Leveraging Artificial Intelligence (AI) in Strengthening the Legal Framework for Regulation of Wildlife and Forest Crimes in Nigeria

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Abstract. Artificial intelligence (AI) applications and machine learning models have extended beyond merely solving computer-related problems to tackle environmental sustainability issues. One such case is countermanding the demand and supply of illegal forest and wildlife products. In Nigeria, the challenges of improving its ability to combat the high rate of wildlife and forest crimes within its borders remain daunting. Despite existing laws, Nigeria remains both a source and a key intermediary for wildlife smuggling and crimes involving protected species. This paper analyses the potential of AI as a tool for strengthening the existing legal framework on wildlife crimes in Nigeria. The findings of this paper demonstrate that the current framework for preventing forest and wildlife crime is being breached due to a lack of resources available to enforcement authorities. Thus, leveraging AI's potential presents innovative solutions to strengthen compliance with these laws.

Keywords: Artificial intelligence, wildlife, forest crimes, leveraging AI, improved compliance, Nigeria

1. Introduction

AI, traditionally a computer science domain, refers to machines' ability to display intelligence distinct from the innate intelligence found in humans and other living beings.[1] Wang and Srinivasan defined the term as science and engineering concerned with creating machines exhibiting human-like intelligence.[2] Thus, to effectively accomplish activities begun by humans, AI robots must first learn from experience to adapt to new inputs and overcome problems that arise in daily life.[3]

John McCarthy introduced AI in 1956 as a field of science and engineering focused on developing intelligent machines.[4] AI is primarily concerned with the replication of human intelligence within computer systems. Its main goal is to develop computer systems that mimic human thinking and decision-making processes. Today, AI is making significant strides and finding applications across various industries, including gaming, finance, retail, business, and government. This technology is not limited to a single field but is profoundly impacting diverse

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1   Bharat H. Desai, "Taming the Beast: On the Global Regulation of Artificial Intelligence for a Safe Future, SIS Blog, 24 July 2023: https://sisblogjnu.wixsite.com/website/post/blog-special-taming-the-beast-on-the-global-regulation-of-artificial-intelligence-for-a-safe-future; D.L. Poole, A.K. Mackworth, R. Goebel, *Computational Intelligence: A Logical Approach* (Oxford University Press New York 1998).

2   Z. Wang, R.S. Srinivasan, 'A review of artificial intelligence based building energy use prediction: contrasting the capabilities of single and ensemble prediction models' (2017) Renewable Sustainable Energy Review 75 796.

3   Lake, Brenden M., et al. 'Building Machines That Learn And Think Like People' (2017) *Behavioral and Brain Sciences* 40

4   John, McCarthy, et al. 'A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence August 31, 1955' (2006) *AI magazine* 27.4 12.

sectors. As 21st-century environmental concerns escalate, AI is essential to tackle many of these sustainability issues. Research has suggested that AI can help direct public attention to common environmental problems, making them easier to manage.[5] Over the last 50 years, emphasis on AI's robustness has emphasised the necessity of environmental sustainability during the development and application of technology, according to Jha.[6] The employment of AI-related technology in lowering the prevalence of wildlife trafficking and forest crimes in many developed countries is one such indicator of environmental sustainability that has profited from its practical use in recent years.[7] According to Rusch and Arora, the fight against the illicit wildlife poaching industry remains daunting given its high profit and low exponentials.[8] However, AI-based approaches can reverse the narrative and turn it into a high-risk enterprise.[9]

Nigeria has become a significant source and transit country for illegally traded wildlife products in the last ten years. The United Nations Office on Drugs and Crime UNODC's World Wildlife Crime Report (WWCR) 2020 reported that in 2019 in Nigerian ports, the amount of confiscated pangolin scales surged to 51 tons, a significant increase from the 2 tons seized in 2015.[10] Data shows that Nigeria plays an increasingly important part in the illegal ivory trade, with approximately 25% of all confiscated ivory worldwide being transported through Nigerian ports.[11] Despite efforts by the government at both the federal and state levels through the machinery of law and the establishment of agencies to stem the trend of wildlife and forest crimes, Nigeria faces a daunting task in boosting its capacity to combat wildlife trafficking crossing its borders. Therefore, there is a need for focused and strategic measures to strengthen the nation's ability to mount a forceful and effective legal retort to the issue of wildlife and forest types of crimes.[12]

This paper thus explores the gap as to how the Nigerian government can leverage on AI to achieve enhanced compliance with the existing legal framework on biodiversity conservation and reduce the incidents of crimes against its wildlife and forests. The use of AI for environmental sustainability in Nigeria has not been discussed much. To bridge this gap, this paper finds how AI techniques and options can best be used to strengthen the challenges in compliance with the extant laws on wildlife and forest crimes in Nigeria. The paper will be structured into six parts, the first being the introduction. The second part examines the levels and domains of AI for environmental sustainability. The third part is an exposés on the preponderance of wildlife and forest crimes as a significant drawback for Nigeria's biodiversity conservation and environmental sustainability. The fourth part discusses the extant legal responses of the government to this problem. At the same time, the fifth section proposes the infusion of AI-related technologies as a solution for strengthening the capacity of these laws to achieve their objectives, whilst the last section is the concluding paragraph.

2. Levels and Realms of AI for Environmental Sustainability

In the contemporary digital era, the term "AI" denotes the capacity of a computer-controlled robot to perform tasks based on the cognitive abilities of intelligent humans.[13] This concept finds extensive application

5   Yogesh K., Dwivedi, et al. 'Climate Change and Cop26: Are Digital Technologies and Information Management Part of the Problem or the Solution? An Editorial Reflection And Call To Action' (2022) *International Journal of Information Management* 63 102456; Ben, Shneiderman 'Bridging The Gap Between Ethics And Practice: Guidelines For Reliable, Safe, And Trustworthy Human-Centered Ai Systems' (2020) *ACM Transactions on Interactive Intelligent Systems* (TiiS) 10.4 1.

6   K. Jha, et al. 'A Comprehensive Review On Automation In Agriculture Using Artificial Intelligence' (2019) *Artif Intell Agric 2 1*.

7   Nandutu, Irene, Marcellin Atemkeng, and Patrice Okouma 'Integrating AI Ethics In Wildlife Conservation AI Systems In South Africa: A Review, Challenges, And Future Research Agenda.' (2021) AI & SOCIETY 1-13.

8   Natasha Rusch and Payal Arora 'AI-Based Strategies To Combat Wildlife Trafficking And Wet Markets In Asia: A Critical Review (May 2021) <https://cutt.ly/7BkxP22> (accessed on 10 October 2022)

9   Ibid

10 UNODC, World Wildlife Crime Report 2020: Trafficking in Protected Species <https://www.unodc.org/documents/data-and-analysis/wildlife/2020/World_Wildlife_Report_2020_9July.pdf> (accessed on 13 October 2022)

11 Ibid

12 In this study, wildlife and forest crime is defined as the unlawful harvesting, trading, processing, killing, holding, and consumption of wild plants and animals, wherever they reside.

