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Internet of Things Applications in Natural Resource Management

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Abstract

The Internet of Things (IoT) contributes significantly to economic, social, and environmental growth. The present setting for successfully applying IoT to accomplish the Sustainable Development Goals of Natural Resource Management is deliberated in this paper. The potential and prospects of the IoT in a variety of renewable and nonrenewable natural resources, as well as present IoT difficulties, are discussed. The study methodology focuses on the IoT context in issues, as well as various IoT initiatives that are being implemented to manage such resources. Technical problems, soil, water, land, air, animal, forestry, and human application on Internet of Things for Development to accomplish the Sustainable that may benefit the globe are some of the key elements.

Keywords

Air, Forestry, Livestock management, Natural resource, Nonrenewable, Renewable, soil, water resource, water.

INTRODUCTION

Since the beginning of time, there has been a human presence on the planet. Humans and other kinds of life rely on freely available resources to thrive. Renewable and non-renewable of natural resources available in the nature. Water, soil, natural gas, oil, and forests are examples of natural resources. Managing natural resources by personally visiting the location is inconvenient and time-consuming. Modern IoT approaches offer a way for gathering data without having to physically visit the location. IoT based technologies are used to manage and gather all of these data for efficient resource use and can contribute to mankind's development. With the advancement of smart devices, the Internet may be extended into the physical world of Internet-of-Things (IoT) by integrating them into a sharing inciting system. Sensors and actuators in the IoT mix with the environment and collaborate with one another over the internet to complete a task. Wireless Sensor Networks (WSNs) may be integrated into IoT to overcome the difficulties of constant communication between any items e.g., people or objects. WSNs and IoT have been used in environmental monitoring, precision agriculture, water quality, pollution control, forest management, and different non-renewable resource management over the years. Machine and process control automation and traceability Because of its ability to self-organize, configure, diagnose, and self-heal, WSN was chosen for this activity. The Wireless Sensor Network (WSN) is a network that includes radio frequency (RF) transceivers, sensors, microcontrollers, and power sources. However, there has been a paradigm shift as a result of the IoT emergency's, RF identification, cloud computing, middleware systems, Machine Learning, Artificial Intelligence and end-user applications are just a few of the technologies that make up the Internet of Things more robust and useable. The use of IoT in natural resource management may empower our society by providing proper decision making and robotics technologies that connect goods, information for better quality, productivity and profit.

The rest of the paper is organized as follows. Section 2 discusses about the Background study of IoT applications on Natural Resources management and different methods. Section 3 presents a systematic review on how Internet of things application can help to manage the Natural resources and tells the comparison of recognized works by the different Authors. Section 4 discusses the different techniques used to manage the different renewable and nonrenewable Natural Resources. Section 5 presents the research challenges and future scope. Finally, Section 6 concludes the paper.

BACKGROUND STUDY

Sustainability is essential for the management of land and water resources, waters, soils, vegetation, and wildlife, with an emphasis on how control affects current and future generations' quality of life. The control of people's relations with natural landscapes is the duty of natural resource management. Consumption of natural resources encompasses development planning, irrigation, biodiversity conservation, and the tall viability of agricultural, mining, ecotourism, fishing, and forestry sectors. It recognizes that people and their livelihoods are dependent on humanity's health and productivity, and that land stewards play a key role in protecting that health and productivity.

IoT applications on in Water Resource Management:

From ubiquitous computing to smart homes, traffic management systems to transportation, and a variety of other areas, the Iot devices is linked to practically every comfort in our lives. Water management systems have already been severely influenced by the Internet of Things. Although ensuring appropriate water usage is difficult, effective integration of IoT technology in Water Management Systems

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will probably make our lives easier and aid in the preservation of our precious resources. The IoT does have the potential to play a vital role in

Water Conservation:

As a consequence of the fast development of the human people, Water conservation solutions are urgently needed. For effective and maintainable development and management of aquatic resources, exact water usage forecasting according to multiple beneficial uses is critical [1]. The IoT-based water preservation system is planned to keep and restrict water wastage in commercial environments. Meanwhile water shortage is increasing, water should be saved using any of the available technologies to fulfil future demand [2]. One approach to implement a clean water management plan or water conservation is to use an IoT-based water reduction system [3].

