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Research Article

Coupling the Power of Artificial Intelligence on Human and Climate Change Impacts Mitigation in Oban Biodiversity Hotspot Loss, Nigeria

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Abstract

The current human efforts to grapples with the pressing challenges of human and climate change impacts on biodiversity loss hotspots have not yield the expected outcome, thereby creating an urgent need for a more sustainable and innovative approach to mitigate the threats from local to global level. This paper explores the various applications of Artificial Intelligence (AI) in monitoring endangered animal species and forest degradation within the Oban Division of the Cross River National Park with a view to boosting sustainable species conservation and averting biodiversity hotspot loss. It evaluates the key potentials and real benefits of AI-driven technologies in optimizing species protection and conservation efforts in the hotspot. It also explores the challenges and opportunities associated with the adoption of AI in biodiversity hotspot monitoring and conservation; and propose recommendations for future research and policy interventions. The paper adopts a qualitative method in reviewing existing studies of AI applications in species conservation and narrows it down to the Oban biodiversity hotspot. The results show that species in the study area are under serious human and nature-induced threats. Also, though AI possesses one of the most intuitive and environmental-friendly options for species monitoring and protection, its application in the protected hotspot is still at zero level due to limited capacity and awareness. We recommend AI driven capacity building via staff training, as well as provision of place-centered AI-technologies to aid accurate monitoring and avert species extinction in the Oban hotspot. Also, local content development and promotion of indigenous technologies, ideas, policies and programmes should be urgently prioritized.

Keywords

Artificial Intelligence, Species Monitoring, Conservation, Biodiversity Loss, Hotspot

1. Introduction

The areal differentiation in the distributions of plant and animal species vary based on geographic spaces (hotspots) and time due to the role of natural and human drivers. Natural drivers such as climate change (extreme temperature and rainfall) instigate forced migration and impaired animal reproduction [1]. Human drivers such as hunting, harvesting, and the conversion of natural habitats for agriculture, urbanization, and industrial activity are fast-tracking the risks and

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losses of species [2]. The identified stressors on protected habitats can be rated as key threat to species in biodiversity. However, efforts to determine the general impacts have not received much research attention especially in developing nations (where key global biodiversity hotspots are located), thereby constraining place-centered (hotspots) conservation priorities for endemic species.

One of the past efforts of biodiversity and species protection dates back to 1992, when the United Nations Environment Program organized a *Convention on Biological Diversity* (CDB). The agreement was signed by 168 countries, including Nigeria, with updated strategic plan for global biodiversity conservation for the years between 2011 and 2020 as discussed in Aichi, Japan. It included the establishment of a conservation target of 17 percent for terrestrial and inland water ecosystems [3]. Yet, the level of policy implementations varied based on national and/ or local responsibilities as well as their interests in given hotspots. Most importantly, none of the past or current conservation strategies has had yet attempt to bring AI-driven technologies to the center of species monitoring and protection within the Oban biodiversity hotspot.

In proposing possible alternative and the efficacies of AI driven-technologies in species monitoring in China, Lin, Wang and Ji [4] posited that AI plays a key role in recognizing species from sounds, images or videos. In their notion, the value of AI is demonstrated thus:

"*We have trained acoustic models for more than 800 Chinese birds and some common chirping insects and frogs, which can be identified from sound files recorded by acoustic sensors. For video and image data, we also have trained models for recognizing 1300 Chinese birds and 400 mammals, which help to discover and count animals captured by image sensors. Moreover, we propose a special method for detecting species through features of voices, images and niche features of animals. It is a flexible framework to adapt to different combinations of acoustic and image sensors. All models were trained with labeled voices, images and distribution data from Chinese species database*" [4].

The preceding notion suggests that the application of *acoustic sensors* which remains one of the focal geospatial tools sustainably utilized by Geographers, Environmentalists and Earth Scientists can best be described as 'a new wind in an old bottle, given its existence in researches prior to the 21st century' [5]. The installation of acoustic devices in designing AI can offer sustainable options for it to analyze audio recordings to detect and classify species (animal and birds) calls, tracking species poaching/ presence, and forest logging.

