**Journal of Digital Health and Precision Medicine**

https://www.harrisonacademicpress.com/index.php/JDHPM

**Vol 1, Issue 1, 2026**

# DESIGN OF A WSN NODE FOR FOREST TREES AGAINST POACHING

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**ABSTRACT**

The WSN nodes are designed to be energy-efficient, cost-effective, and capable of sensing various environmental parameters. We discuss the selection of appropriate sensor nodes and the integration of advanced technologies, to enhance the WSN's ability to identify and differentiate between human and wildlife movement within the forest.

To ensure robust data transmission, we propose a hierarchical communication protocol that allows nodes to relay information efficiently, forming a self-healing and self-organizing network. Furthermore, we implement an intrusion detection system that can detect any attempt to tamper with the nodes or the network. The deployment strategy is based on the analysis of historical poaching patterns and the identification of vulnerable areas. By distributing nodes intelligently, we aim to maximize the coverage of the forest while minimizing the number of nodes required for the surveillance, thus optimizing resource utilization.

To validate the effectiveness of our proposed WSN node forest, we conduct extensive simulations and real-world field tests. The results demonstrate the system's ability to promptly detect poaching activities and alert relevant authorities in real-time, aiding in the rapid response to potential threats.

The proposed WSN node forest showcases a promising solution for safeguarding vulnerable forest areas against poaching. By leveraging cutting-edge technology and environmentally sensitive design, our approach contributes to biodiversity preservation and provides valuable insights for wildlife conservation efforts.

Nowadays there are many incidents about smuggling of trees like Sandal, Sagwan etc. These trees are very costly and meagre. Smuggling/theft of most important trees such as sandal wood in forests, poses a serious threat to forest resources, causes significant economic damage and ultimately has quite a devastating effect on the environment all over the world. These trees are very costly as well as less available in the world. These are used in medical sciences as well as cosmetics. Because of huge amount of money involved in selling of such trees smuggling occurs. To restrict their smuggling and to save forests around the globe some preventive measures needs to be deployed. We have developed a system which can be used to restrict smuggling. The design system uses three sensors tilt sensor to detect the inclination of tree when its being cut, temperature sensor to detect forest fires, sound sensor for effective detection of illegal logging i.e. even the sounds generated while axing the tree are also sensed, METAL sensor, fire and smoke sensors. Data generated from these sensors is continuously monitored

with the aid of TCP TELNET App. With respect to the sensors, their output devices are activated through relay switch. For tilt sensor and sound sensor a buzzer is activated and for temperature sensor a water pump is activated. Generated data is stored in TCP TELNET over the Wi-Fi module. Forest officials are notified when any event occurs so that appropriate action can be taken.

## I. INTRODUCTION

Poaching isn't related to India only, China, Australia and African countries are also struggling with same issue. Indian sandalwood costs 12000 to 13000 INR per kg [1] whereas in international market Red Sanders costs INR 10 crore per ton. The Indian sandalwood tree has become rare in recent years,in an attempt to control its possible loss the Indian government is trying to limit the exportation of sandalwood [2]. For an individual, maximum permissible purchase limit is not to exceed 3.8kg as per Govt. If the tree is already government controlled, then its removal is prohibited whether on private or temple grounds until the tree is thirty years old. Smuggling of sandalwood has created socio economic and law and order problems in areas bordering in India.The main objective of this project is to develop a system which can be used to restrict smuggling of sandalwood trees.

Currently there is no system or any medium to detect illegal logging and cutting of trees. A mean by which, the forest officials know what's happening with trees should be installed. Such system would help in detectingand alerting so that proper actions could be taken. Putting this problem in mind, we are designing a system which help us to achieve our goal i.e. TO PROTECT NATURE.

According to a journal published in IJARCET [5] AntiSmuggling of trees was designed using flex sensors and ZigBee. Disadvantages: Wireless Communication in this system used ZigBee¬ Module which is very slow and has lesser range than WiFi Module which is used in Proposed System. Flex Sensors are merely sensors but tilt sensors are¬ inclinometers(which are used to measure slope or elevation and readouts apart from just signals). The existing system is not practically implemented.

The main idea is to design a portable wireless sensor node which will be a part of a Wireless Sensor Network. This system will consist of two modules one involving sensors and controller module which will be at tree spot and another one is Android phone. The Blynk application will continuously receive sensor data. This is an IOT based project where the sensor data is continuously uploaded to cloud(Blynk server) over a Wi-Fi module. In case of tilt sensor and the buzzer turns on when tree bends and for temperature sensor water pump is turned on in case of forest fire through relay switch.