13 Pantano, E., and Scarpi, D. I, Robot, You, Consumer: Measuring Artificial Intelligence Types and their Effect on Consumers Emotions in Service. (2022). *Journal of Service Research* 25 583 - 600.

in developing systems endowed with mental faculties akin to human beings, including the capacity for reasoning, generalisation, learning from past experiences, and seeking meaning.[14] In simpler terms, AI research centres on harnessing language, logic, perception, and learning to analyse and address complex problems.s many. AI systems are now present in many areas of our life.[15] Various data-driven, networked, and automated applications help us communicate, trade, and acquire information daily. Today, all facets of business, research, and policy-making already utilise technology to advance knowledge, manage processes more effectively, and ultimately control and influence our environment.[16] This has also been extended to the field of environmental sustainability.[17]

In their research on the contribution of AI to achieving the Sustainable Development Goals (SDG), Vinuesa. highlighted that AI's advantages could arise from its ability to analyse extensive, interconnected databases to devise collaborative efforts toward environmental conservation.[18] The study indicates that AI development can help comprehend climate change, compute its potential effects, and foster low-carbon energy systems that rely heavily on renewable energy and energy efficiency – all essential for dealing with climate change. In a related study, Akshara also explained that AI can help protect local ecosystems by assisting environmental agencies in making informed decisions to reduce air pollution and protect public health.[19] Mohammadi,[20] found that AI tools, including neural networks and objective-oriented methods, can rapidly and efficiently classify vegetation cover types in satellite images. This data can inform environmental decision-making and management, leading to the prevention or reversal of desertification trends. Furthermore, Vinuesa argued that AI can help tackle SDG 14's goal of reducing marine pollution by using algorithms to detect oil spills quickly.[21]

Similarly, Cowls J. 's research explained that the potential of AI and other technologies will allow us to understand better and tackle environmental challenges by increasing our knowledge base through the results provided by analysing large amounts of data on the environment.[22] For instance, biodiversity research can benefit from developing machine learning (MLE) processing solutions that can be used to predict ecosystem services.[23] AI applications and MLE models are now being used more often for predicting and improving water conservation.[24] In the same vein, area neural networks, expert systems, pattern recognition, and fuzzy logic models are helping to provide more knowledge in the energy sector with a focus on renewable energy,[25] and Computer Vision and Decision Support are now used in transportation.[26]

14   Mao, X., Li, W., Lei, C., Jin, J., Duan, F., and Chen, S. 'A Brain–Robot Interaction System by Fusing Human and Machine Intelligence'. (2019). *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 27, 533-542.

15   Andrada, Gloria, Robert W. Clowes, and Paul R. Smart. 'Varieties of transparency: Exploring agency within AI systems.' (2023) *AI & society* 38.4:1321-1331.

16   Soni, G., Mangla, S., Singh, P., Dey, B., and Dora, M. 'Technological interventions in social business: Mapping current research and establishing future research agenda.' (2021). Technological Forecasting and Social Change, 169, 120818; Tajpour, M. Hosseini, E., Mohammadi, M. and Bahman-Zangi, B. 'The Effect of Knowledge Management on the Sustainability of Technology-Driven Businesses in Emerging Markets: The Mediating Role of Social Media.' (2022) Sustainability 14, 8602. https://doi.org/10.3390/su14148602

17   Westergård, Rune. *One Planet Is Enough: Tackling Climate Change and Environmental Threats through Technology* (Springer, 2017)

18   Ricardo Vinuesa et al. 'The Role of Artificial Intelligence In Achieving The Sustainable Development Goals' (2020) Nature Communications. 11 <https://doi.org/10.1038/s41467-019-14108-y> (accessed on 20 October 2022)

19   Kaginalkar, Akshara, et al. 'Review Of Urban Computing In Air Quality Management As Smart City Service: An Integrated Iot, Ai, And Cloud Technology Perspective' (2021) Urban Climate 39 100972.

20   M Mohammadi, et al 'Energy Hub: From a Model To a Concept–a Review' (2017) *Renew Sust Energ Rev* 80 1512

21   Op Cit Ricardo Vinuesa et al. 2020

22   Cowls, J., et al 'The AI Gambit: Leveraging Artificial Intelligence To Combat Climate Change—Opportunities, Challenges, And Recommendations' (2021) *AI & Society* <https://doi.org/10.1007/s00146-021-01294-x> (accessed on 20 October 2022)

23   Simon, Willcock, et al. 'Machine learning for ecosystem services' (2018) Ecosystem services 33 165

24   Sun, Alexander Y., and Bridget R. Scanlon. 'How Can Big Data and Machine Learning Benefit Environment and Water Management: a Survey of Methods, Applications, and Future Directions.' (2019) *Environmental Research Letters* 14.7 073001.

25   M Mohammadi, et al 'Energy Hub: From a Model To a Concept–a Review' (2017) *Renew Sust Energ Rev* 80 1512

26   Asadi, Reza, and Mehdi Ghatee. 'A Rule-Based Decision Support System in Intelligent Hazmat Transportation System.' (2015) *IEEE Transactions on Intelligent Transportation Systems* 16.5 2756

In addition to the above, AI enables firms to autonomously tackle environmental challenges, such as waste removal, for improved sustainability.[27] Cheng, Lefeng, and Tao Yu believe that AI involves Machine Learning (ML), which allows machines to use past data and experiences for problem-solving.[28] Thus, ML can be used to anticipate environmental issues, such as stream flow and water quality metrics.

Sustainable agriculture is another aspect of environmental sustainability that has benefited from AI and its technologies. Through robotics, which combines cognitive behaviour from humans, such as emotions and thinking, AI robots can now execute tasks using human actions and other manipulations.[29] This has simplified farm tasks such as seeding, planting, fertilising, weeding, spraying, irrigating, harvesting, and shepherding, which would typically require more human labour. AI also allows for water resource variables, crop nutrition levels, and weed/crop differentiation predictions.[30]

AI has also addressed the challenge of managing large amounts of constantly changing environmental data when determining environmental protection tactics. For example, AI has been implemented in the design of wastewater treatment plants to improve their effectiveness and capacity. Additionally, AI has led to innovative waste management approaches, such as developing intelligent trash cans and waste-sorting robots at landfills.[31] Artificial Neural Networks (ANN) have offered several solutions for detecting and warning of oil spills in marine life conservation and pollution prevention. AI-based Autonomous Underwater Vehicles (AUVs) and underwater robots have enabled the forecasting of the propagation of invasive species, tracing marine debris, observing ocean currents, identifying "dead zones," and gauging pollution levels. These tools can also create an open living database of aquatic health and fish populations, carry out deep sea assessments, and provide real-time monitoring of sea pollution.[32]

Therefore, no doubt, utilising AI-related technologies has the potential to help in achieving the vision of environmental sustainability.

3. Wildlife and Forest Crimes: A Legal Challenge

The nation of Nigeria abounds in natural resources.[33] Its varied climatic conditions and physical features contribute to the abundance of its wildlife and forests, creating one of the richest biodiversities in Africa.[34] These resources have economic and nutritional values and ecological, medicinal, educational, scientific, recreational, and socio-cultural importance.[35] Nigeria's natural environments vary greatly, spanning from semi-arid savannas to mountainous forests and encompassing fertile seasonal floodplains, rainforests, expansive forests of freshwater swamps and a varied assortment of coastal vegetation.[36] Nigeria's Niger Delta is home to Africa's most significant mangrove habitats.[37]

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27 Nti, Emmanuel Kwame, et al. 'Environmental Sustainability Technologies in Biodiversity, Energy, Transportation and Water Management using Artificial Intelligence: A Systematic Review' (2022) Sustainable Futures 100068.

28 Cheng, Lefeng, and Tao Yu. 'A new generation of AI: A review and perspective on machine learning technologies applied to smart energy and electric power systems' (2019) *International Journal of Energy Research* 43.6 1928

29 Duckett, Tom, et al. 'Agricultural Robotics: the Future of Robotic Agriculture' (2018) arXiv preprint arXiv 1806; Kragic, Danica, et al. 'Interactive, Collaborative Robots: Challenges and Opportunities (2018) *IJCAI* 34

30 Chlingaryan, Anna, Salah Sukkarieh, and Brett Whelan 'Machine Learning Approaches For Crop Yield Prediction And Nitrogen Status Estimation In Precision Agriculture: A Review' (2018) *Computers And Electronics In Agriculture* 61

31 Sarc, Renato, et al. 'Digitalisation and Intelligent Robotics in Value Chain of Circular Economy Oriented Waste Management–A Review' (2019) *Waste Management* 95, 476.

32 Ibid

33 Susan Amiesa Fubara, Iledare, O. Gershon O. and Ejemeyovwi, J. 'Natural Resource Extraction and Economic Performance of the Niger Delta Region in Nigeria.' (2019) *International Journal of Energy Economics and Policy*.

34 Philips, J.'The Trouble with Nigeria.'(2005) *African Studies Review* 48, 133

35 Ugochukwu, Collins NC, and Jürgen Ertel. 'Negative Impacts of Oil Exploration on Biodiversity Management in the Niger Delta Area of Nigeria' (2008) Impact assessment and project appraisal 26.2 139.

36 Schoneveld, G. 'The politics of the forest frontier: negotiating between conservation, development, and indigenous rights in Cross River State, Nigeria.' (2014) *Land Use Policy* 38 147-162.