Smart Irrigation:

One of the most water-intensive sectors is agriculture. The smart irrigates technology irrigates soil using data from soil moisture sensors, preventing over- or under-watering and crop damage [4]. Smart irrigation IoT platform has a flexible design that allows you to simply combine IoT and machine learning (ML) components to create a smart irrigation solution [5]. In the precision agricultural landscape, smart irrigation management solutions based on the Internet of Things can help achieve optimal water resource use [6].

Waste Water Management:

The obligation to monitor the water quality of bodies of water, water treatment facilities, and industries is always a tremendous challenge in today's world because this task is performed by a human, which necessitates a great deal of effort and the use of extremely expensive sensors. This method needs a significant amount of human labour, money, and time, all of which are insufficient for the task at hand [7]. IoT system that can constantly monitor key parameters of a waste water treatment facility and notify the plant operator in the event of an emergency [8]. As a consequence, information technology approaches and ICT play an increasingly important role in water resource management, including minimizing excessive fresh water waste and regulating and monitoring water pollution. The IoT is a communication technology that allows homeowners and farmers to manage available water and reduce waste [9].

Water Quality Testing and Analysis:

Many people are now suffering from hazardous ailments as a result of contaminated wate[10]. The IoT based water quality motoring system consist of following things Units for data collecting, base station, and remote server monitoring unit. The following are the system's primary characteristics of Economical implementation, High data detection accuracy, Low power consumption, Real-time data monitoring and reporting, Adaptability [11].

Application of IoT in Air quality monitoring:

Global air quality has deteriorated as a result of increased industrial activity and growing urbanization of human populations. Every day, thousands of factories and billions of automobiles emit massive amounts of pollutants into the air, endangering human health. Many epidemiological A range of health concerns have been related to air pollution in research, which is the reason of quality monitoring air has become a must to avoid or mitigate these problem [12]. The IoT based air quality system makes use of economical air quality monitoring nodes, Low-cost semiconductor gas sensors and Wi-Fi modules make up these devices. This system measures gas concentrations such as CO, CO2, SO2, and NO2 using semiconductor sensors. The sensors will gather information on a number of environmental factors and communicate it to the Raspberry Pi, which will act as a base station [13].

IoT application on sustainable Forestry Management:

Water and air filtration, soil erosion mitigation, and habitat for wildlife are all rely on forests and grasslands. The Iot has the ability to play a big role in forest ecosystem management and stability. The Internet of Things can help with species and habitat protection, timber harvesting, forest soil surface mitigation, forest fire prediction, mitigation, and disputes in forest management [14]. Pollution by nature can intensify this threat by causing harm to themselves and society. The forest management and wild life departments deal with a variety of concerns, including rehabilitation animals in the wild and animal migration to residential neighborhoods. The tree's lives have changed significantly, resulting in an unpleasant forest environment [15]. Appropriate information about them is made accessible to appropriate authorities at the proper time, allowing them to act quickly to prevent a big disaster. A system and algorithm that uses multiple metrics, wireless technologies, sensors, and the Iot, as well as cloud computing, to offer actual info on forest fires and disasters [16]. The Iot (IoT) is a wireless sensor network that can make data available in near real time to a multiple stakeholder, include researchers, environmentalists, and forest administrators, and may incentivize members to engage in big data gathering. The use of in situ measurements as ground-truthed training examples for remote sensing data could enhance forest monitoring by expanding the temporal and spatial dimensions of monitoring, leading to a greater understanding of forestry activities and hazards [18].

IoT application on mining and mineral resource management:

IoT is currently being used in mines for specialised tasks such as gas detection, machine placement, people tracking, and actual drifting dam surveillance at various phases of the mining procedure. Mines may be made safer for workers while also being more cost-effective and productive to run via the Iot technology [18]. There are various opportunities available in the mining industries from manufacturing to management process [19].