In a generalized context of the Guinea forest hotspots of West Africa and Oban Division of the Cross River National Parks in particular, species tend to suffer serious threat and losses from humans due to 'expansion of living space, encroaching and disturbing other creatures in an attempt to feed the growing population and boost socioeconomic development' [6]. Within the protected Oban Divisions of the Cross River National Parks, the Convention on Biological Biodiversity (CBD) targets to secure Earth's life-supporting systems and conservation of plant and animal species have suffered many failures due to poverty, greed, and conflicting interests.

In Context of endemism and threats, Brooks et al. [17] reported that the regional biodiversity hotspots possess a total of 2,250 plants species of which 244 are under serious threat or extinction; a total of 90 birds of which 30 are under threat (see also BirdLife International [18], 45 mammals with 35 under serious threat of extinction, 19 reptiles with 4 under serious of threats, and 89 amphibians with no threat incidence of threat. Amidst Brooks *et al*. [17] generalized inventories; there are serious cases of hunting for bush meat, poaching, logging, and trading with prohibited animals in Oban hotspot. The actions had drastically reduced the density of large mammals. Most of the hunting is done with wire snares and guns to supply the bushmeat traders, forest elephants for ivory [7].

Currently, a super highway has been proposed by Government to link Cross River State and Cameroun. A project that is believed will not only enhance access, but also help resolve the protracted boundary issue, increase threat to species movement, and scrambled for agricultural land by native and others residing in the neighbourhood of the protected hotspot.

Increase in climate change indicators (extreme temperature and rainfall oscillations) and human encroachments of the Oban biodiversity hotspot (such as hunting, deforestation, bush burning and farming) tend to intensify irreversible negative impacts on plant and animal species. Also, the eclipse nature of stakeholders' knowledge of species conservation options, poor policy implementation on ecosystem, and limited knowledge gap in research tend to intensify threats and extinction of endemic and exotic species. The past and present crude and manual methods of specie monitoring adopted by conservation officials (rangers and allied stakeholders) constitute another serious setback. The lapses often accelerate endemic and exotic species poaching/ losses.

The conflicting interests and issues that often manifest among villagers, hunters, poachers, and conservation officials suggest serious threat to endangered species in the protected Oban hotspots [7]. The threat necessitate the identification of human orchestrated challenges and proffer better measures for sustainable promotion and protection of the endangered and vulnerable species in the hotspot. The fragile location of Oban biodiversity hotspot at the trans-boundary zone of Nigeria and Cameroon also pose serious monitoring constraint to Rangers in protecting and monitoring endemic species such as birds, mammals and reptiles.

Research evidences have predicted that the 'disturbances of protected habitat areas (e.g. perforation, dissection, fragmentation, and shrinkage) will lead to astronomical reduction and even extinct of global species by 2050' [8, 9]. The threat scenarios is justifiably underestimated given the unsophisticated and poor monitoring methods adopted by conservation officials and Rangers across distinct protected biodiversity hotspots. In Oban division of the Cross River National Park, research on the applications of more sophisticated technology called Artificial Intelligence (AI) is not well-known.

Amidst the gap defined by ignorance, Kormos [10] opined that researches on specie distributions in the Oban hotpot are still at the seminal level. Yet, research inventory reveals that the hotspot accommodates astronomical magnitudes of animal such as species of birds, mammals, amphibians, and primates [10], endemic to the protected area are not only endangered, but on the verge of extinction triggered by human exploitative excesses [11-13]. Hence, Agaldo *et al.* [14] had emphasized the need for urgent actions to reduce the rate of human induced habitat and species losses in the hotspot.