37 Afinotan, Lawrence A., and Victor Ojakorotu. 'The Niger Delta crisis: Issues, challenges and Prospects' (2009) *African journal of political science and international relations* 3.5. 191.

Nigeria is home to an estimated 4,715 vascular plant species, 285 mammal species, 117 amphibian species, over 775 fish species and, potentially, many more undocumented species.[38] Nonetheless, Nigeria's wildlife reserves are rapidly declining due to human activities, especially modifications in land use and overexploitation through practices like fishing, logging, and hunting.[39] Of particular importance to this study is the impact of wildlife and forest crimes as a significant driver of this overexploitation, a dilemma for wildlife conservation in the country.

On September 8 2022, the Nigeria Customs Service at Murtala Mohammed Airport seized 7,000 pieces of donkey genitals with a declared value of more than N216 million that were intended for export to Hong Kong.[40] Although, according to the Customs Area Controller, Sambo Dangaladima, this was the first time they were seizing such an item, the Organised Crime and Corruption Project (OCCRP) reported that in July of the same year, 2,820 donkey hides valued at $116,000 was being prepared for illegal export from the country were seized by the Nigerian Customs Service.[41] This is coming a month after the Leadership Newspaper reported that Muhammad Umar, Controller of the Kano/Jigawa Command of the same unit, verified that the command had handed over 3,712 confiscated donkey skins and three bags of donkey penises weighing 100 kg each.[42] Despite the Nigerian government's endeavours, the situation above exemplifies the country's current state and pervasiveness of wildlife crimes.

Studies conducted over the years have demonstrated that these crimes against nature have been on the rise for a considerable amount of time and have persisted despite government efforts to stop them, providing a significant barrier to wildlife conservation in Nigeria. In a study by Olateru and Egonmwan on the challenges of wildlife conservation in Nigeria's Okomu National Park,[43] wildlife loss is increasing in the park due to wildlife and forest crimes despite being a designated protected area for the country. According to the study, despite efforts to prevent it, Okomu National Park is subject to poaching, farming, logging, and non-timber product collection, albeit its adverse impacts on wildlife conservation. This was mainly due to the community's view that nature provided wildlife for commercial and subsistence purposes rather than for preservation. In a related study by Jacob Daniel, a Cross River National Park case study was conducted to examine wildlife poaching in Nigerian national parks. The author found that the economic incentive behind wildlife and forest crimes poses a significant threat to the future of Nigeria's diverse ecosystems.[44] The study's data revealed that even though most respondents were aware of the park's restrictions on animal poaching and the consequences for violators, they continued to break these laws without consequence. The dynamics and socioeconomic drivers of the illegal hunting of wildlife for consumption in Oba Hills Forest Reserve, located in Southwest Nigeria, were investigated by Akinsorotan. The study concluded that controlling wildlife and forest crimes remains extremely difficult in Nigeria, leaving the future of wildlife conservation bleak.[45] Using illegal bushmeat hunting as a case study, the authors found that poverty and people's perception remains the primary driver of wildlife and forest crimes in Nigeria, and the resultant effect is a decline in wildlife conservation. These crimes continue to persist owing to the demand from wealthier communities. Many of those involved in these crimes are in it either for luxury, to meet market demands for ivory at local and international levels, or meat for subsistence or commercial uses.

38 Rekola, Mika, et al. 'Global Outlook on Forest Education (GOFE) A Special Report: Forest Education in Africa' (2019). <https://tinyurl.com/cvs7tm77> (accessed on 25 November 2022)

39 Okosodo, Ehi Francis, and Odangowei Inetiminebi Ogidi. "Biodiversity Conservation Strategies and Sustainability." Sustainable Utilization and Conservation of Africa's Biological Resources and Environment., 2023. Singapore: Springer Nature Singapore 61-84.

40 Rebecca Ejifoma 'Customs Intercepts Donkey Genitals Worth N216M in Lagos' *Thisday Newspaper* (Nigeria, 08 September 2022) <https://tinyurl.com/4rt6bmby> (accessed on 18 November 2022)

41 JoSef Skrdlik 'Nigeria: Customs Intercepted a Massive Shipment of Donkey Skins' (01 July 2022) <https://tinyurl.com/2s2ype5f> (accessed on 18 November 2022)

42 Hussaini Jirgi 'Customs Command Hands Over 3,712 Donkey Skins To NAQS' *Leadership Newspaper* (Nigeria June 2022) <https://bit.ly/3I0JSLn> (accessed on 18 November 2022)

43 Olaleru, Fatsuma and Egonmwan, Rosemary 'Wildlife conservation challenges in Okomu National Park, Nigeria' (2014). *Ethiopian Journal of Environmental Studies and Management* 670.

44 Jacob, Daniel 'Wildlife Poaching in Nigeria National Parks: A Case Study of Cross River National Park' (2015). *International Journal of Molecular Ecology and Conservation* 57

45 OA Akinsorotan 'Dynamics and Socioeconomic Drivers of Illegal Hunting of Wildlife Animal for Consumption in Oba Hills Forest Reserve in Southwest Nigeria' (2020) *J. Appl. Sci. Environ. Manage*. 24 287-298

Similarly, Beekman's book explains that Lake Chad has dramatically decreased in size, losing more than 90% due to water overutilisation and climate change.[46] This has led to the destruction of fisheries, agriculture, and pastures, resulting in an estimated 49 million people who depend on its resources, mainly in Nigeria, to be in a precarious situation. The jeopardy faced by the sustenance of local communities and the preservation of natural ecosystems and biodiversity cannot be understated. These factors are fundamental for a just and sustainable society, a robust economy, and a secure future. Consequently, curbing overexploitation, which includes wildlife crime, is a significant obstacle to conserving the flora and fauna in and around the lake. A study conducted by Omifolaji[47] revealed that Nigeria boasts the presence of three out of the four pangolin species found in the Afro-tropical forests of Sub-Saharan Africa. The research shed light on the fact that these remarkable creatures are frequently hunted for various purposes, including as a source of bushmeat, for ethno-medicinal remedies, and even as a game. Over the last five years, the escalation of demand from global markets has led to a surge in poaching incidents and seizures. This has resulted in the depletion of local pangolin populations and the destruction of their habitats in West and Central African countries, including Nigeria.

Mahi and Usman's study[48] showed that community members often rationalise and justify hunting as part of their heritage and felt the establishment of Kainji National Park was intruding on this. This became a significant catalyst for illegal hunting, with poachers employing various tactics. These tactics included resorting to mystical powers, targeting vultures, offering bribes, utilising community members as informants, predicting the movements of park rangers, selling hunted animals to familiar and new customers, and leveraging their expertise in navigating the forest environment. The persistence of poaching can be attributed to the rich diversity of available wildlife and the unfortunate presence of corruption among park rangers. This paints a concerning picture of the challenges faced in combating illegal hunting.

According to the World Wildlife Crime Report 2020 by the UNODC, the illegal trade of ivory is estimated to be worth anywhere between $310 to $570 million, while the trade in rhino horn is valued at $170 to $280 million.[49] In July 2021, three suspects were arrested, and 196 sacks containing 4.6 Kgs. of pangolin claws, 888.5 kgs of ivory and 7,167 Kgs. of pangolin scales were seized by the Nigerian Customs Service during a search at a residence in Lagos.[50] Similarly, in September 2021, two suspects were arrested, and 15 sacks with over 1 tonne of pangolin scales, representing more than 2,500 dead pangolins, and 5 kgs of pangolin claws were seized.[51] This illegal wildlife trade has devastatingly affected wildlife conservation in Nigeria. For example, Yankari National Park, the stronghold of Nigerian savanna elephants (L. Africana), experienced a population decline from 350 in 2006 to only 100 in 2015 due to poaching and ivory trafficking.[52] There are also reports of endangered hooded vultures being openly traded in Nigerian markets.[53]

Wildlife and forest crimes severely threaten nations' resources, with their most profound impact felt by vulnerable individuals and communities.[54] Unfortunately, the consequences of conservation efforts are often

46 BeekmanHans E. *Facing the Facts: Assessing the Vulnerability of Africa's Water Resources to Environmental Change* (UNEP/Earthprint, 2006)

47 Omifolaji, J. K. et al 'The Emergence Of Nigeria As a Staging Ground In The Illegal Pangolin Exportation To South East Asia' (2020) Forensic Science International: Reports 100138.