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Application of IoT in animal health management:

The Iot in Animal Healthcare uses wearable sensors and software to control and maintain animal health information. These techniques provide a precise health status and disease prediction that is most efficient in human but can be applied to animals with minor modifications. Many of these more advanced technologies have become increasingly important in the care and development of livestock. By integrating existing medical sensors, a digitally connected platform is created that enables for more efficient communication with animals [20]. For actual tracking of physiological signals such as body temp, pulse rate, and ruminate in relation to ambient temperature and humidity, a model of a smart animal health monitoring internet based of Iot has been built. Different sensors are mounted on animals' bodies provide data on their current health, which may be accessed easily via the web [21]. It is constituted of a local IoT network for gathering data from animals and a cloud platform with power and memory capabilities for collecting data independently. Machine learning capabilities are built into the cloud platform, enabling for the extraction of useful data [22].

Application of IoT fishery and water resources management:

Smart fish farm and monitoring control system based on internet of Things (IoT) that includes a predictive modelling for automated water management as well as tracking the breeding and selling of fish. Then use a QR code tag on an underwater product, this system would help fish farmers smartly action to manage fish farming water filtration hardware, as well as customers' track and view chronological farming process data, allowing fish farmers increase revenue while protecting customer food security [23].

LITERATURE REVIEW

Natural resource management is challenging and contentious by character. To start with, scientists are focused with ecological, meteorological, and climate cycle, as well as wildlife, vegetation, and terrain. Everything is interconnected in nature. A change to these can have far and/or long-term consequences, many of which could be irreversible. Second, policy makers must consider many stakeholders and their interests, policies, politics, geographical borders, and financial implications in addition to the complexity of natural systems. The Internet of Things makes it impossible to fully satisfy all aspects at the same time. There is various research available to manage those resources using IoT. Water is the most valuable natural resources. [24] Author has presented a water quality monitoring strategy that shifts away from traditional methods and toward emerging technologies. Based on artificial intelligence and machine learning, the author suggested a technique for detecting real-time water quality. The traditional method for determining water quality is time-consuming, and its accuracy is debatable The study compared numerous water quality parameters such as Acidity, Sediment, Temp, Chlorine (Cl), Conductivity (EC), Biological oxygen demand (DO), Total solids (TH), Total dissolved solids (TS), Total suspended matter (TSS), and Biological oxygen (BOD) all around world, monitor the trend using by machine learning ANN-K technique only.[25] This research presents a viable and cost-effective method for water quality without requiring human interaction, especially in remote places. Author has explored the Iot (IoT), cloud computing, and machine learning, among many other modern technologies. Future work may improve our results and make this system more effective by adding more quality sensor that detects different physical and chemical parameters that influence water quality and provide accurate results. [26] Author used machine learning Algorithms. K-Means clustering was used to estimate water quality using a training data set containing multiple water samples. The Arduino Uno and Raspberry Pi 3 were used to build this system as a low-cost automated prototype. [27] Traditional farming processes have been improved by using advanced IoT methods can aid in resource optimization, environmental forecasting, manpower reduction, heath prediction, and identifying the type and family of plant, among other things.[28] Forestry and grassland are essential for air and water cleansing, minimizing land degradation, and giving habitat for wildlife. Tree Driven Forestry Research, Forest things like local wildlife, land use graze patterns, inventories, water, air Agro - forestry, forest resources, landscapes administration, and operations, and other IoT applications have various opportunities. The IoT virtual forest IoT database application could be used to manage sustainable forestry. [28] Another vital resource for humanity's development is soil. Iot may evaluate at moisture levels, soil composition, soil quality, and climate change impacts. Farmer may pick which type of crop is ideal for the specific soil due to soil moisture levels, soil type, soil conditions, and water quality instead of using traditional, time-consuming techniques. As a result of climate change, farmers may benefit. [29] Conventional water quality testing techniques are inefficient, time-consuming, and wasteful of human resources. Developed water quality monitoring system that uses many sensors and zigbee to check the quality of water in real time. This method is easy to track and alerting to the authority. [30] Scalability, self-organization, data quantities, data interpretation, interoperability, automatic discovery, power supply, security, and privacy are all issues that the Internet of Things faces. Mobile computing, RFID, wireless sensor networks, and embedded systems can all be used to

resolve all this difficulty. [31] The Iot (IoT) is a resource and facilitator of industrial automation, and it offers vital insights into a broad range of mining business domains and challenges. To resolve existing issues, the mining industry's industrial IoT framework has been developed. This same technological advances like edge computing and Fog computing could explored for future technical issues. [32] The Iot for Sustainable Mining refers to the application of IoT technology to satisfy the twin goals of long-term metal recovery and a healthy environment for a thriving planet. IoT

