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Use of Artificial Intelligence in achieving environmental sustainability

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Abstract
Urban population growth and technological innovation have led to climatic, technological and economic changes that can significantly affect the value of life in cities. As a reaction to the changes, the idea of future cities was developed, which refers to a new type of application of communication technology to minimize the significant impact of cities and their inhabitants. Artificial intelligence is one of the technologies used to develop the cities for future. Research shows that artificial intelligence (AI) is rapidly improving and will play an important role in helping city-wide smart systems in various fields, including environmental sustainability. The relationship between artificial intelligence and the sustainability of future cities must also be analyzed. To identify this relationship, this research paper will focus on the role of Artificial Intelligence, its applications, and the challenges associated with concepts and technologies which will help in achieving environmental sustainability in future cities.

Keywords
Artificial Intelligence, Sustainability, Future, Environment, Opportunities, Urban population, Machine learning, Cognitive, Vision, Prediction, Analyzing, cities, Urbanization.

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1.0 Aim

The aim of this research paper is to understand the role, application, challenges and concepts of artificial intelligence in achieving environmental sustainability in future cities.

2.0 Objectives

1) Firstly, to understand how nowadays cities are center for economic, technological development and how urbanization have a negative impact on our environment.

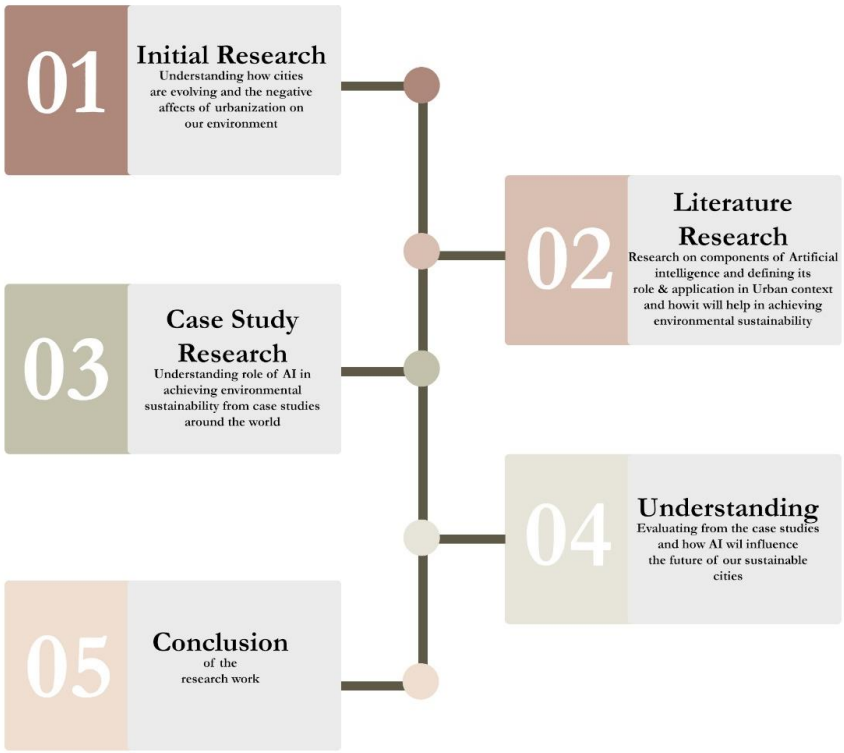
2) Understanding various components of artificial intelligence and the role of AI in an urban context.

3) Decoding the various environmental sustainability goals throughout the world.

4) Understanding how AI is helping in achieving environmental sustainability through various case Studies around the world.

