USE OF UAV TECHNOLOGY FOR ENVIRONMENTAL CONSERVATION

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Abstract. *Unmanned Aerial Vehicles (UAVs), commonly known as drones, have revolutionized the landscape of environmental conservation and preservation. This abstract provides a comprehensive overview of the multifaceted and indispensable roles that UAV technology plays in safeguarding our natural ecosystems. UAVs have become instrumental in environmental research, monitoring, and protection, offering an unparalleled capacity to enhance data collection, reduce costs, and minimize human impact on delicate environments. These versatile devices are equipped with high-resolution cameras, sensors, and cutting-edge technologies, allowing scientists and conservationists to gain unprecedented insights into the Earth's biodiversity, ecological systems, and changing landscapes. As the challenges of environmental conservation grow more complex and urgent, UAVs stand at the forefront of innovation and change. They enable researchers, conservationists, and policymakers to gather accurate, up-to-date information, which is paramount for informed decision-making and timely interventions. This abstract underscores the pivotal role of UAVs in addressing the ecological challenges of our time and shaping a more sustainable and informed approach to environmental stewardship. By offering a panoramic view of our world, UAVs are helping to protect and preserve it for future generations. Looking ahead, the potential for UAVs in environmental conservation appears boundless. These unmanned aerial systems open up new horizons in our commitment to preserving and protecting Earth's precious ecosystems for future generations.*

Keywords: *UAV, technology, equipment, environment, conservation*

INTRODUCTION

The natural world is experiencing unprecedented challenges due to climate change, habitat loss, and the increasing pressures of human activity. In this critical juncture, technology has emerged as a powerful ally in the ongoing efforts to preserve and protect our fragile ecosystems. Among the most innovative and versatile tools in the environmental conservation arsenal are Unmanned Aerial Vehicles (UAVs), commonly known as drones.

This introduction sets the stage for a comprehensive exploration of the transformative role of UAV technology in environmental conservation. It recognizes the urgency of addressing environmental issues and highlights the multifaceted applications of UAVs in safeguarding the Earth's natural heritage (ANDERSON et all., 2013).

For decades, environmental conservation has relied on a combination of human efforts, ground-based data collection, and satellite imagery (COLOMINA et all., 2014). While these methods have yielded invaluable insights, they often come with limitations. Ground-based data collection can be time-consuming and hazardous in certain terrains, and satellite imagery may lack the fine details needed for precise environmental assessments.

UAVs have emerged as a game-changer, offering the ability to navigate through the skies and gather data with unprecedented precision and efficiency. Equipped with advanced sensors, cameras, and data analysis capabilities, drones have opened new frontiers in the field of environmental conservation (FOODY, 2002).

In the following sections, we will delve into the myriad applications of UAV technology, ranging from wildlife monitoring and habitat assessment to disaster response and climate change research. We will explore how these unmanned vehicles are transforming our approach to environmental preservation, enhancing our understanding of ecosystems, and contributing to the development of sustainable solutions to the pressing environmental challenges of our time.

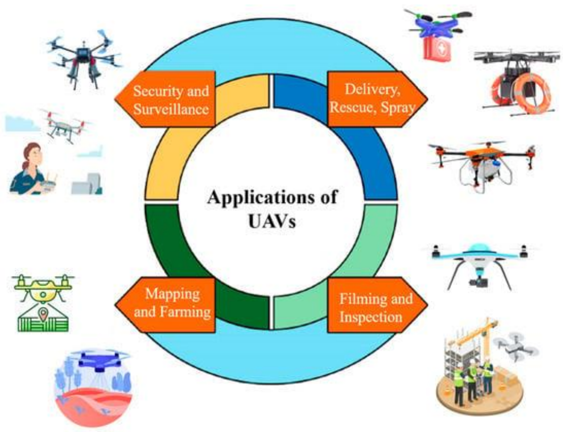

Figure 1. Application scenarios of UAVs (Mohsan et all., 2023)

The deployment of UAVs is a testament to the boundless potential of technology in harmonizing our quest for progress with the imperative to protect and conserve the natural world (MOHSAN, et all., 2023).