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can help with a variety of process, monitoring, and sustainability issues. so all challenges related IoT can solve. [33] In this study, the authors use a range of sensors. With these sensors, all of the human interactive task is automated, and it will be simple to monitor the fish farming remotely. The main disadvantage is human presence are required WSN may use to resolve the issues. [34] Intelligent management and aquatic product tracking are the two elements of the proposed system. Only dissolve oxygen parameters can be verified using the suggested approach, which is based on 120 sets of data. Future research could incorporate Nitric oxide and other factors, as well as a larger number of data sets.

TECHNICAL CHALLENGES

IoT application challenges in Agriculture:

Connectivity issues in Agricultural area: The most of farms are located in rural areas with limited internet to support high transmission speeds. Furthermore, crops, forests, and other physical barriers may hinder communication lines. These issues drive up data transmission costs and are to blame for the delayed adoption of precision agricultural technologies. Farmers will be able to bypass this obstacle by using unoccupied TV airwaves to transmit information. Meager TV reception often results in the availability of Grey Spaces in TV broadcast frequencies, which may then be used. This is especially useful in isolated places. The broadcast bands of Ultra High Frequency (UHF) and Very High Frequency (VHF) may also double the intensity of Wi-Fi signals, making them stronger. These benefits will lower prices while improving connection, resulting in more use of precision agricultural systems.

High cost hardware devices: Farmers now use a sparsely network of sensors to gather data on agricultural circumstances. Aside from the sensors' physical limits, farmers keep relying on older farming technology, limiting their output. Unmanned aerial vehicles can help farmers reduce expenses by extending geographical coverage and generating precise maps. In areas where drones are prohibited because to government regulations, poor battery life, or prohibitive costs, tied Eyes balloons are used instead. These aerial sensors continuously take photographs of agricultural conditions, which are used to improve data collected by ground sensors. As a result, this strategy saves money on equipment while obtaining more precise data.

Disrupted connectivity and data gathering: Farmers, like any other IoT system built on a cloud computing platform, needed robust internet connections. However, bandwidth is insufficient to send Big Data data to the cloud for analysis.

water resource management Challenges:

Nature protects water resources by renewing them through precipitation, surface run-off, and groundwater levels. When it comes to Water resource management, people provide the greatest hurdle. Human activity has contaminated freshwater resources such as rivers and lakes. There may be a future conflict over fresh water if sustainable water management is not followed. Water is an essential component of life and without it, life on Earth would be impossible. Droughts caused by climate change have caused severe water shortages in most regions of the world. Many rivers have dried up, become contaminated, and have been encroached upon. Water is an essential component of life and without it, life on Earth would be impossible. Droughts caused by climate change have caused severe water shortages in most regions of the world. Many rivers have dried up, become contaminated, and have been encroached upon. The question now, more than ever, is whether future generations will have enough freshwater to survive. Freshwater was used by people for a variety of purposes, including drinking, sanitation, watering, livestock, and irrigation, to name a few. Humanity does have a part to play in WRM, and it is up to them to decide. To actively engage in discovering sustainable solutions to water resource management, people must make lifestyle and economic trade-offs. In current ages, Internet-of-Things (IoT)-based technology has been gaining traction in the WSS. However, there are a slew of obstacles that might stymie its expansion. As examples, power consumption, coverage (for sensors and wireless communication technologies), security and privacy, complexity, big data processing, connection, deployment cost, and interoperability are all issues.