5) To understand how Artificial Intelligence will influence the future of our cities

3.0 Methodology



4.0 Introduction

Cities are center of economic growth, job creation, new ideas, technological development, communication and networking, knowledge and social change. Most of the population lives in cities. Every year, more and more people move to cities and their surrounding megacities to take advantage of the opportunities offered by these denser spaces. Today we can see the answers that allowed the advancement of the second industrial revolution, namely steel and electricity. High-rise buildings and skyscrapers answered our demand for proximity to do business in the same places. Electrified and underground railways allowed faster travel for more people in congested urban areas. Thanks to elevators, escalators and advanced construction equipment, our buildings have become bigger and our subways deeper. Urbanization also affects the regional environment more widely. In areas downwind of large industrial complexes, the amount of precipitation, air pollution and the number of thunderstorm days also increase. Due to uncontrolled urbanization in India, environmental degradation has occurred very rapidly and has caused many problems such as housing shortages, water quality degradation, excessive air pollution, noise, dust and heat, solid and hazardous waste disposal problems, and deforestation causing an increase in stream temperatures (e.g. increase in maximum daily temperature, especially summer extremes). This is partly due to the development of urban heat islands or local heat storage near city center.

Over time this urbanization will have a very bad effect on the cities and if not controlled it will affect the cities more dangerously and catastrophically and we will have to face the consequences. But now, with the help of artificial intelligence, we can minimize the impact of urbanization on the urban environment. Some of the most significant developments are occurring in the field of artificial intelligence (AI). Basically, AI is a set of programmed algorithms that mimic human decision making. Artificial intelligence (AI) has become an important field in dealing with most environmental sustainability issues such as biodiversity, energy, transportation and water management. Biodiversity research has developed machine learning or natural language processing solutions to predict ecosystem services. Applications of artificial intelligence and machine learning models have been increasingly used to predict and optimize water resource conservation. Regional neural network, expert systems, pattern recognition and fuzzy logic models are the main focus areas of energy. Applications of computer vision and decision support have been found in traffic. Timely monitoring of measures is necessary to improve environmental sustainability.

5.0 Various components of Artificial Intelligence

- **Machine Learning -** Using machine learning, AI finds patterns in data, uncovers insights and improves results for whatever task the system needs to perform.

- **Deep Learning -** A type of machine learning that allows artificial intelligence to learn and improve by processing data. Deep learning uses artificial neural networks that mimic the biological neural networks of the human brain to process data, find relationships between data, and make inferences or results based on positive and negative reinforcement.
- **Neural Networks -** The process of analyzing data sets repeatedly to find relationships and interpret meaning from undefined data.
- **Cognitive Computing -** Another important part of artificial intelligence systems designed to imitate human-machine interactions, allowing computer models to imitate the functioning of the human brain when performing complex tasks such as analyzing text, speech or images.
- **Natural Language Processing -** A critical part of the AI process because it allows computers to recognize, analyze, interpret and truly understand human language, whether written or spoken.
- **Computer Vision -** With Computer Vision, AI systems identify components of visual data and analyze them to derive facts.

6.0 Defining role of Artificial Intelligence in an Urban context

6.1 Role of Artificial Intelligence

Cities are constantly innovating with the help of artificial intelligence. Thanks to the artificial intelligence technology used in smart cities, these cities are able to manage traffic, waste and maintenance, and predict energy consumption, pollution risks and environmental impacts. Smart cities have less impact on climate change, make smarter decisions and improve the quality of life. This list looks at ten different ways artificial intelligence is helping to do just that.

Artificial intelligence in smart cities plays an important role in making urbanization smarter and aims for sustainable growth, where cities are equipped with advanced functions to live, walk, shop and enjoy a safer and more comfortable life in such an environment. In fact, if a city has evolved into a smart one, AI can help provide sustainable solutions to various challenges for residents such as management, sanitation, traffic congestion, security monitoring, parking management and many others.

7.0 A way Forward Approach

The adoption of artificial intelligence in city management can bring significant direct and indirect benefits to both citizens and governments.

With fast, scalable and evolving solutions, cities are in a better position to improve their operations and services to residents. AI-powered technologies that can adapt to situations and predict scenarios or solutions that decision-makers can act on are a key asset for cities to plan for the future and implement services.

7.1 Various use or application of AI in the cities which will help in the future

1. Security

Security cameras using artificial intelligence can analyze footage in real time and identify criminal behavior that can be reported and dealt with immediately.

2. Maintenance

A company called Road-Botics has developed a technology using artificial intelligence that has the ability to analyze road images and then assess problems and produce cost-effective solutions.

