Chapter 5
AI and IoT in Edge Computing for Climate Analysis and Sustainability

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ABSTRACT

AI, IoT, and edge computing are integrated to perform sustainability and climate analyses. AI has been employed in modeling and weather prediction, while IoT performs the gathering of real-time environmental data. The approach guarantees sensitive data processing locally with less bandwidth and delay. It provides real-time decision making, enhanced accuracy of climate data, and faster processing. However, issues such as data privacy, interoperability, and technical complexity have also been observed. Standard protocols, scalable infrastructure, and best practices have been done for data management.

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INTRODUCTION

Innovative technical solutions like edge computing, IoT integration, and AI were developed to address climate change and achieve sustainability urgently. These technologies remain key factors in sustainability since they greatly improve environmental monitoring and climate analysis. A general overview of these technologies and their functions in climate analysis is provided in this introduction. Because it maintains intricate algorithms that model climate change and forecast weather patterns with unprecedented accuracy, AI is a serious tool in climate science (Bibri et al., 2024).

AI makes sense of large datasets by identifying patterns and trends that often evade conventional methods using machine learning techniques. This forecasting capability is important in predicting severities of weather events and their impact, thus, helping in the finding of long-term strategies for climate resilience. The so-called Internet of Things, or integrated sensor device network, provides data on the study of climate. Such devices send real-time information from different locations by observing environmental conditions related to temperature, humidity, air quality, and soil moisture (Bourechak et al., 2023). Frequency and granularity of data allow for deep analytics, enabling a deeper understanding of local and global changes. Edge computing technology reduces bandwidth usage and latency while it improves privacy by processing and analyzing data closer to the source. Especially useful in real-time applications, such as in climate analysis, data processing on-site with a natural catastrophe can speed up decision-making and response times to save lives and reduce damages caused by it all (Slama, 2022).

The combination of edge computing, IoT, and AI provides a strong foundation for sustainability and climate studies. IoT sensors pick up a great amount of environmental data, which are then subject to processing with AI algorithms right on the edge for real-time analytics and immediate insights. This methodology makes for faster reactions to situations or changes in the environment. Commonly, the data from IoT devices streams to the architecture edge computing nodes, which generate actionable insights for both short- and long-term climate policies (Iftikhar et al., 2023). These two synergy factors will enhance the real-time analysis and improvement of data quality. Disaster preparedness and effective resource management with well-informed policy decisions are the consequences of these impacts.

With minimum quantity of chemical inputs and more efficient usage of water, precision agriculture makes the most of real-time soil and meteorological data. Healthy cities may be a result of continuously monitored traffic patterns and air quality to enhance urban design. In particular, exponential growth in environmental data due to edge computing saves energy in the transportation of data and in centralized processing, diminishing its carbon footprint (Chang et al., 2021). Some of the issues that arise relate to interoperability, technological challenges, and data protection