48 Okoro Paul Mmahi and Abubakar Usman "Hunting Is Our Heritage; We Commit No Offence": Kainji National Park Wildlife Poachers, Kaiama, Kwara State Nigeria' (2020) *Deviant Behavior*, 41:12 1510.

49 UNODC, World Wildlife Crime Report 2020: Trafficking in Protected Species, Vienna 2020, <> (accessed on 30 October 2022).

50 Wildlife Justice Commission 'Joint operation with Nigeria Customs Service leads to three arrests, seizure of 7.1 tonnes of pangolin scales and 870 kg of ivory' (04 August 2021) <https://bit.ly/3viil0b> (accessed on 25 November 2022)

51 Ibid.

52 Salamatu Jidda-Fada 'Nigeria's Elephants and the Dwindling Populations - Any Hope for Recovery?' *Thisday Newspaper* (Nigeria 07 September 2021) <https://tinyurl.com/zy6b2kxr> (accessed on 24 November 2022).

53 DL Ogada and R Buij 'Large declines of the Hooded Vulture Necrosyrtes monachusacross its African range' (2011) *OSTRICH* 82(2) 101

54 Folharini, S., Melo, S., and Cameron, S. 'Effect of protected areas on forest crimes in Brazil.' (2021). *Journal of Environmental Planning and Management*, 65 272 - 287; Douglas, L., and Alie, K. 'High-value natural resources: Linking wildlife conservation to international conflict, insecurity, and development concerns.' (2014). *Biological Conservation* 171 270-277; Akanwa, A. O., Banerjee, A., Jhariya, M. K., Muoghalu, L. N., Okonkwo, A. U., Ikegbunam, F. I., and Madukasi, E. I. Climate-Induced Conflicts Between Rural Farmers and Cattle Herders: Implications on Sustainable Agriculture and Food Security in Nigeria. (2023). *Ecorestoration for Sustainability*, 373-416.

overlooked. These crimes persist due to their low-risk nature and minimal sanctions, rendering them an attractive option for criminals. Several factors drive wildlife and forest crimes in Nigeria, and addressing these issues is vital to reducing the nation's vulnerability.[55] Foremost among the drivers of such crimes are porous borders, enabling illicit trade in wildlife and forest products to flourish.[56]

Additionally, corruption at various levels of governance further exacerbates the problem, fostering an environment where criminal activities can thrive with relative impunity.[57] Political apathy and enforcement challenges compound these issues, making it imperative to devise effective strategies for combating these crimes. The following section will examine the frameworks to combat these drivers and reduce Nigeria's vulnerability.

4. Policy, Legal and Institutional Responses

Nigeria faces massive challenges in preventing wildlife and forest crimes. Laws exist to confront these crimes, particularly those associated with vulnerable and endangered species, to create a unified response to the prevalence of these offences. This analysis will examine existing legislation tackling wildlife crimes in Nigeria.

4.1. Nigeria's Legal Framework on Combating Wildlife Crimes

4.1.1. National Environmental Standards and Regulations Enforcement Agency (Establishment) Act, 2007

The aim of the Act is inferable from its long title, which outlines its purpose as the establishment of a national environmental standards and regulations enforcement agency (NESREA) responsible for protecting and developing Nigeria's environment, along with other related issues. The Act defines the environment in Section 37, which encompasses water, air, land, and all living beings and plants in those areas, including their various relationships. Given that the interdependence of two environmental elements—human beings and the creatures that live there—causes wildlife and forest crimes to persist, this definition is pertinent to the theme of this paper. Due to this interrelationship, the Act's provisions are thus relevant to preventing wildlife crime in Nigeria.

NESREA is tasked with several primary responsibilities, including protecting and developing the environment, preserving biodiversity, and promoting sustainable natural resource management. Additionally, the agency collaborates with local and international stakeholders to enforce environmental standards, regulations, rules, laws, policies, and guidelines. Ultimately, NESREA is responsible for safeguarding Nigeria's water, air, land, forests, and wildlife.[58] NESREA's responsibilities encompass wildlife crime prevention, as specified in Sections 7(a), (c), and (e) of the Act. Section 7(a) mandates enforcing environmental laws, standards, policies, and guidelines, making NESREA a critical enforcer of wildlife crime prevention laws in Nigeria. In addition, Section 7(c) requires the agency to enforce international agreements, protocols, conventions, and treaties on various environmental concerns such as climate change, biodiversity, conservation, desertification, forestry, oil and gas, chemicals, hazardous wastes, ozone depletion, *marine and wildlife*,[59] pollution, sanitation, and any other environmental agreements that may be ratified. Similarly, Section 7(e) imposes on the agency the responsibility of ensuring compliance with guidelines and laws governing the sustainable management of Nigeria's ecosystem, biodiversity conservation, and utilisation of natural resources such as wildlife and forests.

55 Kopnina, H., Muhammad, N. Z., & Olaleru, F. 'Exploring attitudes to biodiversity conservation and Half-Earth vision in Nigeria: A preliminary study of community attitudes to conservation in Yankari Game Reserve.' (2022) *Biological Conservatio* 272 109645.

56 Okunade, S. 'Perspectives on Illegal Routes in Nigeria.' (2017). *African Research Review*, 11, 14-24.; Okoli, A. C. Cows, Cash and Terror. (2019). Africa Development/Afrique et Développement 44.2 53-76.

57 Okwuwada, N. The modern day consequences, causes, and nature of kidnapping, terrorism, banditry, and violent crime in Nigeria: A comprehensive analysis. (2023). MPRA Paper No. 117671 <https://mpra.ub.uni-muenchen.de/117671/> (Accessed on 13 September 2023)

58 Constitution of the Federal Republic of Nigeria 1999 (As Amended) S 20

59 Emphasis Mine

In addition, NESREA has the power to prohibit the use of procedures, equipment, technology or any other means that may cause environmental degradation,[60] oversee field compliance with standards and take legal action against offenders,[61] set up mobile courts to handle violations swiftly,[62] conduct investigations into pollution and natural resources degradation,[63] NESREA is also responsible for establishing monitoring networks, gathering and analysing environmental data from all regions, and collaborating with other pertinent agencies to develop standards and regulations that aim to prevent, reduce, and eliminate pollution, safeguard animal species, and to avoid wildlife crimes, particularly those that threaten endangered species.[64]

In sum, enforcing provisions of all laws relating to the protection of animal species and the prevention of wildlife crimes, particularly preventing endangered species from becoming extinct, represents the agency's overall duty concerning the subject matter of discourse.[65]

4.1.2. The Endangered Species (Control of Trade of International Trade and Trafficking) Act

The Endangered Species (Control of Trade of International Trade and Trafficking) Act (ESA.)[66] represents Nigeria's most comprehensive wildlife and crime prevention law. The ESA was put in place to protect and conserve wildlife and safeguard endangered species from over-exploitation—a requirement of international treaties that Nigeria has signed. First enacted in 1985 and amended in 2016,[67] the ESA is arranged into nine sections and two schedules. This Act prohibits the hunting, capturing, or trading of animal species listed in the First Schedule (these species are threatened with extinction). Additionally, persons are prohibited from hunting, capturing, trading, or otherwise dealing with animal species listed in the Second Schedule (these species may become threatened with extinction unless trade is regulated) - except with a license from this Act.[68]

Section 6 of the ESA prohibits any action that could cause wildlife mass destruction. This includes banning several activities, such as using drugs, poisons, poisoned weapons or baits, hunting with motorised vehicles, setting fires, using firearms with multi-round firing capacity, hunting or capturing at night, and utilising explosives to catch fish or hunt wildlife.[69] Section 5(1)(a) imposes a 5,000,000 Naira fine for anyone who trades in, possesses, or otherwise deals with species listed in Schedule 1. Those who re-offend will be fined 1,000,000 Naira and 12 months imprisonment. Section 5(1) (b) further sets a 1,000,000 Naira fine for anyone who trades in, possesses, or otherwise deals with species listed in Schedule 2 with Six months for a recidivist offender.

