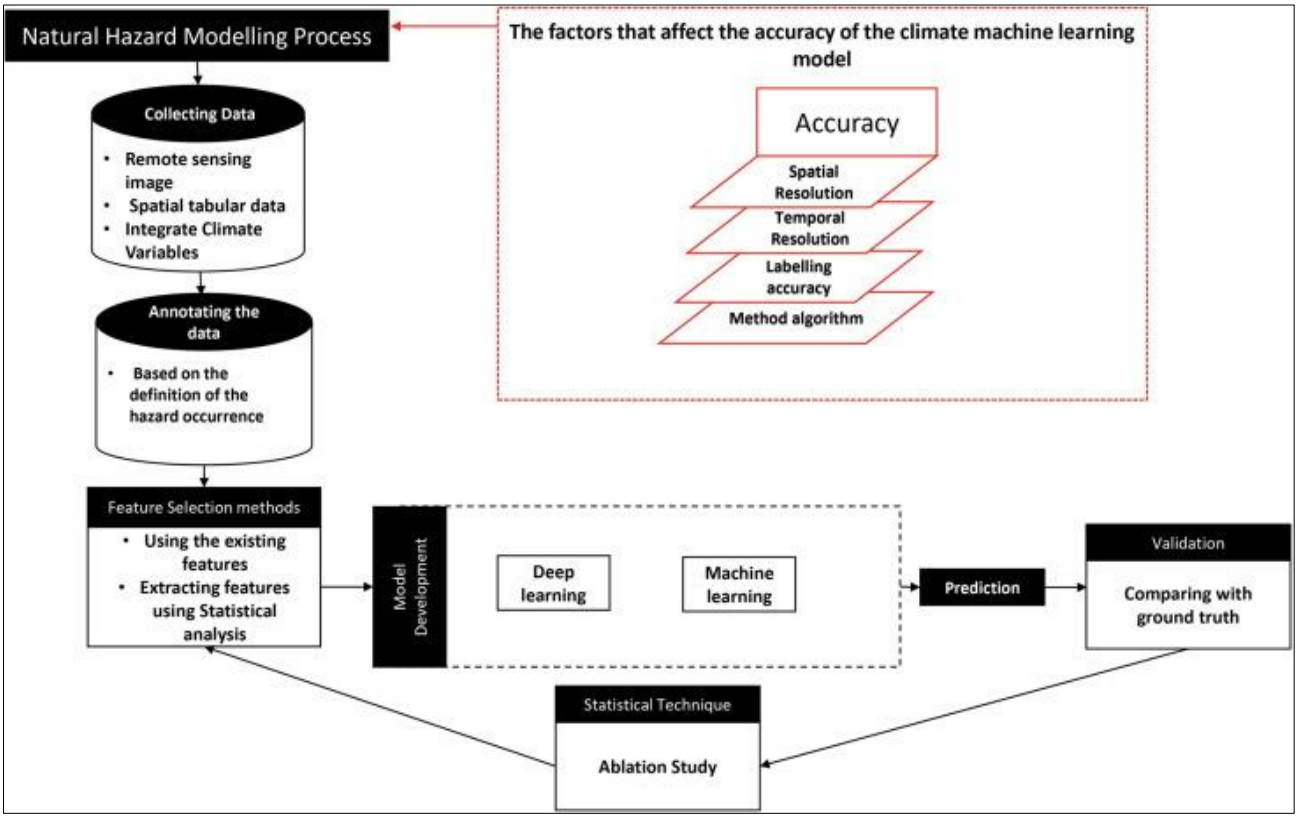

Fig. 4: General flowchart of using machine learning approaches for natural hazards

7. CONCLUSION

AI offers innovative solutions to address various aspects of climate change, from monitoring environmental changes to optimizing energy systems and promoting sustainable practices. However, its implementation must be guided by ethical considerations, equitable access, and a focus on minimizing its environmental footprint. By leveraging AI responsibly, we can take significant strides toward a sustainable and resilient future.

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