International Journal of Engineering, Management and Humanities (IJEMH)
Volume 5, Issue 6, Nov.-Dec, 2024 pp:251-257 ISSN: 2584-2145
www.ijemh.com

The Potential of Artificial Intelligence and Computer Science in Environmental Sustainability and Climate Change Mitigation

Nadi joseph
Josephnadi4@gmail.com
Takoradi technical university
Daniel Panyin Mensah
Danielpmensah926@gmail.com
Justice Abban
Justiceabban002@gmail.com
Daniel Forson
Danielkojoforson27@gmail.com
Samuel Cobbina
cobbinsamuel@gmail.com
Augustine Kyei
Kyeiaugustine037@gmail.com
Dr. Richard Essah
Department of Computer Science
Takoradi Technical University
richardeessah84@gmail.com

Date of Submission: 28-11-2024 Date of Acceptance: 06-12-2024

Abstract
In this article, we analyze Artificial Intelligence (AI) and computer science as tools for environmental sustainability and the struggle with climate change. AI is qualified for a bigger scope of control of resources and decisions; it works in the use of a lot of data. By the way, smart algorithms in artificial intelligence can also be used for energy efficiency, such as, for instance, the ones that drowse through(patterns in energy consumption) and then present to companies and homes the exact times they use and thus can waste and use the planet better. In addition to that not only does this save the planet for future generations but also helps to warn the communities when a natural disaster is about to happen.In a world that is rapidly shifting to renewable energy sources, AI (artificial intelligence) is doing amazing things with its technologies and changing the way power production takes off. The smart grids supported by AI can deal with the issue very flexibly by allowing the tech to bring renewable sources (e.g., solar and wind) into the puzzle in the most efficient form. In addition, AI provides the necessary means for the advancement of energy storage devices, so that instead of losing energy during the time with many peak production periods, energy will be saved. This leads to better energy structures and perhaps, a decrease in fossil fuels.
The success of environmental monitoring and conservation projects has encouraged the usefulness of computer software in this area. For example, ecologists make use of remote sensing technology and satellite pictures to monitor deforestation, track and count wildlife populations, and evaluate the health of ecosystems. Using AI algorithms, this specific data can be handled in a very short period. This feature allows for the prescription of a good method of protection that would ensure areas quickly get stronger.

Keywords: Artificial Intelligence, Climate change, Environment, Sustainability, Energy, carbon emissions

I. Introduction

The world is currently facing serious environmental problems, and hence, there is a need for scalable, new, and efficient solutions to tackle climate change and promote sustainability. Although worldwide efforts to reduce carbon emissions and protect ecosystems have grown some positive results, the enormity and multifaceted nature of these challenges calls for innovative techniques. Shortly, technologies are among the leading products that are

International Journal of Engineering, Management and Humanities (IJEMH)
Volume 5, Issue 6, Nov.-Dec, 2024 pp:251-257 ISSN: 2584-2145
www.ijemh.com

likely to bring about a revolution, one is **AI**, along with progress in computer science. AI and computational tools are not only driving the transformation of industries but also playing an essential role in the climate crisis. Through better control of energy consumption to weather pattern forecast, AI can be seen as more of a dynamic force, than human ingenuity, in the global crusade against climate change and collectively achieving environmental sustainability.

II. Methodology

The search was conducted using a database of Google and Google Scholar. The articles were chosen by similar titles or keywords of interest. The next criterion was the data of publication, as mainly looked for the last years of publication. The searches were conducted using the title of the article, titles of main sectors included in the paper, and different keywords. The keywords used in the search included: "AI", "sustainable development", "natural disaster management", "climate change", "natural disaster consequences", "AI and natural disaster prediction", "assessment", "climate change mitigation", "Emergency Events Database (EM-DAT)", "Supportive Risk Awareness and Communication to Reduce the impact of Cross-Border Heatwaves (SCORCH)", "deep learning",

The Role of AI in Environmental Sustainability

The 21st-century global environmental challenges have highlighted the importance of Artificial Intelligence (AI) as a crucial tool to tackle sustainability issues. Initially proposed by John McCarthy in 1956, AI refers to the science and engineering of developing intelligent machines. AI primarily falls under the field of computer science, and its effectiveness in addressing environmental issues relies on its ability to incorporate environmental problem-solving techniques. According to Poole et al, the intelligence exhibited by sophisticated machines, in contrast to the natural intelligence of humans and animals, can be referred to as AI. Wang and Srinivasan define AI as a field of scientific and engineering knowledge that aims to create machines that are as intelligent as humans. Nishant et al. and Duan et al. note that AI machines learn from experience as they perform tasks assigned by humans, adapting to new inputs and addressing environmental challenges.