3. Predicting Future Needs

With energy monitoring technology, cities can know when new energy sources are needed or when more sustainable methods can be adopted.

4. Controlling Pollution

Researchers have developed technology that uses artificial intelligence and machine learning to analyze current pollution levels and predict pollution levels in the next two hours.

5. Parking System

Parking lots can use license plate recognition technology to identify passing cars, which can also pay fees and tickets.

6. Public Transportation

This technology allows mass transit to receive and use real-time update dates and tracking, improving planning and customer satisfaction.

7. Waste Management

Smart cities are starting to use artificial intelligence in their waste management. This type of technology allows cities to track recycling and identify what can be recycled in the area.

8. Traffic Management

The traffic management technology known as "CIRCLES" can predict and reduce traffic using deep learning algorithms, which can then also reduce traffic pollution.

9. Energy Tracking

With the help of artificial intelligence, smart cities can analyze and monitor the energy use of companies and citizens, and based on this information, it can then be decided where renewable energy sources are used.

10. The Environment

Smart cities can use artificial intelligence to see their impact on the local environment, global warming and pollution levels.

8.0 How AI will help in achieving Environmental Sustainability

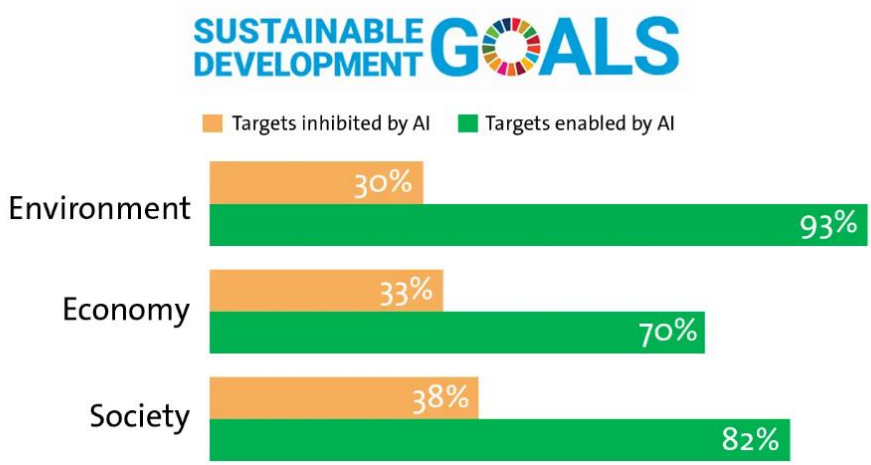


Figure 1 – showing sustainable development goals

Artificial Intelligence (AI) systems can be energy intensive, and people working with AI have an urgent need to address potentially large environmental impacts. Environmental criteria have also become the main performance indicator of companies and industries. Artificial intelligence can be an effective tool in the fight against climate change. For example, self-driving cars with artificial intelligence can reduce emissions by 50 percent by 2050 by identifying the most efficient routes. Using artificial intelligence in agriculture results in higher yields, and peanut farmers in India have achieved 30 percent higher yields using artificial intelligence technology. In addition, AI can provide faster and more accurate analysis of satellite images that identify disaster areas in need of aid or rainforest destruction.

AI-powered data analysis can also help predict dangerous weather patterns and increase accountability by monitoring whether governments and companies are meeting their emissions targets.

8.1 Environment Sustainability Goals

The United Nations has defined the goals of sustainable development, which can be grouped under three pillars: environment, economy and society.

Artificial intelligence can accelerate global efforts to protect the environment and conserve natural resources by identifying reductions in energy emissions, carbon removal, helping to develop greener transportation networks, monitoring, deforestation, and predicting extreme weather events. Below are examples of how AI provides ways to respond to the most pressing environmental challenges.