MATERIAL AND METHODS

Our research employed an analytical methodology to investigate the applications of UAV technology in the field of environmental conservation (ŞMULEAC et all., 2017; CASIAN et all., 2019). This analytical approach was crucial in examining the various components, equipment, and techniques used in drone-based environmental studies. The first step in our methodology involved selecting appropriate UAV models based on the specific needs of the environmental conservation tasks. Factors considered included flight range, payload capacity, and endurance. UAVs were configured with specialized sensors, such as multispectral cameras, LiDAR, and thermal imaging systems, tailored for environmental data collection (WANG et all., 2017; SMULEAC et all., 2012).

To ensure data accuracy and reliability, ground truthing and validation were conducted. Fieldwork and manual data collection served as benchmarks for assessing the quality of information obtained from UAVs (LU, et all., 2004).

The implementation of our study embraced a methodical and rigorous analytical approach, guaranteeing a systematic evaluation of UAV (Unmanned Aerial Vehicle) technology in the realm of environmental conservation. Our commitment to this meticulous process was driven by the recognition of the transformative potential inherent in UAVs and the imperative to establish their significant role in preserving our natural environment (ŞMULEAC et all., 2022).

Central to the success of our study was the deployment of specialized equipment tailored to the unique demands of environmental conservation. These cutting-edge UAV technologies were equipped with advanced sensors, cameras, and data collection devices, enabling a level of precision and detail crucial for comprehensive environmental assessments (MISHRA et all., 2017). The integration of these sophisticated tools allowed us to delve into previously inaccessible or challenging terrains, providing unprecedented insights into ecosystems and facilitating a deeper understanding of environmental dynamics.

Meticulous data collection and analysis formed the backbone of our study, ensuring the reliability and accuracy of the information acquired (GONÇALVES et all., 2018). The UAVs, acting as airborne data collection platforms, gathered a wealth of information on biodiversity, habitat health, and environmental changes (ȘMULEAC et all., 2020). This data, when subjected to rigorous analysis, yielded valuable insights, enabling us to draw meaningful conclusions about the impact of UAV technology on environmental conservation.

Adherence to ethical and regulatory standards was a cornerstone of our research methodology. Recognizing the potential implications and ethical considerations associated with deploying technology in natural environments, we prioritized the responsible and ethical use of UAVs. Compliance with regulatory frameworks ensured that our study not only contributed to scientific knowledge but also upheld the principles of environmental ethics and respect for biodiversity (PAȘCALĂU et all., 2022).

In summary, our study was guided by a commitment to excellence in research methodology. The combination of specialized equipment, meticulous data practices, and strict adherence to ethical and regulatory standards fortified our efforts to showcase the indispensable role of UAVs in the preservation of our natural environment. This comprehensive approach not only validated the efficacy of UAV technology but also underscored the importance of integrating technological advancements with ethical considerations in environmental research and conservation.

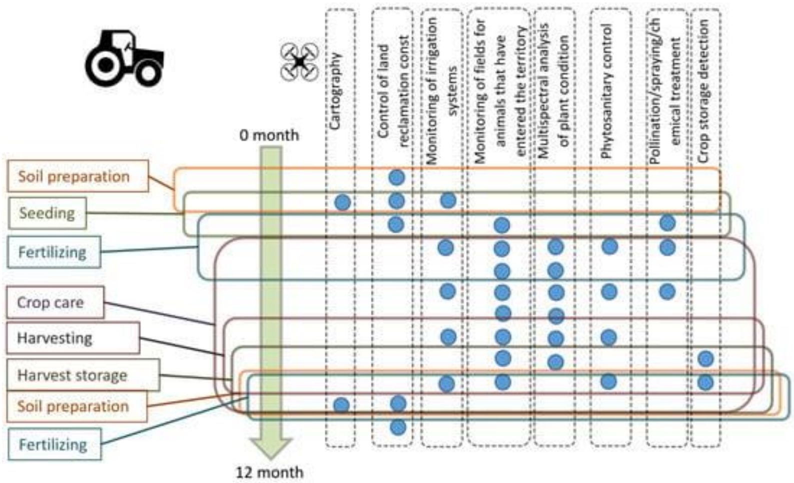

Figure 2. Periods of agrotechnical activities of precision farming and possible use of UAVs (Mukhamediev et all., 2021)