The low level of conservation options and intervention strategies can partly be attributed to: poor communication between conservation officials and the villagers; limited knowledge of nature-human relationships; and exploitative excesses of the rural people [15]. There is a need research to prioritize people and place-oriented wildlife conservation and sustainable management options with a view to offering better cost-effective strategies for the protection of terrestrial species from human land-use disturbances and consolidating human-ecosystem relationships in protected Oban biodiversity hotspot.

The central issues agitating the mind of the researcher in the course of this work are: what are the key benefits of AI-driven technologies in optimizing species protection and conservation efforts in Oban biodiversity hotspot? What are the challenges and opportunities associated with the adoption of AI in Oban biodiversity hotspot monitoring and conservation? Hence, addressing the issues will facilitate place-centered policy recommendations for future research and offer guide to sustainable specie monitoring to the choice of appropriate AI technology-aided devices for alleviating the exploitative excesses and risks emanating from climate-and-human driven actions.

2. Materials and Methods

From the geographical dimension, the Oban Division of the Cross River National Park biodiversity hotspot is located between Latitudes 5°17^{1} and 5°28^{1} North of the Equator as well as Longitudes 8°33^{1} and 8°47^{1} East of Greenwich Meridian as envisaged in Agaldo, Gwom & Apeverga [14]. It is one of the protected areas that make up West Africa Biodiversity Hotpots [16]. It is a forest reserve that covers a total land area of 2800 kilometer square with its peak at the Great Oban Hill and extends to the western flank of Cameroun. It is a trans-boundary protected area with the contiguous Korup National Park in Cameroon. It increases the total area of forest under protection, facilitates the sharing of data and information and makes conservation more efficient (Cross River National Park, 2010) [7].

This study employed a qualitative method (with emphasis on discourse analysis of existing literature). The essence is to identify appropriate place-centered options in coupling the benefits and challenges of AI-driven technology to reduce human and climate change impact that triggered species losses and threats in the Oban Division of Cross River National Park. The researchers employ discourse analyses in elucidating the current possibilities of AI in plants and animal species' monitoring, protection, and conservation with a view to suggesting place-centered options for averting or mitigating the risks, losses or extinction of endemic and exotic species in Oban biodiversity hotspot.

3. Discourses and Results

The results emanating from various discourses are sequentially presented in what follow.

3.1. Past Issues and the Need for AI in Optimizing Species Protection

Human knowledge of species distributions in the threatened and/or their threat-free refugia are still limited [19], creating challenge in individual ability to prioritize conservation efforts for biodiversity [20]. In context of Oban hotspot, the prioritize research efforts directed to close the gap on species are rather eclipse. The mona monkey is a forest species native to West Africa. Once common across its native range, it has become rare and even extirpated in some areas due to habitat loss and over-hunting by humans [21]. Where it is still common, its densities vary between 15 and 49 ind/ km^2 (Glenn *et al.* cited in Umo et al. [22]. Similarly, the Preuss's red colobus monkey *Procolobus preussi*, crowned guenon *Cercopithecus pogonias* and drills are ranked as endangered species in IUCN red list Taylor & Smith [23].

The reported scenarios are pointers to the past failures in species monitoring, protection, and conservation options adopted by stakeholders in the regional hotspots. They depend basically on biodiversity baseline measurements and change monitoring, which traditionally involved time-intensive manual data collection and analysis. In it treatise, GPAI [1] envisioned that:

"*….Three broad categories of applications of AI for understanding patterns of biodiversity and biodiversity change can be identified: 1) AI for automated direct species monitoring; 2) AI for predicting derived biodiversity metrics across space and time; and 3) AI for inferring environmental variables that are important for further understanding and managing these patterns of biodiversity*" [1].

From the preceding treatise, it is infers that AI-driven technological applications in biodiversity protection and species monitoring can manifest in three distinct domains, yet variation exist based on the users' preferences of software devices (packages) and the purpose each user may want to achieve. A Juxtaposition of the treaties led the stratifications of two dominance preferences and their utilitarian values compose of (1) mobile Sensors and, (2) Stationary Sensors. The identified options are expatiated in the discourses that follow.