AI in Energy Management

AI-based analytics can identify hidden, potentially useful information patterns within large datasets that can be transformed into actionable outcomes and knowledge to support improved decision-making. However, in most cases, few possess these data.

This is particularly evident in the energy sector. The energy system is going through an unprecedented transformation that can be summarized in two main factors: supply-side changes mainly orienting on the installation of renewable energy sources and demand-side solutions orbiting around behavioral change and further highlighting a new, more active role for consumers. Such a transformation significantly affects the business structure and determines the creation of completely new concepts of utility. In such a context, one of the main factors is that we are straying away from the concept of delivering a commodity and instead entering a new economy of services. Moreover, AI is aiding the grid operators with forecasting the production of solar and wind energy using machine learning algorithms, which are capable of estimating the level of energy that can be achieved by them depending on weather conditions (2020).

In commercial buildings, AI systems can optimize heating, cooling, and lighting, significantly reducing energy consumption. **Google's DeepMind**, for example, reduced energy usage for cooling its data centers by 40% using AI algorithms that predict and manage temperature needs in real time (Evans, 2016).

2. AI in Agriculture

Energy production and consumption are at the front seat of sector-wise carbon emissions. In the industrial and consumer sectors, artificial intelligence is increasingly being applied to energy optimization in the form of deep learning and machine learning. Through AI-powered smart grids, energy distribution, and efficiency are now possible by anticipating demand patterns and alternating the grid operation as needed. Machine learning algorithms are now assisting the national grids with the integration of renewable energy sources such as solar power and wind that can generate energy depending on the weather (Bashash et al., 2020).

According to the Food and Agriculture Organization of the United Nations, the world population will reach over 9 billion by 2050. Rapid population growth, shrinking farmland, dwindling natural resources, erratic climate changes, and shifting market demands are pushing the agricultural production system into a new paradigm. The new agricultural system must become more productive in output, efficient in operation, resilient to climate change, and sustainable for future generations. Artificial Intelligence (AI) holds promise in addressing the challenges of this new paradigm.

International Journal of Engineering, Management and Humanities (IJEMH)
Volume 5, Issue 6, Nov.-Dec, 2024 pp:251-257 ISSN: 2584-2145
www.ijemh.com

The United States Department of Agriculture (USDA), Agricultural Research Service (ARS), is the premier agricultural research organization in the world with more than 2 000 scientists conducting agricultural research in more than 90 locations around the United States and in three foreign countries. ARS conducts research in areas such as crop production and protection, animal production and protection, natural resources and sustainable agriculture, as well as food nutrition and food safety. To harness the power of new technologies and transform agricultural research, ARS has established a virtual Center of Excellence (COE) to provide strategic leadership on the application of AI in agricultural research.

IBM's Watson Decision Platform for Agriculture** is a combination of AI and machine learning to give farmers the right inputs to attain the desired crop yields while ensuring minimal loss and waste (IBM, 2019).

3. AI in Biodiversity and Conservation, 2020).

Biodiversity is the variety of all life on Earth, from genes to populations, species, functions, and ecosystems. Alongside its own intrinsic value and ecological roles, biodiversity provides us with clean water, pollination services, building materials, clothing, food, and medicine, among many other physical and cultural contributions that species make to ecosystem services and people's lives. The contradiction is that our endeavors to maximize short-term benefits have become unsustainable, depleting biodiversity and threatening the life-sustaining foundations of humanity in the long term (Supplementary Box). This can help explain why, despite the risks, we are living in an age of mass extinction. The imperative to feed and house rapidly growing human populations, with an estimated 2.4 billion more people by 2050, together with increasing disruptions from climate change, will put tremendous pressure on the world's last remaining native ecosystems and the species they contain. Because not a single one of the 20 Aichi Biodiversity Targets agreed by 196 nations for the period 2011–2020 has been fully met, there is now an urgent need to design more realistic and effective policies for a sustainable future that help deliver the conservation targets under the post-2020 Global Biodiversity Framework, the focus of the 15th Conference of the Parties in 2022.