RESULTS AND DISCUSSIONS

Our research has demonstrated that UAV technology significantly improves wildlife monitoring and conservation efforts. UAVs equipped with high-resolution cameras and thermal imaging sensors have enabled more accurate and non-intrusive wildlife.

counts, behaviour observation, and habitat assessments. These advancements have led to a better understanding of animal populations and contributed to more effective conservation strategies. UAVs have minimized the human impact on sensitive ecosystems (OKEOWO et all., 2017). By replacing ground-based surveys and manned aircraft flights, drones have reduced disturbances to wildlife and fragile habitats.

This reduction in human presence enhances conservation efforts and minimizes stress on the environment (PAȘCALĂU et all., 2021). The use of UAV technology has proven cost-effective in environmental conservation efforts. Our research indicates that UAVs have significantly reduced the costs associated with data collection, surveying, and monitoring, making such efforts more accessible to a broader range of organizations and initiatives.

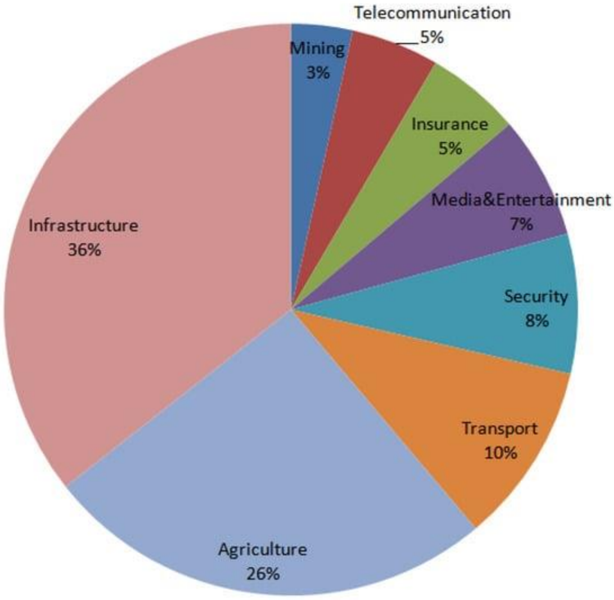

Figure 3. Market prospects of using UAVs (Mukhamediev et all., 2021)

These results underscore the transformative impact of UAV technology in environmental conservation (MUKHAMEDIEV et all., 2021). Drones have become invaluable tools in enhancing the efficiency, accuracy, and sustainability of conservation efforts. They are facilitating a deeper understanding of our natural world and contributing to more informed decision-making for the protection and preservation of our environment.

CONCLUSIONS

The incorporation of Unmanned Aerial Vehicles (UAVs), commonly known as drones, marks a paradigm shift in environmental conservation, unlocking transformative capabilities across monitoring, research, and the safeguarding of our planet's natural ecosystems. In essence, the utilization of UAV technology signifies a pivotal moment in our continuous endeavour to preserve the natural world. Drones have not merely become tools; they are revolutionary agents reshaping the landscape of data acquisition, decision-making, and proactive environmental protection.

Drones have ushered in a new era of environmental monitoring, providing unprecedented access to remote and challenging terrains. This capability allows for real-time data collection, enabling scientists and conservationists to observe ecosystems with a level of detail and frequency previously unattainable. The result is a profound enhancement in our understanding of environmental changes, biodiversity dynamics, and ecosystem health.

Moreover, the versatility and innovation embedded in drone technology have redefined the conservation landscape. From assessing the impacts of climate change to tracking wildlife populations, drones have become invaluable allies in our pursuit of sustainability. The data gathered facilitates evidence-based decision-making, enabling stakeholders to implement timely and effective conservation measures.