In context of *mobile sensors*, the used of AI for direct specie monitoring can be carried out with the aid of several mobile sensors. For instance, AI can be design to works with *satellite-driven* devices from airspace using models such as optical, SAR and LiDAR to track the movement of animals across distinct geographical locations, logging of wood, poaching of protected animals, forecast species migration patterns, poaching risks, and aid proactive future conservation. More so, using appropriate predictive geo-spatial (Satellite Imagery Analysis and Remote Sensing) Technologies powered in AI algorithms do enhance habitat change detection especially forest cover, identifying deforestation, logging activities, and natural disturbances such as wildfires.

In the basis of forecast metrics, AI can operate with the aid of *UAV software devices* such as RGB, THERMAL and LiDAR install in drone to gather data and used for predicting or deriving biodiversity metrics within a given hotspot over a period of time. That is to say, AI-equipped drones hold captivating values of capturing images and videos, detecting animals' movements, poaching activities, land use changes, deforestation, and allied encroachment. A sensor network coupled in AI-powered machine can engage and aid weather data recording, processing, and tracking environmental conditions such as temperature, rainfall, humidity and wind, that define habitat conditions and influence species' behaviours over time sequence.

The third band of AI application in mobile devices is the *On-animal Sensors*. In this option, the animals in the protected biodiversity hotspot are scanned using the eye or allied sensitive organs for image recognition and the captured image are install in AI device to signal migration, behaviours, movements, and allied activities of the animals within and outside the hotspot.

From the dimension of stationary devices, the AI-powered Camera Trap devices offer a very vital option for detecting and monitoring animals' activities with a protected hotspot. Such Camera trap with AI-powered image recognition creates enable grounds for conservation officials and/ or other stakeholders to remain within a geographical space and identify species, detect poaching, and monitor population changes.

Another AI-powered stationary device is Bioacoustics Sensor. It is equipped *with microphone designed for applications requiring high Signal to Noise Ratio, low distortion (high AOP), and IP57 dust and water resistance. The recordings made by Spectrum are stored and then uploaded to the cloud database via Long Term Evolution (LTE) using a multi-operator sim. Such actions allow further data processing based on sound bursts' spectral content. An algorithm recognizes the buzz (sounds) in the recorded audio, track, and isolates it as a single event, producing an output file with the number of buzzes or counts as described in Alberti* et al. *[24]*.

AI-driven platforms facilitate online communities, forums, and collaboration spaces where learners can connect, share knowledge, and collaborate on projects. Natural language understanding (NLU) enables intelligent moderation, content filtering, and knowledge exchange among participants. Coupling the power of AI, capacity building efforts can be made more accessible, inclusive, and effective, empowering individuals and biodiversity hotspots to thrive. Hence, AI-powered platforms enable people engage in data collection and specie labeling.

3.2. Drivers of Hotspot Losses and the Need for AI Applications

It has been established in the introduction section of this paper that the key drivers of species in losses in hotspots are associated with human and natural factors. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems (IPBES) [25] linked the drivers to two groups (i.e. direct and indirect factors). In context of Oban division of the Cross River National Park, the drivers of species losses and threat of extinction are succinctly presented and explored in the discussions that follow.

Dynamics in Land Use Patterns:

The degree of dynamisms in Oban biodiversity hotspot as a result of land use pattern induced by farming, urbanization, infrastructure (road construction), and bush fire have instigated varying levels of threats to the protected species. For instance, the crashes between communities sharing common boundaries with the Oban biodiversity hotspot over land tend to create fears and enabling ground for encroachment and clearing of forested area for farming and allied agricultural practices which invariably increased the incidences of animals and birds migration out of the refugia. The cost-benefit analysis and environmental impact assessment of the proposed super highway to link Nigeria and Cameroun is not out yet. Therefore, one cannot state for certainty whether it is a blessing or curse for species on the area.