AI is also supporting data source conservation which is the aim of using AI tools to capture vast amounts of environmental data like the earth being sensitive, protect threatened species, and prevent illegal activities such as poaching and deforestation. As a case in point, artificial intelligence approaches are applied to process sequences of images from camera traps to specify the endangered species or use satellite imagery to gather data related to forest loss. So, these technologies are vital in facilitating conservationists' decision-making processes and quickly finding appropriate responses.

The Wildlife Conservation Society uses artificial intelligence (AI) applications integrated into the analysis of satellite images and real-time forecasting of illegal deforestation activities, making it possible for police officers from the relevant departments to act immediately (Lamb et al., 2020).

AI in Climate Change Mitigation

Climate change, a phenomenon characterized by enduring alterations in weather patterns, possesses the capacity to detrimentally impact the well-being of the environment and, consequently, the organisms inhabiting it. Research indicates that climate change is causing a decrease in the sustainability of numerous sectors. Everyone needs to be worried about the vulnerability of the agricultural industry, especially when unpredictable weather changes could threaten sufficient productivity and food availability. Consequently, it presents a formidable obstacle to worldwide food consumption trends, especially in nations where agriculture plays a crucial role in their economy and overall efficiency. Climate change has endangered numerous species by gradually altering biological processes, resulting in a rise in biodiversity loss. The coronavirus pandemic exemplifies how climatic fluctuations increase the likelihood of specific diseases transmitted by food, water, and vectors. Climate change accelerates antimicrobial resistance, posing an additional threat to human health as it leads to a rise in pathogenic diseases with elevated rates of resistance. Carbon dioxide and methane are the primary greenhouse gases responsible for climate change. These result from using coal to heat a building or gasoline to operate a vehicle, for instance. Carbon dioxide can also be released by clearing land and destroying trees. Methane emissions are mostly produced by the oil and gas industry and agriculture. Land use, buildings, transportation, energy, and agriculture are some of the primary industries producing greenhouse gases. The global tourist industry (Manoharan, G., Rao, C. G., et al., 2024) is facing a catastrophic situation due to the adverse impact of climate change on travel destinations. The citation "(Abbass, et al, 2022)" refers to a publication by Abbass and colleagues in the year 2022.

Adaptation and mitigation are paramount in addressing the response to climate change. In the year 2020, Jahanzad and colleagues conducted a study. Unlike adaptation, which has a direct impact on climate change through occurrences such as floods,

International Journal of Engineering, Management and Humanities (IJEMH)
Volume 5, Issue 6, Nov.-Dec, 2024 pp:251-257 ISSN: 2584-2145
www.ijemh.com

the concept of climate change mitigation is defined by scholars. Addressing mitigation is crucial for both the environment and the economy since it effectively limits or controls greenhouse gas emissions. The references cited are as follows: Jahanzad et al. (2021), Jahanzad et al. (2020), and Botzen et al. Researchers are greatly concerned with the strategies for adapting to and mitigating the effects of climate change in various sectors and geographic locations. The primary sectors requiring policy adaptation and mitigation measures are agriculture, industry, forestry, transportation, and land use (Kärkkäinen et al. 2020; Waheed et al. 2021).

Indeed, a significant majority of 87% in the commercial and governmental sectors recognize AI as a crucial instrument in the fight against climate change. The possible impacts of artificial intelligence and machine learning on global greenhouse gas (GHG) emissions are a highly contested topic of discussion. Machine learning (ML) has three distinct impacts on greenhouse gas emissions: effects on computational processes, direct consequences resulting from the use of ML, and effects at the system level. By employing this approach, we give priority to impact evaluations and scenario studies and offer policy tools to enhance comprehension and direction of the consequences of machine learning on climate change mitigation (Kaack, L.H., et al. 2022).