Power Consumption: Large-scale infrastructure is required for water resource management; hence IoT-based technology must meet some particular application criteria in such systems. In a leakage monitoring and detection application, smart sensors used to capture pressures and flow rates along pipes are often grouped in a sensor node for uninterrupted real-time data. These sensors are battery-operated and are designed to last for many years without needing to be recharged. In modem smart sensors, the measurement data is processed by such an embedded CPU. This procedure uses a lot of energy, which is a serious worry.

Complexity: The application determines the level of complexity of loT-based technology. In smart water network design, an IoT-based technology can be used to identify and monitor water leaks, pipeline health, and water quality all at the same time on the same water supply system. In each of these situations, the system must be constructed in accordance with the application requirements. Furthermore, the formulation and construction of a large number of smart sensors required for such application is typically a difficult task.

Cost: Water resource management is a big, intricate infrastructure that is expensive to implement. As a result, monitoring such systems effectively involves the deployment of a broad range of sensors that can provide real-time readings. As the future of IoT-based Sensor, Working Number of Nodes changes, so do the application requirements, necessitating the development of new smart sensors to meet that goal. As a result, the overall cost of installing such a system rises.

Coverage Problem: The coverage of sensors and wireless communication technologies is another major barrier to using

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IoT-based technology in water resource management. Sensor coverage refers to the length of time that Io'I' smart sensors can see the physical environment they are measuring. Coverage is a crucial requirement in sensor development.

Interoperability: Interoperability of IoT-connected devices and sensors is another concern. In order to share data in this case, several smart devices and networks must be able to communicate with one another. As Internet of Things-based applications in water network management become more widespread, several low-cost micro-electromechanical devices will develop and be deployed. As a result, the interoperability of new devices with existing sensors is a major challenge.

Challenges in Air Quality Monitoring:

Integrating intelligence into traditional electrical equipment so that it can perform independently and reliably is a fundamental issue in developing IoT solutions for smart ambient air quality control. A secondary issue is coordinating the various platforms of various devices, as well as their specific features, in order to make them work as a cohesive network for the overall solutions aim [35]. In more detail, an intelligent air quality monitoring system that combines flexibility, dependability, effectiveness, and economy may be built by combining embedded systems, wireless sensors (WSNs), cloud service, the Global Positioning System (GPS), and the Android platform. The Air Advantages, Expenses, and Attainment Assessment Process evaluates the benefits, costs, and attainment of air quality. Development of considerably more dependable, practical real-time air quality monitoring systems that will deliver correct information [36].

Major Challenges in soil quality Monitoring:

Apart from the weather, the fertility, temperature, and wetness content of the soil are all important factors in crop health. Most farmers with tiny plots of land, on the other hand, are ill-equipped to monitor soil quality. They have no way of knowing if the soil in their fields has the proper pH levels, whether there is enough water in the soil at any one moment, or whether the soil's temperature will allow water to be retained until the next irrigation cycle. They find it difficult to keep these qualities at acceptable levels since they are unable to monitor these properties on their property. Even if farmers have the resources to adjust certain elements, such as irrigation, natural fertilizers, and modern agricultural equipment, this is true. As a result of not monitoring the chemical composition of the soil, wasteful resource utilization and soil deterioration occur. Farmers often cultivate crops that are not only quantitatively unimpressive but also nutritionally deficient because they lack the capacity to analyses and modify these characteristics. Due to insufficient monitoring, resources are wasted, and crops are harmed as a result of over-irrigation or fertilizer application. In the long term, this is detrimental not just to the farmers' financial prospects, but also to the health of people who consume the food.