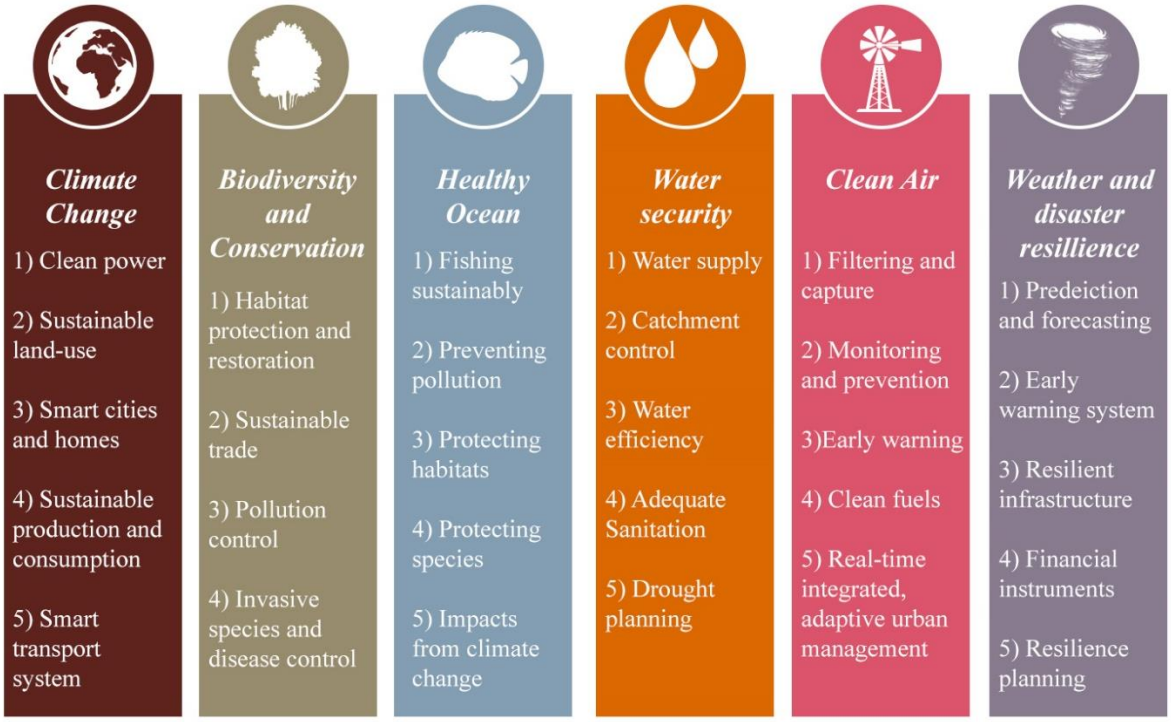


Figure 2

Goal 1: Climate Change

a) Using machine learning to optimize energy production and demand in real time, increasing predictability and efficiency and the use of renewable energy.

b) Smart sensors and meters can be used in buildings to collect information and monitor, analyze and optimize energy consumption in buildings.

Goal 2: Biodiversity and Conservation

a) Combined with satellite imagery, AI can detect changes in land use, vegetation, forest cover and natural disasters.

b) Invasive species can be monitored, identified and tracked using the above technology by identifying and monitoring their occurrence. A company called Blue River Technology uses artificial intelligence to detect the presence of invasive species and other changes in biodiversity.

Goal 3: Ocean Health

a) Artificial intelligence can gather information about areas of the ocean that are difficult or inaccessible and thus help protect species and habitats. Illegal fishing can also be monitored by artificial intelligence.

b) Robots powered by artificial intelligence can be used to monitor ocean conditions such as pollution levels, temperature and PH.

Goal 4: Water Issues

a) Artificial intelligence is widely used by hydrologists to predict water use in a given geographic area and to make weather forecasts to make informed policy decisions.

b) Artificial intelligence and satellite data can help predict weather, soil and underwater conditions and predict drought.

Goal 5: Healthy Air

a) Air purifiers equipped with artificial intelligence can record air quality and environmental data in real time and adjust the filtering efficiency.

b) AI-based simulations can send alerts to people living in urban areas about pollution levels in their area. There are tools that can be used to quickly and accurately identify sources of contamination.

Goal 6: Weather forecast and Disaster resiliency

AI-powered predictive analytics combined with drones, advanced sensor platforms and similar tools can monitor earthquakes, floods, storms, sea level changes and other potential natural hazards.