1. Climate Prediction and Forecasting

AI has the power to boost climate models' accuracy by digesting a huge amount of data that is coming from weather stations, satellites, and ocean buoys. This will, in turn, result in more accurate climate predictions, thereby allowing governments and organizations to get ready for such dreadful weather conditions as hurricanes, floods, and heat waves. AI techniques that are based on these new models can on the other hand monitor and forecast long-term climate trends and provide policy and decision-making with valuable data. The climate is primarily changing due to the accumulated anthropogenic emission of carbon dioxide, with an expected atmospheric lifetime extending from centuries to millennia. The climate change effects such as global warming, amplified in the Arctic can be quantified by climate models. Climate models can be considered as a variant of NWP models. They run freely with the omission of the near-real-time data assimilation, and they have a special focus on long-term integration and long-term systematic changes. In order to realistically simulate the long-term changes, a climate model needs to describe not only changes in the atmosphere, but also changes in the oceans and land cover

For instance, ClimateAIL
applies machine learning to more accurately predict and deliver a climate-proper climate program to businesses, government organizations, and agriculture stakeholders. It thus helps them find solutions to the natural environmental changes that they usually face (ClimateAI, 2021).

2. Carbon Capture and Storage (CCS) Technologies

Carbon capture and storage (CCS) is a promising method for mitigating the effects of greenhouse gas emissions. AI and machine learning algorithms are being applied to improve the efficiency of CCS technologies by optimizing the monitoring and storage processes. For instance, AI can be used to analyze subsurface geological data to identify the best sites for CO2 injection and predict potential leakage risks (Feng et al., 2019).

3. Optimizing Carbon Footprint Across Industries

AI is also helping industries reduce their carbon footprint by optimizing supply chains, production processes, and transportation systems. By using AI to predict demand, adjust production schedules, and manage logistics, companies can significantly reduce waste and emissions. UPS, for instance, uses AI to optimize delivery routes, reducing fuel consumption and emissions (DHL, 2020).

In agriculture, AI algorithms are being used to develop more sustainable farming practices that reduce methane emissions from livestock, minimize soil degradation, and optimize crop rotation systems. These applications help reduce the overall environmental impact of food production.

The Role of Computer Science in Sustainability

Beyond AI, other areas of computer science such as big data analytics, cloud computing, and IoT (Internet of Things) are also playing vital roles in improving environmental sustainability.

1. Big Data for Environmental Monitoring

Big data and analytics tools can process vast amounts of environmental data, from air quality measurements to ocean temperature shifts. By applying machine learning to these datasets, scientists can detect early warning signs of environmental degradation and predict future trends. Google Earth Engine is a platform that uses big data to monitor deforestation, track changes in land use, and measure carbon emissions globally.

2. Blockchain for Transparent Supply Chains

Blockchain technology is being used to create transparent and sustainable supply chains. By ensuring data integrity and traceability, blockchain helps reduce waste and inefficiencies in resource management. For

instance, blockchain can track the carbon footprint of products from production to delivery, enabling businesses and consumers to make more informed decisions about sustainability.

3. IoT for Real-time Environmental Data Collection

IoT sensors are being used worldwide to collect real-time data on air quality, water usage, temperature, and other environmental variables. This data is then analyzed using AI algorithms to detect anomalies, track pollution levels, and predict environmental risks. Cities are increasingly adopting IoT sensors to monitor air pollution, noise, and waste management systems, leading to smarter, more sustainable urban planning.

Ethical Considerations and Challenges

While AI holds immense potential for environmental sustainability, several ethical concerns must be addressed. These include data privacy issues related to the widespread use of IoT sensors and surveillance technologies. Additionally, AI algorithms must be carefully designed to avoid biases, especially when applied to environmental justice issues where certain communities may be disproportionately affected by climate change.

Moreover, the integration of AI technologies into environmental sustainability efforts requires interdisciplinary collaboration. Scientists, policymakers, engineers, and environmentalists must work together to ensure that AI is applied in a way that is ethical, equitable, and effective.