### 1.1 AIM & OBJECTIVES

The Aim of this project is design of a wsn node for forest trees against poaching. To archive the above aim the following objective of the project are fulfilled.

1. Study of Internet of Things
2. Study of About Various Types of Sensors
3. Implementation of Block Diagram by using Software
4. Integration of Various Hardware Components and Getting the

Result

## II. LITERATURE REVIEW

1. Endangered red sandalwood seized from smugglers in Berhampur [3]. 2. The Times of India, Ahmadabad. Plan to curb interstate smuggling of forest woods. 3.200 teak trees cut, timber smuggled in Lucknow [4]. 4. Punjab News line Network (18th December 2010)-The situation has gone quite worse as timber and lakhs or Rupees are criminally being sold right under the nose of department.

ZigBee is a mesh network protocol. It is designed to carry small data packets over short distances while maintaining low power consumption. Zigbee runs on a mesh topology network, it means that information travels from a single sensor node on a web of nodes (each of which act as a data source and a repeater) until the transmission gets to the gateway. It uses a version of the IEEE [8](Institute of Electronics Engineering) 802.15.4 standard; it is widely used in local area sensor data networks. ZigBee uses the 2.4 GHz ISM frequency band and since this is a global standard, the applications of ZigBee can be used virtually anywhere. The application of ZigBee includes home automation, security systems, HVAC systems, smart lighting, and more. Generally we can say that, the energy can be stored in a capacitor, super capacitor, or battery. When the application needs to provide the huge energy spikes at that time capacitors are used. When the device needs toe steady flow of energy at that time batteries re used because it leaks less energy. For independent sensor networks current interest of peoples in low power energy harvesting. An energy harvesting scheme puts power stored into a capacitor then boosted/regulated to a second storage capacitor or battery for the use in the microprocessor. The power is transmitted possibly through a wireless method and it is generally used in a sensor application and the data stored .In this system we are going to setup a combination of such software and hardware that by using the same or by implementing the system in the forest area will help to protect the trees in the forest without any human need for surveillance in the forest. However, the punitive measures have remained largely ineffective, but still poachers was continue to thrive. The most promising solution is– “the implementation of a real time, wireless sensor network and data logging system” which will be a sophisticated and a cheap modern technology to make monitoring more robust, effective and feasible. WSN is a most emerging technology, widely used in many industrial applications such as monitoring, maintenance, security and control application, specific in remote monitoring applications etc. In forest areas, WSN are widely used for fire detection in forest, to detect rearing/poaching of wild animals, for environmental monitoring, etc. Hence WSN has many advantageous applications in real world and so used in this system. The installation and maintenance of Wireless Sensor Network is easy; because they eliminate the use of expensive cables and because of that it saves cost. To design a portable wireless sensor node is the main idea presented in this system which is a part of wireless sensor Network. It will be mounted on trunk of each tree, which is capable of detecting theft as well as automatically initiate & send alarm signals if any to remote terminal through wireless media. A network interface used here i.e.

Xbee RF module has IEEE[8] 802.15.4 standard or ZigBee which is developed as an open global standard for wireless technology.

## III. DESIGN OF HARDWARE

This chapter briefly explains about the Hardware implementation of authentication of IoT based based Women safety System. It discuss the circuit diagram of each module in detail.

### 3.1.ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Arduino board has the following new features:




FIG:3.1 Arduino Uno

### 3.2. POWER SUPPLY

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as "Regulated D.C Power Supply".

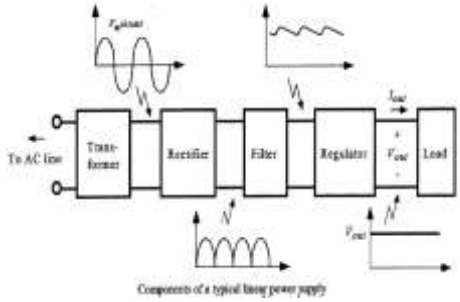
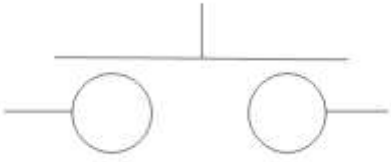



FIG 3.3:Block Diagram of Power Supply

### 3.3. PUSH ON-SWITCH

A push button is a momentary or non-latching switch which causes a temporary change in the state of an electrical circuit only while the switch is physically actuated. An automatic mechanism (i.e. a spring) returns the switch to its default position immediately afterwards, restoring the initial circuit condition. There are two types:

- A push to make switch allows electricity to flow between its two contacts when held in. When the button is released, the circuit is broken. This type of switch is also known as a Normally Open (NO) Switch. (Examples: doorbell, computer case power switch, calculator buttons, individual keys on a keyboard).