Major challenges in Live Stock Management:

Internet of things can resolve many challenges which is including vetenary care, Increasing animal farm production and well-being, remote diagnostics, and future smart farming. Remote care and diagnostics for hard-to-reach regions and urgent situations might be enabled by IoT technology in agricultural and animal care. Animals can obtain instant care and improvement of their condition by allowing a medical expert to access data and diagnostics through wearable devices remotely. Farmers save time and money by not having to go to the vet. For environmental and humanitarian reasons, the care of animals on livestock farms has been a hot concern in recent years. Farmers must adhere to a slew of rules and restrictions

Major challenges forestry and natural resources:

Although the power IoT continues to evolve, the essential principle stays the same. The mechanism to "see" how things are (using appropriate sensors/devices for sound, vibration, picture, GPS, temperature, moisture, and so on), transfer the data to a location where it is processed, and provide the insights/advice to assist in taking appropriate decisions. It might explore using what the global forest management community has learned, deploying technologies that have shown to be successful, and developing new solutions that can be duplicated elsewhere

Poaching of wild animals: The authorities have faced several obstacles, including wildlife poaching. According to estimations, India is one of the most hazardous countries for forest guards, with over 160 men killed while protecting the woods. Poachers have mostly targeted tigers, although smaller animals like as monitor lizards and pangolins have also been heavily killed. Thermal imaging applications can be used to detect poachers or illegal individuals in the woods. At camera traps, imaging analytics may be used to distinguish between humans and animals and take appropriate action.

Illegal mining and logging: Illegal logging of valuable wood has occurred in distant areas that are difficult to monitor and patrol. Sandalwood, rosewood, and oak trees have all been targeted in India, with criminals even cutting them down in city boundaries. GPS, vibration, and shock sensors can help gather sounds/signals and match them to "sound signatures" associated with chainsaws or axe strikes to trigger alarms. Furthermore, even if the poachers succeed in felling a tree, the imbedded sensors will aid in their detection. Illegal mining/quarrying within forest limits is a similar problem that may be handled using drone technology.

Conflicts between humans and animals: In the eastern/north eastern states of Orissa, West Bengal, Assam, Arunachal Pradesh, Jharkhand and others, these conflicts have been the most serious. The primary cause has been the loss of domestic animals as ecosystems have shrunk and animals have ventured into settlements to plunder the standing crops. Sensors may be used in creative ways to generate responses that dissuade animals while not killing

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them.

Forest health monitoring: The enviable duty of monitoring enormous areas of land with little resources falls to forest management. By evaluating the turbidity of water, IoT makes it possible to monitor the soil condition, water quality of rivers passing through forests, and the quantity of pollutants discharged by upstream industry, if any, or the extent of deforestation. Smart dendro meters, which include bands that extend in unison with the development of the trees, can be used to continually monitor the growth of the trees during reforestation works. The monitoring effort is greatly reduced. These methods are successful when used in combination with space technology.

Summer heat and forest fires: IoT can aid in the continual monitoring of water availability in these tanks and the careful planning of water replenishment. Forest fires are the misery of the Himalayan dry deciduous woods and coniferous forest zones. Many forest fires can be averted if critical climatic factors such as temperature, relative humidity, and wind speed are properly monitored and compared to the McArthur Forest Fire Danger Index. By monitoring CO2 and CO levels, as well as smoke detection, an alarm system may be developed to assist in the early stages of a fire.

Different Techniques

Different Technique used to manage the natural resources

Author/Year of publications	Technique used	Advantages	Limitations
IOT Based Water Quality Monitoring System(Pappu et al., 2017)	This system makes use of three sensors (pH, conductivity, turbidity, temperature), processing module microcontroller	The low cost, efficient, real-time water quality monitoring system.	The whole system has been tested on a closed-door environment.
Real-Time Water Quality Monitoring System using Internet of Things(Das & Jain, 2017)	This system makes use of three sensors (pH, conductivity, temperature), processing module microcontroller, and two data transmission modules Zigbee and GSM.	The real-time water quality monitoring system has been implemented and evaluated at a cheap cost. Officials can use this technique to keep track of the amounts of pollution in water bodies and issue quick warnings to the public.	The temperature in the area remains between 32 and 34 degrees. Water has a conductivity of 7 to 9.
Water Parameter Analysis for Industrial Application using IoT(Nikkam & Pawar, 2016)	The three subunits of the water quality motoring system are as follows: 1 and 2). Units for data collecting, base station, and remote server (Monitoring unit). The following are the system's primary characteristics: 1) low cost of implementation; 2) high data detection accuracy; 3) low power consumption; 4) real-	Implemented system makes awareness and avoids major risk related to spreading of polluted industrial water at a long distance with low cost.	Hardware design should be more accurate and updated.