The increased fines under the ESA have not stopped the illegal harvesting of protected animals, such as pangolins, for culinary or therapeutic purposes.[70] Frequent seizures of illegal traffickers indicate that the ESA is not equipped with enough technology to prevent the hunt and capture of these animals. AI technologies can help to better protect Nigeria's endangered species from over-exploitation and make wildlife conservation and management strategies more effective instead of waiting until dead animals or their parts are found at export ports.

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60 NESREA 2007, S 8(d)
61 NESREA 2007 S 8(e)
62 NESREA 2007 S 8(f)
63 NESREA 2007 S 8(g)
64 NESREA 2007 Section 8(o)
65 Nkechi Isaac 'NESREA Seizes Cub, Arrests 2 for Illegal Wildlife Trading' *Science Nigeria (*Nigeria 10 February, 2022) (accessed on 0 December 2022).
66 Endangered Species (Control of Trade of International Trade and Trafficking)Act Cap E9, Laws of the Federation of Nigeria 2004
67 The amendment made in 2016 was aimed at increasing fines to achieve a more deterrent effect and to align with prevailing economic conditions.
68 ESA. S 1
69 This study finds that although the ESA. prescribed prohibited methods for taking or hunting wild animals, there are no penalties attached to the use of these prohibited methods.
70 Mary-Ann O. Ajayi 'Pangolin Trafficking In Nigeria In The Face Of Wildlife Laws' (2020) *Law and Social Justice Review (LASJURE)* 153

4.1.3. Protection of Endangered Species in international Trade Regulation 2011

PESITR 2011[71] is founded on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), of which Nigeria is a signatory. It seeks to protect endangered species by regulating international trade in such species. This law covers live specimens, leather goods, jewellery, medicinal products, and products made from endangered species. It prohibits trade in Appendix I species except in exceptional cases where they face the risk of extinction. Trade in Appendix II species is allowed only through a permit system. The National Wildlife Enforcement Monitoring Unit (NWEMU) and the Nigerian Customs Service (NCS) enforce the regulation, which applies only to international trade, as the protection of species in Nigeria is governed by other national laws.

Violation of the Regulations is punishable by severe fines and lengthy prison sentences.[72] For instance, importing, exporting, re-exporting, or introducing any specimen listed in Appendices I, II, and III to the Convention and the Schedules to the Act and these Regulations without a valid permit or certificate is illegal.[73] A person guilty of the above offence could face a maximum fine of 5 million Naira, up to three years in prison, or both.[74] Possessing, selling, or exhibiting any specimens of species listed in Appendices I, II, and III of the Convention or the Schedules to the Act and these Regulations are also prohibited under Section 7(3) of the regulation if they were obtained in violation of the Convention, Act, and Regulations. If convicted of this offence, offenders can face a penalty of up to 5 million Naira in fines, imprisonment for up to three years, or both. Furthermore, Section 7(11) states that a corporation may be subject to a fine of as much as twenty million Naira and that its top officers may get a sentence of up to seven years in jail or both if found guilty of violating any of these rules.

The National Wildlife Species Protection Act

The Act provides for the conservation and management of Nigeria's wildlife and protecting endangered species. This is per CITES, the Convention on Biological Diversity (CBD and the Convention on Migratory Species of Wild Animals (CMS), and its daughter Agreements and protocols. Section 1 of the Act prohibits the hunting and trading wildlife in Nigeria. The First Schedule of the Act lists animal and plant species either native to Nigeria or deemed endangered, and their hunting or trade is prohibited. The Second Schedule includes such species that, although not currently in the endangerment of extinction, could be in danger unless their trade is regulated under a license issued by this Act.

Section 5(2) states that any person violating the Act's provisions by hunting, capturing, possessing, trading, or engaging in any transactions involving wild fauna and flora specimens without the appropriate permits is deemed to have committed an offence. If found dealing with a specimen listed under the First Schedule without the required permit, the offender may face a penalty of up to 500,000 Naira in fines, imprisonment for up to five (5) years, or both. In the case of a specimen under the Second Schedule, the penalty is a fine of up to 300,000 Naira imprisonment for up to three (3) years, or both. Moreover, utilising any of the techniques outlined in Section 9 to capture, fish, take, or hunt without permission can result in a penalty of 1,000,000 Naira in fines or imprisonment for up to 10 years.

4.1.4. The National Park Services Act 1999

The National Park Service of Nigeria, established by the Act, is responsible for preserving, enhancing, and protecting wild animals, plants, and other vegetation in National Parks. The Act comprises 53 sections organised into 7 parts. These parts focus on the Establishment of the National Park Service and its Governing Board, its Objectives, functions, and powers; Staff of Service; Establishment and Management Principles of National Parks; Offences and penalties; and Miscellaneous.

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71 National Environmental (Protection of Endangered Species in International Trade) Regulations, 2011 (S.I. No. 16 of 2011).

72 See Part iii titled Offences and Penalties

73 National Environmental (Protection of Endangered Species in International Trade) Regulations, 2011, S7(1)

74 National Environmental (Protection of Endangered Species in International Trade) Regulations, 2011, S 7(2)

Specifically, to prevent wildlife and forest crimes, the Act provides that all wild animals and plants in their natural habitat belong to the Federal Government to benefit Nigeria and humanity.[75] The Act prohibits unauthorised entry into national parks and restricts certain park activities.[76] These activities include the hunting or capture of animals,[77] destruction or collection of animals,[78] possession of a live or dead wild animal, bird, or reptile,[79] use of instruments such as snares, traps, or calling devices to hunt, and possession or use of weapons,[80] explosives, snares, or traps within the park.[81] Anyone found guilty of such offences violates the Act.[82]

Violators will face a penalty consisting of a fine of not more than 20,000 Naira imprisonment for a maximum of two years, or both in contravention of Section 29 of the Act.[83] Where the offence involves a mother of a young animal or any endangered, protected, or prohibited species, in such case, the offender will be punished with imprisonment ranging from three months to five years without the possibility of a fine.[84] Furthermore, suppose a person is found to have committed an offense under section 31 of this Act. In that case, they can be punished with a fine ranging from 5,000 to 25,000, Naira or a prison sentence lasting from six months to five years, or both the fine and imprisonment, upon conviction.[85] Although it has been argued that these fines are not stringent enough to achieve the goals of the Act, this study opines that the main challenge centres on catching the offenders first. According to Mmahi and Usman's analysis,[86] the primary culprits of these crimes are the local inhabitants of the communities around these parks, who view the parks as an incursion into their space. Their indigenous knowledge of the area makes it especially easy for them to navigate their way in and out of the parks without being detected, let alone apprehended.

Furthermore, a critical factor in this issue is insufficient staffing to monitor these parks' borders and boundaries adequately. Interestingly, this challenge presents an opportunity for a practical solution by applying AI-related technologies. By leveraging these technologies, we can potentially address this staffing shortfall and enhance the protection of these vital natural areas.

National Ivory Action Plan

In 2013, Nigeria was identified by the CITES Standing Committee as a transit point for the illegal trafficking of elephant ivory and other wildlife products, resulting in a "secondary concern" status.[87] Nigeria created the National Ivory Action Plan (NIAP) in 2014 to eliminate illegal ivory trading.[88] The NIAP took proactive steps by collaborating with multiple national agencies and engaging various stakeholders. This strategic effort aimed to combat poaching and foster improved cooperation with neighbouring countries. To be more concise, the plan seeks to achieve the following objectives:

1. Enhance laws and penalties to combat wildlife crime and illegal ivory trafficking,
2. Prosecute wildlife crimes effectively and impose appropriate penalties to discourage offenders,
3. Use intelligence and investigations to disrupt criminal syndicates engaged in the trafficking of wildlife,
4. Enhance coordination both nationally and regionally to improve border control and deter the illegal trafficking of wildlife and
5. Enhance the protection of remaining elephant populations in critical areas of Nigeria.