Direct Exploitation of Protected Species:

The infiltration of poachers, hunters, and trader on prohibited animals (to kill, steal or hunt for bush meats for commercial or domestic purposes) are among the top factors accelerating species loss and threat of extinction in the Oban hotspot. A notable example is the mona monkey that is currently on the verge of extinction. Also, logging for timbers, fuel wood collection, and charcoal production constitute major drivers of forest degradation [26], due to high cost of kerosene and cooking gas. The scenarios are posing distinct threats to species natural habitats. In the sub-Sahara Africa where the Guinea forest and Cross River National Game Reserve in particular are located, fuelwood and charcoal demand for domestic and commercial purposes have recorded an exponential growth. Though the predicted dependency for cooking stood at 653 million will reached in 2009 will reached 918 million in 2030 [27], but no serious attempt has as yet been made to quantify or model human-induced risk in CRNGR for enhance species conservation priorities.

Other contributory factors that trigger threat to species in Oban division of the biodiversity hotspot are extreme scenarios of rainfall, temperature and humidity collectively described as impacts of climate change, invasion of alien species, and environmental pollution.

The drivers present in this section are in turn driven by underlying forces, or indirect drivers, which include production and consumption patterns, high demand for bush meat, human population dynamics and trends, and dire desire for technological innovations. GPAI [1] observed that the rate at which drivers of threats to biodiversity hotspot varies by region and can exacerbate one another through cumulative pressures, risking irreversible tipping points.

Applying AI to the monitoring of these drivers of Oban division of the biodiversity loss cross temporal and spatial boundaries and are highly complex in distinct ways. Yet, AI can be a vital tool for monitoring the identified drivers, their interrelationships and associated risks to ensure continued provision of the ecosystem services which humans depend on for everyday life (such as food (including meat and drug), shelter, and clothing within and outside the hotspot.

4. Benefits Versus Challenges of AI: Taking Side

Within the literature, diverging patterns of human and nature-induced threats to species in the protected biodiversity hotpots have been reported. A recapitulation of recent treatise by Living Planet Report creates an atmosphere for not only curiosity, but also phobia, when stated thus:

"*Seventy five percent of the Earth's ice-free land surface has already been significantly altered, most of the oceans are polluted, and more than 85% of the area of wetlands has been lost. This destruction of ecosystems has led to 1 million species (500,000 animals and plants and 500,000 insects) being threatened with extinction over the coming decades to centuries. However, many of these extinctions are preventable if we conserve and restore nature. 3 Remaining species populations have declined, on average, by 69% since 1970*" [28].

Considering the dimensional and dimensionless values of AI in plant and animal monitoring, protection and conservation in distinct refugia (hotspots) across the world, it is unarguably clear that humans-nature interactions over the last century have caused more harm and disequilibrium that will not be easily corrected as shown in Living Planet Report [28]. Yes, the AI-driven science and technologies are widely promoted, celebrated, and recommended for use by geographers, environmentalists, scientists, technologists, humanists, conservationists, and others, to bridge the gap between endemic/ exotic species losses and protection. There exist serious prices which the capacity and willingness to pay can determine the sustainability of the successes in species conservation, protection, and monitoring in Oban biodiversity hotspot.

In furtherance of the benefits, appropriate AI-driven technological application can enhance easy detection of poor health state of protected vertebrates in the Oban hotspot, thereby aiding quick medical diagnosis, individualized treatment plans, remote sick animal monitoring, and improving healthcare outcomes. In another perspective, AI holds high possibility of boosting sustainable development and conservation of biodiversity hotspot by coupling and optimizing species use, monitoring environmental indicators, and predicting natural disasters, mitigating risks and fostering resilience on the vulnerable plant and animal over time [4].