9.0 Case Studies
9.1 New York

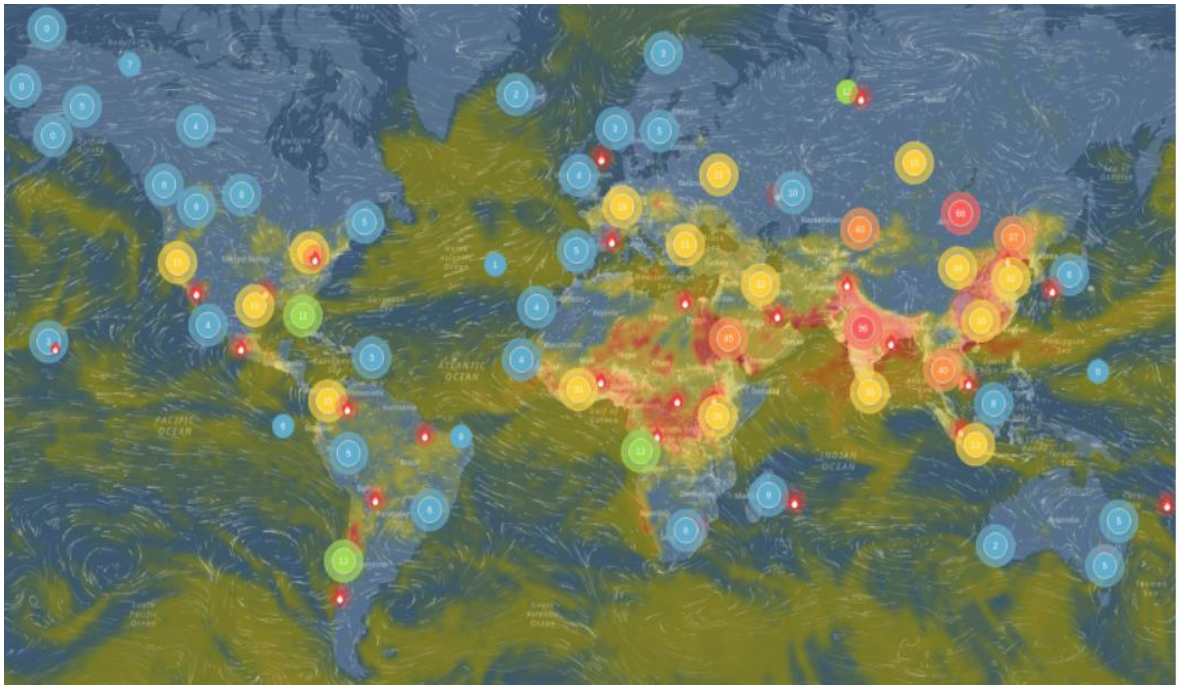


Figure 3 – showing WESR platform

Launched in 2022, UNEP's World Environment Situation Room (WESR) is one digital platform that uses artificial intelligence capabilities to analyze complex and multifaceted data. WESR processes, aggregates and visualizes the best available Earth observation and sensor data to inform near-real-time analyzes and future projections of a variety of factors, including atmospheric carbon dioxide concentrations, glacier mass changes and sea level rise. Over time, the goal is for WESR to become something of a mission control center for Earth, where all of our critical environmental indicators can be seamlessly monitored to guide operations.