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75 The National Park Services Act 1999, S 20(1)
76 The National Park Services Act 1999, S 29(1)
77 The National Park Services Act 1999, S 30 (1)(a)
78 The National Park Services Act 1999, S 30(1)(b)
79 The National Park Services Act 1999 S 30(1) (j)
80 The National Park Services Act 1999 S 30(1)(q)
81 The National Park Services Act 1999 S 31
82 The National Park Services Act 1999 S 37 lists the various penalties for contravening the provisions of the Act.
83 The National Park Services Act 1999 S 37 lists the various penalties for contravening the provisions of the Act.
84 The National Park Services Act 1999, S37(2)(a)
85 The National Park Services Act 1999 , S 37(3)
86 Okoro Paul Mmahi and Abubakar Usman ' "Hunting Is Our Heritage; We Commit No Offence": Kainji National Park Wildlife Poachers, Kaiama, Kwara State Nigeria' (2020) *Deviant Behavior*, 41:12 1510.
87 Challender, Daniel WS, and Colman O'Criodain *Addressing trade threats to pangolins in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)*' (Pangolins. Academic Press, 2020)
88 See <https://tinyurl.com/mvt374rv> (accessed on 20 November 2022).

The NIAP prioritised amending the legal framework for endangered species by increasing fines and drafting the National Wildlife Protection Bill,[89] which imposes deterrent penalties such as fines and prison sentences. To reduce elephant poaching, the NIAP also provided modern equipment and improved the status/capacity of patrol staff at key priority sites.

4.1.5. National Strategy on Wildlife and Forest Crime 2022–2026

To tackle wildlife and forest crime in Nigeria more effectively, the Ministry of Environment, with support from the Government of Germany and UNODC, has developed the National Strategy on Wildlife and Forest Crime 2022–2026.[90] This marks the first time such a strategy has been implemented in Nigeria, and it is being developed as part of a more comprehensive initiative to strengthen the country's response to wildlife and forestry product trafficking. The strategy will work alongside the support of the European Union and the International Consortium on Combating Wildlife Crime (ICCWC) to evaluate Nigeria's response to wildlife and forest crime through various assessments and frameworks. Additionally, corruption risk assessments will be conducted in Nigeria's wildlife and forest sectors. Nigeria's five-year strategy to abolish illegal wildlife trade, titled "A Nigeria Free of Wildlife Crime," comprises seven objectives:

1. Enhance institutional capabilities for intuiting, detecting, and deterring wildlife crime.
2. Improve the legal framework to discourage wildlife crime and promote sustainable trade through harmonisation and strengthening.
3. Enhance cooperation and coordination among nations and international organisations to tackle wildlife crime.
4. Comply with national and international regulations to regulate legal trade and combat wildlife crime.
5. Curb corruption and financial crime to prevent wildlife crime.
6. Increase public and political awareness of the importance of nature and the impact of wildlife crime.
7. Implement initiatives to empower local communities in preventing wildlife crime.

As laudable as this strategy may seem, the implementation of its objective may be short-circuited, particularly its first two sets of goals, without access to technological solutions which AI provides. This is premised on the fact that the institutions saddled with achieving these objectives, the Nigerian Financial Intelligence Unit (NFIU), NESREA, Economic and Financial Crimes Commission (EFCC), NCS, National Park Service, INTERPOL Central Bureau Nigeria, Economic, and Financial Crimes Commission (EFCC) do not possess the necessary staffing and infrastructure to ensure compliance with their primary set objectives let alone maximising the efficacy of the inaugural national wildlife strategy and obtaining widespread recognition.

In addition to the federal laws discussed above,[91] some state legislations also exist to complement the federal government's efforts at combating the scourge of wildlife and forest crimes in the country. These state laws reflect statewide commitment to conservation and protection. For instance, some of these state legislations include: Cross River State Forestry and Wildlife Law No. 3 of 2010, Kano State Wild Animals Law 1963 (as amended in 1975), Taraba State Wild Animals Law 1963 Cap 143, Lagos State Wildlife Preservation Law 1959 as amended in 1972, River State Animals Preservation Law Cap 140 1963, Adamawa State Wildlife Law Cap 143 of 1963.

4.2. Factors Inhibiting the Effectiveness of Wildlife Crime Prevention Laws

From the laws examined in the previous section, Nigeria has extensive legislation for conserving its natural resources, but enforcement is often weak, allowing for large-scale violations of these laws. The UNODC report confirms this, listing Nigeria as a central transit point for illegal wildlife trade and a key source of endangered species like ivory and pangolins. These gaps in enforcement are limiting a coordinated response to wildlife crime prevention.

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89   It is important to note that till date the bill is yet to be passed into law by the National Assembly
90   See <https://tinyurl.com/2x6u97fu> (accessed on 20 November 2022).
91   Other Laws worthy of note on Wildlife and Forest Crimes prevention in Nigeria include The Constitution of Nigeria 1999 (as amended 2011); The Money Laundering (Prohibition) Act 2011 as amended; The Customs and Excise Management Act 1959; The National Environmental (Control of Alien and Invasive Species) Regulations 2013; The Extradition Act 2015 (as amended); Nigerian Financial Intelligence Unit Act 2018; Advanced Fee Fraud and Other Related Fraud Offences Act 2006;

One of the primary factors undermining the effectiveness of combating wildlife crimes in Nigeria is the lack of essential knowledge among enforcement agencies, leading to a dearth of arrests and successful prosecutions. This knowledge deficit extends to CITES and to changes in wildlife protection laws, which judicial authorities often remain uninformed about. This critical lack of awareness permeates law enforcement officers, police personnel, and wildlife officials, hampering their ability to enforce existing regulations and combat wildlife crimes effectively. Compounding this issue is the absence of adequate tools and resources to identify illegal wildlife products, further exacerbating the challenges in detecting and apprehending those engaged in wildlife trafficking. An illustration of this difficulty is the interception of a staggering 7,000 pieces of male donkey genitals at Murtala Mohammed Airport on September 8, 2022. These illicit goods were concealed in a manner that would have gone undetected were it not for the unmistakable putrid odour they emitted.[92]

The effectiveness of wildlife crime regulations in Nigeria also faces significant impediments from the nation's limited capacity to gather, analyse, and proactively address intelligence related to these illicit activities. A notable deficiency is the absence of a comprehensive national database dedicated to monitoring wildlife crime, which hampers the ability to conduct proactive investigations, pinpoint high-risk areas, and identify individuals involved in such criminal activities. Currently, seizures predominantly occur reactively, either in response to specific intelligence or during routine customs inspections. Furthermore, there is a notable scarcity of trained enforcement officials equipped with the skills to prevent wildlife crime. For instance, while NESREA maintains 28 offices with a staff complement of 100 in each office, the presence of personnel at critical points such as borders, airports, and ports is notably sparse. Within the Nigerian Customs Department, only a few officers have received adequate training, and many lack the necessary equipment for effectively detecting and combating wildlife crimes.

This study underscores that wildlife crimes and trafficking are not accorded the priority they deserve in Nigeria. Coupled with the abovementioned inadequacies, this lack of emphasis has resulted in fragmented and disjointed law enforcement efforts. Furthermore, there is a shortage of higher-level policies or established protocols to support these enforcement initiatives. Corruption represents a formidable barrier to effective law enforcement, particularly at high-risk entry and exit points such as 'sESREA

Having identified these gaps and problems associated with the enforcement of laws on wildlife crime prevention in Nigeria, it is apposite to state that the increase in the use of AI for environmental sustainability, particularly wildlife conservation, demonstrates that an increasing number of countries and experts on wildlife conservation are incorporating this technology to meet their needs.[93] The following section examines the potential of AI in strengthening the Nigerian legal framework on the subject matter.

5. Artificial Intelligence as an Algorithm for Strengthening Legal Framework for Wildlife and Forest Crime Prevention

Advances in computation, technology and AI-related research have increased their application in environmental conservation.[94] Recently, the social media space was awash with the story of a Nigerian man who was to be deported from Canada for unknowingly killing a rare parrot species. The parrot at the time it was killed was fitted with a Global Positioning System (GPS) tracker,[95] an AI-related technology initially created to help soldiers and

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92   Rebecca Ejifoma 'Customs Intercepts Donkey Genitals Worth N216M in Lagos' *Thisday Newspaper* (Nigeria, 08 September 2022) <https://tinyurl.com/4rt6bmby> (accessed on 18 November 2022).