Drones play a crucial role in addressing the profound environmental challenges we face. They contribute to the development of more efficient conservation strategies, enhance disaster response capabilities, and aid in the protection of endangered species and critical habitats. This integration of technology and conservation efforts not only amplifies our impact but also fosters a more sustainable and resilient future for our planet.

Looking ahead, the potential for UAVs in environmental conservation appears boundless. These unmanned aerial systems open up new horizons in our commitment to preserving and protecting Earth's precious ecosystems for future generations. As technology continues to advance, the seamless synergy between UAVs and environmental conservation will likely lead to further breakthroughs, ensuring that we remain at the forefront of efforts to address the dynamic challenges confronting our natural world. The era of drone-assisted environmental conservation promises a brighter, more sustainable future where technological innovation becomes an indispensable tool in the hands of those dedicated to safeguarding the Earth's ecological heritage.

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BIBLIOGRAPHY

ANDERSON, K., & GASTON, K. J., 2013- Lightweight unmanned aerial vehicles will revolutionize spatial ecology. Frontiers in Ecology and the Environment, 11(3), 138-146.

ANDERSON, K., & KNAPE, J., 2018- Measuring animal–environment interactions: Successes, challenges, and the road ahead. Movement Ecology, 6(1), 1-12.

BOHRER, G., BECK, P. S., NGENE, S. M., SKIDMORE, A. K., & DOUGLAS-HAMILTON, I., 2014- Elephant movement closely tracks precipitation-driven vegetation dynamics in a Kenyan forest-savanna landscape. Movement Ecology, 2(1), 2-3.

CHABOT, D., & BIRD, D. M., 2012- Wildlife research and management methods in the 21st century: Where do unmanned aircraft fit in? Journal of Unmanned Vehicle Systems, 1(1), 15-30.

CASIAN, A., ȘMULEAC, A., & SIMON, M. (2019). Possibilities of using the UAV photogrammetry in the realization of the topo-cadastral documentation. Research Journal of Agricultural Science, 51(2), 96-106.

COLOMINA, I., & MOLINA, P., 2014- Unmanned aerial systems for photogrammetry and remote sensing: A review. ISPRS Journal of Photogrammetry and Remote Sensing, 92, 79-97.

DANDOIS, J. P., & ELLIS, E. C., 2010- Remote sensing of vegetation structure using computer vision. Remote Sensing, 2(4), 1157-1176.

DECHANT, B., METCALFE, D. B., & DEVRED, E., 2017- A novel approach for quantifying spatial patterns of chlorophyll fluorescence with unmanned aerial systems. Journal of Experimental Botany, 68(6), 1535-1543.

FERNÁNDEZ-HERNÁNDEZ, J., SUÁREZ, L., VEGA, M. A., LORENZO, H., & ALONSO, M. C., 2015- UAVs: A tool for evaluating a seawater intrusion in a coastal aquifer. Journal of Applied Geophysics, 112, 54-63.

FOODY, G. M., 2002- Status of land cover classification accuracy assessment. Remote Sensing of Environment, 80(1), 185-201.

FOODY, G. M., & CUTLER, M. E., 2003- Tree biodiversity in protected and logged Bornean tropical rain forests and its measurement by remote sensing. Journal of Applied Ecology, 40(1), 150-162.

GAULTON, R., SHAW, R., CARVER, S., CLARK, M., & CAMERON, D., 2015- The impact of environmental heterogeneity on spatial patterns of vegetation in semi-arid rangelands: evidence from earth observation data. International Journal of Applied Earth Observation and Geoinformation, 38, 216-230.

GONÇALVES, G., HENRIQUES, R., & DA SILVA, E. A., 2015- Unmanned Aerial Systems in the Environmental Monitoring Context. In Unmanned Aerial Systems (pp. 229-253). Springer.