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A Self-Powered, Real-Time, LoRaWAN IoT-based Soil Health Monitoring System(Ramson et al., 2021)	DESIGN OF THE IOT-SHM SYSTEM	All critical elements of the IoT system, including soil health tests and location data acquisition, long-range data transmission, data storage, data presentation, and a downlink channel for possible crop production feedback control.	Future work in the area of IoT-based soil health monitoring systems will include the generation of soil maps from sensor and geo-location data, as well as the interfacing of additional sensors to study soil nitrate, phosphate, redox, pH, O2, and microbial activity, and the integration of machine learning algorithms to provide feedback with the goal of improving crop production.
An IoT Based System for Remote Monitoring of Soil Characteristics(Isaac et al., 2016)	The system is based on the STM32 NUCLEO microcontroller platform. The microcontroller, sensor, and communication blocks are the three basic blocks.	A system based on the Internet of Things for measuring soil pH, temperature, and moisture has been demonstrated.pH, temperature, and moisture sensor designs have been successfully deployed and validated with minimum error.	Future studies includes design of Agriculture Sensors, power efficiency, and cloud integration
Design and Implementation of IoT-enabled Compost Monitoring System (Siswoyo Jo et al., 2019)	The Compost Monitoring system consist of Wireless Sensor Node,Internet-of-Things, LoRa Communication	This study is appropriate for managing farms with a diversified environment, where various crops, livestock, and composting buildings must be precisely monitored over a vast region.	Monitoring and data collecting have the potential to be expanded to smart data processing and integrated decision support for farm practitioners.

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A new generation of sensors and monitoring tools to support climate-smart forestry practices (Torresan et al., 2021)	Different Sensors used to monitor tree growth, timber production, Forest health	Technology is advanced enough to monitor a forest in real time and at enormous temporal and spatial dimensions	The prices are still prohibitive in practice. However, addressing real-time monitoring requirements may not necessitate the invention of revolutionary new technology.
Internet of Things in Animal Healthcare (IoTAH): Review of Recent Advancements in Architecture, Sensing Technologies and Real-Time Monitoring (Karthick et al., 2020)	This setup is based on different types of sensors, gyroscope, accelerometer, and motion sensors.	This setup domestic and wild animals behaviors and health can be monitor.	The behaviors pattern can be predict through AI/ML.

Research Challenges

1) How to design a low cost water quality monitoring system which can provide various features like pH,TDS, water pollutant and real time monitoring.
2) How to monitor the industrial water quality with various dynamic features like cost, reusability, flexibility, power consumption, real time data acquisition.
3) How to create an effective water saving and preparation model AI/ML models and usage patterns for IoT.
4) How to Use of IOT for water conservation in rural areas has significant potential to control the wastage of water in rural area
5) An IoT-based soil health monitoring system includes the creation of soil maps utilising sensor and geo-location data, the connection of sensor arrays to analyse soil nitrate, phosphate, redox, pH, O2, and microbial activity, and the integration of machine learning algorithms to provide feedback.
6) How to provide a wealth of real-time information about smart irrigation to be able to make better decisions using AI/ ML technologies.
7) How to create a cost-effective air quality monitoring system that detects real-time data of different parameters such as smoke, carbon monoxide, and PM levels in the environment and informs individuals when the amount of these components exceeds a particular threshold?
8) how to build a system may be further improved to consume less power. This module is suitable for use in both urban and rural regions to monitor the air quality.
9) How wireless and IoT technology can able to help create a sustainable forestry models and prevent the different hazard in real time and proper monitoring

CONCLUSION

This report summarizes the present state of IoT applications in natural resource management research. The goal of this chapter is to learn how to apply IoT and WSN technologies to traditional natural resource management, such as water, soil, air, forest, animal, and biodiversity management. This paper lays the groundwork for understanding the fundamentals of IoT and highlights the field's research challenges. We've gone over a few natural resource management approaches that could help us control our quality of life. We demonstrated current studies on water quality, air, soil, forestry, and animal health, among other topics

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