9.1.1 Monitoring methane emissions (Machine and Deep learning)

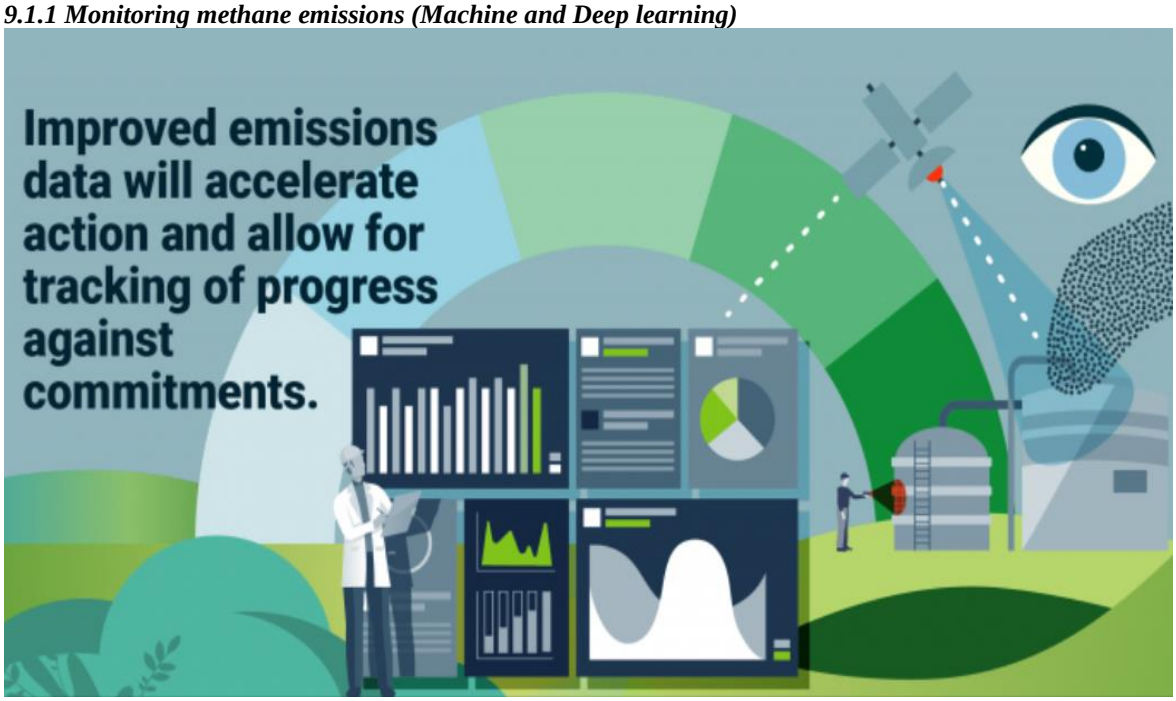


Figure 4

One of the UNEP-led initiatives in the WESR digital ecosystem is the International Methane Emission Observatory (IMEO). The platform serves as a global public database of empirically verified methane emissions. IMEO's technology enables us to collect and integrate various methane emissions data streams to create a global public record of empirically verified methane emissions with unprecedented accuracy and precision. Reducing methane emissions from the energy sector is one of the fastest, most feasible and cost-effective ways to limit the effects of global warming.

9.1.2 Tracking the Air Quality *(Deep learning)*

Another environmental monitoring initiative that UNEP established with IQ Air is the air pollution monitoring platform GEMS. IQ Air aggregates data from more than 25,000 air quality monitoring stations in more than 140 countries and uses artificial intelligence to provide real-time insights into the effects of air quality on the population and help inform public health efforts.

9.1.3 Measuring environmental footprints (Deep learning)

Other areas where artificial intelligence can have an impact is the calculation of the environmental and climate footprint of a product. It can help calculate the footprint of products throughout their life cycle and supply chain, allowing businesses and consumers to make the most informed and effective decisions.

9.1.4 Reducing ICT emissions (Deep learning)

E-waste is a major concern, as only 17.4 percent is currently recycled and disposed of in an environmentally friendly manner. According to the UN Global E-waste Monitor report, the amount of e-waste will increase to almost 75 million tons by 2030. UNEP research suggests that to target this waste, consumers should reduce consumption, recycle electronics and repair what can be repaired.

9.2 Singapore

9.2.1 Major environmental issue Singapore is facing

In Singapore, a popular regional hub for data centers, there is growing concern about rising energy consumption and a growing carbon footprint.

9.2.2 Agriculture *(Deep learning)*

Modern agricultural companies can use artificial intelligence to analyze their farm data for crop forecasting or climate control. Since agriculture is a labor-intensive industry, AI will allow space-starved Singapore to grow more food with fewer resources. On the ground, one such step in this direction is A*STAR's partnership with Singapore-based Agri-tech firm Archisen, which has incorporated artificial intelligence into its in-house facilities.