### 3.4. LED:

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated.[5] When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons.

This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 $mm^2$) and integrated optical components may be used to shape the radiation pattern.

Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity and limited to red. Modern LEDs are available across the visible, ultraviolet,
and infrared wavelengths, with very high brightness.



FIG 3.6: LED

### ESP8266 WIFI :

The **ESP8266** is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.

The chip first came to the attention of western makers in August 2014 with the **ESP-01** module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted.[2] The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.[3]

The **ESP8285** is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.[4]



### LCD DISPLAY

A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.




FIG: 3.11. LCD

### 3.7. GPS

A GPS tracking unit is a device, normally carried by a moving vehicle or person, that uses the Global Positioning System to determine and track its precise location, and hence that of its carrier, at intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location database, or Internet-connected computer, using a cellular(GPRS or SMS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real time or when analysing the track later, using GPS tracking software. Data tracking software is available for smart phones with GPS capability. The GPS was originally developed for use by the United States military, but in the 1980s, the United States government allowed the system to be used for civilian purposes. Though the GPS satellite data is free and works anywhere in the world, the GPS device and the associated software must be bought or rented.

A GPS device can retrieve from the GPS system location and time information in all weather conditions, anywhere on or near the Earth. A GPS reception requires an unobstructed line of sight to four or more GPS satellites, and is subject to poor satellite signal conditions. In exceptionally poor signal conditions, for example in urban areas, satellite signals may exhibit multipath propagation where signals bounce off structures, or are weakened by meteorological conditions. Obstructed lines of sight may arise from a tree canopy or inside a structure, such as in a building, garage or tunnel. Today, most standalone GPS receivers are used in automobiles.

The GPS capability of smart phones may use assisted GPS (A-GPS) technology, which can use the base station or cell towers to provide the device location tracking capability, especially when GPS signals are poor or unavailable. However, the mobile network part of the A-GPS technology would not be available when the Smartphone is outside the range of the mobile reception network, while the GPS aspect would otherwise continue to be available.

The Russian Global Navigation Satellite System (GLONASS) was developed contemporaneously with GPS, but suffered from incomplete coverage of the globe until the mid-2000s. GLONASS can be added to GPS devices to make more satellites available and enabling positions to be fixed more quickly and accurately, to within 2 meters.

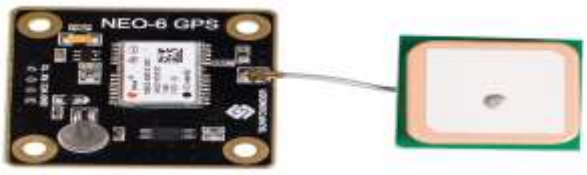



FIG:3.13 GPS Modem

### 3.8. BUZZER

Digital systems and microcontroller pins lack sufficient current to drive the circuits like relays, buzzer circuits etc. While these circuits require around 10milli amps to be operated, the microcontroller's pin can provide a maximum of 1-2milli amps current. For this reason, a driver such as a power

transistor is placed in between the microcontroller and the buzzer circuit.

**3.8.1.MEMS:**

MEMS are a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components. They are fabricated using integrated circuit (IC) batch processing techniques and can range in size from a few micrometers to milli metres. These devices (or systems) have the ability to sense, control and actuate on the micro scale, and generate effects on the macro scale.

The interdisciplinary nature of MEMS utilizes design, engineering and manufacturing expertise from a wide and diverse range of technical areas including integrated circuit fabrication technology, mechanical engineering, materials science, electrical engineering, chemistry and chemical engineering, as well as fluid engineering, optics, instrumentation and packaging. The complexity of MEMS is also shown in the extensive range of markets and applications that incorporate MEMS devices. MEMS can be found in systems ranging across automotive, medical, electronic, communication and defence applications. Current MEMS devices include accelerometers for airbag sensors, inkjet printer heads, computer disk driveread/write heads, projection display chips, blood pressure sensors, optical switches, microvalves, biosensors and many other products that are all manufactured and shipped inhigh commercial volumes.