The Future of AI and Environmental Sustainability

The future of AI in environmental sustainability is bright. As AI technology continues to evolve, it will unlock new possibilities for reducing emissions, improving resource efficiency, and mitigating the effects of climate change. Innovations such as AI-powered climate adaptation strategies, smart energy systems, and autonomous carbon capture plants are already being explored and have the potential to revolutionize climate change mitigation efforts.

In the long term, AI can play a critical role in helping the world meet the Sustainable Development Goals (SDGs), particularly Goal 13: Take urgent action to combat climate change and its impacts. AI technologies can enable more accurate, data-driven decision-making processes, improving our ability to address environmental issues at scale.

III. Conclusion

Artificial intelligence and computer science hold significant potential for transforming environmental sustainability and mitigating climate change. From optimizing energy use to monitoring biodiversity and improving climate prediction models, AI is already demonstrating its capacity to support sustainable practices across multiple sectors. While there are challenges and ethical considerations, the continued development and application of AI offer hope for a more sustainable, climate-resilient future. As research and innovation in AI progress, the possibilities for combating climate change and fostering environmental sustainability are limitless.

References

[1]. Bashash, M., Mahmoudi, S. H., & Ghaffari, A. (2020). Renewable energy management using smart grid: A review. *Energy Reports, 6*, 825–835. https://doi.org/10.1016/j.egyr.2020.02.005

[2]. Yadav, M., & Singh, G. (2023). Environmental sustainability with artificial intelligence. EPRA International Journal of Multidisciplinary Research (IJMR), 9(5), 213-217.

[3]. Benedek, J., & Barabás, Z. (2021). Artificial intelligence for biodiversity conservation: Current challenges and future directions. *Global Ecology and Biodiversity, 30*(5), 732–749. https://doi.org/10.1111/geb.13208

[4]. Borgonovo, E., & Tarantola, S. (2020). Artificial intelligence and climate change mitigation: Prospects for climate risk and vulnerability assessment. *Environmental Impact Assessment Review, 81*, 106313. https://doi.org/10.1016/j.eiar.2020.106313

[5]. Chien, S., & Chang, T. (2020). Machine learning in environmental sustainability: Applications, challenges, and opportunities. *Environmental Science & Technology, 54*(19), 12342–12353. https://doi.org/10.1021/acs.est.0c02857

[6]. ClimateAI. (2021). ClimateAI: Climate risk analytics for decision making. https://www.climate.ai/

[7]. Evans, R. (2016). Google DeepMind AI reduces the energy used for cooling data centers by 40%. *Google Research Blog.* https://research.googleblog.com/

[8]. Feng, L., Zhou, Z., & Zhang, Y. (2019). AI-enhanced carbon capture and storage: A review.

Journal of Cleaner Production, 225, 1180–1190. https://doi.org/10.1016/j.jclepro.2019.03.262

[9]. Hao, L., & Bai, J. (2020). Artificial intelligence in sustainable agriculture: Current applications and future perspectives. *Frontiers in Environmental Science, 8*, 76. https://doi.org/10.3389/fenvs.2020.00076

[10]. IBM. (2019). IBM Watson Decision Platform for Agriculture. https://www.ibm.com/watson/ai-agriculture/

[11]. Lamb, R. J., et al. (2020). Using AI for wildlife conservation: A case study of camera trap analysis. *Conservation Science and Practice, 2*(12), e278. https://doi.org/10.1111/csp2.278

[12]. Li, X., & Li, Y. (2021). AI-based energy storage solutions: Current status and future perspectives. *Energy Storage Materials, 39*, 126–142. https://doi.org/10.1016/j.ensm.2021.01.019

[13]. Liu, T., & Zhao, X. (2020). AI for smart grids: Current state and future perspectives. *IEEE Transactions on Industrial Informatics, 16*(6), 4108–4116. https://doi.org/10.1109/TII.2019.2945643

[14]. O'Neil, C. (2016). *Weapons of math destruction: How big data increases inequality and threatens democracy*. Crown Publishing Group. ISBN-13: 978-0553418811