93   According to the UNODC's project "Strengthening Nigeria's Response to the Trafficking of Wildlife and Forestry Products," there have been no successful prosecutions of wildlife and forestry product trafficking cases in Nigeria. This makes such crimes a high-profit illicit activity with a low-risk of being caught. Furthermore, most large-scale seizures of trafficked wildlife products that pass through Nigerian ports are discovered in the destination countries, indicating a low capacity for detection and investigation See <https://www.unodc.org/nigeria/en/strengthening-nigerias-response-to-the-trafficking-of-wildlife-and-forestry-products-2020-2022.html>. (accessed on 23 November 2022)

94   K.N Shivaprakash 'Potential for Artificial Intelligence (AI) and Machine Learning (ML) Applications in Biodiversity Conservation Managing Forests, and Related Services in India' (2022) *Sustainability* 14, 7154.

95   Nigerian Man Deported From Canada a Month After Relocation For Killing a Parrot (13 October 2022) <https://tinyurl.com/yc5z6yza> (accessed on 10 November 2022).

military ships, planes, and vehicles locate themselves correctly anywhere in the world. It is now used to track wildlife. The arrest was made primarily due to GPS monitoring, which allows conservationists to attach a radio receiver to an animal and use that information to determine its whereabouts and the direction in which it is going.

There is no doubt that enforcing wildlife protection laws is a difficult task, but using technology can make it easier. Technology, such as data science and big data, can help address various wildlife monitoring and forest management issues. These objectives involve safeguarding, rejuvenating, and encouraging the sustainable utilisation of land-based ecosystems, promoting sustainable management of forests, combating desertification, halting and reversing soil degradation, and preventing biodiversity decline. Recent advances in wildlife conservation have been made by applying AI, which could be adopted in Nigeria to strengthen the enforcement of wildlife crime prevention laws. Some of such advantages of AI for wildlife crime prevention include;

Classification, Study, and Protection of Wildlife Species

Today, scientists use artificial intelligence to gain insights into the factors that threaten endangered species worldwide.[96] This involves using AI to provide data on various aspects of the species' lives, such as their birthplaces, survival rates, migration patterns, and distance travelled.[97] AI has allowed wildlife researchers to study wild animal species together and develop protective strategies by tracking their behaviours and predicting the possible extinction of endangered animals. Applying AI in Nigeria, where there is a diverse range of animal species, to legal efforts at wildlife crime prevention will make it easier to determine the location of animals, their sighting dates, migration patterns, and social groups. This will enable conservationists and law enforcement agents to more effectively monitor and protect animals in their natural habitats. For example, DeepMind, a UK-based company, has deployed an AI-based model in Tanzania's Serengeti National Park to identify animal species and count their numbers. This effort aims to recognise wild animals and protect endangered species before it becomes too late.[98] Microsoft's Species Classification API Demo also employs a machine-learning model to identify more than 5000 animal and plant species. Additionally, the World Wildlife Fund and Intel are collaborating with researchers on a project that uses artificial intelligence to monitor and safeguard Siberian tigers in China. By utilising AI, the project can analyse vast amounts of data collected through advanced camera traps to observe Siberian tigers. Deploying a similar approach in Nigeria's national parks would improve the identification, study, and protection of animal species and strengthen the enforcement of the country's wildlife crime prevention laws, particularly the National Parks Act and the NESREA Act.

Data Collection, Analysis, and Dissemination

AI enables the quick collection and analysis of extensive datasets, providing detailed data on natural activity. This data reveals the path to preserving animal species and gives a comprehensive view of the planet's biodiversity. AI further helps experts by providing complete data and analysis reports to make informed decisions, aiding in developing conservation policies. For instance, Katharina Schmidt, the founder of apic.ai, and her team created a beehive monitor to collect data using Tensor Flow, Google's open-source machine learning platform, to save the world's bee population.[99] The information has helped observe different bee behaviours, such as bee counts, migratory patterns, or whether they carry pollen.[100] Protection Assistant for Wildlife Security (PAWS is another AI-powered application that leverages predictive analysis and resource optimisation to aid rangers in their duties. By analysing data, PAWS provides information about the terrain, animal populations, natural pathways, and foot

96 Pereira, P., Ternes, M., Nunes, J. and Giglio, V. 'Overexploitation and behavioral changes of the largest South Atlantic parrotfish (Scarus trispinosus): Evidence from fishers' knowledge.'(2021). *Biological Conservation* 254, 108940; Visioni, A., Basile, B., Amri, A., Sanchez-Garcia, M. and Corrado, G. 'Advancing the Conservation and Utilization of Barley Genetic Resources: Insights into Germplasm Management and Breeding for Sustainable Agriculture'. (2023) *Plants* 12.18 3186. ; Ai, Z., Ishihama, F. and Hanasaki, N. 'Mapping current and future seawater desalination plants globally using species distribution models'. (2022) *Water Resources Research* 58.7 e2021WR031156.

97 Gupta, Satish Kumar. 'Artificial Intelligence Is Curse Or Boon.. (2022) Galaxy International *Interdisciplinary Research Journal* 10.2 155

98 Jon Fingas 'DeepMind uses AI to track Serengeti Wildlife with Photos'(08 August 2019) <https://tinyurl.com/ypvp8h8r> (accessed on 15 December 2022).

99 Alessia Morichi ' Bees, Machine Learning And How Small Things Can Make The Difference (20 May 2022) <https://bit.ly/3YPlD8S> (accessed on 16 December 2022).

100 Ibid

traffic, among other factors.[101] Similarly, Wildlife Insight is a cloud-based platform that utilises AI to enable multiple organisations to upload, store, manage, and share their data. The platform allows efficient and rapid processing of data collected from the field and seamlessly integrates with the Google Cloud for easy analysis and mapping.[102]

By leveraging the capabilities of AI, it is possible to address the gap in enforcing existing wildlife crime prevention laws in Nigeria, which is currently limited by a lack of capacity for a comprehensive strategic response. The information derived from analysed data can be shared among agencies for wildlife crime prevention, improving critical areas of expertise, such as species assessment and intelligence-led investigations.

Nigeria's enforcement agencies, which include police, customs, judiciary, and wildlife officials, have a limited understanding of CITES, which can also be remedied through data gathered from AI technologies. Additionally, this data would be relevant in the development of a national strategy to combat wildlife crime, as well as the formulation of standard procedures for inter-agency collaborations.

Detection and Control of Wildlife and Forest Resources Poaching

One major challenge with wildlife conservation in Nigeria is the high rate of wildlife crimes- the illegal practice of the intensive slaughter of animals, which reduces the number of these species and forest resources poaching. AI tools can now assist in managing illicit activities related to poaching by utilising a human-free monitoring system. AI-enabled drones and night vision cameras can facilitate the swift detection of poachers on the ground and alert forest rangers to take preventive measures before any harm is caused to wildlife. Cameras equipped with AI and rapid alert systems can also quickly identify humans carrying weapons or engaging in suspicious activities. This will aid wildlife crime prevention agencies such as NESREA and officials of the National Park Service to detect and stop wildlife crimes before they occur. For example, The Protection Assistant for Wildlife Security (PAWS),[103] an AI system created by the University of Southern California, uses past poaching records to anticipate future locations. It factors location, timing, and ranger patrols to make its predictions. With the algorithm generated from this data, park rangers in the Nigerian National Parks will be able to accurately predict which areas to patrol and identify the most vulnerable areas of the parks, thus taking appropriate and proactive actions toward wildlife crime prevention. In the same vein, using The Rainforest Connection, an AI system developed by a San Francisco-based NGO,[104] park rangers can effectively identify the optimal route for patrolling, search for traps and snares, and quickly detect wildlife crimes.

Similarly, using The Elephant Listening Project, developed by Cornell University researcher Peter Wrege and his team,[105] wildlife conservationists could collect and categorise information about savanna elephants living in Nigeria's dense rainforests. By placing audio recorders in the forest to observe jungle sound, this AI technology could help Nigeria's wildlife crime prevention agencies separate noises locate elephants, and trace poachers' movements. In addition to the aforementioned, Project SEEKER, a groundbreaking multi-species artificial intelligence (AI) tool developed utilising Microsoft Azure Machine Learning Services, represents a significant leap forward in the fight against illegal wildlife trafficking.[106] This innovative AI model is designed to identify illegally trafficked wildlife concealed within luggage and cargo autonomously, and it has recently undergone successful trials at Heathrow Airport, where it processed a remarkable volume of up to 250,000 bags daily.[107] The results showed a detection rate exceeding 70%, particularly excelling in identifying ivory items,

101 Isabelle, Diane A., and Mika Westerlund. 'A Review and Categorization of Artificial Intelligence-Based Opportunities in Wildlife, Ocean and Land Conservation' (2022) *Sustainability* 14.4 1979.