9.2.3 Energy Usage *(Deep learning)*

One area where artificial intelligence is expected to play a key role is energy use. They are developing a system based on artificial intelligence known as "Microgrids" to help detect emerging energy that may or may not depend on prevailing weather conditions. Thus helping to optimize energy resources.

9.2.4 Reducing Carbon Footprint *(Deep learning)*

The use of AI creates an ever-increasing carbon footprint, but AI itself can and has actually been used as part of sustainability efforts. Singapore has developed an AI-based machine that monitors and enables a more efficient reduction of the city's carbon footprint.

9.3 Columbia

9.3.1 AI to find the lost Tree species *(Computer vision)*

Figure 5

Hurricane Maria's winds damaged thousands of hectares of rainforest, but the only way to know which tree species were destroyed and which survived the magnitude of the hurricane is through pictures. In 2017, a NASA flight from Puerto Rico produced very high-resolution photos of the treetops. But how is it possible to distinguish one species from another, when you look at the green mass in such a large area from above? The human eye could theoretically handle that, but processing thousands of images would take forever.

The team uses artificial intelligence to analyze high-resolution photos and combine them with data from Uriarte, who mapped and identified each tree in specific plots. Using these specific pieces of land, the AI can determine how different trees appear from above in airline ticket images.

Figure 6

9.3.2 AI is used for energy *(Deep learning)*

The Department of Energy's SLAC National Accelerator Laboratory uses machine learning and artificial intelligence to identify grid vulnerabilities, fix them before they fail, and restore power more quickly when failures occur.

The goal is to develop a grid that can automatically and seamlessly manage renewable energy and recover from system failures with little human intervention and satellite images showing where trees growing over power lines could cause problems in a storm.

Wind energy companies use artificial intelligence to make each turbine produce more electricity per revolution by combining real-time weather and operational data. AI allows each individual propeller to determine the speed and direction of the wind coming from other propellers and adjust accordingly.

9.3.3 Making cities more livable and sustainable *(Deep learning)*

In Colombia, an artificial intelligence system that can predict air pollution, track pollution sources and create possible strategies to deal with it.

Another arm developed by IBM could help cities plan for future heat waves. The AI would simulate the climate on an urban scale and study different strategies to test how well they mitigate heat waves.

For example, if a city wants to plant new trees, machine learning models could determine the best planting locations to get optimal tree coverage and reduce sidewalk heat.

9.3.4 Smart Agriculture *(Deep learning)*

Data from sensors in the field that monitor crop moisture, soil composition and temperature will help AI improve production and know when plants need watering. AI systems know the best times to plant, spray and harvest crops, as well as when to fight disease and other problems. This increases efficiency, improves yield and reduces the use of water, fertilizers and pesticides.

Figure 7

10.0 Evaluation from the Case Studies

From the above Case Studies, it is concluded that how artificial intelligence can influence the future of our cities in various ways.

Early detection of crop diseases and problems is possible with AI-augmented agriculture using robotics. The use of AI in agriculture results in higher yields, such as in Singapore, and peanut farmers in India have also achieved 30 percent higher yields with AI technology. Artificial intelligence integrated into satellite images can detect changes in land use, vegetation, forest cover and the effects of natural disasters. Early detection of plant diseases and problems is possible with AI-augmented agriculture using robotics. In addition, AI can provide faster and more accurate analysis of satellite images that identify disaster areas and rare tree species that need help or destruction of rainforests. Now there are also air purifiers with integrated artificial intelligence that can record air quality and environmental data in real time and adjust the filtering efficiency. The effectiveness of artificial intelligence in monitoring air quality, methane emissions and IOT (electronic waste) emissions will actually help save our environment in the future.

11.0 How Artificial Intelligence will influence the future of our sustainable cities

Artificial intelligence (AI) is shaping many global sectors. Degradation of the natural environment and the climate crisis are complex issues that require the most advanced and innovative solutions. But how much artificial intelligence can really help solve the climate crisis.