HAALA, N., & ROTTENSTEINER, F., 2014- Contextual classification and object detection in urban area by means of airborne laser scanning data. ISPRS Journal of Photogrammetry and Remote Sensing, 87, 152-165.

HENGL, T., HEUVELINK, G. B., & ROSSITER, D. G., 2007- About regression-kriging: From equations to case studies. Computers & Geosciences, 33(10), 1301-1315.

HORNING, N., ROBINSON, J., & STERLING, E. (2010). Remote sensing for ecology and conservation. New York: Oxford University Press.

KATTENBORN, T., EBERLE, J., & WEGMANN, M., 2015- High-resolution vegetation mapping in Kruger National Park, South Africa, from UAV data. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 40, 295.

KOOISTRA, L., WANDERS, N., FRUMAU, K., & DE WIT, A., 2013- Crowdsourcing vegetation height information from digital surface models. Geosciences, 3(2), 162-180.

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2014). Remote sensing and image interpretation. John Wiley & Sons.

LU, D., & WENG, Q., 2004- A survey of image classification methods and techniques for improving classification performance. International Journal of Remote Sensing, 25(5), 1005-1030.

MANCINI, A., DUBBINI, M., GATTELLI, M., STECCHI, F., FABBRI, S., & GABBIANELLI, G., 2013- Using unmanned aerial vehicles (UAV) for high-resolution reconstruction of topography: The structure from motion approach on coastal environments. Remote Sensing, 5(12), 6880-6898.

MOHSAN, S.A.H.; KHAN, M.A.; GHADI, Y.Y., 2023- Editorial on the Advances, Innovations and Applications of UAV Technology for Remote Sensing. Remote Sens. 15, 5087. https://doi.org/10.3390/rs15215087

MCCARTHY, D. P., DONALD, P. F., SCHARLEMANN, J. P., BUCHANAN, G. M., BALMFORD, A., GREEN, J. M., ... & MANICA, A., 2012- Financial costs of meeting global biodiversity conservation targets: current spending and unmet needs. Science, 338(6109), 946-949.

MISHRA, A., & DAVIS, J. R., 2017- An overview of unmanned aerial vehicle (UAV) for environmental monitoring. In 2017 IEEE International Conference on Smart Grid and Smart Cities (ICSGSC) (pp. 300-305). IEEE.

MUKHAMEDIEV, R.I.; SYMAGULOV, A.; KUCHIN, Y.; ZAITSEVA, E.; BEKBOTAYEVA, A.; YAKUNIN, K.; ASSANOV, I.; LEVASHENKO, V.; POPOVA, Y.; AKZHALOVA, A.; ET AL., 2021- Review of Some Applications of Unmanned Aerial Vehicles Technology in the Resource-Rich Country. Appl. Sci., 11, 10171. https://doi.org/10.3390/app112110171

OKEOWO, T. A., & OYEDUN, A. O., 2018- Assessment of unmanned aerial vehicles (UAVs) for environmental monitoring in Nigeria. Environmental Monitoring and Assessment, 190(3), 143.

PAȘCALĂU, R., STANCIU, S., ȘMULEAC, L., ȘMULEAC, A., SĂLĂȘAN, C., URLICĂ, A. A., ET AL., 2021- Protecting nature through languages, Research Journal of Agricultural Science, 53(2).

PAȘCALĂU, R., STANCIU, S., ȘMULEAC, L., ȘMULEAC, A., SĂLĂȘAN, C., URLICĂ, A. A., BAKLI, M., ET AL., 2021- Teaching Climate Change In Class, A Must And A Challenge, Research Journal of Agricultural Science, 53(2).

PAȘCALĂU, R., STANCIU, S., ȘMULEAC, L., ȘMULEAC, A., AHMADI KHOEI, M., DANCI, M., FEHÉR, A., ET AL., 2020- The importance of English language in attracting foreign tourists in the Mures Valley region, namely in the wine road area, county of Arad, Western Romania, Research Journal of Agricultural Science, ISSN: 2668-926X, Vol. 52(2).