**Motion / Vibration Sensors**



FIG 3.19 : Vibration

Motion sensors are very similar in design to tilt switches; in fact, some tilt switches are used as motion sensors. The sensor will be in one condition (open or closed) at rest. When it is subjected to motion it will continually change state as long as it remains in motion. Some common applications include: anti-theft devices, man-down alarms to detect non motion, smart appliances to turn off power when not in use and portable equipment to do the same.

**3.9.1.FLAME SENSOR**

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire, allowing flame detection. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system. When used in applications such as industrial furnaces, their role is to provide confirmation that the furnace is working properly; in these cases they take no direct action beyond notifying the operator or control system. A flame detector can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flame.

**3.9.2.VISIBLE SENSOR**

A visible light sensor (for example a camera: 0.4 to 0.7 µm) is able to present an image, which can be understood by a human being. Furthermore, complex image processing analysis can be executed

by computers, which can recognize a flame or even smoke. Unfortunately, a camera can be blinded, like a human, by heavy smoke and by fog. It is also possible to mix visible light information (monitor) with UV or infrared information, in order to better discriminate against false alarms or to improve the detection range. The corona camera is an example of this equipment. In this equipment the information of an UV camera mixed with visible image information. It is used for tracing defects in high voltageequipment and fire detection over high distances.

### 3.10.PROXIMITY SENSOR

- A proximity sensor can detect metal targets approaching the sensor, without physical contact with the target. Proximity sensors are roughly classified into the following three types according to the operating principle: the high-frequency oscillation type using electromagnetic induction, the magnetic type using a magnet, and the capacitance type using the change of capacitance.



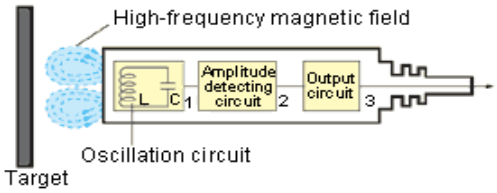



FIG 3.22:Proximity Sensor

### 3.11.MQ2- SENSOR



FIG 3.23: MQ2 sensor

## IV. DESCRIPTION

MQ2 flammable gas and smoke sensor detects the concentrations of combustible gas in the air and outputs its reading as an analog voltage. The sensor can measure concentrations of flammable gas of 300 to 10,000 ppm. The sensor can operate at temperatures from -20 to 50°C and consumes less than 150 mA at 5 V.

Connecting five volts across the heating (H) pins keeps the sensor hot enough to function correctly. Connecting five volts at either the A or B pins causes the sensor to emit an analog voltage on the other pins. A resistive load between the output pins and ground sets the sensitivity of the detector. Please note that the picture in the datasheet for the top configuration is wrong. Both configurations have the same pin out consistent with the bottom configuration. The resistive load should be calibrated for your particular application using the equations in the datasheet, but a good starting value for the resistor is 20 kΩ.

## V. BLOCK DIAGRAM:

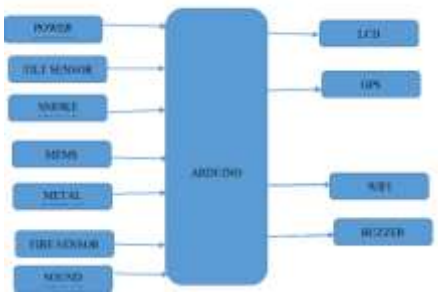


Fig 5.1 block diagram

### 5.2. SOFTWARE REQUIREMENTS:

- Arduino IDE

### 5.3. HARDWARE REQUIREMENTS:

1. Arduino UNO
2. Push Button
3. ESP8266
4. GSM
5. LCD Display
6. GPS
7. Buzzer

### 5.4. WORKING:

The main working of this project is that anytime a forest senses danger, has to do, is to hold on the sensor of the device. Once the sensor is activated, it tracks the place of the fire, tilt or vibration using GPS (Global Positioning System) and sends location using Wi-Fi (wireless fidelity), to a server in the police control room.

Designing a Wireless Sensor Node (WSN) for forest trees against poaching requires careful consideration of various factors to ensure its effectiveness and efficiency. The primary goal is to monitor and deter poaching activities while being energy-efficient to operate in remote forest areas. Below is a general outline of the design:

1. **Sensor Selection:**
   - Metal Detector: Cutting of trees can be done by various sharp metallic objects so that to detect the metal this sensor is used.
   - Acoustic Sensors (Sound Sensor): To detect gunshot sounds or other suspicious noises.
   - Tilt Sensors: To detect movement of trees , if the tree is tilted then this sensor will sense.
   - Fire Sensors: To monitor temperature, humidity, and other environmental conditions relevant to the forest ecosystem.
   - Smoke Sensor : It will sense the smoke in forest.
2. **Processing and Decision-Making:**
   - Integrate a microcontroller (e.g., Arduino, Raspberry Pi) to process sensor data locally.
   - Implement algorithms for detecting poaching events or suspicious activities.
   - Minimize false positives to reduce unnecessary data transmission and conserve energy.
3. **Power Management**:
   - Utilize energy-efficient components to reduce power consumption.
   - Incorporate rechargeable batteries or energy harvesting techniques (e.g., solar panels) for sustainable power supply.
   - Implement sleep/wake cycles to conserve energy when no suspicious activity is detected.
4. **Localization :**
   - Include a GPS module for precise location tracking of the sensor node and poaching events.
   - Use triangulation techniques if multiple nodes are deployed for better accuracy.
5. **Enclosure and Durability:**
   - Design a rugged and waterproof enclosure to protect the electronics from environmental elements.
   - Ensure the node is tamper-resistant to prevent disabling by poachers.
6. **Data Storage:**
   - Integrate onboard memory to store locally processed data if communication is temporarily unavailable.

- Implement data compression techniques to optimize storage space.

**7. Remote Monitoring and Control:**

- Develop a user-friendly interface for remote monitoring and configuration adjustments.
- Enable real-time alerts to notify forest rangers or authorities of potential poaching incidents.

**8. Scalability:**

- Design the WSN node for easy deployment and scalability, allowing for the addition of more nodes as needed.

**9. Collaborative Network:**

- Create a network of interconnected nodes to cover a larger area and share data for better analysis.

## VI. SIMULATION RESULT



Fig: 6.1 simulation result

## VII. CONCLUSION & FUTURE SCOPE

The design of a Wireless Sensor Network (WSN) node for forest trees to combat poaching holds significant promise in addressing the critical issue of wildlife protection. The developed WSN node serves as a reliable and efficient tool to monitor and safeguard vulnerable forest areas, providing real-time data on potential poaching activities. By combining various sensors and communication technologies, the WSN node can detect and transmit crucial information about unauthorized intrusions, thereby enabling timely responses from law enforcement agencies and forest management authorities.

**KEY ADVANTAGES OF THE WSN NODE INCLUDE:**

- Real-time monitoring: The WSN node offers real-time monitoring of forested areas, ensuring rapid detection of poaching incidents, and facilitating immediate intervention.
- Low power consumption: The designed node incorporates energy-efficient components and protocols, resulting in prolonged battery life, reducing the maintenance frequency and costs.
- Scalability: The modular and scalable design of the WSN node allows easy expansion and adaptation to different forest environments, enhancing its versatility for widespread deployment.
- Cost-effectiveness: The WSN node's cost-effective design ensures that it can be widely deployed, even in resource-constrained regions, contributing to a more extensive and efficient protection network.

**FUTURE SCOPE:**

The development of a WSN node for forest trees against poaching opens up various opportunities for further advancements and improvements in the field of wildlife protection. Some potential future scopes are as follows:

- Integration of Artificial Intelligence (AI): By integrating AI algorithms, the WSN node can enhance its poaching detection capabilities

through pattern recognition, behavior analysis, and anomaly detection. This will lead to a more accurate and efficient monitoring system.

- Collaboration with Drones: Combining WSN nodes with drone technology can create a comprehensive and dynamic monitoring system. Drones can be deployed to cover larger areas and provide real-time visual data, while the WSN nodes offer additional data from various sensors.
- Data Analytics and Predictive Models: Employing advanced data analytics and predictive models can help anticipate poaching hotspots and patterns, enabling proactive measures to prevent poaching before it occurs.
- Wildlife Conservation Research: The data collected by the WSN nodes can be invaluable for wildlife conservation research, enabling scientists and conservationists to study animal behavior, habitat changes, and ecological impacts more effectively.
- Collaboration with Law Enforcement Agencies: To maximize the impact of the WSN node, close collaboration with law enforcement agencies, forest departments, and local communities is essential. This collaborative approach can streamline response times and ensure a more coordinated effort against poaching.

- Energy Harvesting: Exploring energy harvesting techniques, such as solar or kinetic energy, can further extend the lifespan of WSN nodes and reduce their reliance on conventional power sources.

In conclusion, the development of a WSN node for forest trees against poaching is a significant step towards wildlife protection. Embracing advancements in technology, data analytics, and collaboration can further enhance the efficiency and impact of the system, contributing to the preservation of precious wildlife and their habitats.

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