1. Autonomous and connected electric vehicles

Autonomous vehicles (AVs) controlled by artificial intelligence will enable the transition to on-demand mobility in the coming years and decades. Greenhouse gas emissions from urban traffic can be significantly reduced through route and traffic optimization, ecological driving algorithms, programmed car "pools" and autonomous ride-sharing services.

2. Distributed energy grids

AI can improve the predictability of renewable energy demand and supply in a decentralized grid, improve energy storage, efficiency and load management, contribute to renewable energy integration and reliability, and enable dynamic pricing and trading, creating market incentives.

3. Smart agriculture and food systems

It promises to increase the resource efficiency of the agricultural industry, reduce the use of water, fertilizers and pesticides that damage important ecosystems, and increase resilience to extreme climatic conditions.

4. Next generation weather and climate prediction

A new field of climate informatics is blossoming, using artificial intelligence to revolutionize weather forecasts and improve our understanding of the effects of climate change.

5. Smart disaster response

AI can analyze simulations and real-time data (including social media data) about weather events and disasters in the region to look for vulnerabilities and improve disaster preparedness, provide early warning and prioritize response by coordinating emergency information capabilities.

6. Renewable Energy and clean fuels

Artificial intelligence can apply powerful forecasting capabilities and smart grid systems to manage the supply and demand of renewable energy. For example, more accurate weather forecasts can optimize efficiency, reduce costs and reduce unnecessary carbon pollution. In addition, it can improve energy storage, efficiency and load management, and contribute to the integration and reliability of renewable energy sources.

7. Pollution monitoring & early detection

There are now air purifiers with integrated artificial intelligence that can record real-time air quality and environmental data and adjust filtration efficiency. In addition, simulations based on artificial intelligence can be used to send alerts to people in urban areas about pollution levels in those areas. This allows sources of pollution to be detected much earlier.

8. Electric Vehicles

With the rise of companies like Tesla and rising gas prices, more and more companies are paying more attention to the electric vehicle market.

The Environmental Protection Agency (EPA) explains how electric cars produce fewer greenhouse gases over their lifetime, including both exhaust and upstream. An all-electric car produces no emissions. The biggest advantage of electric cars is their direct impact on the environment. Greenhouse gas (GHG) emissions from cars are believed to be the largest source of climate change.

9. Better conservation of natural resources

The smart technology behind this idea, known as smart grids, can also monitor conditions that cause lights to dim or brighten. A smart grid, also known as "electricity with a brain", is an electrical grid system that delivers energy efficiently, safely and reliably. This includes various operational and energy initiatives such as renewable energy sources, smart meters, smart appliances and more.

10. Environmental Sustainability

Artificial intelligence can improve monitoring of environmental conditions and crops. Artificial intelligence can also manage the supply and demand of renewable energy. This positive effect on the environment explains the widespread use of artificial intelligence in the management of the environment and global climate change.

11. Financial Sustainability

Artificial intelligence technology can help companies encourage consumers to make quick decisions and detect fraud and financial crimes using machine learning. For example, machine-driven asset management services (Robo-advisors) and algorithmic trading help financial institutions optimize financial decisions.

12.0 Conclusion

This article shows how urbanization is an important factor in the serious deterioration of our environment. As a reaction to the changes, the idea of future cities and how artificial intelligence can help achieve environmental sustainability on various topics such as biodiversity, energy, pollution levels and water was developed. Monitoring is important in the use of artificial intelligence and environmental sustainability. However, different interventions are needed to measure the positive and negative effects of AI on environmental sustainability. Cities are constantly innovating with the help of artificial intelligence. The benefits offered by artificial intelligence include improving environmental management, environmental efficiency of industry and reducing environmental risks and safety. In order to improve environmental sustainability, timely, accurate and precise measurements and monitoring measures are needed. From the paper it is concluded that artificial intelligence can promote sustainability by helping to prevent mistakes and plan for sustainability goals more effectively. Artificial Intelligence (AI) is the ally that sustainability needs to more effectively plan, implement, advise and plan for the future of our planet and its sustainability, and how AI can help us build more efficiently, use resources more sustainably and reduce and manage waste more effectively.

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