102 Fang, Fei, et al. 'Predicting Poaching For Wildlife Protection' (2017) *IBM Journal of Research and Development* 61.6, 3

103 Duberry, Jérôme 'Artificial Intelligence and Environmental Civil Society Organisations' (2019) Global Environmental Governance in the Information Age: Civil Society Organizations and Digital Media 145.

104 Devin Coldewey 'Rainforest Connection Enlists Machine Learning To Listen For Loggers And Jaguars In The Amazon' *Biotech & Health* (23 March, 2018) <https://tcrn.ch/2pH83Wc> (accessed on 11 December 2022).

105 Melanie Lefkowtiwz 'AI Speeds Effort to Protect Endagered Elephants' Cornell Chronicle (27 August 2018) https://bit.ly/3z3B918 (accessed on 17 December 2022).

106 Daniel Haines, Azure Data & AI Solution Specialist.Project SEEKER: Using artificial intelligence for good (31 January 2022) <https://tinyurl.com/2v8mh23p> (accessed on 14 September 2023)

107 See <https://www.airport-technology.com/news/heathrow-microsoft-wildlife-trafficking/?cf-view> (accessed on 14 September 2023).

including tusks and horns.[108] What sets Project SEEKER apart is its potential to revolutionise the way airports and security systems address the critical issue of illegal wildlife trafficking. Its successful deployment at Heathrow Airport underscores its effectiveness in rapidly and accurately identifying prohibited wildlife products, bolstering global efforts to combat this illicit trade. Nigeria's airport security systems cannot detect illegal wildlife items concealed in baggage and cargo. Project SEEKER has the potential to fill this significant gap, fortifying Nigeria's defences against wildlife trafficking. This integration could mark a pivotal moment in the country's environmental conservation and sustainability commitment. The illegal timber trade is often regarded as lucrative as the illegal wildlife trade. This is because the forest provides a home for the animals to thrive; as such, the illicit timber trade also affects wildlife conservation. AI and MLE algorithms are now used with spatial analysis to accurately forecast and monitor deforestation worldwide and keep track of global deforestation rates using monitoring systems.[109] For instance, Rainforest Connection utilises old, discarded cell phones equipped with solar power to detect illegal timber felling in forests. The cell phones are mounted on treetops and record chainsaw sounds. The data is then sent to cell phone towers, where Google's AI and MLE library distinguishes chainsaw noise from other sounds. Using this data and the sensor's location, forest managers are informed to prevent illegal tree felling.[110] Tools like Outland Analytics, Terramonitor, Global Forest Watch, and Future Forest Map are also being used to create maps and continuously monitor deforestation in real time using open-source satellite data.[111] To successfully combat wildlife crime, Outland Analytic employs AI-based audio recognition algorithms to identify the sounds of chainsaws and unlicensed vehicles and instantly sends email alerts to the concerned authorities.[112]

AI has the potential to revolutionise the fight against wildlife trafficking in Nigeria. Using object recognition and machine learning, AI can identify species, verify shipping contents, detect online sales, and recognise trafficking patterns. Additionally, AI-powered scanning equipment can detect contraband in luggage and cargo, prompting manual inspection.[113] Finally, AI algorithms can bolster existing laws to reduce the rate of wildlife crimes over time. AI could have the most significant potential to identify contraband, trafficking routes, and patterns while reducing personnel and investigation needs.

Control of Illegal Animal Trade on Social Media

Online illegal wildlife trafficking has significantly increased due to the growth of social media and e-commerce platforms, making it extremely difficult to identify and stop such criminal activity. These online marketplaces have allowed traders to trade illegally in wildlife worldwide, making it challenging to track supply chains. AI technology is being developed to automatically scan and explore massive amounts of online data to stop this trade and address this rising problem. The "Coalition to End Wildlife Trafficking Online" (CEWTO), which unites 34 e-commerce, search, and social media technology companies to work with wildlife organisations to stop this illegal trade, was established in 2018 by the World Wildlife Fund (WWF) and the International Fund for Animal Welfare (IFAW). One such enterprise is Baidu, a well-known Chinese multinational tech company with a speciality in AI and the internet, which is collaborating with the CEWTO to develop AI tools for identifying wildlife for sale listings online.

Analysing the Effect of Climate Change on Wildlife Species

When obtaining data on how climate change affects animals and minimising its effects through strategic planning, AI technology has shown to be a beneficial tool. The tremendous data issues associated with climate change make deploying AI extremely helpful. Scientists have been monitoring greenhouse gases and their sources

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108 See https://www.smithsdetection.com/press-releases/smiths-detection-collaborates-with-microsoft-and-heathrow-to-develop-ai-tool-to-uncover-wildlife-trafficking/ (accessed on 14 September 2023).

109 Reichstein, Markus, et al. 'Deep Learning and Process Understanding for Data-Driven Earth System Science' (2019) *Nature* 566.7743, 195.

110 Metcalf, O.C. et al 'A Novel Method for Using Ecoacoustics to Monitor Post-Translocation Behaviour in an Endangered Passerine' (2019) *Methods Ecol. Evol.* 626

111 Shivaprakash, Kadukothanahally Nagaraju, et al. 'Potential for Artificial Intelligence (AI) and Machine Learning (ML) Applications in Biodiversity Conservation, Managing Forests, and Related Services in India' (2022) *Sustainability* 14.12, 7154.

112 Kim, K.S, and Park, J.H. A Survey Of Applications Of Artificial Intelligence Algorithms In Eco-Environmental Modelling. (2009) *Environ. Eng. Res.* 102

113 Engstrom, David Freeman, et al. 'Government by algorithm: Artificial intelligence in federal administrative agencies' (2020) NYU School of Law, Public Law Research Paper 20

for a long time, but evaluating and using the data[114] effectively has been challenging. Improving climate modelling and predictions is one of the most essential advantages of AI technology in the context of climate change. Models for forecasting the weather are becoming more accurate thanks to recent developments in machine learning. AI is also increasingly used to analyse model results and contrast them with observations from the outside world. With AI, it is now easier to monitor temperature increases that directly affect many species' chances of surviving, leading to a lack of food, fewer possibilities for reproduction, and changes to the environment for local fauna. AI techniques are also included in species recognition systems, remote sensing tools, and animal monitoring sensors to assess ecological changes using visual or auditory data.[115]

6. Conclusion

The government has enacted laws and policies in Nigeria to prevent wildlife and forest crimes. However, these laws are not always effective, as offenders frequently go unpunished due to insufficient resource allocation by environmental compliance authorities. AI-related technologies have the potential to address this ongoing issue by managing and monitoring ecosystems. New data-gathering technologies such as UAS, satellites, and camera traps generating large amounts of data have significantly impacted ecology and conservation sciences. By using technology to reduce poaching and preserve marine life, among other things, AI techniques can help Nigeria achieve its environmental protection goals and contribute to its Sustainable Development Goals. It is essential to strengthen the existing legal framework on wildlife crime prevention in light of AI's potential to unlock benefits far beyond this century. Failing to do so may result in a future that could leave conservation efforts in limbo for years to come.

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114 Rahman, M. M., Hasan, M. A., Shafiullah, M., Rahman, M. S., Arifuzzaman, M., Islam, M. K. and Rahman, S. M. 'A critical, temporal analysis of Saudi Arabia's initiatives for greenhouse gas emissions reduction in the energy sector' (2022) *Sustainability* 14.19 12651; Zhang, Y., Ni, X. and Wang, H. Visual analysis of greenhouse gas emissions from sewage treatment plants based on CiteSpace: From the perspective of bibliometrics. (2023) *Environmental Science and Pollution Research* 30.16 45555-45569.

115 AI is also been used to provide habitats for animal and plant species. German researchers and scientists plan to develop 'weather stations' for biodiversity to provide better protection to plants, insects, birds, and perhaps even large animals.