PAȘCALĂU, R., STANCIU, S., ȘMULEAC, L., ȘMULEAC, A., AHMADI KHOEIE, M., FEHÉR, A., SĂLĂȘAN, C., DANCI, M., BAKLI, M., AMARA, M., ET AL., 2020- Academic vocabulary in teaching English for agriculture, Research Journal of Agricultural Science, ISSN: 2668-926X, Vol. 52(2).

PAȘCALĂU, R., ȘMULEAC, L., STANCIU, S. M., IMBREA, F., ȘMULEAC, A., BAKLI, M., AMARA, M., 2022- Non-formal education in teaching foreign languages for agriculturists, Research Journal of Agricultural Science, 54(2), ISSN: 2668-926X.

PINTO, N., CARREIRA, J., MARQUES, J., & BATISTA, J., 2016- BOSSnet: Early recognition of invasive plants in large scale environmental monitoring programs. Environmental Modelling & Software, 85, 1-10.

RANGO, A., LALIBERTE, A., HERRICK, J. E., WINTERS, C., HAVSTAD, K., STEELE, C., ... & BROWNING, D., 2009- Unmanned aerial vehicle-based remote sensing for rangeland assessment, monitoring, and management. Journal of Applied Remote Sensing, 3(1), 033542.

SMITH, A. F., DANDOIS, J. P., & JOHNSON, B. R., 2015- Forest canopy gap characterization from terrestrial lidar and unmanned aerial vehicle structure-from-motion photogrammetry. Forests, 6(3), 1127-1144.

ȘMULEAC, LAURA, FLORIN IMBREA, IOANA CORODAN, ANIȘOARA IENCIU, ADRIAN ȘMULEAC, AND DAN MANEA. "The influence of anthropic activity on Somes River water quality." AgroLife Scientific Journal 6, no. 2 (2017): 178-182.

ȘMULEAC, L., RUJESCU, C., ȘMULEAC, A., IMBREA, F., RADULOV, I., MANEA, D., IENCIU, A., ADAMOV, T., PAȘCALĂU, R., 2020- Impact of Climate Change in the Banat Plain, Western Romania, on the Accessibility of Water for Crop Production in Agriculture, Agriculture, Vol 10.

ȘMULEAC, L., SIMONA, N., IENCIU, A., ȘMULEAC, A., DANIEL, D., 2016 - Topographic survey for the monitoring of the impact of the BRUA/ROHUAT pipe on water flow in the irrigation system at Fântânele, Arad County, Romania, International Multidisciplinary Scientific GeoConference: SGEM, Vol 3.

ȘMULEAC, L., RĂDULESCU, H., ȘMULEAC, A., PAȘCALĂU, R., AMARA, M., BAKLI, M., LAȚO, A., 2022- The impact of agricultural, industrial and household activities on the Surduc Lake Water, Research Journal of Agricultural Science, 54(3); ISSN: 2668-926X.

ȘMULEAC ADRIAN, LAURA ȘMULEAC, RAUL PAȘCALAU, GEORGE POPESCU, ADINA HORABLAGA, 2022 - Using Ground Control Points (GCP) and UAV poind cloud processinf in Water Management, International Multidisciplinary Scientific GeoConference: SGEM, Vol. 22, Issue 3.2, Pages 231-238, Publisher - Surveying Geology & Mining Ecology Management (SGEM)

SMULEAC, A., HERBEI, M., & POPESCU, C. (2012) - Creating the digital terrain model of the USAMVB area using modern technology. Research Journal of Agricultural Science, 44(3).

TURNER, W., SPECTOR, S., GARDINER, N., FLADELAND, M., STERLING, E., & STEININGER, M., 2011- Free and open-access satellite data are key to biodiversity conservation. Biological Conservation, 173, 173-176.

WANG, J., ZHANG, L., CHEN, Y., & WANG, J., 2017- Developing unmanned aerial vehicle remote sensing technology for monitoring karst landscapes: A review. Journal of Applied Remote Sensing, 11(4), 042616.