In context of challenges Gupta and Patel [29] identified issue relating to institution, legal, and transparency domains. Among the cardinal, yet likely constraints associated with AI applications in Oban hotspot conservation are legal and transparency. The complex nature of AI software and algorithms often lack transparency, making it difficult to understand their decision-making processes and implications. Interpretable AI models and techniques are needed to foster trust and accountability. Similarly, revolutionary research trends in AI innovations seem to out-weight the regulatory and legal frameworks. This suggests possible issues especially in liability, intellectual property rights, and algorithmic transparency. Clear and adaptive regulations are necessary to address emerging risks and ensure accountability [1, 29].

Another possible aspect of challenge to adequate AI application in species conservation and protection in the Oban biodiversity hotspot relate to fear of job displacements. This can also attract the corresponding risks of upsurge in crime rates and social inequality especially among the semi-skilled and unskilled workers on one part, as well as inadequate data to fast-track AI operations in the hotspot. Indeed, data privacy, security breaches, and misuse. Robust data governance frameworks, encryption methods, and cyber security measures are needed to protect sensitive information. To address the challenges requires multi-stakeholder collaboration, proactive regulation, and responsible innovation practices to ensure that AI technologies are deployed ethically, equitably, and sustainably for nature and society benefits.

Since over 70 percent of top biodiversity hotspots are located within the developing countries of Africa, Asia, and South America (such as Nigeria, Cameroun, Madagascar, Indian, Brazil and Ecuador) with very poor level of economic, technological, political, and infrastructural development, the sustainability of AI projects in species conservation are rather eclipse.

Key issues agitating the minds of the authors in the work are: (a). since all AI-driven devices need sustainable power and data supply to operate with and the Oban Division of the biodiversity hotspot is 'at the center of nowhere within a jungle', who will maintain the facilities? (b). what about the activities of unknown (kidnappers, hackers, terrorists, internet fraudsters, militants, smugglers)? (c). is the AI-devices rooted from each hotspot with local content? (d). are the stakeholders willing and able to adapt and adopt, finance, and maintain the new AI technologies?

There is a need for the less developed nations like Nigeria to develop and used their technologies to solve their problems instead of relying on those from the developed nations that are often lack local contents, and thereby accelerating over-dependency on the foreign manufacturer. Where such are not feasible, it becomes inevitable to develop nature-positive solutions based on connectivity, willingness, and collaboration among conservationists, organizations, nations, governments, businesses, individuals and allied stakeholders to change their behaviours and build a better future of species conservation and protection for posterity.

5. Conclusion and Recommendations

The discourses in the various sections of this work reveal the popularity and promotion of AI tools as a surrogate for monitoring, protecting, and preserving the already endangered species from local to global context. There are indications that stakeholders may be willing to adapt and adopt the emerging AI innovations. However, willingness without basic capacities to back them is just like swimming in the Ocean of failures. Nigeria and allied developing nations of the world must rise up to their expectations and build a future they can call their own through local content development and promotion of indigenous technologies, ideas, and policies and programmes.

This study therefore recommends for:

1) Increase Financial Investment in Biodiversity: This can be achieve through direct government funding of biodiversity project investment, grants, and allied supports from conservation society as well as Nigerian Oil and Gas sectors, and Ecological Fund.
2) Increase Enlightenment Campaign and Capacity building: This is very important in area of awareness creation using traditional institution, workshops, seminar, manpower training, and environmental education to boost the applications of AI infrastructure and key AI-driven equipment supply.
3) Promote collaborations and collectivities in biodiversity Protection: It can be done through collaborated efforts of Federal and State government and philanthropic organizations with past track records of sustainable supports for AI applications in species conservation as exemplified in United States via Flora Family Foundation, Gordon and Betty Moore Foundation, Oak Foundation, MacArthur Foundation, The David and Lucile Packard Foundation and others.

Abbreviations

AI	Artificial Intelligence
CRNP	Cross River National Park

Author Contributions

Ezinne Okoroafor: Conceptualization, Data curation, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing

Ikpong Sunday Umo: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Ifeanyi Gerry Ukwe: Data curation, Methodology, Project administration, Resources, Software, Validation, Writing – original draft

Conflicts of Interest

The authors declare no conflicts of interest.

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