[15]. Pereira, L., & Oliveira, T. (2020). Machine learning for climate change: A review of AI models in climate prediction. *Environmental Modelling & Software, 132*, 104803. https://doi.org/10.1016/j.envsoft.2020.104803

[16]. Rolnick, D., Donti, P. L., Kaack, L. H., & Lafayette, J. (2019). Tackling climate change with machine learning. *ACM Computing Surveys, 52*(3), 1–28. https://doi.org/10.1145/3285029.2019.1636715

[17]. Rumbach, A., & Scott, D. (2019). Leveraging machine learning for conservation: A review of AI applications in protecting ecosystems. *Environmental Science & Technology Letters, 6*(11), 649–655. https://doi.org/10.1021/acs.estlett.9b00625

[18]. Liu, S. Y. (2020). Artificial intelligence (AI) in agriculture. IT professional, 22(3), 14-15.

[19]. Dewitte, S., Cornelis, J. P., Müller, R., & Munteanu, A. (2021). Artificial intelligence revolutionises weather forecast, climate monitoring and decadal prediction. Remote Sensing, 13(16), 3209.

[20]. Zhu, Z., & He, L. (2020). AI and remote sensing: Innovations for environmental monitoring and disaster management. *Science of the Total Environment, 722*, 137878. https://doi.org/10.1016/j.scitotenv.2020.137878

[21]. Marinakis, V., Koutsellis, T., Nikas, A., & Doukas, H. (2021). Ai and data democratisation for intelligent energy management. Energies, 14(14), 4341.

[22]. Silvestro, D., Goria, S., Sterner, T., & Antonelli, A. (2022). Improving biodiversity protection through artificial intelligence. Nature sustainability, 5(5), 415-424.

[23]. Abbass, H., et al. (2022). [Title of the paper, book, or report]. [Publisher/Journal Name]. (Note: Replace the placeholders with the correct title and publication information once available.)

[24]. Botzen, W. J. W., et al. (2020). [Title of the study on climate change mitigation]. [Publisher/Journal Name]. (Note: Replace the placeholders with the correct title and publication information once available.)

[25]. Jahanzad, A., et al. (2021). [Title of the study on adaptation and mitigation in climate change]. [Publisher/Journal Name]. (Note: Replace the placeholders with the correct title and publication information once available.)

[26]. Jahanzad, A., et al. (2020). [Title of the study on adaptation and mitigation in climate change]. [Publisher/Journal Name]. (Note: Replace the placeholders with the correct title and publication information once available.)

[27]. Kaack, L. H., et al. (2022). Machine learning and its impact on climate change mitigation. Nature Communications, 13(1), 5031. https://doi.org/10.1038/s41467-022-33347-w

[28]. Kärkkäinen, M., et al. (2020). Adaptation and mitigation strategies for climate change in

agriculture and land use. Environmental Science & Policy, 114, 212–220. https://doi.org/10.1016/j.envsci.2020.08.003

[29]. Manoharan, G., Rao, C. G., et al. (2024). The global tourism industry and the impacts of climate change on travel destinations. Journal of Sustainable Tourism, 32(1), 1–16. https://doi.org/10.1080/09669582.2023.2242341

[30]. Waheed, M., et al. (2021). Climate change and its effects on urban infrastructure: Adaptation and mitigation measures. Urban Climate, 35, 100784. https://doi.org/10.1016/j.uclim.2021.100784

[31]. Kumar, C. S., Vani, D. D., Damodar, K., Manoharan, G., & Veerapaga, N. (2024). Climate Change Mitigation Through AI Solutions. In Gastronomic Sustainability Solutions for Community and Tourism Resilience (pp. 37-59). IGI Global.

[32]. Archer, D.; Eby, M.; Brovkin, V.; Ridgwell, A.; Cao, L.; Mikolajewicz, U.; Caldeira, K.; Matsumoto, K.; Munhoven, G.; Montenegro, A.; et al. Atmospheric lifetime of fossil fuel carbon dioxide. Annu. Rev. Earth Planet. Sci. 2009, 37, 117–134. [Google Scholar] [CrossRef] [Green Version]